

NPTEL : Introduction to Aerospace Propulsion (Aerospace Engineering)

Co-ordinators : Prof. Bhaskar Roy, Prof. A M Pradeep

Lecture 1 - Course Intro & Historical development of flights

Lecture 2 - Early development of aircraft propulsive devices

Lecture 3 - Development of Jet propulsion for aircraft

Lecture 4 - Introduction to thermodynamics, Scope and method, Basic concepts: system, surroundings, property, intensive and extensive, state, equilibrium and state postulate, process, path and cycle

Lecture 5 - Quasi-static processes, zeroth law of thermodynamics and temperature, concept of energy and its various forms, internal energy, enthalpy

Lecture 6 - Specific heats at constant pressure and volume Work and heat transfers

Lecture 7 - Tutorial

Lecture 8 - First law of thermodynamics for closed systems

Lecture 9 - First law of thermodynamics for open systems/flow processes

Lecture 10 - Second law of thermodynamics, heat engines, refrigerators and heat pumps, Kelvin-Planck and Clausius statement of second law of thermodynamics

Lecture 11 - Reversible and irreversible processes, concept of entropy

Lecture 12 - Increase of entropy principle, third law of thermodynamics, absolute entropy, perpetual motion machines

Lecture 13 - Tutorial

Lecture 14 - Carnot cycle, Carnot principle, thermodynamic temperature scale

Lecture 15 - Exergy, availability and second law efficiency

Lecture 16 - Tutorial

Lecture 17 - Gas and vapour power cycles, Otto cycle, Diesel cycle, Dual cycle

Lecture 18 - Rankine cycle, Brayton cycle, Stirling and Ericsson cycles

Lecture 19 - Thermodynamic property relations, Jacobean and Legendre transformations, Maxwell's equations

Lecture 20 - Tutorial

Lecture 21 - Properties of gas and vapour mixtures

Lecture 22 - One-dimensional compressible flows, isentropic flows

Lecture 23 - Flows with friction and heat transfer, normal and oblique shocks

Lecture 24 - Piston-prop engines: Otto cycles; Ideal and Real cycles

Lecture 25 - IC Engines for aircraft application

Lecture 26 - Performance parameters of IC engines

Lecture 27 - Supercharging of aircraft IC engines

Lecture 28 - Tutorial: IC Engines

Lecture 29 - Propeller fundamentals

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[Lecture 30 - Propeller aerodynamic theories - I](#)

[Lecture 31 - Propeller aerodynamic theories - II](#)

[Lecture 32 - Tutorial: Propellers](#)

[Lecture 33 - Ideal cycles for Jet engines](#)

[Lecture 34 - Ideal cycles for variants of jet engines](#)

[Lecture 35 - Tutorial](#)

[Lecture 36 - Fundamentals of Ramjets and Pulsejets](#)

[Lecture 37 - Fundamentals of Rocket engines](#)

[Lecture 38 - Fundamentals of Missile engines](#)

[Lecture 39 - Various space vehicles and their engines](#)

[Lecture 40 - Closure of the lecture series : recap](#)

NPTEL : Jet Aircraft Propulsion (Aerospace Engineering)

Co-ordinators : Prof. A M Pradeep, Prof. Bhaskar Roy

- Lecture 1 - Introduction & Development of Jet Aircraft Propulsion
- Lecture 2 - How the Aircraft Jet Engines make Thrust
- Lecture 3 - Jet Engine Basic Performance Parameters
- Lecture 4 - Turbojet, Reheat Turbojet and Multi-spool Engines
- Lecture 5 - Turbofan, Turbo-prop and Turboshaft engines
- Lecture 6 - Ideal and Real Brayton cycles
- Lecture 7 - Jet Engine Cycles for Aircraft propulsion
- Lecture 8 - Cycle components and component performances
- Lecture 9 - Tute-1
- Lecture 10 - Analysis of engine real cycles
- Lecture 11 - Tute-2
- Lecture 12 - Thermodynamics of Compressors
- Lecture 13 - Thermodynamics of Turbines
- Lecture 14 - Axial Compressors : two dimensional analytical model
- Lecture 15 - Cascade analysis; Loss and Blade performance estimation
- Lecture 16 - Free Vortex theory; Single-Multi-stage characteristics
- Lecture 17 - Tutes-3
- Lecture 18 - Elements of centrifugal compressor
- Lecture 19 - Centrifugal Compressor characteristics: Surging, Choking
- Lecture 20 - Axial flow turbines; Turbine Blade 2-D (cascade) analysis
- Lecture 21 - Multi-staging: Axial Turbine; Turbine Cooling Technology
- Lecture 22 - Radial Turbine Aerodynamics & Thermodynamics; Losses
- Lecture 23 - Tutes-4
- Lecture 24 - Types of combustion chambers: mechanism & parameters
- Lecture 25 - Pr. Loss, Combustion efficiency; Combustion intensity
- Lecture 26 - Practical combustion system ; Stability, Fuel injection
- Lecture 27 - Intakes for Powerplant: Transport / Military Aircraft
- Lecture 28 - Subsonic, Transonic, Supersonic Intake Designs
- Lecture 29 - Nozzle : fixed and variable geometry nozzles
- Lecture 30 - C-D nozzle and their uses
- Lecture 31 - Tute-5

[Lecture 32 - Engine Off Design Operations](#)

[Lecture 33 - Aircraft Engine component matching: Dimensional analysis](#)

[Lecture 34 - Engine component matching and Sizing](#)

[Lecture 35 - Installed Performance of Engine](#)

[Lecture 36 - Tute-6](#)

[Lecture 37 - Use of Ramjets and Pulsejets in Aircraft propulsion](#)

[Lecture 38 - Thermodynamic Cycle & Performance Parameters](#)

[Lecture 39 - Flow in Diffusers, Combustors and Nozzles](#)

[Lecture 40 - Performanace and Design of Ramjet & Scramjet Engines](#)

[Lecture 41 - Tute-7](#)

[Lecture 42 - Future of Aircraft Propulsion](#)

- Lecture 1 - Introduction to Turbo machines Syllabus, References and Schedules
- Lecture 2 - Axial Flow Compressors and Fans : Introduction to Compressor Aerothermodynamics
- Lecture 3 - A two dimensional analytical model :Cascade
- Lecture 4 - 2D losses in Axial flow Compressor Stage : Primary losses
- Lecture 5 - Tutorial 1 : Two Dimensional Axial Flow Compressors
- Lecture 6 - 3D Flows in Blade Passages, Secondary Flows, Tip leakage Flow, Scrubbling
- Lecture 7 - Three Dimensional Flow Analysis : Radial Equilibrium Concept
- Lecture 8 - Classical Blade Design Laws : Free Vortex and other Laws
- Lecture 9 - Three Dimensional Flow Analysis in Axial Flow Compressor
- Lecture 10 - Tutorial 2 : Three Dimensional Axial Flow Compressors
- Lecture 11 - Axial Compressor Characteristics: Single stage, Multi stage and Multi spool Characteristics
- Lecture 12 - Instability in Axial Compressors
- Lecture 13 - Inlet Distortion and Rotating Stall, Control of Instability
- Lecture 14 - Transonic Compressors and Shock Structure Models, Transonic Compressor Characteristics
- Lecture 15 - Axial Flow Compressor Design, Inter Spool Duct
- Lecture 16 - Design of Compressor Blades, Aerofoil Design (Subsonic, Transonic, Supersonic Profiles)
- Lecture 17 - Design of Compressor Blade: 3D Blade Shapes of Rotors and Stators
- Lecture 18 - Noise Problem in Axial Compressors and Fans
- Lecture 19 - Axial Flow Turbines: Introduction to Turbines Aerothermodynamics
- Lecture 20 - Axial Flow Turbines: Turbine Blade 2D (Cascade) Analysis
- Lecture 21 - Axial Flow Turbines: Work done, Degree of Reaction, Losses and Efficiency
- Lecture 22 - Axial Flow Turbines: Blade and Axial Flow Passages, Exit Flow Matching with Nozzle
- Lecture 23 - Tutorial 3 : Axial Flow Turbines
- Lecture 24 - Multi staging and Multi spooling of Turbine
- Lecture 25 - 3D Flow in Turbine: 3D Flow Theories, Free Vortex Theories etc.
- Lecture 26 - Tutorial 4 : 3D Flows in Axial Flow Turbines
- Lecture 27 - Turbine Blade Cooling – Fundamentals of Heat Transfer, Blade Cooling Requirements
- Lecture 28 - Turbine Blade Cooling Technologies
- Lecture 29 - Turbine Blade Design: Turbine Profiles, Aerofoil Data and Profile Construction
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- Lecture 31 - Centrifugal Compressors: Thermodynamics and Aerodynamics

[Lecture 32 - Centrifugal Compressors: Characteristics, Stall, Surge Problems](#)

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[Lecture 39 - CFD for Turbomachinery: Flow Track and Inter-spool Duct Design using CFD](#)

[Lecture 40 - CFD for Turbomachinery: 2D and 3D Blade Generation and Analysis Using CFD](#)

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Lecture 2 - Introduction to International Standard Atmosphere (ISA)

Lecture 3 - Pressure, Temperature, Density and Viscosity Variation with Altitude in ISA

Lecture 4 - Other Standard Atmospheres

Lecture 5 - Aircraft Component Nomenclature - Wing and its Components

Lecture 6 - Aircraft Component Nomenclature - Fuselage and its Components

Lecture 7 - Aircraft Component Nomenclature - Tail Plane and its Components

Lecture 8 - Tutorial 1 - Aircraft Component Nomenclature

Lecture 9 - Essentials of Incompressible Flow - Part I

Lecture 10 - Essentials of Incompressible Flow - Part II

Lecture 11 - Bernoulli's Equation and Coanda Effect

Lecture 12 - Mach Number

Lecture 13 - Tutorial 2 - Incompressible Flow and Flow Visualization

Lecture 14 - Viscous Flow and Reynolds Number

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Lecture 16 - Pressure Measurement

Lecture 17 - Air Speed Measurement - Pitot Static Tube

Lecture 18 - Air Speed Corrections

Lecture 19 - Altitude and ROC/ROD Measurement

Lecture 20 - Measurements in Compressible Flows

Lecture 21 - Non Pneumatic Instruments

Lecture 22 - Introduction to Aerofoils and Aerofoil Nomenclature

Lecture 23 - Aerofoils - A Visit to the Past

Lecture 24 - Thick Aerofoils

Lecture 25 - Low Reynolds Number Aerofoils

Lecture 26 - Lift Generation by Wings - Part I

Lecture 27 - Lift Generation by Wings - Part II

Lecture 28 - Coefficient of Lift and Coefficient of Pressure

Lecture 29 - Tutorial on Aerofoils

Lecture 30 - Critical Mach Number

Lecture 31 - Wave Drag

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[Lecture 61 - Take-off Performance of Flight - Part I](#)

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Lecture 1 - What is Aircraft Design

Lecture 2 - Aircraft Design Process

Lecture 3 - Design Stages

Lecture 4 - Phases in Aircraft Design

Lecture 5 - The Design Spiral

Lecture 6 - Importance of Cost in Aircraft Design

Lecture 7 - Basic Laws of Aircraft Design

Lecture 8 - Requirements Capture

Lecture 9 - Quality Function Deployment

Lecture 10 - House of Quality Chart

Lecture 11 - Example of HoQ for HALE UAV

Lecture 12 - Illustration of HOQ-GA aircraft

Lecture 13 - Airliners

Lecture 14 - Key Issues in Design of Airliners

Lecture 15 - Design Considerations - Future Airliners

Lecture 16 - Supersonic Transport Aircraft

Lecture 17 - Airliner and Supersonic Aircraft, some additional concepts

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Lecture 19 - Design Considerations - GA Aircraft

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Lecture 25 - Canards and Flying Wing

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Lecture 30 - Aircraft Configuration Design - Closing Remarks

Lecture 31 - Choices in Aircraft Layout

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- Lecture 36 - Landing Gear Layout - Part 1
- Lecture 37 - Landing Gear Layout - Part 2
- Lecture 38 - Landing Gear of some Famous Aircraft
- Lecture 39 - Tutorial on OpenVSP
- Lecture 40 - Initial Sizing in Aircraft Design
- Lecture 41 - Estimation of Empty Weight Fraction
- Lecture 42 - Estimation of Mission Segment Weights
- Lecture 43 - Estimation of Fuel Weight Fractions
- Lecture 44 - Estimation of maximum L/D
- Lecture 45 - Estimation of engine parameters
- Lecture 46 - Estimation of Design gross weight
- Lecture 47 - Take-off weight build up
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- Lecture 51 - Component Buildup Method
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Lecture 13 - Constant (T/m) Solution

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Lecture 16 - Multi-stage Configuration Basics

Lecture 17 - Multi-stage Solution Basics

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Lecture 19 - Optimal Staging Strategy

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NPTEL : Aero elasticity (Aerospace Engineering)

Co-ordinators : Prof. C. Venkatesan

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NPTEL : Instability and Transition of Fluid Flows (Aerospace Engineering)

Co-ordinators : Prof. Tapan K. Sengupta

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NPTEL : Introduction to Propulsion (Aerospace Engineering)

Co-ordinators : Dr. D.P. Mishra

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- Lecture 5 - Concepts of Equilibrium and its State
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Lecture 7 - Aircraft Rigid Body Equation of Motion

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Lecture 10 - Forces and Moments on Aircraft

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Lecture 2 - Ancient Indian Civilization's Gift to the World

Lecture 3 - Why do we need to look at Ancient Indian Science and Technology?

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Lecture 5 - Brief Review of Ancient Indian Scriptures

Lecture 6 - Basic Principles of carrying out science and technology

Lecture 7 - Arrays of Physics, chemistry and Indoor games

Lecture 8 - Marvels of Ancient Indian Technology

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Lecture 10 - Problems arising due to modern agricultural practices

Lecture 11 - Pesticides and soil degradation

Lecture 12 - Agriculture - A Primary Productive Activity

Lecture 13 - An Agricultural Tools - A Plough

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Lecture 15 - Sowing Methods

Lecture 16 - Indigenous cattle and manuring

Lecture 17 - Ancient Indian Textile Technology

Lecture 18 - Handlooms and Charkha

Lecture 19 - Different types of Handlooms

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Lecture 21 - Thatched Roof House

Lecture 22 - Rural Walls and Roof materials

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Lecture 24 - First and Second of Indian Civilization

Lecture 25 - Town topologies and Brick and Tile making process

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Lecture 27 - Ancient Indian Wells

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- Lecture 2 - Cruise Experiment (Theory)
- Lecture 3 - Weighment Experiment and cockpit panel description
- Lecture 4 - Drag Polar Experiment
- Lecture 5 - CG and Climb Experiment
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- Lecture 2 - Thermodynamic property, state, equilibrium and process
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- Lecture 4 - Macroscopic and microscopic forms of energy
- Lecture 5 - Different forms of work, energy transfer and sign convention
- Lecture 6 - First law of thermodynamics and energy balance
- Lecture 7 - Efficiency of mechanical and electrical devices
- Lecture 8 - Examples on basic concept and energy balance
- Lecture 9 - Phase change of a pure substance
- Lecture 10 - Property diagrams of pure substances
- Lecture 11 - Thermodynamic properties of a pure substance from a property table
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- Lecture 14 - Examples on properties of pure substances
- Lecture 15 - Quasi equilibrium, moving boundary work
- Lecture 16 - Polytropic process
- Lecture 17 - Energy analysis of closed system and unrestrained expansion
- Lecture 18 - Internal energy, enthalpy, and specific heats of ideal gas
- Lecture 19 - Internal energy, enthalpy, and specific heats of solids and liquids
- Lecture 20 - Examples on energy balance for closed systems and moving boundary work
- Lecture 21 - Conservation of mass and steady flow processes
- Lecture 22 - Flow work and energy of flowing fluid
- Lecture 23 - Energy balance for steady flow devices
- Lecture 24 - Throttling valve, mixing chamber and heat exchanger
- Lecture 25 - Energy analysis of steady and unsteady flow devices
- Lecture 26 - Examples on mass and energy analysis of open systems
- Lecture 27 - Second law of thermodynamics, heat engine and cyclic devices
- Lecture 28 - COP of refrigerator and heat pump, second law statements
- Lecture 29 - Perpetual motion machines, reversible and irreversible processes, Carnot cycle
- Lecture 30 - Carnot principles, thermodynamic temperature scale, Carnot HE and HP
- Lecture 31 - Examples on second law of thermodynamics

Lecture 32 - Clausius inequality, application of second law

Lecture 33 - Entropy, increase in entropy principle, isentropic process

Lecture 34 - Change in entropy of solids, liquids and ideal gases

Lecture 35 - Reversible flow work, multistage compressor, efficiency of pump and compressors

Lecture 36 - Entropy balance in closed system and control volume

Lecture 37 - Examples on entropy change in a system

Lecture 38 - Exergy and second law efficiency

Lecture 39 - Exergy of a fixed mass and flowing stream

Lecture 40 - Exergy transfer due to heat, mass and work, exergy destruction

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Lecture 46 - Analysis of Brayton cycle

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Lecture 48 - Rankin and Carnot vapour power cycles

Lecture 49 - Ideal regenerative Rankin cycle and combined gas-vapour cycle

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Lecture 53 - Thermodynamic property relations: Clapeyron equation and Maxwell relations

Lecture 54 - Thermodynamic property relations: Joule-Thomson coefficient and cyclic relations

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Lecture 58 - Examples on property relations and reaction thermodynamics

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Lecture 3 - Basic Design - Lift and Drag

Lecture 4 - Range and Endurance

Lecture 5 - Mission Requirements

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Lecture 7 - Fuel Consumption : Cruise Flight

Lecture 8 - L/D for Maximum Range and Endurance

Lecture 9 - Range and endurance for Jet-driven Aircraft

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Lecture 12 - Design Considerations : Aerofoil Selection

Lecture 13 - Design Considerations : Wing

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Lecture 25 - Wing Loading

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Lecture 28 - Take off: V_{stall} and High Lift Devices

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- Lecture 5 - Properties of liquid and solid fuels, various modes of combustion
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- Lecture 8 - Laws of thermodynamics and Stoichiometry
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NPTEL : Gas Dynamics (Aerospace Engineering)

Co-ordinators : Dr. T.M. Muruganandam

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NPTEL : Introduction to CFD (Aerospace Engineering)

Co-ordinators : Prof. M. Ramakrishna

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- Lecture 23 - Importance and applications of extrusion technology in food processing
- Lecture 24 - Changes of properties and functional components of extruded foods
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- Lecture 27 - Packaging considerations: Barrier and mechanical properties of food packaging materials
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- Lecture 29 - Sanitary components and requirements
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- Lecture 31 - Special Lecture: Membrane Separation

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- Lecture 2 - Introduction to Natural Resource bases - Part 2A
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- Lecture 4 - Introduction to Natural Resource bases - Part 2C
- Lecture 5 - Resource management Paradigms - Part 1
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- Lecture 23 - Watershed management
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- Lecture 30 - A Tutorial on Tragedy of the Commons
- Lecture 31 - Environmental Management Systems (EMS)

- Lecture 32 - National Environment Policy (NEP)
- Lecture 33 - Modeling And Simulations Applications in Agriculture for NRM - Part 1
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- Lecture 48 - CBNRM in Kenya
- Lecture 49 - Model sensitivity and Uncertainty
- Lecture 50 - MCDA in Agriculture
- Lecture 51 - MCDM for NRM - Part 1
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- Lecture 55 - Remote Sensing and GIS Application in Agriculture and NRM - Part 1
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- Lecture 61 - ICT: Introduction
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[Lecture 10 - Maize crop production](#)

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[Lecture 14 - Cowpea crop production](#)

[Lecture 15 - Groundnut crop production](#)

[Lecture 16 - Sesame crop production](#)

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Lecture 3 - Climate and Scale of Change

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Lecture 5 - Modified Agriculture - Precision Agriculture

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Lecture 8 - Geographical Information System (GIS)

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Lecture 10 - Analysis - Map overlay

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Lecture 12 - GIS Type and Available GIS Softwares

Lecture 13 - Village Cadastral Map and Property Card

Lecture 14 - Cadastral Maps and Contents

Lecture 15 - Creation of Cadastral Information Base

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Lecture 17 - Creation of Village Boundary Based Basin Analysis

Lecture 18 - Village Information System

Lecture 19 - Needs and Weather Forecast

Lecture 20 - Cloud Types and Rain Bearing Clouds

Lecture 21 - Weather Satellites and Cloud Pattern Reading

Lecture 22 - Rainfall and Supplementary Irrigation

Lecture 23 - Synergistic Use

Lecture 24 - Surface Rainfall - Run off Assessment and Model

Lecture 25 - Soil and Water Assessment Tools (SWAT) Model

Lecture 26 - Groundwater Availability

Lecture 27 - Groundwater Potential Mapping

Lecture 28 - Water Storage and Water Availability and Release

Lecture 29 - Growth of Crop Area in Command Area and Impact Climate Change

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Lecture 3 - Insect classification based on economic importance

Lecture 4 - Pest, causes for outbreaks and categories

Lecture 5 - Pest, causes for outbreaks and categories (Continued...)

Lecture 6 - Pest surveillance and methods of sampling

Lecture 7 - Principles of Pest Management and History

Lecture 8 - IPM, Definition and Concepts

Lecture 9 - Ecological Methods of Pest Management - Legal and Cultural

Lecture 10 - Ecological Methods of Pest Management - Cultural (Continued...)

Lecture 11 - Ecological Methods of Pest Management - Cultural (Continued...)

Lecture 12 - Ecological Methods of Pest Management - Physical

Lecture 13 - Ecological Methods of Pest Management - Mechanical

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Lecture 15 - Host Plant Resistance (Continued...)

Lecture 16 - Biological Control - Predators

Lecture 17 - Biological Control - Parasitoids

Lecture 18 - Biological Control - Microbes: Fungi, Bacteria and Viruses

Lecture 19 - Biological Control - Microbes: Entomopathogenic Nematodes

Lecture 20 - Pest management by modifying insect behaviour

Lecture 21 - Use of sex pheromones in pest management

Lecture 22 - Use of attractants and repellants in pest management

Lecture 23 - Pest management through radiation technology - Principles

Lecture 24 - Sterile Insect Technique - case studies

Lecture 25 - Pest management through botanicals

Lecture 26 - Pest management through botanicals (Continued...)

Lecture 27 - Chemical Control - History and classification

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Lecture 29 - Chemical Control - Considerations for Chemicals Integration

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Lecture 31 - Insecticide as component of IPM

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[Lecture 43 - IPM in Sugarcane \(Continued...\)](#)

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[Lecture 45 - IPM in Cabbage](#)

[Lecture 46 - IPM in Mango](#)

[Lecture 47 - IPM in Grapes](#)

Lecture 1 - Introduction

Lecture 2 - Relationship between Food, Nutrition and Health 1

Lecture 3 - Relationship between Food, Nutrition and Health 2

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Lecture 5 - Digestion, absorption and utilization of Nutrients 2

Lecture 6 - Recommended dietary allowances

Lecture 7 - Carbohydrate

Lecture 8 - Fiber

Lecture 9 - Protein

Lecture 10 - Protein - health significance

Lecture 11 - Fat

Lecture 12 - Energy 1

Lecture 13 - Energy 2

Lecture 14 - Energy 3

Lecture 15 - Fat Soluble Vitamins 1

Lecture 16 - Fat Soluble Vitamins 2

Lecture 17 - Fat Soluble Vitamins 3

Lecture 18 - Water Soluble Vitamins 1

Lecture 19 - Water Soluble Vitamins 2

Lecture 20 - Water soluble Vitamins 3

Lecture 21 - Water soluble Vitamins 4

Lecture 22 - Major minerals 1

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Lecture 24 - Trace minerals 1

Lecture 25 - Trace minerals 2

Lecture 26 - Water

Lecture 27 - Nutritional Disorders

Lecture 28 - Balanced diet and food groups

Lecture 29 - Food guide for selecting adequate diet, practical aspects of food selection

Lecture 30 - Meal planning

Lecture 31 - Other aspects affecting food selection

[Lecture 32 - Food sanitation and hygiene](#)

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[Lecture 36 - Diet during fevers](#)

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Weather Forecast in Agriculture and Agro-advisory (WF) (Agriculture)

Co-ordinators : Dr. R. Nagarajan, Co Faculty, Dr.T.N.Balasubramanian (Rtd.), Instructor Incharge

Lecture 1 - Introduction

Lecture 2 - Basic aspects of Atmosphere, Climate, Weather

Lecture 3 - Basic aspects of Rainfall and their application in crop production

Lecture 4 - Basic aspects of Temperature and their application in crop production

Lecture 5 - Basic aspects of Relative humidity, Cloud cover and their application in crop production

Lecture 6 - Basic aspects of wind, wind direction and their application in crop production

Lecture 7 - Three weather codes and crop production

Lecture 8 - Crop production risks and their management

Lecture 9 - Weather sensitive crops, stages and farm operations

Lecture 10 - Crop-weather interactions and definition

Lecture 11 - Crop-Weather Interactions: Wheat, Rice and Maize

Lecture 12 - Crop-Weather Interactions: Sorghum, Groundnut and Pigeon pea

Lecture 13 - Crop-Weather Interactions: Cotton and Sugarcane

Lecture 14 - Crop-Weather Interactions: Sugarbeet and Chickpea

Lecture 15 - Crop-Weather Interactions: Sunflower and Mustard

Lecture 16 - Genesis of weather forecast in India and Abroad

Lecture 17 - Types of weather forecast and details

Lecture 18 - Types of weather forecast and details (Continued...)

Lecture 19 - Simple methods of verification of weather forecast with real event

Lecture 20 - Traditional knowledges on weather forecast and their validity

Lecture 21 - Weather thumb rules and their validity

Lecture 22 - Development and component of agro advisory for weather forecast

Lecture 23 - Development and component of agro advisory for weather forecast (Continued...)

Lecture 24 - Model agro advisories for selected five days weather forecast

Lecture 25 - Mass communication mode of agro advisories and their effectiveness

Lecture 26 - Discussion on weather forecast and agro advisory from different website

Lecture 27 - Role of climate manager on farm management decision based on weather forecast at village level and assignment

Lecture 28 - Development of selected weather window for issuing agro advisory - case study from Tamil Nadu

Lecture 29 - Model of agro advisory for 54 selected weather window of Tamil Nadu for rice

Lecture 30 - Response farming- a type of farm planning being practiced in Australia considering seasonal climate forecast

Lecture 31 - Case study in India on the adoption of weather based crop production - Crop management

[Lecture 32 - Case study in India on the adoption of weather based crop production - Pest and disease management](#)

[Lecture 33 - Case study in India on the adoption of weather based animal production](#)

[Lecture 34 - Cost benefit analysis for the case study done on crop management](#)

[Lecture 35 - Cost benefit analysis for the case study done on animal management](#)

[Lecture 36 - Summary](#)

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Lecture 2 - Highlights Week 0 and 1

Lecture 3 - What is ICT?

Lecture 4 - Architecture of a Computer

Lecture 5 - Architecture of a Phone

Lecture 6 - What is the Internet?

Lecture 7 - What is WWW?

Lecture 8 - Highlights Week 2

Lecture 9 - Phones, Smart Phones, Phablets, Tablets

Lecture 10 - Introduction to Android

Lecture 11 - Network Architectures - Part-1 (Introduction to Computer Networks)

Lecture 12 - Network Architectures - Part-2 (Overview of Network Architecture)

Lecture 13 - Network Architectures - Part-3 (Architecture of Internet)

Lecture 14 - Mobile Wireless Communications - Introduction (Module-1)

Lecture 15 - Mobile Wireless Communication (Module-2)

Lecture 16 - Highlights Week 3

Lecture 17 - Adaptive and Responsive Websites

Lecture 18 - Data management

Lecture 19 - Knowledge Representation

Lecture 20 - Knowledge Representation Techniques

Lecture 21 - Expert Systems

Lecture 22 - Highlights Week - 4

Lecture 23 - Speech Recognition

Lecture 24 - Speech Synthesis

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**NPTEL : NOC:Post Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products
(Agriculture)**

Co-ordinators : Prof. Hari Niwas Mishra

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Lecture 5 - Post Industrial Revolution: Against the Machine Movement - Art and Craft Movement and Art Nouveau - Part 1

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Lecture 9 - Phases of Modern Architecture - Bauhaus

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Lecture 11 - Creative and Cultural Industries: Understanding Definition; Significance and Scope

Lecture 12 - Building Crafts: Definitions; Perspectives and Frameworks

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Lecture 9 - Urban Environment and Ecology

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Lecture 12 - Transparency and Accountability

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Lecture 18 - Visioning for Cities

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Lecture 21 - Basic Concepts of Planning and Development

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Lecture 4 - Design Methods - II

Lecture 5 - Human Factor in Interaction Design

Lecture 6 - User Research - I

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Lecture 8 - Low Fidelity Design - I

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Lecture 2 - Disaster Recovery and Build Back Better: Risk Perception and Disaster Risk Preparedness - Part 1

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Lecture 6 - Culture, climate change adaptation and disaster risk reduction

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Lecture 12 - Gadri discussions: social dimension of risk, health and DRM

Lecture 13 - Community Participation in Disaster Risk Governance : Voices from Mumbai and Ghana

Lecture 14 - Community Participation in Disaster Risk Governance : Insights From Mumbai

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Lecture 17 - Information for Disaster Preparedness

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Lecture 19 - Diffusion of Disaster Preparedness Technology : What Pioneers Contribute ?

Lecture 20 - Cities and Climate Change: Adaptation and Mitigation

Lecture 21 - Temporary Shelter Construction in India

Lecture 22 - Temporary shelter construction in Kenya

Lecture 23 - Build back better in Nepal recovery

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Lecture 27 - Tsunami reconstruction in Tamilnadu - Part 1 (Approach)

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Lecture 30 - Cultural theory of risk

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- Lecture 2 - Buildings, Needs and 'Sustainability'
- Lecture 3 - Sustainability and Sustainable Development
- Lecture 4 - Historic Origins of Sustainability
- Lecture 5 - Pioneers of Sustainable Development
- Lecture 6 - Environmental Impacts of Development: Impacts on Water
- Lecture 7 - Environmental Impacts of Development: Impacts on Land and Air
- Lecture 8 - Social and Economic Impacts of Development
- Lecture 9 - Agenda 21 and UN Goals
- Lecture 10 - Established needs for Sustainability in Building Sector
- Lecture 11 - Definition and Characteristics of Sustainability
- Lecture 12 - Flavors of Sustainable Architecture
- Lecture 13 - Indicators and Terminologies in Sustainable Architecture
- Lecture 14 - Process of Designing Green Buildings
- Lecture 15 - Green Building Ratings and Components
- Lecture 16 - Fundamentals of Thermal Comfort
- Lecture 17 - Climatic Considerations, Physiological Objectives of Design
- Lecture 18 - Fundamentals of Climate Responsive Buildings - I
- Lecture 19 - Fundamentals of Climate Responsive Buildings - II
- Lecture 20 - Visual and Acoustic Comfort
- Lecture 21 - Sustainable Sites - I
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- Lecture 46 - Vernacular Architecture - I
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- Lecture 48 - Codes and Standards
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- Lecture 51 - Whole Building Performance - I
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- Lecture 1 - Introduction to Structure, Form and Architecture
- Lecture 2 - Relationship of Structure to Architectural Buildings - Part I
- Lecture 3 - Relationship of Structure to Architectural Buildings - Part II
- Lecture 4 - Loads on Structures
- Lecture 5 - Synthesis of Architectural and Structural Form
- Lecture 6 - Connecting Structure and Architecture - Part I
- Lecture 7 - Connecting Structure and Architecture - Part II
- Lecture 8 - Structural Transformation in Architectural History
- Lecture 9 - Factors affecting the Structural Forms
- Lecture 10 - Learning from Animal's Architecture
- Lecture 11 - Basic Structural Properties
- Lecture 12 - Structural Requirements
- Lecture 13 - Structural Arrangement
- Lecture 14 - Structural Forms and Shapes
- Lecture 15 - Structural Materials
- Lecture 16 - Structural Typology
- Lecture 17 - Compressive Structures
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- Lecture 19 - Load Bearing Structures
- Lecture 20 - Temporary Structures
- Lecture 21 - Framed Structure
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- Lecture 23 - Vault Structures
- Lecture 24 - Dome Structures
- Lecture 25 - Grid Structures
- Lecture 26 - Shell Structures
- Lecture 27 - Trusses and Space Frames
- Lecture 28 - Folded Plate Structures
- Lecture 29 - Membrane Structures
- Lecture 30 - Pneumatic Structures
- Lecture 31 - Structure and Architectural Forms in Windy Areas

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Lecture 3 - Sheet Layout and Fixing Sheet

Lecture 4 - Types of Lines and Graphic Symbols

Lecture 5 - Lettering

Lecture 6 - Dimensioning

Lecture 7 - Basic Geometrical Construction

Lecture 8 - Scales

Lecture 9 - Curves used in Engineering Practice: Conic Sections

Lecture 10 - Curves used in Engineering Practice: Cycloids, Trochoids and Involutives

Lecture 11 - Introduction to Orthographic Projection

Lecture 12 - Orthographic Projections - 1st Quadrant Vs 3rd Quadrant

Lecture 13 - Orthographic Projections - Projection of Points

Lecture 14 - Orthographic Projections - Introduction to Projection of Lines

Lecture 15 - Locus of Points

Lecture 16 - Projection of lines parallel to both the reference planes

Lecture 17 - Projection of line parallel to one and perpendicular to another plane

Lecture 18 - Projection of lines inclined to one plane

Lecture 19 - Projection of lines inclined to both the planes

Lecture 20 - Projection of a point and line on auxiliary plane

Lecture 21 - Projection of a plane perpendicular to both the reference planes

Lecture 22 - Projection of a plane perpendicular to one and parallel to another plane

Lecture 23 - Projection of a plane inclined to one and perpendicular to the other plane

Lecture 24 - Projection of a plane inclined to both the reference planes - I

Lecture 25 - Projection of a plane inclined to both the reference planes - II

Lecture 26 - Introduction to types of solids

Lecture 27 - Projection of solids in simple positions

Lecture 28 - Projection of solids with axis inclined to one of the reference planes and parallel to another

Lecture 29 - Projection of solids with axis inclined to both the reference planes

Lecture 30 - Projection of spheres

Lecture 31 - Orthographic Projections Introduction to Sections of Solids

[Lecture 32 - Orthographic Projections Sections of Prisms](#)

[Lecture 33 - Orthographic Projections Sections of Pyramids](#)

[Lecture 34 - Orthographic Projections Sections of Cylinders](#)

[Lecture 35 - Orthographic Projections Sections of Cones](#)

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- Lecture 2 - Urbanization and Sustainable Development
- Lecture 3 - Urban Planning and 73-74 Constitution Amendment Acts
- Lecture 4 - Types and Level of Plans
- Lecture 5 - Regional Plan - I
- Lecture 6 - Regional Plan - II
- Lecture 7 - Development Plan - I
- Lecture 8 - Development Plan - II (Case Study- Draft Bhopal Development Plan 2031)
- Lecture 9 - Zonal Plan
- Lecture 10 - Town Planning Scheme
- Lecture 11 - Local Area Plan (Urban Redevelopment Plan)
- Lecture 12 - Special Purpose Plan (AMRUT)
- Lecture 13 - Special Purpose Plan (HRIDAY)
- Lecture 14 - Special Purpose Plan (Smart City)
- Lecture 15 - Perspective Plan (Agenda 2030 SDGs)
- Lecture 16 - Contextualizing Cities (Egyptian, Mesopotamian, and Indus Valley Civilization)
- Lecture 17 - Contextualizing Cities (Vedic Period)
- Lecture 18 - Contextualizing Cities (Greek and Roman)
- Lecture 19 - Contextualizing Cities (Industrial Revolution)
- Lecture 20 - Contextualizing Cities (1900-1939)
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- Lecture 22 - Contextualizing Cities (1980-2021)
- Lecture 23 - Public Health and Urban Planning - I
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- Lecture 27 - Housing Issues in India
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- Lecture 2 - Isometric projection of planar figures - quadrilaterals
- Lecture 3 - Isometric projection of planar figures - circles, semi circles and curves
- Lecture 4 - Isometric projection of straight prisms
- Lecture 5 - Isometric projection of straight pyramids
- Lecture 6 - Isometric projection of Straight Cylinders
- Lecture 7 - Isometric projection of Cones
- Lecture 8 - Isometric projection of Frustums of cones and pyramids
- Lecture 9 - Isometric projection of section of solids
- Lecture 10 - Isometric projection of spheres
- Lecture 11 - Isometric projection of combination of solids
- Lecture 12 - Isometric Projection of intersecting solids
- Lecture 13 - Converting orthographic views to isometric drawing - 1
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- Lecture 18 - Axonometric projection of prisms and pyramids
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- Lecture 20 - Axonometric projection of intersecting solids and combination of solids

Lecture 1 - State of Global Environment (Air)

Lecture 2 - State of Global Environment (Biodiversity)

Lecture 3 - State of Global Environment (Oceans and Coasts)

Lecture 4 - State of Global Environment (Land and Soil)

Lecture 5 - State of Global Environment (Freshwater)

Lecture 6 - Definition, Process and Purpose of EIA

Lecture 7 - EIA Impact Areas, Current and Emerging - Part I

Lecture 8 - EIA Impact Areas, Current and Emerging - Part II

Lecture 9 - EIA Origin in USA and World-Wide Development

Lecture 10 - EIA in India

Lecture 11 - World Sustainable Development Timeline (1970-1999)

Lecture 12 - World Sustainable Development Timeline (2000-2021)

Lecture 13 - EIA Law, Policy and Institutional arrangements for EIA systems - Part I

Lecture 14 - EIA Law, Policy and Institutional Arrangements for EIA Systems - Part II - Air

Lecture 15 - EIA Law, Policy and Institutional Arrangements for EIA Systems - Part III - Air

Lecture 16 - EIA Law, Policy and Institutional arrangements for EIA Systems - Part IV - Water and Geology

Lecture 17 - EIA Law, Policy and Institutional Arrangements for EIA Systems - Part V - Ecology

Lecture 18 - EIA Law, Policy and Institutional Arrangements for EIA Systems - Part VI - Coastal Ecology and Geomorphology

Lecture 19 - EIA Law, Policy and Institutional arrangements for EIA Systems - Part VII - Noise

Lecture 20 - EIA Law, Policy and Institutional arrangements for EIA Systems - Part VIII - Ecosystem Services

Lecture 21 - EIA Law, Policy and Institutional Arrangements for EIA Systems - Part IX - Cultural Heritage and Health

Lecture 22 - EIA Law, Policy and Institutional Arrangements for EIA Systems - Part X

Lecture 23 - EIA Law, Policy and Institutional Arrangements for EIA Systems - Part XI

Lecture 24 - EIA Law, Policy and Institutional Arrangements for EIA Systems - Part XII

Lecture 25 - EIA Law, Policy and Institutional Arrangements for EIA Systems - Part XIII

Lecture 26 - EIA Process - Starting and Initial Stage

Lecture 27 - EIA Process - Impact Prediction

Lecture 28 - EIA Process - Impact Evaluation, Mitigation and Enhancement

Lecture 29 - EIA Process - Participation, Presentation and Review

Lecture 30 - EIA Process - Follow-Up (Monitoring and Auditing)

Lecture 31 - EIA Methods - Air Assessment - Part I

- [Lecture 32 - EIA Methods - Air Assessment - Part II](#)
- [Lecture 33 - EIA Methods - Water Assessment](#)
- [Lecture 34 - EIA Methods - Soil, Land and Geology](#)
- [Lecture 35 - EIA Methods - Climate and Climate Change - Part I](#)
- [Lecture 36 - EIA Methods - Climate and Climate Change - Part II](#)
- [Lecture 37 - EIA Methods for Ecology \(Definitions and Concepts\)](#)
- [Lecture 38 - EIA Methods for Ecology \(Baseline Study\)](#)
- [Lecture 39 - EIA Methods for Ecology \(Impact Prediction and Evaluation\)](#)
- [Lecture 40 - EIA Methods - Ecosystem Services - Part I](#)
- [Lecture 41 - EIA Methods - Ecosystem Services - Part II](#)
- [Lecture 42 - EIA Methods - Coastal Ecology and Geomorphology - Part I](#)
- [Lecture 43 - EIA Methods - Coastal Ecology and Geomorphology - Part II](#)
- [Lecture 44 - EIA Methods - Noise](#)
- [Lecture 45 - EIA Methods - Transport](#)
- [Lecture 46 - EIA Methods - Landscape and Visuals](#)
- [Lecture 47 - EIA Methods - Cultural Heritage](#)
- [Lecture 48 - EIA Methods - Health](#)
- [Lecture 49 - EIA Methods - Socio-Economic Impacts \(SIA\) - Part I](#)
- [Lecture 50 - EIA Methods - Socio-Economic Impacts \(SIA\) - Part II](#)
- [Lecture 51 - EIA Methods - Land Acquisition, Resettlement and Livelihoods](#)
- [Lecture 52 - EIA Methods - Resource Efficiency](#)
- [Lecture 53 - EIA Methods - Risk and Risk Assessment](#)
- [Lecture 54 - EIA Methods - Cumulative Effects](#)
- [Lecture 55 - EIA - Environmental Management Plans](#)
- [Lecture 56 - EIA - Widening the scope: Strategic Environmental Assessment](#)
- [Lecture 57 - EIA - Reporting and Review of EIA Quality](#)
- [Lecture 58 - EIA Case Study - Mumbai Metro Line 3, Colaba - Bandra - SEEPZ](#)
- [Lecture 59 - EIA Case Study - Development of Water Aerodrome, Andaman and Nicobar - Part - I](#)
- [Lecture 60 - EIA Case Study - Development of Water Aerodrome, Andaman and Nicobar - Part - II](#)

Lecture 1 - Introduction - Part 1

Lecture 2 - Introduction - Part 2

Lecture 3 - Pre-Independence - Part 1: Indo-Saracenic Architecture

Lecture 4 - Pre-Independence - Part 2: Colonial Architecture and Art Deco

Lecture 5 - Pre-Independence to Independence - Part 1

Lecture 6 - Pre-Independence to Independence - Part 2

Lecture 7 - Revivalism

Lecture 8 - The First Generation (1945-1970) - Part 1

Lecture 9 - The First Generation (1945-1970) - Part 2

Lecture 10 - The First Generation (1945-1970) - Part 3

Lecture 11 - The First Generation (1945-1970) - Part 4

Lecture 12 - The First Generation (1945-1970) - Part 5

Lecture 13 - The First Generation (1945-1970) - Part 6

Lecture 14 - Impact of Western Architects: Le Corbusier - Part 1

Lecture 15 - Impact of Western Architects: Le Corbusier - Part 2

Lecture 16 - Impact of Western Architects: Le Corbusier - Part 3

Lecture 17 - Impact of Western Architects: Le Corbusier - Part 4

Lecture 18 - Impact of Western Architects: Le Corbusier - Part 5

Lecture 19 - Impact of Western Architects: Le Corbusier - Part 6

Lecture 20 - Impact of Western Architects: Walter Gropius - Part 1

Lecture 21 - Impact of Western Architects: Walter Gropius - Part 2

Lecture 22 - Impact of Western Architects: Louis I Kahn - Part 1

Lecture 23 - Impact of Western Architects: Louis I Kahn - Part 2

Lecture 24 - Impact of Western Architects: Louis I Kahn - Part 3

Lecture 25 - Impact of Western Architects: Louis I Kahn - Part 4

Lecture 26 - Introduction to Critical Regionalism - Part 1

Lecture 27 - Introduction to Critical Regionalism - Part 2

Lecture 28 - Critical Regionalism in Indian Architecture - Part 1

Lecture 29 - Critical Regionalism in Indian Architecture - Part 2

Lecture 30 - Critical Regionalism in Indian Architecture - Part 3

Lecture 31 - Critical Regionalism in Indian Architecture - Part 4

[Lecture 32 - Critical Regionalism in Indian Architecture - Part 5](#)

[Lecture 33 - Structure: The Works of Mahendra Raj](#)

[Lecture 34 - Point-Blocks and High Rises - Part 1](#)

[Lecture 35 - Point-Blocks and High Rises - Part 2](#)

[Lecture 36 - Search for a new Architecture - Part 1](#)

[Lecture 37 - Search for a new Architecture - Part 2](#)

[Lecture 38 - Search for a new Architecture - Part 3](#)

[Lecture 39 - Search for a new Architecture - Part 4](#)

[Lecture 40 - Search for a new Architecture - Part 5](#)

Lecture 1 - Culture, Identity and Built Environment

Lecture 2 - Space and Meaning in Balinese Vernacular Architecture

Lecture 3 - Adobe Construction and Religious Structures

Lecture 4 - Social System, Beliefs and its Architecture

Lecture 5 - Anthropology of Shelter-Conclusion

Lecture 6 - Stone as a Vernacular Resource Material

Lecture 7 - Earth as Vernacular Resource Material

Lecture 8 - Bamboo as Vernacular Resource Material

Lecture 9 - Timber as Vernacular Resource Material

Lecture 10 - Advanced Material Adaptations: The conclusion

Lecture 11 - Cultural Geography and Vernacular Architecture

Lecture 12 - Cultural Geography and Small-scale Features in the Landscape

Lecture 13 - Acculturation in Architecture

Lecture 14 - Tradition and Transmission

Lecture 15 - Transformation in Vernacular Context

Lecture 16 - Disasters Vulnerability and Traditions

Lecture 17 - Learning Disaster Mitigation from the Vernacular

Lecture 18 - The Second Birth: Lessons from Disaster Recovery

Lecture 19 - Climate Change and Traditions

Lecture 20 - Yonmenkaigi (Four square table system) Method for Collaborative Knowledge Development

Lecture 1 - Introduction to Interaction Design

Lecture 2 - Components of Interaction Design

Lecture 3 - Interaction Design Process

Lecture 4 - Understanding User

Lecture 5 - Conceptual Design - Part 1

Lecture 6 - Conceptual Design - Part 2

Lecture 7 - Role of Cognition

Lecture 8 - Role of Social Interaction

Lecture 9 - Designing for Emotional Interaction

Lecture 10 - Interactive Interfaces

Lecture 11 - Data Gathering

Lecture 12 - Data Analysis

Lecture 13 - Discovering Requirements

Lecture 14 - User Personas and Scenarios

Lecture 15 - Design and Prototyping - Part 1

Lecture 16 - Design and Prototyping - Part 2

Lecture 17 - Visual Interface Design

Lecture 18 - Elements of User Interface

Lecture 19 - Affordances and UI Transformations

Lecture 20 - Component-Based Design Systems

NPTEL : NOC:Understanding and Reducing Ghg Emissions - Focus on Scope 1 and 2 Emission Reduction through Building Design and Construction (Architecture)

Co-ordinators : Prof. Avlokita Agrawal

- Lecture 1 - Introduction, Sustainability, And Sustainable Development
- Lecture 2 - Sustainable Development And Sustainable Goals
- Lecture 3 - Sustainable Development Goals and Climate Change
- Lecture 4 - Climate Risk
- Lecture 5 - Impact of Development on Climate Natural Components
- Lecture 6 - UNFCCC
- Lecture 7 - Kyoto Protocol
- Lecture 8 - The Paris Agreement
- Lecture 9 - Green House Gases
- Lecture 10 - Carbon Footprint and Calculation
- Lecture 11 - The GHG Protocol
- Lecture 12 - ISO International Standards
- Lecture 13 - Identification and Determination of Scope 1,2 and 3 GHG Emissions
- Lecture 14 - Identification and Determination of Scope 1,2 and 3 GHG Emissions - Part II
- Lecture 15 - Identification and Determination of Scope 1,2 and 3 GHG Emissions - Part III
- Lecture 16 - India Specific GHG Programs - I
- Lecture 17 - India Specific GHG Programs - II
- Lecture 18 - Accounting Methods and Data Collection
- Lecture 19 - Tools for Calculation of GHG
- Lecture 20 - Understanding the Role of Buildings and Related Emissions
- Lecture 21 - Understanding Emissions of Airports
- Lecture 22 - Understanding Emissions of University Campuses
- Lecture 23 - Understanding Emissions of Fuel Supply Companies
- Lecture 24 - Understanding Emissions of IT Companies
- Lecture 25 - Understanding Emissions of Real Estate Companies
- Lecture 26 - Thermal Comfort in Building
- Lecture 27 - Passive Design Measures
- Lecture 28 - Advanced Passive Design Measures
- Lecture 29 - Natural and Mechanical Ventilation
- Lecture 30 - Daylighting and Lighting Design

[Lecture 31 - Factors Affecting Material Selection in Building?](#)

[Lecture 32 - Material Selection for Emission Reduction](#)

[Lecture 33 - Reducing Emission from purchased Electricity](#)

[Lecture 34 - Strategies of Renovation and Retrofitting for Emission Reduction](#)

[Lecture 35 - Case studies of Various Efficient Building Design](#)

[Lecture 36 - Calculation of Emissions Reduction from HVAC System](#)

[Lecture 37 - Calculation of Emission Reduction from Fenestration](#)

[Lecture 38 - Calculation of Emission Reduction from Building Envelope](#)

[Lecture 39 - Calculation of Emission Reduction from Source of Energy](#)

[Lecture 40 - Course Summary](#)

Lecture 1 - Introduction

Lecture 2 - Atmosphere-A brief survey (Pressure, Temperature and Chemical composition)

Lecture 3 - Atmosphere-A brief survey (Continued...) (Vertical structure of the atmosphere)

Lecture 4 - Vertical structure of atmosphere (Continued...) and The Earth system - Oceans

Lecture 5 - The Earth system - Oceans (Continued...) and Marine biosphere

Lecture 6 - The Earth system - Hydrological cycle

Lecture 7 - The Earth system - Hydrological cycle (Continued...) and Carbon cycle

Lecture 8 - The Earth system - Carbon cycle (Continued...), and Carbon in the oceans Earth's crust

Lecture 9 - The Earth system - Carbon in the oceans Earth's crust

Lecture 10 - Atmospheric Thermodynamics- Introduction

Lecture 11 - The hydrostatic equation

Lecture 12 - Hypsometric equation and pressure at sea level

Lecture 13 - Basic Thermodynamics

Lecture 14 - Concept of air parcel and dry adiabatic lapse rate

Lecture 15 - Potential temperature

Lecture 16 - Skew-T In-P chart

Lecture 17 - Problems using Skew-T In-P chart

Lecture 18 - Problems using Skew-T In-P chart (Continued...)

Lecture 19 - Problems using Skew-T In-P chart (Continued...)

Lecture 20 - Lifting Condensation Level (LCL)

Lecture 21 - Lifting Condensation Level (LCL) (Continued...)

Lecture 22 - Saturated Adiabatic and Pseudo-adiabatic processes

Lecture 23 - Equivalent potential temperature and wet bulb potential temperature

Lecture 24 - Föhn's rule - Chinook winds

Lecture 25 - Problems on Chinook wind and static stability

Lecture 26 - Static stability-Brunt-Väisälä frequency

Lecture 27 - Conditional and convective instability

Lecture 28 - Static stability - Problems using radiosonde data and skew T In P chart

Lecture 29 - The second law of thermodynamics – Clausius Clapeyron relation

Lecture 30 - Clausius Clapeyron relation (Continued...)

Lecture 31 - Atmospheric radiation – Radiation laws

[Lecture 32 - Planck's distribution and Inverse square law](#)

[Lecture 33 - Physics of scattering, emission and absorption](#)

[Lecture 34 - Physics of scattering, emission and absorption \(Continued...\)](#)

[Lecture 35 - Radiative Transfer Equation " Derivation](#)

[Lecture 36 - Radiative Transfer Equation \(Continued...\)](#)

[Lecture 37 - Radiative heating profiles of the atmosphere](#)

[Lecture 38 - Climate Dynamics " Introduction](#)

[Lecture 39 - Climate sensitivity and feedback](#)

[Lecture 40 - Climate change](#)

[Lecture 41 - Atmospheric dynamics](#)

Lecture 1 - Introduction

Lecture 2 - Blackbody radiation

Lecture 3 - Properties of real surfaces

Lecture 4 - Spectral and directional variations

Lecture 5 - Shape factor

Lecture 6 - Triangular enclosure

Lecture 7 - Evaluation of shape factors

Lecture 8 - Radiation in enclosures

Lecture 9 - Electrical analogy

Lecture 10 - Applications

Lecture 11 - Non-gray enclosures

Lecture 12 - Enclosure with Specular surfaces

Lecture 13 - Integral method for enclosures

Lecture 14 - Introduction to gas radiation

Lecture 15 - Plane parallel model

Lecture 16 - Diffusion approximation

Lecture 17 - Radiative equilibrium

Lecture 18 - Optically thick limit

Lecture 19 - Radiation spectroscopy

Lecture 20 - Isothermal gas emissivity

Lecture 21 - Band models

Lecture 22 - Total Emissivity method

Lecture 23 - Isothermal gas enclosures

Lecture 24 - Well-stirred furnace model

Lecture 25 - Gas radiation in complex enclosures

Lecture 26 - Interaction between radiation and other modes of heat transfer

Lecture 27 - Radiation heat transfer during flow over flat plate

Lecture 28 - Radiation and Climate

Lecture 29 - Radiative-convective equilibrium

Lecture 30 - Radiative equilibrium with scattering

Lecture 31 - Radiation measurement

[Lecture 32 - Radiation with internal heat source](#)

[Lecture 33 - Particle scattering](#)

[Lecture 34 - Scattering in the atmosphere](#)

[Lecture 35 - Non-isotropic scattering](#)

[Lecture 36 - Approximate methods in scattering : 1](#)

[Lecture 37 - Approximate methods in scattering : 2](#)

[Lecture 38 - Monte Carlo method](#)

NPTEL : The monsoon and its variability (Atmospheric Science)

Co-ordinators : Prof. Sulochana Gadgil

Lecture 1 - Preamble and Introduction to the Indian Monsoon

Lecture 2 - Nature of the variability of the Indian Monsoon

Lecture 3 - Monsoon variability through the eye in the sky, seasonal variation of the surface wind and pressure

Lecture 4 - Background about the atmosphere and rotating systems

Lecture 5 - Rainfall and clouds over the tropics

Lecture 6 - Organization of clouds over mesoscale, synoptic scale and planetary scales

Lecture 7 - The Indian monsoon: is it a gigantic land-sea breeze?

Lecture 8 - Monsoons and the seasonal variation of tropical circulation and rainfall

Lecture 9 - Evolution of the ideas about the basic system responsible for the Indian monsoon - Part 1

Lecture 10 - Evolution of the ideas about the basic system responsible for the Indian monsoon - Part 2

Lecture 11 - Tropical Convergence Zones and the Indian monsoon - Part 1

Lecture 12 - Tropical Convergence Zones and the Indian monsoon - Part 2

Lecture 13 - Variability of organized convection over the tropical oceans

Lecture 14 - Heat lows and the TCZ

Lecture 15 - Monsoonal regions of the world

Lecture 16 - Seasonal transitions - Part 1 : spring to summer transition

Lecture 17 - Seasonal transitions - Part 2 : spring to summer transition

Lecture 18 - Seasonal transitions - Part 3 : Advance and retreat of the summer monsoon

Lecture 19 - Climatic clusters of the Indian region

Lecture 20 - Active-weak spells and breaks in the monsoon - Part 1

Lecture 21 - Active-weak spells and breaks in the monsoon - Part 2

Lecture 22 - Intraseasonal variation and intraseasonal oscillations

Lecture 23 - The tropical oceans

Lecture 24 - El Nino Southern Oscillation (ENSO) - Part 1

Lecture 25 - El Nino Southern Oscillation (ENSO) - Part 2

Lecture 26 - El Nino Southern Oscillation (ENSO) - Part 3

Lecture 27 - El Nino Southern Oscillation (ENSO) - Part 4

Lecture 28 - El Nino Southern Oscillation (ENSO) - Part 5

Lecture 29 - El Nino Southern Oscillation (ENSO) - Part 6

Lecture 30 - Indian Ocean and the monsoon - Part 1

Lecture 31 - Indian Ocean and the monsoon - Part 2

[Lecture 32 - Indian Ocean Dipole - Part 1](#)

[Lecture 33 - Indian Ocean Dipole - Part 2](#)

[Lecture 34 - Interannual variation of the Indian summer Monsoon rainfall: Links to events over the Pacific and Equatorial Indian Ocean](#)

[Lecture 35 - Monsoon Variability and Agriculture - Part 1](#)

[Lecture 36 - Monsoon Variability and Agriculture - Part 2](#)

[Lecture 37 - Monsoon Variability and Agriculture - Part 3](#)

[Lecture 38 - Monsoon Variability and Agriculture - Part 4](#)

[Lecture 39 - Indian Summer Monsoon, GDP and Agriculture](#)

[Lecture 40 - Monsoon Prediction - Part 1](#)

[Lecture 41 - Monsoon Prediction - Part 2](#)

[Lecture 42 - Concluding Remarks](#)

Lecture 1 - Preliminary Concepts

Lecture 2 - Vector Analysis

Lecture 3 - Analysis of Forces

Lecture 4 - Analysis of Equilibrium

Lecture 5 - Structural Mechanics - Part-1

Lecture 6 - Structural Mechanics - Part-2

Lecture 7 - Friction and its Applications - Part-1

Lecture 8 - Friction and its Applications - Part-2

Lecture 9 - Friction and its Applications - Part-3

Lecture 10 - Properties of Surfaces - Part-1

Lecture 11 - Properties of Surfaces - Part-2

Lecture 12 - Properties of Surfaces - Part-3

Lecture 13 - Moments and Products of Inertia

Lecture 14 - Methods of Virtual Work and Potential Energy - Part-1

Lecture 15 - Methods of Virtual Work and Potential Energy - Part-2

Lecture 16 - Stability of Equilibrium

Lecture 1 - Introduction

Lecture 2 - Motivation

Lecture 3 - Management

Lecture 4 - Work Ethics

Lecture 5 - Comparison Between Theories

Lecture 6 - Job Enrichment

Lecture 7 - Team Building and Participation

Lecture 8 - Other Leadership Styles

Lecture 9 - Empowerment

Lecture 10 - Barriers to Communication

Lecture 11 - Issues in Leadership

Lecture 12 - Participation Management and Team Working Part - 1

Lecture 13 - Participation Management and Team Working Part - 2

Lecture 14 - Participation Management and Team Working Part - 3

Lecture 15 - Participative Management and Team Working Part - 5

Lecture 16 - Organizations

Lecture 17 - Some Management Concepts - Part - 1

Lecture 18 - Some Management Concepts - Part - 2

Lecture 19 - Some Management Concepts - Part - 3

Lecture 20 - Diversity at Work Place and Management Issues

Lecture 21 - Industrial Relations and Conflict Management - Part - 1

Lecture 22 - Industrial Relations and Conflict Management - Part - 2

Lecture 23 - Selection and Training of Employees

Lecture 24 - Performance Management - Part - 1

Lecture 25 - Performance Management - Part - 2

Lecture 26 - Performance Management - Part - 3

Lecture 27 - Management Research: Some Methodological Issues-Part-2

Lecture 28 - Corporate Social Responsibilities

Lecture 29 - Women, Work and Organizations: Management Perspective - Part - 1

Lecture 30 - Women, Work and Organizations: Management Perspective - Part - 2

Lecture 31 - Selection, Recruitment and Training

[Lecture 32 - Management of Change in Organization](#)

[Lecture 33 - Organizational Development](#)

[Lecture 34 - Values, Ethics and Corporate Social Responsibilities - Part - 1](#)

[Lecture 35 - Values, Ethics and Corporate Social Responsibilities - Part - 2](#)

[Lecture 36 - Management: Now and Beyond - Part - 1](#)

[Lecture 37 - Management: Now and Beyond - Part - 2](#)

[Lecture 38 - Management: Now and Beyond - Part - 3](#)

[Lecture 39 - Conclusions](#)

Lecture 1 - Introduction

Lecture 2 - Internal Energy Enthalpy

Lecture 3 - Crystal Geometry

Lecture 4 - Crystal Geometry

Lecture 5 - Crystal Geometry

Lecture 6 - Crystal Structure

Lecture 7 - Close Packing of Spheres of Equal Size

Lecture 8 - Structure of Solid Materials

Lecture 9 - Non Crystalline Solids

Lecture 10 - Polymers (Continued)

Lecture 11 - Crystal Imperfections

Lecture 12 - Crystal Imperfections

Lecture 13 - Crystal Imperfections

Lecture 14 - Crystal Imperfections

Lecture 15 - Crystal Imperfections

Lecture 16 - Phase Diagrams

Lecture 17 - Phase Diagrams

Lecture 18 - Phase Diagrams

Lecture 19 - Diffusion in Solids

Lecture 20 - Diffusion in Solids

Lecture 21 - Phase Transformations

Lecture 22 - Phase Transformations

Lecture 23 - Phase Transformations

Lecture 24 - Transformations in Steels: Eutectoid Steel

Lecture 25 - Phase Transformations; Precipitation Hardening

Lecture 26 - Mechanical Behaviour of Materials

Lecture 27 - Plastic Deformation

Lecture 28 - Plastic Deformation

Lecture 29 - Plastic Deformation

Lecture 30 - Strengthening Mechanisms Creep

Lecture 31 - Fracture

[Lecture 32 - Conductors and Resistors](#)

[Lecture 33 - Conductors and Resistors](#)

[Lecture 34 - Superconductors](#)

[Lecture 35 - Superconductors](#)

[Lecture 36 - Semiconductors](#)

- Lecture 1 - Errors in Computation and Numerical Instability
- Lecture 2 - Solution of Nonlinear Algebraic Equations - Part 1
- Lecture 3 - Solution of Nonlinear Algebraic Equations - Part 2
- Lecture 4 - Solution of Nonlinear Algebraic Equations - Part 3
- Lecture 5 - Solution of Nonlinear Algebraic Equations - Part 4
- Lecture 6 - Solution of Nonlinear Algebraic Equations - Part 5
- Lecture 7 - Solution of Nonlinear Algebraic Equations - Part 6
- Lecture 8 - Solution of Nonlinear Algebraic Equations - Part 7
- Lecture 9 - Solution of Nonlinear Algebraic Equations - Part 8
- Lecture 10 - Solution of Nonlinear Algebraic Equations - Part 9
- Lecture 11 - Solution of a System of Linear Algebraic Equations - Part 1
- Lecture 12 - Solution of a System of Linear Algebraic Equations - Part 2
- Lecture 13 - Solution of a System of Linear Algebraic Equations - Part 3
- Lecture 14 - Solution of a System of Linear Algebraic Equations - Part 4
- Lecture 15 - Solution of a System of Linear Algebraic Equations - Part 5
- Lecture 16 - Solution of a System of Linear Algebraic Equations - Part 6
- Lecture 17 - Solution of a System of Linear Algebraic Equations - Part 7
- Lecture 18 - Solution of a System of Linear Algebraic Equations - Part 8
- Lecture 19 - Solution of a System of Linear Algebraic Equations - Part 9
- Lecture 20 - Solution of a System of Linear Algebraic Equations - Part 10
- Lecture 21 - Solution of a System of Linear Algebraic Equations - Part 11
- Lecture 22 - Solution of a System of Linear Algebraic Equations - Part 12
- Lecture 23 - Solution of a System of Linear Algebraic Equations - Part 13
- Lecture 24 - Solution of a System of Linear Algebraic Equations - Part 14
- Lecture 25 - Interpolation and Approximation - Part 1
- Lecture 26 - Interpolation and Approximation - Part 2
- Lecture 27 - Interpolation and Approximation - Part 3
- Lecture 28 - Interpolation and Approximation - Part 4
- Lecture 29 - Interpolation and Approximation - Part 5
- Lecture 30 - Interpolation and Approximation - Part 6
- Lecture 31 - Interpolation and Approximation - Part 7

[Lecture 32 - Interpolation and Approximation - Part 8](#)

[Lecture 33 - Interpolation and Approximation - Part 9](#)

[Lecture 34 - Numerical Differentiation and Integration - Part 1](#)

[Lecture 35 - Numerical Differentiation and Integration - Part 2](#)

[Lecture 36 - Numerical Differentiation and Integration - Part 3](#)

[Lecture 37 - Numerical Differentiation and Integration - Part 4](#)

[Lecture 38 - Numerical Differentiation and Integration - Part 5](#)

[Lecture 39 - Numerical Differentiation and Integration - Part 6](#)

[Lecture 40 - Numerical Differentiation and Integration - Part 7](#)

[Lecture 41 - Numerical Differentiation and Integration - Part 8](#)

Lecture 1 - Engineering Mechanics

Lecture 2 - Equilibrium - I

Lecture 3 - Equilibrium - II

Lecture 4 - Equilibrium - III

Lecture 5 - Plan Trusses - I

Lecture 6 - Plan Trusses - II

Lecture 7 - Friction

Lecture 8 - Properties of Surfaces - I

Lecture 9 - Properties of Surfaces - II

Lecture 10 - Properties of Surfaces - III

Lecture 11 - Method of Virtual Work

Lecture 12 - Motion of Particles Planar Polar Coordinates

Lecture 13 - Motion With Constraints

Lecture 14 - Motion of Particle With Friction

Lecture 15 - Motion of Particles With Drag

Lecture 16 - Momentum

Lecture 17 - Work and Energy - I

Lecture 18 - Work and Energy - II

Lecture 19 - Work and Energy - III

Lecture 20 - Work and Energy - IV

Lecture 21 - Rotational Motion - I

Lecture 22 - Rotational Motion - II

Lecture 23 - Rotational Motion - III

Lecture 24 - Rotational Motion - IV

Lecture 25 - Rotational Motion - V

Lecture 26 - Rotational Motion - VI

Lecture 27 - Simple Harmonic Motion - I

Lecture 28 - Simple Harmonic Motion - II

Lecture 29 - Simple Harmonic Motion - III

Lecture 30 - Motion in Uniformly Accelerating Frames

Lecture 31 - Motion In Rotating Frame

[Module - 1 lecture - 1](#)

[Module - 1 lecture - 2](#)

[Module - 1 lecture - 3](#)

[Module - 1 lecture - 4](#)

[Module - 2 lecture - 1](#)

[Module - 2 lecture - 2](#)

[Module - 2 lecture - 3](#)

[Module - 2 lecture - 4](#)

[Module - 2 lecture - 5](#)

[Module - 3 lecture - 1](#)

[Module - 3 lecture - 2](#)

[Module - 3 lecture - 3](#)

[Module - 3 lecture - 4](#)

[Module - 3 lecture - 5 \(Lecture Missing\)](#)

[Module - 3 lecture - 6](#)

[Module - 3 lecture - 7](#)

[Module - 3 lecture - 8](#)

[Module - 4 lecture - 1](#)

[Module - 4 lecture - 2](#)

[Module - 4 lecture - 3](#)

[Module - 4 lecture - 4](#)

[Module - 4 lecture - 5](#)

[Module - 4 lecture - 6](#)

[Module - 4 lecture - 7](#)

[Module - 4 lecture - 8](#)

[Module - 4 lecture - 9](#)

[Module - 4 lecture - 10](#)

[Module - 4 lecture - 11](#)

[Module - 4 lecture - 12](#)

Lecture 1 - Real Number

Lecture 2 - Sequences I

Lecture 3 - Sequences II

Lecture 4 - Sequences III

Lecture 5 - Continuous Function

Lecture 6 - Properties of Continuous Function

Lecture 7 - Uniform Continuity

Lecture 8 - Differentiable Functions

Lecture 9 - Mean Value Theorem

Lecture 10 - Maxima - Minima

Lecture 11 - Taylor's Theorem

Lecture 12 - Curve Sketching

Lecture 13 - Infinite Series I

Lecture 14 - Infinite Series II

Lecture 15 - Tests of Convergence

Lecture 16 - Power Series

Lecture 17 - Riemann Integral

Lecture 18 - Riemann Integrable Functions

Lecture 19 - Applications of Riemann Integral

Lecture 20 - Length of a curve

Lecture 21 - Line Integrals

Lecture 22 - Functions of Several Variables

Lecture 23 - Differentiation

Lecture 24 - Derivatives

Lecture 25 - Mean Value Theorem

Lecture 26 - Maxima Minima

Lecture 27 - Method of Lagrange Multipliers

Lecture 28 - Multiple Integrals

Lecture 29 - Surface Integrals

Lecture 30 - Green's Theorem

Lecture 31 - Stokes Theorem

Lecture 32 - Gauss Divergence Theorem

[Lecture 1 - Nature and Scope of HRM](#)

[Lecture 2 - Analysing and Designing Job - I](#)

[Lecture 3 - Analysing and Designing Job - II](#)

[Lecture 4 - Human Resource Planning - I](#)

[Lecture 5 - Human Resource Planning - II](#)

[Lecture 6 - Recruitment and Selection](#)

[Lecture 7 - Performance Evaluation and Appraisal - I](#)

[Lecture 8 - Performance Evaluation and Appraisal \(Continued...\)](#)

[Lecture 9 - Training and Development](#)

[Lecture 10 - Employee Welfare](#)

[Lecture 11 - Safety, Health, Environment](#)

[Lecture 12 - Industrial Relations](#)

[Lecture 13 - Total Quality Management](#)

[Lecture 14 - Organization Culture](#)

[Lecture 15 - Change Management - Part - I](#)

[Lecture 16 - Change Management - Part - II](#)

[Lecture 17 - Wage and Salary Administration](#)

[Lecture 18 - Career Planning - Part - I](#)

[Lecture 19 - Career Planning - Part - II](#)

[Lecture 20 - Contemporary Issues in HRM - I](#)

[Lecture 21 - Contemporary Issues in HRM - II](#)

[Lecture 22 - Contemporary Issues in HRM - III](#)

NPTEL : Leadership (Basic Courses (Semester 1 and 2))

Co-ordinators : Prof. Kalyan Chakravarti

Lecture 1 - Introduction to Leadership: Functions

Lecture 2 - Leadership Roles: Leaders Vs Managers: Theories

Lecture 3 - Leadership Styles: Effective Vs Successful Managers

Lecture 4 - Leadership Behaviour: Emergence: Leadership and Trust

Lecture 5 - Leadership Styles: Adaptation-Studies/Case: From Sindhi to Siddhi (Part-I)

Lecture 6 - Case: From Sindhi to Siddhi (Part-II) Transformation Leadership

Lecture 7 - Leadership Skills: Leadership and Management

Lecture 8 - Competencies and Skills of Leaders: Issues in Organizational Leadership

Lecture 9 - Case: The DVC Story-A First Person Account - Leadership in Action (Part-I)

Lecture 10 - Case: The DVC Story-A First Person Account- Leadership in Action (Part-II)

Lecture 11 - Case: Rai Bahadur Mohan Singh Oberoi (Part-I) Issues in Institution Building

Lecture 12 - Case: Rai Bahadur Mohan Singh Oberoi (Part-II)

Lecture 13 - Case: Self Regulation-The Key to Institution Building - Framework of Institution Building

Lecture 1 - Introduction - I

Lecture 2 - Introduction - II

Lecture 3 - Introduction - III

Lecture 4 - Concept of Information - I

Lecture 5 - Concept of Information - II

Lecture 6 - Decision Making Process

Lecture 7 - Impact of IS on Management - I

Lecture 8 - Impact of IS on Management - II

Lecture 9 - Hardware Software Overview - I

Lecture 10 - Hardware Software Overview - II

Lecture 11 - Knowledge Management

Lecture 12 - Learning Organization

Lecture 13 - Decision Analysis - I

Lecture 14 - Decision Analysis - II

Lecture 15 - Decision Analysis - III

Lecture 16 - Data Flow Diagrams - I

Lecture 17 - Data Flow Diagrams - II

Lecture 18 - Data Flow Diagrams - III

Lecture 19 - Data Flow Diagrams - IV

Lecture 20 - System Design - I

Lecture 21 - System Design - II

Lecture 22 - DBMS - I

Lecture 23 - DBMS - II

Lecture 24 - DBMS - III

Lecture 25 - DBMS - IV

Lecture 26 - DBMS - V

Lecture 27 - OOAD - I

Lecture 28 - OOAD - II

Lecture 29 - OOAD - III

Lecture 1 - Simple Harmonic Oscillators

Lecture 2 - Damped Oscillator - I

Lecture 3 - Damped Oscillator - II

Lecture 4 - Oscillator With External Forcing - I

Lecture 5 - Oscillator With External Forcing

Lecture 6 - Resonance

Lecture 7 - Coupled Oscillations

Lecture 8 - Sinusoidal Plane Waves - I

Lecture 9 - Electromagnetic waves - I

Lecture 10 - Electromagnetic Waves - II

Lecture 11 - The Vector Nature of Electromagnetic Waves

Lecture 12 - The Electromagnetic Spectrum

Lecture 13 - The Electromagnetic Spectrum - II

Lecture 14 - Interference - I

Lecture 15 - Interference - II

Lecture 16 - Interference - III

Lecture 17 - Interference - IV

Lecture 18 - Coherence

Lecture 19 - Coherence

Lecture 20 - Diffraction - I

Lecture 21 - Diffraction - II

Lecture 22 - Diffraction - III

Lecture 23 - Diffraction - IV

Lecture 24 - X-Ray Diffraction

Lecture 25 - Beats

Lecture 26 - The Wave Equation

Lecture 27 - Solving the Wave Equation

Lecture 28 - Waves

Lecture 29 - Standing Waves

Lecture 30 - Standing Waves

Lecture 31 - Polarization

[Lecture 32 - Compton Effect](#)

[Lecture 33 - Wave - Particle Duality](#)

[Lecture 34 - Wave - Particle Duality](#)

[Lecture 35 - Probability Amplitude](#)

[Lecture 36 - Probability](#)

[Lecture 37 - Schrodinger Wave Equation](#)

[Lecture 38 - Measurements](#)

[Lecture 39 - Particle in a Potential](#)

[Lecture 40 - Potential Well](#)

[Lecture 41 - Potential Well](#)

[Lecture 42 - Potential Well](#)

[Lecture 43 - Quantum Tunneling](#)

[Lecture 44 - Quantum Tunneling](#)

Lecture 1 - Strategy: Philosophy;Competition;Competitive Advantage - Part - I

Lecture 2 - Strategy: Philosophy;Competition;Competitive Advantage - Part - II

Lecture 3 - Case Study - Group Presentation on Case - I (Baddi's Solvent)

Lecture 4 - Case Study - Group Presentation on Case - II

Lecture 5 - Case Study - Group Presentation on Case - III

Lecture 6 - Case Study - Group Presentation on Case - IV Form

Lecture 7 - Strategy: Implementation in Organizations

Lecture 8 - Strategy: Design: Process: Managing Strategic Change

Lecture 9 - Case Study: The House of Tata

Lecture 10 - Case Study: The House of Tata

Lecture 11 - Group Presentation - II

Lecture 1 - Introduction to Basic Electronics

Lecture 2 - Electronic Devices 1

Lecture 3 - Electronics Devices II Resistor in series and parallel

Lecture 4 - Some Useful Laws in Basic Electronics

Lecture 5 - Some Useful Theorems in Basic Electronics

Lecture 6 - Semi Conductor Diodes

Lecture 7 - Applications of Diodes

Lecture 8 - Wave Shaping using Diodes

Lecture 9 - Zener Diode Characteristics

Lecture 10 - Transistors

Lecture 11 - Transistor Biasing - Common Emitter Circuits, Fixed Bias, Collector to base Bias

Lecture 12 - Transistor Biasing - Emitter Current Bias, Thermal Stability (RC Coupled Amplifier)

Lecture 13 - Basic Characteristic of an Amplifier - Simple Transistor model, Common emitter Amplifier

Lecture 14 - Hybrid Equivalent Circuit, H-Parameters

Lecture 15 - Circuit Analysis using H-Parameters

Lecture 16 - Frequency Response of Amplifiers

Lecture 17 - Frequency Analysis

Lecture 18 - Power Amplifiers

Lecture 19 - Differential Amplifiers Circuit

Lecture 20 - Integrated Chip

Lecture 21 - Typical Characteristic of Operation Amplifier

Lecture 22 - Four Types of Feed Back

Lecture 23 - Four Types of Feed Back

Lecture 24 - Mathematical Operations

Lecture 25 - Mathematical Operations

Lecture 26 - Mathematical Operations

Lecture 27 - Characteristics of Operation Amplifier

Lecture 28 - Characteristics of Operation Amplifier

Lecture 29 - Characteristics of Operation Amplifier

Lecture 30 - Inverter/Non-Inverter Circuits

Lecture 31 - Applications of Op Amps

[Lecture 32 - Non-Linear Op Amp circuits](#)

[Lecture 33 - Applications of Op Amps](#)

[Lecture 34 - Active Diode Circuits](#)

[Lecture 35 - Oscillators](#)

[Lecture 36 - Logarithmic and Anti-Logarithmic Amplifier](#)

[Lecture 37 - Filters](#)

[Lecture 38 - Unit Junction Transistor](#)

[Lecture 39 - Silicon Controlled Rectifier](#)

[Lecture 40 - Field Effect Transistor](#)

Lecture 1 - Introduction

Lecture 2 - Newtonian mechanics

Lecture 3 - Dynamics in phase space

Lecture 4 - Linear dynamical systems

Lecture 5 - Autonomous dynamical systems (Part 1)

Lecture 6 - Autonomous dynamical systems (Part 2)

Lecture 7 - Lagrangian formalism

Lecture 8 - Summary of classical electromagnetism

Lecture 9 - Charged particle in an electromagnetic field

Lecture 10 - Hamiltonian dynamics (Part 1)

Lecture 11 - Hamiltonian dynamics (Part 2)

Lecture 12 - Hamiltonian dynamics (Part 3)

Lecture 13 - Dynamical symmetry (Part 1)

Lecture 14 - Dynamical symmetry (Part 2)

Lecture 15 - Randomness in phase space; chaos

Lecture 16 - Discrete-time dynamics: maps (Part 1)

Lecture 17 - Discrete-time dynamics: maps (Part 2)

Lecture 18 - Problems and solutions (Part 1)

Lecture 19 - Problems and solutions (Part 2)

Lecture 20 - Classical statistical mechanics: Introduction

Lecture 21 - Some probability distributions; isolated system

Lecture 22 - The microcanonical ensemble

Lecture 23 - Thermodynamics

Lecture 24 - The canonical ensemble

Lecture 25 - Connection between statistical mechanics and thermodynamics

Lecture 26 - Probability distributions

Lecture 27 - Probability distributions (concl.). Phase transitions (Part 1)

Lecture 28 - Phase transitions (Part 2)

Lecture 29 - Phase transitions (Part 3)

Lecture 30 - Phase transitions (Part 4); misc. topics

Lecture 31 - Problems and solutions (Part 3)

[Lecture 32 - Continuous groups in physics \(Part 1\)](#)

[Lecture 33 - Continuous groups in physics \(Part 2\)](#)

[Lecture 34 - Continuous groups in physics \(Part 3\)](#)

[Lecture 35 - Noether's Theorem. Special Relativity \(Part 1\)](#)

[Lecture 36 - Special Relativity \(Part 2\)](#)

[Lecture 37 - Special Relativity \(Part 3\)](#)

[Lecture 38 - Special Relativity \(Part 4\)](#)

Lecture 1 - Introduction to Chemistry & Quantum Chemical Mechanics

Lecture 2 - Particle in a box (one and two dimensions)

Lecture 3 - Particle in a box (One and Two Dimensions) Continued

Lecture 4 - Harmonic Oscillator and Molecular Vibration

Lecture 5 - Harmonic Oscillator (Continued)

Lecture 6 - Hydrogen Atom - Radial Solution

Lecture 7 - Hydrogen Atom Part III Angular Solutions

Lecture 8 - Hydrogen Atom - Angular Solutions (Continued)

Lecture 9 - Hydrogen Atom - Angular Solutions (Continued)

Lecture 10 - Oppenheimer Approximation and Superposition

Lecture 1 - Programing Basics

Lecture 2 - Introduction to Pointers

Lecture 3 - Pointers And Arrays

Lecture 4 - External Functions and Argument Passing

Lecture 5 - Representation of Numbers

Lecture 6 - Numerical Error

Lecture 7 - Error Propagation and Stability

Lecture 8 - Polynomial Interpolation-1

Lecture 9 - Polynomial Interpolation-2

Lecture 10 - Error In Interpolation Polynomial

Lecture 11 - Polynomial Interpolation

Lecture 12 - Cubic Spline Interpolation

Lecture 13 - Data Fitting : Linear Fit

Lecture 14 - Data Fitting : Linear Fit

Lecture 15 - Data Fitting : Non Linear Fit

Lecture 16 - Matrix Elimination and Solution

Lecture 17 - Solution To Linear Equations

Lecture 18 - Matrix Elimination

Lecture 19 - Eigen Values of A Matrix

Lecture 20 - Eigen Values And Eigen Vectors

Lecture 21 - Solving NonLinear Equations

Lecture 22 - Solving NonLinear Equations Newton Raphson Method

Lecture 23 - Methods For Solving NonLinear Equations

Lecture 24 - System of NonLinear Equations

Lecture 25 - Numerical Derivations

Lecture 26 - High order Derivatives From Difference Formula

Lecture 27 - Numerical Integration - Basic Rules

Lecture 28 - Comparison of Different Basic Rules

Lecture 29 - Gaussian Rules

Lecture 30 - Comparison of Gaussian Rules

Lecture 31 - Solving Ordinary Differential Equations

[Lecture 32 - Solving ordinary differential equations](#)

[Lecture 33 - Adaptive step size Runge Kutta scheme](#)

[Lecture 34 - Partial Differential Equations](#)

[Lecture 35 - Explicit and Implicit Methods](#)

[Lecture 36 - The Crank - Nicholson Scheme For Two Spatial](#)

[Lecture 37 - Fourier Transforms](#)

[Lecture 38 - Fast Fourier Transforms](#)

Lecture 1 - Introduction to Quantum Physics;Heisenberg's uncertainty principle

Lecture 2 - Introduction to linear vector spaces

Lecture 3 - Characteristics of linear vector spaces

Lecture 4 - Functions in a linear vector space

Lecture 5 - Linear operations in a linear vector space and their eigenvalues

Lecture 6 - Classical Vs Quantum Mechanics

Lecture 7 - Quantum Physics

Lecture 8 - Quantum Physics

Lecture 9 - Quantum Physics

Lecture 10 - Quantum Physics

Lecture 11 - Quantum Physics

Lecture 12 - Quantum Physics

Lecture 13 - Quantum Physics

Lecture 14 - Quantum Physics

Lecture 15 - Quantum Physics

Lecture 16 - Quantum Physics

Lecture 17 - Quantum Physics

Lecture 18 - Quantum Physics

Lecture 19 - Quantum Physics

Lecture 20 - Quantum Physics

Lecture 21 - Quantum Physics

Lecture 22 - Quantum Physics

Lecture 23 - Quantum Physics

Lecture 24 - Quantum Physics

Lecture 25 - Quantum Physics

Lecture 26 - Quantum Physics

Lecture 27 - Quantum Physics

Lecture 28 - Quantum Physics

Lecture 29 - Quantum Physics

Lecture 30 - Quantum Physics

Lecture 31 - Quantum Physics

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : Engineering Physics I (Basic Courses (Semester 1 and 2))

Co-ordinators : Prof. Rajdeep Chatterjee, Prof. B.K. Patra, Prof. M.K. Srivastava, Prof. G.D. Verma

Lecture 1 - Introduction

Lecture 2 - Malus law & Superposition of ways

Lecture 3 - Double Refraction

Lecture 4 - Interference of polarized light

Lecture 5 - Optical Activity

Lecture 6 - Introduction

Lecture 7 - Stationary Waves & Reflection, Refraction and Diffraction

Lecture 8 - Ultrasonics

Lecture 9 - Acoustics of Buildings - Part I

Lecture 10 - Acoustics of Buildings - Part II

Lecture 11 - Interference of light Part-1

Lecture 12 - Interference of light Part-2

Lecture 13 - Interference of light Part-3

Lecture 14 - Interference by Division of Wave front

Lecture 15 - Interference by Division of Amplitude

Lecture 16 - Coherence and Application of Interference

Lecture 17 - Diffraction Part-1

Lecture 18 - Diffraction Part-2

Lecture 19 - Diffraction Part-3

Lecture 20 - Diffraction by a circular aperture

Lecture 21 - Kinetic theory of gases - Part-1

Lecture 22 - Kinetic theory of gases - Part-2

Lecture 23 - Maxwellian distribution law of velocity - Part-1

Lecture 24 - Maxwellian distribution law of velocity - Part-2

Lecture 25 - Maxwellian distribution law of velocity - Part-3

Lecture 26 - Vanderwaal's equation of states - Part-1

Lecture 27 - Vanderwaal's equation of states - Part-2

Lecture 28 - Vanderwaal's equation of states - Part-3

Lecture 29 - Fluid Mechanics - Part-1

Lecture 30 - Fluid Mechanics - Part-2

Lecture 31 - Introduction of special relativity

[Lecture 32 - Consequences of special relativity-1](#)

[Lecture 33 - Consequences of special relativity-2](#)

[Lecture 34 - Consequences of special relativity-3](#)

[Lecture 35 - Consequences of special relativity-4](#)

[Lecture 36 - Consequences of special relativity-5](#)

[Lecture 37 - Introduction](#)

[Lecture 38 - Image formation by lenses](#)

[Lecture 39 - Lens aberrations - Part I](#)

[Lecture 40 - Lens aberrations - Part II](#)

Lecture 1 - Complex Integration

Lecture 2 - Contour Integration

Lecture 3 - Cauchy's Integral Theorem

Lecture 4 - Cauchy's Integral Formula

Lecture 5 - Application of Cauchy Integral Formula

Lecture 6 - Zeros, Singularities and Poles

Lecture 7 - Residue Integration Method

Lecture 8 - Residue Theorem

Lecture 9 - Evaluation of Real Integrals

Lecture 10 - Evaluation of Real Improper Integrals-1

Lecture 11 - Evaluation of Real Improper Integrals-2

Lecture 12 - Evaluation of Real Improper Integrals-3

Lecture 13 - Evaluation of Real Improper Integrals-4

Lecture 14 - Evaluation of Real Integrals - Revision

Lecture 15 - Matrix Algebra Part - 1

Lecture 16 - Matrix Algebra Part - 2

Lecture 17 - Determinants Part - 1

Lecture 18 - Determinants Part - 2

Lecture 19 - Solution of System Equation

Lecture 20 - Linear Algebra Part - 1

Lecture 21 - Linear Algebra part - 2

Lecture 22 - Linear Algebra Part - 3

Lecture 23 - Linear Algebra Part - 4

Lecture 24 - Inner Product

Lecture 25 - Linear Transformation Part - 1

Lecture 26 - Linear Transformation Part - 2

Lecture 27 - Eigenvalues Eigenvectors Part - 1

Lecture 28 - Eigenvalues Eigenvectors Part - 2

Lecture 29 - Quadratic Forms

Lecture 30 - Diagonalization Part - 1

Lecture 31 - Diagonalization Part - 2

[Lecture 32 - Solution of System of Linear Equation](#)

[Lecture 33 - Functions of Complex Variables Part - 1](#)

[Lecture 34 - Functions of Complex Variables Part - 2](#)

[Lecture 35 - Taylor Series](#)

[Lecture 36 - Laurent Series](#)

[Lecture 37 - Rank of a Matrix](#)

[Lecture 38 - Complex Numbers Their Geometrical Representation](#)

Lecture 1 - Solution of ODE of First Order and First Degree

Lecture 2 - Linear Differential Equations of the First Order

Lecture 3 - Approximate Solution of An Initial Value

Lecture 4 - Series Solution of Homogeneous Linear I

Lecture 5 - Series Solution of Homogeneous Linear II

Lecture 6 - Bessel Functions and Their Properties

Lecture 7 - Bessel Functions And Their Properties (Continued..)

Lecture 8 - Laplace Transformation

Lecture 9 - Laplace Transformation (Continued..)

Lecture 10 - Applications Of Laplace Transformation

Lecture 11 - Applications Of Laplace Transformation (Continued..)

Lecture 12 - One Dimensional Wave Equation

Lecture 13 - One Dimensional Heat Equation

Lecture 14 - Introduction to Differential Equation

Lecture 15 - First Order Differential Equations and Their Geometric Interpretation

Lecture 16 - Differential Equations of First Order Higher Degree

Lecture 17 - Linear Differential Equation of Second Order-Part - 1

Lecture 18 - Linear Differential equation of Second Order-Part - 2

Lecture 19 - Euler-Cauchy Theorem

Lecture 20 - Higher Order Linear Differential Equations

Lecture 21 - Higher Order Non homogeneous Linear Equations

Lecture 22 - Boundary Value Problems

Lecture 23 - Sturm Liouville boundary Value Problem

Lecture 24 - Fourier Series-Part - 1

Lecture 25 - Fourier Series-Part - 2

Lecture 26 - Convergence of the Fourier Series

Lecture 27 - Fourier Integrals

Lecture 28 - Fourier Transforms

Lecture 29 - Partial Differential Equation

Lecture 30 - First Order Partial Differential Equation

Lecture 31 - Second Order Partial Differential Equations - I

[Lecture 32 - Second Order Partial Differential Equations - II](#)

[Lecture 33 - Solution of One Dimensional Wave Equation](#)

[Lecture 34 - Solution of HomogeneousNon Homogeneous Equations](#)

[Lecture 35 - Fourier Integral Transform Method for Heat Equation](#)

[Lecture 36 - Three Dimensional Laplace Equation](#)

[Lecture 37 - Solution of Drichlet Problem](#)

[Lecture 38 - Numerical Method for Laplace Poisson equation](#)

[Lecture 39 - ADI Method for Laplace and Poisson Equation](#)

- Lecture 1 - Introduction - Concept of Management
- Lecture 2 - Lecture 2
- Lecture 3 - Management By Objectives
- Lecture 4 - Organizing & Organization
- Lecture 5 - Organizing - II
- Lecture 6 - Coordinating
- Lecture 7 - Communication - I
- Lecture 8 - Communication - II
- Lecture 9 - Leadership
- Lecture 10 - Controlling
- Lecture 11 - Motivation and Organization Culture
- Lecture 12 - Japanese Management
- Lecture 13 - Comparison of Japanese and American Management
- Lecture 14 - Managerial Functions in International Business
- Lecture 15 - Marketing Functions: Channels of Distribution
- Lecture 16 - Management and Society
- Lecture 17 - Social Responsibility and Ethics - II
- Lecture 18 - Functions of Personnel Management
- Lecture 19 - Manpower Planning
- Lecture 20 - Selection - I
- Lecture 21 - Selection - II
- Lecture 22 - Performance Appraisal - I
- Lecture 23 - Performance Appraisal - II
- Lecture 24 - Training and Development - I
- Lecture 25 - Training and Development - II
- Lecture 26 - Job Design and Payment Systems - I
- Lecture 27 - Job Design and Compensation Systems
- Lecture 28 - Organizational Development - I
- Lecture 29 - Organizational Development - II
- Lecture 30 - Organization Theory - I
- Lecture 31 - Organization Theory - II

[Lecture 32 - Group Dynamics - I](#)

[Lecture 33 - Group Dynamics - II](#)

[Lecture 34 - Group Dynamics - III](#)

[Lecture 35 - Conflict Management - I](#)

[Lecture 36 - Conflict Management - II](#)

[Lecture 37 - Managing Creativity and Innovation](#)

[Lecture 38 - Creativity and Managing Innovation Process - II](#)

[Lecture 39 - Stress Management - I](#)

[Lecture 40 - Stress Management - II](#)

Lecture 1 - Introduction

Lecture 2 - Graphs and functions - I

Lecture 3 - Graphs and functions - II

Lecture 4 - Functions and derivatives

Lecture 5 - Calculation of derivatives

Lecture 6 - Differentiation and its application in Biology - I

Lecture 7 - Differentiation and its application in Biology - II

Lecture 8 - Differentiation and its application in Biology - III

Lecture 9 - Differentiation and its application in Biology - IV

Lecture 10 - Integration - I

Lecture 11 - Integration - II

Lecture 12 - Differential equations - I

Lecture 13 - Differential equations - II

Lecture 14 - Vectors - I

Lecture 15 - Vectors - II

Lecture 16 - Vectors - III

Lecture 17 - Nernst equation

Lecture 18 - Diffusion - I : Diffusion equation

Lecture 19 - Diffusion - II : Mean-square displacement

Lecture 20 - Diffusion - III : Einstein's relation

Lecture 21 - Statistics : Mean and variance

Lecture 22 - Statistics : Distribution function

Lecture 23 - Understanding Normal distribution

Lecture 24 - Fitting a function to experimental data

Lecture 25 - Size of a flexible protein: Simplest model

Lecture 26 - Uniform and Poisson distributions; Knudsen's analysis

Lecture 27 - Fourier Series - I

Lecture 28 - Fourier Series - II

Lecture 29 - Fourier transform

Lecture 30 - Master equation: Polymerization dynamics, Molecular motor motion

Lecture 31 - Evolution: Simplest model

[Lecture 32 - Tutorial - I](#)

[Lecture 33 - Tutorial - II](#)

[Lecture 34 - Temperature, Energy and Entropy](#)

[Lecture 35 - Partition function, Free energy](#)

[Lecture 36 - Bending fluctuations of DNA and spring-like proteins](#)

[Lecture 37 - Force-extension and looping of DNA](#)

[Lecture 38 - Thermodynamics of protein organization along DNA](#)

[Lecture 39 - Learning mathematics with the help of a computer](#)

NPTEL : Proteomics: Principles and Techniques (Biotechnology)

Co-ordinators : Prof. Sanjeeva Srivastava

[Lecture 1](#)

[Lecture 2](#)

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[Lecture 40](#)

[Lecture 0 - Proteins and Gel-Based Proteomics; Course Introduction](#)

[Lecture 1 - Introduction to amino acids](#)

[Lecture 2 - Introduction to proteins](#)

[Lecture 3 - Protein folding & misfolding](#)

[Lecture 4 - Protein purification techniques](#)

[Lecture 5 - Introduction to proteomics](#)

[Lecture 6 - Systems biology and proteomics](#)

[Lecture 7 - Sample preparation and pre-analytical factors](#)

[Lecture 8 - Sample preparation: Pre-analytical factors \(Continued...\)](#)

[Lecture 9 - Sample preparation: Protein extraction and quantification](#)

[Lecture 10 - One-dimensional electrophoresis](#)

[Lecture 11 - 2-DE: Rehydration, IEF & Equilibration](#)

[Lecture 12 - 2-DE: Second dimension, staining & destaining](#)

[Lecture 13 - 2-DE: Gel analysis](#)

[Lecture 14 - 2-DE: Applications](#)

[Lecture 15 - 2-DE: Applications \(Continued...\) & Challenges](#)

[Lecture 16 - 2D-DIGE: Basics](#)

[Lecture 17 - 2D-DIGE: Data analysis](#)

[Lecture 18 - 2D-DIGE: Applications](#)

[Lecture 19 - Protein identification using MALDI-TOF/TOF](#)

[Lecture 20 - Proteomics experiment data analysis & challenges](#)

Lecture 0 - Introductory lecture

Lecture 1 - Introduction to proteomics

Lecture 2 - Proteomics and sample preparation

Lecture 3 - Bacterial protein extraction

Lecture 4 - In-gel digestion

Lecture 5 - Fundamentals of mass spectrometry

Lecture 6 - Chromatography technologies

Lecture 7 - Liquid chromatography

Lecture 8 - Mass spectrometry: Ionization sources

Lecture 9 - Mass spectrometry: Mass analyzers

Lecture 10 - MALDI sample preparation and analysis

Lecture 11 - Introduction to quantitative proteomics

Lecture 12 - Hybrid mass spectrometry configurations

Lecture 13 - SILAC: In Vivo labeling

Lecture 14 - iTRAQ: In Vitro labeling

Lecture 15 - TMT: In vitro labeling

Lecture 16 - Quantitative proteomics data analysis

Lecture 17 - Proteomics and Systems biology I

Lecture 18 - Proteomics & Systems biology II

Lecture 19 - Proteomics applications

Lecture 20 - Advances and challenges in proteomics

Lecture 1 - Introduction to Interactomics

Lecture 2 - An overview of label-free technologies

Lecture 3 - An overview of surface plasmon resonance (SPR)

Lecture 4 - An overview of surface plasmon resonance imaging (SPRi)

Lecture 5 - Basics of SPR: Surface chemistry

Lecture 6 - Basics of SPR: Experimental design

Lecture 7 - Protein immobilization for protein-protein interaction studies

Lecture 8 - Protein-protein interaction study: Binding analysis

Lecture 9 - Protein-protein interaction study: Kinetic analysis

Lecture 10 - Protein-small molecule interaction study: Immobilization and binding analysis

Lecture 11 - Protein-small molecule interaction study: Kinetic analysis

Lecture 12 - SPR: Interactive Session - I

Lecture 13 - SPR: Interactive Session - II

Lecture 14 - An overview of ellipsometry and interferometry techniques

Lecture 15 - An introduction to BioLayer Interferometry (BLI) and its applications in protein research

Lecture 16 - Kinetic analysis of protein-protein interaction using BLI

Lecture 17 - Label-free quantification of proteins using BLI

Lecture 18 - Diffraction-based biosensors - I

Lecture 19 - Diffraction-based biosensors - II

Lecture 20 - Nanotechniques in proteomics - I

Lecture 21 - Nanotechniques in proteomics - II

Lecture 22 - High throughput platforms of interactomics: Protein arrays

Lecture 23 - Conventional label based detection techniques for Protein microarrays

Lecture 24 - Novel detection techniques for Protein microarrays

Lecture 25 - Recombinational cloning and its application for Protein microarrays

Lecture 26 - An introduction to Cell-free protein synthesis

Lecture 27 - Cell-free synthesis based protein microarrays: PISA and NAPPA

Lecture 28 - Cell-free synthesis based protein microarrays: MIST, DAPA and Halotag Arrays

Lecture 29 - Digging deeper into NAPPA: Basic Workflow

Lecture 30 - Digging deeper into NAPPA: Surface Chemistry, Printing and Assessment

Lecture 31 - Application of cell free expression protein microarrays in biomarker discovery

[Lecture 32 - Application of cell free expression protein microarrays in immunological studies](#)

[Lecture 33 - Basics of microarray image scanning](#)

[Lecture 34 - Software for Image scanning and data processing](#)

[Lecture 35 - Microarray Data Analysis - Part I](#)

[Lecture 36 - Microarray Data Analysis - Part II](#)

[Lecture 37 - Application of protein microarray in biomarker discovery - I](#)

[Lecture 38 - Application of protein microarray in biomarker discovery - II](#)

[Lecture 39 - Systems biology and networks](#)

[Lecture 40 - Challenges in proteomics](#)

Lecture 1 - Introduction to amino acids

Lecture 2 - Introduction to proteins

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NPTEL : Animal Physiology (Biotechnology)

Co-ordinators : Prof. Mainak Das

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NPTEL : Bio electricity (Biotechnology)

Co-ordinators : Prof. Mainak Das

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Lecture 8 - Chemical Equilibrium - III

Lecture 9 - Chemical Equilibrium - IV

Lecture 10 - Chemical Equilibrium - V

Lecture 11 - Chemical Kinetics - I

Lecture 12 - Chemical Kinetics - II

Lecture 13 - Chemical Kinetics - III

Lecture 14 - Chemical Kinetics - IV

Lecture 15 - Chemical Kinetics - V

Lecture 16 - Chemical Kinetics - Reaction Mechanism - Part A

Lecture 17 - Chemical Kinetics - Reaction Mechanism - Part B

Lecture 18 - Chemical Kinetics - Catalysis - Part A

Lecture 19 - Chemical Kinetics - Catalysis - Part B

Lecture 20 - Chemical Kinetics - Catalysis - Part C

Lecture 21 - Nitrogen chemistry - Part A

Lecture 22 - Nitrogen chemistry - Part B

Lecture 23 - Chlorine chemistry and disinfection - Part A

Lecture 24 - Chlorine chemistry and disinfection - Part B

Lecture 25 - Chlorine chemistry and disinfection - Part C

Lecture 26 - Radioactivity - Part A

Lecture 27 - Radioactivity - Part B

Lecture 28 - Radioactivity - Part C

Lecture 29 - Radioactivity - Part D

Lecture 30 - Radioactivity - Part E

Lecture 31 - Introduction - I

[Lecture 32 - Introduction - II](#)

[Lecture 33 - Overview of microbial life - I](#)

[Lecture 34 - Overview of microbial life - II](#)

[Lecture 35 - Overview of microbial life - III](#)

[Lecture 36 - Cell chemistry - I](#)

[Lecture 37 - Cell chemistry - II](#)

[Lecture 38 - Cell Biology - I](#)

[Lecture 39 - Cell Biology - II](#)

[Lecture 40 - Cell Biology - III](#)

[Lecture 41 - Cell Biology - IV](#)

[Lecture 42 - Microscopy - I](#)

[Lecture 43 - Microscopy - II](#)

[Lecture 44 - Microbial Metabolism - I](#)

[Lecture 45 - Microbial Metabolism - II](#)

[Lecture 46 - Microbial Metabolism - III](#)

[Lecture 47 - Xenobiotics - I](#)

[Lecture 48 - Xenobiotics - II](#)

[Lecture 49 - Microbial Growth - I](#)

[Lecture 50 - Microbial Growth - II](#)

[Lecture 51 - Microbial Growth - III](#)

[Lecture 52 - Microbial Growth and Control - I](#)

[Lecture 53 - Microbial Growth and Control - II](#)

[Lecture 54 - Pathogens and diseases - I](#)

[Lecture 55 - Pathogens and diseases - II](#)

[Lecture 56 - Metabolic Diversity - I](#)

[Lecture 57 - Metabolic Diversity - II](#)

[Lecture 58 - Metabolic Diversity - III](#)

[Lecture 59 - Metabolic Diversity - IV](#)

[Lecture 60 - Metabolic Diversity - V](#)

[Lecture 61 - Metabolic Diversity - VI](#)

[Lecture 62 - Biogeochemical cycles - I](#)

[Lecture 63 - Biogeochemical cycles - II](#)

NPTEL : NOC:Environmental Biotechnology (Biotechnology)

Co-ordinators : Prof. Pinaki Sar

Lecture 1 - Introduction of Environmental Biotechnology, Scope and applications of the subject

Lecture 2 - Introduction of Environmental Biotechnology, Scope and applications of the subject

Lecture 3 - Ecosystem : Basic concepts of structure and function

Lecture 4 - Ecosystem : Basic concepts of structure and function (Continued...)

Lecture 5 - Microbial Ecology

Lecture 6 - Microbial Ecology (Continued...)

Lecture 7 - Microbial Ecosystems and Biogeochemical Cycling

Lecture 8 - Biogeochemical Cycles

Lecture 9 - Microbial ecology and environmental biotechnology - Part A

Lecture 10 - Microbial ecology and environmental biotechnology - Part B

Lecture 11 - Microbial ecology and environmental biotechnology - Part B (Continued...)

Lecture 12 - Microbial ecology and environmental biotechnology - Part B (Continued...)

Lecture 13 - Microbial ecology and environmental biotechnology - Part C

Lecture 14 - Microbial ecology and environmental biotechnology - Part C (Continued...)

Lecture 15 - Microbial ecology and environmental biotechnology - Part C (Continued...)

Lecture 16 - Microbial Ecology and Environmental Biotechnology - Part C (Continued...)

Lecture 17 - Microbiology of Environmental Engineering System

Lecture 18 - Microbiology of Environmental Engineering System

Lecture 19 - Microbiology of Environmental Engineering System

Lecture 20 - Microbiology of Environmental Engineering System (Continued...)

Lecture 21 - Physiological Ecology and Resource Exploitation by Microorganisms

Lecture 22 - Physiological ecology and Resource Exploitation by Microorganisms (Continued...)

Lecture 23 - Physiological ecology and Resource Exploitation by Microorganisms (Continued...)

Lecture 24 - Physiological ecology and Resource Exploitation by Microorganisms (Continued...)

Lecture 25 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology

Lecture 26 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

Lecture 27 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

Lecture 28 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

Lecture 29 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

Lecture 30 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

Lecture 31 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

[Lecture 32 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology \(Continued...\)](#)

[Lecture 33 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology \(Continued...\)](#)

[Lecture 34 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology \(Continued...\)](#)

[Lecture 35 - Bioremediation](#)

[Lecture 36 - Bioremediation \(Continued...\)](#)

[Lecture 37 - Bioremediation \(Continued...\)](#)

[Lecture 38 - Bioremediation \(Continued...\)](#)

[Lecture 39 - Biodegradation](#)

[Lecture 40 - Biodegradation](#)

[Lecture 41 - Biodegradation \(Continued...\)](#)

[Lecture 42 - Microbial Interactions with Heavy Metals and Metalloids](#)

[Lecture 43 - Microbial Interactions with Heavy Metals and Metalloids - Bioremediation](#)

[Lecture 44 - Biohydrometallurgy](#)

[Lecture 45 - Enhanced biological phosphorus removal process \(EBPR\)](#)

[Lecture 46 - Biological nitrogen removal](#)

[Lecture 47 - Microbially Enhanced Oil Recovery \(MEOR\)](#)

[Lecture 48 - Emerging Pollutants](#)

[Lecture 49 - Carbon capture, Carbon Sequestration and Utilization](#)

[Lecture 50 - Bioenergy and Environmental Biotechnology](#)

[Lecture 51 - Bioremediation case studies](#)

[Lecture 52 - Bioremediation case studies \(Continued...\)](#)

Lecture 1 - Amino Acids - I

Lecture 2 - Amino Acids - II

Lecture 3 - Amino Acids - III

Lecture 4 - The Peptide Bond

Lecture 5 - Discussion Class

Lecture 6 - Primary Structure

Lecture 7 - Secondary Structure

Lecture 8 - Tertiary and Quaternary Structure

Lecture 9 - Protein Interactions

Lecture 10 - Discussion Class

Lecture 11 - Protein folding and structure

Lecture 12 - Thermodynamics of Protein Folding

Lecture 13 - Protein Structure Methods

Lecture 14 - Protein Denaturation

Lecture 15 - Discussion Class

Lecture 16 - Protein Isolation Methods

Lecture 17 - Protein Purification

Lecture 18 - Biophysical Methods - I

Lecture 19 - Biophysical Methods - II

Lecture 20 - Biophysical Methods - III

Lecture 21 - Types of Protein ligand interactions

Lecture 22 - Kinetics and Thermodynamics of protein-ligand binding

Lecture 23 - Experimental methods in protein ligand interactions

Lecture 24 - Protein ligand docking

Lecture 25 - Discussion class

Lecture 26 - Enzymes I - Classification

Lecture 27 - Enzymes - II

Lecture 28 - Enzyme Mechanisms - I

Lecture 29 - Enzyme Mechanisms - II

Lecture 30 - Enzyme mechanisms - III

Lecture 31 - Enzyme Kinetics - I

- Lecture 32 - Enzyme Kinetics - II
- Lecture 33 - Enzyme Inhibition - I
- Lecture 34 - Enzyme Inhibition - II
- Lecture 35 - Discussion class
- Lecture 36 - Motor Proteins - I
- Lecture 37 - Motor Proteins - II
- Lecture 38 - Metalloproteins - I
- Lecture 39 - Metalloproteins - II
- Lecture 40 - Myoglobin and Hemoglobin
- Lecture 41 - Membrane Proteins - I
- Lecture 42 - Membrane proteins - II
- Lecture 43 - Membrane Transport - I
- Lecture 44 - Membrane Transport - II
- Lecture 45 - Electron Transport Chain
- Lecture 46 - Protein Carbohydrate Interactions - I
- Lecture 47 - Protein Carbohydrate Interactions - II
- Lecture 48 - Protein Nucleic Acid Interactions - I
- Lecture 49 - Protein Nucleic Acid Interactions - II
- Lecture 50 - Protein Nucleic Acid Interactions - III
- Lecture 51 - Protein Protein Interactions - I
- Lecture 52 - Protein Protein Interactions - II
- Lecture 53 - Protein Peptide Interactions
- Lecture 54 - Chaperone proteins
- Lecture 55 - Protein Nanoparticle Interactions
- Lecture 56 - Oxidative stress in Proteins
- Lecture 57 - Enzyme action and Proteolytic cleavage
- Lecture 58 - Intrinsically disordered proteins
- Lecture 59 - Viral proteins
- Lecture 60 - Overview of Course

Lecture 1 - Introduction - 1

Lecture 2 - Introduction - 2

Lecture 3 - Signals and Systems Overview

Lecture 4 - Important Signals

Lecture 5 - System

Lecture 6 - LSI Systems

Lecture 7 - Image Quality

Lecture 8 - Local Contrast

Lecture 9 - Blurring and Noise

Lecture 10 - Physics of Radiography

Lecture 11 - Types of Ionizing Radiations

Lecture 12 - EM Radiation

Lecture 13 - Attenuation Models

Lecture 14 - Radiation Dosimetry

Lecture 15 - PR_Instrument

Lecture 16 - PR_Instru_CA

Lecture 17 - PR_Image_formation

Lecture 18 - Imaging Equation_updated

Lecture 19 - Film screen_Optical Density

Lecture 20 - PR_Image Quality

Lecture 21 - CT_Intsru

Lecture 22 - CT_Instru_finish

Lecture 23 - CT Back projection

Lecture 24 - CT_BP_finish

Lecture 25 - Fan beam_IQ

Lecture 26 - CT_IQ_Artifact

Lecture 27 - Nuclear Med_Phys

Lecture 28 - Nuclear_Med_Radiotracers

Lecture 29 - Planar_Scintigraphy_Instru

Lecture 30 - Planar_Scintigraphy_Im and IQ

Lecture 31 - Spect_Pet

[Lecture 32 - Ultrasound_Intro_Phys](#)

[Lecture 33 - Ultrasound Phys_Interactions](#)

[Lecture 34 - US doppler and Instrumentation](#)

[Lecture 35 - US_Beampattern](#)

[Lecture 36 - Approximations](#)

[Lecture 37 - US_Imaging Equation_modes](#)

[Lecture 38 - Parameters of interest](#)

[Lecture 39 - Beam Steering : Phased Array](#)

[Lecture 40 - MRI_Intro_S1-S9](#)

[Lecture 41 - MRI_Phys_S10-S16](#)

[Lecture 42 - MRI_Phys_S17-S20](#)

[Lecture 43 - MRI_Phys_S21-S28](#)

[Lecture 44 - MRI_Phys_S29-S39](#)

[Lecture 45 - MRI_Phys_S40-S44](#)

[Lecture 46 - MRI_Phys_S45_S52](#)

[Lecture 47 - MRI_Instru_S1_S16](#)

[Lecture 48 - MRI_Instru_s17_s26](#)

[Lecture 49 - MRI_slice sel_S27_S41](#)

[Lecture 50 - MRI_Freq_Encode_S42_S60](#)

[Lecture 51 - MRI_DAQ_S61_S69](#)

[Lecture 52 - MRI_RECON_S70_S82](#)

[Lecture 53 - MRI_IQ_S83_S96](#)

Lecture 1 - Introduction

Lecture 2 - Next Generation Sequencing Technologies - 454 Sequencing

Lecture 3 - Illumina Sequencing By Synthesis (SBS)

Lecture 4 - Single Molecule Real Time (SMRT) Sequencing

Lecture 5 - Ion Torrent and Nanopore Sequencing

Lecture 6 - Sequencing Coverage, Quality Score and Experiment Design

Lecture 7 - Data Formats

Lecture 8 - Data Formats (Continued...)

Lecture 9 - Data Quality

Lecture 10 - Data QC and Trimming

Lecture 11 - Hands-on: Setting up the system

Lecture 12 - Basic Shell Commands

Lecture 13 - Data Download and Exploration

Lecture 14 - Hands-on 1 - Data exploration and QC

Lecture 15 - Hands-on 1 - Data QC and Trimming

Lecture 16 - Read Mapping

Lecture 17 - Mapping Algorithms

Lecture 18 - Suffix tree-based mapping algorithm

Lecture 19 - Burrows-Wheeler Transform (BWT)

Lecture 20 - Read Mapping with BWT

Lecture 21 - Bowtie2 tool

Lecture 22 - Mapping reads with Bowtie2

Lecture 23 - Bowtie2 output

Lecture 24 - SAM and BAM format

Lecture 25 - SAM format: Alignment section

Lecture 26 - Variant Calling

Lecture 27 - Calling SNP/SNVs and Indels

Lecture 28 - Hands-on analysis : Variant Calling

Lecture 29 - VCF Files

Lecture 30 - Variant Annotation

Lecture 31 - Analysis of CNVs and SVs

- Lecture 32 - Introduction to RNA sequencing
- Lecture 33 - RNA-seq data processing pipeline
- Lecture 34 - Transcriptome Assembly and Quantification
- Lecture 35 - Transcript Abundance Quantification
- Lecture 36 - Biases in RNA-seq experiments
- Lecture 37 - Data Normalization Methods
- Lecture 38 - Data Normalization Methods (Continued...)
- Lecture 39 - Differential Gene Expression (DGE) Analysis
- Lecture 40 - DGE analysis results and visualizations
- Lecture 41 - Multiple hypothesis testing correction
- Lecture 42 - FDR correction and interpretation of DGE analysis results
- Lecture 43 - Functional Enrichment Analysis
- Lecture 44 - RNA-seq data analysis - Hands-on 2
- Lecture 45 - Hands-on 2: Setting up the system
- Lecture 46 - Hands-on 2: Preliminary Data Analysis
- Lecture 47 - Sample Specific Bias Correction
- Lecture 48 - Differential Gene Expression Analysis I
- Lecture 49 - DGE Analysis with spike-ins
- Lecture 50 - DGE Analysis Results and Functional Enrichment Analysis
- Lecture 51 - Genome Assembly
- Lecture 52 - Shortest Common Superstring (SCS) assembly
- Lecture 53 - Overlap-Layout-Consensus (OLC) approach
- Lecture 54 - de Bruijn Graph (DBG) based assembly
- Lecture 55 - Assembly and Quality Control
- Lecture 56 - Applications of NGS in Epigenomics
- Lecture 57 - Detecting DNA Methylations
- Lecture 58 - Genome-wide Transcription Factor(TF) Binding Sites
- Lecture 59 - Chromatin Accessibility
- Lecture 60 - Genome Organization in 3D

- Lecture 1 - Neuron Structure
- Lecture 2 - Networks of Neurons and Synapses
- Lecture 3 - Basic Structures in the Brain
- Lecture 4 - Systems of neural processing
- Lecture 5 - Methods of Recording Neural Activity
- Lecture 6 - Membrane Potential and All or None Spike
- Lecture 7 - Patch Clamp Measurements
- Lecture 8 - Ion channels
- Lecture 9 - Current injection: Synapses
- Lecture 10 - Single Neuron Acitivity
- Lecture 11 - Point and compartmental models of neurons
- Lecture 12 - Hodgkin Huxley Equations - I
- Lecture 13 - Hodgkin Huxley Equations - II
- Lecture 14 - Reducing the HHE and Moris-Lecar Equations (MLE)
- Lecture 15 - Properties of MLE
- Lecture 16 - Phase Plane Analysis - I
- Lecture 17 - Phase Plane Analysis - II
- Lecture 18 - Phase Plane Analysis - III
- Lecture 19 - Analysing HHE with Phase Plane Analysis - I
- Lecture 20 - Analysing HHE with Phase Plane Analysis - II
- Lecture 21 - Random variables and random process
- Lecture 22 - Spike train statistics and response measure
- Lecture 23 - Receptive fields and models of receptive fields
- Lecture 24 - Stimulus to Response mapping (Coding) - I
- Lecture 25 - Stimulus to Response mapping (Coding) - II
- Lecture 26 - Stimulus to Response Mapping (Coding) - III
- Lecture 27 - Response to Stimulus Mapping (Decoding)
- Lecture 28 - Basics of Information Theory - I
- Lecture 29 - Basics of Information Theory - II
- Lecture 30 - Maximally Informative Dimensions
- Lecture 31 - Intro to Discrimination based methods

[Lecture 32 - Kullback Leibler Distance](#)

[Lecture 33 - Measuring Spike Train Distances - I](#)

[Lecture 34 - Measuring Spike Train Distances - II](#)

[Lecture 35 - Signal and Noise Correlations](#)

[Lecture 36 - Statistical Methods in Discrimination](#)

[Lecture 37 - Single Cell Decoding - I: Two Alternative Forced Choice task in Monkeys](#)

[Lecture 38 - Single Cell Decoding - II: Using ROC Curves for discrimination](#)

[Lecture 39 - Single Cell Encoding - I: Operant Conditioning Task in Ferrets](#)

[Lecture 40 - Single Cell Encoding - II: Learning in avoidance and approach methods in Ferrets](#)

[Lecture 41 - Plasticity - Synaptic Transmission and Synaptic Strength](#)

[Lecture 42 - Ways of modification of Synaptic Strength](#)

[Lecture 43 - Type of Plasticity](#)

[Lecture 44 - Short Term Plasticity - I](#)

[Lecture 45 - Short Term Plasticity - II](#)

[Lecture 46 - Long Term Plasticity](#)

[Lecture 47 - Spike Time Dependent Plasticity](#)

[Lecture 48 - Hebbian Plasticity](#)

[Lecture 49 - BCM Rule](#)

[Lecture 50 - Synaptic Normalization](#)

[Lecture 51 - Adaptation](#)

[Lecture 52 - Models of Short Term Plasticity](#)

[Lecture 53 - Attention - I](#)

[Lecture 54 - Attention - II](#)

[Lecture 55 - Developmental Cicuits](#)

[Lecture 56 - Optimal Coding in Visual System](#)

[Lecture 57 - Optimal Coding in Auditory System](#)

[Lecture 58 - Optimal Coding of Deviant Stimuli in Development](#)

[Lecture 59 - Spike Timing Dependent Plasticity - a theoretical Perspective](#)

[Lecture 60 - Important Problems in Neuroscience](#)

Lecture 1 - Ionic basis of membrane potential

Lecture 2 - Physiology of voltage gated channels

Lecture 3 - Physiology of voltage gated channels

Lecture 4 - Cardiac muscle physiology

Lecture 5 - Action potential of cardiac muscle - 1

Lecture 6 - Action potential of cardiac muscle - 2

Lecture 7 - Conducting system of heart

Lecture 8 - ECG-Physiological basis

Lecture 9 - ECG-Normal, Technical aspects

Lecture 10 - ECG Interpretation

Lecture 11 - Abnormal ECG - 1

Lecture 12 - Abnormal ECG - 2

Lecture 13 - ECG and Myocardial Infarction

Lecture 14 - Heart rate and Blood pressure - Baroreflex pathway

Lecture 15 - ECG and Hypertension

Lecture 16 - Autonomic regulation of heart

Lecture 17 - Heart rate variability (HRV)

Lecture 18 - Heart rate variability-interpretation and clinical uses, Blood pressure variability

Lecture 19 - Autonomic Function Tests - 1

Lecture 20 - Autonomic Function Tests - 2

Lecture 1 - Introduction

Lecture 2 - Mass balance, Heat Balance, flow sheet

Lecture 3 - Costing

Lecture 4 - Costing (continued), Physical and chemical principles in Down stream

Lecture 5 - Problems in Mass balance, flow sheet

Lecture 6 - Cell Breakage

Lecture 7 - Cell breakage (Continued...)

Lecture 8 - Solid Liquid Separation

Lecture 9 - Solid Liquid Separation (Continued...)

Lecture 10 - Solid Liquid separation-problems

Lecture 11 - Pre-treatment and Filters

Lecture 12 - Adsorption

Lecture 13 - Adsorption

Lecture 14 - Adsorption

Lecture 15 - Adsorption

Lecture 16 - Liquid-Liquid Extraction

Lecture 17 - Liquid-Liquid Extraction

Lecture 18 - Liquid-Liquid Extraction

Lecture 19 - Liquid liquid extraction

Lecture 20 - Reversed micellar and aqueous two phase extraction

Lecture 21 - Membranes

Lecture 22 - Membranes

Lecture 23 - Membranes

Lecture 24 - Membranes

Lecture 25 - Precipitation

Lecture 26 - Chromatography

Lecture 27 - Chromatography

Lecture 28 - Chromatography

Lecture 29 - Chromatography

Lecture 30 - Chromatography

Lecture 31 - Chromatography

[Lecture 32 - Chromatography](#)

[Lecture 33 - Crystallisation](#)

[Lecture 34 - Drying](#)

[Lecture 35 - Drying and distillation](#)

[Lecture 36 - Future trends](#)

NPTEL : Thermodynamics (Biotechnology)

Co-ordinators : Prof. G.K. Suraishkumar

Lecture 1 - Introduction and Review

Lecture 2 - Need for Analysis Additional Thermodynamic Functions State and Path Variables

Lecture 3 - Equations for a Closed system Chemical Potential Concept Gibbs-Duhem Equation

Lecture 4 - Maxwell's relations

Lecture 5 - Inter-Relationships between Thermodynamic Variables

Lecture 6 - Some Useful Mathematical Manipulations

Lecture 7 - Thermodynamic Relations for a Closed System with 1 mole of a pure Substances

Lecture 8 - Maximum Work, Lost Work Review of Closed Systems

Lecture 9 - Open Systems

Lecture 10 - Equations of State - Virial Equations

Lecture 11 - Equations of State - Cubic Equations

Lecture 12 - Volume Estimation

Lecture 13 - Volume Estimation (Continued...) Generalized correlations

Lecture 14 - Generalized correlations (Continued...) Residual Properties

Lecture 15 - Residual Properties (Continued...)

Lecture 16 - Generalized Correlations and Residual Properties

Lecture 17 - Fugacity Coefficient Estimation

Lecture 18 - Review of Module 3

Lecture 19 - Learning Aspects Chemical Potential Formulations

Lecture 20 - Lewis and Randall rule partial Molar Properties

Lecture 21 - Partial Molar Property Estimation from Mixing Experiments

Lecture 22 - Partial Molar Property Estimation (Continued...) Excess Property

Lecture 23 - Activity Coefficient from Excess Property

Lecture 24 - Activity Coefficient from Excess Property (Continued...)

Lecture 25 - Activity Coefficient from Excess Property (Continued...) Models for Activity Coefficient in Binary Systems

Lecture 26 - Models for Activity Coefficient in Binary Systems (Continued...)

Lecture 27 - Review of Module 4

Lecture 28 - Criteria for Phase Equilibrium Phase Rule for Non-reacting Biosystems

Lecture 29 - Clausius - Clayperon Equation

Lecture 30 - Clausius - Clayperon Equation (Continued...) vapour-Liquid Equilibrium

Lecture 31 - Vapour-Liquid Equilibrium (Continued...) Estimation of Fugacity coefficient from Equilibrium P-V-T Data

[Lecture 32 - Liquid/Liquid and Solid/Liquid Equilibria](#)

[Lecture 33 - Review of Module 5](#)

[Lecture 34 - Criteria for Bio-reaction Equilibria](#)

[Lecture 35 - Phase rule for Reacting Biosystems Equilibrium constants](#)

[Lecture 36 - Effect of Temperature and Pressure on the Equilibrium constants](#)

[Lecture 37 - Reaction in Liquid or Solid Phases](#)

[Lecture 38 - Free energy Changes for some Bioreactions](#)

[Lecture 39 - Electrolytes](#)

[Lecture 40 - Course Review](#)

- Lecture 1 - Introduction
- Lecture 2 - Mass balance, Heat Balance, Flow sheet
- Lecture 3 - Costing
- Lecture 4 - Cell Breakage
- Lecture 5 - Solid Liquid Separation
- Lecture 6 - Pre-treatment and Filters/centrifuge
- Lecture 7 - Liquid-Liquid Extraction
- Lecture 8 - Liquid-Liquid extraction (Continued...)
- Lecture 9 - Adsorption
- Lecture 10 - Reversed micellar and aqueous two phase extraction
- Lecture 11 - Membranes
- Lecture 12 - Membranes (Continued...)
- Lecture 13 - Product stabilization, Drying, Lyophilisation
- Lecture 14 - Precipitation and crystallization
- Lecture 15 - Electrophoresis / SDS PAGE
- Lecture 16 - Chromatography
- Lecture 17 - Chromatography (Continued...1)
- Lecture 18 - Chromatography (Continued...2)
- Lecture 19 - Chromatography (Continued...3)
- Lecture 20 - Future trends, Other downstream operations/Summary of the course

Lecture 1 - Introduction

Lecture 2 - Experimental Design Strategy

Lecture 3 - Data types : Binomial distribution

Lecture 4 - Poisson Distribution

Lecture 5 - Normal Distribution

Lecture 6 - Standardized Normal Distribution / t-distribution

Lecture 7 - t-distribution/confidence interval

Lecture 8 - Statistical tests

Lecture 9 - t-Test

Lecture 10 - t-Tests

Lecture 11 - t-test

Lecture 12 - F-tests

Lecture 13 - F-tests

Lecture 14 - ANOVA

Lecture 15 - ANOVA

Lecture 16 - Anova

Lecture 17 - Anova

Lecture 18 - Anova

Lecture 19 - Anova

Lecture 20 - Anova

Lecture 21 - Normality test / Odds ratio

Lecture 22 - Chi square distribution

Lecture 23 - Chi square distribution / test

Lecture 24 - Chi square test

Lecture 25 - Chi square test and Weibull Distribution

Lecture 26 - Weibull Distribution

Lecture 27 - Weibull distribution.

Lecture 28 - Non-parametric test

Lecture 29 - Non parametric test/homogeneity of variance / beta distribution

Lecture 30 - Exponential / hypergeometric distributions

Lecture 31 - Hypergeometric / Log normal distribution

[Lecture 32 - Design of experiments \(DOE\) - Introduction](#)

[Lecture 33 - Factorial Design](#)

[Lecture 34 - Full factorial design](#)

[Lecture 35 - Fractional factorial design](#)

[Lecture 36 - Other designs](#)

[Lecture 37 - Second order designs](#)

[Lecture 38 - Second order design](#)

[Lecture 39 - Regression analysis](#)

[Lecture 40 - Control charts](#)

Lecture 1 - Introduction

Lecture 2 - Sterilization

Lecture 3 - Solution to PP 1.1

Lecture 4 - Some important concepts

Lecture 5 - Enzyme bioreactors, enzyme kinetics

Lecture 6 - Solution to PP 2.1

Lecture 7 - Inhibited enzyme kinetics

Lecture 8 - Solution to PP 2.2

Lecture 9 - Measurement principles and methods

Lecture 10 - Batch growth kinetics

Lecture 11 - Solution to PP 3.1

Lecture 12 - Bioreactor analysis: chemostat and fed-batch

Lecture 13 - Solution to PP 3.2

Lecture 14 - Bioreactor environment parameters

Lecture 15 - Bioreactor env. par. (DO)

Lecture 16 - Solution to PP 4.1

Lecture 17 - Shear stress, scale-up, scale-down

Lecture 18 - Cell view: stoichiometry; degree of reductance

Lecture 19 - Solution to PP 5.1

Lecture 20 - Culture status, metabolic flux analysis

Lecture 21 - Course summary

- Lecture 1 - Introduction to Biomaterials
- Lecture 2 - Background history
- Lecture 3 - History
- Lecture 4 - Properties - Mechanical and Physico-chemical
- Lecture 5 - Properties - Mechanical and Physico-chemical
- Lecture 6 - Mechanical properties
- Lecture 7 - Mechanical Properties (Continued...)
- Lecture 8 - Resorbability, biodegradation
- Lecture 9 - Resorbability, biodegradation (Continued...)
- Lecture 10 - Biofilm
- Lecture 11 - Biofilm (Continued...)
- Lecture 12 - Biofilm (Continued...)
- Lecture 13 - Biofilm (Continued...)
- Lecture 14 - Material characterization - Analytical instruments
- Lecture 15 - Analytical instruments
- Lecture 16 - Analytical instruments (Continued...)
- Lecture 17 - Analytical instruments (Continued...)
- Lecture 18 - Biological responses, compatibility, cytotoxicity
- Lecture 19 - Biological Responses
- Lecture 20 - Cell-biomaterial interaction
- Lecture 21 - Animal trials (in vivo)
- Lecture 22 - Animal trials
- Lecture 23 - Metals-types, classifications, applications
- Lecture 24 - Metals - properties
- Lecture 25 - Metals - properties (Continued...)
- Lecture 26 - Metals - properties (Continued...)
- Lecture 27 - Metals
- Lecture 28 - Polymers-types, classifications, applications
- Lecture 29 - Polymers
- Lecture 30 - Polymers (Continued...)
- Lecture 31 - Polymer blends

[Lecture 32 - Natural biopolymers](#)

[Lecture 33 - Natural biopolymers - \(Continued...\)](#)

[Lecture 34 - Biopolymers- proteins / hydrogels](#)

[Lecture 35 - Hydrogels](#)

[Lecture 36 - Experiments](#)

[Lecture 37 - surface modification-Demonstration](#)

[Lecture 38 - Ceramics](#)

[Lecture 39 - Cardiovascular and ocular biomaterials](#)

[Lecture 40 - Sterilisation/Device failure](#)

Lecture 1 - Concepts and importance of Bioinformatics

Lecture 2 - Complexities in biological systems

Lecture 3 - DNA sequence analysis

Lecture 4 - Sequence based parameters

Lecture 5 - Database

Lecture 6 - Database categories

Lecture 7 - Protein structure and function - I

Lecture 8 - Protein structure and function - II

Lecture 9 - Protein sequence databases - I

Lecture 10 - Protein sequence databases - II

Lecture 11 - Pairwise alignment - I

Lecture 12 - Pairwise alignment - II

Lecture 13 - Uniprot Demo

Lecture 14 - Sequence alignment - I

Lecture 15 - Sequence alignment - II

Lecture 16 - Sequence alignment: Online resources - I

Lecture 17 - Sequence alignment: Online resources - II

Lecture 18 - Conservation score - I

Lecture 19 - Conservation score - II

Lecture 20 - Blast Demo

Lecture 21 - Phylogenetic trees - I

Lecture 22 - Phylogenetic trees - II

Lecture 23 - Protein sequence analysis - I

Lecture 24 - Protein sequence analysis - II

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- Lecture 7 - Protein: Protein Chemistry, Chirality, Peptide bond and Levels of protein structures
- Lecture 8 - Protein: Dihedral angles, Peptide bond and Ramachandran Plot
- Lecture 9 - Protein: Super Secondary Structures, Motif, Domains, Non-covalent interactions
- Lecture 10 - Protein: Folding of Protein, Thermodynamics and Kinetics of protein folding, Characterization of Proteins
- Lecture 11 - Introduction to Structural Biology Techniques - Part I
- Lecture 12 - Introduction to Structural Biology Techniques - Part II
- Lecture 13 - X-ray Crystallography: Crystallization - Part I
- Lecture 14 - X-ray Crystallography: Crystallization - Part II
- Lecture 15 - X-ray Crystallography: Crystal Mounting
- Lecture 16 - X-ray Crystallography: Production of X-ray and its properties
- Lecture 17 - X-ray Crystallography: Journey to 3D land
- Lecture 18 - X-ray Crystallography: Crystal Symmetry
- Lecture 19 - X-ray Crystallography: Instrumentation in X-ray Crystallography
- Lecture 20 - X-ray Crystallography: Data collection and processing
- Lecture 21 - X-ray Crystallography: Data Analysis - Part I
- Lecture 22 - X-ray Crystallography: Data Analysis - Part II
- Lecture 23 - X-ray Crystallography: Phase Problem - Part I
- Lecture 24 - X-ray Crystallography: Phase Problem - Part II
- Lecture 25 - X-ray Crystallography: Refinement and Structure deposition to PDB
- Lecture 26 - Introduction to Spectroscopy and NMR
- Lecture 27 - Basic Principles of NMR and Instrumentation
- Lecture 28 - NMR Sample Preparation and Chemical Shift related concepts
- Lecture 29 - Factors effecting NMR Spectra (1D and 2D)
- Lecture 30 - 2D and 3D NMR Spectroscopy focusing on protein structure
- Lecture 31 - Introduction to Spectroscopy

Lecture 32 - UV-Vis and CD spectroscopy

Lecture 33 - Fluorescence Spectroscopy and Green Fluorescence Protein (GFP)

Lecture 34 - Infrared and Raman Spectroscopy for protein

Lecture 35 - Raman Spectroscopy, Raman Microscopy and Raman Crystallography for studying protein

Lecture 36 - Introduction to Microscopy

Lecture 37 - Functioning details of Cryo Electron Microscopy (Cryo EM)

Lecture 38 - Cryo Electron Microscopy: Data Collection and Analysis

Lecture 39 - A concise story of advancement Cryo-EM

Lecture 40 - Protein Data Bank

Lecture 41 - History of Molecular Visualizations of Biological Macromolecules

Lecture 42 - Description of structure related files (.pdb, .mmCIF, .mtz, etc.)

Lecture 43 - Demonstration of COOT

Lecture 44 - 3D visualization using Pymol

Lecture 45 - Demonstration of Pymol

Lecture 46 - Why we need MD Simulation

Lecture 47 - Molecular Dynamic Simulation Process - Part I

Lecture 48 - Molecular Dynamic Simulation Process - Part II

Lecture 49 - Molecular Dynamic Simulation Process - Part III

Lecture 50 - Application of Molecular Dynamic Simulation

Lecture 51 - What, How and Which of Protein Engineering

Lecture 52 - How to make logical Protein Engineering: Process of Rational design

Lecture 53 - Success story of Rational Protein designing: Focusing on De Novo Process

Lecture 54 - Designing Protein by mimicking nature: Process of Directed Evolution

Lecture 55 - Achievement, Challenges, and Future direction in the field of Protein Engineering

Lecture 56 - Introduction to Structure Based Drug Discovery (SBDD)

Lecture 57 - Rational Drug Discovery

Lecture 58 - Docking Based Virtual Screening: Progress, Challenges and Future perspective

Lecture 59 - What makes a small molecule an ideal drug: Developing in silico ADMETox Model

Lecture 60 - Structure Based Drug Discovery: Case study and Conclusion

Lecture 1 - Introduction to Learning and Memory - I : Historical perspective

Lecture 2 - Introduction to Learning and Memory - II : Classification

Lecture 3 - Associative Learning I : Rules of Associative learning

Lecture 4 - Associative learning II : Garcia and Koelling's Experiment, Kamin's Blocking Experiment

Lecture 5 - Introduction to the Rescorla Wagner Model

Lecture 6 - Application of Rescorla Wagner Model - I

Lecture 7 - Application of Rescorla Wagner Model - II

Lecture 8 - Application of Rescorla Wagner Model - III

Lecture 9 - Application of Rescorla Wagner Model - IV

Lecture 10 - Limitations of Rescorla Wagner Model

Lecture 11 - Introduction of Reinforcement Learning - I : Thorndike's view, Tolman's views, Skinner Box

Lecture 12 - Introduction of Reinforcement Learning - II : Classification, Thorndike's view, Tolman's views, Skinner Box (Continued...)

Lecture 13 - Introduction of Reinforcement Learning - III : Understanding scheduling of reinforcers in operant conditioning

Lecture 14 - Sign Tracking vs Goal Oriented/Tracking; Linking complex behaviors to simple molecules

Lecture 15 - Sign Tracking vs Goal Oriented; Learning Linking complex behaviors to simple molecules - II

Lecture 16 - Memory in Molecular Terms - I : Protein synthesis in memory consolidation

Lecture 17 - Memory in Molecular Terms - II : Long term potentiation

Lecture 18 - Memory in Molecular Terms - III : Properties of a memory molecule

Lecture 19 - Memory in Molecular Terms - IV : Remote memory and its characteristics

Lecture 20 - Memory in Molecular Terms - V : Selective labelling of memory encoding neurons and their manipulation

Lecture 1 - Drug Delivery Introduction and Pharmacokinetics

Lecture 2 - Pharmacokinetics (Continued...)

Lecture 3 - Pro-drugs and Polymers Introduction

Lecture 4 - Polymers - Synthesis

Lecture 5 - Polymers - Properties

Lecture 6 - Biomedical Polymers

Lecture 7 - Biodegradable Polymers and Polymer Drug Conjugates - I

Lecture 8 - Polymer Drug Conjugates - II

Lecture 9 - Research Paper Discussion and Diffusion Controlled Systems

Lecture 10 - Controlled Release: Reservoir System - I

Lecture 11 - Controlled Release: Reservoir Systems and Non-erodible Systems

Lecture 12 - Controlled Release: Non-erodible Systems and Erodible systems

Lecture 13 - Math Exercise

Lecture 14 - Hydrogels - I

Lecture 15 - Hydrogels - II

Lecture 16 - Hydrogels - III

Lecture 17 - Hydrogels - IV

Lecture 18 - Nano and Micro-particles - I

Lecture 19 - Nano and Micro-particles - II

Lecture 20 - Nano and Micro-particles - III

Lecture 21 - Nano and Micro-particles - IV

Lecture 22 - Nano and Micro-particles - V

Lecture 23 - Nano and Micro-particles - VI

Lecture 24 - Nano and Micro-particles - VII

Lecture 25 - Protein Adsorption - I

Lecture 26 - Protein Adsorption - II

Lecture 27 - Protein Adsorption - III

Lecture 28 - Tissue Engineering - I

Lecture 29 - Tissue Engineering - II

Lecture 30 - Tissue Engineering - III

Lecture 31 - Drug Delivery in Tissue Engineering - I

- Lecture 32 - Drug Delivery in Tissue Engineering - II
- Lecture 33 - Implant Associated Infections - I
- Lecture 34 - Implant Associated Infections - II
- Lecture 35 - Route Specific Delivery: Oral Route - I
- Lecture 36 - Route Specific Delivery: Oral Route - II
- Lecture 37 - Route Specific Delivery: Oral and Subcutaneous Route
- Lecture 38 - Route Specific Delivery: Intramuscular, Transdermal - I
- Lecture 39 - Route Specific Delivery: Transdermal - II
- Lecture 40 - Route Specific Delivery: Transdermal and Inhalation Route
- Lecture 41 - Route Specific Delivery: Inhalation - II, Buccal and Rectal Administration
- Lecture 42 - Research Paper Discussion: Dry Powder Particle Delivery
- Lecture 43 - Route Specific Delivery: Intra-articular and Intravenous Administration
- Lecture 44 - Intravenous Administration: Approved Nanocarriers and Immune System
- Lecture 45 - Immune System - II
- Lecture 46 - Complement System and Blood Clotting
- Lecture 47 - Blood Clotting and Hemocompatibility of Materials; Adaptive Immune Response
- Lecture 48 - Adaptive Immune Response and Vaccine
- Lecture 49 - Vaccines
- Lecture 50 - Vaccines and Immuno-isolated Cell Therapy
- Lecture 51 - Immuno-isolated Cell Therapy
- Lecture 52 - Immuno-isolated Cell and Gene Therapy
- Lecture 53 - Gene Delivery: Vectors
- Lecture 54 - Gene Delivery: Polymers
- Lecture 55 - Genes as Vaccines
- Lecture 56 - Vaccines: Gene Delivery and Other Variants
- Lecture 57 - Cancer Vaccines
- Lecture 58 - Cancer Vaccine: Immunotherapy
- Lecture 59 - Responsive Delivery Systems - I
- Lecture 60 - Responsive Delivery Systems - II
- Lecture 61 - Targeted Drug Delivery System
- Lecture 62 - Targeted Drug Delivery System: Research Paper Discussion
- Lecture 63 - Nanotoxicology and Translation Pathways

Lecture 1 - Introduction

Lecture 2 - Substrate

Lecture 3 - Substrate (Continued...)

Lecture 4 - Introduction to cleanroom

Lecture 5 - Contamination and surface cleaning

Lecture 6 - Advanced cleaning techniques

Lecture 7 - Defects

Lecture 8 - Diffusion

Lecture 9 - Diffusion - Advanced Concepts

Lecture 10 - Ion Implantation

Lecture 11 - Ion Implantation (Continued...)

Lecture 12 - Native Films

Lecture 13 - Native Films: Advanced Concepts

Lecture 14 - Native Films: Defects at Si/SiO₂ interface

Lecture 15 - Methods and Some Definitions

Lecture 16 - Chemical Vapor Deposition: Basics

Lecture 17 - Chemical Vapor Deposition: Precursor Transport

Lecture 18 - Chemical Vapor Deposition: Types of CVD Equipment

Lecture 19 - Chemical Vapor Deposition: Nucleation and Growth

Lecture 20 - Chemical Vapor Deposition: Other Details

Lecture 21 - Atomic Layer Deposition

Lecture 22 - Atomic Layer Deposition (Continued...)

Lecture 23 - Physical Vapor Deposition: Basics

Lecture 24 - Physical Vapor Deposition: Evaporation

Lecture 25 - Physical Vapor Deposition: Sputtering

Lecture 26 - Metallization: Contact resistance

Lecture 27 - Metallization: Electromigration and Epilogue

Lecture 28 - Pattern Transfer Basics

Lecture 29 - Optical lithography basics: resist process - 1

Lecture 30 - Optical lithography basics: resist process - 2

Lecture 31 - Optical Lithography: Contact and Proximity printing

- Lecture 32 - Optical Lithography: Stepper and Scanner
- Lecture 33 - Projection Lithography: Image formation basics
- Lecture 34 - Projection Lithography: Image formation in photoresist
- Lecture 35 - Optical lithography: Surface Reflection
- Lecture 36 - Optical Lithography: Mask Technology
- Lecture 37 - Lithography process technology glossary
- Lecture 38 - Optical Lithography: Resolution enhancement
- Lecture 39 - Electron beam lithography: Basics
- Lecture 40 - Electron beam lithography: Resist process
- Lecture 41 - Emerging lithography techniques
- Lecture 42 - Etching Figures of Merit
- Lecture 43 - Wet etching Basics
- Lecture 44 - Wet Etching Recipes
- Lecture 45 - Wet Etching Recipes
- Lecture 46 - Dry etch: Plasma Basics
- Lecture 47 - Dry etch: Plasma etching basics
- Lecture 48 - Dry etch: Plasma tool configuration
- Lecture 49 - Dry etch: Etch mechanism
- Lecture 50 - Dry etch: Etch chemistry
- Lecture 51 - Chemical Mechanical Polishing (CMP): Basics
- Lecture 52 - Chemical Mechanical Polishing (CMP): Tool and process
- Lecture 53 - Design for Manufacturability - 1
- Lecture 54 - Design for Manufacturability - 2
- Lecture 55 - Design for Manufacturability: Case study
- Lecture 56 - Process integration
- Lecture 57 - PV integration
- Lecture 58 - CMOS integration
- Lecture 59 - Lab demo: Silicon Nitride cantilever fabrication - 1
- Lecture 60 - Lab demo: Silicon Nitride cantilever fabrication - 2
- Lecture 61 - CMOS process for photonics application

**NPTEL : NOC:Optical Spectroscopy and Microscopy: Fundamentals of Optical Measurements and Instrumentation
(Biotechnology)**

Co-ordinators : Prof. Balaji Jayaprakash

- Lecture 1 - Optical Focus and Localisation of Light
- Lecture 2 - Relating Photon's Momentum to Spot Size
- Lecture 3 - Shortest Pulse of Light: How fast can we shutter the light?
- Lecture 4 - Behaviour of light through polarizers: Introduction
- Lecture 5 - Nature of Light: Introduction to Photo Multiplier Tubes
- Lecture 6 - Revisiting Polarisation Through Ket Vectors
- Lecture 7 - Light through Polarisers: Detailed Description - I
- Lecture 8 - Light through Polarisers: Detailed Description - II
- Lecture 9 - Time Dependent Perturbation Theory (TDPT): Overview
- Lecture 10 - TDPT in Steps-1: Unperturbed and Perturbed Hamiltonian
- Lecture 11 - TDPT in Steps-2: Introducing the switch and first approximation
- Lecture 12 - TDPT in Steps-3: Finding the co-efficients
- Lecture 13 - Fermi's Golden Rule
- Lecture 14 - Beer Lambert's Law from TDPT
- Lecture 15 - Einstein's Phenomenology
- Lecture 16 - Einstein's Coefficients, Fluorescence and Lifetime
- Lecture 17 - Fock States and Photonic Treatment of Light
- Lecture 18 - Operators in Fock State Space
- Lecture 19 - Light Matter Interaction and Rudimentary Feynman Diagrams
- Lecture 20 - Emergence of Spontaneous and Stimulated Emission Processes
- Lecture 21
- Lecture 22
- Lecture 23
- Lecture 24
- Lecture 25
- Lecture 26 - Introduction to LASER
- Lecture 27 - LASER population dynamics
- Lecture 28 - LASER population dynamics - Part- 2
- Lecture 29 - Real world LASER and characteristics of LASER emission
- Lecture 30 - Temporal and Spatial Coherence

- Lecture 31 - Transverse and Longitudinal modes of LASER
- Lecture 32 - Pulsed LASER
- Lecture 33 - Q-switching in detail
- Lecture 34 - Q-switching in detail - Part 2
- Lecture 35 - Basics of mode locking
- Lecture 36 - Basics of mode locking - Part 2
- Lecture 37 - Pulse compression
- Lecture 38 - Real world system (Mode lock Part-2)
- Lecture 39 - TEM mode
- Lecture 40 - Alignment basics
- Lecture 41 - Non-Linear Optics
- Lecture 42 - Confocal Detection
- Lecture 43 - Interference Filters
- Lecture 44 - Laser Scanning System - 1
- Lecture 45 - Laser Scanning System - 2
- Lecture 46 - Alignment of Moving Beams
- Lecture 47 - Decoding an Objective Lens - 1
- Lecture 48 - Decoding an Objective Lens - 2
- Lecture 49 - Designing Lens Systems
- Lecture 50 - Astigmatism and Field Curvature
- Lecture 51 - Intro to Lab Session
- Lecture 52 - Optics in LAB: Aligning light through an optical fiber - 1
- Lecture 53 - Optics in Lab: Telescope
- Lecture 54 - Kinematic Mounts
- Lecture 55 - Alignment with out iris
- Lecture 56 - Fluorescence Spectrometer - 1
- Lecture 57 - Fluorescence Spectrometer - 2
- Lecture 58 - Ti:Sapphire Laser and Two Photon Fluorescence

Lecture 1 - Introduction to Cell Biology, Cell components, organization and processes - Part I

Lecture 2 - Introduction to Cell Biology, Cell components, organization and processes - Part II

Lecture 3 - DNA: The genetic material - Part I

Lecture 4 - DNA: The genetic material - Part II

Lecture 5 - Regulation of the cell cycle - Part I

Lecture 6 - Regulation of the cell cycle - Part II

Lecture 7 - Checkpoints: The DNA damage and DNA replication checkpoints

Lecture 8 - The Ubiquitin Proteasome system

Lecture 9 - S-phase: Regulation of entry into S-phase and DNA Replication

Lecture 10 - DNA replication - Part I

Lecture 11 - DNA Replication - Part II

Lecture 12 - DNA Replication - Part III

Lecture 13 - DNA Replication - Part IV

Lecture 14 - Mitosis - Part I

Lecture 15 - Cytokinesis

Lecture 16 - Aging and Senescence

Lecture 17 - Apoptosis - Part I

Lecture 18 - Apoptosis - Part II

Lecture 19 - Meiosis - Part I

Lecture 20 - Meiosis - Part II

Lecture 21 - Nuclear organization

Lecture 22 - SMC proteins and chromosome organization - Real-Time imaging of DNA loop-extrusion by SMC complexes

Lecture 23 - The cohesin complex and its functions - The mysterious biological function of chromosome loops

Lecture 24 - Chromatin organization

Lecture 25 - SMC proteins and chromosome organization - Introduction

Lecture 26 - Meiosis - Part III

Lecture 27 - Mitosis - Part II

Lecture 28 - Cell diversity and properties of specialized cells-Budding yeast as a model system

Lecture 29 - The Plant Cell

Lecture 30 - Stem cells - Part I Intro-SL

Lecture 31 - Stem cells - Part II

[Lecture 32 - Nerve cells](#)

[Lecture 33 - The Cancer Cell](#)

Lecture 1 - Course Overview - I

Lecture 2 - Course Overview - II

Lecture 3 - Design Equations - I

Lecture 4 - Design Equations - Illustrative Examples

Lecture 5 - Design Equations - II : Plug Flow Recycle Reactors

Lecture 6 - Illustrative Examples : 1) Plug Flow Recycle 2) Multiple reactions - I

Lecture 7 - Illustrative Examples : 1) Recycle Reactor with Condenser 2) CSTR with Recycle

Lecture 8 - Multiple Reactions - II

Lecture 9 - Modelling Multiple Reactions in Soil Environment - III

Lecture 10 - Semi Continuous Reactor Operation

Lecture 11 - Catalyst Deactivation - I

Lecture 12 - Catalyst Deactivation - II

Lecture 13 - Illustrative Example : 1) Determination of deactivation Parameters 2) Design for Deactivating Catalyst

Lecture 14 - Energy Balance - I

Lecture 15 - Energy Balance - II

Lecture 16 - Reacting Fluids as Energy Carrier

Lecture 17 - Illustrative Example : Energy Balance in Stirred Vessels

Lecture 18 - Energy Balance - III : Design for Constant T Operation

Lecture 19 - Energy Balance - IV : Temperature Effects on Rate & Equilibria

Lecture 20 - Energy Balance - V : Stability Analysis of Exothermic Stirred Tank

Lecture 21 - Illustrative Example : Stability of Exothermic Stirred Tank

Lecture 22 - Energy Balance - VI : 1) Tubular Reactor Heated/Cooled from Wall 2) Transient Behavior of CSTR

Lecture 23 - Illustrative Example : 1) Plug Flow with Heat Effects 2) Multiple Reactions

Lecture 24 - Illustrative Example : 1) Further Considerations in Energy Balance 2) Multiple Reactions

Lecture 25 - Illustrative Example : 1) Hot Spot as Design Basis 2) Design for Instantaneous Reactions

Lecture 26 - Residence Time Distribution Methods

Lecture 27 - Residence Time Distribution Models

Lecture 28 - Shrinking core Gas-Solid reactions Model

Lecture 29 - Shrinking core Ash Diffusion Model & Combination of Resistances

Lecture 30 - 1) Gas Solid Reactions Temperature Effects on Rate & Equilibria 2) Introduction to Population Balance - I

Lecture 31 - Illustrative Example : Temperature Effects on Rate & Equilibria

[Lecture 32 - Population Balance Modelling - II](#)

[Lecture 33 - Population Balance Modelling - III](#)

[Lecture 34 - Illustrative Examples : Population Balance Models](#)

[Lecture 35 - Introduction to Environmental Reactions](#)

[Lecture 36 - Reaction Engineering Examples in Biochemical & Environmental Engineering](#)

[Lecture 37 - Illustrative Examples : 1\) Biomethanation 2\) Alcohol via Fermentation 3\) Natural Selection](#)

[Lecture 38 - Illustrative Examples : 1\) Enzyme Reaction 2\) Microbial Reaction 3\) Waste Treatment](#)

[Lecture 39 - Oxygen Sag Analysis in Rivers](#)

[Lecture 40 - Illustrative Examples : 1\) Oxygen Sag Analysis 2\) Population Balance Modelling of Forest 3\) Sponge Iron Process](#)

[Lecture 41 - Illustrative Example : Gas- Solid Reaction RTD Models Reaction Network](#)

Lecture 1 - Introduction and Motivation

Lecture 2 - Linearization of Mechanistic Models

Lecture 3 - Linearization of Mechanistic Models (Continued...)

Lecture 4 - Introduction to z-transforms and Development of Grey-box models

Lecture 5 - Introduction to Stability Analysis and Development of Output Error Models

Lecture 6 - Introduction to Stochastic Processes

Lecture 7 - Introduction to Stochastic Processes (Continued...)

Lecture 8 - Development of ARX models

Lecture 9 - Statistical Properties of ARX models and Development of ARMAX models

Lecture 10 - Development of ARMAX models (Continued...) and Issues in Model Development

Lecture 11 - Model Structure Selection and Issues in Model Development (Continued...)

Lecture 12 - Issues in Model Development (Continued...) and State Realizations of Transfer Function Models

Lecture 13 - Stability Analysis of Discrete Time Systems

Lecture 14 - Lyapunov Functions and Interaction Analysis and Multi-loop Control

Lecture 15 - Interaction Analysis and Multi-loop Control (Continued...)

Lecture 16 - Multivariable Decoupling Control and Soft Sensing and State Estimation

Lecture 17 - Development of Luenberger Observer

Lecture 18 - Development of Luenberger Observer (Continued...) and Introduction to Kalman Filtering

Lecture 19 - Kalman Filtering

Lecture 20 - Kalman Filtering (Continued...)

Lecture 21 - Kalman Filtering (Continued...)

Lecture 22 - Pole Placement State Feedback Control Design and Introduction to Linear Quadratic Gaussian (LQG) Control

Lecture 23 - Linear Quadratic Gaussian (LQG) Regulator Design

Lecture 24 - Linear Quadratic Gaussian (LQG) Controller Design

Lecture 25 - Model Predictive Control (MPC)

Lecture 26 - Model Predictive Control (Continued...)

Lecture 1 - Introduction to catalysts and catalysis

Lecture 2 - Steps in catalytic reaction: adsorption, desorption and reaction

Lecture 3 - Derivation of the rate equation

Lecture 4 - Heterogenous data analysis for reactor design - I

Lecture 5 - Heterogenous data analysis for reactor design - II

Lecture 6 - Catalyst deactivation and accounting for it in design - I

Lecture 7 - Catalyst deactivation and accounting for it in design - II

Lecture 8 - Synthesize the rate equation

Lecture 9 - Introduction to intraparticle diffusion

Lecture 10 - Intraparticle diffusion: Thiele modulus and effectiveness factor Part - I

Lecture 11 - Intraparticle diffusion: Thiele modulus and effectiveness factor Part - II

Lecture 12 - Intraparticle diffusion: Thiele modulus and effectiveness factor Part - III

Lecture 13 - Effectiveness factor and Introduction to external mass transfer

Lecture 14 - External Mass Transfer

Lecture 15 - Implications to rate data interpretation and design - I

Lecture 16 - Implications to rate data interpretation and design - II

Lecture 17 - Packed-bed reactor design

Lecture 18 - Fluidized bed reactor design - I

Lecture 19 - Fluidized bed reactor design - II

Lecture 20 - Gas-liquid reactions-1: Theories of mass transfer into agitated liquids

Lecture 21 - GLR-2: Effect of chemical reaction on mass transfer: the slow reaction regime

Lecture 22 - GLR-3: Transition to fast reaction, and the Fast reaction regime

Lecture 23 - GLR-4: Fast reaction example; Instantaneous reaction regime

Lecture 24 - GLR-5: Transition to Instantaneous reaction; Reaction regimes in surface renewal theories

Lecture 25 - GLR-6: Reaction regimes in surface renewal theories (Continued..)

Lecture 26 - GLR-7: Surface renewal theories: Instantaneous reaction and Summing up

Lecture 27 - Fluid-solid non-catalytic reactions - I

Lecture 28 - Fluid-solid non-catalytic reactions - II

Lecture 29 - Fluid-solid non-catalytic reactions - III

Lecture 30 - Distribution of residence time

Lecture 31 - Measurement of residence time distribution

[Lecture 32 - Residence time distribution function](#)

[Lecture 33 - Reactor diagnostics and troubleshooting](#)

[Lecture 34 - Modeling non-ideal reactors](#)

[Lecture 35 - Residence time distribution: Performance of non-ideal reactors](#)

[Lecture 36 - Non-ideal Reactors: Tanks-in-series model](#)

[Lecture 37 - Non-ideal Reactors: Dispersion model](#)

[Lecture 38 - Non-ideal Reactors: Dispersion model and introduction to multiparameter models](#)

[Lecture 39 - Non-ideal Reactors: Multiparameter models](#)

Lecture 1 - Introduction and Overview

Lecture 2 - Fundamentals of Vector Spaces

Lecture 3 - Basic Dimension and Sub-space of a Vector Space

Lecture 4 - Introduction to Normed Vector Spaces

Lecture 5 - Examples of Norms, Cauchy Sequence and Convergence, Introduction to Banach Spaces

Lecture 6 - Introduction to Inner Product Spaces

Lecture 7 - Cauchy Schwarz Inequality and Orthogonal Sets

Lecture 8 - Gram-Schmidt Process and Generation of Orthogonal Sets

Lecture 9 - Problem Discretization Using Appropriation Theory

Lecture 10 - Weierstrass Theorem and Polynomial Approximation

Lecture 11 - Taylor Series Approximation and Newton's Method

Lecture 12 - Solving ODE - BVPs Using Finite Difference Method

Lecture 13 - Solving ODE - BVPs and PDEs Using Finite Difference Method

Lecture 14 - Finite Difference Method (Continued...) and Polynomial Interpolations

Lecture 15 - Polynomial and Function Interpolations, Orthogonal Collocations Method for Solving ODE -BVPs

Lecture 16 - Orthogonal Collocations Method for Solving ODE - BVPs and PDEs

Lecture 17 - Least Square Approximations, Necessary and Sufficient Conditions for Unconstrained Optimization

Lecture 18 - Least Square Approximations -Necessary and Sufficient Conditions for Unconstrained Optimization Least Square Approximations (Continued....)

Lecture 19 - Linear Least Square Estimation and Geometric Interpretation of the Least Square Solution

Lecture 20 - Geometric Interpretation of the Least Square Solution (Continued...) and Projection Theorem in a Hilbert Spaces

Lecture 21 - Projection Theorem in a Hilbert Spaces (Continued...) and Approximation Using Orthogonal Basis

Lecture 22 - Discretization of ODE-BVP using Least Square Approximation

Lecture 23 - Discretization of ODE-BVP using Least Square Approximation and Galerkin Method

Lecture 24 - Model Parameter Estimation using Gauss-Newton Method

Lecture 25 - Solving Linear Algebraic Equations and Methods of Sparse Linear Systems

Lecture 26 - Methods of Sparse Linear Systems (Continued...) and Iterative Methods for Solving Linear Algebraic Equations

Lecture 27 - Iterative Methods for Solving Linear Algebraic Equations

Lecture 28 - Iterative Methods for Solving Linear Algebraic Equations: Convergence Analysis using Eigenvalues

Lecture 29 - Iterative Methods for Solving Linear Algebraic Equations: Convergence Analysis using Matrix Norms

Lecture 30 - Iterative Methods for Solving Linear Algebraic Equations: Convergence Analysis using Matrix Norms (Continued...)

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[Lecture 31 - Iterative Methods for Solving Linear Algebraic Equations: Convergence Analysis \(Continued...\)](#)

[Lecture 32 - Optimization Based Methods for Solving Linear Algebraic Equations: Gradient Method](#)

[Lecture 33 - Conjugate Gradient Method, Matrix Conditioning and Solutions of Linear Algebraic Equations](#)

[Lecture 34 - Matrix Conditioning and Solutions and Linear Algebraic Equations \(Continued...\)](#)

[Lecture 35 - Matrix Conditioning \(Continued...\) and Solving Nonlinear Algebraic Equations](#)

[Lecture 36 - Solving Nonlinear Algebraic Equations: Wegstein Method and Variants of Newton's Method](#)

[Lecture 37 - Solving Nonlinear Algebraic Equations: Optimization Based Methods](#)

[Lecture 38 - Solving Nonlinear Algebraic Equations: Introduction to Convergence analysis of Iterative Solution Techniques](#)

[Lecture 39 - Solving Nonlinear Algebraic Equations: Introduction to Convergence analysis \(Continued...\) and Solving ODE-IVPs](#)

[Lecture 40 - Solving Ordinary Differential Equations - Initial Value Problems \(ODE-IVPs\) : Basic Concepts](#)

[Lecture 41 - Solving Ordinary Differential Equations - Initial Value Problems \(ODE-IVPs\) : Runge Kutta Methods](#)

[Lecture 42 - Solving ODE-IVPs : Runge Kutta Methods \(Continued...\) and Multi-step Methods](#)

[Lecture 43 - Solving ODE-IVPs : Generalized Formulation of Multi-step Methods](#)

[Lecture 44 - Solving ODE-IVPs : Multi-step Methods \(Continued...\) and Orthogonal Collocations Method](#)

[Lecture 45 - Solving ODE-IVPs: Selection of Integration Interval and Convergence Analysis of Solution Schemes](#)

[Lecture 46 - Solving ODE-IVPs: Convergence Analysis of Solution Schemes \(Continued...\)](#)

[Lecture 47 - Solving ODE-IVPs: Convergence Analysis of Solution Schemes \(Continued...\) and Solving ODE-BVP using Single Shooting Method](#)

[Lecture 48 - Methods for Solving System of Differential Algebraic Equations](#)

[Lecture 49 - Methods for Solving System of Differential Algebraic Equations \(Continued...\) and Concluding Remarks](#)

Lecture 1 - History of the theory of Natural Selection - 1

Lecture 2 - History of the theory of Natural Selection - 2

Lecture 3 - Exponential growth models

Lecture 4 - Logistic Growth Models - 1

Lecture 5 - Logistic Growth Models - 2

Lecture 6 - Modelling selection - 1

Lecture 7 - Modelling Selection - 2 : Two species

Lecture 8 - Modelling Selection - 3 : Two and more species

Lecture 9 - Modelling Mutations - 1

Lecture 10 - Modelling Mutations - 2

Lecture 11 - Modelling Mutations - 3

Lecture 12 - Genetic Code and Sequence Spaces

Lecture 13 - Sequence Spaces as Networks

Lecture 14 - Sequence Space to Fitness Landscape

Lecture 15 - Properties of Fitness Landscapes and Quasi-species

Lecture 16 - Integrating Reproduction, Selection and Mutation

Lecture 17 - Obtaining Fitness Landscapes Experimentally

Lecture 18 - NK Model of Fitness Landscape

Lecture 19 - Modelling Evolution on Fitness Landscapes - 1

Lecture 20 - Modelling Evolution on Fitness Landscapes - 2

Lecture 21 - Modelling Evolution on Fitness Landscapes - 3

Lecture 22 - Role of Randomness in Evolution

Lecture 23 - Genetic Drift in Evolution of Microbial Populations

Lecture 24 - Dynamics of a Moran Process without Selection

Lecture 25 - Dynamics of a Moran Process without Selection

Lecture 26 - Evolution, Selection, and Genetic Drift

Lecture 27 - Representing Microbial Evolution

Lecture 28 - Estimating Timescales of Evolution

Lecture 29 - Estimating the Speed of Microbial Evolution

Lecture 30 - Evolutionary Dynamics when Mutations are Rare

Lecture 31 - Evolutionary Dynamics when Mutations are Rapid - 1

[Lecture 32 - Evolutionary Dynamics when Mutations are Rapid - 2](#)

[Lecture 33 - Evolutionary Dynamics when Mutations are Rapid - 3](#)

[Lecture 34 - Evolutionary Game Theory - 1](#)

[Lecture 35 - Evolutionary Game Theory - 2](#)

[Lecture 36 - Evolutionary Game Theory - 3](#)

[Lecture 37 - Evolutionary Game Theory - 4](#)

[Lecture 38 - Evolutionary Game Theory Applied to Moran Process](#)

[Lecture 39 - Evolutionary Games During Weak Selection](#)

[Lecture 40 - Evolutionary Dynamics of HIV](#)

Lecture 1 - Introduction

Lecture 2 - Introduction to Conduction

Lecture 3 - Energy Balance

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Lecture 2 - General Introduction, Definitions, Surface Tension

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Lecture 21 - Equations of State, Cohesion Repulsion, Limiting Area

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- Lecture 2 - General heat conduction equation
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- Lecture 4 - One dimensional steady state conduction in cylindrical and spherical coordinate
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- Lecture 8 - Analysis of lumped parameter model
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- Lecture 12 - Dimensional analysis for forced convection
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- Lecture 17 - Heat transfer co-relations for flow across tube banks
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- Lecture 20 - Boundary layer equations
- Lecture 21 - Approximate analysis in boundary layer
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NPTEL : Mass Transfer Operations I (Chemical Engineering)

Co-ordinators : Dr. B. Mandal

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- Lecture 3 - Fick's Law of Diffusion
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- Lecture 8 - Multicomponent Diffusion and Diffusivity in Solids
- Lecture 9 - Concept of Mass Transfer Coefficient
- Lecture 10 - Dimensionless Groups and Co-relations for Convective
- Lecture 11 - Mass Transfer co-efficient in Laminar Flow Condition
- Lecture 12 - Boundary Layer Theory and Film Theory in Mass Transfer
- Lecture 13 - Mass Transfer Coefficients in Turbulent Flow
- Lecture 14 - Interphase Mass Transfer and Mass Transfer Theories - Part I
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- Lecture 17 - Agitated and Sparged Vessels
- Lecture 18 - Tray Column - Part I
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- Lecture 25 - Mass Transfer Coefficients Correlation and HETP Concept
- Lecture 26 - Tray Tower Design and Introduction to Multicomponent System
- Lecture 27 - Introduction to Distillation and Phase diagrams
- Lecture 28 - Azeotropes and Enthalpy Concentration Diagrams
- Lecture 29 - Flash Distillation
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Lecture 14 - Reactor Non-ideality, Residence Time Distribution (RTD) and Types of Chemical Reactions & Catalysts

Lecture 15 - Types of Reactors and Selection Criteria

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- Lecture 29 - PV principle, advantages, mass transfer and applications, hybrid distillation/PV
- Lecture 30 - Problems and solutions based on ED and PV
- Lecture 31 - Concept, types of LM, mechanism of mass transfer in LM, choice of solvent and carrier, applications

[Lecture 32 - Basic principle of gas separation, transport mechanism, factors affecting gas separation, applications](#)

[Lecture 33 - Basic principle of MD, mechanism, process parameters, membranes, applications](#)

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Lecture 8 - Supplementary: Preliminary Statistical analysis for metaheuristic techniques

Lecture 9 - Supplementary: Preliminary Statistical analysis - MATLAB implementation

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- Lecture 2 - Basic Features of Chemical Process
- Lecture 3 - Unit systems and dimensions
- Lecture 4 - Variables and Properties of Material in System
- Lecture 5 - Pressure and Temperature of Flow Process
- Lecture 6 - Rate of Process
- Lecture 7 - Principles of material balance and calculation
- Lecture 8 - Material Balances on Processes with Recycle and Bypass
- Lecture 9 - Material balances on reactive processes
- Lecture 10 - Material balances on combustion reactions
- Lecture 11 - State Equation of Ideal Gas and Calculation
- Lecture 12 - State Equation of non-Ideal Gas and Calculation
- Lecture 13 - Phase equilibrium
- Lecture 14 - Equilibrium Laws, Humidity and Saturation
- Lecture 15 - Humidity, Saturation Psychrometric chart
- Lecture 16 - Process of phase change: Condensation and vaporization
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NPTEL : Fluid Mechanics (Chemical Engineering)

Co-ordinators : Dr. V. Shankar

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NPTEL : Mass Transfer II (Chemical Engineering)

Co-ordinators : Prof. Nishith Verma

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Lecture 2 - Introduction (Continued...)

Lecture 3 - Optimum design and design documentation

Lecture 4 - Introduction to Mass Transfer Processes

Lecture 5 - Phase Equilibrium

Lecture 6 - Phase Equilibrium (Continued...)

Lecture 7 - Phase Equilibrium (Continued...)

Lecture 8 - Distillation

Lecture 9 - Flash Distillation and Design problem

Lecture 10 - Fractionation

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Lecture 12 - McCabe-Thiele construction for number of ideal stages

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Lecture 14 - Multi-component fractionation design

Lecture 15 - Batch Distillation

Lecture 16 - Practical issues in designing distillation processes

Lecture 17 - Design of absorbers

Lecture 18 - Design of absorbers (Continued...)

Lecture 19 - Design of absorbers (Continued...)

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Lecture 21 - Tower and Tower internals (Continued...)

Lecture 22 - Tower and Tower internals (Continued...)

Lecture 23 - Sieve Tray Design

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Lecture 25 - Sieve Tray Design (Continued...)

Lecture 26 - Bubble Cap Tray Design

Lecture 27 - Bubble Cap Tray Design (Continued...)

Lecture 28 - Bubble Cap Tray Design (Continued...)

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- Lecture 62 - Process Design using Simulators
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Lecture 10 - PDE - Integral transforms

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Lecture 12 - Stability of finite difference schemes

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Lecture 14 - Numerical solution of implicit formulation - Tridiagonal matrix

Lecture 15 - Numerical solution of PDE - Finite volume method

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- Lecture 32 - FUG method of stage calculations
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- Lecture 54 - Solution of the population balance equation
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Lecture 8 - Phase plane analysis of linear autonomous second order systems (Continued...)

Lecture 9 - Analysis of a free spring-mass system

Lecture 10 - Analysis of a free spring-mass system (Continued...)

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Lecture 12 - Similarity solution for non-autonomous higher order dynamics

Lecture 13 - Similarity solution for non-autonomous higher order dynamics (Continued...)

Lecture 14 - Analysis of a forced spring-mass system

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Lecture 16 - Phase portraits of linear autonomous systems of order three and higher

Lecture 17 - Phase portraits of linear autonomous systems of order three and higher (Continued...)

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Lecture 20 - Analysis of complex reaction systems (Continued...)

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Lecture 22 - Logistic population growth model

Lecture 23 - Logistic population growth model (Continued...)

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Lecture 26 - Logistic population growth with threshold population

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Lecture 30 - Analysis of fixed points and bifurcation in discrete domain (Continued...)

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NPTEL : NOC:Metallocene and Metal-Carbene based Organometallic Compounds as Industrially Important Advanced Polyolefin Catalysts (Chemical Engineering)

Co-ordinators : Prof. Sanjib K. Patra

Lecture 1 - A Brief Introduction to Polymers

Lecture 2 - A Brief Introduction to Polymers (Continued...)

Lecture 3 - Polyethylene and Polypropylene: Chemical structure and properties

Lecture 4 - Polyethylene and Polypropylene: Chemical structure and properties (Continued...)

Lecture 5 - Common polymerization protocol and mechanism

Lecture 6 - Common polymerization protocol and mechanism (Continued...)

Lecture 7 - Common polymerization protocol and mechanism: Controlled Polymerization

Lecture 8 - Anionic living polymerization and Coordination polymerization

Lecture 9 - Transition metal/Organometallic complexes: Unique reactions

Lecture 10 - Metallocene compounds: Structure and Bonding

Lecture 11 - Metallocene compounds: Structure and Bonding (Continued...)

Lecture 12 - Bonding in Metallocene, MOT and Electronic nature

Lecture 13 - Bonding and Electronic nature in Bent Metallocene

Lecture 14 - Bonding and Electronic nature in Bent Metallocene (Continued...)

Lecture 15 - General Synthetic Strategies for Metallocenes (Parallel and Bent)

Lecture 16 - Properties and Unique Reactivities of parallel and bent Metallocenes

Lecture 17 - Unique Reactivities of bent Metallocenes

Lecture 18 - Unique Reactivities of bent Metallocenes (Continued...)

Lecture 19 - Coordination polymerization of olefin and stereoregularity

Lecture 20 - Olefin polymerization by Zeigler Natta Catalyst: Important features

Lecture 21 - Coordination polymerization of olefin by Metallocene Catalysts: A new avenue in polyolefin catalysts

Lecture 22 - Coordination polymerization of olefin by Metallocene Catalysts: A new avenue in polyolefin catalysts (Continued...)

Lecture 23 - Symmetry of metallocene and Stereoregularity in polyolefin

Lecture 24 - Symmetry of metallocene and Stereoregularity in polyolefin (Continued...)

Lecture 25 - Metallocene to Post-metallocene catalysts for olefin polymerization

Lecture 26 - Metallocene to Post-metallocene catalysts for olefin polymerization (Continued...)

Lecture 27 - Polymerization strategy for industrial preparation of LLDPE

Lecture 28 - Polymerization strategy for industrial preparation of LLDPE (Continued...)

Lecture 29 - Metallocene and Post-metallocene Catalysts: Homogeneous to Heterogeneous and Lab to Industry

Lecture 30 - Metallocene and Post-metallocene Catalysts: Homogeneous to Heterogeneous and Lab to Industry (Continued...)

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[Lecture 31 - Depolymerization of synthetic polymers: Role of organometallic and metallocene based catalysts](#)

[Lecture 32 - Depolymerization of synthetic polymers: Role of organometallic and metallocene based catalysts](#)

[Lecture 33 - Metal-carbene complexes as versatile catalysts for multiple useful reactions: A short introduction](#)

[Lecture 34 - Metal-carbene complexes as versatile catalysts for multiple useful reactions: A short introduction \(Continued...\)](#)

[Lecture 35 - Bonding and Electronic properties in Metal-carbene complexes](#)

[Lecture 36 - General synthetic protocol of Metal-carbene complexes](#)

[Lecture 37 - N-Heterocyclic carbene \(NHC\) complex: Bonding and General synthetic protocol](#)

[Lecture 38 - Alkene metathesis by metal-carbene catalysts and its mechanism](#)

[Lecture 39 - Utility of metal-carbene catalysts in alkene polymerization](#)

[Lecture 40 - Industrially important polymers by ROMP: Recent development and scope; Overall summary of this course](#)

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- Lecture 2 - Kinematics - 2
- Lecture 3 - Kinematics - 3
- Lecture 4 - Kinematics - 4
- Lecture 5 - Kinematics - 5 - Shear Stress
- Lecture 6 - Kinematics - 6 and Conservation Equation - 1
- Lecture 7 - Conservation Equation - 2
- Lecture 8 - Conservation Equation - 3 - Conservation of Momentum
- Lecture 9 - Conservation Equation - 4 - Conservation of Momentum - 2
- Lecture 10 - Conservation Equation - 5 - Conservation of Momentum - 3
- Lecture 11 - Exact Solution - 1
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- Lecture 14 - Exact Solution - 4
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- Lecture 16 - Boundary Layer Analysis - 2
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- Lecture 18 - Boundary Layer Analysis - 4: Blasius Solution - 1
- Lecture 19 - Boundary Layer Analysis - 4: Blasius Solution - 2
- Lecture 20 - Boundary Layer Analysis - 5: Momentum Integral Method - 1
- Lecture 21 - Boundary Layer Analysis - 6: Momentum Integral Method - 2
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- Lecture 29 - Turbulence - 7
- Lecture 30 - Turbulence - 8 and Final Wrap-up
- Lecture 31 - Fundamentals and Mechanism of Heat Transfer

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[Lecture 33 - Fundamentals and Mechanism of Heat Transfer \(Continued...\)](#)

[Lecture 34 - Fundamentals and Mechanism of Heat Transfer \(Continued...\)](#)

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Lecture 2 - Introduction of Structure-Property-Process Correlation of Polymer, Elastomer and Composite - 1

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Lecture 11 - Identification by Chemical Techniques, Implication of National and International Standards alongwith Practical Demonstration

Lecture 12 - Identification by Chemical Techniques, Implication of National and International Standards alongwith Practical Demonstration (Continued...)

Lecture 13 - Identification by Chemical Techniques, Implication of National and International Standards alongwith Practical Demonstration (Continued...)

Lecture 14 - Identification by Chemical Techniques, Implication of National and International Standards alongwith Practical Demonstration (Continued...)

Lecture 15 - Identification by Chemical Techniques, Implication of National and International Standards alongwith Practical Demonstration (Continued...)

Lecture 16 - Introduction of UV-Vis and infrared spectroscopy for polymers, elastomers and composites

Lecture 17 - Introduction of UV-Vis and infrared spectroscopy for polymers, elastomers and composites (Continued...)

Lecture 18 - Introduction of UV-Vis and infrared spectroscopy for polymers, elastomers and composites (Continued...)

Lecture 19 - Introduction of UV-Vis and infrared spectroscopy for polymers, elastomers and composites (Continued...)

Lecture 20 - Introduction of UV-Vis and infrared spectroscopy for polymers, elastomers and composites (Continued...)

Lecture 21 - Application of infrared spectroscopy for blends, modification of polymers, compatibilizaion, coupling etc.

Lecture 22 - Application of infrared spectroscopy for blends, modification of polymers, compatibilizaion, coupling etc.

Lecture 23 - Application of infrared spectroscopy for blends, modification of polymers, compatibilizaion, coupling etc.

Lecture 24 - Practical demonstration on UV-Visible spectroscopy

Lecture 25 - Practical demonstration on FTIR spectroscopy and Sulphur analyzer

Lecture 26 - Introduction to Photoacoustic spectroscopy (PA), Raman spectroscopy, Atomic absorption spectroscopy and Electron spin response (ESR) spectroscopy

Lecture 27 - Introduction to Photoacoustic spectroscopy (PA), Raman spectroscopy, Atomic absorption spectroscopy and Electron spin response (ESR) spectroscopy (Continued...)

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Lecture 28 - Introduction to Photoacoustic spectroscopy (PA), Raman spectroscopy, Atomic absorption spectroscopy and Electron spin response (ESR) spectroscopy (Continued...)

Lecture 29 - Introduction to Photoacoustic spectroscopy (PA), Raman spectroscopy, Atomic absorption spectroscopy and Electron spin response (ESR) spectroscopy (Continued...)

Lecture 30 - Introduction to Photoacoustic spectroscopy (PA), Raman spectroscopy, Atomic absorption spectroscopy and Electron spin response (ESR) spectroscopy (Continued...)

Lecture 31 - NMR Spectroscopy- principles and fundamentals. Application of NMR in polymer, elastomer and composites

Lecture 32 - NMR Spectroscopy- principles and fundamentals. Application of NMR in polymer, elastomer and composites (Continued...)

Lecture 33 - NMR Spectroscopy- principles and fundamentals. Application of NMR in polymer, elastomer and composites (Continued...)

Lecture 34 - NMR Spectroscopy- principles and fundamentals. Application of NMR in polymer, elastomer and composites (Continued...)

Lecture 35 - NMR Spectroscopy- principles and fundamentals. Application of NMR in polymer, elastomer and composites (Continued...)

Lecture 36 - Thermal analysis techniques and application in polymer, elastomer and composites

Lecture 37 - Thermal analysis techniques and application in polymer, elastomer and composites (Continued...)

Lecture 38 - Thermal analysis techniques and application in polymer, elastomer and composites (Continued...)

Lecture 39 - Practical demonstration on TGA, DSC and DMA

Lecture 40 - XRD, XPS and XRF. Principles, Fundamentals and Application in Polymer, Elastomer and Composites

Lecture 41 - XRD, XPS and XRF. Principles, Fundamentals and Application in Polymer, Elastomer and Composites (Continued...)

Lecture 42 - XRD, XPS and XRF. Principles, Fundamentals and Application in Polymer, Elastomer and Composites (Continued...)

Lecture 43 - XRD, XPS and XRF. Principles, Fundamentals and Application in Polymer, Elastomer and Composites (Continued...)

Lecture 44 - XRD, XPS and XRF. Principles, Fundamentals and Application in Polymer, Elastomer and Composites (Continued...)

Lecture 45 - Introduction to microscopy (Optical, AFM) with special reference to electron microscopy (SEM, FESEM and HRTEM)

Lecture 46 - Introduction to microscopy (Optical, AFM) with special reference to electron microscopy (SEM, FESEM and HRTEM) (Continued...)

Lecture 47 - Introduction to microscopy (Optical, AFM) with special reference to electron microscopy (SEM, FESEM and HRTEM) (Continued...)

Lecture 48 - Introduction to microscopy (Optical, AFM) with special reference to electron microscopy (SEM, FESEM and HRTEM) (Continued...)

Lecture 49 - Introduction to microscopy (Optical, AFM) with special reference to electron microscopy (SEM, FESEM and HRTEM) (Continued...)

Lecture 50 - Applications of microscopy in polymers, elastomers and composites

Lecture 51 - Applications of microscopy in polymers, elastomers and composites (Continued...)

Lecture 52 - Practical demonstration on optical microscopy

Lecture 53 - Practical demonstration on atomic force microscopy (AFM)

Lecture 54 - Practical demonstration on image processing using standard software (Image)

Lecture 55 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances

Lecture 56 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances (Continued...)

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[Lecture 57 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances \(Continued...\)](#)

[Lecture 58 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances \(Continued...\)](#)

[Lecture 59 - Chromatography, DETA, Quantification from Rate Dependent Methods, Reverse Engineering and Recent Advances \(Continued...\)](#)

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Lecture 2 - Analysis of the Need of Computers in Process Industries

Lecture 3 - Analysis of the Need of Computers in Process Industries (Continued...)

Lecture 4 - Discussion on Computational Tools available to Chemical Engineers

Lecture 5 - Analysis and Comparison of different Programming Languages

Lecture 6 - MATLAB Primer - Basic Features

Lecture 7 - MATLAB Primer - Writing Codes

Lecture 8 - MATLAB Primer - Coding (Continued...)

Lecture 9 - MATLAB Primer - Coding (Continued...)

Lecture 10 - MATLAB Primer - Plotting and Presentation of Results

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Lecture 12 - LAB 1 - Analysis of Frictional Losses in Pipe Flows Theory and Solution Strategy

Lecture 13 - LAB 1 - Analysis of Frictional Losses in Pipe Flows Solution of the Problem under ...

Lecture 14 - LAB 1 - Analysis of Frictional Losses in Pipe Flows Solution of the Problem under ...

Lecture 15 - LAB 1 - Analysis of Frictional Losses in Pipe Flows Presentation and Interpretation ...

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Lecture 17 - LAB 2 - Steady-state Operation of a Diabatic CSTR Theory and Solution Strategy

Lecture 18 - LAB 2 - Steady-state Operation of a Diabatic CSTR Solution of the Problem under ...

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Lecture 22 - LAB 3 - Analysis of Multicomponent Distillation Theory and Solution Strategy

Lecture 23 - LAB 3 - Analysis of Multicomponent Distillation Solution of the Problem under Various ...

Lecture 24 - LAB 3 - Analysis of Multicomponent Distillation Solution of the Problem under Various ...

Lecture 25 - LAB 3 - Analysis of Multicomponent Distillation Presentation and Analysis of Results

Lecture 26 - LAB 4 - Analysis of Cooling of a Solid Body in a Reservoir Problem Definition ...

Lecture 27 - LAB 4 - Analysis of Cooling of a Solid Body in a Reservoir Theory and Solution ...

Lecture 28 - LAB 4 - Analysis of Cooling of a Solid Body in a Reservoir Solution of the Problem ...

Lecture 29 - LAB 4 - Analysis of Cooling of a Solid Body in a Reservoir Solution of the Problem ...

Lecture 30 - LAB 4 - Analysis of cooling of a solid body in a reservoir Presentation ...

Lecture 31 - LAB 5 - Analysis of unsteady-state operation of cascade CSTR's Problem Definition ...

- Lecture 32 - LAB 5 - Analysis of unsteady-state operation of cascade CSTR's Theory and Solution ...
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- Lecture 35 - LAB 5 - Analysis of unsteady-state operation of cascade CSTR's Presentation ...
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- Lecture 41 - LAB 7 - Reaction-diffusion in a spherical catalyst pallet Problem definition and ...
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- Lecture 45 - LAB 7 - Reaction-diffusion in a spherical catalyst pallet Analysis and interpretation ...
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- Lecture 47 - LAB 8 - Heat conduction in higher dimensions Background theory and solution strategy
- Lecture 48 - LAB 8 - Heat conduction in higher dimensions Problem solution
- Lecture 49 - LAB 8 - Heat conduction in higher dimensions Problem solution (Continued...)
- Lecture 50 - LAB 8 - Heat conduction in higher dimensions Problem solution and analysis
- Lecture 51 - LAB 9 - Process economics and optimisation Problem definition and analysis
- Lecture 52 - LAB 9 - Process economics and optimisation Theory and solution strategy
- Lecture 53 - LAB 9 - Process economics and optimisation Solution of the problem
- Lecture 54 - LAB 9 - Process economics and optimisation Solution of the problem (Continued...)
- Lecture 55 - LAB 9 - Process economics and optimisation Solution of the problem and analysis of ...
- Lecture 56 - LAB 10 - Regression and curve - fitting of data Problem definition and analysis
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- Lecture 58 - LAB 10 - Regression and curve - fitting of data Problem solution
- Lecture 59 - LAB 10 - Regression and curve - fitting of data Problem solution (Continued...)
- Lecture 60 - Review of the course

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Lecture 2 - Concept of Seismic Reflection, Introduction to Drilling

Lecture 3 - Drilling Mud and Mechanisms of Recovery of Petroleum

Lecture 4 - Composition of Crude Petroleum and Evaluation of Oil Stocks

Lecture 5 - Evaluation of Oil Stocks: Vaporization Characteristics

Lecture 6 - Primary Processing of Crude Oil: Desalting

Lecture 7 - Primary Processing of Crude Oil: Atmospheric Distillation Unit (ADU)

Lecture 8 - Primary Processing of Crude Oil: Reflux Systems, Vacuum Distillation Unit (VDU)

Lecture 9 - Products and Process Utilities in Primary Processing, Pipe Still Heater

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Lecture 11 - Secondary Processing: Decomposition of Residues: Thermal Cracking

Lecture 12 - Coking, Gasification and Steam Cracking

Lecture 13 - Secondary Processing: Decomposition of Residues: Hydrocracking

Lecture 14 - Secondary Processing: Decomposition of Residues: Catalytic Cracking

Lecture 15 - Secondary Processing: Decomposition of Residues: Process description of FCC

Lecture 16 - Properties and Testing of Petroleum Products

Lecture 17 - Properties and Testing of Petroleum Products (Continued...)

Lecture 18 - Properties and Testing of Petroleum Products (Continued...)

Lecture 19 - Properties and Testing of Petroleum Products (Continued...)

Lecture 20 - Properties and Testing of Petroleum Products (Continued...)

Lecture 21 - Petroleum fractions from distillation units

Lecture 22 - Petroleum fractions from distillation units (Continued...)

Lecture 23 - Petroleum fractions from distillation units (Continued...)

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Lecture 3 - Eulerian approach, Conservation Equation, Derivation of Mass Conservation Equation and Statement of the momentum conservation equation

Lecture 4 - Forces acting on a control volume; Stress tensor; Derivation of the momentum conservation equation ; Closure problem; Deformation of a fluid element in fluid flow

Lecture 5 - Kinematics of deformation in fluid flow; Stress vs strain rate relation; Derivation of the Navier-Stokes equations

Lecture 6 - Equations governing flow of incompressible flow; Initial and boundary conditions; Wellposedness of a fluid flow problem

Lecture 7 - Equations for some simple cases; Generic scalar transport equation form of the governing equations; Outline of the approach to the solution of the N-S equations.

Lecture 8 - cut out the first 30s; Spatial discretization of a simple flow domain; Taylor's series expansion and the basis of finite difference approximation of a derivative; Central and one-sided difference approximations; Order of accuracy of finite difference ap

Lecture 9 - Finite difference approximation of pth order of accuracy for qth order derivative; cross -derivatives; Examples of high order accurate formulae for several derivatives

Lecture 10 - One -sided high order accurate approximations; Explicit and implicit formulations for the time derivatives

Lecture 11 - Numerical solution of the unsteady advection equation using different finite difference approximations

Lecture 12 - Need for analysis of a discretization scheme; Concepts of consistency, stability and convergence and the equivalence theorem of Lax ; Analysis for consistency

Lecture 13 - Statement of the stability problem; von Neumann stability analysis of the first order wave equation

Lecture 14 - Consistency and stability analysis of the unsteady diffusion equation; Analysis for two- and three -dimensional cases; Stability of implicit schemes

Lecture 15 - Interpretation of the stability condition; Stability analysis of the generic scalar equation and the concept of upwinding ; Diffusive and dissipative errors in numerical solution; Introduction to the concept of TVD schemes

Lecture 16 - Template for the generic scalar transport equation and its extension to the solution of Navier-Stokes equations for a compressible flow.

Lecture 17 - Illustration of application of the template using the MacCormack scheme for a three-dimensional compressible flow

Lecture 18 - Stability limits of MacCormack scheme; Limitations in extending compressible flow schemes to incompressible flows ; Difficulty of evaluation of pressure in incompressible flows and listing of various approaches

Lecture 19 - Artificial compressibility method and the streamfunction-vorticity method for the solution of NS equations and their limitations

Lecture 20 - Pressure equation method for the solution of NS equations

Lecture 21 - Pressure-correction approach to the solution of NS equations on a staggered grid; SIMPLE and its family of methods

Lecture 22 - Need for efficient solution of linear algebraic equations; Classification of approaches for the solution of linear algebraic equations.

Lecture 23 - Direct methods for linear algebraic equations; Gaussian elimination method

Lecture 24 - Gauss-Jordan method; LU decomposition method; TDMA and Thomas algorithm

Lecture 25 - Basic iterative methods for linear algebraic equations: Description of point -Jacobi, Gauss-Seidel and SOR methods

Lecture 26 - Convergence analysis of basic iterative schemes; Diagonal dominance condition for convergence; Influence of source terms on the diagonal dominance condition; Rate of convergence

Lecture 27 - Application to the Laplace equation

Lecture 28 - Advanced iterative methods: Alternating Direction Implicit Method; Operator splitting

Lecture 29 - Advanced iterative methods; Strongly Implicit Procedure; Conjugate gradient method; Multigrid method

Lecture 30 - Illustration of the Multigrid method for the Laplace equation

Lecture 31 - Overview of the approach of numerical solution of NS equations for simple domains; Introduction to complexity arising from physics and geometry

Lecture 32 - Derivation of the energy conservation equation

Lecture 33 - Derivation of the species conservation equation; dealing with chemical reactions

Lecture 34 - Turbulence; Characteristics of turbulent flow; Dealing with fluctuations and the concept of time-averaging

Lecture 35 - Derivation of the Reynolds-averaged Navier-Stokes equations; identification of the closure problem of turbulence; Boussinesq hypothesis and eddy viscosity

Lecture 36 - Reynolds stresses in turbulent flow; Time and length scales of turbulence; Energy cascade; Mixing length model for eddy viscosity

Lecture 37 - One-equation model for turbulent flow

Lecture 38 - Two-equation model for turbulent flow; Numerical calculation of turbulent reacting flows

Lecture 39 - Calculation of near-wall region in turbulent flow; wall function approach; near-wall turbulence models

Lecture 40 - Need for special methods for dealing with irregular flow geometry; Outline of the Body-fitted grid approach; Coordinate transformation to a general, 3-D curvilinear system

Lecture 41 - Transformation of the governing equations; Illustration for the Laplace equation; Appearance and significance of cross-derivative terms; Concepts of structured and unstructured grids.

Lecture 42 - Finite volume method for complicated flow domain; Illustration for the case of flow through a duct of triangular cross-section.

Lecture 43 - Finite volume method for the general case

Lecture 44 - Generation of a structured grid for irregular flow domain; Algebraic methods; Elliptic grid generation method

Lecture 45 - Unstructured grid generation; Domain nodalization; Advancing front method for triangulation

Lecture 46 - Delaunay triangulation method for unstructured grid generation

Lecture 47 - Co-located grid approach for irregular geometries; Pressure correction equation for a co-located structured grid; Pressure correction equation for a co-located unstructured grid.

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Lecture 9 - Non Linear Algebraic Equations - Part 1

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Lecture 12 - A review of Fourier transforms - Lecture 3.5 (Properties of Fourier transforms)

Lecture 13 - A review of Fourier transforms - Lecture 3.6 (Discrete Fourier transform)

Lecture 14 - A review of Fourier transforms - MATLAB demo of Fourier transform and periodogram

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Lecture 11 - CVD Film Property Measurements: Qualitative and Quantitative

Lecture 12 - CVD in Tungsten Filament Lamps

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Lecture 15 - CVD Transport Phenomena: Conservation Equations

Lecture 16 - CVD Transport Phenomena: Constitutive Laws

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Lecture 24 - CVD Applications: CVD of nano-Structured Films

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Lecture 27 - Review of CVD Basics: Part-II (PDF Lecture)

Lecture 28 - CVD Question Bank (PDF Lecture)

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Lecture 30 - Basics of Nano-Structured Material Synthesis: Part-II

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[Lecture 35 - Multi-component Transport Fundamentals: Mass Conservation Equations \(Adobe Presenter\)](#)

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- Lecture 5 - What is Chemical Reaction Engineering - Part I
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- Lecture 27 - PFR and MFR in series.
- Lecture 28 - Unsteady state MFR and PFR
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- Lecture 2 - Intro to Kinetics (Continued...) for catalytic reactions in different reactors
- Lecture 3 - Heterogeneous rate of reactions and different types of kinetic models for non-catalytic reactions
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- Lecture 7 - (Continued...) & Proof of Pseudo steady state assumption
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- Lecture 9 - Shrinking core model (Continued...) for type D reactions (Continued...)
- Lecture 10 - Reactors, Homogeneous reaction model, Design of non-catalytic gas solid reactors
- Lecture 11 - Design of non-catalytic gas solid reactors (Continued...)
- Lecture 12 - Design of non-catalytic gas solid reactors (Continued...)
- Lecture 13 - Design equation for MF of solids, uniform gas composition, const. single particle size, Shrinking core model.
- Lecture 14 - Design equation for MF of solids, mixture of particles for different sizes but unchanging size, uniform gas composition, SCM
- Lecture 15 - Design equation for MF of solids with elutriation, mixture of particles of different size, uniform gas composition, SCM
- Lecture 16 - General Performance equation for non-catalytic gas solid reactions
- Lecture 17 - Catalytic reactions (LHHW Kinetic model)
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- Lecture 19 - LHHW Kinetic model (Continued...) - Part II
- Lecture 20 - Industrially important catalytic reaction models
- Lecture 21 - Inter and Intraphase effectiveness factor
- Lecture 22 - Interface effectiveness factor & Generalized nonisothermal effectiveness factor for external mass transfer step
- Lecture 23 - Generalized nonisothermal effectiveness factor for external mass transfer step (Continued...)
- Lecture 24 - Mass transfer correlations for various reactors
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- Lecture 27 - Non-isothermal intraphase effectiveness factor
- Lecture 28 - Inter and Intraphase effectiveness factor (Continued...)
- Lecture 29 - Inter and Intraphase Mass transfer
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Lecture 4 - Loops and Execution Control

Lecture 5 - Tutorial: Using Arrays

Lecture 6 - MATLAB Files -- Scripts and Functions

Lecture 7 - Plotting and Output

Lecture 8 - How to submit MATLAB Assignment

Lecture 9 - Errors in Numerical Computation

Lecture 10 - Truncation Errors and Taylors Series

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Lecture 15 - Higher Order Differentiation Formulae

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Lecture 21 - Gauss Elimination and Back-Substitution

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Lecture 2 - Flow in a rectangular duct: Problem formulation

Lecture 3 - Flow in a rectangular duct: Discretization of flow domain

Lecture 4 - Tutorial 1: Converting PDE to algebraic equation using FD approximation

Lecture 5 - Tutorial 1 (Continued...) Solution for algebraic equations using Gauss-Seidel Method

Lecture 6 - Flow in a triangular duct: Problem formulation

Lecture 7 - Flow in a triangular duct: Discretization of flow domain

Lecture 8 - Tutorial 2: Converting PDE to algebraic equation using Finite Volume method

Lecture 9 - Tutorial 2 (Continued...) Description of FV method and solution using G-S Method

Lecture 10 - Effect of grid spacing & upcoming course outline

Lecture 11 - Mass conservation equations

Lecture 12 - Momentum conservation equations

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Lecture 14 - Kinematics of deformation in fluid flow

Lecture 15 - Equations governing fluid flow in incompressible fluid

Lecture 16 - Navier-Stokes equation for simple cases of flow

Lecture 17 - Energy conservation equations

Lecture 18 - Practical cases of fluid flow with heat transfer in CFD point of view

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Lecture 20 - Equations governing fluid flow with chemical reactions

Lecture 21 - Concept of wellposedness of mathematical problems

Lecture 22 - Introduction to finite difference methods

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Lecture 30 - Properties of Numerical Schemes: Stability analysis

Lecture 31 - Tutorial on Stability Analysis

- Lecture 32 - Analysis of Generic 1-d scalar transport equation
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- Lecture 34 - N-S equation in compressible flow- Mac Cormack Scheme
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- Lecture 51 - Alternating Direction Implicit (ADI) method
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- Lecture 54 - Body Fitted Grid Approach
- Lecture 55 - Formulation Of Finite Volume Method
- Lecture 56 - Methods For Unstructured Grid Generation
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Lecture 8 - Statistics for Variance and Proportion

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Lecture 11 - Hypothesis testing of means

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Lecture 14 - Hypothesis testing using confidence interval

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Lecture 9 - Velocity gradient and strain rate - 1

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Lecture 11 - Kinematics for simple flows - 1

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- Lecture 43 - Survey of material functions for multiphase systems - 1
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- Lecture 55 - Survey of material functions for multiphase macromolecular systems
- Lecture 56 - Problems during rheometry - example of cone and plate - 1
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- Lecture 63 - Live Session

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Lecture 4 - Introduction to Control Structures

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NPTEL : System Identification (Chemical Engineering)

Co-ordinators : Dr. Arun K.Tangirala

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NPTEL : Synthetic and Natural Supramolecular Architectures: An Approach Towards Molecular Technology (Chemical Engineering)

Co-ordinators : Prof. Chebrolu Pulla Rao

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Lecture 20 - Catalytic reforming

Lecture 21 - Alkylation, Isomerisation and Polymerisation

Lecture 22 - Desulphurisation Processes and Recovery of Sulphur

Lecture 23 - Profile of petrochemical Industry and its structure

Lecture 24 - Naphtha and gas cracking for production of olefins

Lecture 25 - Recovery of chemicals from FCC and steam cracking

Lecture 26 - Synthesis gas and its derivatives: Hydrogen, CO, Methanol, Formaldehyde

Lecture 27 - Ethylene derivatives: Ethylene Oxide, Ethylene glycol, Ethylene dichloride and Vinyl chloride

Lecture 28 - Propylene, Propylene oxide and Isopropanol

Lecture 29 - Aromatics Production

Lecture 30 - Aromatics product profile, Ethyl benzene & Styrene, Cumene and phenol, Bisphenol, Aniline

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Lecture 31 - Introduction to polymer, Elastomer and Synthetic Fibre, Polymerisation

Lecture 32 - Polymers: Polyolefins, Polyethylene, Polypropylene Polystyrene

Lecture 33 - Polyvinylchloride, polycarbonate, thermoset resin: phenolformaldehyde, uriaformaldehyde and melamineformaldehyde

Lecture 34 - Elastomers: Styrene butadiene Rubber(SBR), Poly butadiene, Nitrile rubber

Lecture 35 - Polymides or Nylons(PA)

Lecture 36 - DMT and Terephtalic Acid, Polyester, PET resin, PTB resin

Lecture 37 - Acrylic Fibre, Modified Acrylic Fibre, Acrylonitrile, Acrolein, Propylene Finber, Polyurethane

Lecture 38 - Viscose Rayon and Acetate rayon

Lecture 39 - Pesticide

Lecture 40 - Dye and Intermediates

Lecture 1 - Process integration, methods and area of application

Lecture 2 - Fundamental concepts related to heat integration - Part 1

Lecture 3 - Fundamental concepts related to heat integration - Part 2

Lecture 4 - Data extraction

Lecture 5 - Hot composite curves

Lecture 6 - Cold composite curves

Lecture 7 - Hot and cold composite curves and the pinch

Lecture 8 - Threshold problems

Lecture 9 - Energy targeting procedure

Lecture 10 - Problem Table Algorithm - Part 1

Lecture 11 - Grand composite curve

Lecture 12 - Problem Table Algorithm - Part 2

Lecture 13 - Number of units target

Lecture 14 - Shell targeting - Part 1

Lecture 15 - Area targeting - Part 1

Lecture 16 - Area targeting - Part 2

Lecture 17 - Coast targeting - Part 1

Lecture 18 - Coast targeting - Part 2

Lecture 19 - Supertargeting- optimization of $\hat{I}^* t \min$

Lecture 20 - Global & stream specific $\hat{I}^* t \min$ and its relevance

Lecture 21 - Topology Trap

Lecture 22 - Rules for Pinch Design Method (PDM) - Part 1

Lecture 23 - Rules for Pinch Design Method (PDM) - Part 2

Lecture 24 - Application of PDM for MER Hen Synthesis

Lecture 25 - Design for threshold problems

Lecture 26 - Design for single pinch problems

Lecture 27 - Design for multi pinch problems

Lecture 28 - HEN optimization

Lecture 29 - Remaining problem analysis

Lecture 30 - Driving Force Plot

Lecture 31 - Low Temperature process Design - Part 1

[Lecture 32 - Low Temperature process Design - Part 2](#)

[Lecture 33 - Integration of Gas turbine with process - Part 1](#)

[Lecture 34 - Integration of Gas turbine with process - Part 2](#)

[Lecture 35 - Placement and Integration of Distillation Column](#)

[Lecture 36 - Heat Integration of evaporators](#)

[Lecture 37 - Integration of heat pump](#)

[Lecture 38 - Placement of Heat Engine, Heat pump and Reactors](#)

[Lecture 39 - Integration of Furnace](#)

[Lecture 40 - Problem solving using HINT Software - Part 1](#)

[Lecture 41 - Problem solving using HINT Software - Part 2](#)

[Lecture 42 - Problem solving using HINT Software - Part 3](#)

[Lecture 43 - Problem solving using HINT Software - Part 4](#)

NPTEL : Mechanical Operations (Chemical Engineering)

Co-ordinators : Prof. Shabina Khanam

Lecture 1 - Introduction

Lecture 2 - Characterization of a single particle - 1

Lecture 3 - Characterization of a single particle - 2

Lecture 4 - Characterization of collection of particles - 1

Lecture 5 - Characterization of collection of particles - 2

Lecture 6 - Fine grain size distribution

Lecture 7 - Effectiveness of screen - 1

Lecture 8 - Effectiveness of screen - 2

Lecture 9 - Industrial screening equipment

Lecture 10 - Size reduction

Lecture 11 - Laws of comminution

Lecture 12 - Examples of Laws of comminution - 1

Lecture 13 - Examples of Laws of comminution - 2

Lecture 14 - Size reduction equipment - 1

Lecture 15 - Size reduction equipment - 2

Lecture 16 - Particle dynamics - 1

Lecture 17 - Particle dynamics - 2

Lecture 18 - Particle dynamics-Examples

Lecture 19 - Classification and Jigging - 1

Lecture 20 - Classification and Jigging - 2

Lecture 1 - Introduction - 1

Lecture 2 - Introduction - 2

Lecture 3 - Characterization of wastes - 1

Lecture 4 - Characterization of wastes - 2

Lecture 5 - Characterization of wastes - 3

Lecture 6 - Tutorial on Chatacterization of wastes

Lecture 7 - Energy production from wastes through incineration - 1

Lecture 8 - Energy production from wastes through incineration - 2

Lecture 9 - Tutorial on incineration

Lecture 10 - Energy production from wastes through gasification - 1

Lecture 11 - Energy production from wastes through gasification - 2

Lecture 12 - Syngas utilization - 1

Lecture 13 - Syngas utilization - 2

Lecture 14 - Energy production from wastes through pyrolysis - 1

Lecture 15 - Energy production from wastes through pyrolysis - 2

Lecture 16 - Tutorial on gasification

Lecture 17 - Tutorial on Pyrolysis

Lecture 18 - Densification of solids - 1

Lecture 19 - Densification of solids - 2

Lecture 20 - Efficiency improvement of power plant - 1

Lecture 21 - Efficiency improvement of power plant - 2

Lecture 22 - Energy production from waste plastics - 1

Lecture 23 - Energy production from waste plastics - 2

Lecture 24 - Gas clean up - 1

Lecture 25 - Gas clean up - 2

Lecture 26 - Energy production from organic wastes through anaerobic digestion - 1

Lecture 27 - Energy production from organic wastes through anaerobic digestion - 2

Lecture 28 - Design of anaerobic digester

Lecture 29 - Introduction to Microbial fuel cells

Lecture 30 - Energy production from organic wastes through fermentation - 1

Lecture 31 - Energy production from organic wastes through fermentation - 2

[Lecture 32 - Tutorial on anaerobic digestion](#)

[Lecture 33 - Tutorial on fermentation](#)

[Lecture 34 - Energy production from wastes through transesterification - 1](#)

[Lecture 35 - Energy production from wastes through transesterification - 2](#)

[Lecture 36 - Tutorial on transesterification](#)

[Lecture 37 - Cultivation of algal biomass and treatment of waste water - 1](#)

[Lecture 38 - Cultivation of algal biomass and treatment of waste water - 2](#)

[Lecture 39 - Energy production form algal biomass - 1](#)

[Lecture 40 - Energy production form algal biomass - 2](#)

Lecture 1 - Introduction

Lecture 2 - Sedimentation and Batch Sedimentation Test - 1

Lecture 3 - Sedimentation and Batch Sedimentation Test - 2

Lecture 4 - Centrifugal Sedimentation and Equipment - 1

Lecture 5 - Centrifugal Sedimentation and Equipment - 2

Lecture 6 - Filtration - 1

Lecture 7 - Filtration - 2

Lecture 8 - Filtration - 3

Lecture 9 - Continuous Filtration - 1

Lecture 10 - Continuous Filtration - 2

Lecture 11 - Fluidisation - 1

Lecture 12 - Fluidisation - 2

Lecture 13 - Liquid Fluidisation

Lecture 14 - Gas Fluidisation - 1

Lecture 15 - Gas Fluidisation - 2

Lecture 16 - Flotation - 1

Lecture 17 - Flotation - 2

Lecture 18 - Transportaion of solids - 1

Lecture 19 - Transportaion of solids - 2

Lecture 20 - Transportaion of solids - 3

- Lecture 1 - Introduction to the course, Macromolecules and Life, Molecular flexibility
- Lecture 2 - Classification of polymers, Types of polymerization, Average molecular weights and polydispersity
- Lecture 3 - Motivation to study polymer physics
- Lecture 4 - Random Walk Models of Single Chain I: end-to-end distance of a polymer chain, freely jointed chain, drunkard walk
- Lecture 5 - Random Walk Models of Single Chain II: general random walk on a lattice
- Lecture 6 - Random Walk Models of Single Chain III: Freely rotating chain, definition of persistence length
- Lecture 7 - Models of semiflexible chains (Kratky Porod Model) - Part I
- Lecture 8 - Models of semiflexible chains (Kratky Porod Model) - Part II
- Lecture 9 - Probability density of an ideal chain - Part I
- Lecture 10 - Probability density of an ideal chain - Part II
- Lecture 11 - Entropic Elasticity, Bead-Spring Model, Simulations of random walk models
- Lecture 12 - Derivation of Diffusion equation, Einstein notation
- Lecture 13 - Definition of Radius of gyration
- Lecture 14 - Radius of gyration for an ideal chain, concept of ideality
- Lecture 15 - Nonbonded interactions, hydrophobic and hydrophilic behaviour
- Lecture 16 - Definition of excluded volume; good, bad, and theta solvent
- Lecture 17 - Virial expansion, Flory theory for good solvent
- Lecture 18 - Flory theory for bad solvent, self-similarity and fractal nature of polymers
- Lecture 19 - Derivation of fractal dimension, concentration regimes and overlap concentration
- Lecture 20 - Size, shape, and structure. Gyration tensor and measures of asphericity.
- Lecture 21 - Order-disorder transition
- Lecture 22 - Scattering experiments, Pair correlation function
- Lecture 23 - Structure of polymer chain, Introduction to Monte Carlo simulations of polymer chains
- Lecture 24 - Monte Carlo algorithm: Detailed Balance, Metropolis algorithm
- Lecture 25 - Practical aspects of Monte Carlo simulation
- Lecture 26 - Molecular Dynamics Simulations, Review of Thermodynamics
- Lecture 27 - Solution Thermodynamics - I
- Lecture 28 - Solution Thermodynamics - II
- Lecture 29 - Solution Thermodynamics - III
- Lecture 30 - Solution Thermodynamics - IV
- Lecture 31 - Phase separation regime, Introduction to lattice model of solutions

[Lecture 32 - Lattice Model of Solutions - I](#)

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[Lecture 34 - Phase behaviour of liquid solutions](#)

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[Lecture 52 - Microscopic definition of stress tensor - I](#)

[Lecture 53 - Microscopic definition of stress tensor - II, Dumbbell model, introduction to Rouse model](#)

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[Lecture 56 - Rheology of complex fluids](#)

[Lecture 57 - Rheometers and rheological tests - I](#)

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[Lecture 59 - Maxwell model - I](#)

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Lecture 2 - Stress and Strain Relationship - 1

Lecture 3 - Stress and Strain Relationship - 2

Lecture 4 - Terminologies

Lecture 5 - Design of shell

Lecture 6 - Design of heads - 1

Lecture 7 - Design of heads - 2

Lecture 8 - Design of heads - 3

Lecture 9 - Compensation for Opening - 1

Lecture 10 - Compensation for Opening - 2

Lecture 11 - L D ratio

Lecture 12 - Design of Flanges - 1.1

Lecture 13 - Design of Flanges - 1.2

Lecture 14 - Design of Flanges - 2.1

Lecture 15 - Design of Flanges - 2.2

Lecture 16 - Design of support - 1

Lecture 17 - Design of support - 2

Lecture 18 - Vessel under external pressure - 1

Lecture 19 - Vessel under external pressure - 2

Lecture 20 - Vessel under very high pressure

Lecture 1 - Safety and Accident Loss Statistics

Lecture 2 - Risk Management and Hazardous Substance Rules

Lecture 3 - Nature of Accident and major disasters

Lecture 4 - Fundamental Principles: Scale up and Runaway Reactions

Lecture 5 - Problems related to Safety and Accident Loss Statistics

Lecture 6 - Toxicology: Introduction, Routes and Exposure

Lecture 7 - Toxicology: Elimination, Responses, Treatment

Lecture 8 - Dose Response Relationship

Lecture 9 - Dose Response and Threshold Dose: Predictive models and Extrapolation

Lecture 10 - Industrial Hygiene: Regulations and Identification

Lecture 11 - Material Safety Data Sheet - I

Lecture 12 - Material Safety Data Sheet - II

Lecture 13 - Industrial Hygiene: Evaluation

Lecture 14 - Noise, vibration and Radiation

Lecture 15 - Industrial Hygiene: Control

Lecture 16 - Problems related to Industrial Hygiene

Lecture 17 - Introduction to Source Models

Lecture 18 - Source Models for Gas

Lecture 19 - Source Models for Pool Boiling

Lecture 20 - Source Model Problems

Lecture 21 - Fire and Explosions: Introduction

Lecture 22 - Fire and Explosions: Flammability Characteristics

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Lecture 24 - Explosion and its Classification - II

Lecture 25 - Fire Extinguishers - I

Lecture 26 - Fire Extinguishers - II

Lecture 27 - Problems related to Fire and Explosion

Lecture 28 - Designs to prevent Fire and Explosion: Inerting and Purging

Lecture 29 - Designs to prevent Fire and Explosion: Static Electricity

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- [Lecture 33 - Introduction to Reliefs](#)
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- [Lecture 37 - Hazard and Hazard Identification: Introduction](#)
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- [Lecture 46 - Accident Research: Introduction](#)
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- [Lecture 48 - Accident Investigation Procedure - I](#)
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- [Lecture 50 - Jaipur Terminal Fire, India: October 29, 2009](#)
- [Lecture 51 - The Flixborough UK, Cyclohexane Disaster: June 01, 1974](#)
- [Lecture 52 - Seveso Accident: July 10, 1976](#)
- [Lecture 53 - The Chernobyl Nuclear Disaster: April 26, 1986](#)
- [Lecture 54 - Bhopal Gas Tragedy: December 03, 1984](#)
- [Lecture 55 - Bhopal Gas Tragedy: Investigation](#)
- [Lecture 56 - Nuclear Radiation](#)
- [Lecture 57 - Process Safety Management](#)
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- [Lecture 59 - Safety: Laws and Regulations](#)
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Lecture 2 - Coal as a Source of Energy

Lecture 3 - Characterization of Coal

Lecture 4 - Conventional Route for Energy Production from Coal

Lecture 5 - Tutorial 1

Lecture 6 - Cleaner Route for Energy Production from Coal

Lecture 7 - Gasification of Coal - 1

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Lecture 9 - Direct Liquefaction of Coal

Lecture 10 - Tutorial 2

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Lecture 12 - Characteristics of Crude Oil and Petroleum Products

Lecture 13 - Refining of Crude Oil for Liquid Fuels Production

Lecture 14 - Conversion of Intermediate Products

Lecture 15 - Tutorial 3

Lecture 16 - Impurities Removal from Liquid Fuels

Lecture 17 - Residue Upgradation - 1

Lecture 18 - Residue Upgradation - 2

Lecture 19 - Heavy Crude Oil Processing

Lecture 20 - Tutorial 4

Lecture 21 - Properties and Routes for Energy Production

Lecture 22 - Syn Gas Production from Natural Gas

Lecture 23 - Syn Gas to Liquid Fuel Production

Lecture 24 - Hydrogen Production from Natural Gas

Lecture 25 - Tutorial 5

Lecture 26 - Solar Energy - 1

Lecture 27 - Solar Energy - 2

Lecture 28 - Wind Energy - 1

Lecture 29 - Wind Energy - 2

Lecture 30 - Tutorial 6

Lecture 31 - Hydro Energy - 1

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Lecture 2 - Introduction to polymerization process - II

Lecture 3 - A Short History of polymerization process, monomers and its distribution

Lecture 4 - Gradient and graft copolymer, polymer and its compositions, isomerism in polymers - I

Lecture 5 - Gradient and graft copolymer, polymer and its compositions, isomerism in polymers - II

Lecture 6 - Bonding forces in polymers

Lecture 7 - Molecular weight and its distribution

Lecture 8 - Control on Polymer Synthesis - I

Lecture 9 - Control on Polymer Synthesis - II

Lecture 10 - Control on Polymer Synthesis - III

Lecture 11 - Morphology of polymers

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Lecture 13 - Introduction to reactor design - II

Lecture 14 - Temperature dependent term and Interpretation of batch reactor data - I

Lecture 15 - Temperature dependent term and Interpretation of batch reactor data - II

Lecture 16 - Interpretation of batch reactor data - III

Lecture 17 - Interpretation of batch reactor data - IV

Lecture 18 - Design equation for ideal reactors

Lecture 19 - Design Equation for Single Reaction System

Lecture 20 - Multiple reactor system

Lecture 21 - Recycle reactor and autocatalytic reaction

Lecture 22 - Multiple reactions system - I

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Lecture 24 - Multiple reactions system - III

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Lecture 30 - Step Growth Polymerization - III

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- Lecture 32 - Radical Chain Polymerization Introduction
- Lecture 33 - Radical Chain Polymerization Comparison with Ionic Chain Polymerization
- Lecture 34 - Radical Chain Polymerization Mode of Propagation
- Lecture 35 - Radical Chain Polymerization Rate of Polymerization
- Lecture 36 - Radical Chain Polymerization Rate Expression
- Lecture 37 - Radical Chain Polymerization Process Analysis - I
- Lecture 38 - Radical Chain Polymerization Process Analysis - II
- Lecture 39 - Radical Chain Polymerization Half-life, Propagation and Termination - I
- Lecture 40 - Radical Chain Polymerization Half-life, Propagation and Termination - II
- Lecture 41 - Radical Chain Polymerization Redox Initiation
- Lecture 42 - Radical Chain Polymerization Photochemical and Ionization Initiation
- Lecture 43 - Radical Chain Polymerization Other Initiation Techniques - I
- Lecture 44 - Radical Chain Polymerization Other Initiation Techniques - II
- Lecture 45 - Heterogeneous Polymerization Introduction - I
- Lecture 46 - Heterogeneous Polymerization Introduction - II
- Lecture 47 - Population Balance Modeling Other Techniques - I
- Lecture 48 - Population Balance Modeling Other Techniques - II
- Lecture 49 - Emulsion Polymerization Batch Polymerization
- Lecture 50 - Emulsion Polymerization Semi-continuous polymerization
- Lecture 51 - Emulsion Polymerization Nucleation, Morphology and Reactor Types - I
- Lecture 52 - Emulsion Polymerization Nucleation, Morphology and Reactor Types - II
- Lecture 53 - Emulsion Polymerization PSD and Implementation of the Process - I
- Lecture 54 - Emulsion Polymerization PSD and Implementation of the Process - II
- Lecture 55 - Living and dormant Polymerization
- Lecture 56 - Ionic Polymerization - I
- Lecture 57 - Ionic Polymerization - II
- Lecture 58 - Ionic Polymerization - III
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Lecture 1 - Introduction

Lecture 2 - Classification of exchangers - 1

Lecture 3 - Classification of exchangers - 2

Lecture 4 - Basic Design Parameters - 1

Lecture 5 - Basic Design Parameters - 2

Lecture 6 - Double Pipe Heat Exchanger - 1

Lecture 7 - Double Pipe Heat Exchanger - 2

Lecture 8 - Double Pipe Heat Exchanger - 3

Lecture 9 - Types of Shell and Tube exchangers

Lecture 10 - Exchanger Tubes

Lecture 11 - Exchanger Shell

Lecture 12 - STE design - Kern's method - 1

Lecture 13 - STE design - Kern's method - 2

Lecture 14 - STE design - Kern's method - 3

Lecture 15 - STE design - Kern's method: Example - 4

Lecture 16 - STE design - Kern's method: Example - 5

Lecture 17 - STE design - Bell's method - 1

Lecture 18 - STE design - Bell's method - 2

Lecture 19 - STE design - Bell's method - 3

Lecture 20 - STE design - Bell's method: Example - 4

Lecture 21 - STE design - Bell's method: Example - 5

Lecture 22 - Design of Condenser - 1

Lecture 23 - Design of Condenser - 2

Lecture 24 - Design of Condenser - 3

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Lecture 26 - Design of Condenser - 5

Lecture 27 - Design of Reboiler - 1

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- [Lecture 39 - Design of Crystallizer - 1](#)
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Lecture 1 - Introduction to the course

Lecture 2 - Molecular basis of energy and entropy

Lecture 3 - Probability and probability distributions

Lecture 4 - Probability distributions and thermodynamic equilibrium

Lecture 5 - Energy distribution in molecular systems

Lecture 6 - First and second law of thermodynamics

Lecture 7 - Reversible and irreversible processes; third law of thermodynamics; legendre transformation; thermodynamic functions for one component system

Lecture 8 - Thermodynamic functions for multi-component systems; chemical potential; why do we minimize thermodynamic functions?

Lecture 9 - Extensive and intensive variables; gibbs duhem relation; euler theorem; maxwell relations

Lecture 10 - Discrete and continuous probabilities; stirling approximation

Lecture 11 - Binomial distribution approaches Gaussian distribution for large n; definition of drunkard walk

Lecture 12 - Solution of drunkard walk; Lagrange multipliers

Lecture 13 - Energy distribution in molecular system revisited; introduction to thermodynamic ensembles

Lecture 14 - Canonical ensemble: most probable distribution, partition function

Lecture 15 - Definition of temperature; third law of thermodynamics

Lecture 16 - Canonical ensemble: Helmholtz free energy, averages and fluctuations, specific heat, deriving ideal gas law

Lecture 17 - Partition function of a dense gas; grand canonical ensemble: partition function, most probable distribution

Lecture 18 - Computing properties in grand canonical ensemble

Lecture 19 - Isothermal isobaric ensemble

Lecture 20 - Summary of thermodynamic ensembles; partition function of an ideal gas

Lecture 21 - Mixing and phase separation, phase equilibrium of a multiphase multicomponent system, Gibbs phase rule

Lecture 22 - Pure component phase diagram; solution thermodynamics: Helmholtz free energy density

Lecture 23 - Characterizing mixing and phase separation using Helmholtz free energy density

Lecture 24 - Common tangent construction, definition of binodal, spinodal, and critical point

Lecture 25 - Osmotic pressure and chemical potential

Lecture 26 - Lattice model of liquid solutions - I

Lecture 27 - Lattice model of liquid solutions - II

Lecture 28 - Lattice model of liquid solutions - III

Lecture 29 - Critical review of Lattice model, theoretical basis of molecular dynamics simulation

Lecture 30 - Theoretical basis of molecular dynamics simulation

Lecture 31 - Interaction energy and force field

Lecture 32 - Liouville theorem; theoretical basis of Monte Carlo simulation

Lecture 33 - Introduction to Monte Carlo simulation method

Lecture 34 - Markov chain algorithm, condition for equilibrium and detailed balance

Lecture 35 - Metropolis algorithm, periodic boundary condition

Lecture 36 - Numerical implementation of Monte Carlo simulation: Python Examples - I

Lecture 37 - Numerical implementation of Monte Carlo simulation: Python Examples - II

Lecture 38 - Numerical implementation of Monte Carlo simulation: Python Examples - III

Lecture 39 - Numerical implementation of Monte Carlo simulation: Python Examples - IV

Lecture 40 - Numerical implementation of Monte Carlo simulation: Python Examples - V

Lecture 41 - Particle simulations: comparison with quantum chemical and continuum simulations; bridging length and time scales

Lecture 42 - Pair potentials

Lecture 43 - Saving CPU time: short range and long range interactions

Lecture 44 - Bonded and non-bonded interactions, force fields

Lecture 45 - Practical aspects of molecular simulations

Lecture 46 - Numerical implementation of MD; thermostat and barostat

Lecture 47 - MD simulations - efficiency and parallelization, sampling and averaging, analysis of simulation trajectories

Lecture 48 - MD simulations - analysis of simulation trajectories (continued), Case Studies - I

Lecture 49 - MD simulations - Case Studies - II

Lecture 50 - MD simulations - Case Studies - III

Lecture 51 - Free energies and phase behavior; extension of canonical ensemble Monte Carlo to other ensembles

Lecture 52 - Extension of canonical ensemble Monte Carlo to other ensembles (Continued...)

Lecture 53 - Monte Carlo in Gibbs ensemble and semi-grand canonical ensemble, thermodynamic integration

Lecture 54 - Thermodynamic integration (continued); Widom's particle insertion; overlapping distribution method

Lecture 55 - Multiple histogram method; umbrella sampling; thermodynamic cycle; potential of mean force; pulling simulations; metadynamics; tackling time scale issues

Lecture 56 - Tackling time scale issues (continued); nonequilibrium molecular dynamics; mesoscale simulations: Langevin dynamics and Brownian dynamics, kinetic Monte Carlo simulations; dissipative particle dynamics

Lecture 57 - Multiparticle collision dynamics; lattice Boltzmann method; coarse-graining

Lecture 58 - Case studies

Lecture 59 - Simulations of chemical reactions using Kinetic Monte Carlo simulations

Lecture 60 - Reactive force fields; Ab initio molecular dynamics and other advanced methods; molecular simulations in chemical engineering; concluding remarks

Lecture 1 - Introduction to Chemical Process Utilities

Lecture 2 - Energy Perspective to the Utilities

Lecture 3 - Power Cycle

Lecture 4 - Fuel Analysis

Lecture 5 - Practice problems related to power cycle and fuel analysis

Lecture 6 - Heat Transfer Utilities - I

Lecture 7 - Heat Transfer Utilities - II

Lecture 8 - Plate and Frame Heat Exchangers Types

Lecture 9 - Solar Energy - I

Lecture 10 - Solar Energy - II

Lecture 11 - Heat Transfer Media and Solar energy

Lecture 12 - Water

Lecture 13 - Water Chemistry

Lecture 14 - Inhibition and Water Treatment

Lecture 15 - Boiler Water treatment

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NPTEL : NOC:Essentials of Oxidation, Reduction and C-C Bond Formation. Application in Organic Synthesis (Chemistry and Biochemistry)

Co-ordinators : Prof. Yashwant D Vankar

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Lecture 35 - Sharpless asymmetric epoxidation: Mechanism, stereochemistry and kinetic resolution

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Lecture 13 - Tetrapotassium diphosphate preparation

Lecture 14 - Hydroxy apatite

Lecture 15 - P₄S₁₀ and phosphide preparation

Lecture 16 - Sulfur and copper (I) phosphide

Lecture 17 - Sulfur compounds and sulfur from H₂S and SO₂

Lecture 18 - Sulfuric acid, catalyst and S₂Cl₂, applications

Lecture 19 - Sulfur dichloride, thionyl chloride

Lecture 20 - Thiosulfates and dithionite

Lecture 21 - Sodium hydroxyl methanesulfinate and hydrogen sulfide

Lecture 22 - Halogen and halogen compounds

Lecture 23 - Fluorine and inorganic fluorides

Lecture 24 - Hydrogen fluoride and aluminum fluoride

Lecture 25 - Cryolite and other industrially important fluoride salts

Lecture 26 - Electrochemical fluorination, sulfonyl fluorides

Lecture 27 - Chloralkali electrolysis

Lecture 28 - Ion conduction membrane in electrolysis

Lecture 29 - Hydrochloric acid manufacture

Lecture 30 - Bromine and bromine compounds

Lecture 31 - Hydrogen bromide and alkali bromates

Lecture 32 - Iodine and iodine compounds

Lecture 33 - Mineral fertilizers

Lecture 34 - Nitrogen fertilizer and Urea

Lecture 35 - Potassium fertilizer

Lecture 36 - Metals and their compounds: Lithium

Lecture 37 - Sodium and its compounds

Lecture 38 - Potassium and its compounds

Lecture 39 - Magnesium and its compounds

Lecture 40 - Calcium and its compounds

Lecture 41 - Barium and its compounds

Lecture 42 - Chromium and its compounds

Lecture 43 - Manganese and its industrially important compounds

Lecture 44 - Silicon and its compounds

Lecture 45 - Organosilicon compounds, organoalkoxysilanes

Lecture 46 - Organomercapto silanes and silicones

Lecture 47 - Silicone rubber

Lecture 48 - Inorganic solids: glass

Lecture 49 - Zeolites

Lecture 50 - Inorganic Fibres: asbestos, textile glass and optical fibres

Lecture 51 - Glass fibre production and construction materials

Lecture 52 - Ceramics and its manufacturing processes

Lecture 53 - Specialty ceramic products

Lecture 54 - Ferrites and porcelain enamel

Lecture 55 - Layers of enamelling

Lecture 56 - Carbon modifications: Glassy carbon, foamed carbon, carbon black

Lecture 57 - Activated carbon

Lecture 58 - Metallic hard materials: Carbides, borides, silicides

Lecture 59 - Fillers and inorganic pigments

Lecture 60 - Oxide pigments, luminescent pigments, corrosion protection pigments, magnetic pigments

[Lecture 1 - Introduction](#)

[Lecture 2 - Structure and Geometry of Carbenes](#)

[Lecture 3 - Structure and Geometry of Carbenes \(Continued...\)](#)

[Lecture 4 - Generation of Carbene](#)

[Lecture 5 - Generation of Carbene \(Continued...\)](#)

[Lecture 6 - Generation of Carbene \(Continued...\)](#)

[Lecture 7 - Reaction of Carbene](#)

[Lecture 8 - Reaction of Carbene \(Continued...\)](#)

[Lecture 9 - Reaction of Carbene \(Continued...\)](#)

[Lecture 10 - Reaction of Carbene \(Continued...\)](#)

[Lecture 11 - Reaction of Carbene \(Continued...\)](#)

[Lecture 12 - Reaction of Carbene \(Continued...\)](#)

[Lecture 13 - Reaction of Carbene \(Continued...\)](#)

[Lecture 14 - Reaction of Carbene \(Continued...\)](#)

[Lecture 15 - Reaction of Carbene \(Continued...\)](#)

[Lecture 16 - Nitrene](#)

[Lecture 17 - Nitrene \(Continued...\)](#)

[Lecture 18 - Reaction of Nitrene](#)

[Lecture 19 - Reaction of Nitrene \(Continued...\)](#)

[Lecture 20 - Reaction of Nitrene \(Continued...\)](#)

Lecture 1 - A brief introduction to Molecules of Life: Structure of Amino acids and their various charged forms

Lecture 2 - Biological Macromolecules and Small molecules: Importance and functions

Lecture 3 - Amino Acids: The building block of proteins

Lecture 4 - Amino acids: separation and detection, Electrophoresis and Ninhydrin reaction

Lecture 5 - Method of determination of Amino acid sequence: primary structure of polypeptide/protein

Lecture 6 - Selective peptide bond cleavage: Enzymatic and Non-enzymatic methods

Lecture 7 - Peptide synthesis: Protecting groups for amine and carboxyl functionality

Lecture 8 - Peptide synthesis (Continued...) Protection, coupling and deprotection method

Lecture 9 - Recent development of coupling agents; Merrifield's method of solid phase peptide synthesis

Lecture 10 - Hierarchical structure of proteins: Secondary, tertiary and quaternary structure

Lecture 11 - Ramachandran plot and protein purification techniques

Lecture 12 - Protein purification techniques (Continued...)

Lecture 13 - Introduction to Enzymes and its kinetics

Lecture 14 - Enzyme catalysed reactions and introduction to catalytic activity of proteases

Lecture 15 - Enzyme Kinetics (Continued...)

Lecture 16 - Concept of Enzyme Inhibition

Lecture 17 - Concept of Enzyme Inhibition (Continued...)

Lecture 18 - Problems on Enzyme Kinetics and Enzyme Inhibition

Lecture 19 - Synthetic Biology

Lecture 20 - Synthetic Biology (Continued...)

Lecture 21 - Synthetic Biology (Continued...)

Lecture 22 - Nucleic Acid

Lecture 23 - Nucleic Acid (Continued...)

Lecture 24 - DNA sequencing method

Lecture 25 - DNA sequencing method (Continued...)

Lecture 26 - DNA sequencing method (Continued...)

Lecture 27 - Synthesis of oligonucleotide

Lecture 28 - Central dogma: DNA replication, transcription and translation

Lecture 29 - Central dogma: DNA replication, transcription and translation (Continued...)

Lecture 30 - Central dogma: DNA replication, transcription and translation (Continued...)

Lecture 31 - Central dogma: DNA replication, transcription and translation (Continued...)

[Lecture 32 - Central dogma: DNA replication, transcription and translation \(Continued...\)](#)

[Lecture 33 - Molecular Biology](#)

[Lecture 34 - Molecular Biology \(Continued...\)](#)

[Lecture 35 - Chemistry of cofactors/coenzymes](#)

[Lecture 36 - Chemistry of cofactors/coenzymes \(Continued...\)](#)

[Lecture 37 - Chemistry of cofactors/coenzymes \(Continued...\)](#)

[Lecture 38 - Chemistry of cofactors/coenzymes \(Continued...\)](#)

[Lecture 39 - Chemistry of cofactors/coenzymes \(Continued...\)](#)

[Lecture 40 - Chemistry of cofactors/coenzymes \(Continued...\)](#)

[Lecture 41 - Introduction to Drug Discovery Process](#)

[Lecture 42 - Fundamental Principles of Drug Development Process](#)

[Lecture 43 - Combinatorial chemistry](#)

[Lecture 44 - Neurotransmitters](#)

[Lecture 45 - Catechol amine based and GABA neurotransmitters](#)

[Lecture 46 - Hypertension: humoral mechanism and renin/angiotensin system](#)

[Lecture 47 - Inhibitor design of angiotensin converting enzyme](#)

[Lecture 48 - Antimicrobial drugs](#)

[Lecture 49 - Chemistry of penicillins](#)

[Lecture 50 - Resistance to beta-lactam antibiotics](#)

[Lecture 51 - Mechanistic studies of beta-lactamase](#)

[Lecture 52 - Non beta-lactam antibiotics](#)

[Lecture 53 - Mechanistic enzymology of Isopenicillin N synthase](#)

[Lecture 54 - Polyketide Biosynthesis](#)

[Lecture 55 - Biosynthesis of macrolide polyketides and introduction to virus](#)

[Lecture 56 - Anti-viral drugs](#)

[Lecture 57 - Cancer and Chemotherapy](#)

[Lecture 58 - Anti-cancer drugs \(Continued...\)](#)

[Lecture 59 - Aromatase inhibition and Anti-ulcer drugs](#)

[Lecture 60 - Cholesterol lowering agents](#)

[Lecture 61 - Cholesterol Biosynthesis](#)

[Lecture 62 - Pharmacokinetics and pharmacodynamics](#)

[Lecture 63 - QSAR principles](#)

Lecture 1 - Importance of Polymer Science and Brief Historical background

Lecture 2 - Definitions/Terminologies, Classifications

Lecture 3 - Classifications, Nomenclature

Lecture 4 - Classification by Polymerization Mechanism, Nomenclature

Lecture 5 - Molecular Weight, Big Picture of Polymer Science, Common Polymers

Lecture 6 - Examples of Step Polymers, Linear Step Polymerization

Lecture 7 - Linear Step Polymerization: MW Control, MW Distribution, Kinetics

Lecture 8 - Linear Step Polymerization: Kinetics (Continued...), Equilibrium Consideration, General Requirements for Achieving High MW; Non-linear Step Polymerization

Lecture 9 - Linear Step Polymerization: Summary - General Requirement, Non-Linear Step Polymerization

Lecture 10 - Types of Chain polymerization, Mechanism and Kinetics of Radical Chain Polymerization

Lecture 11 - Kinetics of Radical Chain Polymerization (Continued...), Various Types of Initiators

Lecture 12 - Thermal Initiation (Continued...), Molecular Weight and Kinetic Chain Length, Other Types of Radical Initiators, Transfer Reactions

Lecture 13 - Transfer Reactions, Effect of Temperature on Rate and MW, MW Distribution, ceiling Temperature

Lecture 14 - Energetics and Thermodynamics of Chain Polymerization, MW Distribution, Common Polymers

Lecture 15 - Thermodynamics of Chain Polymerization, MW Distribution, Common Polymers

Lecture 16 - Process Conditions, Emulsion Polymerization

Lecture 17 - Emulsion Polymerization (Continued...), Common Polymers by Radical Chain Polymerization, RDRP

Lecture 18 - Reversible - Deactivation Radical Polymerizations (RDRP)

Lecture 19 - RAFT Polymerization (Continued...), Ionic Polymerization

Lecture 20 - Polymer Stereochemistry and Zeigler - Natta Coordination Polymerization

Lecture 21 - Ring Opening Polymerization, Copolymers

Lecture 22 - Copolymerization (Continued...)

Lecture 23 - Polymers in Solution : Flory - Huggins Theory

Lecture 24 - Polymers in Solution : Application of Flory - Huggins Theory

Lecture 25 - Polymers in Solution : Solubility Parameter, Polymer Phase Separation and Fractionation

Lecture 26 - Polymers Chain Dimensions

Lecture 27 - Frictional Properties of Polymer Molecules in Dilute Solution, Determination of Polymer MW (Overview)

Lecture 28 - Membrane Osmometry, End Group Analysis, Dilute Solution Viscometry

Lecture 29 - Dilute Solution Viscometry, Light Scattering Techniques for MW

Lecture 30 - Gel Permeation Chromatography

[Lecture 31 - Light Scattering Techniques for MW and Size Measurements \(Continued...\)](#)

[Lecture 32 - Mass Spectroscopy of Polymers](#)

[Lecture 33 - Polymer Processing](#)

[Lecture 34 - Mechanical Properties, Amorphous State](#)

[Lecture 35 - Thermal Properties: Amorphous State](#)

[Lecture 36 - Thermal Properties: Crystalline State](#)

[Lecture 37 - Thermal Properties: Factors Influencing \$T_m\$, Determination of \$T_g\$ and \$T_m\$, Other Thermal Properties](#)

[Lecture 38 - Thermomechanical Properties, Viscoelasticity](#)

[Lecture 39 - Thermomechanical Properties, Viscoelasticity \(Continued...\)](#)

[Lecture 40 - Optical, Electrical, Barrier Properties; Chemical Resistance and Weathering of Polymers](#)

[Lecture 41 - Polymer Additives](#)

[Lecture 42 - Polymer Blends, Concluding Remarks](#)

NPTEL : NOC:Structure, Stereochemistry and Reactivity of Organic Compounds and Intermediates: A Problem Solving Approach (Chemistry and Biochemistry)

Co-ordinators : Prof. A. Basak

Lecture 1 - Introduction to structure and stereochemistry of organic molecules: salient features of symmetry elements; Role of principal axis, sigma plane, centre of symmetry, and alternating axis of symmetry in deciding chirality

Lecture 2 - Introduction to point group notation, classification, symmetry number and order

Lecture 3 - Examples of various point group notations, chiral and achiral point groups, examples of various point groups

Lecture 4 - Solving problems on point groups (C_n , C_{nv} , C_{nh} , D_{nd})

Lecture 5 - Conformational Analysis of Perhydrophenanthrene

Lecture 6 - Concept Clearing Session on Achiral Point Groups

Lecture 7 - Axial, Planar and Helical Chirality, assignment of absolute configuration to such molecules

Lecture 8 - Concept of pseudoasymmetry; Reflection variance/invariance problem; methods of nomenclature system

Lecture 9 - Conformational analysis of bicyclic systems: the Decalins

Lecture 10 - Conformational analysis of Perhydrophenanthrene

Lecture 11 - Conformational analysis of Perhydroanthracene

Lecture 12 - Revisiting conformational analysis of Perhydrophenanthrene

Lecture 13 - Revisiting conformational analysis of Perhydroanthracene

Lecture 14 - Introduction to Linear Polarized light and interaction with chiral materials; Circular Birefringence, Circular Dichroism

Lecture 15 - ORD, CD and Cotton Effect (CE); Empirical rule to determine the sign of CE, 2-axial haloketone rule

Lecture 16 - Octant rule: application to substituted cyclohexanone and decalone system

Lecture 17 - Application of Octant rule to tricyclic system; drawing of octant projection

Lecture 18 - Application of Octant rule to steroidal ketones; drawing of octant projection

Lecture 19 - Stereoelectronic effects on conformation and reactivity

Lecture 20 - Examples of anomeric effect and Stereoelectronic effect

Lecture 21 - Baldwin rules

Lecture 22 - Cyclization in enolic systems

Lecture 23 - Problem solving on Baldwin rules

Lecture 24 - Reactive Functionalities: Chemistry of Alkynes

Lecture 25 - Reactive Functionalities: Chemistry of Alkynes (Continued...), arynes and enediynes

Lecture 26 - Reactive Functionalities: Ene-diynes (Continued...), allenes and Ketenes

Lecture 27 - Beta - Lactam Synthesis

Lecture 28 - Chemistry of radicals

Lecture 29 - Reactivity of radicals: Frontier orbital approach.

Lecture 30 - Radical mediated C-C bond formation

[Lecture 31 - Radical mediated C-C bond formation \(Continued...\)](#).

[Lecture 32 - Radical mediated decarboxylation and deoxygenation](#)

[Lecture 33 - Dynamic Stereochemistry: Conformationally rigid and mobile systems](#)

[Lecture 34 - Dynamic Stereochemistry: Conformational analysis of elimination and addition](#)

[Lecture 35 - Dynamic Stereochemistry: Stereoselectivity in carbonyl reduction](#)

[Lecture 36 - Dynamic Stereochemistry: Reactivity of unsaturated carbonyl and enolate systems](#)

[Lecture 37 - Dynamic Stereochemistry: Enolate as nucleophile](#)

[Lecture 38 - Dynamic Stereochemistry: stereochemical issues in cyclohexenone reduction and alpha-electrophilic substitution in carbonyls](#)

[Lecture 39 - Dynamic Stereochemistry: Asymmetric aldol reactions](#)

[Lecture 40 - Dynamic Stereochemistry: Asymmetric aldol reaction \(Continued...\)](#)

Lecture 1 - Review of Quantum Chemistry

Lecture 2 - Postulates of Quantum Mechanics - I

Lecture 3 - Postulates of Quantum Mechanics - II

Lecture 4 - Exactly Solvable Models - I

Lecture 5 - Exactly Solvable Models - II

Lecture 6 - Exactly Solvable Models - II (Continued...)

Lecture 7 - Variational Principle - I

Lecture 8 - Variational Principle - II

Lecture 9 - Variational Method: Applications - I

Lecture 10 - Linear Variational Method

Lecture 11 - Applications of Linear Variational Method

Lecture 12 - Variational Method in Chemical Bonding - I

Lecture 13 - Variational Method in Chemical Bonding - II

Lecture 14 - Variational Method in Chemical Bonding - III

Lecture 15 - Molecular Orbital Treatment of Polyatomics

Lecture 16 - Molecular Orbital Treatment of Polyatomics

Lecture 17 - Perturbation Theory

Lecture 18 - Examples of Perturbation Theory - I

Lecture 19 - Examples of Perturbation Theory - II

Lecture 20 - Molecular Response to Electric Field - I

Lecture 21 - Molecular Response to Electric Field - II

Lecture 22 - Degenerate Perturbation Theory

Lecture 23 - Excited States of He Atom - I

Lecture 24 - Excited States of He Atom - II

Lecture 25 - Slater Determinants - I

Lecture 26 - Slater Determinants - II

Lecture 27 - Energy Expectation Value with Slater Determinants - I

Lecture 28 - Energy Expectation Value with Slater Determinants - II

Lecture 29 - Self-Consistent Field Method

Lecture 30 - Canonical HF Equations

Lecture 31 - Hartree-Fock Energy

[Lecture 32 - Hartree-Fock-Roothan Equations](#)

[Lecture 33 - The Density Matrix](#)

[Lecture 34 - Evaluation of Molecular Properties](#)

[Lecture 35 - Basis Sets - I](#)

[Lecture 36 - Basis Sets - II](#)

[Lecture 37 - Electron Correlation and Post HF Methods](#)

[Lecture 38 - Time-Dependent Perturbation Theory - I](#)

[Lecture 39 - Time-Dependent Perturbation Theory - II](#)

[Lecture 40 - Slowly Switched Constant Perturbation](#)

[Lecture 41 - Oscillating Perturbation](#)

[Lecture 42 - Einstein's Coefficients](#)

Lecture 1 - Metal Ions In Biological Systems

Lecture 2 - Metallobiosite structures

Lecture 3 - Biomolecular structure and molecular biology component

Lecture 4 - Structures of nucleic acids

Lecture 5 - Coordination Chemistry in action

Lecture 6 - Coordination of peptide building blocks

Lecture 7 - Occurrence and availability

Lecture 8 - Potential ligands of different types

Lecture 9 - Metal ion insertion

Lecture 10 - Organic cofactors and siderophores

Lecture 11 - Introduction

Lecture 12 - CD and Raman spectroscopy

Lecture 13 - EPR

Lecture 14 - NMR and X-ray

Lecture 15 - Electrochemical methods

Lecture 16 - Metal ion assimilation

Lecture 17 - Transport of metal ions in bacteria and plants

Lecture 18 - Transport of metal ions in fungi and mammals

Lecture 19 - Homeostasis in bacteria and plants

Lecture 20 - Homeostasis in fungi and mammals

Lecture 21 - Transport across membranes

Lecture 22 - Ion channels and ion pumps

Lecture 23 - (K⁺) channels

Lecture 24 - (Na⁺) channels

Lecture 25 - (Na⁺)-(K⁺) ATPase

Lecture 26 - (Mg²⁺) dependent enzymes and kinases

Lecture 27 - Phosphatases and enolases

Lecture 28 - Photoreception and enzymes

Lecture 29 - (Ca²⁺) transporting, binding and sensor proteins

Lecture 30 - Cell signaling by (Ca²⁺) binding and sensing

Lecture 31 - Functions of iron ions and iron ion proteins

- Lecture 32 - Heme proteins for (O₂) transport and storage
- Lecture 33 - Activators of (O₂) and electron transport proteins
- Lecture 34 - Iron-sulfur proteins
- Lecture 35 - Mononuclear and dinuclear non-heme enzymes
- Lecture 36 - Oxygen transport and SOD activity
- Lecture 37 - Type 1 blue copper proteins
- Lecture 38 - Type 2 non-blue copper proteins
- Lecture 39 - Type 3 dinuclear copper proteins
- Lecture 40 - Multicopper and mixed-copper enzymes
- Lecture 41 - Coordination chemistry and function of zinc ions
- Lecture 42 - Carbonic anhydrase and lyases
- Lecture 43 - Carboxypeptidase and metalloproteinases
- Lecture 44 - Alcohol dehydrogenase and Beta-lactamase
- Lecture 45 - Redox catalysis by manganese ions
- Lecture 46 - Redox catalysis by manganese ions
- Lecture 47 - Catalysis by manganese and cobalt ions
- Lecture 48 - Cobalt ion dependent proteins and enzymes
- Lecture 49 - Nickel proteins and enzymes
- Lecture 50 - More nickel ion bearing enzymes
- Lecture 51 - Carbon, hydrogen and oxygen
- Lecture 52 - Nitrogen and Silicon
- Lecture 53 - Phosphorus
- Lecture 54 - Sulfur and Selenium
- Lecture 55 - Chlorine and Iodine
- Lecture 56 - Brain and blood-brain barrier (BBB)
- Lecture 57 - Zinc and copper ions
- Lecture 58 - Iron ions
- Lecture 59 - Metal ion based drugs and metallotherapeutics
- Lecture 60 - Chemotherapy, radiotherapy and contrast agents

- Lecture 1 - Enolate generation, structure of enolates and related topic - I
- Lecture 2 - Enolate generation, structure of enolates and related topic - II
- Lecture 3 - Enolate generation, structure of enolates and related topic - III
- Lecture 4 - Different mode of asymmetric induction in enolate alkylation
- Lecture 5 - Revisit again, Different mode of asymmetric induction in enolate alkylation
- Lecture 6 - Substrate directed stereocontrol in acyclic and cyclic system
- Lecture 7 - Substrate directed enolate alkylation in bicyclic system
- Lecture 8 - Seebach's SRS principle and related systems - I
- Lecture 9 - Seebach's SRS principle and related systems - II
- Lecture 10 - Seebach's SRS principle and related systems - III
- Lecture 11 - Evans oxazolidinone and related systems - I
- Lecture 12 - Evans oxazolidinone and related systems - II
- Lecture 13 - Evans oxazolidinone and related systems - III
- Lecture 14 - Evans oxazolidinone and related systems - IV
- Lecture 15 - Evans oxazolidinone and related systems - V
- Lecture 16 - Helmchen's auxiliary, Oppolzer's sultam based auxiliary
- Lecture 17 - Camphor based N-acyloxazolidinones as chiral auxiliary
- Lecture 18 - Myer's ephedrine, Chiral Weinreb amide equivalents and related systems
- Lecture 19 - Myer's ephedrine and related systems
- Lecture 20 - Chiral Weinreb amide equivalents and related systems
- Lecture 21 - Meyer's oxazoline based alkylation - I
- Lecture 22 - Meyer's oxazoline based alkylation - II
- Lecture 23 - Meyer's bicyclic lactam based enolate alkylation
- Lecture 24 - Meyer's bicyclic lactam based alkylation
- Lecture 25 - Meyer's bicyclic lactams, Gleason's bicyclic thioglycolate lactam based systems
- Lecture 26 - Few problem solving from Meyer's oxazoline/bicyclic lactam based alkylation
- Lecture 27 - Schollkopf's bis-lactim ether and related systems; Auxiliary induced chiral relay
- Lecture 28 - Chiral relay systems in amino acid derived enolate alkylation
- Lecture 29 - Williams oxazinone, Yamada's chiral glycine enolate and related system
- Lecture 30 - Tricycloiminolactone as chiral glycine equivalents
- Lecture 31 - Najera's auxiliary, Davies diketopiperazine and related system

Lecture 32 - Ender's RAMP/SAMP, Coltart's cyclic carbamate hydrazone, Ellman's sulfinamide and related

Lecture 33 - Ender's RAMP/SAMP based systems

Lecture 34 - Ender's RAMP/SAMP based systems

Lecture 35 - Ender's RAMP/SAMP, Coltart's cyclic carbamate hydrazone, Ellman's sulfinamide

Lecture 36 - Coltart's cyclic carbamate hydrazone and its exploration

Lecture 37 - Memory of chirality in enolate alkylation

Lecture 38 - Organocatalytic methods for enolate alkylation (SOMO activation)

Lecture 39 - Enantioselective alkylation with chiral PTC

Lecture 40 - Overall analysis of the entire discussion

Lecture 1 - Bioenergetics: Understanding the significance in Biological Systems

Lecture 2 - Regulation of Enzyme Activity

Lecture 3 - Digestion and Absorption of Carbohydrates

Lecture 4 - Glycolysis, alcohol and lactic acid fermentation

Lecture 5 - Biochemistry of TCA Cycle (I)

Lecture 6 - TCA Cycle (II) - Regulation and special characteristics

Lecture 7 - Neoglucogenesis

Lecture 8 - Regulation of Glycolysis and Neoglucogenesis - I

Lecture 9 - Regulation of Glycolysis and Neoglucogenesis - II Cori Cycle, Rapoport Leubering

Lecture 10 - Hexose Monophosphate Shunt : Steps and Phases

Lecture 11 - Hexose Monophosphate Shunt : Regulation and Significance

Lecture 12 - Glycogen Metabolism - I

Lecture 13 - Glycogen Metabolism - II

Lecture 14 - Glycogen Metabolism - III

Lecture 15 - Glycogen Metabolism - IV

Lecture 16 - Galactose Metabolism and Associated Disorders

Lecture 17 - Fructose Metabolism and Associated Disorders

Lecture 18 - Regulation of Blood Glucose

Lecture 19 - Diabetes Mellitus and Metabolic Alterations

Lecture 20 - Digestion and absorption of Lipid

Lecture 21 - Lipoprotein Metabolism - I

Lecture 22 - Lipoprotein Metabolism - II

Lecture 23 - Lipoprotein metabolism - III

Lecture 24 - Fatty acid catabolism (Oxidation of Fatty acids) - I

Lecture 25 - Fatty acid catabolism (Oxidation of Fatty acids) - II

Lecture 26 - Fatty acid catabolism (Oxidation of Fatty acids) - III

Lecture 27 - Metabolism of Ketone Bodies

Lecture 28 - Biosynthesis of Fatty acid and its regulation

Lecture 29 - Biosynthesis of triacylglycerol, phosphoglycerides and sphingolipids

Lecture 30 - Cholesterol Metabolism

Lecture 31 - Digestion and absorption of Protein

Lecture 32 - Transformation of Amino acids

Lecture 33 - Metabolism of Ammonia and ammonia toxicity

Lecture 34 - Urea cycle - Steps, Significance and Energetics

Lecture 35 - Urea Cycle - Regulation and Enzyme Deficiency Disorders

Lecture 36 - Metabolism of Phenylalanine and Associated Disorders

Lecture 37 - Tyrosine Metabolism - I

Lecture 38 - Tyrosine Metabolism - II (Catecholamines)

Lecture 39 - Tyrosine Metabolism - III

Lecture 40 - Tryptophan Metabolism

Lecture 41 - Metabolism of Sulphur containing Amino acids (Methionine and Cysteine)

Lecture 42 - Metabolism of Glycine and its disorders

Lecture 43 - Metabolism of Serine, Threonine and Alanine

Lecture 44 - Branched chain amino acid metabolism and their disorders

Lecture 45 - Metabolism of Histidine, Proline, Arginine and Lysine

Lecture 46 - Heme Metabolism - I (Heme Synthesis and Regulation)

Lecture 47 - Heme Metabolism - II (Disorders of Heme Synthesis - Porphyrrias)

Lecture 48 - Heme Metabolism - III (Heme Degradation, Transport and Bilirubin Metabolism)

Lecture 49 - Disorders of Bilirubin Metabolism

Lecture 50 - Nucleotide Metabolism - I (Purine Metabolism)

Lecture 51 - Nucleotide Metabolism - II (Disorders of Purine Metabolism)

Lecture 52 - Nucleotide Metabolism - III (Pyrimidine Metabolism and Disorders)

Lecture 53 - Inborn errors of Metabolism

Lecture 54 - Integration of Metabolism - I (Cellular and Organ level integration)

Lecture 55 - Integration of Metabolism - II (Starve feed cycle)

Lecture 56 - Integration of Metabolism - III (Metabolic Control Analysis)

Lecture 57 - Obesity, Metabolic Syndrome and Role of Adipokines

Lecture 58 - Fatty Liver and alcohol metabolism

Lecture 59 - Energy metabolism and Nutritional disorders, Protein Energy Malnutrition and Dietary

Lecture 60 - Metabolism in Cancer Cells

Lecture 1 - Remembering the Masters: From Zeeman to Zavoisky

Lecture 2 - Introduction to EPR spectroscopy

Lecture 3 - Electron-Nuclear Hyperfine Interaction - I

Lecture 4 - Electron-Nuclear Hyperfine Interaction - II

Lecture 5 - Magnetic Moment in Magnetic Field - I

Lecture 6 - Magnetic Moment in Magnetic Field - II

Lecture 7 - EPR Instrumentations - I

Lecture 8 - EPR Instrumentations - II

Lecture 9 - EPR Instrumentations - III

Lecture 10 - EPR Instrumentations - IV

Lecture 11 - Quantum Mechanical Description of EPR - I

Lecture 12 - Quantum Mechanical Description of EPR - II

Lecture 13 - Introduction to Spin Relaxation

Lecture 14 - Theory of First-order EPR Spectra - I

Lecture 15 - Theory of First-order EPR Spectra - II

Lecture 16 - How to Analyse First-order EPR Spectra

Lecture 17 - How to Record EPR Spectra

Lecture 18 - Second-order Effects on EPR Spectra

Lecture 19 - Photochemistry and EPR Spectroscopy

Lecture 20 - Electron Spin Polarisation - I

Lecture 21 - Electron Spin Polarisation - II

Lecture 22 - Anisotropic Interactions in EPR Spectroscopy

Lecture 23 - Theoretical Basis of isotropic Hyperfine Coupling

Lecture 24 - Spin Relaxation and Bloch Equations - I

Lecture 25 - Spin Relaxation and Bloch Equations - II

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3 - Part I](#)

[Lecture 3 - Part II](#)

[Lecture 4 - Part I](#)

[Lecture 4 - Part II](#)

[Lecture 4 - Part III](#)

[Lecture 5 - Part I](#)

[Lecture 5 - Part II](#)

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[Lecture 5 - Part IV](#)

[Lecture 5 - Part V](#)

[Lecture 6 - Part I](#)

[Lecture 6 - Part II](#)

[Lecture 6 - Part III](#)

[Lecture 6 - Part IV](#)

[Lecture 7 - Part I](#)

[Lecture 7 - Part II](#)

[Lecture 8 - Part I](#)

[Lecture 8 - Part II](#)

[Lecture 8 - Part III](#)

[Lecture 9 - Part I](#)

[Lecture 9 - Part II](#)

[Lecture 9 - Part III](#)

[Lecture 10](#)

- Lecture 1 - Electromagnetic radiation
- Lecture 2 - Interaction of radiation with matter
- Lecture 3 - Introduction to chemical applications
- Lecture 4 - Analysis of spectra
- Lecture 5 - Radiation densities and Einstein's semi classical model
- Lecture 6 - Introduction to quantum mechanics - I
- Lecture 7 - Introduction to quantum mechanics - II
- Lecture 8 - Born-Oppenheimer approximation
- Lecture 9 - Beer-Lambert law
- Lecture 10 - Diatomic Vibration Spectra Hermonic Model
- Lecture 11 - Diatomic Vibration Morse Oscillator Model
- Lecture 12 - Normal Vibrational modes Triatomic molecules
- Lecture 13 - Normal Vibrational modes Polyatomic molecules
- Lecture 14 - Vibrational Polyatomic Infrared Spectroscopy Local Modes and Group Frequencies
- Lecture 15 - Microwave spectra of di-atomic molecules
- Lecture 16 - Diatomic Molecules Microwave Energies and Transitions
- Lecture 17 - Methodology of solving problems
- Lecture 18 - Rotational and Vibrational Line Intensities
- Lecture 19 - Microwave Spectra of Polyatomic molecules (Symmetric tops)
- Lecture 20 - Video Tutorial 2 : Part - I
- Lecture 21 - Video Tutorial 2 : Part - II
- Lecture 22 - Introduction to Tensors
- Lecture 23 - Polarizability Tensor
- Lecture 24 - Introduction to Rotational Raman Spectra.
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NPTEL : Watershed Management (Civil Engineering)

Co-ordinators : Dr. T.I. Eldho

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Co-ordinators : Dr. P. Banerji

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Co-ordinators : Dr. Deepankar Choudhury

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NPTEL : Concrete Technology (Civil Engineering)

Co-ordinators : Dr. B. Bhattacharjee

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NPTEL : Water Management (Civil Engineering)

Co-ordinators : Dr. A.K. Gosain

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- Lecture 2 - Soil - Water - Plant Relationships
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- Lecture 4 - Soil - Water - Plant Relationships (Continued...)
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**NPTEL : NOC:Geoenvironmental Engineering (Environmental Geotechnology) Landfills, Slurry Ponds and Contaminated Sites
(Civil Engineering)**

Co-ordinators : Prof. Manoj Datta

- Lecture 1 - Introduction to Geoenvironmental Engineering
- Lecture 2 - Sources and Impact of Contamination
- Lecture 3 - Waste-Soil Interaction
- Lecture 4 - Solid Waste Generation and Disposal
- Lecture 5 - Waste Minimization by Integrated Solid Waste Management (ISWM)
- Lecture 6 - Integrated Solid Waste Management (ISWM) - Case Studies
- Lecture 7 - Principles of Landfilling
- Lecture 8 - Planning of Landfills - Part 1
- Lecture 9 - Planning of Landfills - Part 2
- Lecture 10 - Liners for Landfills - Part 1
- Lecture 11 - Liners for Landfills - Part 2
- Lecture 12 - Liners for Landfills - Part 3
- Lecture 13 - Liners for Landfills - Part 4
- Lecture 14 - Covers for Landfills - Part 1
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- Lecture 16 - Generation and Control of Leachate
- Lecture 17 - Generation and Control of Landfill Gas
- Lecture 18 - Stability of Slopes - Part 1
- Lecture 19 - Stability of Slopes - Part 2
- Lecture 20 - Stability of Slopes - Part 3
- Lecture 21 - (Lecture Missing)
- Lecture 22 - Some Solved Examples
- Lecture 23 - Subsurface Monitoring Around Landfills - Part 1
- Lecture 24 - Subsurface Monitoring Around Landfills - Part 2
- Lecture 25 - Cost of Geotechnical Components of Landfills
- Lecture 26 - Construction and Operation of Landfills
- Lecture 27 - Site Selection for Landfills
- Lecture 28 - Closure, Rehabilitation and Expansion of MSW Landfills
- Lecture 29 - Control and Remedial Measures at Contaminated Sites - Part 1
- Lecture 30 - Control and Remedial Measures at Contaminated Sites - Part 2

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[Lecture 31 - Slurry Disposal on Land](#)

[Lecture 32 - Disposal of Slurry Waste in Ponds and Impoundments and Dry Waste in Mounds](#)

[Lecture 33 - Geotechnical Properties of Coal Ash and Mine Tailings - Part 1](#)

[Lecture 34 - Geotechnical Properties of Coal Ash and Mine Tailings - Part 2](#)

[Lecture 35 - Planning and Design of Slurry Ponds](#)

[Lecture 36 - Stability of Incrementally Raised Embankments - Part 1](#)

[Lecture 37 - Stability of Incrementally Raised Embankments - Part 2](#)

[Lecture 38 - Remedial Measures for Slope Failures in Embankments / Dykes of Slurry Ponds](#)

[Lecture 39 - Environmental Control at Slurry Ponds](#)

[Lecture 40 - Geotechnical Reuse of Waste Materials - Part 1](#)

[Lecture 41 - Geotechnical Reuse of Waste Materials - Part 2](#)

[Lecture 42 - End-of-the-Course Review](#)

- Lecture 1 - Introduction to Environmental Factors - 1
- Lecture 2 - Introduction to Environmental Factors - 2
- Lecture 3 - Introduction to Environmental Factors - 3
- Lecture 4 - Introduction to Environmental Factors - 4
- Lecture 5 - Introduction to Environmental Factors - 5
- Lecture 6 - Introduction to Environmental Factors - 6
- Lecture 7 - Introduction to Environmental Factors - 7
- Lecture 8 - Comfort and Heat Transfer Concepts
- Lecture 9 - Heat Flow in Buildings - 1
- Lecture 10 - Heat Flow in buildings - 2
- Lecture 11 - Heat Flow in buildings - 3
- Lecture 12 - Admittance Method - 1
- Lecture 13 - Admittance Method - 2
- Lecture 14 - Heat Flow in buildings - 1 (Frequency Domain)
- Lecture 15 - Heat Flow in buildings - 2 (Frequency Domain)
- Lecture 16 - Heat Flow in buildings - 2 (Frequency Domain)
- Lecture 17 - Heat flow in buildings
- Lecture 18 - Admittance Method
- Lecture 19 - Comfort - 1
- Lecture 20 - Comfort - 2
- Lecture 21 - Comfort and Thermal Design of Buildings - 1
- Lecture 22 - Comfort and Thermal Design of Buildings - 2
- Lecture 23 - Comfort and Thermal Design of Buildings - 3
- Lecture 24 - Thermal Design of Unconditioned Building
- Lecture 25 - External Shading Multipliers for external suns shading
- Lecture 26 - Passive Concepts
- Lecture 27 - Design for Thermal Efficiency
- Lecture 28 - Ventilation - 1
- Lecture 29 - Ventilation - 2
- Lecture 30 - Natural ventilation design
- Lecture 31 - Noise and Acoustic Fundamentals - 1

- [Lecture 32 - Noise and Acoustic Fundamentals - 2](#)
- [Lecture 33 - Noise and Acoustic Fundamentals - 3](#)
- [Lecture 34 - Noise and Acoustic Fundamentals, Noise Outdoors](#)
- [Lecture 35 - Noise outdoors](#)
- [Lecture 36 - Sound within enclosure - 1](#)
- [Lecture 37 - Sound within enclosure - 2](#)
- [Lecture 38 - Sound within enclosure - 3](#)
- [Lecture 39 - Sound within enclosure - 4](#)
- [Lecture 40 - Sound within enclosure - 5](#)
- [Lecture 41 - Sound within enclosure - 6](#)
- [Lecture 42 - Sound within enclosure, isolation](#)
- [Lecture 43 - Isolation - 1](#)
- [Lecture 44 - Isolation - 2](#)
- [Lecture 45 - Auditorium - 1](#)
- [Lecture 46 - Auditorium - 2](#)
- [Lecture 47 - Daylighting - 1](#)
- [Lecture 48 - Daylighting - 2](#)
- [Lecture 49 - Daylighting - 3](#)
- [Lecture 50 - Daylighting - 4](#)
- [Lecture 51 - Daylighting - 5](#)
- [Lecture 52 - Daylighting - 6](#)
- [Lecture 53 - Artificial Lighting](#)
- [Lecture 54 - Design Sky models](#)
- [Lecture 55 - Live Session](#)

Lecture 1 - Basic concepts of Fire Protection - I

Lecture 2 - Basic concepts of Fire Protection - II

Lecture 3 - Fire Resistance

Lecture 4 - Introduction Process of Combustion

Lecture 5 - ventilation and fuel Process of Combustion controlled fire

Lecture 6 - Process of Combustion: Flashover condition

Lecture 7 - Effect of Fire on Construction Materials

Lecture 8 - Design for Fire Resistance: Steel

Lecture 9 - Design for Fire Resistance: Steel

Lecture 10 - Design for Fire Resistance: Concrete

Lecture 11 - Fire Safety: Urban Planning

Lecture 12 - Fire Safety: Escape and Refuge

Lecture 13 - Fire safety: Internal planning, Detection and Suppression

Lecture 14 - Fire Safety: Detection and Suppression

Lecture 15 - Introduction to Lift Design

Lecture 16 - Design of Lift systems

Lecture 17 - Design of Lift systems: expected stops and floor of reversal

Lecture 18 - Design of Lift systems: Different cases

Lecture 19 - Design of Lift systems: Simulation and arrangement and Escalators

Lecture 20 - Introduction to System and Flow Systems

Lecture 21 - Water Supply System: Constant Demand

Lecture 22 - Water Supply System: Variable Demand and Diversity Factor

Lecture 23 - Diversity factor (Continued...)

Lecture 24 - Control Systems

Lecture 25 - Introduction to HVAC

Lecture 26 - Governing Equations for HVAC Process

Lecture 27 - Numerical Problem on HVAC System

Lecture 28 - Numerical Problem on HVAC System (Continued...)

Lecture 29 - Psychrometric Chart: Equation based Approach

Lecture 30 - Flow in Pipe Networks and Fixture Units

Lecture 31 - Flow in Pipe Networks (Continued...) and Design of Water Supply Distribution System

[Lecture 32 - Design of Water Supply Distribution System \(Continued...\) and Flow in Waste Water pipes](#)

[Lecture 33 - Electrical Systems \(introduction\)](#)

[Lecture 34 - Design of Electrical Systems](#)

[Lecture 35 - Intelligent Building](#)

[Lecture 36 - Life cycle cost and basics of building maintenance](#)

[Lecture 37 - Stages of maintenance management](#)

[Lecture 38 - Planning for building maintenance](#)

[Lecture 39 - Periodicity of maintenance management](#)

[Lecture 40 - Estimation of repair cycle](#)

[Lecture 41 - Cost profile of maintenance](#)

[Lecture 42 - Lamp replacement](#)

[Lecture 43 - Building inspection, Planned and Ad-hoc maintenance](#)

[Lecture 44 - Condition survey and health evaluation of buildings](#)

[Lecture 45 - Diagnosis of building by visual survey](#)

[Lecture 46 - Case studies of visual survey](#)

[Lecture 47 - Effect of corrosion and Alkali Aggregate Reaction](#)

[Lecture 48 - Sampling and choice of test location](#)

[Lecture 49 - Non Destructive Testing - 1](#)

[Lecture 50 - Non Destructive Testing - 2](#)

[Lecture 51 - Core strength test](#)

[Lecture 52 - Carbonation and Chloride measurement](#)

[Lecture 53 - Electrical methods of progress measurement](#)

[Lecture 54 - Repair, Rehabilitation and Retrofit](#)

[Lecture 55 - Periodicity and economics of condition survey](#)

[Lecture 56 - Interpretation of test results](#)

Lecture 1 - Introduction and Planet Equivalent

Lecture 2 - Basics of Carbon Cycle

Lecture 3 - Factors Affecting carbon Cycle

Lecture 4 - Fundamentals of Sustainability

Lecture 5 - Role of Materials and Embodied Energy

Lecture 6 - Case Study for Energy in Building

Lecture 7 - Calculation of Ecological Footprint

Lecture 8 - Role of Cement in Sustainability and Calculation of Chemical Exergy

Lecture 9 - Fuel for Cement

Lecture 10 - Cementitious/Supplementary Cementitious Materials and Their Characterization

Lecture 11 - Strength of Concrete With Supplementary Cementitious Materials and Composite Cements

Lecture 12 - Types of Composite Cements

Lecture 13 - Alternative Fuel for cement and Embodied Energy

Lecture 14 - Life Cycle Embodied Energy and Concrete Sustainability

Lecture 15 - Strength of Concrete and Use of Admixtures

Lecture 16 - Curing Methods and Use of Waste Water for Mixing and Curing

Lecture 17 - Modern Composite Concrete

Lecture 18 - Recycled Aggregate-ITZ and Processing

Lecture 19 - Classification of Recycled Aggregate: Crushing and Grinding of Aggregates

Lecture 20 - Crushing and Grinding: Bond's Law+Operational Energy: U-Value

Lecture 21 - Operational Energy: Thermal Conductivity Models

Lecture 22 - Operational Energy: Thermal Conductivity Models (Continued...)

Lecture 23 - Operational Energy: Estimation of Thermal Conductivity

Lecture 24 - Thermal Diffusivity and Clay Bricks

Lecture 25 - Types of Bricks Kilns and Carbon Balance

Lecture 26 - Carbon Balance, Comparison of Various Types of Brick Kilns and Sealants, Paints, Adhesive

Lecture 27 - Sealants, Health Hazards of Building Materials and Emission Models

Lecture 28 - Emission Models and Testing

Lecture 29 - Energy Efficient Design of Buildings

Lecture 30 - Design Optimization of Buildings

Lecture 31 - Building Design Optimization Using Genetic Algorithm

[Lecture 32 - Urban Heat Island: Radiation Concepts](#)

[Lecture 33 - Urban Heat Island: Urban Canopy Layer](#)

[Lecture 34 - Evapotranspiration: Theory and Models](#)

[Lecture 35 - Evapotranspiration: Case Study and Surface Water Balance](#)

[Lecture 36 - Energy Conservation Building Code \(ECBC2007\)](#)

[Lecture 37 - Energy Conservation Building Code \(ECBC2007\) \(Continued...\)](#)

[Lecture 38 - ECBC Compliant Methodology](#)

[Lecture 39 - OTTV Methodology](#)

[Lecture 40 - Solar Energy and Solar Cells](#)

[Lecture 41 - Solar Photo Volatic Cells](#)

[Lecture 42 - Solar Water Heating](#)

[Lecture 43 - Design Strategies and the Green Design Process](#)

[Lecture 44 - Green Building Rating Systems](#)

[Lecture 45 - Autoclaved Aerated Concrete, Insulated Precast System and Insulated Precast Forms](#)

[Lecture 46 - Insulated Concrete Form and Tunnel Form](#)

[Lecture 47 - Modular Construction](#)

Lecture 1 - Introduction to Projects

Lecture 2 - Inputs to Scheduling

Lecture 3 - Critical Path Method

Lecture 4 - Precedence Diagramming Method

Lecture 5 - Line of Balance Method

Lecture 6 - Resource-driven Scheduling

Lecture 7 - Information-driven Scheduling

Lecture 8 - Dependency Structure Matrix - I

Lecture 9 - Dependency Structure Matrix - II

Lecture 10 - Dependency Structure Matrix - III

Lecture 11 - Beeline Diagramming Method

Lecture 12 - Other Scheduling Techniques

Lecture 1 - Introduction to Safety in Construction

Lecture 2 - Introduction to Safety Standards; Signs, Signals in Construction

Lecture 3 - Role of Stakeholders in Construction safety

Lecture 4 - Cost of Injury Vs Investment in Safety

Lecture 5 - Safety Program Accident/Incident Investigation

Lecture 6 - PPE in Construction

Lecture 7 - A Case Study on Construction Safety

Lecture 8 - Introduction to Fatal Falls

Lecture 9 - Fall hazard in Concerting

Lecture 10 - Fall hazard in Demolition Works

Lecture 11 - Safety in Demolition Work Practical Examples

Lecture 12 - Trench Cav-ins

Lecture 13 - Tunneling Safety

Lecture 14 - Struck by and Caught-inbetween

Lecture 15 - Crane Safety

Lecture 16 - A case Study on Construction Safety - Jigar-Crane

Lecture 17 - A case Study on Construction Safety - Safety Talk

Lecture 18 - Fire Safety and Steel Construction

Lecture 19 - Electrical Safety

Lecture 20 - A case Study on Construction Safety - Contractual Provision on Construction Zone Safety

Lecture 21 - Health Issues in Construction

Lecture 22 - Ergonomics and Health Issues with Concerting

Lecture 23 - General Safety Precautions

Lecture 24 - Safety in MEP Services

Lecture 25 - Managing Hazards in Construction

Lecture 26 - BIM for Construction

Lecture 27 - BIM for Safety

- Lecture 1 - Introduction - advanced hydraulics & course structure
- Lecture 2 - Various classifications of open channel flows
- Lecture 3 - Flow classifications & velocity distribution
- Lecture 4 - Pressure distribution
- Lecture 5 - Equation of continuity & energy
- Lecture 6 - Specific energy & critical flow
- Lecture 7 - Energy, momentum & specific force
- Lecture 8 - Computation of critical flow - Part 1
- Lecture 9 - Critical flow computations
- Lecture 10 - Introduction to uniform flow
- Lecture 11 - Manning's equation and normal depth
- Lecture 12 - Uniform Flow Computations - Part 1
- Lecture 13 - Uniform flow in compound sections, concept of normal slope
- Lecture 14 - Uniform flow approximation for flood discharge
- Lecture 15 - Design of channels for uniform flow
- Lecture 16 - Design of channels using uniform flow
- Lecture 17 - Design of erodible channels
- Lecture 18 - Introduction to gradually varied flows
- Lecture 19 - Gradually varied flow equations
- Lecture 20 - Classification of gradually varied flow - Part 1
- Lecture 21 - Classification of gradually varied flow - Part 2
- Lecture 22 - Gradually varied flow profiles with change in bed slopes
- Lecture 23 - GVF profile properties and transitional depths
- Lecture 24 - Gradually varied flow computations - Part 1
- Lecture 25 - Gradually varied flow computations RK method - Part 2
- Lecture 26 - Standard step method for gradually varied flow computations
- Lecture 27 - Spatially varied flow
- Lecture 28 - Features on spatially varied flow
- Lecture 29 - Rapidly varied flow - introduction
- Lecture 30 - Theoretical aspects of hydraulic jump
- Lecture 31 - Characteristics of jumps in rectangular channel

[Lecture 32 - Features of hydraulic jumps](#)

[Lecture 33 - Jumps as energy dissipators](#)

[Lecture 34 - Jump controls](#)

[Lecture 35 - Surges - Part 1](#)

[Lecture 36 - Surges - Part 2](#)

[Lecture 37 - Channel transitions - Part 1](#)

[Lecture 38 - Channel transitions - Part 2](#)

[Lecture 39 - Channel transitions - Part 3](#)

[Lecture 40 - Application of momentum principles](#)

[Lecture 41 - Pumps - 1](#)

[Lecture 42 - Turbines - Part 3 \(pumps, turbines\)](#)

[Lecture 43 - Turbines, cavitation](#)

- Lecture 1 - Introduction to Design of Steel Structures
- Lecture 2 - Connections
- Lecture 3 - Riveted Connections
- Lecture 4 - Design of Rivet Joint
- Lecture 5 - Welding
- Lecture 6 - Design of Fillet and Butt Welds
- Lecture 7 - Bolted Connection
- Lecture 8 - Eccentric Connections: Rivet Joints
- Lecture 9 - Design of Eccentric Connection With Load Lying in Plane of Joint Rivet Bolt
- Lecture 10 - Eccentric Connection With Load Perpendicular to Plane of Riveted Joint
- Lecture 11 - Analysis and Design of Join with Seat Connection
- Lecture 12 - Eccentric Connection
- Lecture 13 - Load Lying Perpendicular to the Plane of Weld Joint
- Lecture 14 - Tension Member
- Lecture 15 - Design of Tension Member
- Lecture 16 - Design of Tension Member: Gusset Plates, Lug Angles and Tension Splices
- Lecture 17 - Design of Tension Member: Subjected to Axial and Bending
- Lecture 18 - Compression Member
- Lecture 19 - Design of Compression Member
- Lecture 20 - Design of Eccentrically Loaded tension Member
- Lecture 21 - Built up Compression Member
- Lecture 22 - Design of Built up Compression Member
- Lecture 23 - Lacing for Built Up Compression Member
- Lecture 24 - Design of Lacing System
- Lecture 25 - Design of Batten Plates
- Lecture 26 - Introduction to Flexural Members: Beams
- Lecture 27 - Design Procedure of Beam Members
- Lecture 28 - Design of Laterally Supported Beams
- Lecture 29 - Design of Laterally Unsupported Beams
- Lecture 30 - Built-Up Beams
- Lecture 31 - Built-Up Beams: Curtailment of the Flange Plates and Shear Connections

[Lecture 32 - Design of a Built-Up Beams](#)

[Lecture 33 - Design of Shear Connections and Purlins](#)

[Lecture 34 - Gantry Girders](#)

[Lecture 35 - Design of Gantry Girders](#)

[Lecture 36 - Introduction to Plate Girders - Part 1](#)

[Lecture 37 - Introduction to Plate Girders - Part 2](#)

[Lecture 38 - Design of a Plate Girder](#)

[Lecture 39 - Column Base - Part 1](#)

[Lecture 40 - Column Base - Part 2](#)

- Lecture 1 - Introduction to Hydraulics
- Lecture 2 - Open Channel Hydraulics - Part 1
- Lecture 3 - Open Channel Hydraulics - Part 2
- Lecture 4 - Velocity and Pressure Distribution
- Lecture 5 - Practical use of velocity co-efficient in channel flow
- Lecture 6 - Conservation Principles & Governing Equations
- Lecture 7 - Uniform Flow
- Lecture 8 - Uniform Flow Formula
- Lecture 9 - Computation of Uniform Flow - Part 1
- Lecture 10 - Computation of Uniform Flow - Part 2
- Lecture 11 - Uniform Flow in Mobile Boundary Channel
- Lecture 12 - Incipient Motion Condition and Regime of Flow
- Lecture 13 - Concept of Specific Energy
- Lecture 14 - Computation of Critical Depth
- Lecture 15 - Specific Force, Critical Depth & Sequent Depth
- Lecture 16 - Non-uniform Flow: Gradually Varied Flow
- Lecture 17 - Classification of Gradually Varied Flow
- Lecture 18 - Characteristic of Gradually Varied Flow
- Lecture 19 - Characteristic of Gradually Varied Flow & its Computation
- Lecture 20 - Gradually Varied Flow & its Computation
- Lecture 21 - Computation of Gradually Varied Flow
- Lecture 22 - Gradually Varied Flow: Numerical Methods and Problem Solving
- Lecture 23 - Rapidly Varied Flow: Hydraulic Jump
- Lecture 24 - Hydraulic Jump
- Lecture 25 - Flow Over Hump and Channel Contraction
- Lecture 26 - Canal Design - 1
- Lecture 27 - Canal Design - 2
- Lecture 28 - Design of Alluvial Channel - 1
- Lecture 29 - Design of Alluvial Channel - 2
- Lecture 30 - Design of Alluvial Channel - 3
- Lecture 31 - Unsteady Flow: Waves and its Classification

[Lecture 32 - Unsteady Flow Part - 2](#)

[Lecture 33 - Unsteady Flow Part - 3](#)

[Lecture 34 - Pipe Flow: Friction Loss](#)

[Lecture 35 - Pipe Flow: Losses in Pipes](#)

[Lecture 36 - Pipe in Series & Parallel](#)

[Lecture 37 - Pipe Network Analysis](#)

[Lecture 38 - Water Hammer & Surge Tank](#)

[Lecture 39 - Pipe Flow Friction Loss](#)

[Lecture 40 - Pipe Flow: Losses in Pipe](#)

Lecture 1 - Introduction to Higher Surveying

Lecture 2 - Understanding reference system, reference frame, and coordinate system for Earth

Lecture 3 - Coordinate and datum transformations

Lecture 4 - Projected coordinate system

Lecture 5 - Fundamentals of astronomy

Lecture 6 - Applications of concepts of astronomy

Lecture 7 - Time

Lecture 8 - Application of concepts of astronomy and time

Lecture 9 - Fundamental concepts of error, accuracy, and error propagation

Lecture 10 - Applications of error propagation

Lecture 11 - Observation Equation Method of adjustments

Lecture 12 - Condition Equation Method and Combined Method of adjustments

Lecture 13 - Analysis of adjustments and reporting of errors

Lecture 14 - Global Positioning System (GPS)

Lecture 15 - Introduction to Photogrammetry

Lecture 16 - Vertical photogrammetry

Lecture 17 - Stereo photogrammetry

Lecture 18 - Analytical photogrammetry - I

Lecture 19 - Analytical photogrammetry - II

Lecture 20 - Photogrammetric products

Lecture 21 - Image matching

Lecture 22 - Close range photogrammetry

Lecture 23 - Fundamentals of LiDAR

Lecture 24 - LiDAR data acquisition

Lecture 25 - Geolocation and errors of LiDAR data

Lecture 26 - Information extraction from LiDAR data

Lecture 27 - RADAR fundamentals - I

Lecture 28 - RADAR fundamentals - II

Lecture 29 - RADAR fundamentals - III

Lecture 30 - Radargrammetry

Lecture 31 - Geoscience perspective for RADAR applications

[Lecture 32 - Fundamental concepts of hydrographic survey](#)

[Lecture 33 - Field procedures for hydrographic Surveying](#)

[Lecture 34 - Modern techniques for hydrographic Survey](#)

[Lecture 35 - Navigation](#)

[Lecture 36 - Conclusive lecture](#)

Lecture 1 - Fundamental Aspects of Unsaturated Soil Mechanics and its Basic Principles

Lecture 2 - Phases of Unsaturated Soils-I

Lecture 3 - Phases of Unsaturated Soils-II

Lecture 4 - Equilibrium between Air and Water Phases

Lecture 5 - Capillary Phenomenon in Unsaturated Soils - I

Lecture 6 - Capillary Phenomenon in Unsaturated Soils - II

Lecture 7 - Summary: Fundamental Principles and Constitutive Relationships

Lecture 8 - Concept of Water Retention and Soil Water Characteristics - I

Lecture 9 - Concept of Water Retention and Soil Water Characteristics - II

Lecture 10 - Hydraulic conductivity functions and determination of state variables

Lecture 11 - Suction Measurement/Control Techniques - I

Lecture 12 - Suction Measurement/Control Techniques - II

Lecture 13 - Summary: Suction Measurement and Control Techniques

Lecture 14 - HCF Determination

Lecture 15 - SWCC and HCF Models

Lecture 16 - HCF Modelling

Lecture 17 - Fitting of SWCC and HCF modelling

Lecture 18 - Pedo-transfer Functions (PTF)

Lecture 19 - Steady-State Flow Through Soils

Lecture 20 - Steady-State and Transient Flow

Lecture 21 - Analytical Methods for Transient Flow - I

Lecture 22 - Analytical Methods for Transient Flow - II

Lecture 23 - Shear Strength of Unsaturated Soils

Lecture 24 - Suction-Controlled Direct Shear Test

Lecture 25 - Suction-Controlled Triaxial Test

Lecture 26 - Extended M-C Criterion - I

Lecture 27 - Extended M-C Criterion - II

Lecture 28 - Extended M-C Criterion - III

Lecture 29 - Concept of Suction Stress - I

Lecture 30 - Concept of Suction Stress - II

Lecture 31 - Concept of Suction Stress - III

[Lecture 32 - Summary: Shear Strength of Unsaturated Soils and Introduction to Volume Change](#)

[Lecture 33 - Swelling Behaviour of Soils](#)

[Lecture 34 - Estimation of Swelling Pressure in the Laboratory and Behaviour of Collapsible soil](#)

[Lecture 35 - Volume Change Behaviour of Bentonite and Kaolin Clay](#)

[Lecture 36 - Demonstration of Various Experiments Related to Unsaturated Soil Mechanics](#)

Lecture 1 - Introduction

Lecture 2 - Phases and classification of subsurface Investigation

Lecture 3 - Test Pits+ Borings

Lecture 4 - Ground water table and rock drilling

Lecture 5 - Standard Penetration Test

Lecture 6 - Cone Penetration Test

Lecture 7 - Dilatometer Test

Lecture 8 - Pressuremeter Test

Lecture 9 - Seismic reflection method

Lecture 10 - Seismic refraction method

Lecture 11 - Electrical Resistivity Survey

Lecture 12 - Magnetic Survey

Lecture 13 - Surface wave method

Lecture 14 - Gravity Survey

Lecture 15 - Offshore Investigation

Lecture 16 - Geophysical Investigation in Offshore Environment

Lecture 17 - Sampling and Geotechnical Investigations in Offshore Environment

Lecture 18 - Important Terminologies in Offshore Environment

Lecture 19 - Dynamic Testing in Pile Driving

Lecture 20 - Dynamic Testing in Pile (Low Strain)

Lecture 21 - Conclusion

- Lecture 1 - Basic Concepts of Fluid
- Lecture 2 - Properties of Fluid
- Lecture 3 - Properties of Fluid
- Lecture 4 - Concepts of Hydrostatic
- Lecture 5 - Measurement of Pressure and Hydrostatic forces
- Lecture 6 - Buoyancy, Metacentre, Stability and Rigid body motion
- Lecture 7 - Reynolds Transport Theorem
- Lecture 8 - Conservation of Mass
- Lecture 9 - Conservation of Momentum
- Lecture 10 - Conservation of Momentum Applications
- Lecture 11 - Bernoulli's Equation
- Lecture 12 - Applications of Bernoulli's Equation
- Lecture 13 - Fluid Statics Applications: Example Problems
- Lecture 14 - Conservation of Momentum: Example problems
- Lecture 15 - Bernoulli's Equation: Problems Solving on Black Board
- Lecture 16 - Lagrangian and Eulerian Descriptions
- Lecture 17 - Motion and deformation of fluid elements
- Lecture 18 - Problems Solving on Black Board
- Lecture 19 - Dimensional Homogeneity
- Lecture 20 - Dimensional Analysis and Similarity
- Lecture 21 - Laminar and Turbulent Flows
- Lecture 22 - Losses in Pipe Fittings
- Lecture 23 - Flow in Noncircular Conduits and Multiple Path Pipeflow
- Lecture 24 - Mass Conservation Equation - I
- Lecture 25 - Mass Conservation Equation - II
- Lecture 26 - Stream Function
- Lecture 27 - Cauchy's Equation
- Lecture 28 - The Navier-Stokes Equation - Part I
- Lecture 29 - The Navier-Stokes Equation - Part II
- Lecture 30 - The Navier-Stokes Equation - Part III
- Lecture 31 - Approximate solutions of Navier Stokes Equation: Boundary Layer Approximation

[Lecture 32 - Boundary Layer Approximation - II](#)

[Lecture 33 - Boundary Layer Approximation - III](#)

[Lecture 34 - Open Channel Flow - I](#)

[Lecture 35 - Open Channel Flow - II](#)

[Lecture 36 - Open Channel Flow - III](#)

[Lecture 37 - Drag and Lift](#)

Lecture 1 - Overview and Introduction

Lecture 2 - Basics of Remote Sensing

Lecture 3 - Error corrections in satellite image

Lecture 4 - Error Identification and Correction - I

Lecture 5 - Error Identification and Correction - II

Lecture 6 - Error Identification and Correction - III

Lecture 7 - DIP - I

Lecture 8 - DIP - II

Lecture 9 - DIP - III

Lecture 10 - DIP - IV

Lecture 11 - Image Classification - I

Lecture 12 - Image Classification - II

Lecture 13 - Photogrammetry

Lecture 14 - Thermal Remote Sensing

Lecture 15 - Microwave Remote Sensing

Lecture 16 - HRS - I

Lecture 17 - HRS - II

Lecture 18 - HRS - III

Lecture 19 - HRS - IV

Lecture 20 - HRS - V

Lecture 21 - GIS - I

Lecture 22 - GIS - II

Lecture 23 - Applications of Remote Sensing and GIS - I

Lecture 24 - Applications of Remote Sensing and GIS - II

- Lecture 1 - Introduction to River Engineering
- Lecture 2 - Basic properties of sediment - I
- Lecture 3 - Basic properties of sediment - II
- Lecture 4 - Mass Conservation
- Lecture 5 - Linear Momentum Equation
- Lecture 6 - Navier-Stokes Equations
- Lecture 7 - St. Venant Equation and Solver
- Lecture 8 - Specific Energy and Critical Flow
- Lecture 9 - Hydraulic Jump and Celerity
- Lecture 10 - Floodwave Celerity and Loop Rating Curve
- Lecture 11 - Sediment Transport in River - I
- Lecture 12 - Sediment Transport in River - II
- Lecture 13 - Sediment Transport in River - III
- Lecture 14 - Physical River Models
- Lecture 15 - Bridge Scour: processes and estimation
- Lecture 16 - Bridge Scour-II
- Lecture 17 - Jet Scour and River Navigation
- Lecture 18 - River Training Work
- Lecture 19 - Riverbank Stabilization - I
- Lecture 20 - Riverbank Stabilization - II
- Lecture 21 - Riverbank Protection and Control Structures
- Lecture 22 - River Equilibrium - I
- Lecture 23 - River Equilibrium - II
- Lecture 24 - River Equilibrium - III

Lecture 1 - Introduction to solid waste

Lecture 2 - Functional elements

Lecture 3 - Types and sources of solid waste

Lecture 4 - Sampling and characteristics

Lecture 5 - Estimation of solid waste quantity

Lecture 6 - Factors affecting solid waste generation rate

Lecture 7 - Handling, separation and storage at source

Lecture 8 - Processing at source

Lecture 9 - Primary collection

Lecture 10 - Types of collection system

Lecture 11 - Analysis of collection system - Part I

Lecture 12 - Analysis of collection system - Part II

Lecture 13 - Analysis of collection system - Part III

Lecture 14 - Need and types of transfer station

Lecture 15 - Transport means and methods

Lecture 16 - Unit operation for component separation

Lecture 17 - Material recovery facilities (MRF)

Lecture 18 - Recycling of dry waste components

Lecture 19 - Waste as a fuel

Lecture 20 - Incineration/Combustion

Lecture 21 - Flue gas characteristics and treatment

Lecture 22 - Solid residue generation, characterization and treatment

Lecture 23 - Waste-to-energy (WtE) plants (case studies) pyrolysis and gasification

Lecture 24 - Definition and phases of composting

Lecture 25 - Factors affecting composting process

Lecture 26 - Types of composting - I

Lecture 27 - Types of composting - II

Lecture 28 - Compost quality

Lecture 29 - Vermicomposting

Lecture 30 - Definition, stages and factors affecting anaerobic digestion

Lecture 31 - Pretreatment and co-digestion for enhancement of biogas production

[Lecture 32 - Types of biogas digesters](#)

[Lecture 33 - Site selection and types of landfill](#)

[Lecture 34 - Leachate collection and treatment](#)

[Lecture 35 - Landfill gas collection and treatment](#)

[Lecture 36 - Design of landfill and Bio-minning of old dumpsite](#)

[Lecture 37 - Construction and demolition waste](#)

[Lecture 38 - Management of bio-medical, e-waste and inert waste](#)

[Lecture 39 - Integrated solid waste management \(ISWM\)](#)

[Lecture 40 - Municipal solid waste management rules](#)

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Lecture 1 - Planning process of equipment

Lecture 2 - Estimation of Ownership cost (Average Annual Investment method)

Lecture 3 - Estimation of Ownership cost (Time value method)

Lecture 4 - Operating cost of Equipment

Lecture 5 - Equipment cost estimation

Lecture 6 - Equipment life and replacement analysis - Part 1

Lecture 7 - Equipment life and replacement analysis - Part 2

Lecture 8 - Equipment life and replacement analysis - Part 3

Lecture 9 - Engineering Fundamentals of Moving Earth

Lecture 10 - Bull Dozers

Lecture 11 - Scrapers - Part 1

Lecture 12 - Scrapers - Part 2

Lecture 13 - Front End loaders

Lecture 14 - Excavators

Lecture 15 - Trucks

Lecture 16 - Piles and Pile driving equipment - Part 1

Lecture 17 - Piles and Pile driving equipment - Part 2

Lecture 18 - Cranes - Part 1

Lecture 19 - Cranes - Part 2

Lecture 20 - Concreting Equipment - Part 1

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Lecture 22 - Summary

- Lecture 1 - Introduction to course content
- Lecture 2 - Stress acting at a point - Cauchy stress
- Lecture 3 - Stress acting at a point - Stress tensor
- Lecture 4 - Stress acting on a plane
- Lecture 5 - Stress acting on a plane example
- Lecture 6 - Transformation of stress tensor
- Lecture 7 - Stress invariants
- Lecture 8 - Relationship between stress invariants
- Lecture 9 - Principle stresses and Eigen vectors
- Lecture 10 - Strain in soils
- Lecture 11 - Cause effect relationship
- Lecture 12 - Important constitutive relationship
- Lecture 13 - 3D to 2D idealization
- Lecture 14 - Mathematical formulation plane stress plane strain
- Lecture 15 - Mathematical formulation axisymmetric
- Lecture 16 - Summary of Module 1
- Lecture 17 - Basics of shear strength
- Lecture 18 - Stress representation
- Lecture 19 - Shear strength granular soil - I
- Lecture 20 - Shear strength granular soil - II
- Lecture 21 - Shear strength cohesive soil
- Lecture 22 - Shear strength cohesive soil - Stress strain
- Lecture 23 - Pore water pressure and Skemptions equation
- Lecture 24 - Overall pore water pressure parameter
- Lecture 25 - Pore water pressure - plane strain-effect of sampling
- Lecture 26 - Pore water pressure estimation
- Lecture 27 - Triaxial test
- Lecture 28 - Interpretation triaxial test - UU UCS
- Lecture 29 - Interpretation triaxial test - CU
- Lecture 30 - Interpretation triaxial test - CD
- Lecture 31 - Some additional aspects of shear strength

- Lecture 32 - Summary of Module 2
- Lecture 33 - Stress path and representation
- Lecture 34 - Failure line in stress path
- Lecture 35 - Stress path-some common cases - I
- Lecture 36 - Stress path-some common cases - II
- Lecture 37 - Stress path-triaxial test-drained
- Lecture 38 - Stress path-triaxial test-undrained
- Lecture 39 - Stress path-additional undrained case
- Lecture 40 - Stress path-field cases - I
- Lecture 41 - Stress path-field cases - II
- Lecture 42 - Stress path problems
- Lecture 43 - Summary of Module 3
- Lecture 44 - Introduction-critical state soil mechanics
- Lecture 45 - Introduction-critical state soil mechanics
- Lecture 46 - CSSM-2 D representation
- Lecture 47 - Peak state
- Lecture 48 - Soil yielding
- Lecture 49 - Cam clay
- Lecture 50 - Modified Cam clay
- Lecture 51 - Prediction of soil behavior from MCCM
- Lecture 52 - Prediction of soil behavior from MCCM
- Lecture 53 - Strain from MCCM
- Lecture 54 - State boundary surface
- Lecture 55 - CSSM problems
- Lecture 56 - Summary of Module 4
- Lecture 57 - Closure of Advanced Soil Mechanics Course

- Lecture 1 - Introduction, classification of plates and some useful relations
- Lecture 2 - Theory of thin plate bending
- Lecture 3 - Plate equations and boundary conditions with examples
- Lecture 4 - Exercises on the plate bending theory
- Lecture 5 - Simply supported plate subjected to distributed loading
- Lecture 6 - Simply supported plate subjected to concentrated load and couple
- Lecture 7 - Simply supported plate resting on elastic foundation and other examples
- Lecture 8 - General formulation for rectangular plate with two opposite edges simply supported
- Lecture 9 - Levy's solution for different loading and boundary conditions
- Lecture 10 - Rectangular plate with Levy's boundary condition subjected to edge moment
- Lecture 11 - Transformation of plate equation from rectangular co-ordinates to polar co-ordinates
- Lecture 12 - Axi-symmetrical bending of circular plate under pure moment and uniformly distributed load
- Lecture 13 - Examples in axisymmetrical bending of solid and annular plate
- Lecture 14 - Variational principle in plate problem
- Lecture 15 - Applications of Rayleigh-Ritz and Gallerkin's method
- Lecture 16 - Finite difference method in plate bending
- Lecture 17 - Plate subjected to inplane forces and transverse load
- Lecture 18 - Buckling load of rectangular plate plate with Navier's boundary condition
- Lecture 19 - Buckling load of rectangular with Levy's boundary condition
- Lecture 20 - Rayleigh-Ritz and Gallerkin method in buckling of plate
- Lecture 21 - Finite difference method in buckling of plate
- Lecture 22 - Introduction to shell structure and behavior of stretched membrane
- Lecture 23 - Classification of shell structure
- Lecture 24 - Stress resultants and couples in shells
- Lecture 25 - Membrane analysis of shells of surface of revolution
- Lecture 26 - Analysis of Spherical dome
- Lecture 27 - Some examples of axi-symmetrical cases in surface of revolution
- Lecture 28 - Membrane theory in pressure vessels
- Lecture 29 - Membrane theory in pressure vessel in the form a Torus and in a tank of arbitrary meridian
- Lecture 30 - Membrane theory of hyperboloid of revolution: Application to cooling tower
- Lecture 31 - Differential Equations of Equilibrium in Cylindrical shell using membrane hypothesis

[Lecture 32 - Membrane Analysis of Cylindrical Shell roof subjected to self weight and snow load](#)

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[Lecture 34 - Simplified Bending Theory of Cylindrical Shell-Beam and Arch theories](#)

[Lecture 35 - General bending theory of cylindrical shell](#)

[Lecture 36 - Some applications of symmetrical bending of circular cylindrical shell](#)

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- Lecture 2 - Classical Optimization
- Lecture 3 - Introduction to Linear Problem
- Lecture 4 - General system of equations
- Lecture 5 - Simplex Method
- Lecture 6 - Solution of Linear Problem using Excel Solver
- Lecture 7 - Bracketing Method
- Lecture 8 - Region Elimination Methods
- Lecture 9 - Gradient Based Method and Examples
- Lecture 10 - Convex Function
- Lecture 11 - Line Search Methods for Multi-Variable Problems
- Lecture 12 - Quadratic Approximation Method
- Lecture 13 - Constrained Optimization I: Equality constraints
- Lecture 14 - Constrained Optimization II: Inequality constraints
- Lecture 15 - Constrained Optimization III: Penalty function methods
- Lecture 16 - Introduction to Metaheuristic Optimization
- Lecture 17 - Genetic Algorithms - Part I
- Lecture 18 - Genetic Algorithms - Part II
- Lecture 19 - Genetic Algorithms - Part III
- Lecture 20 - Real Coded Genetic Algorithms
- Lecture 21 - Multi-modal optimization
- Lecture 22 - Introduction to R
- Lecture 23 - GA using R (Unconstrained problem)
- Lecture 24 - GA using R (Constrained problem)
- Lecture 25 - Constraint Handling in GAs
- Lecture 26 - Evolution Strategies (ESs)
- Lecture 27 - Particle swarm optimization
- Lecture 28 - Introduction to R - Part II
- Lecture 29 - Multi-objective Genetic Algorithms
- Lecture 30 - Introduction to Differential Evolution
- Lecture 31 - Introduction to Matlab

[Lecture 32 - Optimization using Matlab \(Classical methods\)](#)

[Lecture 33 - A tutorial on Differential Evolution](#)

[Lecture 34 - NSGA II Using R](#)

[Lecture 35 - Optimization using MATLAB](#)

[Lecture 36 - Optimization using Excel Solver](#)

[Lecture 37 - Multi-objective Genetic Algorithms using MATLAB](#)

[Lecture 38 - Solution of a Design Problem Using MATLAB](#)

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Lecture 3 - Introduction to Reynolds Transport Theorem

Lecture 4 - Derivation of Reynolds Transport Theorem - Part I

Lecture 5 - Derivation of Reynolds Transport Theorem - Part II

Lecture 6 - Conservations Laws

Lecture 7 - Numerical Examples

Lecture 8 - Summary of Module - I

Lecture 9 - Atmospheric Water

Lecture 10 - Water Vapor Dynamics

Lecture 11 - Precipitable Water in the Static Atmospheric Column

Lecture 12 - Numerical Examples on Basic Atmospheric Parameters

Lecture 13 - Precipitation-Types and Formation

Lecture 14 - Terminal Velocity

Lecture 15 - Thunderstorm Cell Model

Lecture 16 - Numerical Examples on Terminal Velocity and Thunderstorm Cell

Lecture 17 - Forms of Precipitation

Lecture 18 - Measurement of rainfall

Lecture 19 - Raingauge Network

Lecture 20 - Presentation of Rainfall Data

Lecture 21 - Analysis of Rainfall Data

Lecture 22 - Average Areal Rainfall

Lecture 23 - Evaporation

Lecture 24 - Evaporation-Energy Balance Method

Lecture 25 - Evaporation-Aerodynamic Method

Lecture 26 - Evaporation-Combined Method

Lecture 27 - Numerical Examples on Evaporation

Lecture 28 - Evaporation-Empirical method

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Lecture 30 - Evapotranspiration-Numerical Example

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[Lecture 42 - Summary of Module - III](#)

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[Lecture 44 - Excess Rainfall and Direct Runoff](#)

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[Lecture 54 - Hydrograph Analysis-UH](#)

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[Lecture 78 - Hydrologic Design](#)

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NPTEL : NOC:Expansive Soil (Civil Engineering)

Co-ordinators : Prof. Anil Kumar Mishra

Lecture 1 - Formation of soil

Lecture 2 - Index properties and classification of soil

Lecture 3 - Engineering properties of soil - I

Lecture 4 - Engineering properties of soil - II

Lecture 5 - Clay mineralogy

Lecture 6 - Properties of clay particles

Lecture 7 - Definition, type and behaviour

Lecture 8 - Mechanism of soil-water interaction

Lecture 9 - Swelling of expansive soil

Lecture 10 - Factors controlling DDL thickness

Lecture 11 - Determination of swelling properties

Lecture 12 - Classification and prediction

Lecture 13 - Factors controlling swelling of soil

Lecture 14 - Shrinkage behaviour of soil

Lecture 15 - Factors controlling shrinkage behavior of soils

Lecture 16 - Measurement of various shrinkage characteristics of soil

Lecture 17 - Cyclic Swelling-Shrinkage Behaviour of Soil

Lecture 18 - Thermo-Mechanical-Hydraulic-Chemical Behaviour - I

Lecture 19 - Thermo-Mechanical-Hydraulic-Chemical Behaviour - II

Lecture 20 - Thermo-Mechanical-Hydraulic-Chemical Behaviour - III

Lecture 21 - Mechanical Methods

Lecture 22 - Hydraulic methods

Lecture 23 - Chemical methods - 1

Lecture 24 - Chemical methods - 2

Lecture 25 - By inclusion or confinement

Lecture 26 - Foundation on expansive soil

Lecture 27 - Use of expansive soil for various geotechnical engineering applications

Lecture 28 - Closure lecture

- Lecture 1 - General Introduction and Modelling of Dynamic Systems
- Lecture 2 - Time Domain Analysis of Linear System - Harmonic input
- Lecture 3 - Time Domain Analysis of Linear System - Arbitrary Input
- Lecture 4 - Transformed technique in vibration of linear system
- Lecture 5 - Formulation of problem: Equilibrium Approach
- Lecture 6 - Formulation of problem by Energy Principle
- Lecture 7 - Hamilton's principles for formulating vibration problems
- Lecture 8 - Lagrange's equation for formulating vibration problems
- Lecture 9 - One Dimensional Wave Equation
- Lecture 10 - D'Alembert's Solution of the Wave Equation
- Lecture 11 - Transverse Vibration of String
- Lecture 12 - Forced Transverse Vibration of String
- Lecture 13 - Axial Vibration of Bar
- Lecture 14 - Torsional Vibration of Bar
- Lecture 15 - Some typical problems in axial and torsional vibrations
- Lecture 16 - Transverse vibration of beams
- Lecture 17 - Natural frequencies and mode shapes of beams with various end conditions
- Lecture 18 - Free damped transverse vibration analysis of beam
- Lecture 19 - Forced damped vibration analysis of Euler Bernoulli beam
- Lecture 20 - Vibration of beams subjected to moving load
- Lecture 21 - Some special topics on the transverse vibration of beam
- Lecture 22 - Combination of continuous and lumped parameter system
- Lecture 23 - State space solutions in vibration problems
- Lecture 24 - Beam with moving oscillator, pulsating force and rolling mass
- Lecture 25 - Vibration of membrane
- Lecture 26 - Vibration of Circular membrane
- Lecture 27 - Vibration of Rectangular plate
- Lecture 28 - Free vibration of rectangular plates
- Lecture 29 - Forced vibration of rectangular plates
- Lecture 30 - Approximate method for vibration analysis
- Lecture 31 - Rayleigh-Ritz method for vibration analysis

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[Lecture 34 - Response of continuous systems to transient excitations](#)

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Lecture 2 - Random Variable

Lecture 3 - Functions of Random Variables

Lecture 4 - Joint Distributions

Lecture 5 - Mt. Gen. Func. and CLT

Lecture 6 - Theory of Estimation

Lecture 7 - Goodness of Fit

Lecture 8 - MVFOSM

Lecture 9 - MVFOSM (Continued...)

Lecture 10 - Hasofer-Lind Rel. Index

Lecture 11 - Rackwitz's Algorithm (Continued...)

Lecture 12 - HL-RF for Non-Normal Problems

Lecture 13 - HL-RF for Correlated Problems

Lecture 14 - FORM using MATLAB

Lecture 15 - FORM using MATLAB (Continued...)

Lecture 16 - FORM Using FEM

Lecture 17 - Morgenstern Model

Lecture 18 - Nataf Model

Lecture 19 - Rosenblatt Transformation

Lecture 20 - Brietung's Model

Lecture 21 - Tvedt's Model

Lecture 22 - Monte-Carlo Simulation

Lecture 23 - Importance Sampling

Lecture 24 - Least Square Curve Fitting

Lecture 25 - Orthogonal Polynomials

Lecture 26 - RSM

Lecture 27 - Stochastic Response Surface Method

Lecture 28 - Moving Least Square Method

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[Lecture 36 - Introduction to Stochastic FEM](#)

NPTEL : Advanced Hydrology (Civil Engineering)

Co-ordinators : Dr. Ashu Jain

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Lecture 1 - Introduction and course overview

Lecture 2 - Constituents of concrete - Part 1 of 2

Lecture 3 - Constituents of concrete - Part 2 of 2

Lecture 4 - Admixtures in concrete – mineral and chemical

Lecture 5 - Hydration of cement

Lecture 6 - Basic properties of concrete

Lecture 7 - Proportioning of concrete mixes - Part 1 of 3

Lecture 8 - Proportioning of concrete mixes - Part 2 of 3

Lecture 9 - Proportioning of concrete mixes - Part 3 of 3

Lecture 10 - Pores and porosity in concrete

Lecture 11 - Porosimetry – measuring pores in concrete

Lecture 12 - Principles of quality control in concrete construction

Lecture 13 - Quality control and acceptance criteria for concrete based on compressive strength

Lecture 14 - Fibre reinforced concrete

Lecture 15 - High strength concrete

Lecture 16 - Mass concrete - Part 1 of 2

Lecture 17 - Mass concrete - Part 2 of 2

Lecture 18 - Concreting in cold weather

Lecture 19 - Concreting in hot weather

Lecture 20 - Roller compacted concrete

Lecture 21 - Self-compacting concrete

Lecture 22 - Testing self-compacting concrete

Lecture 23 - Shotcrete and underwater concrete

Lecture 24 - Alkali – aggregate reaction - Part 1 of 2

Lecture 25 - Alkali – aggregate reaction - Part 2 of 2

Lecture 26 - Reinforcement corrosion in concrete

Lecture 27 - Chloride penetration in concrete

Lecture 28 - Using epoxy-coated bars in concrete structures

Lecture 29 - Using FRP as reinforcement in concrete structures - Part 1 of 2

Lecture 30 - Using FRP as reinforcement in concrete structures - Part 2 of 2

Lecture 31 - Grouting and importance of formwork in concrete construction

[Lecture 32 - Carbonation and freezing & thawing in concrete structures](#)

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NPTEL : Environmental Air Pollution (Civil Engineering)

Co-ordinators : Prof. Mukesh Sharma

- Lecture 1 - Introduction to Atmosphere
- Lecture 2 - Air Pollution Systems
- Lecture 3 - Air Quality Standards
- Lecture 4 - Types and Forms of Air Pollutants
- Lecture 5 - Measurement Units and Particulate classification
- Lecture 6 - Interpretation and Particle size Distribution
- Lecture 7 - Atmospheric formation of Air Pollutants - I
- Lecture 8 - Atmospheric formation of Air Pollutants - II
- Lecture 9 - Atmospheric formation of Air Pollutants - III
- Lecture 10 - Kinetics of Air pollution and combustion processes
- Lecture 11 - Internal Combustion Engine and Air Pollution - I
- Lecture 12 - Internal Combustion Engine and Air Pollution - II
- Lecture 13 - Air Pollution and Health - I
- Lecture 14 - Air Pollution and Health - II
- Lecture 15 - Emission Inventory
- Lecture 16 - Sources of Air Pollution
- Lecture 17 - Emission from Fugitive Sources and Sulfuric Acid Production
- Lecture 18 - Aluminium Production and Air Pollution - I
- Lecture 19 - Aluminium Production and Air Pollution - II
- Lecture 20 - Coke Production and Air Pollution
- Lecture 21 - Examples for Practice
- Lecture 22 - Meteorological Measurements and their interpretation
- Lecture 23 - Examples for Practice - Dispersion Modeling
- Lecture 24 - Vertical Temperature Profile of Atmosphere
- Lecture 25 - Stability, Mixing Height and Plume Behavior - I
- Lecture 26 - Stability, Mixing Height and Plume Behavior - II
- Lecture 27 - Examples - Solar Radiation Based Stability Calculation
- Lecture 28 - Air Quality Modeling - I
- Lecture 29 - Air Quality Modeling - II
- Lecture 30 - Derivation of Gaussian Model
- Lecture 31 - Gaussian Model - Useful Formulation

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NPTEL : Water Resources Engineering (Civil Engineering)

Co-ordinators : Dr. Pranab K Mohapatra, Prof. Rajesh Srivastava

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[Lecture 1 - Geotechnical Measurements & Explorations](#)

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NPTEL : Application of Soil Mechanics (Civil Engineering)

Co-ordinators : Dr. Nihar Ranjan Patra

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Lecture 27 - Porphyroblasts

Lecture 28 - Boudinage and Pinch-and-Swell Structures - I

Lecture 29 - Boudinage and Pinch-and-Swell Structures - II

Lecture 30 - Stereonet Problem I: True dip from two apparent dips

Lecture 31 - Stereonet Problem II: True dip from strike and one apparent dip

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- [Lecture 37 - Faults and Faulting - I](#)
- [Lecture 38 - Stereonet Problem VI - Fold geometry from interlimb angle and fold axes](#)
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- [Lecture 43 - Basic of Litho-Structural Mapping](#)
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Lecture 1 - Introduction to Earthquake Geology - Part I

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Lecture 3 - Introduction to Earthquake Geology - Part III

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Lecture 5 - Fundamentals Related to Paleoseismology - Part I

Lecture 6 - Fundamentals Related to Paleoseismology - Part II

Lecture 7 - Fundamentals Related to Paleoseismology - Part III

Lecture 8 - Plate Tectonics - Part I

Lecture 9 - Plate Tectonics - Part II

Lecture 10 - Plate Tectonics - Part III

Lecture 11 - Plate tectonics - Part IV

Lecture 12 - Plate Tectonics - Part V

Lecture 13 - Seismic Zonation of India

Lecture 14 - Interior of the Earth - Part I

Lecture 15 - Interior of the Earth - Part II

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Lecture 17 - Earthquake Forecasting and Prediction Model - Part II

Lecture 18 - Earthquake Forecasting and Prediction Model - Part III

Lecture 19 - Earthquake in Interplate and Intraplate Region

Lecture 20 - Earthquake Magnitude and Intensity Scale - Part I

Lecture 21 - Earthquake Magnitude and Intensity Scale - Part II

Lecture 22 - Fundamentals Related to Active Faults - Part I

Lecture 23 - Fundamentals Related to Active Faults - Part II

Lecture 24 - Fundamentals Related to Active Faults - Part III

Lecture 25 - Fundamentals Related to Active Faults - Part IV

Lecture 26 - Lab and Field Techniques in Active Fault Mapping and Paleoseismic studies - Part I

Lecture 27 - Lab and Field Techniques in Active Fault Mapping and Paleoseismic studies - Part II

Lecture 28 - Lab and Field Techniques in Active Fault Mapping and Paleoseismic studies - Part III

Lecture 29 - Lab and Field Techniques in Active Fault Mapping and Paleoseismic studies - Part IV

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Lecture 31 - Extensional Tectonic Environments and Related Landforms - Part I

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- [Lecture 34 - Extensional Tectonic Environments and Related Landforms - Part IV](#)
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- [Lecture 36 - Compressional Tectonic Environments and Related Landforms - Part II](#)
- [Lecture 37 - Compressional Tectonic Environments and Related Landforms - Part III](#)
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- [Lecture 40 - Compressional Tectonic Environments and Related Landforms - Part VI](#)
- [Lecture 41 - Compressional Tectonic Environments and Related Landforms - Part VII](#)
- [Lecture 42 - Strike-Slip Tectonic Environments and Related Landforms - Part I](#)
- [Lecture 43 - Strike-Slip Tectonic Environments and Related Landforms - Part II](#)
- [Lecture 44 - Strike-Slip Tectonic Environments and Related Landforms - Part III](#)
- [Lecture 45 - Strike-Slip Tectonic Environments and Related Landforms - Part IV](#)
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- [Lecture 51 - Coastal Geomorphic Markers - Part I](#)
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- [Lecture 54 - Tsunami and Paleostunami signatures Investigation - Part I](#)
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- Lecture 2 - Concrete - A composite material
- Lecture 3 - Basic properties (Fresh concrete)
- Lecture 4 - Basic properties (Hardened concrete)
- Lecture 5 - Fundamentals of proportioning concrete mixes
- Lecture 6 - Proportioning of normal concrete mixes
- Lecture 7 - Concrete mix proportions: Analysis and adjustments
- Lecture 8 - Pores and porosity in concrete
- Lecture 9 - Admixtures in concrete
- Lecture 10 - Curing of Concrete
- Lecture 11 - Cold weather Concreting
- Lecture 12 - Hot Weather Concreting
- Lecture 13 - Special Topics I - Importance of Right Methods and Specifications
- Lecture 14 - Heat of Hydration of Cement and Thermal Stresses
- Lecture 15 - Antiwashout Underwater Concrete
- Lecture 16 - Concreting Underwater
- Lecture 17 - Roller Compacted Concrete
- Lecture 18 - Self Compacting Concrete - I
- Lecture 19 - Self Compacting Concrete - II
- Lecture 20 - Self Compacting Concrete - III
- Lecture 21 - Special Topics - Rheology
- Lecture 22 - Fibre-Reinforced Concrete - I
- Lecture 23 - Fibre-Reinforced Concrete - II
- Lecture 24 - Fibre-Reinforced Concrete - III
- Lecture 25 - Mixing of Concrete
- Lecture 26 - Shotcrete
- Lecture 27 - High Strength Concrete
- Lecture 28 - Using Polymers in Concrete
- Lecture 29 - Improving the Quality of Cover Concrete
- Lecture 30 - Compaction of Concrete
- Lecture 31 - Precast Concrete

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Lecture 2 - Introduction to Geosciences in Civil Engineering - II

Lecture 3 - Introduction to Geosciences in Civil Engineering - III

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Lecture 5 - Plate Tectonics and Continental Drift - II

Lecture 6 - Plate Tectonics and Continental Drift - III

Lecture 7 - Plate Tectonics and Continental Drift - IV

Lecture 8 - Plate Tectonics and Continental Drift - V

Lecture 9 - Plate Tectonics and Continental Drift - VI

Lecture 10 - Plate Tectonics and Continental Drift - VII

Lecture 11 - Plate Tectonics and Continental Drift - VIII

Lecture 12 - Rock-Forming Minerals and their Properties - I

Lecture 13 - Rock-Forming Minerals and their Properties - II

Lecture 14 - Rock-Forming Minerals and their Properties - III

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Lecture 16 - Igneous Rocks and their Properties - II

Lecture 17 - Igneous Rocks and their Properties - III

Lecture 18 - Sedimentary Rocks and their Properties - I

Lecture 19 - Sedimentary Rocks and their Properties - II

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Lecture 21 - Metamorphic Rocks and their Properties - I

Lecture 22 - Metamorphic Rocks and their Properties - II

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Lecture 24 - Seismology and Internal Structure of the earth - Part 2

Lecture 25 - Seismology and Internal Structure of the earth - Part 3

Lecture 26 - Seismology and Internal Structure of the earth - Part 4

Lecture 27 - Seismology and Internal Structure of the earth - Part 5

Lecture 28 - Seismic Events and Sediments Amplification - I

Lecture 29 - Seismic Events and Sediments Amplification - II

Lecture 30 - Geological Structures - I

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[Lecture 42 - Landslides and Associated Hazard](#)

[Lecture 43 - Rock Mass Classification System](#)

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Lecture 1 - Introduction

Lecture 2 - Soil Exploration

Lecture 3 - Soil Exploration - Penetration Tests

Lecture 4 - Soil Exploration - Geophysical Exploration

Lecture 5 - Shallow Foundation - Introduction

Lecture 6 - Shallow Foundation : Bearing Capacity - I

Lecture 7 - Shallow Foundation : Bearing Capacity - II

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Lecture 11 - Shallow Foundation - Settlement Calculation - I

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Lecture 13 - Shallow Foundation - Settlement Calculation - III

Lecture 14 - Design of Shallow Foundation

Lecture 15 - Design of Raft Foundation

Lecture 16 - Deep Foundation - Introduction

Lecture 17 - Pile Foundation - Load Carrying Capacity - I

Lecture 18 - Pile Foundation - Load Carrying Capacity - II

Lecture 19 - Pile Foundation - Load Carrying Capacity - III and Settlement Calculation

Lecture 20 - Tension and Lateral Loaded Piles

Lecture 21 - Well Foundation

Lecture 22 - Well Foundation (Continued...)

Lecture 23 - Design of Retaining Wall

Lecture 24 - Design of Retaining Wall (Continued...)

Lecture 25 - Design of Sheet Piles

Lecture 26 - Design of Sheet Piles (Continued...)

Lecture 27 - Design of Sheet Piles (Continued...)

Lecture 28 - Design of Sheet Piles (Continued...)

Lecture 29 - Reinforced Earth

Lecture 30 - Reinforced Retaining Wall

Lecture 31 - Seismic Design of Retaining Wall

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[Lecture 33 - Soil - Foundation Interaction](#)

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[Lecture 36 - Soil - Foundation Interaction \(Continued...\)](#)

[Lecture 37 - Soil - Foundation Interaction \(Continued...\)](#)

[Lecture 38 - Soil - Foundation Interaction \(Continued...\)](#)

[Lecture 39 - Soil - Foundation Interaction \(Continued...\)](#)

[Lecture 40 - Soil - Foundation Interaction \(Continued...\)](#)

NPTEL : Ground Water Hydrology (Civil Engineering)

Co-ordinators : Dr. Anirban Dhar, Dr. V.R. Desai

- Lecture 1 - Introduction : Ground Water (GW) Utilization and Historical Background, GW in hydrologic Cycle
- Lecture 2 - Ground Water in & % Hydrologic Cycle (Continued...), Ground Water Budget, Ground Water Level Fluctuations and Environmental Influence
- Lecture 3 - Ground water Level Fluctuations and Environmental Influence (Continued...) Literature/Data/Internet Resources
- Lecture 4 - Ground water Level Fluctuations and Environmental Influence (Continued...) Literature/Data/Internet Resources
- Lecture 5 - Occurrence and Movement of Ground Water : Origin and Age of Ground Water, Rock Properties Affecting Ground Water, Ground Water Column
- Lecture 6 - Zones of Aeration and Saturation; Aquifers and their characteristics/classification
- Lecture 7 - Aquifer Classification (Continued...), Ground water Basins and Springs; Darcy's Law; Permeability
- Lecture 8 - Determination of Permeability : Heterogeneity and Anisotropy
- Lecture 9 - Ground Water (GW) flowrates and flow directions; general flow equations through porous media
- Lecture 10 - General Flow Equations Through Porous Media (Continued...), Dupuit's Assumptions
- Lecture 11 - 1-D Unconfined Ground water Flows; Steady Flow into Wells
- Lecture 12 - Steady Flow into Wells (Continued...); Unsteady Flow into Wells
- Lecture 13 - Unsteady Flow into Wells (Continued...)
- Lecture 14 - Unsteady Radial Flow in Confined and Unconfined Aquifers
- Lecture 15 - Unsteady Radial Flow in Leaky Aquifers (Continued...); Well Flow Near Aquifer Boundaries
- Lecture 16 - Well Flow for Special Conditions; Partially Penetrating Wells; Horizontal Wells and Collector Wells; Multiple Well Systems
- Lecture 17 - Well Completion; Well Development; Well Protection; Well Rehabilitation; Well testing for Yields
- Lecture 18 - Well Protection/Rehabilitation/Testing for yield (Continued...); Artificial Ground Water Recharge : Concept and Methods
- Lecture 19 - Concept and methods of Artificial Ground Water Recharge (Continued...); Recharge Mounds and Induced Recharge
- Lecture 20 - Induced Recharge (Continued...); Wastewater recharge for reuse; Water spreading
- Lecture 21 - Pollution and Quality Analysis of Ground Water : Sources of Pollution of GW-Municipal, Industrial, Agricultural and Miscellaneous
- Lecture 22 - Ground Water Pollution from Industrial, Agricultural and Miscellaneous Sources (Continued...)
- Lecture 23 - Ground Water Pollution from Miscellaneous Sources (Continued...), Attenuation and Underground Distribution of Pollutants
- Lecture 24 - Potential Evaluation of Ground water Pollution; Physical/Chemical/Biological analysis of Ground Water quality; Criteria and measures of Ground water quality
- Lecture 25 - Ground water salinity and samples ; Graphical representations of ground water quality
- Lecture 26 - Graphical representations of ground water quality (Continued...), Surface/Sub-Surface Investigation Of Ground Water: Geological/geophysical exploration; Remote sensing/electrical resistivity methods
- Lecture 27 - Surface Investigation of ground water (Continued...): Electrical resistivity seismic refraction/gravity/magnetic methods

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Lecture 28 - Seismic refraction/gravity/magnetic methods (Continued...);Sub-surface investigation of ground water: Geographical/resistivity methods

Lecture 29 - Sub-surface investigation of ground water (Continued...): Geographical/resistivity/spontaneous potential/radiation of methods of logging

Lecture 30 - Radiation method of logging (Continued...); Temperature/caliper/fluid conductivity/fluid velocity/miscellaneous logging methods

Lecture 31 - Saline Water Intrusion in Aquifers:Occurence, Features affecting aquifers,Bodon - Ghyben - Hergberg Principle

Lecture 32 - Saline Water Intrusion in Aquifers : Bodon - Ghyben - Hergberg principle (Continued...), Analytical Solution of Saline Water Intrusion in Coastal Aquifer

Lecture 33 - Saline Water Intrusion in Aquifers : Analytical Solution of Saline Water Intrusion in Coastal Aquifer (Continued...), Density dependent salt water intrusion model

Lecture 34 - Saline Water Intrusion in Aquifers : Geochemical Investigations, Control of salt water intrusion, Practical Modeling of salt water intrusion

Lecture 35 - Modeling and Management of Ground Water : Ground Water Simulation Models, Ground Water Management Model : Confined Aquifer

Lecture 36 - Modeling and Management of Ground Water : Ground Water Management Model : Confined and Unconfined Aquifer, Linked Simulation - Optimization, Meta Model Based Approach

Lecture 37 - Modeling and Management of Ground Water : Contaminant Source Identification , Monitoring Network Design

Lecture 38 - Modeling and Management of Ground Water : Aquifer Yield and Ground Water Availability, Effects of Ground Water Development, Regional Scale Development of Ground Water

Lecture 39 - Modeling and Management of Ground Water : Conjunctive Surface - Subsurface Modeling of Overland Flow including flow through Vadose zone

Lecture 40 - Modeling and Management of Ground Water : Ground Water - Surface Water Interaction

Lecture 1 - Introduction to Numerical Methods

Lecture 2 - Error Analysis

Lecture 3 - Introduction to Linear Systems - I

Lecture 4 - Linear Systems - II

Lecture 5 - Linear Systems - III

Lecture 6 - Linear Systems - Error Bounds

Lecture 7 - Error Bounds and Iterative Methods for Solving Linear Systems

Lecture 8 - Iterative Methods for Solving Linear Systems - I

Lecture 9 - Iterative Methods - II

Lecture 10 - Iterative Methods - III

Lecture 11 - Iterative Methods for Eigen Value Extraction

Lecture 12 - Solving Nonlinear Equations - I

Lecture 13 - Solving Nonlinear Equations - II

Lecture 14 - Solving Multi Dimensional Nonlinear Equations - I

Lecture 15 - Solving Multi Dimensional Nonlinear Equations - II

Lecture 16 - ARC Length and Gradient Based Methods

Lecture 17 - Gradient Based Methods

Lecture 18 - Conjugate Gradient Method - I

Lecture 19 - Conjugate Gradient Method - II

Lecture 20 - Nonlinear Conjugate Gradient and Introduction to PDEs

Lecture 21 - Eigenfunction Solutions for the Wave Equation

Lecture 22 - Analytical Methods for Solving the Wave Equation

Lecture 23 - Analytical Methods for Hyperbolic and Parabolic PDEs

Lecture 24 - Analytical Methods for Parabolic and Elliptic PDEs

Lecture 25 - Analytical Methods for Elliptic PDE's

Lecture 26 - Series Solutions for Elliptic PDE's and Introduction to Differential Operators

Lecture 27 - Differential Operators - I

Lecture 28 - Differential Operators - II

Lecture 29 - Differential Operators - III

Lecture 30 - Interpolation

Lecture 31 - Polynomial Fitting

[Lecture 32 - Orthogonal Polynomials - I](#)

[Lecture 33 - Orthogonal Polynomials - II](#)

[Lecture 34 - Orthogonal Polynomials - III](#)

[Lecture 35 - Spline Functions](#)

[Lecture 36 - Orthogonal Basis Functions for Solving PDE's - I](#)

[Lecture 37 - Orthogonal Basis Functions for Solving PDE's - II](#)

[Lecture 38 - Integral Equations - I](#)

[Lecture 39 - Integral Equations - II](#)

[Lecture 40 - Integral Equations - III](#)

NPTEL : Probability Methods in Civil Engineering (Civil Engineering)

Co-ordinators : Dr. Rajib Maity

Lecture 1 - Introduction - Role of Probability in Civil Engineering

Lecture 2 - Random Events and Probability Concept

Lecture 3 - Set Theory and Set Operations

Lecture 4 - Axioms of Probability

Lecture 5 - Probability of Events

Lecture 6 - Concept and Definition of Random Variables

Lecture 7 - Probability Distribution of Random Variables

Lecture 8 - CDF and Descriptors of Random Variables

Lecture 9 - Further Descriptors of Random Variables

Lecture 10 - Discrete Probability Distribution

Lecture 11 - Probability Distribution of Continuous RVs

Lecture 12 - Probability Distribution of Continuous RVs (Continued...1)

Lecture 13 - Probability Distribution of Continuous RVs (Continued...2)

Lecture 14 - Functions of Single Random Variables

Lecture 15 - Functions of Random Variables - Different Methods

Lecture 16 - Functions of Random Variables - Different Methods (Continued...)

Lecture 17 - Expectation and Moments of Functions of RV

Lecture 18 - Expectation and Moments of Functions of RV (Continued...)

Lecture 19 - Joint Probability Distribution

Lecture 20 - Marginal Probability Distribution

Lecture 21 - Conditional Probability Distribution

Lecture 22 - Conditional Probability Distribution (Continued...)

Lecture 23 - Properties of Multiple Random Variables

Lecture 24 - Properties of Multiple Random Variables (Continued...)

Lecture 25 - MGF of Multivariate RVs and Multivariate Probability Distributions

Lecture 26 - Multivariate Distribution and Functions of Multiple Random Variables

Lecture 27 - Functions of Multiple Random Variables (Continued...1)

Lecture 28 - Functions of Multiple Random Variables (Continued...2)

Lecture 29 - Introduction to Copulas

Lecture 30 - Introduction to Copulas (Continued...)

Lecture 31 - Probability Models using Normal Distribution

[Lecture 32 - Probability Models using Log Normal and Exponential Distribution](#)

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[Lecture 37 - Hypothesis Testing](#)

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[Lecture 40 - Regression Analyses and Correlation \(Continued...\)](#)

Lecture 1 - Introduction - I

Lecture 2 - Materials

Lecture 3 - Different Methods of Design of Reinforced Concrete Structures

Lecture 4 - Working Stress Method

Lecture 5 - Working Stress Method (Continued...)

Lecture 6 - Limit State of Collapse Flexure - I

Lecture 7 - Limit State of Collapse Flexure - II

Lecture 8 - Design of Doubly Reinforced Beam Flexure - I

Lecture 9 - Design of Doubly Reinforced Beam Flexure - II

Lecture 10 - Design of Doubly Reinforced Beam Flexure

Lecture 11 - Limit State of Collapse Shear

Lecture 12 - Design for Shear

Lecture 13 - Design for Shear (Continued...)

Lecture 14 - Design of Slabs - Part I

Lecture 15 - Design of Slabs - Part II

Lecture 16 - Design of Slabs - Part III

Lecture 17 - Design of Slabs - Part IV

Lecture 18 - Design of Slabs - Part V

Lecture 19 - Design of Columns - Part I

Lecture 20 - Design of Columns - Part II

Lecture 21 - Design of Columns - Part III

Lecture 22 - Design of Columns - Part IV

Lecture 23 - Design of Columns - Part V

Lecture 24 - Design of Footings - Part I

Lecture 25 - Design of Footings - Part II

Lecture 26 - Design of Staircases

Lecture 27 - Design for Torsion - Part I

Lecture 28 - Design for Torsion - Part II

Lecture 29 - Design of RC Slender Columns

Lecture 30 - Deflection of RC Beams

- Lecture 1 - Introduction to Engineering Geology
- Lecture 2 - Geologic Structures
- Lecture 3 - Geologic Maps and Stratigraphic Sections
- Lecture 4 - Remote Sensing in Engineering Geology
- Lecture 5 - Physical Properties of Minerals
- Lecture 6 - Crystallography and Optical Properties
- Lecture 7 - Chemical Characteristics of Minerals
- Lecture 8 - Origin And Types of Rocks
- Lecture 9 - Origin And Types of Soils
- Lecture 10 - Igneous Rocks
- Lecture 11 - Sedimentary Rocks
- Lecture 12 - Metamorphic Rocks
- Lecture 13 - Weathering
- Lecture 14 - Sediment Transport and Deposition
- Lecture 15 - Introduction to Subsurface Exploration
- Lecture 16 - Introduction to Subsurface Exploration
- Lecture 17 - Sampling and Non - Intrusive Methods
- Lecture 18 - Index Properties and Classification of Soils
- Lecture 19 - Index Properties of Rock and Rock Mass
- Lecture 20 - Stress-Strain Behavior of Soil and Rock - I
- Lecture 21 - Stress-Strain Behavior of Soil and Rock - II
- Lecture 22 - In-situ State of Stress
- Lecture 23 - Geologic Considerations in Tunneling
- Lecture 24 - Geologic Considerations in Dam Construction
- Lecture 25 - Groundwater - Preliminaries
- Lecture 26 - Groundwater Flow - I
- Lecture 27 - Groundwater Flow - II
- Lecture 28 - Groundwater Related Engineering Issues
- Lecture 29 - Groundwater Over Utilization
- Lecture 30 - Plate Tectonics
- Lecture 31 - Plate Tectonics - 2 and Earthquake

[Lecture 32 - Earthquake Hazard Assessment](#)

[Lecture 33 - Geologic Hazards - Seismicity and Volcanism](#)

[Lecture 34 - Geologic Hazards - Shoreline Processes](#)

[Lecture 35 - Geologic Hazards - Shoreline Processes](#)

[Lecture 36 - Geologic Hazards - Landslide Hazards - Zoning](#)

[Lecture 37 - Geologic Hazards Subsidence , Collapsible Soils](#)

[Lecture 38 - Preparation of Geologic Sections](#)

[Lecture 39 - Index testing of soil & rocks](#)

[Lecture 40 - Identification of minerals and rock samples](#)

NPTEL : Introduction to Transportation Engineering (Civil Engineering)

Co-ordinators : Dr. K.S. Reddy, Dr. Bhargab Maitra

- Lecture 1 - Transportation Engineering
- Lecture 2 - Elements of Concern and Components
- Lecture 3 - Traffic Stream Characteristics
- Lecture 4 - Traffic Studies : Part - I
- Lecture 5 - Traffic Studies : Part - II
- Lecture 6 - Highway Capacity and Level of Service
- Lecture 7 - Intersection Control and Signalization
- Lecture 8 - Functional Classification, Design Elements
- Lecture 9 - Cross Section Elements
- Lecture 10 - Stopping Sight Distance And Decision Sight
- Lecture 11 - Overtaking, Intermediate and Headlight Sight
- Lecture 12 - Intersection Sight Distance - I
- Lecture 13 - Intersection Sight Distance - II
- Lecture 14 - Horizontal Alignment - I
- Lecture 15 - Horizontal Alignment - II
- Lecture 16 - Horizontal Alignment - III
- Lecture 17 - Horizontal Alignment - IV
- Lecture 18 - Horizontal Alignment - V
- Lecture 19 - Horizontal Alignment - VI
- Lecture 20 - Vertical Alignment - I
- Lecture 21 - Vertical Alignment - II
- Lecture 22 - Vertical Alignment - III
- Lecture 23 - Highway Alignment
- Lecture 24 - Principles of Pavement Design
- Lecture 25 - Traffic Loading - I
- Lecture 26 - Traffic Loading - II
- Lecture 27 - Pavement Materials - I
- Lecture 28 - Pavement Materials - II
- Lecture 29 - Pavement Materials - III
- Lecture 30 - Pavement Materials - IV
- Lecture 31 - Pavement Materials - V

[Lecture 32 - Design of Bituminous Mixes - I](#)

[Lecture 33 - Design of Bituminous Mixes - II](#)

[Lecture 34 - Analysis of Flexible Pavements](#)

[Lecture 35 - Analysis of Concrete Pavements](#)

[Lecture 36 - Flexible Pavement Design Indian Roads Congress](#)

[Lecture 37 - Flexible Pavement Design AASHTO Method - 1993](#)

[Lecture 38 - Concrete Pavement Design Indian Congress Method](#)

[Lecture 39 - Concrete Pavement Design PCA and AASHTO Methods](#)

[Lecture 40 - Pavement Evaluation and Rehabilitation](#)

[Lecture 41 - Overlay Design - IRC Method](#)

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Lecture 2 - Analysis of Stress - I

Lecture 3 - Analysis of Stress - II

Lecture 4 - Analysis of Stress - III

Lecture 5 - Analysis of Stress - IV

Lecture 6 - Analysis of Stress - V

Lecture 7 - Analysis of Strain - I

Lecture 8 - Analysis of Strain - II

Lecture 9 - Analysis of Strain - III

Lecture 10 - Analysis of Strain - IV

Lecture 11 - Analysis of Strain - V

Lecture 12 - Analysis of Strain - VI

Lecture 13 - Analysis of Strain - VII

Lecture 14 - Analysis of Strain - VIII

Lecture 15 - Application of Stress/Strain

Lecture 16 - Application of Stress / Strain

Lecture 17 - Application of Stress / Strain

Lecture 18 - Torsion - I

Lecture 19 - Torsion - II

Lecture 20 - Torsion - III

Lecture 21 - Torsion - IV

Lecture 22 - Bending of Beams - I

Lecture 23 - Bending of Beams - II

Lecture 24 - Bending of Beams - III

Lecture 25 - Bending of Beams - IV

Lecture 26 - Stresses in Beams - I

Lecture 27 - Stresses in Beams - II

Lecture 28 - Stresses in Beams - III

Lecture 29 - Stresses in Beams - IV

Lecture 30 - Deflection of Beams - I

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[Lecture 34 - Combined Stresses - I](#)

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Co-ordinators : Dr. B.N. Rao

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- Lecture 8 - Key Lean Concepts#1 (Wastes)
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Lecture 2 - Introduction to Global Positioning System

Lecture 3 - GPS Positioning Methods

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Lecture 9 - Sensors and Platform

Lecture 10 - Image Interpretation

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Lecture 12 - Rectification and Restoration

Lecture 13 - Image Enhancement

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- Lecture 2 - Gauges and Permanent Way
- Lecture 3 - Wheel and Axles, Coning of Wheels
- Lecture 4 - Track Resistances, Hauling Capacity
- Lecture 5 - Track Modulus, Stresses in Track
- Lecture 6 - Stresses in Components of Track
- Lecture 7 - Rails
- Lecture 8 - Creep in Rails
- Lecture 9 - Wears & Failures in Rails
- Lecture 10 - Jointed or Welded rails
- Lecture 11 - Sleepers
- Lecture 12 - Ballast
- Lecture 13 - Fastenings
- Lecture 14 - Geometric Design - Alignment of Track
- Lecture 15 - Horizontal Curve and Super elevation
- Lecture 16 - Speeds on Track
- Lecture 17 - Transition Curve & Widening of Track
- Lecture 18 - Vertical Curve & Gradients
- Lecture 19 - Turnouts - Components
- Lecture 20 - Crossing and Design of Turnout
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- Lecture 26 - High Speed Tracks
- Lecture 27 - Introduction of Air Transport
- Lecture 28 - Aircraft Characteristics
- Lecture 29 - Aircraft Controls, Airport Site&Size Selection
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- Lecture 1 - What is Geographic Information Systems ?
- Lecture 2 - Different components of GIS
- Lecture 3 - Different types of vector data and concept of topology
- Lecture 4 - Raster data models and comparisons with vector
- Lecture 5 - TIN data model and comparisons with raster
- Lecture 6 - Non-spatial data (attributes) and their type
- Lecture 7 - Raster data compression techniques
- Lecture 8 - Spatial database systems and their types
- Lecture 9 - Pre-processing of spatial datasets
- Lecture 10 - Geo-referencing
- Lecture 11 - Different map projections
- Lecture 12 - Spatial interpolation techniques
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- Lecture 14 - Quality assessment of freely available DEMS
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- Lecture 16 - GIS analysis - Part 2 (Overlaying Operations)
- Lecture 17 - GIS analysis - Part 3 (Buffer Analysis)
- Lecture 18 - Classification Methods
- Lecture 19 - Errors in GIS and Key elements of maps
- Lecture 20 - Limitations of GIS

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Lecture 2 - Climate Classification

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Lecture 6 - Bioclimatic Assessment

Lecture 7 - Thermal Performance of Building Envelop

Lecture 8 - Thermal Performance of Building Envelop - Indices and Measures (1/2)

Lecture 9 - Thermal Performance of Building Envelop - Indices and Measures (2/2)

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Lecture 11 - Shading Analysis

Lecture 12 - Energy Efficiency and Simulation

Lecture 13 - Building Acoustics - Basics

Lecture 14 - Sound Propagation

Lecture 15 - Acoustic Quality Indicators (1/2)

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Lecture 18 - Acoustic Materials

Lecture 19 - Lighting - Basics

Lecture 20 - Lighting – Design Concepts

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Lecture 3 - GPS Signal (Civilian Perspective)

Lecture 4 - GPS Receiver

Lecture 5 - GPS Software

Lecture 6 - GPS Position

Lecture 7 - GPS Positioning (Principle and Methods)

Lecture 8 - Field demonstration of GPS Positioning Method

Lecture 9 - GPS Observables (Types, Errors and Quality)

Lecture 10 - Errors in GPS Observables (Systematics Errors)

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Lecture 12 - GPS Data Pre-Processing - II

Lecture 13 - GPS Data Processing - I

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Lecture 15 - Quality Assessment of GPS Surveying

Lecture 16 - Procedure of GPS Surveying - I

Lecture 17 - Procedure of GPS Surveying - II

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Lecture 2 - Fundamentals and Operations

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Lecture 5 - GPS Signal (Civilian Perspective)

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Lecture 7 - GPS Positioning of Control Point

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Lecture 19 - Accessories of Total Station

Lecture 20 - Handling and Setting of Total Station

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Lecture 2 - Different Techniques of Image Acquisition

Lecture 3 - Why is Digital Image processing Important ?

Lecture 4 - Image characteristics and Different Resolutions in Remote Sensing

Lecture 5 - Electromagnetic spectrum, solar reflection, and thermal emission

Lecture 6 - Color Representation and Transformations

Lecture 7 - Image histograms and statistics

Lecture 8 - Geo-referencing Techniques

Lecture 9 - Image Enhancement Techniques part 1

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Lecture 11 - Multispectral Transform, Scatter Plot, Principal Component Analysis and Decorrelation Stretch

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Lecture 13 - Frequency Domain Fourier Transformation

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Lecture 15 - Image Classification Techniques

Lecture 16 - Principles of Image Interpretation

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Lecture 18 - Image Merging and Image Mosaicing Techniques

Lecture 19 - Application of Image Analysis

Lecture 20 - Limitations and Future of Digital Image Processing

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Lecture 3 - Cell Structure - I

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Lecture 7 - Microbial Energetics - I

Lecture 8 - Microbial Energetics - II

Lecture 9 - Microbial Energetics - III

Lecture 10 - Microbial Energetics - IV

Lecture 11 - Microbial Metabolism - I

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- Lecture 1 - Concept of Digital Elevation Model and How It Is Represented
- Lecture 2 - Various Techniques to Generate Digital Elevation Model - 1
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- Lecture 5 - Importance of Spatial Resolution With DEMs
- Lecture 6 - How To Assess Quality of DEM?
- Lecture 7 - Integration of DEMs With Satellite Data
- Lecture 8 - Common Derivatives of DEMs- Slope and Aspect
- Lecture 9 - Triangulated Irregular Network (TIN) and Its Derivatives
- Lecture 10 - Shaded Relief Models and Their Applications
- Lecture 11 - DEMs Derivatives - 1
- Lecture 12 - DEMs Derivatives - 2
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- Lecture 15 - DEM Based Surface Hydrologic Modelling - 1
- Lecture 16 - DEM Based Surface Hydrologic Modelling - 2
- Lecture 17 - DEM and DAM Simulation and Its Application In Ground Water Hydrology
- Lecture 18 - Applications of DEMs In Solar and Wind Energy Potential Estimations
- Lecture 19 - Applications of DEMs in Viewshed and Flood Hazard Mapping
- Lecture 20 - DEMs Sources, Limitations and Future of Digital Elevation Models

- Lecture 1 - Introduction, Fundamentals of Equilibrium and Kinetics
- Lecture 2 - Equilibrium-Process Feasibility, Gibbs Energy-Standard Condition
- Lecture 3 - Gibbs Free Energy-Non Standard Conditions - I
- Lecture 4 - Gibbs Free Energy-Non Standard Conditions - II
- Lecture 5 - Phase Equilibrium
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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : Design and Analysis of Algorithms (Computer Science and Engineering)

Co-ordinators : Prof. Sundar Viswanathan, Prof. Ajit A Diwan, Prof. Abhiram G Ranade

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Design and Pedagogy of the Introductory Programming Course (Computer Science and Engineering)

Co-ordinators : Prof. Abhiram G Ranade

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:An Introduction to Programming through C++ (Computer Science and Engineering)

Co-ordinators : Prof. Abhiram G Ranade

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Introduction to Computer and Network Performance Analysis using Queuing Systems (Computer Science and Engineering)

Co-ordinators : Prof. Varsha Apte

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- Lecture 2 - Performance metrics and parameters
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- Lecture 5 - Operational Laws
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Lecture 1 - What is theory of computation? Set membership problem, basic notions like alphabet, strings, formal languages

Lecture 2 - Introduction to finite automaton

Lecture 3 - Finite automata continued, deterministic finite automata (DFAs), language accepted by a DFA

Lecture 4 - Regular languages, their closure properties

Lecture 5 - DFAs solve set membership problems in linear time, pumping lemma

Lecture 6 - More examples of nonregular languages, proof of pumping lemma, pumping lemma as a game, converse of pumping lemma does not hold

Lecture 7 - A generalization of pumping lemma, nondeterministic finite automata (NFAs), computation trees for NFAs

Lecture 8 - Formal description of NFA, language accepted by NFA, such languages are also regular

Lecture 9 - 'Guess and verify' paradigm for nondeterminism

Lecture 10 - NFA's with epsilon transitions

Lecture 11 - Regular expressions, they denote regular languages

Lecture 12 - Construction of a regular expression for a language given a DFA accepting it. Algebraic closure properties of regular languages

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Lecture 16 - About minimization of states of DFAs. Myhill-Nerode theorem

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Lecture 21 - Languages generated by a cfg, leftmost derivation, more examples of cfgs and cfls

Lecture 22 - Parse trees, inductive proof that L is $L(G)$. All regular languages are context free

Lecture 23 - Towards Chomsky normal forms: elimination of useless symbols, analysis of reachable symbols, generating nonterminals, order of substeps matter

Lecture 24 - Simplification of cfgs continued, Removal of epsilon productions: algorithm and its correctness

Lecture 25 - Elimination of unit productions. Converting a cfg into Chomsky normal form. Towards pumping lemma for cfls

Lecture 26 - Pumping lemma for cfls. Adversarial paradigm

Lecture 27 - Completion of pumping lemma proof. Examples of use of pumping lemma. Converse of lemma does not hold. Closure properties of cfls

Lecture 28 - Closure properties continued. cfls not closed under complementation

Lecture 29 - Another example of a cfl whose complement is not a cfl. Decision problems for cfls

Lecture 30 - More decision problems. CYK algorithm for membership decision

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Lecture 32 - pda configurations, acceptance notions for pdas. Transition diagrams for pdas

Lecture 33 - Equivalence of acceptance by empty stack and acceptance by final state

Lecture 34 - Turing machines (TM): motivation, informal definition, example, transition diagram

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Lecture 36 - Example continued. Finiteness of TM description, TM configuration, language acceptance, definition of recursively enumerable (r.e.) languages

Lecture 37 - Notion of non-acceptance or rejection of a string by a TM. Multitrack TM, its equivalence to standard TM. Multitape TMs

Lecture 38 - Simulation of multitape TMs by basic model. Nondeterministic TM (NDTM). Equivalence of NDTMs with deterministic TMs

Lecture 39 - Counter machines and their equivalence to basic TM model

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Lecture 41 - Existence of non-r.e. languages, recursive languages, notion of decidability

Lecture 42 - Separation of recursive and r.e. classes, halting problem and its undecidability

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Lecture 14 - Sensor Networks - I

Lecture 15 - Sensor Networks - II

Lecture 16 - Sensor Networks - III

Lecture 17 - Sensor Networks - IV

Lecture 18 - Sensor Networks - V

Lecture 19 - UAV Networks

Lecture 20 - Machine to Machine Communication

Lecture 21 - Interoperability in Internet of Things

Lecture 22 - Introduction to Arduino - I

Lecture 23 - Introduction to Arduino - II

Lecture 24 - Integration of Sensor and Actuators with Arduino - I

Lecture 25 - Integration of Sensor and Actuators with Arduino - II

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Lecture 27 - Introduction to Python Programming - II

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Lecture 29 - Introduction to Raspberry Pi - II

Lecture 30 - Implementation of IoT with Raspberry Pi - I

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- Lecture 34 - Software Defined Networking - Part II
- Lecture 35 - Software Defined IoT Networking - I
- Lecture 36 - Software Defined IoT Networking - II
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- Lecture 39 - Cloud Computing-Service Management and Security
- Lecture 40 - Cloud Computing - Case Studies
- Lecture 41 - Cloud Computing - Practical
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- Lecture 44 - Fog Computing - I
- Lecture 45 - Fog Computing - II
- Lecture 46 - Smart Cities and Smart Homes - I
- Lecture 47 - Smart Cities and Smart Homes - II
- Lecture 48 - Smart Cities and Smart Homes - III
- Lecture 49 - Connected Vehicles - I
- Lecture 50 - Connected Vehicles - II
- Lecture 51 - Smart Grid - I
- Lecture 52 - Smart Grid - II
- Lecture 53 - Industrial Internet of Things - I
- Lecture 54 - Industrial Internet of Things - II
- Lecture 55 - Data Handling and Analytics - I
- Lecture 56 - Data Handling and Analytics - II
- Lecture 57 - Case Study: Agriculture
- Lecture 58 - Case Study: Healthcare
- Lecture 59 - Case Study: Activity Monitoring - I
- Lecture 60 - Case Study: Activity Monitoring - II

- Lecture 1 - Cloud Computing Overview
- Lecture 2 - Cloud Computing Overview (Continued...)
- Lecture 3 - Cloud Computing - Introduction
- Lecture 4 - Cloud Computing Architecture
- Lecture 5 - Cloud Computing Architecture (Continued...)
- Lecture 6 - Cloud Computing Architecture - Deployment Models
- Lecture 7 - Cloud Computing Virtualization
- Lecture 8 - Cloud Computing XML Basics
- Lecture 9 - Cloud Computing XML Basics - II
- Lecture 10 - Cloud Computing Web Services, Service Oriented Architecture
- Lecture 11 - Service Level Agreement
- Lecture 12 - Cloud Economics
- Lecture 13 - Managing Data
- Lecture 14 - Introduction to MapReduce
- Lecture 15 - Open Stack
- Lecture 16 - Cloud Computing - Opensource Cloud - Openstack Demo
- Lecture 17 - Cloud Computing Case Study with a commercial Cloud - Microsoft Azure
- Lecture 18 - Cloud Computing Demo - Microsoft Azure
- Lecture 19 - Cloud Computing Case Study - Google Cloud Platform (GCP)
- Lecture 20 - Cloud Computing Demo - Google Cloud Platform (GCP)
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- Lecture 22 - Cloudeconomics-Tutorial
- Lecture 23 - MapReduce-Tutorial
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- Lecture 25 - Resource Management - II
- Lecture 26 - Cloud Computing: Security - I
- Lecture 27 - Cloud Computing: Security - II
- Lecture 28 - Cloud Computing: Security - III
- Lecture 29 - Cloud Computing: Security Issues in Collaborative SaaS Cloud
- Lecture 30 - Cloud Computing: Broker for Cloud Marketplace
- Lecture 31 - Mobile Cloud Computing - I

- Lecture 32 - Mobile Cloud Computing - II
- Lecture 33 - Fog Computing - I
- Lecture 34 - Fog Computing - II
- Lecture 35 - Use Case-Geo-spatial Cloud
- Lecture 36 - Introduction to DOCKER Container
- Lecture 37 - Green Cloud
- Lecture 38 - Sensor Cloud Computing
- Lecture 39 - IoT Cloud
- Lecture 40 - Course Summary and Research Areas
- Lecture 41 - Cloud-Fog Computing - Overview
- Lecture 42 - Resource Management - I
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- Lecture 44 - Cloud Federation
- Lecture 45 - VM Migration - Basics Migration strategies
- Lecture 46 - VM Migration - Basics Migration strategies
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- Lecture 48 - Docker Container - Overview Docker - Components Docker - Architecture
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- Lecture 50 - Docker Container - Demo
- Lecture 51 - Dew Computing
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- Lecture 54 - Sustainable Cloud Computing - I
- Lecture 55 - Sustainable Cloud Computing - II
- Lecture 56 - Cloud Computing in 5G Era
- Lecture 57 - CPS and Cloud Computing
- Lecture 58 - Case Study I (Spatial Cloud Computing)
- Lecture 59 - Case Study II (Internet of Health Things) - Part A
- Lecture 60 - Case Study II (Internet of Health Things) - Part B

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Lecture 7 - Introduction to C Programming Language

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Lecture 10 - Address and Content of Variables and Types

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Lecture 14 - Use of Logical Operatoers in Branching

Lecture 15 - Branching : IF-ELSE Statement

Lecture 16 - IF-ELSE Statement (Continued...)

Lecture 17 - Switch statement

Lecture 18 - Switch Statement (Continued...) and Introduction to Loops

Lecture 19 - Implementing Repetitions (Loops)

Lecture 20 - Implementation of Loops with for Statement (Continued...)

Lecture 21 - For Statement (Continued...)

Lecture 22 - Example of If-Else

Lecture 23 - Example of Loops

Lecture 24 - Example of Loops (Continued...)

Lecture 25 - Example of Loops (Continued...), Use of FOR Loops

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Lecture 28 - Arrays (Continued...)

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- Lecture 32 - Character Array and Strings
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- Lecture 34 - 2-D Array Operation
- Lecture 35 - Introducing Functions
- Lecture 36 - More on Functions
- Lecture 37 - Function (Continued...)
- Lecture 38 - Scanf and Printf Functions; Function Prototype
- Lecture 39 - Parameter Passing in Function Revision
- Lecture 40 - Parameter Passing in Function Revision (Continued...)
- Lecture 41 - Substitution of # include and Macro
- Lecture 42 - search as a function
- Lecture 43 - Binary Search
- Lecture 44 - Binary Search (Continued...)
- Lecture 45 - Sorting Methods
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- Lecture 47 - Use of Pointer in Function : Context Bubble Sort
- Lecture 48 - Arrays at Strings
- Lecture 49 - Data Representation
- Lecture 50 - Bisection Method
- Lecture 51 - Interpolation
- Lecture 52 - Trapezoidal Rule and Runge-Kutta Method
- Lecture 53 - Recursion
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- Lecture 55 - Structure
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- Lecture 57 - Structure with typedef
- Lecture 58 - Pointer
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Lecture 3 - Cyclic executives

Lecture 4 - Cyclic Scheduler

Lecture 5 - Cyclic Scheduler

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Lecture 12 - Further RMA Generalizations

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Lecture 14 - Solution to Priority Inversion Problem

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Lecture 16 - Priority Ceiling Protocol

Lecture 17 - PCP Priority Inversions

Lecture 18 - Analysis of PCP priority inversions

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Lecture 20 - Unix as a Real-Time operating System

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Lecture 2 - Introduction to Fuzzy Logic

Lecture 3 - Fuzzy membership functions (Continued...) and Defining Membership functions

Lecture 4 - Fuzzy operations

Lecture 5 - Fuzzy relations

Lecture 6 - Fuzzy Relations (Continued...) and Fuzzy propositions

Lecture 7 - Fuzzy implications

Lecture 8 - Fuzzy Inferences

Lecture 9 - Defuzzification techniques (Part-I)

Lecture 10 - Defuzzification Techniques (Part-I) (Continued...)

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Lecture 12 - Fuzzy Logic Controller (Continued...)

Lecture 13 - Fuzzy logic controller (Continued...)

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Lecture 15 - Concept of Genetic Algorithm (Continued...) and GA Strategies

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Lecture 17 - GA operator : encoding scheme (Continued...)

Lecture 18 - GA Operator : Selection

Lecture 19 - GA Operator : Selection (Continued...)

Lecture 20 - GA Operator : Crossover techniques

Lecture 21 - GA Operator : Crossover (Continued...)

Lecture 22 - GA Operator : Crossover (Continued...)

Lecture 23 - GA Operator : Mutation and others

Lecture 24 - Multi-objective optimization problem solving

Lecture 25 - Multi-objective optimization problem solving (Continued...)

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Lecture 27 - Non-Pareto based approaches to solve MOOPs

Lecture 28 - Non-Pareto based approaches to solve MOOPs (Continued...)

Lecture 29 - Pareto-Based approaches to solve MOOPs

Lecture 30 - Pareto-based approaches to solve MOOPs (Continued...)

Lecture 31 - Pareto-based approach to solve MOOPs

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[Lecture 37 - Training ANNs \(Continued....\)](#)

[Lecture 38 - Training ANNs \(Continued....\)](#)

[Lecture 39 - Training ANNs \(Continued....\)](#)

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Lecture 4 - Association Rules

Lecture 5 - Apriori algorithm

Lecture 6 - Rule generation

Lecture 7 - Classification

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Lecture 9 - Decision Tree - II

Lecture 10 - Decision Tree - III

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Lecture 13 - Bayes Classifier - II

Lecture 14 - Bayes Classifier - III

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Lecture 16 - Bayes Classifier - V

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Lecture 19

Lecture 20

Lecture 21

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[Lecture 3 - Introduction to DBMS/2](#)

[Lecture 4 - Introduction to Relational Model/1](#)

[Lecture 5 - Introduction to Relational Model/2](#)

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[Lecture 7 - Introduction to SQL/2](#)

[Lecture 8 - Introduction to SQL/3](#)

[Lecture 9 - Intermediate SQL/1](#)

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[Lecture 12 - Formal Relational Query Languages](#)

[Lecture 13 - Entity-Relationship Model/1](#)

[Lecture 14 - Entity-Relationship Model/2](#)

[Lecture 15 - Entity-Relationship Model/3](#)

[Lecture 16 - Relational Database Design](#)

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[Lecture 18 - Relational Database Design/3](#)

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[Lecture 27 - Indexing and Hashing/2 : Indexing/2](#)

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Lecture 2 - Introduction - II

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Lecture 6 - Life Cycle Model

Lecture 7 - Life Cycle Model

Lecture 8 - Waterfall Model

Lecture 9 - Waterfall Derivatives

Lecture 10 - Incremental Model

Lecture 11 - Evolutionary Model

Lecture 12 - Agile Model

Lecture 13 - Extreme Programming and Scrum

Lecture 14 - Scrum

Lecture 15 - Introduction to requirement specification

Lecture 16 - Requirement gathering and analysis

Lecture 17 - Functional requirements

Lecture 18 - Representation of complex programming logic

Lecture 19 - Design Fundamentals

Lecture 20 - Modular Design

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Lecture 25 - Developing DFD Model

Lecture 26 - Examples of DFD Model development

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Lecture 30 - Structured Design Examples

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- Lecture 32 - Factoring Use Cases
- Lecture 33 - Overview of Class diagram
- Lecture 34 - Inheritance relationship
- Lecture 35 - Association relationship
- Lecture 36 - Aggregation/ Composition and dependency relations
- Lecture 37 - Interaction Modelling
- Lecture 38 - Development of Sequence diagrams
- Lecture 39 - State-Machine diagram
- Lecture 40 - An Object-Oriented design process
- Lecture 41 - Domain Analysis
- Lecture 42 - Examples of object-oriented design
- Lecture 43 - Basic concepts in Testing - I
- Lecture 44 - Basic concepts in Testing - II
- Lecture 45 - Basic concepts in Testing - III
- Lecture 46 - Unit testing strategies - I
- Lecture 47 - Unit testing strategies - II
- Lecture 48 - Equivalence Class Testing - I
- Lecture 49 - Equivalence Class Testing - II
- Lecture 50 - Special Value Testing
- Lecture 51 - Combinatorial Testing
- Lecture 52 - Decision Table Testing
- Lecture 53 - Cause effect graphing
- Lecture 54 - Pairwise Testing
- Lecture 55 - White box Testing
- Lecture 56 - Condition Testing
- Lecture 57 - MC/DC Coverage
- Lecture 58 - MC/DC Testing
- Lecture 59 - Path Testing
- Lecture 60 - Dataflow and Mutation Testing

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Computer Networks and Internet Protocol (Computer Science and Engineering)

Co-ordinators : Prof. Sandip Chakraborty, Prof. Soumya Kanti Ghosh

Lecture 1 - Introduction to Computer Networks - A brief history

Lecture 2 - Data Networks - from Circuit Switching Network to Packet Switching Network

Lecture 3 - Network Protocol Stack

Lecture 4 - Services at the Different Layers of the Protocol Stack

Lecture 5 - Application Layer I - Different Protocols at the Application Layer

Lecture 6 - Application Layer II - Domain Name Systems

Lecture 7 - Application Layer III - The Web

Lecture 8 - Application Layer III - Hypertext Transfer Protocol

Lecture 9 - Application Layer III - Internet Mail Transfer

Lecture 10 - Application Layer IV - File Transfer (FTP)

Lecture 11 - Transport Layer I - Services

Lecture 12 - Transport Layer II - Connection

Lecture 13 - Transport Layer II - Connection (Continued...)

Lecture 14 - Transport Layer IV - Reliability

Lecture 15 - Transport Layer V - Sliding Window Protocols

Lecture 16 - Transport Layer Performance

Lecture 17 - Buffer Management and Congestion Control

Lecture 18 - Transport Layer Primitives

Lecture 19 - Transmission Control Protocol I - Basics

Lecture 20 - Transmission Control Protocol II - Connections

Lecture 21 - Transmission Control Protocol III - Flow Control

Lecture 22 - Transmission Control Protocol IV - Congestion Control

Lecture 23 - User Datagram Protocol

Lecture 24 - Socket Programming - I

Lecture 25 - Socket Programming - II

Lecture 26 - Network Layer I - Introduction

Lecture 27 - IP Addressing (IPv4) I - Classful addressing

Lecture 28 - IP Addressing (IPv4) II - CIDR

Lecture 29 - IP Addressing (IPv4) III - Network Address Translation (NAT)

Lecture 30 - IPv6 Addressing

Lecture 31 - Internet QoS - I (What is QoS)

- [Lecture 32 - Internet QoS - II \(Basic QoS Architecture\)](#)
- [Lecture 33 - Internet QoS - III \(Traffic Policing and Traffic Shaping\)](#)
- [Lecture 34 - Internet QoS - IV \(Traffic Scheduling\)](#)
- [Lecture 35 - Internet QoS - V \(Integrated and Differentiated Service Architecture\)](#)
- [Lecture 36 - IP Routing Table](#)
- [Lecture 37 - Routing in the Internet I - Intra-domain routing](#)
- [Lecture 38 - Routing in the Internet II - Routing protocols](#)
- [Lecture 39 - Routing in the Internet III - Inter-domain Routing](#)
- [Lecture 40 - Routing in the Internet IV - Border Gateway Protocol](#)
- [Lecture 41 - IP Routers](#)
- [Lecture 42 - IP Routers Demo](#)
- [Lecture 43 - Software Defined Networking - I \(Basics\)](#)
- [Lecture 44 - Software Defined Networking - II \(Open Flow\)](#)
- [Lecture 45 - Software Defined Networking - III \(Demo\)](#)
- [Lecture 46 - Data Link Layer - Overview](#)
- [Lecture 47 - Data Link Layer - Basic Concepts](#)
- [Lecture 48 - Data Link Layer - Ethernet](#)
- [Lecture 49 - Data Link Layer - Ethernet \(Continued...\)](#)
- [Lecture 50 - Data Link Layer - Flow and Error Control](#)
- [Lecture 51 - ARP-RAPP-BOOTP-DHCP](#)
- [Lecture 52 - ARP-RAPP-BOOTP-DHCP \(Continued...\)](#)
- [Lecture 53](#)
- [Lecture 54 - Wireless LANs](#)
- [Lecture 55 - Layer 1: Physical Layer](#)
- [Lecture 56 - Layer 1: Physical Layer - II](#)
- [Lecture 57 - Layer 1: Physical Layer - III](#)
- [Lecture 58 - Network Security - Overview](#)
- [Lecture 59 - Network Security - II](#)
- [Lecture 60 - Network Security - III \[TCP/IP Security\]](#)

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NPTEL : NOC:Blockchain Architecture Design and Use Cases (Computer Science and Engineering)

Co-ordinators : Praveen Jayachandran, Prof. Sandip Chakraborty

- Lecture 1 - Introduction to Blockchain - I (Basics)
- Lecture 2 - Introduction to Blockchain - II (History)
- Lecture 3 - Introduction to Blockchain - III (Architecture)
- Lecture 4 - Introduction to Blockchain - IV (Conceptualization)
- Lecture 5 - Basic Crypto Primitives - I
- Lecture 6 - Basic Crypto Primitives - II
- Lecture 7 - Bitcoin Basics - I
- Lecture 8 - Bitcoin Basics - II
- Lecture 9 - Bitcoin Basics - III
- Lecture 10 - Distributed Consensus
- Lecture 11 - Consensus in Bitcoin - I (The Basics)
- Lecture 12 - Consensus in Bitcoin - II (PoW and Beyond)
- Lecture 13 - Consensus in Bitcoin - III (The Miners)
- Lecture 14 - Permissioned Blockchain - I (Basics)
- Lecture 15 - Permissioned Blockchain - II (Consensus)
- Lecture 16 - Permissioned Blockchain - III (RAFT Consensus)
- Lecture 17 - Permissioned Blockchain - IV (Byzantine General Problem)
- Lecture 18 - Permissioned Blockchain - V (Practical Byzantine Fault Tolerance)
- Lecture 19 - Blockchain for Enterprise - Overview
- Lecture 20 - Blockchain Components and Concepts
- Lecture 21 - Hyperledger Fabric - Transaction Flow
- Lecture 22 - Hyperledger Fabric Details
- Lecture 23 - Fabric - Membership and Identity Management
- Lecture 24 - Hyperledger Fabric Network Setup
- Lecture 25 - Fabric Demo on IBM Blockchain Cloud - I
- Lecture 26 - Fabric Demo on IBM Blockchain Cloud - II
- Lecture 27 - Fabric Demo, deploy from scratch - III
- Lecture 28 - Hyperledger Composer - Application Development
- Lecture 29 - Hyperledger Composer - Network Administration
- Lecture 30 - Blockchain Use Cases
- Lecture 31 - Blockchain in Financial Service - I (Payments and Secure Trading)

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- Lecture 32 - Blockchain in Financial Service - II (Compliance and Mortgage)
- Lecture 33 - Blockchain in Financial Service - III (Financial Trade)
- Lecture 34 - Revolutionizing Global Trade
- Lecture 35 - Blockchain in Supply Chain - I
- Lecture 36 - Blockchain in Supply Chain - II
- Lecture 37 - Blockchain in Other Industries
- Lecture 38 - Blockchain in Government - I (Advantages)
- Lecture 39 - Blockchain in Government - II (Use Cases)
- Lecture 40 - Blockchain in Government - III (Digital Identity)
- Lecture 41 - Blockchain in Government - IV (Hyperledger Indy)
- Lecture 42 - Blockchain in Government - V (Tax Payments and Land Registry Records)
- Lecture 43 - Blockchain Security - I (Overview)
- Lecture 44 - Blockchain Security - II (Membership and Access control in Fabric)
- Lecture 45 - Blockchain Security - III (Privacy in Fabric)
- Lecture 46 - Blockchain Security - III (Fabric SideDB)
- Lecture 47 - Research Aspects - I (Consensus Scalability)
- Lecture 48 - Research Aspects - II (Bitcoin-NG)
- Lecture 49 - Research Aspects - III (Collective Signing)
- Lecture 50 - Research Aspects - IV (Byzcoin)
- Lecture 51 - Research Aspects - V (Algorand)
- Lecture 52 - Research Aspects - VI (Cross Fault Tolerance)
- Lecture 53 - Research Aspects - VII (Secured Multi-Party Computation)
- Lecture 54 - Blockchain for Science - I (Blockchain for Big Data)
- Lecture 55 - Blockchain for Science - II (Blockchain and AI)
- Lecture 56 - Comparing Ecosystems - Ethereum
- Lecture 57 - Comparing Ecosystems - Ethereum development tools and Quorum
- Lecture 58 - Comparing Ecosystems - Corda Part 1
- Lecture 59 - Comparing Ecosystems - Corda Part 2
- Lecture 60 - Concluding the course

Lecture 1 - Introduction

Lecture 2 - Octal and Hexadecimal Number Systems

Lecture 3 - Signed and Unsigned Binary Number Representation

Lecture 4 - Binary Addition and Subtraction

Lecture 5 - BCD and Gray Code Representations

Lecture 6 - Error Detection and Correction

Lecture 7 - Logic Gates

Lecture 8 - Logic Families to Implement Gates

Lecture 9 - Emerging Technologies - Part I

Lecture 10 - Emerging Technologies - Part II

Lecture 11 - Switching Algebra

Lecture 12 - Algebraic Manipulation

Lecture 13 - Properties of Switching Functions

Lecture 14 - Obtaining Canonical Representations of Functions

Lecture 15 - Functional Completeness

Lecture 16 - Minimization Using Karnaugh Maps - Part I

Lecture 17 - Minimization Using Karnaugh Maps - Part II

Lecture 18 - Minimization Using Karnaugh Maps - Part III

Lecture 19 - Minimization using Tabular Method - Part I

Lecture 20 - Minimization using Tabular Method - Part II

Lecture 21 - Design of Adders - Part I

Lecture 22 - Design of Adders - Part II

Lecture 23 - Design of Adders - Part III

Lecture 24 - Logic Design - Part I

Lecture 25 - Logic Design - Part II

Lecture 26 - Logic Design - Part III

Lecture 27 - Binary Decision Diagrams - Part I

Lecture 28 - Binary Decision Diagrams - Part II

Lecture 29 - Logic Design using AND-EXOR Network

Lecture 30 - Threshold Logic and Threshold Gates

Lecture 31 - Latches and Flip-Flops - Part I

- Lecture 32 - Latches and Flip-Flops - Part II
- Lecture 33 - Latches and Flip-Flops - Part III
- Lecture 34 - Clocking and Timing - Part I
- Lecture 35 - Clocking and Timing - Part II
- Lecture 36 - Synthesis of Synchronous Sequential Circuits - Part I
- Lecture 37 - Synthesis of Synchronous Sequential Circuits - Part II
- Lecture 38 - Synthesis of Synchronous Sequential Circuits - Part III
- Lecture 39 - Synthesis of Synchronous Sequential Circuits - Part IV
- Lecture 40 - Minimization of Finite State Machines - Part I
- Lecture 41 - Minimization of Finite State Machines - Part II
- Lecture 42 - Design of Registers - Part I
- Lecture 43 - Design of Registers - Part II
- Lecture 44 - Design of Registers - Part III
- Lecture 45 - Design of Counters - Part I
- Lecture 46 - Design of Counters - Part II
- Lecture 47 - Digital-to-Analog Converter - Part I
- Lecture 48 - Digital-to-Analog Converter - Part II
- Lecture 49 - Analog-to-Digital Converter - Part I
- Lecture 50 - Analog-to-Digital Converter - Part II
- Lecture 51 - Analog-to-Digital Converter - Part III
- Lecture 52 - Asynchronous Sequential Circuits - Part I
- Lecture 53 - Asynchronous Sequential Circuits - Part II
- Lecture 54 - Algorithmic State Machine (ASM Chart
- Lecture 55 - Testing of Digital Circuits
- Lecture 56 - Fault Modeling
- Lecture 57 - Test Pattern Generation
- Lecture 58 - Design for Testability
- Lecture 59 - Built-in Self-Test - Part I
- Lecture 60 - Built-in Self-Test - Part II

Lecture 1 - Background: Introduction

Lecture 2 - Probability: Concentration inequalities

Lecture 3 - Linear algebra: PCA, SVD

Lecture 4 - Optimization: Basics, Convex, GD

Lecture 5 - Machine Learning: Supervised, generalization, feature learning, clustering.

Lecture 6 - Memory-efficient data structures: Hash functions, universal / perfect hash families

Lecture 7 - Bloom filters

Lecture 8 - Sketches for distinct count

Lecture 9 - Sketches for distinct count (Continued...)

Lecture 10 - Misra-Gries sketch

Lecture 11 - Frequent Element: Space Saving and Count Min

Lecture 12 - Frequent Element: Count Sketch

Lecture 13 - Near Neighbors

Lecture 14 - Locality Sensitive Hashing

Lecture 15 - Building LSH Tables

Lecture 16 - Approximate near neighbors search: Extensions e.g. multi-probe, b-bit hashing, Data dependent variants

Lecture 17 - Approximate near neighbors search: Extensions e.g. multi-probe, b-bit hashing, Data dependent variants (Continued...)

Lecture 18 - Approximate near neighbors search: Extensions e.g. multi-probe, b-bit hashing, Data dependent variants (Continued...)

Lecture 19 - Randomized Numerical Linear Algebra: Random projection

Lecture 20 - Randomized Numerical Linear Algebra: Random projection (Continued...)

Lecture 21 - Randomized Numerical Linear Algebra: a) Matrix multiplication + QB decomposition

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- Lecture 1 - Principles of Pattern Recognition I (Introduction and Uses)
- Lecture 2 - Principles of Pattern Recognition II (Mathematics)
- Lecture 3 - Principles of Pattern Recognition III (Classification and Bayes Decision Rule)
- Lecture 4 - Clustering vs. Classification
- Lecture 5 - Relevant Basics of Linear Algebra, Vector Spaces
- Lecture 6 - Eigen Value and Eigen Vectors
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- Lecture 8 - Rank of Matrix and SVD
- Lecture 9 - Types of Errors
- Lecture 10 - Examples of Bayes Decision Rule
- Lecture 11 - Normal Distribution and Parameter Estimation
- Lecture 12 - Training Set, Test Set
- Lecture 13 - Standardization, Normalization, Clustering and Metric Space
- Lecture 14 - Normal Distribution and Decision Boundaries I
- Lecture 15 - Normal Distribution and Decision Boundaries II
- Lecture 16 - Bayes Theorem
- Lecture 17 - Linear Discriminant Function and Perceptron
- Lecture 18 - Perceptron Learning and Decision Boundaries
- Lecture 19 - Linear and Non-Linear Decision Boundaries
- Lecture 20 - K-NN Classifier
- Lecture 21 - Principal Component Analysis (PCA)
- Lecture 22 - Fisher's LDA
- Lecture 23 - Gaussian Mixture Model (GMM)
- Lecture 24 - Assignments
- Lecture 25 - Basics of Clustering, Similarity/Dissimilarity Measures, Clustering Criteria.
- Lecture 26 - K-Means Algorithm and Hierarchical Clustering
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- Lecture 28 - Feature Selection : Problem statement and Uses
- Lecture 29 - Feature Selection : Branch and Bound Algorithm
- Lecture 30 - Feature Selection : Sequential Forward and Backward Selection
- Lecture 31 - Cauchy Schwartz Inequality

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Lecture 4 - Case study: Selection of techniques and metrics

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Lecture 8 - Probability distributions - III

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Lecture 11 - Slotted Aloha protocol model and discrete-time birth death process

Lecture 12 - Continuous time Markov chain and queuing theory - I

Lecture 13 - Queuing theory - I (Continued)

Lecture 14 - Queuing theory - II

Lecture 15 - Queuing theory - III

Lecture 16 - Queuing theory - IV

Lecture 17 - Queuing theory - V

Lecture 18 - Queuing theory - VI

Lecture 19 - Queuing networks - I

Lecture 20 - Queuing networks - II

Lecture 21 - Slotted Aloha Markov model

Lecture 22 - Simulations - I

Lecture 23 - Simulations - II

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : Theory of Automata, Formal Languages and Computation (Computer Science and Engineering)

Co-ordinators : Prof. Kamala Krithivasan

Lecture 1 - Grammars and Natural Language Processing

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Lecture 6 - Removal of Unit Productions, Chomsky Normal Form for CFG

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Lecture 9 - Non Deterministic FSA

Lecture 10 - Non Deterministic FSA (Continued.)

Lecture 11 - Non Deterministic FSA with E(Epsilon)- Moves

Lecture 12 - Equivalence Between FSA and Type 3 Grammars

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Lecture 14 - DFSA to Regular Expressions

Lecture 15 - Problems and Solutions - I

Lecture 16 - Pumping Lemmas for Regular Sets and CFL

Lecture 17 - MYHILL - Nerode Theorem

Lecture 18 - Minimization of DFSA

Lecture 19 - FSA with output Moore and Mealy Machines

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Lecture 21 - Pushdown Automata, Equivalence Between Acceptance by Empty Store and Acceptance by Final State

Lecture 22 - Pushdown Automata CFG to PDA

Lecture 23 - Pushdown Automata PDA to CFG

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Lecture 27 - Turing Machines (Continued.)

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- Lecture 2 - Introduction To System : Software
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- Lecture 5 - Processor As a State Machine
- Lecture 6 - Data Path Architecture
- Lecture 7 - Data Path Controller : Micro Programmed
- Lecture 8 - State Machine Design
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- Lecture 11 - Typical Micro Instructions
- Lecture 12 - Addressing Modes
- Lecture 13 - Problem Exercise
- Lecture 14 - Problem Exercise
- Lecture 15 - Introduction to memory system
- Lecture 16 - CPU - Memory Interaction
- Lecture 17 - Cache Organization
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- Lecture 19 - Virtual Memory
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- Lecture 23 - Address Translation and Protection
- Lecture 24 - Programmed I/O
- Lecture 25 - Interrupt Driven I/O
- Lecture 26 - DMA : Direct Memory Access
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- Lecture 28 - Evolution Of I/O
- Lecture 29 - I/O Devices
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Lecture 7 - Structured Query Language - II

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Lecture 9 - Functional Dependencies and Normal Form

Lecture 10 - ER Model to Relational Model Mapping

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Lecture 13 - Indexing Techniques Multi Level

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Lecture 11 - Solution Space Search, Beam Search

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Lecture 14 - Optimization - I (Simulated Annealing)

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Lecture 16 - Population based methods for Optimization

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Lecture 25 - AO* Algorithm

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Programming, Data Structures and Algorithms (Computer Science and Engineering)

Co-ordinators : Prof. Hema A Murthy, Prof. Shankar Balachandran, Dr. N.S. Narayanaswamy

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Lecture 8 - Video Solution to Digital Root Programming Assignment

Lecture 9 - Introduction to arrays

Lecture 10 - Working with 1D arrays

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Lecture 12 - Debugging demo

Lecture 13 - Multi-dimensional arrays

Lecture 14 - Pointers

Lecture 15 - More on pointers

Lecture 16 - Arrays and pointer arithmetic

Lecture 17 - Introduction to Strings

Lecture 18 - More on Strings

Lecture 19 - Video Solution to Print Elements of a Matrix in Spiral Order Programming Assignment

Lecture 20 - Introduction to functions

Lecture 21 - More details on functions

Lecture 22 - Arguments, variables and parameters

Lecture 23 - Pass parameters by reference

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Lecture 25 - Running time of a program

Lecture 26 - Computing time complexity

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[Lecture 48 - Trees](#)

[Lecture 49 - Tree traversal](#)

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- Lecture 2 - Module 1 - Part 1 - Definition of Information Security
- Lecture 3 - Module 1 - Part 2 - Information Security Terminologies
- Lecture 4 - Module 1 - Part 3 - Goals of Information Security
- Lecture 5 - Module 1 - Part 4 - Implementation Issues of the Goals of Information Security - I
- Lecture 6 - Module 1 - Part 5 - Implementation Issues of the Goals of Information Security - II
- Lecture 7 - Module 1 - Part 6 - Control Mechanisms for Information Security - I
- Lecture 8 - Module 1 - Part 7 - Access Control - Administrative and Technical
- Lecture 9 - Module 1 - Part 8 - Passwords - Are they secure? - I
- Lecture 10 - Module 1 - Part 9 - Access Control - Administrative and Technical
- Lecture 11 - Module 1 - Part 10 - Passwords - Are they secure? - III
- Lecture 12 - Module 1 - Part 11 - Multifactor Authentication - Challenges
- Lecture 13 - Module 1 - Part 12 - Application Level Control and Information Security Planning
- Lecture 14 - Module 1 - Part 13 - Information Security - Policy, Standard and Practice
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- Lecture 16 - Module 1 - Part 15 - Managing changes in Information Security Policies
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- Lecture 21 - Module 2 - Part 4 - Cloud Computing (Basic Definitions) - I
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Lecture 4 - Abstract Data Types-Data + Methods

Lecture 5 - List Data Type

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Lecture 7 - Doubly Linked List Data Type

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Lecture 13 - Merging using Queue ADT and Queue types

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Lecture 15 - Binary Tree ADT and traversals

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Lecture 17 - Binary Search Trees

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Lecture 8 - Examples: Analysis of iterative and recursive algorithms

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Lecture 26 - Dijkstras algorithm: analysis

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Co-ordinators : Prof. Ganapathy, Prof. Balaji Srinivasan

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Machine Learning (Computer Science and Engineering)

Co-ordinators : Prof. Henrik Bostrom, Prof. Fredrik Kilander, Prof. Carl Gustaf Jansson

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Applied Accelerated Artificial Intelligence (Computer Science and Engineering)

Co-ordinators : Prof. Satyadhyan Chickerur, Prof. Bharatkumar Sharma, Prof. Adesuyi Tosin, Prof. Satyajit Das

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : ACM India - RBCDSAI Summer School on DS-AI-ML (Computer Science and Engineering)

Co-ordinators : Multi-Faculty

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Lecture 2 - Introduction to Probability; Introduction to machine learning - Part 1

Lecture 3 - Introduction to Probability; Introduction to machine learning - Part 2

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Lecture 20 - 2D FEM Code: Gmsh and Scilab

Lecture 21 - Computation of B and H Field and Method of Weighted Residuals

Lecture 22 - Galerkin Method

Lecture 23 - Calculation of Leakage Inductance of a Transformer

Lecture 24 - Calculation of Inductance of an Induction Motor and a Gapped-Core Shunt Reactor

Lecture 25 - Insulation Design Using FE Analysis

Lecture 26 - Quadratic Finite Elements

Lecture 27 - Time Harmonic FE Analysis

Lecture 28 - Calculation of Eddy Current Losses

Lecture 29 - Eddy Losses in Transformer Windings

Lecture 30 - Torque Speed Characteristics of an Induction Motor and FE Analysis of Axisymmetric Problem

Lecture 31 - Permanent Magnets: Theory

[Lecture 32 - Permanent Magnets: FEM Implementation](#)

[Lecture 33 - Periodic and Antiperiodic Boundary Conditions in Rotating Machines](#)

[Lecture 34 - FE Analysis of Rotating Machines](#)

[Lecture 35 - Voltage Fed Coupled Circuit Field Analysis](#)

[Lecture 36 - Current Fed Coupled Circuit Field Analysis](#)

[Lecture 37 - Transient FE Analysis](#)

[Lecture 38 - Nonlinear FE Analysis](#)

[Lecture 39 - Computation of Forces using Maxwell Stress Tensor](#)

[Lecture 40 - Computation of force using virtual work method](#)

- Lecture 1 - Introduction: Digital signal processing and its objectives
- Lecture 2 - Introduction to sampling and Fourier Transform
- Lecture 3 - Sampling of sine wave and associate complication
- Lecture 4 - Review of Sampling Theorem
- Lecture 5 - Idealized Sampling, Reconstruction
- Lecture 6 - Filters And Discrete System
- Lecture 7 - Answering questions from previous lectures
- Lecture 8 - Desired requirements for discrete system
- Lecture 9 - Introduction to phasors
- Lecture 10 - Advantages of phasors in discrete systems
- Lecture 11 - What do we want from a discrete system?
- Lecture 12 - Linearity - Homogeneity and Additivity
- Lecture 13 - Shift Invariance and Characterization of LTI systems
- Lecture 14 - Characterization of LSI system using its impulse response
- Lecture 15 - Introduction to convolution
- Lecture 16 - Convolution: Deeper ideas and understanding
- Lecture 17 - Characterisation of LSI systems, Convolution-properties
- Lecture 18 - Response of LSI Systems to Complex Sinusoids
- Lecture 19 - Convergence of Convolution and Bibo Stability
- Lecture 20 - Commutativity and Associativity
- Lecture 21 - BIBO Stability of an LSI system
- Lecture 22 - Causality and memory of an LSI system
- Lecture 23 - Frequency response of an LSI system
- Lecture 24 - Introduction and conditions of Stability
- Lecture 25 - Vectors and Inner Product
- Lecture 26 - Interpretation of Frequency Response as Dot Product
- Lecture 27 - Interpretation of Frequency Response as Eigenvalues
- Lecture 28 - Discrete time fourier transform
- Lecture 29 - DTFT in LSI System and Convolution Theorem.
- Lecture 30 - Definitions of sequences and Properties of DTFT
- Lecture 31 - Introduction to DTFT, IDTFT

Lecture 32 - Dual to convolution property

Lecture 33 - Multiplication Property, Introduction to Parseval's theorem

Lecture 34 - Introduction and Property of DTFT

Lecture 35 - Review of Inverse DTFT

Lecture 36 - Parseval's Theorem and energy and time spectral density

Lecture 37 - Discussion on Unit Step

Lecture 38 - Introduction to Z transform

Lecture 39 - Example of Z transform

Lecture 40 - Region of Convergence

Lecture 41 - Properties of Z transform

Lecture 42 - Z- Transform

Lecture 43 - Rational System

Lecture 44 - Introduction and Examples of Rational Z Transform and their Inverses

Lecture 45 - Double Pole Examples and their Inverse Z Transform

Lecture 46 - Partial Fraction Decomposition

Lecture 47 - LSI System Examples

Lecture 48 - Why are Rational Systems so important?

Lecture 49 - Solving Linear constant coefficient difference equations which are valid over a finite range of time

Lecture 50 - Introduction to Resonance in Rational Systems

Lecture 51 - Characterization of Rational LSI system

Lecture 52 - Causality and stability of the ROC of the system function

Lecture 53 - Recap of Rational Systems and Discrete Time Filters

Lecture 54 - Specifications for Filter Design

Lecture 55 - Four Ideal Piecewise Constant Filters

Lecture 56 - Important Characteristics Of Ideal Filters

Lecture 57 - Synthesis of Discrete Time Filters, Realizable specifications

Lecture 58 - Realistic Specifications for low pass filter. Filter Design Process

Lecture 59 - Introduction to Filter Design. Analog IIR Filter, FIR discrete-time filter, IIR discrete-time filter

Lecture 60 - Analog to discrete transform

Lecture 61 - Intuitive transforms, Bilinear Transformation

Lecture 62 - Steps for IIR filter design

Lecture 63 - Analog filter design using Butterworth Approximation

Lecture 64 - Butterworth filter Derivation And Analysis of butterworth system function

Lecture 65 - Chebychev filter Derivation

Lecture 66 - Midsem paper review discussion

Lecture 67 - The Chebyshev Approximation

Lecture 68 - Next step in design: Obtain poles

Lecture 69 - Introduction to Frequency Transformations in the Analog Domain

Lecture 70 - High pass transformation

Lecture 71 - Band pass transformation

Lecture 72 - Frequency Transformation

Lecture 73 - Different types of filters

Lecture 74 - Impulse invariant method and ideal impulse response

Lecture 75 - Design of FIR of length $(2N+1)$ by the truncation method, Plotting the function $V(\omega)$

Lecture 76 - IIR filter using rectangular window, IIR filter using triangular window

Lecture 77 - Proof that frequency response of an fir filter using rectangular window function centred at 0 is real

Lecture 78 - Introduction to window functions

Lecture 79 - Examples of window functions

Lecture 80 - Explanation of Gibbs Phenomenon and its application

Lecture 81 - Comparison of FIR And IIR Filter

Lecture 82 - Comparison of FIR And IIR Filter

Lecture 83 - Comparison of FIR And IIR Filter

Lecture 84 - Introduction and approach to realization (causal rational system)

Lecture 85 - Comprehension of Signal Flow Graphs and Achievement of Pseudo Assembly Language Code

Lecture 86 - Introduction to IIR Filter Realization and Cascade Structure

Lecture 87 - Cascade Parallel Structure

Lecture 88 - Lattice Structure

Lecture 89 - Recap And Review of Lattice Structure, Realization of FIR Function

Lecture 90 - Backward recursion, Change in the recursive equation of lattice

Lecture 91 - Lattice structure for an arbitrary rational system

Lecture 92 - Example realization of lattice structure for rational system

Lecture 93 - Introductory Remarks of Discrete Fourier Transform and Frequency Domain Sampling

Lecture 94 - Principle of Duality, The Circular Convolution

Lecture 1 - Decision Making under Uncertainty

Lecture 2 - Expected Utility Theory - I

Lecture 3 - Expected Utility Theory - II

Lecture 4 - Expected Utility Theory - III

Lecture 5 - Role of Information in Decision Making

Lecture 6 - State Space Modelling of Sequential Decision Making, Example of Inventory Control

Lecture 7 - Inventory Control Problem (Continued...)

Lecture 8 - Policy-A Closed Loop Solution to Stochastic Control Problem

Lecture 9 - Introduction to Markov Decision Processes (MDP)

Lecture 10 - Types of Policy in MDP

Lecture 11 - Interpreting randomised decision rules

Lecture 12 - Stationary Transition Probability: State Diagram Representation and example of Markov policies

Lecture 13 - Example of History Dependent Policies

Lecture 14 - Complexity of the problem using brute force approach

Lecture 15 - Principle of Optimality

Lecture 16 - Dynamic Programming Algorithm

Lecture 17 - DP Algo applied to Inventory Control Problem

Lecture 18 - DP Algo applied to Inventory Control Problem (Continued...)

Lecture 19 - DP Algo applied to Inventory Control Problem (Continued...)

Lecture 20 - Optimal Stopping Problem

Lecture 21 - Optimal Stopping Example: Secretary Problem

Lecture 22 - Optimal Stopping Example: Secretary Problem (Continued...)

Lecture 23 - Optimal Stopping Example: Secretary Problem (Continued...)

Lecture 24 - Linear System Quadratic Cost Problem

Lecture 25 - Linear System Quadratic Cost Problem (Continued...)

Lecture 26 - Solving it via DP algorithm (Continued...)

Lecture 27 - Equivalence between Optimal HR Policy and optimal Markov Deterministic Policy

Lecture 28 - Stochastic Control under incomplete state information

Lecture 29 - Stochastic Control under incomplete state information (Continued...)

Lecture 30 - Stochastic Control under incomplete state information: Example

Lecture 31 - Stochastic Control under incomplete state information: Example (Continued...)

[Lecture 32 - Stochastic Control under incomplete state information: Example \(Continued...\)](#)

[Lecture 33 - Stochastic Control under incomplete state information: Example \(Continued...\)](#)

[Lecture 34 - LQ systems with Imperfect Information - I](#)

[Lecture 35 - LQ systems with Imperfect Information - II](#)

[Lecture 36 - LQ systems with Imperfect Information - III](#)

[Lecture 37 - LQ systems with Imperfect Information - IV](#)

[Lecture 38 - Filtering - I](#)

[Lecture 39 - Filtering - II](#)

[Lecture 40 - Kalman Filtering - I](#)

[Lecture 41 - Kalman Filtering - II](#)

[Lecture 42 - Kalman Filtering - III](#)

[Lecture 43 - Belief State Formulation - I](#)

[Lecture 44 - Belief State Formulation - II](#)

[Lecture 45 - Information Structures - I](#)

[Lecture 46 - Information Structures - II](#)

[Lecture 47 - Witsenhausen Problem - I](#)

[Lecture 48 - Witsenhausen Problem - II](#)

[Lecture 49 - Witsenhausen Problem - III](#)

[Lecture 50 - Witsenhausen Problem - IV](#)

[Lecture 51 - Witsenhausen Problem - V](#)

[Lecture 52 - Witsenhausen Problem - VI](#)

[Lecture 53 - Witsenhausen Problem - VII](#)

[Lecture 54 - Team Decision Theory - I](#)

[Lecture 55 - Team Decision Theory - II](#)

[Lecture 56 - Team Decision Theory - III](#)

[Lecture 57 - Team Decision Theory - IV](#)

[Lecture 58 - Team Decision Theory - V](#)

[Lecture 59 - Team Decision Theory - VI](#)

[Lecture 60 - Team Decision Theory - VII](#)

[Lecture 61 - Communication Theory - I](#)

[Lecture 62 - Communication Theory - II](#)

[Lecture 63 - Communication Theory - III](#)

[Lecture 64 - Communication Theory - IV](#)

NPTEL : Circuit Theory (Electrical Engineering)

Co-ordinators : Prof. S.C. Dutta Roy

- Lecture 1 - Review of Signals and Systems
- Lecture 2 - Review of Signals and Systems
- Lecture 3 - Network Equations; Initial and Final Conditions
- Lecture 4 - Problem Session 1
- Lecture 5 - Step, Impulse and Complete Responses
- Lecture 6 - 2nd Order Circuits:Magnetically Coupled Circuits
- Lecture 7 - Transformer Transform Domain Analysis
- Lecture 8 - Problem Session 2 : Step,Impulse
- Lecture 9 - Network Theorems and Network Functions
- Lecture 10 - Network Functions (Continued.)
- Lecture 11 - Amplitude and Phase of Network Functions
- Lecture 12 - Problem Session 3 : Network Theorems Transform
- Lecture 13 - Poles, Zeros and Network Response
- Lecture 14 - Single Tuned Circuits
- Lecture 15 - Single Tuned Circuits (Continued.)
- Lecture 16 - Double Tuned Circuits
- Lecture 17 - Double Tuned Circuits (Continued.)
- Lecture 18 - Problem Session 4 : Network Functions, Analysis
- Lecture 19 - Double Tuned Circuits (Continued.)
- Lecture 20 - Concept of Delay and Introduction
- Lecture 21 - Two-port Networks (Continued.)
- Lecture 22 - Problem Session 5
- Lecture 23 - Minor - 1
- Lecture 24 - The Hybrid & Transmission Parameters of 2 ports
- Lecture 25 - Problem Session 6 : Two - port networks
- Lecture 26 - Two - port Network parameters
- Lecture 27 - Two-port Interconnections
- Lecture 28 - Interconnection of Two-port Networks (Continued.)
- Lecture 29 - Problem Session 7 : Two-port Networks (Continued.)
- Lecture 30 - Scattering Matrix
- Lecture 31 - Scattering Parameters of a Two-port

- Lecture 32 - Problem Session 8 : Two- port Parameters
- Lecture 33 - Solutions of Minor - 2 Problems
- Lecture 34 - Insertion Loss
- Lecture 35 - Example of Insertion Loss and Elements
- Lecture 36 - Elements of Realizability Theory (Continued.)
- Lecture 37 - Positive Real Functions
- Lecture 38 - Testing of Positive Real Functions
- Lecture 39 - Problem Session 9
- Lecture 40 - More on PRF's and their Synthesis
- Lecture 41 - LC Driving Point Functions
- Lecture 42 - LC Driving Point Synthesis (Continued.)
- Lecture 43 - RC and RL Driving Point Synthesis
- Lecture 44 - Problem Session 10 : LC Driving Point Synthesis
- Lecture 45 - RC & RL One-port Synthesis (Continued.)
- Lecture 46 - Elementary RLC One-port Synthesis
- Lecture 47 - Properties and Synthesis of Transfer Parameters
- Lecture 48 - Resistance Terminated LC Ladder
- Lecture 49 - Resistance Terminated LC Ladder (Continued.)
- Lecture 50 - Problem session 11: Two-port Synthesis
- Lecture 51 - Network Transmission Criteria

Lecture 1 - Introduction to control problem

Lecture 2 - Basic Feedback Structure

Lecture 3 - Introduction to Control Problem (Continued.)

Lecture 4 - Dynamic Systems and Dynamic Response

Lecture 5 - Dynamic Systems and Dynamic Response (Continued.)

Lecture 6 - Dynamic Systems and Dynamic Response (Continued.)

Lecture 7 - Dynamic Systems and Dynamic Response (Continued.)

Lecture 8 - Dynamic Systems and Dynamic Response (Continued.)

Lecture 9 - Dynamic Systems and Dynamic Response (Continued.)

Lecture 10 - Models of Industrial Control Devices and Systems

Lecture 11 - Models of Industrial Control Devices and Systems (Continued.)

Lecture 12 - Models of Industrial Control Devices and Systems(Continued.)

Lecture 13 - Models of Industrial Control Devices and Systems(Continued.)

Lecture 14 - Models of Industrial Control Devices and Systems(Continued.)

Lecture 15 - Models of Industrial Control Devices and Systems(Continued.)

Lecture 16 - Models of Industrial Control Devices and Systems (Continued.)

Lecture 17 - Models of Industrial Control Devices and Systems (Continued.)

Lecture 18 - Models of Industrial Control Devices and Systems (Continued.)

Lecture 19 - Basic Principles of Feedback Control

Lecture 20 - Basic Principles of Feedback Control (Continued.)

Lecture 21 - Basic Principles of Feedback Control (Continued.)

Lecture 22 - Basic Principles of Feedback Control (Continued.)

Lecture 23 - Concepts of stability and Routh Stability Criterion

Lecture 24 - Concepts of stability and Routh Stability Criterion (Continued.)

Lecture 25 - Concepts of stability and Routh Stability Criterion (Continued.)

Lecture 26 - The Performance of Feedback Systems

Lecture 27 - The Performance of Feedback Systems (Continued.)

Lecture 28 - The Performance of Feedback Systems (Continued.)

Lecture 29 - The Performance of Feedback Systems (Continued.)

Lecture 30 - Compensator Design Using Root Locus Plots

Lecture 31 - Compensator Design Using Root Locus Plots (Continued.)

[Lecture 32 - Compensator Design Using Root Locus Plots \(Continued.\)](#)

[Lecture 33 - Compensator Design Using Root Locus Plots \(Continued.\)](#)

[Lecture 34 - Compensator Design Using Root Locus Plots \(Continued.\)](#)

[Lecture 35 - The Nyquist Stability Criterion and Stability Margins](#)

[Lecture 36 - The Nyquist Stability Criterion and Stability Margins \(Continued.\)](#)

[Lecture 37 - The Nyquist Stability Criterion and Stability Margins \(Continued.\)](#)

[Lecture 38 - The Nyquist Stability Criterion and Stability Margins \(Continued.\)](#)

[Lecture 39 - Feedback System Performance Based on the Frequency Response](#)

[Lecture 40 - Feedback System Performance Based on the Frequency Response \(Continued.\)](#)

[Lecture 41 - Compensator Design Using Frequency Response Plots](#)

- Lecture 1 - Embedded Systems: Introduction
- Lecture 2 - Embedded Hardware
- Lecture 3 - PIC: Instruction Set
- Lecture 4 - PIC Peripherals On Chip
- Lecture 5 - ARM Processor
- Lecture 6 - More ARM Instructions
- Lecture 7 - ARM: Interrupt Processing
- Lecture 8 - Digital Signal Processors
- Lecture 9 - More on DSP Processors
- Lecture 10 - System On Chip (SOC)
- Lecture 11 - Memory
- Lecture 12 - Memory Organization
- Lecture 13 - Virtual Memory and Memory Management Unit
- Lecture 14 - Bus Structure
- Lecture 15 - Bus Structure - 2
- Lecture 16 - Bus Structure - 3 Serial Interfaces
- Lecture 17 - Serial Interfaces
- Lecture 18 - Power Aware Architecture
- Lecture 19 - Software for Embedded Systems
- Lecture 20 - Fundamentals of Embedded Operating Systems
- Lecture 21 - Scheduling Policies
- Lecture 22 - Resource Management
- Lecture 23 - Embedded - OS
- Lecture 24 - Networked Embedded Systems - I
- Lecture 25 - Networked Embedded Systems - II
- Lecture 26 - Networked Embedded Systems - III
- Lecture 27 - Networked Embedded Systems - IV
- Lecture 28 - Designing Embedded Systems - I
- Lecture 29 - Designing Embedded Systems - II
- Lecture 30 - Designing Embedded Systems- III
- Lecture 31 - Embedded System Design - IV

[Lecture 32 - Designing Embedded Systems - V](#)

[Lecture 33 - Platform Based Design](#)

[Lecture 34 - Compilers for Embedded Systems](#)

[Lecture 35 - Developing Embedded Systems](#)

[Lecture 36 - Building Dependable Embedded Systems](#)

[Lecture 37 - Pervasive and Ubiquitous Computing](#)

- Lecture 1 - Electric Energy Systems A Perspective
- Lecture 2 - Structure of Power Systems
- Lecture 3 - Conventional Sources of Electric Energy
- Lecture 4 - Hydroelectric Power Generation
- Lecture 5 - Non Conventional Energy Sources
- Lecture 6 - Renewable Energy (Continued.)
- Lecture 7 - Energy Storage
- Lecture 8 - Deregulation
- Lecture 9 - Air Pollutants
- Lecture 10 - Transmission Line Parameters
- Lecture 11 - Capacitance of Transmission Lines
- Lecture 12 - Characteristics and Performance of Transmission Lines
- Lecture 13 - Voltage Regulation (VR)
- Lecture 14 - Power Flow through a Line
- Lecture 15 - Methods of Voltage Control
- Lecture 16 - Compensation of Transmission Lines
- Lecture 17 - Compensation of Transmission Lines (Continued.)
- Lecture 18 - Underground Cables
- Lecture 19 - Cables (Continued.)
- Lecture 20 - Insulators for Overhead Lines
- Lecture 21 - HVDC
- Lecture 22 - HVDC (Continued.)
- Lecture 23 - Distribution Systems
- Lecture 24 - Automatic Generation Control
- Lecture 25 - Automatic Generation Control (Continued.)
- Lecture 26 - Load Flow Studies
- Lecture 27 - Load Flow Problem
- Lecture 28 - Load Flow Analysis (Continued.), Gauss Siedel Method
- Lecture 29 - Newton Raphson (NR), Load Flow Method
- Lecture 30 - Fast Decoupled Load Flow
- Lecture 31 - Control of Voltage Profile

[Lecture 32 - Optimal System Operation \(Economic Operation\)](#)

[Lecture 33 - Optimal Unit Commitment](#)

[Lecture 34 - Optimal Generation Scheduling](#)

[Lecture 35 - Optimal Load Flow \(Continued.\) and Hydro Thermal Scheduling](#)

- Lecture 1 - Introduction to Power System Stability Problem - Part-1
- Lecture 2 - Introduction to Power System Stability Problem - Part-2
- Lecture 3 - Introduction to Power System Stability Problem - Part-3
- Lecture 4 - Solution of Switching Equation
- Lecture 5 - The Equal Area Criterion for Stability - Part-1
- Lecture 6 - The Equal Area Criterion for Stability - Part-2
- Lecture 7 - Transient Stability Analysis of a Multi Machine System
- Lecture 8 - Modeling of Synchronous Machine - Part-1
- Lecture 9 - Modeling of Synchronous Machine - Part-2
- Lecture 10 - Modeling of Synchronous Machine - Part-3
- Lecture 11 - Modeling of Synchronous Machine - Part-4
- Lecture 12 - Synchronous Machine Representation for Stability Studies - Part-1
- Lecture 13 - Synchronous Machine Representation for Stability Studies - Part-2
- Lecture 14 - Excitation Systems - Part-1
- Lecture 15 - Excitation Systems - Part-2
- Lecture 16 - Modeling of Excitation Systems - Part-1
- Lecture 17 - Modeling of Excitation Systems - Part-2
- Lecture 18 - Small Signal Stability of a Single Machine Infinite Bus System - Part-1
- Lecture 19 - Small Signal Stability of a Single Machine Infinite Bus System - Part-2
- Lecture 20 - Small Signal Stability of a Single Machine Infinite Bus System - Part-3
- Lecture 21 - Small Signal Stability of a Single Machine Infinite Bus System - Part-4
- Lecture 22 - Small Signal Stability of a Single Machine Infinite Bus System - Part-5
- Lecture 23 - Dynamic Modeling of Steam turbines and Governors
- Lecture 24 - Dynamic modeling of Hydro Turbines and Governors
- Lecture 25 - Load modeling for Stability Studies
- Lecture 26 - Numerical Integration Methods for Solving a Set of Ordinary Nonlinear Differential Equation
- Lecture 27 - Simulation of Power System Dynamic Response
- Lecture 28 - Dynamic Equivalents for Large Scale Systems - Part-1
- Lecture 29 - Dynamic Equivalents for Large Scale Systems - Part-2
- Lecture 30 - Dynamic Equivalents for Large Scale Systems - Part-3
- Lecture 31 - Direct Method of Transient Stability Analysis - Part-1

[Lecture 32 - Direct Method of Transient Stability Analysis - Part-2](#)

[Lecture 33 - Sub Synchronous Oscillations - Part-1](#)

[Lecture 34 - Sub Synchronous Oscillations - Part-2](#)

[Lecture 35 - Voltage Stability - Part-1](#)

[Lecture 36 - Voltage Stability - Part-2](#)

[Lecture 37 - Voltage Stability - Part-3](#)

[Lecture 38 - Voltage Stability - Part-4](#)

[Lecture 39 - Methods of Improving Stability - Part-1](#)

[Lecture 40 - Methods of Improving Stability - Part-2](#)

Lecture 1 - Review of DC Models of Diodes & BJT's

Lecture 2 - Review of DC Models of BJT (Continued...) and FET

Lecture 3 - FET Characteristics and Models

Lecture 4 - Problem Session-1 on DC Analysis of BJT Circuits

Lecture 5 - BJT Biasing and Bias Stability

Lecture 6 - BJT Bias Stability (Continued...)

Lecture 7 - FET Biasing, Current Sources

Lecture 8 - Problem Session-2 on FET and BJT Characteristics and Biasing

Lecture 9 - Current Mirrors; BJT Small Signal Models

Lecture 10 - Small Signal Amplifiers: Mid Frequency Analysis

Lecture 11 - Mid Frequency Analysis of the CE and CB Amplifier

Lecture 12 - Problem Session-3 on Mid- Frequency Analysis of CE Amplifiers

Lecture 13 - Midband Analysis of CB and CC Amplifiers

Lecture 14 - Midband Analysis of FET Amplifiers

Lecture 15 - Problem Session-4 on Midband Analysis of Amplifiers

Lecture 16 - High Frequency Response of Small Signal Amplifiers

Lecture 17 - High Frequency Response of Small Signal Amplifiers (Continued...)

Lecture 18 - Low Frequency Response of Small Signal Amplifiers

Lecture 19 - Problem Session-5 on Frequency Response of Small Signal Amplifiers

Lecture 20 - Differential Amplifiers

Lecture 21 - Differential Amplifiers (Continued...)

Lecture 22 - Discussion on Minor-1 Problems and Differential Amplifiers (Continued...)

Lecture 23 - Problem Session-6 on Frequency Response of Small Signal Amplifiers (Continued...) and Differential Amplifiers

Lecture 24 - Use of Current Mirrors in Differential Amplifiers

Lecture 25 - FET Differential Amplifiers and Introduction to Power Amplifiers

Lecture 26 - Class B, Class AB and Class A Power Amplifiers

Lecture 27 - Class A Power Amplifiers; Efficiency Considerations

Lecture 28 - Problem Session-7 on Deferential and Power Amplifiers

Lecture 29 - Introduction to Feedback Amplifiers

Lecture 30 - Advantages of Negative Feedback Amplifiers

Lecture 31 - Analysis of Feedback Amplifiers

[Lecture 32 - Analysis of the Series - Series and Other Feedback Configurations](#)

[Lecture 33 - Problem Session-8 on Feedback Amplifiers](#)

[Lecture 34 - Sinusoidal Oscillators : An Example of Positive Feedback](#)

[Lecture 35 - More on Oscillators](#)

[Lecture 36 - Solutions to Minor-2 Exam and Concluding Discussions on Oscillators](#)

[Lecture 37 - Problem Session-9 on Oscillators](#)

[Lecture 38 - Tuned \(or Narrowband\) Amplifiers](#)

[Lecture 39 - Widebanding Techniques : Introduction & Use of Inductors](#)

[Lecture 40 - Widebanding By Using an Inductance](#)

[Lecture 41 - Problem Session-10 on Tuned Amplifiers](#)

[Lecture 42 - Widebanding by Using Compound Devices](#)

[Lecture 43 - Cascode Configuration as Wideband Amplifier](#)

[Lecture 44 - Widebanding by Local Feedback](#)

[Lecture 45 - Problem Session-11 on Minor-3 Problems & Widebanding by Compound Devices](#)

[Lecture 46 - Widebanding by Local Feedback and Feedback Cascades](#)

[Lecture 47 - Widebanding by Overall Feedback and Dual Loop Feedback](#)

[Lecture 48 - The Differential Pair and the Gilbert Cell as Wideband Amplifiers](#)

[Lecture 49 - Correction to Gilbert Cell Analysis and Operational Amplifier Imperfections](#)

[Lecture 50 - Op-Amp offsets, Compensation and Slew Rate](#)

[Lecture 51 - Op-Amp Compensation, Slew Rate and Some Problems](#)

Lecture 1 - Introduction to the Course

Lecture 2 - Digital Representation of Analog Signals, Delta Modulation

Lecture 3 - Digital Representation of Analog Signals, Pulse Code Modulation

Lecture 4 - Digital Representation of Analog Signals

Lecture 5 - Quantization Noise in Delta Modulation (Continued...) and Time Division Multiplexing

Lecture 6 - Introduction to Line Coding

Lecture 7 - Spectral Properties of Line Codes: General Relations

Lecture 8 - Spectral Properties of Line Codes: On-off / Polar / Bipolar Signalling

Lecture 9 - Spectral Properties of Line Codes: Duobinary Manchester and HDB Codes

Lecture 10 - Baseband Pulse Shaping: Nyquist's First Criterion

Lecture 11 - Baseband Pulse Shaping: Raised Cosine Family of Pulses

Lecture 12 - Partial Response Signalling: Duobinary and Modified Duobinary Pulse Shaping

Lecture 13 - Precoding for Duobinary and Modified Duobinary Systems

Lecture 14 - Precoding for Modified Duobinary Systems (Continued...) and General Partial Response Signalling

Lecture 15 - Binary Baseband Digital Modulation Techniques

Lecture 16 - M-ary Baseband Digital Modulation Techniques

Lecture 17 - Passband Digital Modulations - I : PSK and QPSK

Lecture 18 - Passband Digital Modulations - II : Offset QPSK

Lecture 19 - Passband Digital Modulations - III : Minimum Shift Keying (MSK)

Lecture 20 - Passband Digital Modulations - IV : MSK (Continued...) : Passband Waveforms for M-ary Signalling

Lecture 21 - Passband Modulations for Band Limited Channels

Lecture 22 - Baseband and Passband Digital Demodulations : General Issues and Concepts

Lecture 23 - Digital Modulation Part - II Matched Filters

Lecture 24 - Matched Filters and Coherent Demodulation-I

Lecture 25 - Coherent Demodulation for Binary Wave Form

Lecture 26 - Demodulators for Binary Waveforms (Continued...) : Coherent and Noncoherent Receivers for Orthogonal Signalling (OOK and FSK)

Lecture 27 - Performance Analysis of Binary Digital Modulations: Signal and Noise Statistics in Coherent and Noncoherent Receivers

Lecture 28 - Error Rates for Binary Signalling : Coherent Receivers

Lecture 29 - Performance of Non Coherent FSK and Differential Phase Shift Keying

Lecture 30 - Demodulation of DPSK and M-ary Signals

[Lecture 31 - Performance of M'ary Digital Modulations](#)

[Lecture 32 - Performance of M'ary Digital Modulations \(Continued...\)](#)

[Lecture 33 - Introduction to Information Theory, Part-1](#)

[Lecture 34 - Source Coding](#)

[Lecture 35 - Error Free Communication Over a Noisy Channel](#)

[Lecture 36 - The Concept of Channel Capacity](#)

[Lecture 37 - Error Correcting Codes](#)

[Lecture 38 - Error Correcting Codes \(Continued...\)](#)

NPTEL : Introduction To Electronic Circuits (Electrical Engineering)

Co-ordinators : Prof. S.C. Dutta Roy

- Lecture 1 - Introduction to the Course and Basic Electrical Quantity
- Lecture 2 - R.L.C. Components, Energy Considerations, Sources and Circuit Laws
- Lecture 3 - KCL, KVL and Network Analysis
- Lecture 4 - Networks Theorems (Thevenin's Norton's)
- Lecture 5 - Source Transformation; Super Position Theorem and Non-Linear One-Ports
- Lecture 6 - Signal Wave Forms
- Lecture 7 - Periodic Wave Forms and Elements of Amplifiers
- Lecture 8 - Operational Amplifiers and Diodes
- Lecture 9 - Rectifiers and Power Supplies
- Lecture 10 - Wave Shaping Circuits
- Lecture 11 - More on Wave Shaping Circuits and Introduction to Natural Response of Circuits
- Lecture 12 - Natural Response (Continued...)
- Lecture 13 - Natural Response of 2nd Order Circuit
- Lecture 14 - Natural Response of 2nd Order Circuit (Continued...)
- Lecture 15 - Impedance Functions, Poles, Zeros and their Applications
- Lecture 16 - Natural Response and Poles and Zeros and Introduction to Forced Response
- Lecture 17 - Phasors and their Applications in AC Ckts, analysis
- Lecture 18 - More About Phasors and Introduction to Complete Response
- Lecture 19 - Complete Response of Electrical Circuits
- Lecture 20 - AC Circuit Analysis
- Lecture 21 - Filter Circuits and Resonance
- Lecture 22 - Resonance (Continued...)
- Lecture 23 - General Network Analysis
- Lecture 24 - Two-Port Networks
- Lecture 25 - Semiconductor Physics
- Lecture 26 - Semiconductor Physics (Continued...)
- Lecture 27 - More About Diodes Including Zener Diodes
- Lecture 28 - Bipolar Junction Transistors
- Lecture 29 - Transistors Characteristics and Biasing
- Lecture 30 - BJT Biasing and Introduction to Power Amplifiers
- Lecture 31 - BJT Power Amplifiers

[Lecture 32 - Power Amplifier](#)

[Lecture 33 - Power Amplifiers \(Continued...\) and an Introduction to Small Signal Modelling of BJT](#)

[Lecture 34 - Small Signal Model and Small Signal Amplifiers](#)

[Lecture 35 - Small Signal Amplifiers \(Continued...\)](#)

[Lecture 36 - Small Signal Amplifier \(Continued...\)](#)

[Lecture 37 - Small Signal Amplifiers \(Continued...\)](#)

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NPTEL : Advanced Electric Drives (Electrical Engineering)

Co-ordinators : Dr. S.P. Das

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Lecture 1 - Introduction to EMT

Lecture 2 - Coulombs law

Lecture 3 - Vector analysis-I and Introduction to coordinate system

Lecture 4 - Rectangular coordinate system

Lecture 5 - Vector analysis-II

Lecture 6 - Introduction to Electric field

Lecture 7 - Electric field-I

Lecture 8 - Cylindrical coordinate system

Lecture 9 - Transformation and Electric field-II

Lecture 10 - Electric Potential-I

Lecture 11 - Spherical co-ordinate system and Electric potential-II

Lecture 12 - Vector Analysis-III and Electric potential-III

Lecture 13 - Gauss's law and its application-I

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Lecture 15 - Divergence and Poisson's and Laplace's equation

Lecture 16 - Gauss's law and its application -III

Lecture 17 - Vector analysis III (curl and its significance)

Lecture 18 - Conductor and dielectric-I

Lecture 19 - Polarization - I

Lecture 20 - Polarization - II

Lecture 21 - Polarization - II (Continued...)

Lecture 22 - Boundary condition

Lecture 23 - Continuity equation and Conductors - III

Lecture 24 - Conductors IV

Lecture 25 - Conductors IV (Continued...) and Capacitor - I

Lecture 26 - Capacitor - II

Lecture 27 - Capacitor - II (Continued...) and Equipotential Surfaces

Lecture 28 - Solution of Laplace's equation-I

Lecture 29 - Solution of Laplace's equation-I I and method of images-I

Lecture 30 - Method of images-II

Lecture 31 - Solution of Laplace's equation-III

- Lecture 32 - Solution of Laplace's equation-IV
- Lecture 33 - Introduction of magnetic field
- Lecture 34 - Biot savart law and its application
- Lecture 35 - Biot savart law and its application-II
- Lecture 36 - Magnetic vector potential
- Lecture 37 - Magnetic force, torque and dipole
- Lecture 38 - Magnetic force, torque and dipole (Continued...)
- Lecture 39 - Magnetic materials-I
- Lecture 40 - Magnetic materials-I (Continued...) and Magnetic moment
- Lecture 41 - Magnetic materials-I (Continued...) and Boundary condition for Magnetic fields
- Lecture 42 - Inductor and calculation of inductance for different shapes
- Lecture 43 - Inductor and calculation of inductance for different shapes (Continued...)
- Lecture 44 - Faradays law and its application-I
- Lecture 45 - Faradays law and its application-II
- Lecture 46 - Displacement current
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- Lecture 48 - Wave propagation
- Lecture 49 - Solution of Helmholtz equation
- Lecture 50 - Uniform plane waves
- Lecture 51 - Polarization and Poynting Vector
- Lecture 52 - Wave reflections (Normal incidence)
- Lecture 53 - Waves in imperfect dielectrics and Good conductors
- Lecture 54 - Skin depth/effect
- Lecture 55 - Oblique incidence of waves
- Lecture 56 - Oblique incidence of waves (Continued...)
- Lecture 57 - Transmission line
- Lecture 58 - Transmission line model
- Lecture 59 - Steady state sinusoidal response of T-line-I
- Lecture 60 - Steady state sinusoidal response of T-line-II
- Lecture 61 - Steady state sinusoidal response of T-line-II and Smith chart
- Lecture 62 - Application of smith chart-I
- Lecture 63 - Application of smith chart-II
- Lecture 64 - Impedance matching

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- [Lecture 70 - Waveguide Analysis](#)
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- [Lecture 72 - Rectangular waveguide: TM modes](#)
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- [Lecture 77 - Dielectric Waveguide \(Continued...\)](#)
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- [Lecture 80 - Hertzian Dipole Antenna \(Continued...\)](#)
- [Lecture 81 - Quasi-statistics-I](#)
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- [Lecture 83 - Long wire Antenna](#)
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- [Lecture 85 - Numerical solution of Laplace's equation](#)

Lecture 1 - Basics - Definition of Energy and Power of Signals

Lecture 2 - Frequency Domain Representation and Introduction to Discrete Fourier Series

Lecture 3 - Discrete Fourier Series Example and Parseval's Theorem for Periodic Signals

Lecture 4 - Fourier Transform (FT), Inverse Fourier Transform (IFT) of Continuous Signals, Example of FT of Pulse and Sinc Function

Lecture 5 - Modulation Property of Fourier Transform, Dirac Delta or Unit Impulse Function - Definition and Fourier Transform

Lecture 6 - Duality Property of Fourier Transform and Introduction to Linear Time Invariant (LTI) Systems

Lecture 7 - Transmission of Signal through Linear Time Invariant (LTI) Systems and Cross- Correlation of Signals

Lecture 8 - Auto-Correlation of Signal and Energy Spectral Density (ESD)

Lecture 9 - Example for Auto-Correlation of Signal and Energy Spectral Density (ESD)

Lecture 10 - Introduction to Amplitude Modulation (AM), Modulation Index, Envelope Distortion and Over Modulation

Lecture 11 - Spectrum of Amplitude Modulated(AM) Signals and Introduction to Envelope Detection

Lecture 12 - Envelope Detection for Amplitude Modulated (AM) Signals and Time Constant for Capacitor in Envelope Detector

Lecture 13 - Power of Amplitude Modulated (AM) Signals and Power Efficiency of AM Signals

Lecture 14 - Double Sideband (DSB) Suppressed Carrier (SC) Modulation, Spectrum of DSB-SC Signals and Coherent Demodulation

Lecture 15 - Double Sideband(DSB) Suppressed Carrier (SC) Demodulation, Non-coherent demodulation, Impact of Carrier Phase Offset

Lecture 16 - Carrier Phase Offset Example for Double Sideband (DSB) Suppressed Carrier (SC) Demodulation- Wireless Cellular Communication with User Mobility

Lecture 17 - Phase Synchronization using Costas Receiver for Double Sideband (DSB) Suppressed Carrier (SC) Demodulation

Lecture 18 - Introduction to Quadrature Carrier Multiplexing (QCM) and Demodulation of QCM Signals.

Lecture 19 - Introduction to Single Sideband (SSB) Modulation

Lecture 20 - Generation of Single Sideband (SSB) Modulation Signals through Frequency Discrimination

Lecture 21 - Frequency Domain Description of Hilbert Transform \hat{A} - Fourier Spectrum of the Hilbert Transformer

Lecture 22 - Time Domain Description of Hilbert Transform \hat{A} - Impulse Response of the Hilbert Transformer

Lecture 23 - Phase Shifting Method for Generation of Single Sideband (SSB) Modulated Signals based on Hilbert Transform

Lecture 24 - Complex Pre-Envelope and Complex Envelope of Passband Signals

Lecture 25 - Complex Pre- Envelope and Complex Envelope of QCM (Quadrature Carrier Modulated) Signals

Lecture 26 - Introduction to Vestigial Side Band(VSB) Modulation and Non- Ideal Filtering, Spectral Efficiency

Lecture 27 - Properties of Vestigial Side Band Filter for Reconstruction of Message Signal without Distortion

Lecture 28 - Introduction to Angle Modulation, Description of Phase Modulation (PM) and Frequency Modulation (FM)

Lecture 29 - Frequency Modulation (FM) with Sinusoidal Modulation Signal and Pictorial Examples, Insights of PM and FM signals

Lecture 30 - Indirect Method for Generation of FM Signals - Generation of Narrowband FM Signal

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- Lecture 31 - Indirect Method for Generation of FM Signals - Generation of Wideband FM Signal through Frequency Multiplication
- Lecture 32 - Spectrum of Frequency Modulated (FM) Signals
- Lecture 33 - Bandwidth of Frequency Modulated (FM) Signals - Carson's Rule
- Lecture 34 - Demodulation of Frequency Modulated (FM) Signals, Condition of Envelope Detection
- Lecture 35 - Analog to Digital Conversion of Signals and Introduction to Sampling
- Lecture 36 - Spectrum of Sampled Signal, Aliasing and Nyquist Sampling Theorem
- Lecture 37 - Ideal Impulse Train Sampling, Reconstruction of Original Signal from Samples, Sinc Interpolation
- Lecture 38 - Introduction to Pulse Amplitude Modulation (PAM), Sample and Hold, Flat Top Sampling
- Lecture 39 - Pulse Amplitude Modulation (PAM), Spectrum of PAM Signal, Reconstruction of Original Signal from PAM Signal, Equalization
- Lecture 40 - Introduction to Quantization, Uniform Quantizer, Mid-Tread Quantizer
- Lecture 41 - Quantization, Mid-Rise Quantizer, PDF and Power of Quantization Noise, Quantization Noise Power versus Quantizer Resolution
- Lecture 42 - Introduction to Lloyd-Max Quantization Algorithm, Optimal Quantizer Design
- Lecture 43 - Lloyd-Max Quantization Algorithm, Iterative Computation of Optimal Quantization Levels and Intervals
- Lecture 44 - Companding for Non-Uniform Quantization, Mu-law Compressor, A-law Compressor
- Lecture 45 - Introduction to Delta Modulation, One-bit Quantizer
- Lecture 46 - Signal Reconstruction in Delta Modulation, Schematic Diagrams, Slope Overload Distortion and Granular Noise
- Lecture 47 - Differential Pulse Coded Modulation (DPCM), DPCM Signal Reconstruction and Schematic Diagram
- Lecture 48 - Frequency Mixing and Translation in Communication Systems, Heterodyne and Super Heterodyne Receivers
- Lecture 49 - Frequency Translation and Super Heterodyne Receivers, Problem of Image Frequency
- Lecture 50 - Frequency Division Multiplexing (FDM), Carrier Spacing in FDM
- Lecture 51 - Time Division Multiplexing (TDM), Operation of TDM, Sample Spacing in TDM
- Lecture 52 - Bandwidth Requirements for Time Division Multiplexing (TDM), The T1 TDM System : A Case Study

Lecture 1 - Introduction to Error Control Coding - I

Lecture 2 - Introduction to Error Control Coding - II

Lecture 3 - Introduction to Error Control Coding - III

Lecture 4 - Introduction to Linear Block Codes, Generator Matrix and Parity Check Matrix

Lecture 5 - Syndrome, Error Correction and Error Detection

Lecture 6 - Problem Solving Session - I

Lecture 7 - Decoding of Linear Block Codes

Lecture 8 - Distance Properties of Linear Block Codes - I

Lecture 9 - Distance Properties of Linear Block Codes - II

Lecture 10 - Problem Solving Session - II

Lecture 11 - Some Simple Linear Block Codes - I

Lecture 12 - Some Simple Linear Block Codes - II: Reed Muller Codes

Lecture 13 - Bounds on the Size of a Code

Lecture 14 - Problem Solving Session - III

Lecture 15 - Introduction to Convolutional Codes - I: Encoding

Lecture 16 - Introduction to Convolutional Codes - II: State Diagram, Trellis Diagram

Lecture 17 - Convolutional Codes: Classification, Realization

Lecture 18 - Convolutional Codes:Distance Properties

Lecture 19 - Decoding of Convolutional Codes - I: Viterbi Algorithm

Lecture 20 - Decoding of Convolutional Codes - II: BCJR Algorithm

Lecture 21 - Problem solving session - IV

Lecture 22 - Problem solving session - V

Lecture 23 - Performance Bounds for Convolutional Codes

Lecture 24 - Low Density Parity Check Codes

Lecture 25 - Decoding of Low Density Parity Check Codes - I

Lecture 26 - Decoding of Low Density Parity Check Codes - II: Belief Propagation Algorithm

Lecture 27 - Turbo Codes

Lecture 28 - Turbo Decoding

Lecture 29 - Problem Solving Sessions - VI

Lecture 30 - Distance Properties of Turbo Codes

Lecture 31 - Convergence of Turbo Codes

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Lecture 2 - Spectrum of Transmitted Digital Communication Signal and Wide Sense Stationarity

Lecture 3 - Spectrum of Transmitted Digital Communication Signal, Autocorrelation Function and Power Spectral Density

Lecture 4 - Spectrum of Transmitted Digital Communication Signal, Relation to Energy Spectral Density and Introduction to AWGN Channel

Lecture 5 - Additive White Gaussian Noise (AWGN) Properties, Gaussian Noise and White Noise

Lecture 6 - Structure of Digital Communication Receiver, Receiver Filter and Signal-to-Noise Power Ratio (SNR)

Lecture 7 - Digital Communication Receiver, Noise Properties and Output Noise Power

Lecture 8 - Digital Communication Receiver, Optimal SNR and Matched Filter

Lecture 9 - Probability of Error in Digital Communication and Probability Density Functions of Output

Lecture 10 - Probability of Error in Digital Communication, Optimal Decision Rule and Gaussian Q function

Lecture 11 - Introduction to Binary Phase Shift Keying (BPSK) Modulation, Optimal Decision Rule and Probability of Bit-Error or Bit-Error Rate (BER)

Lecture 12 - Introduction to Amplitude Shift Keying (ASK) Modulation

Lecture 13 - Optimal Decision Rule for Amplitude Shift Keying (ASK), Bit Error Rate (BER) and Comparison with Binary Phase Shift Keying (BPSK) Modulation

Lecture 14 - Introduction to Signal Space Concept and Orthonormal Basis Signals

Lecture 15 - Introduction to Frequency Shift Keying (FSK)

Lecture 16 - Optimal Decision Rule for FSK, Bit Error Rate (BER) and Comparison with BPSK, ASK

Lecture 17 - Introduction to Quadrature Phase Shift Keying (QPSK)

Lecture 18 - Waveforms of Quadrature Phase Shift Keying (QPSK)

Lecture 19 - Matched Filtering, Bit Error Rate and Symbol Error Rate for Quadrature Phase Shift Keying (QPSK)

Lecture 20 - Introduction to M-ary PAM (Pulse Amplitude Modulation), Average Symbol Power and Decision rules

Lecture 21 - M-ary PAM (Pulse Amplitude Modulation) -Part-II, Optimal Decision Rule and Probability of Error

Lecture 22 - M-ary QAM (Quadrature Amplitude Modulation) Part-I, Introduction, Transmitted Waveform and Average Symbol Energy

Lecture 23 - M-ary QAM (Quadrature Amplitude Modulation) - Part-II, Optimal Decision Rule, Probability of Error and Constellation Diagram

Lecture 24 - M-ary PSK (Phase Shift Keying) Part-I, Introduction , Transmitted Waveform and Constellation Diagram

Lecture 25 - M-ary PSK (Phase Shift Keying) - Part-II, Optimal Decision Rule, Nearest Neighbor Criterion and Approximate Probability of Error

Lecture 26 - Introduction to Information Theory, Relevance of Information Theory and Characterization of Information

Lecture 27 - Definition of Entropy, Average of Information / Uncertainty of source and Properties of Entropy

Lecture 28 - Entropy Example- Binary Source Maximum and Minimum Entropy of Binary Source

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- Lecture 29 - Maximum Entropy of Source with M-ary Alphabet, Concave/Convex Functions and Jensens Inequality
- Lecture 30 - Joint Entropy , Definition of Joint Entropy of Two Sources and Simple Examples for Joint Entropy Computation
- Lecture 31 - Properties of Joint Entropy and Relation between Joint Entropy and Marginal Entropies
- Lecture 32 - Conditional Entropy, Example of Conditional Entropy and Properties of Conditional Entropy
- Lecture 33 - Mutual Information, Diagrammatic Representation and Properties of Mutual Information
- Lecture 34 - Simple Example of Mutual Information and Practical Example of Mutual Information-Binary Symmetric Channel
- Lecture 35 - Channel Capacity, Implications of Channel Capacity, Claude E. Shannon- Father of Information Theory and Example of Capacity of Binary Symmetric Channel
- Lecture 36 - Differential Entropy and Example for Uniform Probability Density function
- Lecture 37 - Differential Entropy of Gaussian Source and Insights
- Lecture 38 - Joint Conditional/ Differential Entropies and Mutual Information
- Lecture 39 - Capacity of Gaussian channel - Part I
- Lecture 40 - Capacity of Gaussian Channel - Part-II, Practical Implications and Maximum rate in bits/sec
- Lecture 41 - Introduction to Source Coding and Data Compression, Variable Length codes and Unique Decodability
- Lecture 42 - Uniquely Decodable Codes, Prefix-free code, Instantaneous Code and Average Code length
- Lecture 43 - Binary Tree Representation of Code, Example and Kraft Inequality
- Lecture 44 - Lower Bound on Average Code Length and Kullback-Leibler Divergence
- Lecture 45 - Optimal Code length, Constrained Optimization and Morse Code Example
- Lecture 46 - Approaching Lower Bound on Average code length and Block Coding
- Lecture 47 - Huffman Code, Algorithm, Example and Average Code Length
- Lecture 48 - Introduction to channel coding, Rate of Code, Repetition Code and Hamming Distance
- Lecture 49 - Introduction to Convolutional Codes, Binary Field Arithmetic and Linear Codes
- Lecture 50 - Example of Convolutional Code Output and Convolution Operation for Code generation
- Lecture 51 - Matrix Representation of Convolutional Codes, Generator Matrix, Transform Domain Representation and Shift Register Architecture
- Lecture 52 - State Diagram Representation of Convolutional Code, State transitions and Example of Code Generation using State transitions
- Lecture 53 - Trellis Representation of Convolutional Code and Valid Code Words
- Lecture 54 - Decoding of the Convolutional Code, Minimum Hamming distance and Maximum Likelihood Codeword Estimate
- Lecture 55 - Principle of Decoding of Convolutional code
- Lecture 56 - Viterbi Decoder for Maximum Likelihood Decoding of Convolutional Code Using Trellis Representation, Branch Metric Calculation, State Metric Calculation and Example

- Lecture 1 - Introduction to Applied Electromagnetics
- Lecture 2 - Introduction to Transmission lines
- Lecture 3 - Sinusoidal waves on Transmission lines
- Lecture 4 - Terminating T-lines: Reflection and Transmission coefficient
- Lecture 5 - Circuit parameters of a T-line
- Lecture 6 - Lossy Transmission lines and primary constants
- Lecture 7 - When to apply T-line Theory?
- Lecture 8 - Standing Waves on T-lines
- Lecture 9 - Lumped equivalent circuits of T-lines
- Lecture 10 - Impedance transformation and power flow on T-lines
- Lecture 11 - Graphical aid: Smith Chart Derivation
- Lecture 12 - Smith chart applications
- Lecture 13 - Further applications of Smith chart - Part 1
- Lecture 14 - Further applications of Smith chart - Part 2
- Lecture 15 - Impedance matching techniques - Part 1
- Lecture 16 - Impedance matching techniques - Part 2
- Lecture 17 - Impedance matching techniques - Part 3
- Lecture 18 - T-lines in time domain: Lattice diagrams
- Lecture 19 - Further examples of use of lattice diagrams
- Lecture 20 - High-speed digital signal propagation on T-lines
- Lecture 21 - Transient analysis with reactive termination and Time-domain reflectometry
- Lecture 22 - Fault detection using TDR
- Lecture 23 - Why Electromagnetics?
- Lecture 24 - Rectangular coordinate systems
- Lecture 25 - Cylindrical coordinate systems
- Lecture 26 - Review of vector fields and Gradient
- Lecture 27 - Divergence, Curl, and Laplacian operations
- Lecture 28 - Towards Maxwells equations - Part 1
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- Lecture 30 - Faradays law
- Lecture 31 - Completing Maxwells equations and Boundary conditions

- Lecture 32 - Boundary conditions for Electromagnetic fields
- Lecture 33 - Electrostatics-I: Laplace and Poissons equations
- Lecture 34 - Electrostatics-II: Solving Laplaces equation in 1D
- Lecture 35 - Electrostatics-III: Solving Laplaces equation in 2D
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- Lecture 37 - Magnetostatic fields-I: Biot-Savart Law
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- Lecture 39 - Inductance calculations
- Lecture 40 - From Maxwells equations to uniform plane waves
- Lecture 41 - Plane wave propagation in lossless dielectric media
- Lecture 42 - Polarization of plane waves
- Lecture 43 - Can an Ideal capacitor exist?
- Lecture 44 - Skin effect in conductors
- Lecture 45 - Skin effect in round wires
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- Lecture 48 - Application: Reflection from multiple media and anti-reflection coating.
- Lecture 49 - Oblique incidence of plane waves
- Lecture 50 - Total internal reflection
- Lecture 51 - Application: Matrix analysis of reflection from multiple boundaries
- Lecture 52 - Application: Fabry-Perot cavity and Multi-layer films
- Lecture 53 - Introduction to waveguides
- Lecture 54 - Rectangular waveguides
- Lecture 55 - Attenuation and Dispersion in rectangular waveguides
- Lecture 56 - Planar optical waveguides
- Lecture 57 - Application: Optical Fibers
- Lecture 58 - Application: WDM Optical Components
- Lecture 59 - Mach-Zehnder Modulator
- Lecture 60 - Wave Propagation in Anisotropic Medium
- Lecture 61 - Wave Propagation in Ferrites
- Lecture 62 - Magnetic Vector Potential - Part 1
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- Lecture 64 - Fields of a Dipole Antenna

[Lecture 65 - Antenna Parameters and Long wire Antenna](#)

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Lecture 1 - Principles of Signals and Systems- Introduction to Signals and Systems, Signal Classification - Continuous and Discrete Time Signals

Lecture 2 - Analog and Digital Signals

Lecture 3 - Energy and Power Signals

Lecture 4 - Real Exponential Signals

Lecture 5 - Memory/Memory-less and Causal/Non-Causal Systems

Lecture 6 - Properties of Linear Systems

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Lecture 8 - Example Problems - 2

Lecture 9 - Example Problems - 3

Lecture 10 - Properties and Analysis of LTI Systems - I

Lecture 11 - Properties and Analysis of LTI Systems - II

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Lecture 20 - Laplace Transform of LTI Systems

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Lecture 23 - Laplace Transform of RL, RC Circuit

Lecture 24 - Z-Transform

Lecture 25 - Z-Transform Properties - I

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Lecture 27 - Z-Transform of LTI Systems

Lecture 28 - Z-Transform Examples - I

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Lecture 31 - Z-Transform Examples - IV

Lecture 32 - Inverse Z-Transform

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Lecture 36 - Fourier Transform (FT) Introduction

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Lecture 39 - Fourier Transform - Parseval's Relation

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Lecture 47 - Fourier Analysis Examples - VI

Lecture 48 - Fourier Analysis Bode Plot - I

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Lecture 50 - Fourier Transform Examples: Filtering - Ideal Low Pass Filter

Lecture 51 - Fourier Transform Problems: Unit Step Response of RC Circuit, Sampling of Continuous Signal

Lecture 52 - Sampling: Spectrum of Sampled Signal, Nyquist Criterion

Lecture 53 - Sampling: Reconstruction from Sampled Signal

Lecture 54 - Fourier Analysis of Discrete Time Signals and Systems - Introduction

Lecture 55 - Fourier Analysis of Discrete Time Signals - Duality, Parseval's Theorem

Lecture 56 - Discrete Time Fourier Transform: Definition, Inverse DTFT, Convergence, Relation between DTFT and z-Transform, DTFT of Common Signals

Lecture 57 - Discrete Time Fourier Transform: Properties of DTFT - Linearity, Time Shifting, Frequency Shifting, Conjugation, Time-Reversal, Duality

Lecture 58 - Discrete Time Fourier Transform: Properties of DTFT - Differentiation in Frequency, Difference in Time, Convolution, Multiplication, Parseval's Relation

Lecture 59 - DTFT: Discrete Time LTI Systems - LTI Systems Characterized by Difference Equations

Lecture 60 - Discrete Fourier Transform - Definition, Inverse DFT, Relation between DFT and DFS, Relation between DFT and DTFT, Properties - Linearity, Time Shifting

Lecture 61 - Discrete Fourier Transform: Properties - Conjugation, Frequency Shift, Duality, Circular Convolution, Multiplication, Parseval's Relation, Example Problems for Fourier Analysis of Discrete Time Signals

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NPTEL : NOC:Applied Optimization for Wireless, Machine Learning, Big Data (Electrical Engineering)

Co-ordinators : Prof. Aditya K. Jagannatham

Lecture 1 - Vectors and Matrices - Linear Independence and Rank

Lecture 2 - Eigenvectors and Eigenvalues of Matrices and their Properties

Lecture 3 - Positive Semidefinite (PSD) and Positive Definite (PD) Matrices and their Properties

Lecture 4 - Inner Product Space and its Properties: Linearity, Symmetry and Positive Semi-definite

Lecture 5 - Inner Product Space and its Properties: Cauchy Schwarz Inequality

Lecture 6 - Properties of Norm, Gaussian Elimination and Echelon form of matrix

Lecture 7 - Gram Schmidt Orthogonalization Procedure

Lecture 8 - Null Space and Trace of Matrices

Lecture 9 - Eigenvalue Decomposition of Hermitian Matrices and Properties

Lecture 10 - Matrix Inversion Lemma (Woodbury identity)

Lecture 11 - Introduction to Convex Sets and Properties

Lecture 12 - Affine Set Examples and Application

Lecture 13 - Norm Ball and its Practical Applications

Lecture 14 - Ellipsoid and its Practical Applications

Lecture 15 - Norm Cone, Polyhedron and its Applications

Lecture 16 - Applications: Cooperative Cellular Transmission

Lecture 17 - Positive Semi Definite Cone And Positive Semi Definite (PSD) Matrices

Lecture 18 - Introduction to Affine functions and examples

Lecture 19 - norm balls and Matrix properties: Trace, Determinant

Lecture 20 - Inverse of a Positive Definite Matrix

Lecture 21 - Example Problems: Property of Norms, Problems on Convex Sets

Lecture 22 - Problems on Convex Sets (Continued...)

Lecture 23 - Introduction to Convex and Concave Functions

Lecture 24 - Properties of Convex Functions with examples

Lecture 25 - Test for Convexity: Positive Semidefinite Hessian Matrix

Lecture 26 - Application: MIMO Receiver Design as a Least Squares Problem

Lecture 27 - Jensen's Inequality and Practical Application

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Lecture 30 - Conjugate Function and Examples to prove Convexity of various Functions

Lecture 31 - Examples on Operations Preserving Convexity

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Lecture 32 - Examples on Test for Convexity, Quasi-Convexity

Lecture 33 - Examples on Convex Functions

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Lecture 35 - Practical Application: Maximal Ratio Combiner for Wireless Systems

Lecture 36 - Practical Application: Multi-antenna Beamforming with Interfering User

Lecture 37 - Practical Application: Zero-Forcing (ZF) Beamforming with Interfering User

Lecture 38 - Practical Application: Robust Beamforming With Channel Uncertainty for Wireless Systems

Lecture 39 - Practical Application: Robust Beamformer Design for Wireless Systems

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Lecture 42 - Geometric Intuition for Least Squares

Lecture 43 - Practical Application: Multi antenna channel estimation

Lecture 44 - Practical Application: Image deblurring

Lecture 45 - Least Norm Signal Estimation

Lecture 46 - Regularization: Least Squares + Least Norm

Lecture 47 - Convex Optimization Problem representation: Canonical form, Epigraph form

Lecture 48 - Linear Program Practical Application: Base Station Co-operation

Lecture 49 - Stochastic Linear Program, Gaussian Uncertainty

Lecture 50 - Practical Application: Multiple Input Multiple Output (MIMO) Beamforming

Lecture 51 - Practical Application: Multiple Input Multiple Output (MIMO) Beamformer Design

Lecture 52 - Practical Application: Co-operative Communication, Overview and various Protocols used

Lecture 53 - Practical Application: Probability of Error Computation for Co-operative Communication

Lecture 54 - Practical Application: Optimal power allocation factor determination for Co-operative Communication

Lecture 55 - Practical Application: Compressive Sensing

Lecture 56 - Practical Application

Lecture 57 - Practical Application- Orthogonal Matching Pursuit (OMP) algorithm for Compressive Sensing

Lecture 58 - Example Problem: Orthogonal Matching Pursuit (OMP) algorithm

Lecture 59 - Practical Application : L1 norm minimization and regularization approach for Compressive Sensing Optimization problem

Lecture 60 - Practical Application of Machine Learning and Artificial Intelligence: Linear Classification, Overview and Motivation

Lecture 61 - Practical Application: Linear Classifier (Support Vector Machine) Design

Lecture 62 - Practical Application: Approximate Classifier Design

Lecture 63 - Concept of Duality

Lecture 64 - Relation between optimal value of Primal and Dual Problems, concepts of Duality gap and Strong Duality

[Lecture 65 - Example problem on Strong Duality](#)

[Lecture 66 - Karush-Kuhn-Tucker \(KKT\) conditions](#)

[Lecture 67 - Application of KKT condition:Optimal MIMO power allocation \(Waterfilling\)](#)

[Lecture 68 - Optimal MIMO Power allocation \(Waterfilling\)-II](#)

[Lecture 69 - Example problem on Optimal MIMO Power allocation \(Waterfilling\)](#)

[Lecture 70 - Linear objective with box constraints, Linear Programming](#)

[Lecture 71 - Example Problems II](#)

[Lecture 72 - Examples on Quadratic Optimization](#)

[Lecture 73 - Examples on Duality: Dual Norm, Dual of Linear Program \(LP\)](#)

[Lecture 74 - Examples on Duality: Min-Max problem, Analytic Centering](#)

[Lecture 75 - Semi Definite Program \(SDP\) and its application:MIMO symbol vector decoding](#)

[Lecture 76 - Application:SDP for MIMO Maximum Likelihood \(ML\) Detection](#)

[Lecture 77 - Introduction to big Data: Online Recommender System \(Netflix\)](#)

[Lecture 78 - Matrix Completion Problem in Big Data: Netflix-I](#)

[Lecture 79 - Matrix Completion Problem in Big Data: Netflix-II](#)

- Lecture 1 - Overview of fiber-optic communication systems
- Lecture 2 - Review of Maxwell's equations
- Lecture 3 - Uniform plane waves (UWPs) in free-space
- Lecture 4 - Properties of UWPs (propagation constant, polarization, and Poynting vector)
- Lecture 5 - Boundary conditions and reflection from a PEC
- Lecture 6 - Obliquely incident waves-I (TE and TM waves, Snell's laws)
- Lecture 7 - Obliquely incident waves-II (Reflection and transmission coefficients, Brewster angle)
- Lecture 8 - Total internal reflection
- Lecture 9 - Ray theory of dielectric slab waveguides
- Lecture 10 - Transverse resonance condition for slab waveguides
- Lecture 11 - Introduction to optical fibers
- Lecture 12 - Ray theory of light propagation in optical fibers
- Lecture 13 - Concept of waveguide modes
- Lecture 14 - Systematic procedure to obtain modes of a waveguide
- Lecture 15 - Systematic analysis of parallel plate metallic waveguide
- Lecture 16 - Systematic analysis of dielectric slab waveguides
- Lecture 17 - Further discussion on slab waveguides
- Lecture 18 - Modal analysis of step index optical fiber
- Lecture 19 - Properties of modes of step-index optical fiber - I
- Lecture 20 - Properties of modes of step-index optical fiber - II
- Lecture 21 - Linearly polarized modes
- Lecture 22 - Attenuation and power loss in fibers
- Lecture 23 - Introduction to dispersion in fibers
- Lecture 24 - Mathematical modelling of dispersion: Transfer function approach
- Lecture 25 - Pulse propagation equation and its solution
- Lecture 26 - Pre-chirped pulses and Inter and Intra-modal dispersion in optical fibers
- Lecture 27 - Beam Propagation Method
- Lecture 28 - Polarization Effects on Pulse Propagation
- Lecture 29 - Modes in Optical Fibres and Pulse Propagation in Optical Fibres
- Lecture 30 - Graded Index Fibers
- Lecture 31 - Light Sources, Detectors and Amplifiers

- Lecture 32 - Basics of Lasers-I (Structure of Lasers, Process of Photon Emission)
- Lecture 33 - Basics of Lasers-II (Einstein's Theory of Radiation)
- Lecture 34 - Basics of Lasers-III (Population Inversion and Rate Equation for Lasers)
- Lecture 35 - Basic Properties of Semiconductor Laser-I (Energy Gap, Intrinsic and Extrinsic Semiconductors)
- Lecture 36 - Basic Properties of Semiconductor Laser-II (Fermi Level)
- Lecture 37 - Optical Properties of Semiconductors-I (Direct Bandgap and Indirect Bandgap, Density of States)
- Lecture 38 - Optical Properties of Semiconductors-II (Gain, Absorption, Recombination rate) Homojunction Lasers
- Lecture 39 - Double Heterostructure Lasers, Introduction to Quantum Well Lasers
- Lecture 40 - Semiconductor Optical Amplifier
- Lecture 41 - Erbium-doped fiber amplifier
- Lecture 42 - Photodetectors
- Lecture 43 - Noise in Photodetectors
- Lecture 44 - Introduction to WDM components
- Lecture 45 - Couplers, Circulators, FRM and Filters
- Lecture 46 - Filter, MUX/DEMUX, Diffraction grating (FBG and Long period grating)
- Lecture 47 - Optical Modulators-I (Current modulation)
- Lecture 48 - Optical Modulators-II (Electro-optic modulators)
- Lecture 49 - Review of Communication Concepts-I (Deterministic and Random Signals, Baseband and Passband Signals)
- Lecture 50 - Review of Communication Concepts-II (Signal and vectors, Signal energy, Orthonormal basis functions)
- Lecture 51 - Intensity modulation/ Direct Detection
- Lecture 52 - BER discussion for OOK systems
- Lecture 53 - Higher order modulation and Coherent Receiver
- Lecture 54 - Coherent receiver for BPSK systems and BER calculation
- Lecture 55 - Recovering Polarization
- Lecture 56 - DSP algorithms for Chromatic dispersion mitigation
- Lecture 57 - DSP algorithms for Carrier phase estimation - I
- Lecture 58 - DSP algorithms for Carrier phase estimation - II
- Lecture 59 - Nonlinear effects in fiber
- Lecture 60 - Four wave mixing, Loss measurement, Dispersion measurement
- Lecture 61 - Lab Demonstration (Laser diode characteristics, Loss measurement, Optical Intensity Modulation)

Lecture 1 - Introduction and Types of Transmission Lines

Lecture 2 - Distributed Circuit Model of Uniform Transmission Line

Lecture 3 - Voltage and Current Equation of the Transmission line

Lecture 4 - Sinusoidal Excitation of Transmission Line (Propagation constant, Characteristic Impedance)

Lecture 5 - Properties of Transmission Line (Reflection Coefficient, Input Impedance, Standing Wave Ratio)

Lecture 6 - Power Calculations and Introduction to Smith Chart

Lecture 7 - Smith Chart

Lecture 8 - Additional Applications of Smith Chart

Lecture 9 - Time domain Analysis of Transmission Line - I

Lecture 10 - Time domain Analysis of Transmission Line - II

Lecture 11 - Usage of Lattice Diagrams

Lecture 12 - TDR analysis of Transmission Lines

Lecture 13 - Introduction to Propagation of Electromagnetic Waves

Lecture 14 - Uniform Plane Waves - I

Lecture 15 - Uniform Plane Waves - II

Lecture 16 - Poynting Vector, Average Power, Polarization

Lecture 17 - Uniform Plane Waves in Lossy Medium

Lecture 18 - Normal Incidence of Plane Waves

Lecture 19 - Oblique Incidence of Plane Waves - I

Lecture 20 - Oblique Incidence of Plane Waves - II

Lecture 21 - Total Internal Reflection

Lecture 22 - Slab Waveguides

Lecture 23 - Optical Fibers

Lecture 24 - Parallel Plate Waveguides

Lecture 25 - Rectangular Waveguides

Lecture 26 - Modes of Rectangular Waveguides

Lecture 27 - Waveguides summary and Introduction to Radiation

Lecture 28 - Solution to Electric Scalar Potential and Magnetic Vector Potential Equations

Lecture 29 - Further discussion on Magnetic Vector Potential and Elementary Hertzian Dipole

Lecture 30 - Near field and Far-field Antenna and Properties of Antennas

Lecture 31 - Linear antenna - I

[Lecture 32 - Linear antenna - II and Properties of Transmitting and Receiving Antenna](#)

[Lecture 33 - Friis Transmission Formula](#)

[Lecture 34 - Antenna Array](#)

[Lecture 35 - Wireless Channel](#)

[Lecture 36 - Further discussion on Wireless Channel Modelling](#)

[Lecture 37 - Diffraction - I](#)

[Lecture 38 - Diffraction - II](#)

[Lecture 39 - Distribution of Laser Beam](#)

[Lecture 40 - Interference \(Double slit experiment, Fabry Perot Interferometer\)](#)

[Lecture 41 - Summary](#)

Lecture 1 - Basic Concepts

Lecture 2 - Sinusoids and Phasors

Lecture 3 - Circuit Elements - Part 1

Lecture 4 - Circuit Elements - Part 2

Lecture 5 - AC Power Analysis

Lecture 6 - RMS Voltage and Current

Lecture 7 - Topology

Lecture 8 - Star-Delta Transformation and Mesh Analysis

Lecture 9 - Mesh Analysis.

Lecture 10 - Nodal Analysis

Lecture 11 - Linearity Property and Superposition Theorem

Lecture 12 - Source Transformation

Lecture 13 - Duality

Lecture 14 - Thevenin's Theorem - 1

Lecture 15 - Thevenin's Theorem - 2

Lecture 16 - Norton's Theorem - 1

Lecture 17 - Norton's Theorem - 2

Lecture 18 - Maximum Power Transfer Theorem - 1

Lecture 19 - Maximum Power Transfer Theorem - 2

Lecture 20 - Reciprocity and Compensation Theorem

Lecture 21 - First Order RC Circuits

Lecture 22 - First Order RL Circuits

Lecture 23 - Singularity Functions

Lecture 24 - Step Response of RC and RL Circuits

Lecture 25 - Second Order Response

Lecture 26 - Step Response of Second Order Circuits-First Order and Second Order Circuits (Continued...)

Lecture 27 - Step Response of Parallel RLC Circuit-First Order and Second Order Circuits (Continued...)

Lecture 28 - Definition of the Laplace Transform

Lecture 29 - Properties of the Laplace Transform

Lecture 30 - Inverse Laplace Transform

Lecture 31 - Laplace Transform of Circuit Elements

[Lecture 32 - Transfer Function](#)

[Lecture 33 - Convolution Integral](#)

[Lecture 34 - Graphical Approach of Convolution Integral](#)

[Lecture 35 - Network Stability and Network Synthesis](#)

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[Lecture 40 - Interconnection of Networks](#)

[Lecture 41 - Nodal and Mesh Analysis](#)

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[Lecture 43 - Thevenin's, Norton's and, Maximum Power Transfer Theorem](#)

[Lecture 44 - Magnetically Coupled Circuits](#)

[Lecture 45 - Energy in Coupled Circuits and Ideal Transformer](#)

[Lecture 46 - Ideal Transformer and Introduction to Three-Phase Circuits](#)

[Lecture 47 - Balanced Three-Phase Connections](#)

[Lecture 48 - Balanced Wye-Delta and Delta-Delta Connections](#)

[Lecture 49 - Balanced Delta-Wye Connection and Power in Balanced Three-Phase System](#)

[Lecture 50 - Unbalanced Three-Phase System and Three-Phase Power Measurement](#)

[Lecture 51 - Introduction to Graphical Models](#)

[Lecture 52 - State Equations](#)

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[Lecture 54 - State Transition Matrix](#)

[Lecture 55 - State Variable Method to Circuit Analysis](#)

[Lecture 56 - Characteristic Equation, Eigenvalues, and Eigenvectors-State Variable Analysis \(Continued...\)](#)

[Lecture 57 - Modeling of Mechanical Systems](#)

[Lecture 58 - Modeling of The Rotational Motion of Mechanical Systems](#)

[Lecture 59 - Modeling of Electrical Systems](#)

[Lecture 60 - Solving Analogous Systems](#)

Lecture 1 - Introduction to Electric Drives

Lecture 2 - Dynamics of Electric Drives, Four Quadrant Operation, Equivalent Drive Parameters

Lecture 3 - Equivalent Drive Parameters, Friction Components, Nature of Load Torque

Lecture 4 - Steady State Stability, Load Equalization

Lecture 5 - Load Equalization, Characteristics of DC Motor

Lecture 6 - Speed Torque Characteristics of Separately Excited DC Motor and Series DC Motor

Lecture 7 - Field Control of Series Motor, Motoring and Braking of Separately Excited and Series DC motors

Lecture 8 - Speed Control of Separately Excited DC Motor Using Controlled Rectifiers

Lecture 9 - Analysis of Single Phase Full Controlled Converter-fed Separately Excited DC Motor

Lecture 10 - Speed Torque Characteristics of Full Controlled Converter-fed Separately Excited DC Motor, Analysis of Single Phase Half Controlled Converter-fed Separately Excited DC Motor

Lecture 11 - Analysis of Single Phase Half Controlled Converter-fed Separately Excited DC Motor.

Lecture 12 - Three Phase Full Controlled Converter-fed Separately Excited DC Motor, Multi-quadrant Operation of DC Motor

Lecture 13 - Dual Converter-fed DC Motor, Multi-quadrant Operation Using Field Current Reversal

Lecture 14 - DC Chopper-fed Separately Excited DC Motor for Motoring and Braking

Lecture 15 - Two-quadrant DC Chopper, Four-quadrant DC Chopper

Lecture 16 - Dynamic Braking of DC Motor by Chopper Controlled Resistor, Closed-loop Operation of DC Drives, Induction Motor Drives

Lecture 17 - Speed Torque Characteristics of Induction Motor, Operation of Induction Motor from Non-sinusoidal Supply

Lecture 18 - Operation of Induction Motor from Non-sinusoidal Supply

Lecture 19 - Stator Current of Induction Motor with Non-sinusoidal Supply, Operation of Induction Motor with Unbalanced Voltage Supply

Lecture 20 - Single Phasing of Induction Motor, Braking of Induction Motor

Lecture 21 - Dynamic braking of induction motor, AC dynamic braking, DC dynamic braking

Lecture 22 - Analysis of DC dynamic braking of induction motor

Lecture 23 - Self-excited dynamic braking of induction motor, Speed control of induction motor using stator voltage regulator, Variable voltage variable frequency control

Lecture 24 - Variable voltage variable frequency control of induction motor, Open loop V/F control

Lecture 25 - Slip speed control of induction motor, Constant Volt/Hz control with slip speed regulation

Lecture 26 - Closed-loop Volt/Hz control of induction motor with slip speed regulation, Multi-quadrant operation of induction motor drive

Lecture 27 - Current Source Inverter (CSI) fed induction motor drive

Lecture 28 - Closed-loop operation of current source inverter (CSI) fed induction motor drive, Control of slip ring induction motor - Static rotor resistance control

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Lecture 29 - Closed-loop operation of slip ring induction motor with static rotor resistance control, Slip power recovery in slip ring induction motor - Static Kramer drive

Lecture 30 - Static Kramer drive and its closed-loop control, Introduction to synchronous motor

Lecture 31 - Various types of synchronous motors, Equivalent circuit and phasor diagram of cylindrical synchronous motor, Speed-torque characteristics of cylindrical synchronous motor

Lecture 32 - Phasor diagram of salient pole synchronous motor, Expression of power and torque for a salient pole synchronous motor, Synchronous reluctance motor, Open-loop V/f control of synchronous motor

Lecture 33 - Open-loop V/f control, Torque-speed characteristics, Self controlled synchronous motor drive employing load commutated thyristor inverter

Lecture 34 - Detailed analysis of commutation of load commutated thyristor inverter, Derivation of overlap angle and margin angle, Closed-loop speed control scheme for load commutated inverter-fed synchronous motor drive

Lecture 35 - Low cost brushless DC motor (BLDCM), Trapezoidal permanent magnet AC motor

Lecture 36 - Trapezoidal permanent magnet AC motor, Derivation of power and torque, Closed-loop control of trapezoidal BLDC motor, Introduction to switched reluctance motor

Lecture 37 - Construction and operating principle of switched reluctance motor

Lecture 38 - Current/ voltage control for switched reluctance motor, operating modes of switched reluctance motor, Introduction to traction drives

Lecture 39 - Current collector for mainline trains, Nature of traction load, Duty cycle of traction drives

Lecture 40 - Duty cycle of traction drives, Distance between two stops, Calculation of total tractive effort and drive rating

Lecture 1 - Introduction: Fuzzy Sets, Logic and Systems and Applications

Lecture 2 - Introduction: Real Life Applications of Fuzzy Systems

Lecture 3 - Fuzzy Sets and Fuzzy Logic Toolbox in MATLAB - I

Lecture 4 - Fuzzy Sets and Fuzzy Logic Toolbox in MATLAB - II

Lecture 5 - Membership Functions - I

Lecture 6 - Membership Functions - II

Lecture 7 - Nomenclatures used in Fuzzy Set Theory - I

Lecture 8 - Nomenclatures used in Fuzzy Set Theory - II

Lecture 9 - Nomenclatures used in Fuzzy Set Theory - III

Lecture 10 - Set Theoretic Operations on Fuzzy Sets - I

Lecture 11 - Set Theoretic Operations on Fuzzy Sets - II

Lecture 12 - Properties of Fuzzy Sets - I

Lecture 13 - Properties of Fuzzy Sets - II

Lecture 14 - Properties of Fuzzy Sets - III

Lecture 15 - Properties of Fuzzy Sets - IV

Lecture 16 - Properties of Fuzzy Sets - V

Lecture 17 - Distance between Fuzzy Sets - I

Lecture 18 - Distance between Fuzzy Sets - II

Lecture 19 - Distance between Fuzzy Sets - III

Lecture 20 - Arithmetic Operations on Fuzzy Numbers - I

Lecture 21 - Arithmetic Operations on Fuzzy Numbers - II

Lecture 22 - Arithmetic Operations on Fuzzy Numbers - III

Lecture 23 - Complement of Fuzzy Sets

Lecture 24 - T-norm Operators

Lecture 25 - S-norm Operators

Lecture 26 - Parameterized T-Norm Operators

Lecture 27 - Parameterized S-Norm Operators

Lecture 28 - Fuzzy Relation - I

Lecture 29 - Fuzzy Relation - II

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Lecture 31 - Projection of Fuzzy Relation Set

[Lecture 32 - Cylindrical Extension of Fuzzy Set](#)

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[Lecture 38 - Fuzzy Tolerance and Equivalence Relations - I](#)

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[Lecture 41 - Linguistic Hedges](#)

[Lecture 42 - Linguistic Hedges and Negation/ Complement and Connectives](#)

[Lecture 43 - Concentration and Dilation and Composite Linguistic Term and Some Examples](#)

[Lecture 44 - Dilation and Composite Linguistic Term and Some Examples](#)

[Lecture 45 - Some Examples on Composite Linguistic Terms](#)

[Lecture 46 - Contrast Intensification of Fuzzy Sets](#)

[Lecture 47 - Orthogonality of Fuzzy Sets](#)

[Lecture 48 - Fuzzy Rules and Fuzzy Reasoning - I](#)

[Lecture 49 - Fuzzy Rules and Fuzzy Reasoning - II](#)

[Lecture 50 - Fuzzy Inference System](#)

[Lecture 51 - Mamdani Fuzzy Model - I](#)

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[Lecture 54 - Example on Mamdani Fuzzy Model for Single Antecedent with Three Rules](#)

[Lecture 55 - Example on Mamdani Fuzzy Model for Two Antecedents with Four Rules](#)

[Lecture 56 - Larsen Fuzzy Model - I](#)

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[Lecture 58 - Larsen Fuzzy Model - III](#)

[Lecture 59 - Tsukamoto Fuzzy Model](#)

[Lecture 60 - TSK Fuzzy Model](#)

Lecture 1 - Introduction to Peer to Peer Networks

Lecture 2 - Peer to Peer Network in Telephony:Voice over Internet Telephony (VoIP) and Distributed Hash Table (DHT)

Lecture 3 - Building DHT Networks

Lecture 4 - Logarithmic Partitioning of Node ID Space and Index Entry Authenticity

Lecture 5 - Implementation of Voice over Internet Telephony in P2P Way

Lecture 6 - Leaf Nodes, Core Nodes and Type of Messages in DHT Networks

Lecture 7 - Static and Dynamic Partitioning of Node ID Space: Fixed and Floating Partitioning

Lecture 8 - PASTRY Protocol: The Efficient Use of Internet Infrastructure

Lecture 9 - Understanding the PASTRY Protocol through Example

Lecture 10 - Kademia: A DHT Routing Protocol

Lecture 11 - Tapestry: An Evolution of Kademia

Lecture 12 - Understanding the Tapestry Protocol through Example

Lecture 13 - Multi-dimensional Distributed Hash Table: Mapping of Peers into Multidimensional Space

Lecture 14 - Multi-Layer DHT: A Design for Multiple Services

Lecture 15 - Keeping Pairs at Correct Root Nodes

Lecture 16 - Abrupt and Graceful Exit of Root Node: Maintaining Pairs Alive

Lecture 17 - Resilience of Pairs

Lecture 18 - A P2P Distributed File System

Lecture 19 - Storage Space Problem and Incentives to Share Storage

Lecture 20 - P2P Nodes Communications Challenges in Heterogeneous Network Environments

Lecture 21 - P2P Overlaid Multicast: Basic Design

Lecture 22 - P2P Overlaid Multicast: Alternate Design

Lecture 23 - A Design of P2P Email System

Lecture 24 - P2P Mailing List Services: A Basic Design

Lecture 25 - P2P Mailing List Services: An Alternate Design

Lecture 26 - P2P Web: A Basic Design

Lecture 27 - P2P Web Search Engine: A Basic Design

Lecture 28 - P2P Internet: On Being Anonymous

Lecture 29 - P2P in Blockchain

Lecture 30 - P2P Anonymous Communication

Lecture 31 - The Anonymous Communication on the Internet through TOR Network

[Lecture 32 - An Introduction To TOR Browser: The Anonymity Preserving Access of the Web Sites](#)

[Lecture 33 - Hidden Services on TOR Network](#)

[Lecture 34 - MOOC Wrap-Up : Summary of the Course](#)

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NPTEL : NOC:Applied Linear Algebra for Signal Processing, Data Analytics and Machine Learning (Electrical Engineering)

Co-ordinators : Prof. Aditya K. Jagannatham

- Lecture 1 - Vector Properties: Addition, Linear Combination, Inner Product, Orthogonality, Norm
- Lecture 2 - Vectors: Unit Norm Vector, Cauchy-Schwarz inequality, Radar Application
- Lecture 3 - Inner Product Application: Beamforming in Wireless Communication Systems
- Lecture 4 - Matrices, Definition, Addition and Multiplication of Matrices
- Lecture 5 - Matrix: Column Space, Linear Independence, Rank of Matrix, Gaussian Elimination
- Lecture 6 - Matrix: Determinant, Inverse Computation, Adjoint, Cofactor Concepts
- Lecture 7 - Applications of Matrices: Solution of System of Linear equations, MIMO Wireless Technology
- Lecture 8 - Applications of Matrices: Electric Circuits, Traffic flows
- Lecture 9 - Applications of Matrices: Graph Theory, Social Networks, Dominance Directed Graph, Influential Node
- Lecture 10 - Null Space of Matrix: Definition, Rank-Nullity Theorem, Application in Electric Circuits
- Lecture 11 - Gram-Schmidt Orthogonalization
- Lecture 12 - Gaussian Random Variable: Definition, Mean, Variance, Multivariate Gaussian, Covariance Matrix
- Lecture 13 - Linear Transformation of Gaussian Random Vectors
- Lecture 14 - Machine Learning Application: Gaussian Classification
- Lecture 15 - Eigenvalue: Definition, Characteristic Equation, Eigenvalue Decomposition
- Lecture 16 - Special Matrices: Rotation and Unitary Matrices, Application: Alamouti Code
- Lecture 17 - Positive Semi-definite (PSD) Matrices: Definition, Properties, Eigenvalue Decomposition
- Lecture 18 - Positive Semidefinite Matrix: Example and Illustration of Eigenvalue Decomposition
- Lecture 19 - Machine Learning Application: Principle Component Analysis (PCA)
- Lecture 20 - Computer Vision Application: Face Recognition, Eigenfaces
- Lecture 21 - Least Squares (LS) Solution, Pseudo-Inverse Concept
- Lecture 22 - Least Squares (LS) via Principle of Orthogonality, Projection Matrix, Properties
- Lecture 23 - Application: Pseudo-Inverse and MIMO Zero Forcing (ZF) Receiver
- Lecture 24 - Wireless Application: Multi-Antenna Channel Estimation
- Lecture 25 - Machine Learning Application: Linear Regression
- Lecture 26 - Computation Mathematics Application: Polynomial Fitting
- Lecture 27 - Least Norm Solution
- Lecture 28 - Wireless Application: Multi-user Beamforming
- Lecture 29 - Singular Value Decomposition (SVD): Definition, Properties, Example
- Lecture 30 - SVD Application in MIMO Wireless Technology: Spatial-Multiplexing and High Data Rates
- Lecture 31 - SVD for MIMO wireless optimization, water-filling algorithm, optimal power allocation

Lecture 32 - SVD application for Machine Learning: Principal component analysis (PCA)

Lecture 33 - Multiple signal classification (MUSIC) algorithm: system model

Lecture 34 - MUSIC algorithm for Direction of Arrival (DoA) estimation

Lecture 35 - Linear minimum mean square error (LMMSE) principle

Lecture 36 - LMMSE estimate and error covariance matrix

Lecture 37 - LMMSE estimation in linear systems

Lecture 38 - LMMSE application: Wireless channel estimation and example

Lecture 39 - Time-series prediction via auto-regressive (AR) model

Lecture 40 - Recommender system: design and rating prediction

Lecture 41 - Recommender system: Illustration via movie rating prediction example

Lecture 42 - Fast Fourier transform (FFT) and Inverse fast Fourier transform (IFFT)

Lecture 43 - IFFT/ FFT application in Orthogonal Frequency Division Multiplexing (OFDM) wireless technology

Lecture 44 - OFDM system: Circulant matrices and properties

Lecture 45 - OFDM system model: Transmitter and receiver processing

Lecture 46 - Single-carrier frequency division for multiple access (SC-FDMA) technology

Lecture 47 - Linear dynamical systems: definition and solution via matrix exponential

Lecture 48 - Linear dynamical systems: matrix exponential via SVD

Lecture 49 - Machine Learning application: Support Vector Machines (SVM)

Lecture 50 - Support Vector Machines (SVM): Problem formulation via maximum hyperplane separation

Lecture 51 - Sparse regression: problem formulation and relation to Compressive Sensing (CS)

Lecture 52 - Sparse regression: solution via the Orthogonal Matching Pursuit (OMP) algorithm

Lecture 53 - OMP Example for Sparse Regression

Lecture 54 - Machine Learning Application: Clustering

Lecture 55 - K-Means Clustering algorithm

Lecture 56 - Introduction to Stochastic Processes and Markov Chains

Lecture 57 - Discrete Time Markov Chains and Transition Probability Matrix

Lecture 58 - Discrete Time Markov Chain Examples

Lecture 59 - m-STEP Transition Probabilities for Discrete Time Markov Chains

Lecture 60 - Limiting Behavior of Discrete Time Markov Chains

Lecture 61 - Least Squares Revisited: Rank Deficient Matrix

Lecture 62 - Least Squares using SVD

Lecture 63 - Weighted Least Squares

Lecture 64 - Weighted Least Squares Example

[Lecture 65 - Woodbury Matrix Identity - Matrix Inversion Lemma](#)

[Lecture 66 - Woodbury Matrix Identity - Proof](#)

[Lecture 67 - Conditional Gaussian Density - Mean](#)

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[Lecture 69 - Scalar Linear Model for Gaussian Estimation](#)

[Lecture 70 - MMSE Estimate and Covariance for the Scalar Linear Model](#)

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NPTEL : NOC:Digital Switching (Electrical Engineering)

Co-ordinators : Prof. Yatindra N Singh

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Fundamentals of Electric Vehicles: Technology and Economics (Electrical Engineering)

Co-ordinators : Prof. Ashok Jhunjunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha, Prof. L Kannan

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- Lecture 32 - Forward and reverse biased PN junctions
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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Electric Vehicles and Renewable Energy (Electrical Engineering)

Co-ordinators : Prof. Ashok Jhunjunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha, Prof. L Kannan

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Lecture 2 - The drive Torque, Power, Speed and Energy

Lecture 3 - Energy Source

Lecture 4 - Vehicle Auxillary, Petrol pumps and Charging stations

Lecture 5 - Introduction to Electric Vehicles in India

Lecture 6 - Can India Drive its EV program Innovatively and Differently and scale

Lecture 7 - Battery Cost reduction strategy

Lecture 8 - A bit about Batteries, Charging and Swapping Infrastructure

Lecture 9 - Where will we get Lithium for batteries and EV Subsystems

Lecture 10 - Forces acting when a vehicle move

Lecture 11 - Aerodynamic drag, Rolling Resistance and Uphill Resistance

Lecture 12 - Power and torque to accelerate

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Lecture 23 - Why Lithium Ion Battery? - Part 1

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Lecture 25 - Batteries in Future

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NPTEL : Phase-locked loops (Electrical Engineering)

Co-ordinators : Dr. Saurabh Saxena

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Lecture 2 - Course Introduction and Motivation - Part II

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Lecture 8 - Type and Order of PLL

Lecture 9 - Small Signal Analysis of Type-I/II/III PLLs for Phase Step, Frequency Step and Frequency Ramp

Lecture 10 - Frequency Acquisition Range for PLLs

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NPTEL : NOC:DC Microgrid (Electrical Engineering)

Co-ordinators : Prof. Avik Bhattacharya

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Lecture 21 - Design Flow considerations; Beginning a circuit design with schematic work and component layout

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Lecture 23 - Review of CAD output files for PCB fabrication; Photo plotting and mask generation

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Lecture 26 - Photoresist and application methods; UV exposure and developing; Printing technologies for PWBs

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Lecture 29 - Video highlights on manufacturing; Solder mask for PWBs; Multilayer PWBs; Introduction to microvias

Lecture 30 - Microvia technology and Sequential build-up technology process flow for high-density interconnects

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Lecture 31 - Conventional Vs HDI technologies; Flexible circuits; Tutorial session

Lecture 32 - SMD benefits; Design issues; Introduction to soldering

Lecture 33 - Reflow and Wave Soldering methods to attach SMDs

Lecture 34 - Solders; Wetting of solders; Flux and its properties; Defects in wave soldering

Lecture 35 - Vapour phase soldering, BGA soldering and Desoldering/Repair; SMT failures

Lecture 36 - SMT failure library and Tin Whiskers

Lecture 37 - Tin-lead and lead-free solders; Phase diagrams; Thermal profiles for reflow soldering; Lead-free alloys

Lecture 38 - Lead-free solder considerations; Green electronics; RoHS compliance and e-waste recycling issues

Lecture 39 - Thermal Design considerations in systems packaging

Lecture 40 - Introduction to embedded passives; Need for embedded passives; Design Library; Embedded resistor processes

Lecture 41 - Embedded capacitors; Processes for embedding capacitors; Case study examples; Summary of materials in packaging

Lecture 42 - Chapter-wise summary

Lecture 1 - Course introduction and overview

Lecture 2 - Distributed generation technologies

Lecture 3 - Distributed storage technologies

Lecture 4 - Distribution system protection

Lecture 5 - Circuit breaker coordination

Lecture 6 - Symmetrical component analysis and sequence excitation

Lecture 7 - Modeling of distribution system components

Lecture 8 - Protection components

Lecture 9 - Impact of distributed generation of distribution protection

Lecture 10 - Consumption and distribution grounding

Lecture 11 - Islanding of distribution systems

Lecture 12 - Modeling of islanded distribution systems

Lecture 13 - Distribution system problems and examples

Lecture 14 - Distribution system problems and examples continued

Lecture 15 - Anti-islanding methods

Lecture 16 - Solid state circuit switching

Lecture 17 - Relaying for distributed generation

Lecture 18 - Feeder voltage regulation

Lecture 19 - Grounding, distribution protection coordination problems and examples

Lecture 20 - Ring and network distribution

Lecture 21 - Economic evaluation of DG systems

Lecture 22 - Design for effective initial cost

Lecture 23 - Single phase inverters

Lecture 24 - DC bus design in voltage source inverter

Lecture 25 - Electrolytic capacitor reliability and lifetime

Lecture 26 - Inverter switching and average model

Lecture 27 - Common mode and differential mode model of inverters

Lecture 28 - Two leg single phase inverter

Lecture 29 - Distribution system problems, and examples

Lecture 30 - DG evaluation problems and examples

Lecture 31 - Switch selection in two level voltage source inverters and loss evaluation

[Lecture 32 - Thermal model, management and cycling failure of IGBT modules](#)

[Lecture 33 - Semiconductor switch design reliability considerations](#)

[Lecture 34 - AC filters for grid connected inverters](#)

[Lecture 35 - AC inductor design and need for LCL filter](#)

[Lecture 36 - LCL filter design](#)

[Lecture 37 - Examples in power electronic design for DG systems](#)

[Lecture 38 - Examples in power electronic design for DG systems continued](#)

[Lecture 39 - Higher order passive damping design for LCL filters](#)

[Lecture 40 - Balance of hardware component for inverters in DG systems](#)

Lecture 1 - Electronic switches

Lecture 2 - DC - DC converters

Lecture 3 - DC - AC converters

Lecture 4 - Multilevel converters - I

Lecture 5 - Multilevel converters - II

Lecture 6 - Applications of voltage source converter - I

Lecture 7 - Applications of voltage source converter - II

Lecture 8 - Applications of voltage source converter - III

Lecture 9 - Purpose of PWM - I

Lecture 10 - Purpose of PWM - II

Lecture 11 - Low switching frequency PWM - I

Lecture 12 - Low switching frequency PWM - II

Lecture 13 - Selective harmonic elimination

Lecture 14 - Off-line optimized pulsewidth modulation

Lecture 15 - Sine-triangle pulsewidth modulation

Lecture 16 - Harmonic injection pulsewidth modulation

Lecture 17 - Bus-clamping pulsewidth modulation

Lecture 18 - Triangle-comparison based PWM for three-phase inverter

Lecture 19 - Concept of space vector

Lecture 20 - Conventional space vector PWM

Lecture 21 - Space vector based bus-clamping PWM

Lecture 22 - Space vector based advanced bus-clamping PWM

Lecture 23 - Harmonic analysis of PWM techniques

Lecture 24 - Analysis of RMS line current ripple using the notion of stator flux ripple

Lecture 25 - Evaluation of RMS line current ripple using the notion of stator flux ripple

Lecture 26 - Analysis and design of PWM techniques from line current ripple perspective

Lecture 27 - Instantaneous and average dc link current in a voltage source inverter

Lecture 28 - DC link current and DC capacitor current in a voltage source inverter

Lecture 29 - Analysis of torque ripple in induction motor drives - I

Lecture 30 - Analysis of torque ripple in induction motor drives - II

Lecture 31 - Evaluation of conduction loss in three-phase inverter

[Lecture 32 - Evaluation of switching loss in three-phase inverter](#)

[Lecture 33 - Design of PWM for reduced switching loss in three-phase inverter](#)

[Lecture 34 - Effect of dead-time on inverter output voltage for continuous PWM schemes](#)

[Lecture 35 - Effect of dead-time on inverter output voltage for bus-clamping PWM schemes](#)

[Lecture 36 - Analysis of overmodulation in sine-triangle PWM from space vector perspective](#)

[Lecture 37 - Overmodulation in space vector modulated inverter](#)

[Lecture 38 - PWM for three-level neutral-point-clamped inverter - I](#)

[Lecture 39 - PWM for three-level neutral-point-clamped inverter - II](#)

[Lecture 40 - PWM for three-level neutral-point-clamped inverter - III](#)

Lecture 1 - Introduction to DC-DC converter

Lecture 2 - Diode

Lecture 3 - Controlled Switches

Lecture 4 - Prior Art

Lecture 5 - Inductor

Lecture 6 - Transformer

Lecture 7 - Capacitor

Lecture 8 - Issues related to switches

Lecture 9 - Energy storage - Capacitor

Lecture 10 - Energy storage - Inductor

Lecture 11 - Primitive Converter

Lecture 12 - Non-Isolated converter - I

Lecture 13 - Non-Isolated converter - II

Lecture 14 - Isolated Converters - I

Lecture 15 - Isolated Converters - II

Lecture 16 - Conduction Mode

Lecture 17 - Problem set - I

Lecture 18 - Problem set - II

Lecture 19 - Modeling DC-DC converters

Lecture 20 - State space representation - I

Lecture 21 - State Space representation - II

Lecture 22 - Circuit Averaging - I

Lecture 23 - Circuit Averaging - II

Lecture 24 - State Space Model of Boost Converter

Lecture 25 - DC-DC converter controller

Lecture 26 - Controller Structure

Lecture 27 - PID Controller - I

Lecture 28 - PID Controller - II

Lecture 29 - PID Controller - III

Lecture 30 - Implementation of PID controller

Lecture 31 - Pulse Width Modulator

[Lecture 32 - Controller Design - I](#)

[Lecture 33 - Controller Design - II](#)

[Lecture 34 - Controllers and Sensing Circuit](#)

[Lecture 35 - Regulation of Multiple outputs - I](#)

[Lecture 36 - Regulation of Multiple outputs - II](#)

[Lecture 37 - Current Control](#)

[Lecture 38 - Unity Power Factor Converter](#)

[Lecture 39 - Magnetic Design](#)

[Lecture 40 - DC-DC Converter Design](#)

Lecture 1 - Basic Electrical Technology

Lecture 2 - Passive Components

Lecture 3 - Sources

Lecture 4 - Kirchoff's Law

Lecture 5 - Modelling of Circuit - Part 1

Lecture 6 - Modelling of Circuit - Part 2

Lecture 7 - Analysis Using MatLab

Lecture 8 - Sinusoidal steady state

Lecture 9 - Transfer Function and Pole Zero domain

Lecture 10 - Transfer function & pole zero

Lecture 11 - The Sinusoid

Lecture 12 - Phasor Analysis - Part 1

Lecture 13 - Phasor Analysis - Part 2

Lecture 14 - Power Factor

Lecture 15 - Power ports

Lecture 16 - Transformer Basics - Part 1

Lecture 17 - Transformer Basics - Part 2

Lecture 18 - Transformer Basics - Part 3

Lecture 19 - The Practical Transformer - Part 1

Lecture 20 - The Practical Transformer - Part 2

Lecture 21 - The Practical Transformer - Part 3

Lecture 22 - DC Machines - Part 1

Lecture 23 - DC Machines - Part 2

Lecture 24 - DC Generators - Part 1

Lecture 25 - DC Generators - Part 2

Lecture 26 - DC Motors - Part 1

Lecture 27 - DC Motors - Part 2

Lecture 28 - DC Motors - Part 3

Lecture 29 - Three Phase System - Part 1

Lecture 30 - Three Phase System - Part 2

Lecture 31 - Three Phase System - Part 3

[Lecture 32 - Three Phase System - Part 4](#)

[Lecture 33 - Three Phase Transformer - Part 1](#)

[Lecture 34 - Three Phase Transformer - Part 2](#)

[Lecture 35 - Induction Motor - Part 1](#)

[Lecture 36 - Induction Motor - Part 2](#)

[Lecture 37 - Induction Motor - Part 3](#)

[Lecture 38 - Induction Motor - Part 4](#)

[Lecture 39 - Synchronous Machine](#)

Lecture 1 - Electric Drive

Lecture 2 - Controlled Rectifier - Part-1

Lecture 3 - Controlled Rectifier - Part-2 (Three phase)

Lecture 4 - Controlled Rectifier - Part-3 (Three phase)

Lecture 5 - Controlled Rectifier - Part-4 (Three Phase)

Lecture 6 - Controlled Rectifier - Part-5 (Three Phase)

Lecture 7 - Power Electronics Improvements

Lecture 8 - Four Quadrant Dc to Dc Converter

Lecture 9 - Sine Triangle PWM Control of Converter

Lecture 10 - Front-end Ac-Dc Converter with harmonic control

Lecture 11 - Ac to Dc Converter Close Loop Control Schematic

Lecture 12 - Ac-Dc Converter Close loop Control Block Diagram

Lecture 13 - Design of the Converter Controller & AC to DC

Lecture 14 - Front-End Ac to Dc Converter-Design

Lecture 15 - Front-End Ac to Dc Converter - Simulation study

Lecture 16 - Dc Motor Speed Control - Introduction

Lecture 17 - Dc Motor Speed Control - Block Diagram

Lecture 18 - Dc Motor Speed Control Current Control & S C L

Lecture 19 - Dc-Motor Speed Control Controller Design - Part-1

Lecture 20 - Dc Motor Speed Control Controller Design - Part-2

Lecture 21 - Dc Motor Speed Control Controller Design - Part-3

Lecture 22 - Basics of DC to AC Converter - Part-1

Lecture 23 - Basics of DC to AC Converter - Part-2

Lecture 24 - Inverter Sine Triangle PWM

Lecture 25 - Inverter - Current Hysteresis Controlled PWM

Lecture 26 - C H controlled & Basics of space vector PWM

Lecture 27 - Space Vector PWM - Part-2

Lecture 28 - Space Vector PWM - Part-3

Lecture 29 - Space Vector PWM Signal Generation

Lecture 30 - Speed Control of Induction Motor - Part-1

Lecture 31 - Speed Control of Induction Motor - Part-2

[Lecture 32 - High dynamic performance of I M Drive](#)

[Lecture 33 - Dynamic Model of Induction Motor - Part-1](#)

[Lecture 34 - Dynamic Model of Induction Motor - Part-2](#)

[Lecture 35 - Vector Control of Induction Motor](#)

[Lecture 36 - Effect of Switching Time lag in Inverter](#)

[Lecture 37 - Power Switch Protection - Snubbers](#)

Lecture 1 - Introduction to IOTs - Part I

Lecture 2 - Introduction to IOTs - Part II

Lecture 3 - Introduction to IOTs - Examples

Lecture 4 - IOT applications - I

Lecture 5 - IOT applications - II

Lecture 6 - Power management in IOT device

Lecture 7 - Introduction to LDO

Lecture 8 - Design with an LDO

Lecture 9 - Introduction to switching regulators

Lecture 10 - Designing with LDO's, switching regulators and case studies - Part I

Lecture 11 - Designing with LDO's, switching regulators and case studies - Part II

Lecture 12 - Designing with LDO's, switching regulators and case studies - Part II

Lecture 13 - Designing with LDO's, switching regulators and case studies - Part IV

Lecture 14 - Power Conditioning with Energy Harvesters - I

Lecture 15 - Power Conditioning with Energy Harvesters - II

Lecture 16 - Power Conditioning with Energy Harvesters - III

Lecture 17 - Battery less power supply and battery life calculation for embedded devices - I

Lecture 18 - Battery less power supply and battery life calculation for embedded devices - II

Lecture 19 - Battery less power supply and battery life calculation for embedded devices - III

Lecture 20 - Introduction to MQTT

Lecture 21 - Quality of Service in MQTT

Lecture 22 - Standards and Security in MQTT

Lecture 23 - Introduction and Implementation of AMQP

Lecture 24 - Implementation of CoAP and MDNS

Lecture 25 - Basics of RFID

Lecture 26 - RFID protocol and applications

Lecture 27 - BLE Security

Lecture 28 - LPWAN technologies

Lecture 29 - Choice of Microcontrollers

Lecture 30 - Case Study 1 - Joule Jotter

Lecture 31 - Case Study 2 - Cloud Based Systems

Lecture 1 - Advantages of HVAC/DC Transmission, Introduction to Grid Management

Lecture 2 - Transmission system development, Important components of transmission system

Lecture 3 - Insulation coordination, over voltage in power systems

Lecture 4 - Design/selection of insulators, Importance of grading/cc rings

Lecture 5 - Non ceramic insulators performance-service experience

Lecture 6 - Failure of apparatus in the field, importance of reliability and testing

Lecture 7 - Pollution flashover phenomena, modeling etc

Lecture 8 - Planning of High Voltage laboratories

Lecture 9 - Importance of High Voltage testing and techniques employed

Lecture 10 - Basic philosophy of HV testing, tests for various HV apparatus

Lecture 11 - HV testing techniques for various apparatus

Lecture 12 - HV testing on Composite Insulators

Lecture 13 - Surface degradation studies on composite insulators

Lecture 14 - Surface morphological techniques for composite insulators

Lecture 15 - Conductors used for EHV/UHV transmission

Lecture 16 - Corona and interference on transmission lines

Lecture 17 - Introduction of HTLS conductors and their advantages

Lecture 18 - Mechanical considerations for HV conductors

Lecture 19 - Introduction to Towers and importance of foundations

Lecture 20 - Selection/Design of clearances for HV towers

Lecture 21 - Design Optimization for UHV towers

Lecture 22 - Introduction to 1100kV HVDC

Lecture 23 - Introduction to HV Substations

Lecture 24 - Types of Substations, comparison

Lecture 25 - Insulation coordination, Components in a typical substation

Lecture 26 - Preventive maintenance of Substation

Lecture 27 - Electric and magnetic fields, mitigations techniques

Lecture 28 - Importance of Grounding, reducing Earthing resistance

Lecture 29 - Introduction to the use of Fiber optic cables, OPGW

Lecture 30 - Introduction to communication and SCADA

Lecture 31 - Precautions and safety measures in substation

[Lecture 32 - Electrical hazards, minimum clearances in substation](#)

[Lecture 33 - Importance of Generation of HVDC in the laboratory](#)

[Lecture 34 - Importance of Generation of HVAC, Impulse Voltage and Currents in the laboratory](#)

[Lecture 35 - Measurements of High Voltages](#)

[Lecture 36 - Measurements of High Voltages \(Continued...\)](#)

[Lecture 37 - Introduction to digital recorders, measurement](#)

[Lecture 38 - Upgradation/uprating of transmission lines- advantages](#)

[Lecture 39 - Upgradation/uprating of transmission lines- advantages \(Continued...\)](#)

[Lecture 40 - Summary of the course](#)

- Lecture 1 - Introduction to signal processing
- Lecture 2 - Basics of signals and systems
- Lecture 3 - Linear time-invariant systems
- Lecture 4 - Modes in a linear system
- Lecture 5 - Introduction to state space representation
- Lecture 6 - State space representation
- Lecture 7 - Non-uniqueness of state space representation
- Lecture 8 - Introduction to vector space
- Lecture 9 - Linear independence and spanning set
- Lecture 10 - Unique representation theorem
- Lecture 11 - Basis and cardinality of basis
- Lecture 12 - Norms and inner product spaces
- Lecture 13 - Inner products and induced norm
- Lecture 14 - Cauchy Schwartz inequality
- Lecture 15 - Orthonormality
- Lecture 16 - Problem on sum of subspaces
- Lecture 17 - Linear independence of orthogonal vectors
- Lecture 18 - Hilbert space and linear transformation
- Lecture 19 - Gram Schmidt orthonormalization
- Lecture 20 - Linear approximation of signal space
- Lecture 21 - Gram Schmidt orthogonalization of signals
- Lecture 22 - Problem on orthogonal complement
- Lecture 23 - Problem on signal geometry (4-QAM)
- Lecture 24 - Basics of probability and random variables
- Lecture 25 - Mean and variance of a random variable
- Lecture 26 - Introduction to random process
- Lecture 27 - Statistical specification of random processes
- Lecture 28 - Stationarity of random processes
- Lecture 29 - Problem on mean and variance
- Lecture 30 - Problem on MAP Detection
- Lecture 31 - Fourier transform of dirac comb sequence

[Lecture 32 - Sampling theorem](#)

[Lecture 33 - Basics of multirate systems](#)

[Lecture 34 - Frequency representation of expanders and decimators](#)

[Lecture 35 - Decimation and interpolation filters](#)

[Lecture 36 - Fractional sampling rate alterations](#)

[Lecture 37 - Digital filter banks](#)

[Lecture 38 - DFT as filter bank](#)

[Lecture 39 - Noble Identities](#)

[Lecture 40 - Polyphase representation](#)

[Lecture 41 - Efficient architectures for interpolation and decimation filters](#)

[Lecture 42 - Problems on simplifying multirate systems using noble identities](#)

[Lecture 43 - Problem on designing synthesis bank filters](#)

[Lecture 44 - Efficient architecture for fractional decimator](#)

[Lecture 45 - Multistage filter design](#)

[Lecture 46 - Two-channel filter banks](#)

[Lecture 47 - Amplitude and phase distortion in signals](#)

[Lecture 48 - Polyphase representation of 2-channel filter banks, signal flow graphs and perfect reconstruction](#)

[Lecture 49 - M-channel filter banks](#)

[Lecture 50 - Polyphase representation of M-channel filter bank](#)

[Lecture 51 - Perfect reconstruction of signals](#)

[Lecture 52 - Nyquist and half band filters](#)

[Lecture 53 - Special filter banks for perfect reconstruction](#)

[Lecture 54 - Introduction to wavelets](#)

[Lecture 55 - Multiresolution analysis and properties](#)

[Lecture 56 - The Haar wavelet](#)

[Lecture 57 - Structure of subspaces in MRA](#)

[Lecture 58 - Haar decomposition - 1](#)

[Lecture 59 - Haar decomposition - 2](#)

[Lecture 60 - Wavelet Reconstruction](#)

[Lecture 61 - Haar wavelet and link to filter banks](#)

[Lecture 62 - Demo on wavelet decomposition](#)

[Lecture 63 - Problem on circular convolution](#)

[Lecture 64 - Time frequency localization](#)

[Lecture 65 - Basic analysis: Pointwise and uniform continuity of functions](#)

[Lecture 66 - Basic Analysis : Convergence of sequence of functions](#)

[Lecture 67 - Fourier series and notions of convergence](#)

[Lecture 68 - Convergence of Fourier series at a point of continuity](#)

[Lecture 69 - Convergence of Fourier series for piecewise differentiable periodic functions](#)

[Lecture 70 - Uniform convergence of Fourier series of piecewise smooth periodic function](#)

[Lecture 71 - Convergence in norm of Fourier series](#)

[Lecture 72 - Convergence of Fourier series for all square integrable periodic functions](#)

[Lecture 73 - Problem on limits of integration of periodic functions](#)

[Lecture 74 - Matrix Calculus](#)

[Lecture 75 - KL transform](#)

[Lecture 76 - Applications of KL transform](#)

[Lecture 77 - Demo on KL Transform](#)

[Lecture 78 - Live Session](#)

[Lecture 79 - Live Session 2](#)

Lecture 1 - Electronic Equipment Thermal issues

Lecture 2 - Practical Examples - 1

Lecture 3 - Practical Examples - 2

Lecture 4 - CEDT worked examples - 1

Lecture 5 - CEDT worked examples - 2

Lecture 6 - Text book theory

Lecture 7 - Sample heat sinks

Lecture 8 - Published correlations - 1

Lecture 9 - Published correlations - 2

Lecture 10 - Parallel combined effects

Lecture 11 - Mounting of packages

Lecture 12 - Combined Rth of devices

Lecture 13 - Schonholzer moduls

Lecture 14 - 1972 model paper

Lecture 15 - Jensen model

Lecture 16 - Thermal management - 1

Lecture 17 - Thermal management - 2

Lecture 18 - Round up of full model

Lecture 19 - Fan cooling

Lecture 20 - Thermo-electric cooling

Lecture 21 - On-the-net DIY work

Lecture 22 - Practical video

Lecture 23

Lecture 24

Lecture 25

Lecture 26

Lecture 27 - Real packages

Lecture 28 - Prior art

Lecture 29 - OTS standard profiles

Lecture 30 - CAD detailed design of profiles

Lecture 31 - Round up

[Lecture 32 - 4X Peltier Cooler](#)

[Lecture 33 - Manufacturing Video](#)

[Lecture 34 - Peltier heat sink](#)

- Lecture 1 - Introduction to Integrated Circuits (IC) Technology
- Lecture 2 - Introduction to fabrication of IC: Substrates
- Lecture 3 - Introduction to IC fabrication
- Lecture 4 - Introduction to IC fabrication (Continued...)
- Lecture 5 - Introduction to the fabrication of sensors
- Lecture 6 - Introduction to fabrication technology
- Lecture 7 - Introduction to fabrication technology (Continued...)
- Lecture 8 - Introduction to fabrication technology (Continued...)
- Lecture 9 - Introduction to fabrication technology (Continued...)
- Lecture 10 - Introduction to fabrication technology (Continued...)
- Lecture 11 - Process flow for Fabrication of MOSFETs
- Lecture 12 - Operation of Enhancement type MOSFET
- Lecture 13 - Operation of Depletion type MOSFET
- Lecture 14 - MOSFETs Characteristics and Applications (Current Mirrors)
- Lecture 15 - Introduction to Operational Amplifiers
- Lecture 16 - Operational Amplifier Characteristics
- Lecture 17 - Operational Amplifier Characteristics (Continued...)
- Lecture 18 - Characteristics of an op-amp (Continued...)
- Lecture 19 - Operational Amplifier Configurations
- Lecture 20 - Operational Amplifier Configurations (Continued...)
- Lecture 21 - Applications of Operational Amplifier: Differential Amplifier
- Lecture 22 - Applications of Operational Amplifier: Integerator
- Lecture 23 - Applications of Operational Amplifier: Differentiator
- Lecture 24 - Introduction to Passive and Active Filters and op-amp as Low Pass Filter
- Lecture 25 - Operational Amplifier as a High Pass Filter
- Lecture 26 - Operational Amplifier as a Band Pass and Band Reject Filter
- Lecture 27 - Introduction to Oscillator
- Lecture 28 - RC Phase Shift Oscillator using Op-amp
- Lecture 29 - Wein Bridge Oscillator using Op-amp
- Lecture 30 - Hartley and Colpitts Oscillator using Op-amp
- Lecture 31 - Working of Crystal Oscillators

- Lecture 32 - Construction and Operation of UJT Relaxation Oscillators
- Lecture 33 - Introduction to Noise and its Types
- Lecture 34 - Analysis of Data Sheets of an Op-Amp
- Lecture 35 - Analysis of Data Sheets of an Op-Amp (Continued...)
- Lecture 36 - Analysis of Data Sheets of an Op-Amp (Continued...)
- Lecture 37 - Experiment - Introduction to Laboratory Equipment
- Lecture 38 - Experiment - Measurement of Active and Passive elements using Multimeter
- Lecture 39 - Experiment - Working with Laboratory Equipment: Power Supply
- Lecture 40 - Experiment - Working with Laboratory Equipment: Function Generator, Oscilloscope
- Lecture 41 - Experiment - Op-Amp Characteristics: Input Bias Current
- Lecture 42 - Experiment - Op-Amp Characteristics: Input Offset Current
- Lecture 43 - Experiment - Op-Amp Characteristics: Input Offset Voltage
- Lecture 44 - Experiment - Op-Amp as Inverting Amplifier
- Lecture 45 - Experiment - Op-Amp as Non-Inverting Amplifier
- Lecture 46 - Experiment - To study input and output voltage range of an Op-Amp
- Lecture 47 - Experiment - Differential amplifier using op-amp
- Lecture 48 - Experiment - To study the gain of instrumentation amplifier
- Lecture 49 - Experiment - Summing amplifier using op-amp
- Lecture 50 - Experiment - To study op-amp based comparator
- Lecture 51 - Experiment - To study op-amp based integrator and differentiator
- Lecture 52 - Experiment - Study of passive low pass filter
- Lecture 53 - Experiment - Op-amp based active low pass filter
- Lecture 54 - Experiment - Passive and active high pass filter
- Lecture 55 - Experiment - Introduction to experimental set-up of band pass filter
- Lecture 56 - Experiment - Passive and active band pass filter
- Lecture 57 - Experiment - Introduction to experimental set-up for band reject filter
- Lecture 58 - Experiment - Active band reject filter
- Lecture 59 - Experiment - Peak detector circuit using Op-Amp

Lecture 1 - Quantum Mechanics: Concept of Wave Particle, Schrodinders Equation

Lecture 2 - Quantum Mechanics: Particle in a Box

Lecture 3 - Quantum Mechanics: Particle in a Box (Continued...), Harmonic Oscillator

Lecture 4 - Solids: Formation of Bands, Kronig-Penny Model

Lecture 5 - Solids: Kronig-Penny Model (Continued...)

Lecture 6 - Solids: Electrons and Holes

Lecture 7 - Solids: Electrons and Holes (Continued...)

Lecture 8 - Solids: Crystals

Lecture 9 - Density of States

Lecture 10 - Density of States (Continued...), Fermi Function

Lecture 11 - Fermi Function - Carrier Concentration

Lecture 12 - Doping

Lecture 13 - Doping (Continued...)

Lecture 14 - Recombination and Generation

Lecture 15 - Recombination and Generation (Continued...)

Lecture 16 - Recombination and Generation (Continued...), Charge Transport

Lecture 17 - Charge Transport (Continued...)

Lecture 18 - Continuity Equation

Lecture 19 - Junctions

Lecture 20 - Metal Semiconductor Junctions

Lecture 21 - Schottky Contact: Electrostatics

Lecture 22 - Schottky Contact: Current-Voltage (IV) Characteristics

Lecture 23 - Schottky Contact: IV Characteristics (Continued...)

Lecture 24 - Schottky Contact: Small Signal Impedance

Lecture 25 - PN Junctions: Electrostatics

Lecture 26 - PN Junctions: IV Characteristics

Lecture 27 - PN Junctions: Small Signal Impedance

Lecture 28 - PN Junctions: Non-Idealities

Lecture 29 - Bipolar Junction Transistors (BJT)

Lecture 30 - BJT: IV Characteristics

Lecture 31 - BJT: Non-Idealities and Equivalent Circuit Modeling

- Lecture 32 - Metal Oxide Semiconductor Capacitor (MOSCAP)
- Lecture 33 - MOSCAP (Continued...)
- Lecture 34 - MOSCAP: CV Characteristics
- Lecture 35 - MOSCAP: CV Characteristics (Continued...)
- Lecture 36 - MOSFET: Introduction
- Lecture 37 - MOSFET: I-V characteristics
- Lecture 38 - MOSFET: I-V characteristics (Continued...)
- Lecture 39 - MOSFET: I-V characteristics (Continued...)
- Lecture 40 - Subthreshold swing, Additional concepts
- Lecture 41 - Trapped charge, Body-bias
- Lecture 42 - Scaling of MOSFETs
- Lecture 43 - Scaling of MOSFETs (Continued...), Leakage currents in MOSFETs
- Lecture 44 - MOSFET characterization: Parameter extraction
- Lecture 45 - MOSFET characterization: Trapped charges, contact resistance
- Lecture 46 - MOSFET as a switch
- Lecture 47 - MOSFET as a switch (Continued...)
- Lecture 48 - Amplifiers using MOSFET
- Lecture 49 - Amplifiers using MOSFET (Continued...)
- Lecture 50 - Circuits: Frequency Response, Noise
- Lecture 51 - Introduction: Amorphous Semiconductors
- Lecture 52 - Thin Film Transistors
- Lecture 53 - Tutorials Session - 1
- Lecture 54 - Tutorials Session - 2
- Lecture 55 - Tutorials Session - 3

[Lecture 1 - Introduction to Microengineering Devices](#)

[Lecture 2 - Introduction to Microengineering Devices \(Continued...\)](#)

[Lecture 3 - Introduction to Microengineering Devices \(Continued...\)](#)

[Lecture 4 - Silicon, silicon di-oxide and photolithography](#)

[Lecture 5 - Silicon, silicon di-oxide and photolithography \(Continued...\)](#)

[Lecture 6 - Physical Vapour Deposition](#)

[Lecture 7 - Physical Vapour Deposition \(Continued...\)](#)

[Lecture 8 - Photolithography](#)

[Lecture 9 - Mask Aligner](#)

[Lecture 10 - Mask Aligner \(Continued...\)](#)

[Lecture 11 - Micromachining](#)

[Lecture 12 - Micromachining: Fabrication of VOC Sensor](#)

[Lecture 13 - Micromachining: Fabrication of VOC Sensor \(Continued...\)](#)

[Lecture 14 - Micromachining: Fabrication of VOC Sensor and Cantilever](#)

[Lecture 15 - Chemical Vapour Deposition](#)

[Lecture 16 - Typical Microfabricated Devices for Biomedical Applications](#)

[Lecture 17 - Cancer Diagnostic Tool](#)

[Lecture 18 - Process flow for Fabrication of Micro Heater](#)

[Lecture 19 - Process flow for Fabrication of Interdigitated Electrodes](#)

[Lecture 20 - Process flow for Fabrication of Interdigitated Electrodes \(Continued...\)](#)

[Lecture 21 - Process flow for Fabrication of ETM phenotyping](#)

[Lecture 22 - Process flow for Fabrication of Piezo canteliver](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27 - Microchip for Rapid Drug Screening](#)

[Lecture 28 - Microchip for Rapid Drug Screening \(Continued...\)](#)

[Lecture 29 - A Microfluidic chip for rapid bacterial antibiotic Susceptibility testing](#)

[Lecture 30 - Smart Catheter](#)

[Lecture 31 - Smart Catheter: Flexible Force Sensor](#)

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NPTEL : NOC:Electronics Equipment Integration and Prototype Building (Electrical Engineering)

Co-ordinators : Prof. N.V.Chalapathi Rao

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : Advanced VLSI Design (Electronics and Communication Engineering)

Co-ordinators : Prof. A.N. Chandorkar, Prof. D.K. Sharma, Prof. Sachin Patkar, Prof. Virendra Singh

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Co-ordinators : Dr. Debabrata Sikdar, Dr. Debabrata Sikdar

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- Lecture 8 - Reflection and refraction: Fresnel equations
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- Lecture 11 - 1D Photonic crystals
- Lecture 12 - Dispersion relation and photonic band structure
- Lecture 13 - Real and reciprocal lattices
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- Lecture 15 - Emerging Applications of Photonic Crystals
- Lecture 16 - Optical properties of metals
- Lecture 17 - Surface Plasmon Polaritons (SPP): Fundamentals
- Lecture 18 - Applications of SPPs
- Lecture 19 - Localized surface plasmon resonance (LSPR)
- Lecture 20 - Plasmonic nanoparticles: Antenna and Waveguides
- Lecture 21 - Applications of LSPR
- Lecture 22 - Fundamentals of metamaterials
- Lecture 23 - Effective medium theories
- Lecture 24 - Single and Double-Negative Metamaterials
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- Lecture 30 - Applications of metasurfaces and GMR devices
- Lecture 31 - Transformation Optics (TO) and Invisibility Cloaks

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Lecture 2 - Wireless Channel and Fading

Lecture 3 - Rayleigh Fading and BER of Wired Communication

Lecture 4 - BER for Wireless Communication

Lecture 5 - Introduction to Diversity

Lecture 6 - Multi-antenna Maximal Ratio Combiner

Lecture 7 - BER with Diversity

Lecture 8 - Spatial Diversity and Diversity Order

Lecture 9 - Wireless Channel and Delay Spread

Lecture 10 - Coherence Bandwidth of the Wireless Channel

Lecture 11 - ISI and Doppler in Wireless Communications

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Lecture 14 - Generation and Properties of PN Sequences

Lecture 15 - Correlation of PN Sequences and Jammer Margin

Lecture 16 - CDMA Advantages and RAKE Receiver

Lecture 17 - Multi-User CDMA Downlink Part I

Lecture 18 - Multi-User CDMA Downlink Part II

Lecture 19 - Multi-User CDMA Uplink and Asynchronous CDMA

Lecture 20 - CDMA Near-Far Problem and Introduction to MIMO

Lecture 21 - MIMO System Model and Zero-Forcing Receiver

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Lecture 23 - SVD Based Optimal MIMO Transmission and Capacity

Lecture 24 - SVD Based Optimal MIMO Transmission and Capacity

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Lecture 26 - V-BLAST (Continued) and MIMO Beamforming

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- Lecture 5 - Rayleigh Fading Channel
- Lecture 6 - Bit Error Rate (BER) Performance
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- Lecture 8 - Bit Error Rate of Rayleigh Fading Wireless Channel
- Lecture 9 - Exact BER Expression for Rayleigh Fading Wireless Channel
- Lecture 10 - Deep Fade Analysis of Wireless Communication
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- Lecture 18 - Intuition for Deep Fade in Multi-Antenna System
- Lecture 19 - Definition of Diversity Order
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- Lecture 24 - Mobility and Doppler Effect in Wireless Channels
- Lecture 25 - Impact of Doppler Effect on Wireless Channel
- Lecture 26 - Introduction to Code Division Multiple Access (CDMA)
- Lecture 27 - Chip Time and Bandwidth Expansion in CDMA
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- Lecture 35 - Examples of MIMO Systems
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- Lecture 39 - Alamouti Code and Space-Time Block Codes
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Lecture 2 - Axioms of Probability

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Lecture 4 - Independent Events - Mary-PAM Example

Lecture 5 - Independent Events - Block Transmission Example

Lecture 6 - Independent Events - Multiantenna Fading Example

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Lecture 8 - Maximum Aposteriori Probability (MAP) Receiver

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Lecture 11 - Mean, Variance of Random Variables

Lecture 12 - Application: Average Delay and RMS Delay Spread of Wireless Channel

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Lecture 14 - Gaussian Random Variable and Linear Transformation

Lecture 15 - Special Case: IID Gaussian Random Variables

Lecture 16 - Application: Array Processing and Array Gain with Uniform Linear Arrays

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Lecture 19 - Power Spectral Density (PSD) for WSS Random Process

Lecture 20 - PSD Application in Wireless Bandwidth Required for Signal Transmission

Lecture 21 - Transmission of WSS Random Process Through LTI System

Lecture 22 - Special Random Processes Gaussian Process and White Noise AWGN Communication Channel

Lecture 23 - Gaussian Process Through LTI System Example: WGN Through RC Low Pass Filter Not Started

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NPTEL : NOC:Estimation for Wireless Communications, MIMO, OFDM Cellular and Sensor Networks (Electronics and Communication Engineering)

Co-ordinators : Prof. Aditya K. Jagannatham

Lecture 1 - Basics - Sensor Network and Noisy Observation Model

Lecture 2 - Likelihood Function and Maximum Likelihood (ML) Estimate

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Lecture 4 - Properties of Maximum Likelihood (ML) Estimate \hat{A} – Variance and Spread Around Mean

Lecture 5 - Reliability of the Maximum Likelihood (ML) Estimate \hat{A} – Number of Samples Required

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Lecture 11 - Cramer Rao Bound (CRB) for Parameter Estimation

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Lecture 13 - Vector Parameter Estimation \hat{A} – System Model for Multi Antenna Downlink Channel Estimation

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Lecture 16 - Least Squares Solution Maximum Likelihood ML Estimate Pseudo Inverse

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Lecture 23 - Example of ISI Channel and Least Squares based Zero Forcing

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Lecture 7 - Convolutional Codes:Distance Properties

Lecture 8 - Decoding of Convolutional Codes - I: Viterbi Algorithm

Lecture 9 - Decoding of Convolutional Codes - II: BCJR Algorithm

Lecture 10 - Problem Solving Session - I

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Lecture 12 - Performance Bounds for Convolutional Codes

Lecture 13 - Turbo Codes

Lecture 14 - Turbo Decoding

Lecture 15 - Convergence of Turbo Codes

Lecture 16 - Applications of Convolutional Codes

Lecture 17 - Problem Solving Sessions - III

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Lecture 2 - Introduction to Error Control Coding - II

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Lecture 4 - Introduction to Linear Block Codes, Generator Matrix and Parity Check Matrix

Lecture 5 - Syndrome, Error Correction and Error Detection

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Lecture 7 - Decoding of Linear Block Codes

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Lecture 18 - Applications of Linear Block Codes

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- Lecture 2 - Optimal Bayesian Minimum Mean Squared Error (MMSE) Estimate
- Lecture 3 - Derivation of Minimum Mean Squared Error MMSE Estimate for Gaussian Parameter \hat{A} – Part I
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Lecture 2 - Electrical circuit elements: Voltage and current sources; R, C, L; Voltage sources in series; Example of superposition

Lecture 3 - Elements in series and parallel; Superposition in linear circuits

Lecture 4 - Controlled sources; Determining the characteristics of a two terminal element; Realizing a resistor using a VCCS or a CCVS

Lecture 5 - Nodal analysis of a network with conductances and current sources; Setting up the equations; Conductance matrix; Superposition

Lecture 6 - Circuit analysis; Number of KCL and KVL equations in a circuit; Nodal analysis of a network with conductances and current sources; Setting up the equations; Conductance matrix;

Lecture 7 - Nodal analysis with voltage sources and controlled sources; Brief introduction to modified nodal analysis; Use of supernode to solve circuits with voltage sources; Superposition theorem

Lecture 8 - Mesh analysis of a circuit with resistors and voltage sources; Comparison with nodal analysis; Mesh analysis of circuits with current sources-supermesh

Lecture 9 - Choice of nodal versus mesh analysis; Circuit theorems: Pushing a voltage source through a node, splitting a current source, substitution theorem, superposition

Lecture 10 - Thevenin and Norton (theorem and) equivalent circuits; Power conservation in a circuit

Lecture 11 - Tellegen's theorem; Reciprocity theorem

Lecture 12 - Compensation Theorem; Two ports

Lecture 13 - Two port parameters-y parameters

Lecture 14 - Two port parameters(z, h, and g); Reciprocal two ports

Lecture 15 - Opamp, ideal opamp circuits, non-inverting and inverting amplifiers; Ensuring that the opamp has negative feedback

Lecture 16 - RC circuit natural response; First order differential equation

Lecture 17 - RC (first-order) circuit, complete response with step inputs; Transient(natural) and steady state(forced) responses; Zero-state and zero-input responses

Lecture 18 - Step response of RC circuit with loops of voltage sources and capacitors; RL circuits; RLC circuits

Lecture 19 - Second order(RLC circuit) natural response; Series and parallel RLC circuits; Differential equation-characteristic equation and solutions; Forced response of a second order circuit

Lecture 20 - General formulation of second order(RLC circuit) natural response; Natural frequency and damping/quality factor; Series/parallel RLC circuits; R, L, C in sinusoidal steady state

Lecture 21 - Sinusoidal steady state response of RC and RLC circuits

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Lecture 3 - Voltage

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Lecture 6 - Kirchhoff's Voltage law (KVL)

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Lecture 11 - Inductor

Lecture 12 - Mutual Inductor

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Lecture 16 - Series connection of R, L, C, current source

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Lecture 26 - Scaling an element's value using controlled sources

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Lecture 28 - Solution to the assignment on units 3 and 4

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Lecture 30 - Power and energy in a resistor

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Lecture 2 - Embedded System Software and Hardware, stack implementation in ARM, Endianness, condition codes

Lecture 3 - Processor core VS CPU core, ARM7TDMI Interface signals, Memory Interface, Bus Cycle types, Register set, Operational Modes

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Lecture 5 - ARM 5 stage Pipeline, Pipeline Hazards, Data forwarding - a hardware solution

Lecture 6 - ARM ISA and Processor Variants, Different Types of Instructions, ARM Instruction set, data processing instructions

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Lecture 15 - Aborts, software Interrupt Instruction, undefined instruction exception

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Lecture 17 - Thumb state, Thumb Programmers model, Thumb Implementation, Thumb Applications

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Lecture 25 - Cache Memory, Mapping Functions

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Lecture 27 - Processes, Memory Map, Protected Systems, ARM systems with MPU, memory Protection Unit (MPU)

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NPTEL : Nanoelectronics: Devices and Materials (Electronics and Communication Engineering)

Co-ordinators : Dr. Navakanta Bhat, Prof. K.N. Bhat, Dr. S.A. Shivashankar

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Co-ordinators : Dr. R. Krishnakumar

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Lecture 4 - Senmon wa nan desu ka (What is your specialization?)

Lecture 5 - Kore wa hon desu (This is a book)

Lecture 6 - Ikura desu ka (How much is it?)

Lecture 7 - Ima nan-ji desu ka (What is the time now?)

Lecture 8 - Kaigi wa roku-ji-han kara desu (The meeting is from 6:30)

Lecture 9 - Ashita Tokyo e ikimasu. (I will go to Tokyo tomorrow)

Lecture 10 - Watashi wa mainichi roku-ji ni okimasu (I wake up at 6â€™oclock everyday)

Lecture 11 - Itsu Kanpur e kimashita ka (When did you come to Kanpur?)

Lecture 12 - Y?binkyoku wa asoko ni arimasu (The post office is over there)

Lecture 13 - Rao san wa doko ni imasu ka (Where is Mr. Rao?)

Lecture 14 - Pikuniku e ikimash? (Letâ€™s go for a picnic)

Lecture 15 - Kesa pan to tamago o tabemashita (I ate eggs and bread for breakfast)

Lecture 16 - Depa-to no tonari no biru wa gink? desu (The building next to the department store is the bank)

Lecture 17 - Taj hoteru wa ookii hoteru desu(Hotel Taj is a big hotel)

Lecture 18 - Hoteru de nani o tabemashita ka (What did you eat at the hotel?)

Lecture 19 - Tokyo wa ?kikute kirei desu (Tokyo is big and beautiful)

Lecture 20 - Ko-hi- wa oishiku arimasen(Coffee is not tasty)

Lecture 21 - Hantai kotoba (Opposites)

Lecture 22 - Watashi wa mainichi miruku o nomimasu (I drink milk everyday)

Lecture 23 - Watashi wa oniisan ni kamera o moratta(I received a camera from my brother)

Lecture 24 - Nani o tabetai desu ka(What do you want to eat?)

Lecture 25 - Nani o sashiagemasu ka (Giving and Receiving)

Lecture 26 - Sensei wa watashi ni hon o kuremashita (My teacher gave me a book)

Lecture 27 - Chotto matte kudasai (Just a minute please)

Lecture 28 - Ke-ki o tabete mite kudasai (Eat and see how is the cake)

Lecture 29 - Nani o shite imasu ka(What are you doing?)

Lecture 30 - Tokyo ni sunde imasu (I live in Tokyo)

Lecture 31 - Kanji ga kakemasu (I can write Kanji)

[Lecture 32 - Im?to wa ningy? o hoshigatte imasu \(My sister wants a doll\)](#)

[Lecture 33 - Aisukuri-mu ga ke-ki yori suki desu \(I like ice-cream more than cakes\)](#)

[Lecture 34 - Kutsu o kai ni ikimasu \(I am going to buy shoes\)](#)

[Lecture 35 - Ashita motto atsuku narimasu \(It is going to become very hot tomorrow\)](#)

[Lecture 36 - Rainen Tokyo e iku to omoimasu \(I think I will go to Tokyo next year\)](#)

[Lecture 37 - Pen de kaite mo ii desu ka\(Is it alright to write in pen?\)](#)

[Lecture 38 - Comprehensions and Expressions](#)

[Lecture 39 - Basic Kanji](#)

[Lecture 40 - Basic Kanji](#)

[Lecture 1 - Introduction](#)

[Lecture 2 - Pre Siddhantic Astronomy](#)

[Lecture 3 - Siddhantic Astronomy](#)

[Lecture 4 - Astronomy in Medieval India](#)

[Lecture 5 - Introduction to Telescopic Astronomy and Concluding remarks](#)

NPTEL : NOC:Stress Management (General)

Co-ordinators : Prof. Rajlakshmi Guha

- Lecture 1 - What is Stress
- Lecture 2 - Sources of stress
- Lecture 3 - Types of Stress
- Lecture 4 - Personality Factors and Stress
- Lecture 5 - Stress and the College Student
- Lecture 6 - Stress and Nervous System
- Lecture 7 - Hypothalamic-Pituitary-Adrenal (HPA) Axis
- Lecture 8 - Effect of Stress on Immune System
- Lecture 9 - Health Risk Associated with Chronic Stress
- Lecture 10 - Stress and Major Psychiatric Disorders
- Lecture 11 - Understanding your stress level
- Lecture 12 - Role of Personality Pattern, Self Esteem, Locus of Control
- Lecture 13 - Role of Thoughts Beliefs and Emotions - I
- Lecture 14 - Role of Thoughts Beliefs and Emotions - II
- Lecture 15 - Life Situation Intrapersonal : (Assertiveness, Time Management)
- Lecture 16 - Developing Cognitive Coping Skills
- Lecture 17 - Autogenic Training, Imagery and Progressive Relaxation
- Lecture 18 - Other Relaxation Techniques
- Lecture 19 - Exercise and Health
- Lecture 20 - DIY Strategies Stress Management

[Lecture 1 - Introduction to Need of 21st Century Education](#)

[Lecture 2 - Accreditation](#)

[Lecture 3 - Outcome based Learning](#)

[Lecture 4 - Approach to Design Outcome based Learning](#)

[Lecture 5 - Approach to Design Outcome based Learning \(Continued...\)](#)

[Lecture 6 - Instructional Design for Active Learning](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

NPTEL : Ayurvedic Inheritance of India (General)

Co-ordinators : Dr. M.S. Valiathan

Lecture 1 - Roots of Ayurveda

Lecture 2 - Traditional Medicine in Buddhist India

Lecture 3 - Period of Systematization

Lecture 4 - Philosophical ideas in Ayurveda

Lecture 5 - Human Body in Health

Lecture 6 - Human Body in Disease

Lecture 7 - Food and Drinks

Lecture 8 - Code for Healthy Living

Lecture 9 - Diseases

Lecture 10 - Diagnosis and Prognosis

Lecture 11 - Medical Treatment of Diseases

Lecture 12 - Materia Medica

Lecture 13 - Surgical Treatment of Diseases

Lecture 14 - Surgical Instruments

Lecture 15 - Treatment of fractures; some surgical procedures

Lecture 16 - Principles and methods of rejuvenation: enhancement of sexual potency and fertility

Lecture 17 - Selection of Students: Oath at initiation: Process of Training

Lecture 18 - A Science Initiative in Ayurveda (ASIIA)

Lecture 19 - Ayurvedic Biology: Illustrative Studies

Lecture 20 - Conclusion: An Ayurvedic View of Life

Co-ordinators : Dr. G. Phanikumar, Prof. C. Balaji, Dr. Arun K.Tangirala, Dr. Abhijit P. Deshpande, Prof. M.S. Ananth, Dr. Prathap Haridoss

Lecture 1 - Insight into research

Lecture 2 - Role of Guide and Student

Lecture 3 - Art of Re-Search

Lecture 4 - Persistent small steps towards success

Lecture 5 - Overview of research

Lecture 6 - Overview of Literature Survey

Lecture 7 - Literature Survey using Web of Science

Lecture 8 - Literature Survey using Scopus

Lecture 9 - Writing Up

Lecture 10 - Tutorial on using BibTeX with LaTeX to add references to a document

Lecture 11 - Tutorial on using Microsoft Word with Bibliographic Sources

Lecture 12 - Tutorial on using Microsoft Word with endnote entries

Lecture 13 - Experimental skills

Lecture 14 - Data analysis - Part 1

Lecture 15 - Data analysis - Part 2

Lecture 16 - Modelling skills - Part 1

Lecture 17 - Modelling skills - Part 2

Lecture 18 - Safety in laboratory

Lecture 19 - How to make Technical presentation

Lecture 20 - Technical Writing

Lecture 21 - Creativity in research - Part 1

Lecture 22 - Creativity in research - Part 2

Lecture 23 - Creativity in Research - Part 3

Lecture 24 - Group discussion on Ethics in Research

Lecture 25 - Intellectual property - Part 1

Lecture 26 - Intellectual property - Part 2

Lecture 27 - DOE Part 1

Lecture 28 - DOE part 2

Lecture 29 - DOE part 3

Lecture 30 - DOE part 4

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[Lecture 31 - DOE part 5](#)

[Lecture 32 - Research in Applied Mechanics](#)

[Lecture 33 - Research in Chemical Engineering](#)

[Lecture 34 - Research in Civil Engineering](#)

[Lecture 35 - Research in Computer Science and Engineering](#)

[Lecture 36 - Research in Engineering Design](#)

[Lecture 37 - Research in Humanities and Social Sciences](#)

[Lecture 38 - Research in Mechanical Engineering](#)

[Lecture 39 - Research in Metallurgical and Materials Engineering](#)

[Lecture 40 - Research in Ocean Engineering](#)

[Lecture 41 - Research in Management Studies](#)

[Lecture 42 - Research in Aerospace Engineering](#)

[Lecture 43 - Research in Biotechnology](#)

[Lecture 44 - Research in Chemistry](#)

[Lecture 45 - Research in Electrical Engineering](#)

[Lecture 46 - Research in Mathematics](#)

[Lecture 47 - Research in Physics](#)

[Lecture 48 - Discussion with Research Scholars](#)

Lecture 1 - Introduction

Lecture 2 - Origin of Life

Lecture 3 - Evolution

Lecture 4 - Cells

Lecture 5 - Biomolecules: Lipids

Lecture 6 - Biomolecules: Carbohydrates, Water

Lecture 7 - Biomolecules: Amino acids, Proteins

Lecture 8 - Biomolecules: Enzymes

Lecture 9 - Biomolecules: Nucleotides

Lecture 10 - Cell structure and function – Prokaryotes

Lecture 11 - Cell structure and function – Eukaryotes

Lecture 12 - Cell cycle

Lecture 13 - Cell division – mitosis

Lecture 14 - Cell division – meiosis

Lecture 15 - Culture growth

Lecture 16 - Mendelian genetics: Genetic disorders

Lecture 17 - Mendelian genetics: Mendelian inheritance principles

Lecture 18 - Mendelian genetics: Pedigree analysis

Lecture 19 - Mendelian genetics: Non-Mendelian inheritance

Lecture 20 - DNA replication

Lecture 21 - Transcription

Lecture 22 - Translation

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NPTEL : NOC:Digital and the Everyday - from Codes to Cloud (General)

Co-ordinators : Prof. Amit Prakash, Prof. Bidisha Chaudhuri

Lecture 1 - Introduction to the Course

Lecture 2 - Introduction to the Winter School

Lecture 3 - Socio-algorithmic processes and the Everyday - Part 1

Lecture 4 - Socio-algorithmic processes and the Everyday - Part 2

Lecture 5 - Socio-algorithmic processes and the Everyday - Part 3

Lecture 6 - Data Protection and Privacy Regulation in the Digital Era - Part 1

Lecture 7 - Data Protection and Privacy Regulation in the Digital Era - Part 2

Lecture 8 - Data Protection and Privacy Regulation in the Digital Era - Part 3

Lecture 9 - Data-driven Identities - Part 1

Lecture 10 - Data-driven Identities - Part 2

Lecture 11 - Data-driven Identities - Part 3

Lecture 12 - Promises and Challenges of e-Health - Part 1

Lecture 13 - Promises and Challenges of e-Health - Part 2

Lecture 14 - Promises and Challenges of e-Health - Part 3

Lecture 15 - Digital Finance - Part 1

Lecture 16 - Digital Finance - Part 2

Lecture 17 - Digital and our everyday interactions with the state - Part 1

Lecture 18 - Digital and our everyday interactions with the state - Part 2

Lecture 19 - Digital and our everyday interactions with the state - Part 3

Lecture 20 - Creating a Machine Zone through Affected Feedback: Leisure and Entertainment on Social Media - Part 1

Lecture 21 - Creating a Machine Zone through Affected Feedback: Leisure and Entertainment on Social Media - Part 2

Lecture 22 - Creating a Machine Zone through Affected Feedback: Leisure and Entertainment on Social Media - Part 3

- Lecture 1 - Introduction to the course
- Lecture 2 - An Inexperienced Engineering Teacher's View
- Lecture 3 - From traditional lecturing to helping students learn - 1
- Lecture 4 - From traditional lecturing to helping students learn - 2
- Lecture 5 - Better learning (Bloom's Taxonomy)
- Lecture 6 - Problem based learning (PBL) and Problem Solving - Part 1
- Lecture 7 - Problem based learning (PBL) and Problem Solving - Part 2
- Lecture 8 - Writing Learning Outcomes for a Course
- Lecture 9 - Active Learning
- Lecture 10 - Cooperative Group Learning
- Lecture 11 - Flipped Classroom
- Lecture 12 - Effective Laboratory Courses
- Lecture 13 - Assessment - Part 1
- Lecture 14 - Assessment - Part 2
- Lecture 15 - How can we use research in education? - Part A1
- Lecture 16 - How can we use research in education? - Part A2
- Lecture 17 - The Class, as a Whole - Part A3
- Lecture 18 - Psychological Type (Orientation) and Learning - Part B
- Lecture 19 - Cognitive Development Theories - Two Main Examples - Part C
- Lecture 20 - Learning Theories - Part D
- Lecture 21 - Feedback and Reflection - Part 1
- Lecture 22 - Feedback and Reflection - Part 2
- Lecture 23 - Feedback and Reflection - Part 3
- Lecture 24 - Live Session 1
- Lecture 25 - Live Session 2

Lecture 1 - Course mechanics

Lecture 2 - Goals and VR definitions

Lecture 3 - Historical perspective

Lecture 4 - Birds-eye view (general)

Lecture 5 - Birds-eye view (general) (Continued...)

Lecture 6 - Birds-eye view (hardware)

Lecture 7 - Birds-eye view (software)

Lecture 8 - Birds-eye view (sensation and perception)

Lecture 9 - Geometric modeling

Lecture 10 - Transforming models

Lecture 11 - Matrix algebra and 2D rotations

Lecture 12 - 3D rotations and yaw, pitch, and roll

Lecture 13 - 3D rotations and yaw, pitch, and roll (Continued...)

Lecture 14 - Axis-angle representations

Lecture 15 - Quaternions

Lecture 16 - Converting and multiplying rotations

Lecture 17 - Converting and multiplying rotations (Continued...)

Lecture 18 - Homogeneous transforms

Lecture 19 - The chain of viewing transforms

Lecture 20 - Eye transforms

Lecture 21 - Eye transforms (Continued...)

Lecture 22 - Canonical view transform

Lecture 23 - Viewport transform

Lecture 24 - Viewport transform (Continued...)

Lecture 25 - Three interpretations of light

Lecture 26 - Refraction

Lecture 27 - Simple lenses

Lecture 28 - Diopters

Lecture 29 - Imaging properties of lenses

Lecture 30 - Lens aberrations

Lecture 31 - Optical system of eyes

[Lecture 32 - Photoreceptors](#)

[Lecture 33 - Sufficient resolution for VR](#)

[Lecture 34 - Light intensity](#)

[Lecture 35 - Eye movements](#)

[Lecture 36 - Eye movements \(Continued...\)](#)

[Lecture 37 - Eye movement issues for VR](#)

[Lecture 38 - Neuroscience of vision](#)

[Lecture 39 - Three Psychophysical Laws](#)

[Lecture 40 - Sensation and Perception](#)

[Lecture 41 - Psychophysics of Visual Perception](#)

[Lecture 42 - Gamma Encoding](#)

[Lecture 43 - Limiting Resolution](#)

[Lecture 44 - Depth perception](#)

[Lecture 45 - Depth perception \(Continued...\)](#)

[Lecture 46 - Motion perception from Visual System](#)

[Lecture 47 - Frame rates and displays](#)

[Lecture 48 - Frame rates and displays \(Continued...\)](#)

[Lecture 49 - Psychophysics of Depth Perception](#)

[Lecture 50 - Overview](#)

[Lecture 51 - Orientation tracking](#)

[Lecture 52 - Tilt drift correction](#)

[Lecture 53 - Yaw drift correction](#)

[Lecture 54 - Tracking with a camera](#)

[Lecture 55 - Perspective n-point problem](#)

[Lecture 56 - Filtering](#)

[Lecture 57 - Lighthouse approach](#)

[Lecture 58 - Visual Rendering-Overview](#)

[Lecture 59 - Visual Rendering-overview \(Continued...\)](#)

[Lecture 60 - Shading models](#)

[Lecture 61 - Rasterization](#)

[Lecture 62 - Pixel shading](#)

[Lecture 63 - VR-specific problems](#)

[Lecture 64 - Distortion shading](#)

[Lecture 65 - Post-rendering image warp](#)

[Lecture 66 - Why Haptics?](#)

[Lecture 67 - What is Haptics?](#)

[Lecture 68 - Branches of Haptics](#)

[Lecture 69 - Human Haptics - Tactile System](#)

[Lecture 70 - Kinesthetic System](#)

[Lecture 71 - Motor System](#)

[Lecture 72 - Haptic Devices and Interfaces - Kinesthetic Devices](#)

[Lecture 73 - Haptic Devices and Interfaces - Tactile Devices](#)

[Lecture 74 - Physics and Physiology](#)

[Lecture 75 - Auditory perception](#)

[Lecture 76 - Auditory localization](#)

[Lecture 77 - Rendering](#)

[Lecture 78 - Spatialization and display](#)

[Lecture 79 - Combining other senses](#)

[Lecture 80 - Interfaces -overview](#)

[Lecture 81 - Evaluation of VR Systems](#)

[Lecture 82 - Social interaction](#)

[Lecture 83 - System control](#)

[Lecture 84 - Manipulation](#)

[Lecture 85 - Locomotion](#)

[Lecture 86 - Principles of Perception](#)

[Lecture 87 - Introduction to Kalman Filter](#)

[Lecture 88 - Introduction to Extended Kalman Filter](#)

[Lecture 89 - Grand Challenges in VR/AR](#)

[Lecture 90 - Ultimate VR/AR System](#)

- Lecture 1 - Renewable Energy Technologies
- Lecture 2 - Energy Usage by Humans - Estimate of Impact on Atmosphere
- Lecture 3 - Conventional Sources of Energy
- Lecture 4 - Non-Conventional Sources of Energy - An Overview
- Lecture 5 - Energy consumption
- Lecture 6 - Details of Energy usage in each sector
- Lecture 7 - Consequences of Energy consumption
- Lecture 8 - Solar Energy incident on Earth, Solar Spectrum
- Lecture 9 - The Solar Energy Budget
- Lecture 10 - Electromagnetic Radiation - The Solar Spectrum
- Lecture 11 - Solar flat plate collector
- Lecture 12 - Solar Radiator
- Lecture 13 - Solar Energy - The Semiconductor
- Lecture 14 - Solar energy - The p-n junction
- Lecture 15 - Solar Cell - Growing the single crystal and making the p-n junction
- Lecture 16 - Solar Energy - Interaction of p-n junction with radiation
- Lecture 17 - Solar Energy - Solar cell characteristics and usage
- Lecture 18 - Solar Energy - Solar cell construction
- Lecture 19 - Solar Energy - Solar Photocatalysis
- Lecture 20 - Wind Energy - Overview
- Lecture 21 - Wind Energy - Energy Considerations
- Lecture 22 - Wind Energy - Efficiency
- Lecture 23 - Wind Energy - Parts and Materials
- Lecture 24 - Wind Energy - Design Considerations
- Lecture 25 - Ocean Thermal Energy - Conversion (OTEC)
- Lecture 26 - Geothermal Energy
- Lecture 27 - Geothermal Energy Technological aspects
- Lecture 28 - Biomass Usage and Issues
- Lecture 29 - Battery Basics
- Lecture 30 - Battery Testing and Performance
- Lecture 31 - Lithium ion Batteries

[Lecture 32 - Common Battery Structures and Types](#)

[Lecture 33 - Types of Fuel Cells](#)

[Lecture 34 - Fuel Processing for PEM Fuel Cells](#)

[Lecture 35 - Fuel Cells : Concept to Product](#)

[Lecture 36 - Characterization of Electrochemical Devices](#)

[Lecture 37 - Fuel Cells : Parts and Assembly](#)

[Lecture 38 - Supercapacitors](#)

[Lecture 39 - Flywheels](#)

[Lecture 40 - Magnetohydrodynamic Power Generation](#)

NPTEL : NOC:Introduction to Remote Sensing (General)

Co-ordinators : Dr.Arun K.Saraf

Lecture 1 - What is satellite based remote sensing?

Lecture 2 - Development of remote sensing technology and advantages

Lecture 3 - Different platforms of remote sensing.

Lecture 4 - Electromagnetic Spectrum, solar reflection and thermal emission

Lecture 5 - Interaction of EM radiation with atmosphere including atmospheric scattering, absorption and emission

Lecture 6 - Interaction mechanism of EM radiation with ground and spectral response curve

Lecture 7 - Principles of image interpretation

Lecture 8 - Multi-spectral scanners and imaging devices

Lecture 9 - Salient characteristics of Landsat, IRS, Cartosat, Resourcesat sensors

Lecture 10 - Image characteristics and different resolutions in Remote Sensing

Lecture 11 - Image interpretation of different geological landforms, rock types and structures

Lecture 12 - Remote Sensing Integration with GIS and GPS

Lecture 13 - Geo-referencing Technique

Lecture 14 - Basic Image Enhancement Techniques

Lecture 15 - Spatial Filtering, Band ratio and Principal Component Analysis techniques

Lecture 16 - Image Classification Techniques

Lecture 17 - InSAR Techniques in its applications

Lecture 18 - Hyperspectral Remote Sensing

Lecture 19 - Integrated applications of RS and GIS in groundwater studies

Lecture 20 - Limitations of Remote Sensing Techniques

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NPTEL : Contemporary Issues in Philosophy of Mind and Cognition (Humanities and Social Sciences)

Co-ordinators : Dr. Rajakishore Nath, Dr. Ranjan K. Panda

Lecture 1 - Introduction

Lecture 2 - Transcendental Consciousness

Lecture 3 - Plato's Theory of Mind

Lecture 4 - Parable of Cave : Plato's

Lecture 5 - Aristotle's Concept Mind

Lecture 6 - The Concept of Mind in Upanishadas

Lecture 7 - Dualism - I

Lecture 8 - Dualism - II

Lecture 9 - Dualism - III

Lecture 10 - Against Dualism

Lecture 11 - Property Dualism

Lecture 12 - Varieties of Materialism

Lecture 13 - Mind-Body Identity Theory

Lecture 14 - Functionalism

Lecture 15 - Different Models of Cognitive Mind

Lecture 16 - Connectionism and Folk - Psychology

Lecture 17 - Representation - I

Lecture 18 - Representation - II

Lecture 19 - Artificial Intelligence - I

Lecture 20 - Artificial Intelligence - II

Lecture 21 - Artificial Intelligence - III

Lecture 22 - The Limit of Artificial Intelligence - I

Lecture 23 - The Limit of Artificial Intelligence - II

Lecture 24 - Biological Naturalism

Lecture 25 - The Concept of Intentionality

Lecture 26 - The Structure of Consciousness - I

Lecture 27 - The Structure of Consciousness - II

Lecture 28 - Phenomenal Consciousness - I

Lecture 29 - Phenomenal Consciousness - II

Lecture 30 - Language, Representation & Meaning - I

Lecture 31 - Language & Meaning - II

[Lecture 32 - Language & Mind](#)

[Lecture 33 - Language & World - I](#)

[Lecture 34 - Language & World - II](#)

[Lecture 35 - Emergentism & Supervenience](#)

[Lecture 36 - Reduction & Realization - I](#)

[Lecture 37 - Reduction & Realization - II](#)

[Lecture 38 - The Cartesian Mind Revisited](#)

[Lecture 39 - Personal Identity - I](#)

[Lecture 40 - Personal Identity - II](#)

[Lecture 41 - Creativity : Human Vs Machine - I](#)

[Lecture 42 - Creativity : Human Vs Machine - II](#)

- Lecture 1 - Overview
- Lecture 2 - In Conversation with Richard Schechner
- Lecture 3 - Multilingual Plurality: Our Environment - Part I
- Lecture 4 - Multilingual Plurality: Our Environment - Part II
- Lecture 5 - Interplay of Languages and Forms of Writing - Part I
- Lecture 6 - Interplay of Languages and Forms of Writing - Part II
- Lecture 7 - Creativity and Cultures
- Lecture 8 - Notion of Play and The Three Domain Activities
- Lecture 9 - Theory of Enjoyment: Critical Assessment
- Lecture 10 - Divergences and Convergences - Part I
- Lecture 11 - Divergences and Convergences - Part II
- Lecture 12 - Creative and Cultural Spaces for Students
- Lecture 13 - Being and Doing: Writing as Performance
- Lecture 14 - Writers and Writing: The Dialogic Process
- Lecture 15 - Creativity, Writing, Creative Writing: Recent Viewpoints
- Lecture 16 - Issues Related to the Teaching of Creative Writing
- Lecture 17 - Writers on Writing: Albert Camus
- Lecture 18 - Critical Reading of Great Writers: Albert Camus
- Lecture 19 - Critical Reading of Important Writers: Margaret Atwood
- Lecture 20 - Reading and Writing
- Lecture 21 - Indian Writing: Writers/Narrators
- Lecture 22 - Contemporary Indian Writers: The Search for Creativity - Part I
- Lecture 23 - Contemporary Indian Writers: The Search for Creativity - Part II
- Lecture 24 - Mosaic Patterns: Module 2
- Lecture 25 - Introduction to Drama
- Lecture 26 - Performance and Script Writing: Mime
- Lecture 27 - Western Classical Theory
- Lecture 28 - Student Response - I
- Lecture 29 - Indian Drama: Classical Theory and Practice
- Lecture 30 - Interacting Continuum: Classical, Folk and Modern Drama
- Lecture 31 - From The Perspective of Playwriting: Monologue

[Lecture 32 - From The Playwright's Perspective - Part I](#)

[Lecture 33 - From The Playwright's Perspective - Part II](#)

[Lecture 34 - From The Perspective of Playwriting: Anton Chekhov](#)

[Lecture 35 - Drama in the Classroom: Experience and Writing](#)

[Lecture 36 - Student Response - II](#)

[Lecture 37 - Performative Reading of the Cherry Orchard](#)

[Lecture 38 - Short Story as a Genre](#)

[Lecture 39 - Short Stories by Indian Women Writers](#)

[Lecture 40 - Modern Western Short Story](#)

[Lecture 41 - Varieties of Writing Processes](#)

- Lecture 1 - Energy Flow Diagram
- Lecture 2 - Global Trends in Energy Use
- Lecture 3 - Energy Use in India: Some Calculations
- Lecture 4 - Energy and Environment
- Lecture 5 - The Kaya Identity
- Lecture 6 - Emission Factor
- Lecture 7 - Energy and Quality of Life
- Lecture 8 - Energy Inequality
- Lecture 9 - Energy Security
- Lecture 10 - Introduction to Country Energy Balance assignment
- Lecture 11 - Energy balance of Japan
- Lecture 12 - Energy balance of Australia
- Lecture 13 - Energy balance of Mexico
- Lecture 14 - Energy Economics - Part 1
- Lecture 15 - Energy Economics - Part 2
- Lecture 16 - Energy Economics - Part 3
- Lecture 17 - Energy Economics - Tutorial
- Lecture 18 - Energy resources - Part 1
- Lecture 19 - Energy resources - Part 2
- Lecture 20 - Renewable Energy Sources - Part 1
- Lecture 21 - Renewable Energy Sources - Part 2
- Lecture 22 - Materials for Energy
- Lecture 23 - Non Renewable Resource Economics - Part 1
- Lecture 24 - Non Renewable Resource Economics - Part 2
- Lecture 25 - Non Renewable Resource Economics - Part 3
- Lecture 26 - Preferences and Utility
- Lecture 27 - Utility and Social Choice - Part 1
- Lecture 28 - Utility and Social Choice - Part 2
- Lecture 29 - Utility and Social Choice - Part 3
- Lecture 30 - Utility and Social Choice - Part 4
- Lecture 31 - Revision Paper-1 - Part 1

[Lecture 32 - Public and Private Good/Bads](#)

[Lecture 33 - Aggregation of Demand Curves](#)

[Lecture 34 - Externalities](#)

[Lecture 35 - Revision Paper-1 - Part 2](#)

[Lecture 36 - Revision paper-1 - Part 3](#)

[Lecture 37 - Energy Project Financing - Part 1](#)

[Lecture 38 - Energy Project Financing - Part 2](#)

[Lecture 39 - Energy Project Financing - Tutorial](#)

[Lecture 40 - Input Output Analysis - Part 1](#)

[Lecture 41 - Input Output Analysis - Part 2](#)

[Lecture 42 - Input Output Analysis - Part 3](#)

[Lecture 43 - Input Output Analysis - Tutorial](#)

[Lecture 44 - Primary Energy Analysis - Part 1](#)

[Lecture 45 - Primary Energy Analysis - Part 2](#)

[Lecture 46 - Net Energy Analysis - Part 1](#)

[Lecture 47 - Net Energy Analysis - Part 2](#)

[Lecture 48 - Net Energy Analysis - Part 3](#)

[Lecture 49 - Net Energy Analysis - Part 4](#)

[Lecture 50 - Energy Policy - Part 1](#)

[Lecture 51 - Energy Policy - Part 2](#)

[Lecture 52 - Energy Policy Examples - Part 1](#)

[Lecture 53 - Energy Policy Examples - Part 2](#)

[Lecture 54 - Revision Paper-2 - Part 1](#)

[Lecture 55 - Revision Paper-2 - Part 2](#)

[Lecture 56 - Future Energy Systems](#)

Lecture 1 - Aims and objectives of the course

Lecture 2 - Systemic and Textual approaches to study PĀṅīnīan grammar

Lecture 3 - PĀṅīnī and his linguistic background

Lecture 4 - Scholars and texts in the PĀṅīnīan grammatical tradition and their contribution

Lecture 5 - Non-PĀṅīnīan grammatical traditions

Lecture 6

Lecture 7

Lecture 8

Lecture 9

Lecture 10

Lecture 11

Lecture 12

Lecture 13

Lecture 14

Lecture 15

Lecture 16

Lecture 17

Lecture 18

Lecture 19

Lecture 20

Lecture 21

Lecture 22

Lecture 23

Lecture 24

Lecture 25

Lecture 26

Lecture 27

Lecture 28

Lecture 29

Lecture 30

Lecture 31

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

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[Lecture 36](#)

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[Lecture 41](#)

[Lecture 42](#)

[Lecture 43](#)

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[Lecture 48](#)

[Lecture 49](#)

[Lecture 50](#)

[Lecture 51](#)

[Lecture 52](#)

[Lecture 53](#)

[Lecture 54](#)

[Lecture 55](#)

[Lecture 56](#)

[Lecture 57](#)

[Lecture 58](#)

[Lecture 59](#)

[Lecture 60](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

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- Lecture 12 - Justice : A distributive concept
- Lecture 13 - Justice : Procedural and Substantive; Justice as fairness
- Lecture 14 - Justice : Capability approach; libertarian, communitarian conception of Justice
- Lecture 15 - Justice : Feminist conceptions of justice; Global justice
- Lecture 16 - Introduction to Power and authority
- Lecture 17 - Power, legitimacy and hegemony
- Lecture 18 - Power and knowledge; different conceptions of power
- Lecture 19 - Introduction and different conceptions of state and sovereignty
- Lecture 20 - Modern nation state; liberal, Marxist and feminist conceptions of state
- Lecture 21 - State and governmentality
- Lecture 22 - Introduction: Procedural and Substantive Democracy
- Lecture 23 - Various models of democracy
- Lecture 24 - Challenges and Limits of Democracy; Free press and Democracy
- Lecture 25 - Citizenship: Subject and Citizen
- Lecture 26 - T H Marshal and liberal conceptions of citizenship as legal and equal member
- Lecture 27 - Multiculturalism and Cosmopolitan Citizenship
- Lecture 28 - Introduction; Doom and Gloom; Democracy and environmental crisis
- Lecture 29 - Climate change and environmental justice
- Lecture 30 - Revisiting some key themes and concepts

Lecture 1 - Introduction to the Science of Human Behavior - I

Lecture 2 - Introduction to the Science of Human Behavior - II

Lecture 3 - Sensation - I

Lecture 4 - Sensation - II

Lecture 5 - Perception - I

Lecture 6 - Perception - II

Lecture 7 - Learning - I

Lecture 8 - Learning - II

Lecture 9 - Memory - I

Lecture 10 - Memory - II

Lecture 11 - Language - I

Lecture 12 - Language - II

Lecture 13 - Intelligence - I

Lecture 14 - Intelligence - II

Lecture 15 - Emotion - I

Lecture 16 - Emotion - II

Lecture 17 - Personality - I

Lecture 18 - Personality - II

Lecture 19 - Social Influence and Cognition - I

Lecture 20 - Social Influence and Cognition - II

Lecture 21 - Summary

Lecture 1 - Communication and Language - I

Lecture 2 - Communication and Language - II

Lecture 3 - Science of Language - I

Lecture 4 - Science of Language - II

Lecture 5 - Speech Perception - I

Lecture 6 - Speech Perception - II

Lecture 7 - Speech Production - I

Lecture 8 - Speech Production - II

Lecture 9 - Words - I

Lecture 10 - Words - II

Lecture 11 - Words - III

Lecture 12 - Sentences - I

Lecture 13 - Sentences - II

Lecture 14 - Discourse - I

Lecture 15 - Discourse - II

Lecture 16 - Reading and Writing - I

Lecture 17 - Reading and Writing - II

Lecture 18 - Bilingualism - I

Lecture 19 - Bilingualism - II

Lecture 20 - Overall Review

Lecture 1 - Reflections on Development Studies and Development Research

Lecture 2 - Types, Forms, and Processes of Development Studies Research

Lecture 3 - The Rigour in Development Studies Research

Lecture 4 - Paradigms of Development Research

Lecture 5 - Development Research-Development Work Continuum and Action Research in Development Studies

Lecture 6 - Ethics in Development Studies and Development Research

Lecture 7 - Literature Study

Lecture 9 - Introducing Qualitative Research Methods

Lecture 10 - Introducing Qualitative Research Methods (Continued...)

Lecture 11 - Interviews and Focus Group Discussions

Lecture 12 - Participatory Methods and Approaches

Lecture 13 - Conducting Case Studies and Maintaining Field Diaries

Lecture 14 - Introducing Quantitative Research Methods

Lecture 15 - An Overview of Mixed Methods Research

Lecture 16 - Field Surveys and Inventories

Lecture 17 - Logical Framwork and SWOT Analysis

Lecture 18 - The importance of Census and other Secondary Data in Development Studies

Lecture 19 - Communicating Research

Lecture 20 - Operationalizing Rights-based Approaches to Development

Lecture 21 - Poverty Measures and Analysis

Lecture 22 - Gender-sensitive Indicators and Gender Analysis

Lecture 23 - Social Capital Assessment Tools

Lecture 24 - Moitoring and Evaluation

Lecture 25 - A Final Note

Lecture 1 - Introduction and General Outline

Lecture 2 - Sources and Methodology to Study Indian Business History

Lecture 3 - East India Company's early ventures in India

Lecture 4 - Agency Houses: Jagat Seths and Early Banking operations

Lecture 5 - Emergence of Bombay and Cotton Trade, 1750-1850

Lecture 6 - Indian Business: Changes and Styles

Lecture 7 - Emergence of Calcutta: Impact on Industries

Lecture 8 - Swadeshi Movement: Impact on Indian Industries

Lecture 9 - Case Studies: Indian Business Houses: TATAs

Lecture 10 - Indian Economy and Business during WW I

Lecture 11 - Impact of the Second World War WW II

Lecture 12 - Political Economy of the Global wars for India; Case Study: Hindustan Aeronautics Limited (HAL)

Lecture 13 - Impact of Independence and Partition: Evolution of the Railways in India

Lecture 14 - Planning, Statistics and Industrialization Policies

Lecture 15 - Global Currents of economic Thought, 1947-1960

Lecture 16 - Industrial Licensing Policies, Institutions 1947-1964

Lecture 17 - Industrial Licensing Policies, 1966-1980

Lecture 18 - Case Study: Amul and Rural Cooperatives

Lecture 19 - Liberalisation of the Indian Economy, 1990s

Lecture 20 - Business Developments in India; India's Energy Diplomacy through ONGC

Lecture 21 - Indian Business History: Trends and Prospects

Lecture 22 - Learning Outcomes from Indian Business History

Lecture 1 - General Outline and Method

Lecture 2 - Method: Text and Context

Lecture 3 - Intro and Justice

Lecture 4 - State and Philosopher King

Lecture 5 - Communism of Wives and Property and Critical Assessment of his Thought

Lecture 6 - Intro and Ethics or Virtue

Lecture 7 - Politics and His Ideal State

Lecture 8 - Aristotle-III: Citizenship, Views on Revolution and Critical Assessment of his Thought

Lecture 9 - Machiavelli-I: Intro and Virtù and Fortuna

Lecture 10 - Machiavelli-II: Politics, Violence, and Religion

Lecture 11 - Machiavelli-III: Republicanism and Critical Assessment of his Thought

Lecture 12 - Intro and Human Nature

Lecture 13 - The Leviathan or Sovereign

Lecture 14 - Political Obligation and Critical Assessment of his Thought

Lecture 15 - Intro, State of Nature and Natural Rights

Lecture 16 - Limited Government

Lecture 17 - Right to Dissent and Critical Assessment of his Thought

Lecture 18 - Rousseau-I: Intro and Social Contract

Lecture 19 - Rousseau-II: General Will and Critical Assessment of his Thought

Lecture 20 - Kant-I: Intro and What is Enlightenment?

Lecture 21 - Kant-II: Morality, Autonomy and Freedom

Lecture 22 - Kant-III: Kingdom of Ends and Critical Assessment of his Thought

Lecture 23 - Hegel-I: Intro and Freedom

Lecture 24 - Hegel-II: Civil Society and State

Lecture 25 - Hegel-III: Rights and Critical Assessment of his Thought

Lecture 26 - Marx-I: Intro and Historical Materialism

Lecture 27 - Marx-II: State and Class

Lecture 28 - Marx-III: Views on Politics, Communism and Critical Assessment of his Thought

Lecture 29 - Mill-I: Intro, Utilitarianism and Subjection of Women

Lecture 30 - Mill-II: On Liberty, Representative Government and Critical Assessment of his Thought

Lecture 1 - The Nature of Stress - 1

Lecture 2 - The Nature of Stress - 2

Lecture 3 - The Biology of Stress

Lecture 4 - Stress, Health, and Non-infectious Diseases

Lecture 5 - Stress and Infectious Diseases

Lecture 6 - Stress and Psychological Disorders

Lecture 7 - Stress, Trauma and Posttraumatic growth - 1

Lecture 8 - Stress, Trauma and Posttraumatic growth - 2

Lecture 9 - Factors Influencing Stress Tolerance

Lecture 10 - Coping Strategies: Definition and Types

Lecture 11 - Unconscious mind and defensive coping

Lecture 12 - Characteristics of constructive coping; Physical ways of coping

Lecture 13 - Coping with relaxation exercises

Lecture 14 - Mental ways of coping

Lecture 15 - Coping with social support

Lecture 16 - Coping with meditation and mindfulness

Lecture 17 - Positive mental health and well-being

Lecture 18 - Well-being and resilience

Lecture 19 - What is happiness? What makes us happy?

Lecture 20 - Socio-demographic factors and happiness

Lecture 21 - Positive emotions

Lecture 22 - Genetic set point and hedonic adaptation

Lecture 23 - Sustainable happiness model

Lecture 24 - Sustainable happiness with intentional activities

Lecture 25 - Cultivating happiness with gratitude

Lecture 26 - Cultivating happiness with acts of kindness

Lecture 27 - Social comparison and happiness

Lecture 28 - Cultivating happiness with signature strengths 1 (VIA character strengths)

Lecture 29 - Cultivating happiness with signature strengths 2 (Gallup's/Clifton strength finder)

Lecture 30 - Cultivating happiness with Flow

Lecture 31 - Humanistic psychology and self-actualization

[Lecture 32 - Self-determination, motivation, and well-being](#)

[Lecture 33 - Meaning in life and well-being](#)

[Lecture 34 - Life goals and well-being](#)

Lecture 1 - Articulation of consonants - 1

Lecture 2 - Articulation of consonants - 2

Lecture 3 - Articulation of vowels

Lecture 4 - Language endangerment and linguistic diversity

Lecture 5 - Linguistic diversity - consonants in the languages of the world

Lecture 6 - Linguistic diversity - consonants and vowels in the languages of the world

Lecture 7 - Linguistic diversity - conclusion

Lecture 8 - Acoustic analysis: sound waves

Lecture 9 - Acoustic analysis: source filter theory and spectrograms

Lecture 10 - Acoustic analysis: vowels and formants

Lecture 11 - Acoustic analysis: formant calculation

Lecture 12 - Perceptual cues, variability in the speech signal, acoustic-phonetic invariance

Lecture 13 - Segmentation problem, categorical perception, cp in infants and animals

Lecture 14 - Measuring perceptual distinctiveness, multidimensional scaling, speech perception theories

Lecture 15 - development of the ideas of phonemes and features

Lecture 16 - phonemes as categories, phonemes in different languages, allophonic rules

Lecture 17 - problems in phonemic analysis, context and phonotactics

Lecture 18 - Psychological reality of phonemes

Lecture 19 - Distinctive features and natural classes

Lecture 20 - Phonological rule application

Lecture 21 - Distinctive features, feature economy and markedness

Lecture 22 - Morphophonological rules

Lecture 23 - Syllables

Lecture 24 - Stress

Lecture 25 - Phonetics and phonology of intonation, microprosody, stylization

Lecture 26 - Nuclear tone, pitch accent and boundary tones

Lecture 27 - Focus, givenness

Lecture 1 - Empiricism and Rationalism

Lecture 2 - Comte and Positivism; Epistemology and Ontology

Lecture 3 - The Rules of Sociological Method

Lecture 4 - Sociology of Knowledge

Lecture 5 - Religion and the Division of Labour in Society

Lecture 6 - Positivism and Neo-Kantianism

Lecture 7 - Methodology of the Social Sciences

Lecture 8 - Interpretive Sociology

Lecture 9 - Methodological Individualism and Interpretative Understanding of Social Action

Lecture 10 - Weberian Social Sciences: Methodological Implications

Lecture 11 - Materialist Conception of History

Lecture 12 - Dialectic

Lecture 13 - Nature, Ideology and Science

Lecture 14 - Systematic Falsification

Lecture 15 - Hypothetico - Deductive Model

Lecture 16 - The Structure of Scientific Revolutions

Lecture 17 - Popper Versus Kuhn

Lecture 18 - Positivism Versus Hermeneutics - I

Lecture 19 - Positivism Versus Hermeneutics - II

Lecture 20 - Philosophy of Social Sciences: Taking Stock

Lecture 21 - End of the Philosophy of the Social Sciences

Lecture 22 - Return of Grand Theory in the Human Sciences

Lecture 23 - An Overview of the Course

Lecture 1 - Sociology of development: An overview

Lecture 2 - Development historically

Lecture 3 - Decolonization, nationalism and development - I

Lecture 4 - Decolonization, nationalism and development - II

Lecture 5 - Decolonization, nationalism and development - III

Lecture 6 - Social evolution and social change

Lecture 7 - Social change and progress

Lecture 8 - Modernization Theory: An Overview

Lecture 9 - State and Class under Peripheral Capitalism

Lecture 10 - Critique of Samuel Huntington

Lecture 11 - Class, State and Revolution

Lecture 12 - The Empirical Peasantry and the Hypothetical Proletariat

Lecture 13 - Class and Classness: Substitutes and Realities

Lecture 14 - Modernization and Huntington's Argument

Lecture 15 - Huntington, Social Sciences and Ideology

Lecture 16 - The Ideological, Empirical and Methodological Critiques - I

Lecture 17 - The Ideological, Empirical and Methodological Critiques - II

Lecture 18 - Dependency Theory: Intellectual Antecedents

Lecture 19 - The Latin American Debates on Underdevelopment - I

Lecture 20 - The Latin American Debates on Underdevelopment - II

Lecture 21 - Dependency Theory in Transition - I

Lecture 22 - Dependency Theory in Transition - II

Lecture 23 - Critiques of Dependency Theory - I

Lecture 24 - Critiques of Dependency Theory - II

Lecture 25 - Limits to Growth - I

Lecture 26 - Limits to Growth - II

Lecture 27 - E. F. Schmacher's Small is Beautiful

Lecture 28 - Ivan Illich's Towards a History of Needs

Lecture 29 - Paradigms Lost, Paradigms Regained: Development studies in the 21st century - I

Lecture 30 - Paradigms Lost, Paradigms Regained: Development studies in the 21st century - II

- Lecture 1 - Development, Economic Growth and Sustainable Development
- Lecture 2 - Basic Ecosystem Ecology
- Lecture 3 - Environmentalism
- Lecture 4 - Environmental movement
- Lecture 5 - Environmentalism in the global south
- Lecture 6 - Ecofeminism
- Lecture 7 - Feminist political ecology
- Lecture 8 - Marx and ecology
- Lecture 9 - Deep ecology
- Lecture 10 - Gandhi and ecology
- Lecture 11 - Social ecology
- Lecture 12 - Religion, environment and historical roots of ecological crisis
- Lecture 13 - Biodiversity conservation ethics in Buddhism and Hinduism
- Lecture 14 - Christian religion in the age of ecological crisis
- Lecture 15 - Natural resource management
- Lecture 16 - Common property vs. private property
- Lecture 17 - Livelihoods, forests, and conservation
- Lecture 18 - Conservation-induced displacement
- Lecture 19 - Environment impact assessment and national rehabilitation and resettlement policy
- Lecture 20 - Dispossession and land acquisition
- Lecture 21 - Mining, development, and indigenous people
- Lecture 22 - Competing visions of development along the Narmada
- Lecture 23 - Dams, development, and resistance: Case studies
- Lecture 24 - Development theory and gendered approach to development
- Lecture 25 - Gender, environment and sustainable development
- Lecture 26 - Climate change interventions and policy framework
- Lecture 27 - Eastern Himalayas and climate change
- Lecture 28 - Ecological knowledge, biodiversity conservation and sustainability
- Lecture 29 - Traditional religion and conservation of nature in Northeast India: Case study
- Lecture 30 - Indigenous knowledge, environment and development
- Lecture 31 - Relevance of indigenous knowledge: Case study

- Lecture 1 - Introduction to Industrial Organization, Preferences
- Lecture 2 - Utility maximization and derivation of demand curve
- Lecture 3 - Examples of utility maximization, demand curve and market demand curve
- Lecture 4 - Tutorial Module 1
- Lecture 5 - Production Function
- Lecture 6 - Cost minimization problem
- Lecture 7 - Derivation of cost curves
- Lecture 8 - Tutorial on Production and cost curves
- Lecture 9 - Optimal output and supply curve of a firm
- Lecture 10 - Derivation of Market price in competitive market
- Lecture 11 - Long run market price and Pareto optimality
- Lecture 12 - Tutorial on Perfectly Competitive Market
- Lecture 13 - Monopoly price
- Lecture 14 - Price Discrimination - I
- Lecture 15 - Price Discrimination - II
- Lecture 16 - Tutorial on Monopoly
- Lecture 17 - Introduction to Game Theory, Iterated Elimination of Dominated Strategy
- Lecture 18 - Pure Strategy Nash Equilibrium
- Lecture 19 - Mixed Strategy Nash Equilibrium
- Lecture 20 - Existence of Nash Equilibrium in Games with 2 Players and 2 Strategies
- Lecture 21 - Tutorial on Normal Form Games
- Lecture 22 - Dynamic Games, Backward Induction
- Lecture 23 - Subgame Perfect Nash Equilibrium
- Lecture 24 - Tutorial on Dynamic Games
- Lecture 25 - Cournot Duopoly
- Lecture 26 - Cournot Oligopoly
- Lecture 27 - Tutorial on Cournot Competition
- Lecture 28 - Bertrand Competition with and without fixed cost
- Lecture 29 - Bertrand Competition with capacity constraint
- Lecture 30 - Bertrand Competition with capacity constraint
- Lecture 31 - Tutorial on Bertrand Competition

[Lecture 32 - Bertrand Competition with Decreasing returns to scale](#)

[Lecture 33 - Stackelberg Quantity Competition](#)

[Lecture 34 - Tutorial on Bertrand Competition and Stackelberg Quantity Competition](#)

[Lecture 35 - Stackelberg Price Competition](#)

[Lecture 36 - Simultaneous move Hotelling Model](#)

[Lecture 37 - Tutorial on Stackelberg Price Competition](#)

[Lecture 38 - Sequential Move Hotelling Model](#)

[Lecture 39 - Dixit's Model of Entry Deterrence](#)

[Lecture 40 - Tutorial on Sequential move Hotelling Model](#)

[Lecture 41 - Dixit's Model of Entry Deterrence](#)

[Lecture 42 - Bundling and Tying](#)

[Lecture 43 - Tutorial on Dixit's Model of Entry Deterrence](#)

Lecture 1 - Aim of the course, real numbers

Lecture 2 - Logic, proof

Lecture 3 - Definitions

Lecture 4 - Set operations

Lecture 5 - Definitions

Lecture 6 - Linear functions

Lecture 7 - Quadratic functions

Lecture 8 - Exponential functions, etc.

Lecture 9 - Differentiation: preliminaries

Lecture 10 - Rules of differentiation

Lecture 11 - Partial differentiation

Lecture 12 - Higher order differentiations

Lecture 13 - Approximations and elasticities

Lecture 14 - Differentiability, series, PDV

Lecture 15 - NPV, evaluation of investment projects

Lecture 16 - Exponential, logarithmic functions

Lecture 17 - Tutorials - 1a

Lecture 18 - Tutorials - 1b

Lecture 19 - Tutorials - 1c

Lecture 20 - Extreme, stationary points, first derivative test

Lecture 21 - Global and local extreme points

Lecture 22 - Second derivative test

Lecture 23 - Inflection points

Lecture 24 - Profit maximizations

Lecture 25 - Area under a curve, indefinite integral

Lecture 26 - Definite integral

Lecture 27 - Oil extraction, income distribution, PDV

Lecture 28 - Integration by parts, substitution, Lorenz curve

Lecture 29 - First order difference equations, solution

Lecture 30 - Dynamic stability, Cobweb model

Lecture 31 - Market model with inventory, Phase diagrams, Higher order equations

[Lecture 32 - Multiplier-acceleration model](#)

[Lecture 33 - Tutorials - 2a](#)

[Lecture 34 - Tutorials - 2b](#)

Lecture 1 - Nature of human thought - I

Lecture 2 - Brain and cognition, Seat of thought - II

Lecture 3 - Language, meaning, reality - III

Lecture 4 - Categorization

Lecture 5 - Categorization: (Continued...)

Lecture 6 - Frames: another way to understand categories

Lecture 7 - Metaphor

Lecture 8 - Metaphor and Metonymy

Lecture 9 - Image schema

Lecture 10 - Image schema (Continued...)

Lecture 11 - Language acquisition

Lecture 12 - Language acquisition (Continued...)

Lecture 13 - Language in the brain

Lecture 14 - Language in the brain (Continued...)

Lecture 15 - Language and attention

Lecture 16 - Language and visual attention

Lecture 17 - Attention in Sentence processing

Lecture 18 - Executive control/function and its facets

Lecture 19 - Role of executive function in language processing

Lecture 20 - Mental simulation and its relation with language; summary of the course

Lecture 1 - Becoming and being bilingual

Lecture 2 - Attitude, Acculturation and Bilingualism

Lecture 3 - Who is a Bilingual ?

Lecture 4 - Bilingual acquisition among children: simultaneous bilingualism

Lecture 5 - Successive Bilingualism

Lecture 6 - Language and cognition among bilinguals

Lecture 7 - Bilingual cognition (Continued...)

Lecture 8 - Bilingual Memory Models

Lecture 9 - Bilingual brain: neural representation of languages

Lecture 10 - Data from processing studies on bilingual representation in brain

Lecture 11 - Speech perception and comprehension: theories

Lecture 12 - Speech perception and production studies

Lecture 13 - Lexical processing: background

Lecture 14 - Lexical processing: different experimental paradigms: comprehension and production

Lecture 15 - Sentence processing

Lecture 16 - Metalinguistic Awareness

Lecture 17 - Executive Control: bilingual advantage

Lecture 18 - cognitive reserve, new developments

Lecture 19 - New research trends in bilingualism

Lecture 20 - New models. Applied areas

Lecture 1 - Introduction

Lecture 2 - Barriers to Communication - 1

Lecture 3 - Barriers to Communication - 2

Lecture 4 - Barriers to Communication - 3

Lecture 5 - Non-Verbal Communication - 1

Lecture 6 - Non-Verbal Communication - 2

Lecture 7 - Non-Verbal Communication - 3

Lecture 8 - Non-Verbal Communication - 4

Lecture 9 - Non-Verbal Communication - 5

Lecture 10 - Listening Skills - 1

Lecture 11 - Listening Skills - 2

Lecture 12 - Listening Skills - 3

Lecture 13 - Business Letters Writing - 1

Lecture 14 - Business Letters Writing - 2

Lecture 15 - Business Letters Writing - 3

Lecture 16 - Business Letters Writing - 4

Lecture 17 - Report Writing - 1

Lecture 18 - Report Writing - 2

Lecture 19 - Group Discussion - 1

Lecture 20 - Group Discussion - 2

Lecture 21 - Group Discussion - 3

Lecture 22 - Interview Skills - 1

Lecture 23 - Interview Skills - 2

Lecture 24 - Interview Skills - 3

Lecture 25 - Interview Skills - 4

Lecture 26 - Interview Skills - 5

Lecture 27 - Interview Skills - 6

Lecture 28 - Interview Skills - 7

Lecture 29 - Netiquette - 1

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Lecture 31 - Oral Presentation - 1

[Lecture 32 - Oral Presentation - 2](#)

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[Lecture 34 - Cross Cultural Communication - 1](#)

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[Lecture 37 - Cross Cultural Communication - 4](#)

[Lecture 38 - Common Errors - 1](#)

[Lecture 39 - Common Errors - 2](#)

[Lecture 40 - Common Errors - 3](#)

- Lecture 1 - Introduction to Ethics - 'Crito' A Socratic dialogue
- Lecture 2 - Introduction to Ethics -An assessment of Ethical relativism
- Lecture 3 - Consequentialism -Introduction
- Lecture 4 - Consequentialism Rule and Act
- Lecture 5 - Hedonism
- Lecture 6 - Utilitarianism
- Lecture 7 - Deontological theories - Introduction
- Lecture 8 - Deontological theories - Immanuel Kant
- Lecture 9 - Ethical Rules (with reference to W D Ross)
- Lecture 10 - Situation Ethics
- Lecture 11 - Virtue Ethics
- Lecture 12 - Metaethical Theories
- Lecture 13 - Ethical Relativism: A discussion on Universal Declaration of Human Rights
- Lecture 14 - Ethical Naturalism
- Lecture 15 - Ethical Naturalism (Continued...)
- Lecture 16 - Ethical Naturalism-Emotivism
- Lecture 17A - Ethical Non-naturalism
- Lecture 17B - Ethical Non-naturalism-II
- Lecture 18 - Non-cognitive or Nondescriptivist Theories - Intuitionism
- Lecture 19 - Non-cognitive or Nondescriptivist Theories - Intuitionism Nihilism
- Lecture 20 - Why be Moral?
- Lecture 21 - Ethics in the Indian tradition
- Lecture 22 - Theory of Karma - Part 1
- Lecture 23 - Theory of Karma - Part 2
- Lecture 24 - Nishkama Karma - Part 1
- Lecture 25 - Nishkama Karma - Part 2
- Lecture 26 - Gandhian Ethics - Part 1
- Lecture 27 - Gandhian Ethics - Part 2
- Lecture 28 - Gandhian Ethics - Part 3 (Satyagraha)
- Lecture 29 - Purusharthas
- Lecture 30 - Buddhist Ethics - Part 1

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[Lecture 33 - Some ethical issues \(Applied Ethics\) Discussing Peter Singer's 'Famine Affluence and Morality'](#)

[Lecture 34 - Discussing Thomas Pogge's 'Real World Justice' - Part 1](#)

[Lecture 35 - Discussing Thomas Pogge's 'Real World Justice' - Part 2](#)

[Lecture 36 - Discussing Thomas Pogge's 'Real World Justice' - Part 3](#)

[Lecture 37 - Sexuality: Ethical Perspectives - Part 1](#)

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- Lecture 1 - Identification of Arguments
- Lecture 2 - Non-arguments
- Lecture 3 - Types of Arguments: Deductive vs Inductive
- Lecture 4 - Nature and Scope of Deductive and Inductive Arguments
- Lecture 5 - Truth, Validity and Soundness
- Lecture 6 - Strength of Inductive arguments, Counter example method
- Lecture 7 - Toulmin's Model of Argumentation
- Lecture 8 - Identification of Formal and Informal Fallacies
- Lecture 9 - Informal Fallacies: Fallacies of relevance
- Lecture 10 - Fallacies of Weak Induction and Fallacies arising out of ambiguity in Language
- Lecture 11 - Introduction and motivation for Syllogistic Logic
- Lecture 12 - Aristotle theory of Syllogisms - 1
- Lecture 13 - Syllogistic Poem, Reduction of Syllogisms
- Lecture 14 - Syllogistic Poem, Reduction of Syllogisms
- Lecture 15 - Nature and Scope of Propositional Logic
- Lecture 16 - Syntax of Propositional Logic
- Lecture 17 - Logical Connectives: Truth Tables
- Lecture 18 - Truth Table Method: Validity, Consistency, Logical Equivalence
- Lecture 19 - Semantic Tableaux Method for Propositional Logic
- Lecture 20 - Knights and Knaves Puzzles
- Lecture 21 - Semantic Tableaux Method: Further Examples
- Lecture 22 - Natural Deduction Method
- Lecture 23 - Natural Deduction: Examples
- Lecture 24 - Conjunctive and Disjunctive Normal Forms
- Lecture 25 - CNF, DNF and satisfiability and Validity
- Lecture 26 - Resolution and refutation method
- Lecture 27 - Resolution and refutation method: Examples
- Lecture 28 - Axiomatic Propositional Logic
- Lecture 29 - Hilbert Ackermann Axiomatic system
- Lecture 30 - Proofs in the PM system
- Lecture 31 - Hilbert and Ackermann System

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[Lecture 37 - Semantics of Predicate Logic](#)

[Lecture 38 - Truth, satisfiability, validity in Predicate Logic](#)

[Lecture 39 - Formation Trees for wffs in predicate Logic](#)

[Lecture 40 - Semantic Tableaux Method for Predicate Logic](#)

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[Lecture 42 - Natural Deduction in Predicate Logic](#)

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Lecture 2 - Basics Concepts

Lecture 3 - Perspectives On Population

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Lecture 5 - Social Change in India

Lecture 6 - India: A Developing Economy

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Lecture 11 - Demographic Models - I

Lecture 12 - Demographic models - II

Lecture 13 - Contemporary Issues In Modelling Population Processes

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Lecture 15 - Demographic Transition in the Nineteenth and Twentieth Centuries

Lecture 16 - Demographic schism between Developed and Developing Countries and Future Prospects

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Lecture 21 - Urbanization and Development

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- Lecture 2 - Sociological approaches
- Lecture 3 - Nature of society: Individuals and groups
- Lecture 4 - Cooperation and conflict
- Lecture 5 - Family-I: Definition and classification of family
- Lecture 6 - Family-II: Perspectives on family
- Lecture 7 - State-I: Definition of state
- Lecture 8 - State-II: State in India
- Lecture 9 - State-III: The concept of power
- Lecture 10 - State-IV: Functionalist and Marxist perspectives on power
- Lecture 11 - Sociology of work-I: Need for work
- Lecture 12 - Sociology of work-II: Social change and work
- Lecture 13 - Sociology of work-III: Development and work
- Lecture 14 - Sociology of work-IV: Capitalism and motivation for work
- Lecture 15 - Religion-I: Social conditions and religious thought
- Lecture 16 - Religion-II: Bases of religion
- Lecture 17 - Religion-III: Forms of religious beliefs
- Lecture 18 - What is sociology?
- Lecture 19 - Religion-V: Religion and society
- Lecture 20 - Religion-VI: Contributions of Marx and Weber
- Lecture 21 - Education-I: Concept of education?
- Lecture 22 - Education-II: Functions of education
- Lecture 23 - Social stratification-I: Social inequality and stratification
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- Lecture 27 - Deviance-I: Concept of deviance
- Lecture 28 - Deviance-II: Perspectives on deviance
- Lecture 29 - Deviance-III: Theories of deviance
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NPTEL : Money and Banking (Humanities and Social Sciences)

Co-ordinators : Prof. Surajit Sinha

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NPTEL : Selected Topics in Psychology (Humanities and Social Sciences)

Co-ordinators : Prof. Manas K Mandal, Prof. JBP Sinha, Prof. Alok Bajpai, Prof. Rakesh K. Gupta, Prof. Ramadhar Singh, Prof. Braj Bhushan, Prof. Vivek Benegal, Prof. Ajit Dalal, Prof. Girishwar Misra

- Lecture 1 - Introduction Selected Topics in Psychology
- Lecture 2 - Psychology: Emerging of a discipline
- Lecture 3 - Psychology: Emerging of a discipline
- Lecture 4 - Beginning, growth and decline of Western psychology in India
- Lecture 5 - The core and context of Indian psychology
- Lecture 6 - The indigenization of psychology in India
- Lecture 7 - Weaving culture into psychology
- Lecture 8 - Culture and Self: Implications for Social Behaviour
- Lecture 9 - Cultural and organizational behaviour
- Lecture 10 - How do similar attitudes determine attraction?
- Lecture 11 - Why do similar attitudes determine attraction?
- Lecture 12 - A beautiful mind? Perspective on brain , mind and it's challenges
- Lecture 13 - Emotion and well?being
- Lecture 14 - Mental health and illness - Part 1
- Lecture 15 - Mental health and illness - Part 2
- Lecture 16 - Folk Healing Traditions in India
- Lecture 17 - To sleep or not
- Lecture 18 - Issues and challenges in psychological assessment
- Lecture 19 - Nontraditional research in behavioural sciences
- Lecture 20 - What a surprise: My results are nonsignificant
- Lecture 21 - Neuropsychology and cognitive neuroscience research
- Lecture 22 - Functional MRI in psychology - Part 1
- Lecture 23 - Functional MRI in psychology - Part 2
- Lecture 24 - Side bias in human behaviour
- Lecture 25 - Brain microstructural correlates of cognition in Cerebral Palsy
- Lecture 26 - Brain microstructural correlates of cognition in vitamin B12 deficiency
- Lecture 27 - The neuroscience of addictive behaviour
- Lecture 28 - Who is at risk and why? The neurogenetics of vulnerability to addiction - Part 1
- Lecture 29 - Who is at risk and why? The neurogenetics of vulnerability to addiction - Part 2
- Lecture 30 - The gambler's lament: Behavioural addictions? gambling, internet and porn addictions

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

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Lecture 13 - Static Form

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Lecture 15 - Movement by Repetition

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Lecture 2 - Propositional Logic : Syntax

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Lecture 4 - Semantic Tableaux Method for Propositional Logic: General Examples

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- Lecture 3 - Term Structure of Interest Rates - I
- Lecture 4 - Optimization Models In Finance
- Lecture 5 - Crash course on KKT Condition
- Lecture 6 - Mean Variance Portfolio Optimization - I
- Lecture 7 - Mean Variance Portfolio Optimization - II
- Lecture 8 - Mean Variance Portfolio Optimization - III
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- Lecture 10 - Last lecture on Portfolio Optimization
- Lecture 11 - Capital Asset Pricing Model
- Lecture 12 - The Binomial Model [Lox-Ross-Rubenstein Model]
- Lecture 13 - The Binomial Method - II
- Lecture 14 - Binomial Method - III (Multiperiod model)
- Lecture 15 - Binomial model - IV
- Lecture 16 - Girsanov's Theorem (Basic tool)
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- Lecture 18 - Stock price under risk neutral measure
- Lecture 19 - The Black Scholes formula
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- Lecture 6 - External Factors in Perception
- Lecture 7 - Theory of Signal Detection
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- Lecture 10 - Role of Culture in Perception
- Lecture 11 - Basic Concepts of Learning
- Lecture 12 - Classical Conditioning
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- Lecture 17 - Models of Memory
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Lecture 9 - Mythical Associations

Lecture 10 - Idea of Nationalism and Modernism in the Context of Folk Art-I and II

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- Lecture 3 - Human Perceptions: Understanding People
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- Lecture 8 - Inter-Personal Conflicts: Two Examples
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- Lecture 13 - Habits: Guiding Principles
- Lecture 14 - Habits: Identifying Good and Bad Habits
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- Lecture 18 - Forming Habits of Success
- Lecture 19 - Communication: Significance of Listening
- Lecture 20 - Communication: Active Listening
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- Lecture 22 - Telephone Communication: Basic Telephone Skills
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- Lecture 25 - Technology and Communication: Technological Personality?
- Lecture 26 - Technology and Communication: Mobile Personality?
- Lecture 27 - Topic: Technology and Communication: E-Mail Principles
- Lecture 28 - Technology and Communication: How not to Send E-Mails!
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Lecture 12 - Itsu Kanpur e kimashita ka?

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Lecture 18 - Taj hoteru wa ookii hoteru desu.

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- Lecture 41 - Nihongo no jishou ga hoshii desu
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- Lecture 45 - Kore wa tanaka san no jishou da to omoimasu
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- Lecture 53 - Shashin o totte mo ii desu ka?
- Lecture 54 - Mainichi kaisha ni ikanakereba narimasen
- Lecture 55 - Tanaka san wa yoku hatarakimasu

Lecture 1 - Kore wa watashi no hon desu (This is my book)

Lecture 2 - Ima nan ji desu ka? (What is the time now?)

Lecture 3 - Hon wa tsukue no ue ni arimasu (The book is on the table)

Lecture 4 - Ashita kurabu e ikimasen ka? (Will you please come to the club tomorrow?)

Lecture 5 - Kodoma-tachi wa ima asonde imasu (Children are playing now)

Lecture 6 - Kodomotachi wa asonde kara benkyou shimasu (Children will study after playing)

Lecture 7 - Douzo meshiagatte kudasai (Please eat it)

Lecture 8 - Tabete mite kudasai (Please eat and see)

Lecture 9 - Koko de tabenaide kudasai (Please do not eat here)

Lecture 10 - Hitori de ikimasu ka? (Will you go alone?)

Lecture 11 - Irasshaimase ! (Welcome !)

Lecture 12 - Shiken wa dou deshita ka? (How was the exam?)

Lecture 13 - Tomodachi wa tanjoubi ni hana o kuremashita (My friend gave me flowers on my birthday)

Lecture 14 - Tomodachi wa ke-ki o tsukutte kuremashita (My friend made a cake and gave it to me)

Lecture 15 - Kimura to moushimasu (I am Kimura)

Lecture 16 - O-genki desu ka ? (How are you ?)

Lecture 17 - Kare wa 'happyou wa ashita desu' to iimashita (He said, 'the presentation is tomorrow)

Lecture 18 - Tanaka to iu hito ni aimashita (I met a person called Tanaka)

Lecture 19 - Tomodachi ga kuru to omoimasu (I think my friend will come)

Lecture 20 - Watashi wa hitori de ikemasu (I can go alone)

Lecture 21 - Ikka-getsu de dekimasu (I can do it in one month)

Lecture 22 - Kare wa Indo no shuukan no koto o yoku shitte imasu (He know a lot about Indian customs)

Lecture 23 - Aisatsu (Greetings)

Lecture 24 - Aisatsu (Greetings)

Lecture 25 - Chokore-to yori aisukuri-mu ga suki desu (I like ice cream more than chocolate)

Lecture 26 - Dochira ga suki desu ka ? (Which do you like ?)

Lecture 27 - Mira san asobi ni irashite kudasai (Mira san please visit us)

Lecture 28 - Houmon (Visiting)

Lecture 29 - Pen de kaite mo ii desu ka ? (Can I write with a pen?)

Lecture 30 - Konakute mo ii desu ka ? (Is is alright if I do not come ?)

Lecture 31 - Nani mo tabetakunai desu (I do not want to eat anything)

Lecture 32 - Watashi wa eiwa jiten ga hoshii desu (I want an English-Japanese dictionary)

Lecture 33 - Rainen kekkon suru tsumori desu (I intend to get married next year)

Lecture 34 - Soto wa kuraku narimashita (It has become dark outside)

Lecture 35 - Kyuujitai and Shinjitai

Lecture 36 - Nihon e itta koto ga arimasu (I have been to Japan)

Lecture 37 - Minikui ahiru no ko - I (Ugly duckling - I)

Lecture 38 - Minikui ahiru no ko - II (Ugly duckling - II)

Lecture 39 - Working in Japan

Lecture 40 - Haru ni naru to sakura ga saku (When it is spring cherry blossoms will bloom)

Lecture 41 - Mira wa konai kamoshirenai (Mira may not come)

Lecture 42 - Okane ga attara uchi o kaimasu (If I have money I will buy a house)

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Co-ordinators : Prof. Shri Prakash Shukla

Lecture 1 - ààààà, ààààà ààààà/ààààà' ààààà/ààààà ààààà ààààà ààààà... ààààà ààààà, ààààà ààààà

Lecture 2 - ààààà, ààààà ààààà/ààààà' ààààà/ààààà ààààà ààààà ààààà/ààààà ààààà/ààààà ààààà

Lecture 3 - ààààà—ààààà' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà ààààà.

Lecture 4 - ààààà—ààààà' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà/ààààà ààààà

Lecture 5 - àààààààààààààààààà/ààààà ààààà/ààààà ààààà/ààààà ààààà... ààààà ààààà, ààààà ààààà

Lecture 6 - àààààààààààààààààà/ààààà ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà ààààà.

Lecture 7 - àààààààààààààààààà/ààààà ààààà/ààààà ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà

Lecture 8 - àààààààààààààààààà/ààààà ààààà/ààààà ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà—ààààà

Lecture 9 - àààààààààààààààààà' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà ààààà.

Lecture 10 - àààààààààààààààààà' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà, ààààà ààààà.

Lecture 11 - ààààà/ààààà, ààààà' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà... ààààà ààààà, ààààà ààààà

Lecture 12 - ààààà/ààààà, ààààà' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà/ààààà ààààà ààààà.

Lecture 13 - ààààà/ààààà—ààààà' ààààà/ààààà ààààà/ààààà, ààààà' ààààà/ààààà' ààààà/ààààà ààààà/ààààà

Lecture 14 - ààààà/ààààà—ààààà' ààààà/ààààà ààààà/ààààà, ààààà' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà

Lecture 15 - ààààà/ààààà, ààààà, ' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà/ààààà ààààà ààààà.

Lecture 16 - ààààà/ààààà, ' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà/ààààà ààààà ààààà.

Lecture 17 - ààààà/ààààà' ààààà/ààààà ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà/ààààà ààààà ààààà.

Lecture 18 - ààààà/ààààà' ààààà/ààààà ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà/ààààà ààààà ààààà.

Lecture 19 - ààààà, ààààà/ààààà' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà... ààààà ààààà, ààààà ààààà

Lecture 20 - ààààà, ààààà/ààààà' ààààà/ààààà' ààààà/ààààà ààààà/ààààà ààààà/ààààà ààààà—ààààà

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Computer Aided Decision Systems - Industrial Practices using Big Analytics (Humanities and Social Sciences)

Co-ordinators : Prof. Deepu Philip, Prof. Amandeep Singh Oberoi

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- Lecture 57 - BoP Crisis of the Indian Economy in 1991
- Lecture 58 - Crisis and efficiency of exchange rate policies
- Lecture 59 - Concluding Remarks - I
- Lecture 60 - Concluding Remarks - II

Lecture 1 - Introduction: Why Happiness Matters and How We Will Go About Exploring It

Lecture 2 - Can We Define Happiness?

Lecture 3 - Happiness and Wellbeing : Do Cultures and Environments Call the Shots!

Lecture 4 - Doing Happiness' - Philosophical and existential questions, and responses

Lecture 5 - Happiness - antecedents and implications

Lecture 6 - Basic Issues

Lecture 7 - Myths and Misconceptions

Lecture 8 - Happiness - the unanswered questions

Lecture 9 - Evolution of Happiness

Lecture 10 - Belief and Gene

Lecture 11 - Empathy

Lecture 12 - Happiness and Morality

Lecture 13 - Exploring the self and the other

Lecture 14 - Pro-sociality and happiness - Generosity, give and take

Lecture 15 - Pro-sociality and happiness - Virtues and strengths

Lecture 16 - Relationship - Connected and happy

Lecture 17 - Networking and its relevance for happiness and wellbeing

Lecture 18 - Money and Happiness

Lecture 19 - How does optimism affect happiness?

Lecture 20 - Sharing and Belonging

Lecture 21 - Happiness and body language

Lecture 22 - Failure and Resilience

Lecture 23 - Innovation and Happiness

Lecture 24 - Conflicts and Stress

Lecture 25 - Stress and Coping

Lecture 26 - Reconnecting happiness: beyond pandemic

Lecture 27 - Meditation and Mindfulness: An Overview

Lecture 28 - Meditation and Mindfulness: Practice Toolkit

Lecture 29 - Creativity, Intuition and Flow

Lecture 30 - Can we really not be creative and happy?

Lecture 31 - Emotional intelligence

[Lecture 32 - Happiness at work](#)

[Lecture 33 - Nudging and Decision-making](#)

[Lecture 34 - Can we measure happiness? The case of cities and states](#)

[Lecture 35 - Happiness and leadership habits](#)

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[Lecture 37 - Consumerism, happiness and wellbeing](#)

[Lecture 38 - Technology and happiness](#)

[Lecture 39 - Doing research on happiness: Connecting dots](#)

[Lecture 40 - Summing up: Social innovation and project ideas for social transformation](#)

Lecture 1 - Major Environmental Concerns and Pollution

Lecture 2 - Population Growth Models

Lecture 3 - Resource Consumption and Pollution

Lecture 4 - Measuring Environmental Impacts - the IPAT Model and Ecological Footprint

Lecture 5 - Measuring - Earth Overshoot Day, Energy Performance Index and Lifecycle Assessment

Lecture 6 - Principles of Sustainable Development

Lecture 7 - Principles of Sustainable Development (Sustainable Development Goals)

Lecture 8 - Principles of Sustainable Development (Achieving SDGs and Sustainability Indices)

Lecture 9 - Principles of Sustainable Development (Case Study I: Sustainable Urbanization)

Lecture 10 - Principles of Sustainable Development (Case Study II: Green Buildings)

Lecture 11 - Air Pollution (Definition, Causes, Sources and Types)

Lecture 12 - Air Pollution (Influence of Meteorology)

Lecture 13 - Air Pollution (Local Effects and Mitigation Measures)

Lecture 14 - Air Pollution (Regional Issues and Mitigation Measures)

Lecture 15 - Air Pollution (Global Issues and Mitigation Measures, Indoor Air Quality)

Lecture 16 - Climate Change (Definition and Evidence)

Lecture 17 - Climate Change (Causes and Determinants)

Lecture 18 - Climate Change (Projections and Related Impacts)

Lecture 19 - Climate Change (Mitigation Options)

Lecture 20 - Climate Change (Adaption and Policy Responses)

Lecture 21 - Renewable Energy - I (Overview)

Lecture 22 - Renewable Energy - I (Solar Energy - I)

Lecture 23 - Renewable Energy - I (Solar Energy - II)

Lecture 24 - Renewable Energy - I (Solar Energy - III)

Lecture 25 - Renewable Energy - I (Wind Energy)

Lecture 26 - Renewable Energy - II (Geothermal Energy)

Lecture 27 - Renewable Energy - II (Ocean Energy - I)

Lecture 28 - Renewable Energy - II (Ocean Energy - II)

Lecture 29 - Renewable Energy - II (Hydropower)

Lecture 30 - Renewable Energy - II (Bioenergy)

Lecture 31 - Circular Economy (Introduction to the Concept)

- Lecture 32 - Circular Economy (Circular Economy Strategies - I)
- Lecture 33 - Circular Economy (Circular Economy Strategies - II)
- Lecture 34 - Circular Economy (Circular Business Models)
- Lecture 35 - Circular Economy (Industrial Symbiosis)
- Lecture 36 - Hydrologic cycle, sources of water and water pollution
- Lecture 37 - Water Quality Parameters - General
- Lecture 38 - Water Quality Parameters - Oxygendemanding wastes and Microbial
- Lecture 39 - Nitrogen species in rivers and the DO Sag Curve
- Lecture 40 - NGT, WQI and reuse and recycling of wastewater
- Lecture 41 - Importance and Integrated Solid Waste Management
- Lecture 42 - Sources of MSW, MSW Generation Rates and Composition
- Lecture 43 - MSW Composition and Collection
- Lecture 44 - MSW Treatment and Disposal
- Lecture 45 - E-Waste Management
- Lecture 46 - Sound, noise and its characteristics
- Lecture 47 - Audiometry
- Lecture 48 - Effects of noise
- Lecture 49 - Noise rating systems and modeling
- Lecture 50 - Noise control and regulations
- Lecture 51 - Fundamentals of Ecology - I
- Lecture 52 - Fundamentals of Ecology - II
- Lecture 53 - Fundamentals of Ecology - III
- Lecture 54 - Soil Pollution - I
- Lecture 55 - Soil Pollution - II
- Lecture 56 - The Environmental Movement and its global and local impacts
- Lecture 57 - Environmental Law and Rules in India
- Lecture 58 - Important legal judgments pertaining to the Environment
- Lecture 59 - NGT and its important judgments
- Lecture 60 - Rapid Environmental Impact Assessment - A case study of the River Ib Barrage

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[Lecture 15 - Memory and Cognition \(Continued...\)](#)

[Lecture 16 - Thinking and Cognition](#)

[Lecture 17 - Thinking and Cognition \(Continued...\)](#)

[Lecture 18 - Thinking and Cognition \(Continued...\)](#)

[Lecture 19 - Thinking and Cognition \(Continued...\)](#)

[Lecture 20 - Thinking and Cognition \(Continued...\)](#)

[Lecture 21 - Motivation of Learning](#)

[Lecture 22 - Motivation of Learning \(Continued...\)](#)

[Lecture 23 - Motivation of Learning \(Continued...\)](#)

[Lecture 24 - Motivation of Learning \(Continued...\)](#)

[Lecture 25 - Motivation of Learning \(Continued...\)](#)

[Lecture 26 - Emotional Intelligence and Learning](#)

[Lecture 27 - Emotional Intelligence and Learning \(Continued...\)](#)

[Lecture 28 - Emotional Intelligence and Learning \(Continued...\)](#)

[Lecture 29 - Emotional Intelligence and Learning \(Continued...\)](#)

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- [Lecture 34 - Learning and Instruction \(Continued...\)](#)
- [Lecture 35 - Learning and Instruction \(Continued...\)](#)
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- [Lecture 37 - Learning and Pedagogy \(Continued...\)](#)
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- [Lecture 39 - Learning and Pedagogy \(Continued...\)](#)
- [Lecture 40 - Learning and Pedagogy \(Continued...\)](#)
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- [Lecture 42 - Psychology of E-Learning \(Continued...\)](#)
- [Lecture 43 - Psychology of E-Learning \(Continued...\)](#)
- [Lecture 44 - Psychology of E-Learning \(Continued...\)](#)
- [Lecture 45 - Psychology of E-Learning \(Continued...\)](#)
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- [Lecture 47 - Effective Learning: Assessment and Feedback \(Continued...\)](#)
- [Lecture 48 - Effective Learning: Assessment and Feedback \(Continued...\)](#)
- [Lecture 49 - Effective Learning: Assessment and Feedback \(Continued...\)](#)
- [Lecture 50 - Effective Learning: Assessment and Feedback \(Continued...\)](#)
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- [Lecture 52 - Learning for Sustainability \(Continued...\)](#)
- [Lecture 53 - Learning for Sustainability \(Continued...\)](#)
- [Lecture 54 - Learning for Sustainability \(Continued...\)](#)
- [Lecture 55 - Learning for Sustainability \(Continued...\)](#)
- [Lecture 56 - Learning for Sustainability](#)
- [Lecture 57 - Learning for Sustainability \(Continued...\)](#)
- [Lecture 58 - Learning for Sustainability \(Continued...\)](#)
- [Lecture 59 - Learning for Sustainability \(Continued...\)](#)
- [Lecture 60 - Learning for Sustainability \(Continued...\)](#)

- Lecture 1 - How do we define language?
- Lecture 2 - What is knowledge of language?
- Lecture 3 - How is Human communication unique?
- Lecture 4 - Universal properties of language
- Lecture 5 - What do we do in Linguistics?
- Lecture 6 - Transdisciplinary Approach to Linguistics
- Lecture 7 - Rules of Language
- Lecture 8 - Competence and Performance, Langue and Parole
- Lecture 9 - Universal Grammar
- Lecture 10 - Faculty of Language
- Lecture 11 - Introduction to Phonetics
- Lecture 12 - More about Phonetics
- Lecture 13 - Introduction to IPA
- Lecture 14 - Introduction to Phonology
- Lecture 15 - More about Phonology
- Lecture 16 - Introducing Morphology
- Lecture 17 - Morpheme, Morph and Allomorph
- Lecture 18 - Types of Morpheme
- Lecture 19 - Morphological Processes
- Lecture 20 - More about Morphological Process
- Lecture 21 - Morphological Typology
- Lecture 22 - Introducing Syntax
- Lecture 23 - Syntactic Categories and Subcategories
- Lecture 24 - Constituents and Phrase Structures Rules
- Lecture 25 - More about Trees
- Lecture 26 - Different parts of a tree
- Lecture 27 - From Transformation to GB Theory
- Lecture 28 - Introducing Minimalism
- Lecture 29 - Introducing Semantics
- Lecture 30 - Lexical Semantics
- Lecture 31 - Introducing Pragmatics

- Lecture 32 - Language and Script
- Lecture 33 - Defining Computational Linguistics
- Lecture 34 - An Introduction to Corpus Linguistics
- Lecture 35 - Introducing Linguistic Typology
- Lecture 36 - More about Linguistic Typology
- Lecture 37 - Typology through Indian Languages
- Lecture 38 - Language Families of India
- Lecture 39 - More about Language Families of India
- Lecture 40 - India as a Linguistic Area
- Lecture 41 - Introducing Sociolinguistics
- Lecture 42 - Language Maintenance and Language Shift
- Lecture 43 - Multilingualism and Varieties of Language
- Lecture 44 - Language, Dialect and Standardization
- Lecture 45 - Standard Language Ideology
- Lecture 46 - Language Variation
- Lecture 47 - Language Change
- Lecture 48 - Language and Identity
- Lecture 49 - Language Endangerment
- Lecture 50 - Different Aspects of Language Endangerment
- Lecture 51 - Language Documentation
- Lecture 52 - Language Documentation and Revitalization
- Lecture 53 - A Discussion on Field Linguistics
- Lecture 54 - Language Teaching
- Lecture 55 - More about Language Teaching
- Lecture 56 - Sociolinguistics and language teaching
- Lecture 57 - Language Policy
- Lecture 58 - Endangered Languages and its Revitization through Classrooms
- Lecture 59 - Summing up
- Lecture 60 - Summing up

Lecture 1 - Greek Philosophy: Ionians, Pythagoras, Parmenides, Heraclitus and Democritus

Lecture 2 - Sophists, Socrates; philosophy of man; relativism and subjectivism; the idea of good

Lecture 3 - Platos idealism: theory of ideas

Lecture 4 - Plato: theory of knowledge, method of dialectic; theory of soul

Lecture 5 - Aristotles criticism of Platonic idealism and the concepts of Form and Matter

Lecture 6 - Aristotles theory of causation; potentiality and actuality

Lecture 7 - Medieval philosophy: St. Augustine and the Problem of evil; St. Thomas Aquinass concepts of faith and reason; proofs for the existence of God.

Lecture 8 - Modern Philosophy: mail characteristic features; renaissance and scientific revolution; rationalism and empiricism: main features.

Lecture 9 - Descartes: the method in philosophy; the concepts of doubt and indubitable knowledge.

Lecture 10 - Descartes: the mind-body dualism; the concept of God and proofs for Gods existence

Lecture 11 - Spinoza: the concepts of Substance, attributes and modes.

Lecture 12 - Spinozas pantheism-God and nature

Lecture 13 - Leibniz: Monadology; the mind-body problem revisited; concept of God; the concept of pre-established harmony

Lecture 14 - The empiricism of John Locke: ideas and their classification; refutation of innate ideas

Lecture 15 - John Locke: theory of knowledge; concept of substance; the primary and secondary qualities

Lecture 16 - Berkeley: the refutation of the distinction between primary and secondary qualities, immaterialism

Lecture 17 - Berkeleys critique of abstract ideas, esse est percipi, the problem of solipsism; God and self

Lecture 18 - Hume : Impressions and ideas, knowledge concerning relations of ideas and knowledge concerning matters of fact, induction and causality.

Lecture 19 - The external world and the self, personal identity, rejection of metaphysics, scepticism, reason and the passions.

Lecture 20 - Critical Philosophy: characteristic features; kantd objectives: the classification of judgements, possibility of synthetic a priori judgements, the Copernican revolution

Lecture 21 - Kant: forms of sensibility, categories of understanding; the process of knowledge acquisition; phenomenon and noumenon,

Lecture 22 - The Ideas of Reason-soul, God and world as a whole; antinomies; rejection of speculative metaphysics.

Lecture 23 - Kants ethics; freedom and immortality, problems with Kant.

Lecture 24 - Hegel : The conception of Geist (spirit), the dialectical method, concepts of being, non-being and becoming,

Lecture 25 - Absolute idealism; consciousness, self consciousness and reason.

Lecture 26 - Karl Marx: historical materialism; the significance of the proletariat; the base structure-superstructure division.

Lecture 27 - Nietzsche : Critique of western culture, religion and morality; will to power; the idea of superman.

Lecture 28 - Linguistic turn in British philosophy: Russells logical atomism and the refutation of idealism.

Lecture 29 - Wittgenstein : early Wittgensteins conception of language and reality; the picture theory of meaning

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Lecture 30 - Later Wittgensteins conception of language games and forms of life; meaning and use.

Lecture 31 - Logical positivism; against metaphysics and a scientific conception of philosophy; the limitation of logical positivism

Lecture 32 - Husserl : Phenomenology and the methods of reduction; the principle of intentionality.

Lecture 33 - Phenomenological reduction, eidetic reduction and transcendental reduction; transcendental subjectivity; the pure subject.

Lecture 34 - Heidegger : phenomenological hermeneutics; concept of Being; man as being-in-the-world; destruction of the western intellectual tradition.

Lecture 35 - Authentic and inauthentic existence; Truth as disclosure

Lecture 36 - Existentialism: main features; existence precedes essence; freedom and responsibility; finiteness and situatedness of human existence

Lecture 37 - Sartres conception of human existence; man is condemned to be free; rejection of essentialism

Lecture 38 - The concept of being-in-itself, being-for-itself and being-for-others

Lecture 39 - Postmodernism: major trends and chief characteristic features; conceptions of human subject; different postmodern approaches

Lecture 40 - Deconstruction, feminism, discourse theory etc.

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[Lecture 2 - Harold Pinter](#)

[Lecture 3 - The Dumb Waiter](#)

[Lecture 4 - The Dumb Waiter \(Continued...\)](#)

[Lecture 5 - Six Degrees of Separation](#)

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[Lecture 10 - Tom Stoppard - Dogg's Hamlet, Cahoot's Macbeth](#)

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[Lecture 16 - Arthur Miller Clara](#)

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[Lecture 19 - Albert Camus The Fall](#)

[Lecture 20 - Albert Camus The Fall](#)

[Lecture 21 - Albert Camus The Fall](#)

[Lecture 22 - Girish Karnad - Nagamandala](#)

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[Lecture 24 - Girish Karnad - Nagamandala](#)

[Lecture 25 - Short Story - Salman Rushdie's](#)

[Lecture 26 - Short Story2 - Hanif Kureishi's](#)

[Lecture 27 - Modernism Post](#)

[Lecture 28 - Kazuo Ishiguro - Remains of the Day](#)

[Lecture 29 - Kazuo Ishiguro - Remains of the Day](#)

[Lecture 30 - Kazuo Ishiguro - Remains of the Day](#)

[Lecture 31 - Kazuo Ishiguro - Remains of the Day](#)

[Lecture 32 - Michael Ondaatje - The English Patient](#)

[Lecture 33 - Michael Ondaatje - The English Patient](#)

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[Lecture 35 - Asian-American Writing](#)

[Lecture 36 - Amy Tan's - The Joy Luck Club](#)

[Lecture 37 - Amy Tan's - The Joy Luck Club](#)

[Lecture 38 - Amy Tan's - The Joy Luck Club](#)

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[Lecture 40 - Poetry](#)

- Lecture 1 - The Socio-Economic Role of Scarcity and Uncertainty
- Lecture 2 - The Process of Construction of Knowledge
- Lecture 3 - The Roles of Faith and Experience
- Lecture 4 - From Orphism to the Milesians in ancient Greece
- Lecture 5 - Pythagoras and Heraclitus
- Lecture 6 - From Parmenides to the atomists
- Lecture 7 - From the ancient Greece to the emergence of Feudalism
- Lecture 8 - Feudalism and the growth of the Church
- Lecture 9 - The age of Faith: Europe until the crusades
- Lecture 10 - The beginnings of modernity
- Lecture 11 - Scholasticism and St.Thomas
- Lecture 12 - Transformation of Europe towards modernity
- Lecture 13 - Birth of political economy: mercantilism
- Lecture 14 - The debate over mercantilism: Hume and Cantillon
- Lecture 15 - A postscript to mercantilism: Hume and James Stewart
- Lecture 16 - "Natural Order"™ and the market: Quesney and Galiani
- Lecture 17 - Smith: the Invisible Hand
- Lecture 18 - Smith: Growth theory, long run equilibrium and Institutions
- Lecture 19 - Ricardo-Malthus debate
- Lecture 20 - Ricardian economics and more
- Lecture 21 - Equilibrium of the market: from Say to Walras
- Lecture 22 - More on Equilibrium: Cournot, Dupuit, Gossen, von Thunen
- Lecture 23 - Socialists and Marx
- Lecture 24 - The economics of Marx
- Lecture 25 - Marx as an ideologue of revolution
- Lecture 26 - Arrival of modern universals in Economics: Neo classical school
- Lecture 27 - Economic Theory at the time arrival of Keynes
- Lecture 28 - The centrality of the idea of efficiency in the study of market
- Lecture 29 - Keynesian Revolution: Macroeconomics
- Lecture 30 - Keynesian economics
- Lecture 31 - Economics of Institutions

[Lecture 32 - Transaction cost and Economic Anthropology approaches](#)

[Lecture 33 - Evolutionary Economics: the idea of change as evolution](#)

[Lecture 34 - From Schumpeter to neo Schumpeterian evolutionism](#)

[Lecture 35 - The social construction of knowledge: Case of Economics](#)

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Lecture 2 - A Brief Discussion on the Vedas & the Upanishads

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Lecture 4 - The CĀrvĀka School - II

Lecture 5 - The SĀá'...khya School - I

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Lecture 8 - The SĀá'...khya School - IV

Lecture 9 - The SĀá'...khya School - V

Lecture 10 - The SĀá'...khya School - VI

Lecture 11 - The Yoga School - I

Lecture 12 - The Yoga School - II

Lecture 13 - The Yoga School - III

Lecture 14 - The Yoga School - IV

Lecture 15 - The NyĀya School - I

Lecture 16 - The NyĀya School - II

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Lecture 24 - Buddhism - I

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Lecture 26 - Buddhism - III

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Lecture 28 - Buddhism - V

Lecture 29 - Jainism - I

Lecture 30 - Jainism - II

Lecture 31 - Jainism - III

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Lecture 1 - Introduction

Lecture 2 - Student Presentations - I

Lecture 3 - Feedback on Presentations - I

Lecture 4 - Stage Manners

Lecture 5 - Tempo of Speech

Lecture 6 - Some Reasons for Mishearing

Lecture 7 - Topics for Presentations - II

Lecture 8 - Message

Lecture 9 - Tables, Charts, Graphs

Lecture 10 - Power Point Slides

Lecture 11 - Criteria for Evaluation

Lecture 12 - Student Presentations - II

Lecture 13 - Feedback on Presentation - II

Lecture 14 - Topics for Presentation - III

Lecture 15 - On "Saying "Please!"

Lecture 16 - English Rhythm - I

Lecture 17 - English Rhythm - II

Lecture 18 - Phrasal Pause in English - I

Lecture 19 - Phrasal Pause in English - II

Lecture 20 - Units of Time, Weight, Distance

Lecture 21 - Stress in English - I

Lecture 22 - Stress in English - II

Lecture 23 - Stress in English - III

Lecture 24 - Stress in English - IV

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Lecture 27 - Student Presentations - III

Lecture 28 - Student Presentations - III

Lecture 29 - Student Presentations - III (Continued...)

Lecture 30 - Feedback on Presentations - III

Lecture 31 - Some Non-standard Sounds

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[Lecture 33 - Some "Vowel" Sounds in English](#)

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[Lecture 36 - Student Presentations - IV](#)

[Lecture 37 - Student Presentations - IV \(Continued...\)](#)

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[Lecture 28 - Italian cinema](#)

[Lecture 29 - Japanese Cinema](#)

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[Lecture 34 - New Hollywood \(Continued...\)](#)

[Lecture 35 - New Hollywood \(Continued...\)](#)

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[Lecture 37 - Cinema and Genres \(Continued...\)](#)

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[Lecture 39 - Postmodernism & Cinema \(Continued...\)](#)

[Lecture 40 - The Western](#)

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Lecture 2 - Design Features of Language - 1

Lecture 3 - Design Features of Language - 2

Lecture 4 - Design Features of Language - 3

Lecture 5 - Design Features of Language - 4

Lecture 6 - Design Features of Language - 5

Lecture 7 - Production of Speech Sounds

Lecture 8 - Organs of Articulation

Lecture 9 - Functions of Vocal Cords

Lecture 10 - Production of Speech Sounds, Cardinal Vowels

Lecture 11 - English Vowels

Lecture 12 - Diphthong

Lecture 13 - Production of Consonants

Lecture 14 - Consonants

Lecture 15 - Consonants-2

Lecture 16 - Review : Production of Speech Sounds

Lecture 17 - What is Phonology

Lecture 18 - Phonemes & Allophones

Lecture 19 - Phonological Phenomena

Lecture 20 - Syllable Template

Lecture 21 - Syllable

Lecture 22 - Syllable - Based Generalization

Lecture 23 - Syllable - Based Generalization

Lecture 24 - Morphology

Lecture 25 - Units of Word Formation

Lecture 26 - Affixation

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Lecture 29 - Syntax: X-bar Theory

Lecture 30 - Syntax: X-bar Theory (Continued...)

Lecture 31 - Syntax: Phrase Structure (Compliment and Adjuncts)

[Lecture 32 - Syntax: Argument Selection](#)

[Lecture 33 - Syntax: Structure of an IP and Thematic Relations](#)

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[Lecture 36 - Syntax: Case Assignment](#)

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[Lecture 38 - Word Formation-3](#)

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Lecture 1 - Introduction of the Course

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[Lecture 38 - Dickens' A Tale of Two cities Book III : Chapters 8 - 12](#)

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[Lecture 40 - Dickens' A Tale of Two cities Book III : Chapters 13](#)

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[Lecture 49 - The Strange Case of Dr. Jekyll and Mr Hyde, Chapter 5 \(Continued...\)](#)

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[Lecture 51 - The Strange Case of Dr. Jekyll and Mr Hyde, Chapters 8-10](#)

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Lecture 17 - The Goblin Market - Part 1

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Lecture 19 - The Goblin Market - Part 3

Lecture 20 - The Goblin Market - Part 4

Lecture 21 - The Goblin Market - Part 5

Lecture 22 - Tulips - Part 1

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Lecture 27 - The Yellow Wallpaper - Part 4

Lecture 28 - The Second Sex - Part 1

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[Lecture 48 - Angela Carter: Fairytale Sexuality and the Deconstruction of myth](#)

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- Lecture 2 - Epic of Gilgamesh
- Lecture 3 - Beowulf : The Anglo - Saxon narrative poem
- Lecture 4 - The Lusiads by Luis De Camoes
- Lecture 5 - Challenges and Possibilities for World Literature by Kathleen Shields
- Lecture 6 - The Garden of Forking Paths by Borges - Part I
- Lecture 7 - The Garden of Forking Paths by Borges - Part II
- Lecture 8 - A Rose for Emily by William Faulkner - Part I
- Lecture 9 - A Rose for Emily by William Faulkner - Part II
- Lecture 10 - Sonnet 130 by Shakespeare and Love Sonnet XVI by Neruda
- Lecture 11 - Song of Lawino by Okot p' Bitek
- Lecture 12 - Tortures by Wislawa Szymborska
- Lecture 13 - Spivak, Gayatri Chakravorty The Politics of translation
- Lecture 14 - Othello - 1
- Lecture 15 - Othello - 2
- Lecture 16 - Othello - 3
- Lecture 17 - Doll's House
- Lecture 18 - Yellow Wallpaper
- Lecture 19 - Toba Tek Singh
- Lecture 20 - Oroonoko - I
- Lecture 21 - Oroonoko - II
- Lecture 22 - Poetics Of Aristotle - I
- Lecture 23 - Poetics Of Aristotle - II
- Lecture 24 - Longinus on the Sublime - I
- Lecture 25 - Longinus on the Sublime - II
- Lecture 26 - Errata in MC
- Lecture 27 - From Errata to MC
- Lecture 28 - The Third and the final Continent - I
- Lecture 29 - The Third and the final Continent - II
- Lecture 30 - Balthazar's Marvellous Afternoon - I by Marquez
- Lecture 31 - Balthazar's Marvellous Afternoon - II

[Lecture 32 - The Wasteland - I](#)

[Lecture 33 - The Wasteland - II](#)

[Lecture 34 - The Wall by Sartre - I](#)

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[Lecture 37 - Everyday Use](#)

[Lecture 38 - Catcher in the Rye - I](#)

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[Lecture 41 - DR Faustus](#)

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[Lecture 43 - Metamorphosis - I](#)

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[Lecture 45 - Diary Of a Madman](#)

[Lecture 46 - Solid Objects](#)

[Lecture 47 - Dawn of the New Indian Novel in English](#)

[Lecture 48 - Bartleby The Scrivener](#)

[Lecture 49 - The Great Gatsby - I](#)

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Lecture 1 - An Introduction to Intellectual Property

Lecture 2 - What are Rights ?

Lecture 3 - What is Property in IPR ?

Lecture 4 - Meaning of Intellectual in IPR

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Lecture 6 - Defining IPR

Lecture 7 - Kinds of IPRs and their Duration

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Lecture 10 - The Origin of Intellectual Property - Part 2

Lecture 11 - Growth of Intellectual Property

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Lecture 13 - Patents in India

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Lecture 15 - Requirements of a Patent Application

Lecture 16 - Types of Patent Application

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Lecture 18 - Trademarks in India

Lecture 19 - What can be Protected

Lecture 20 - Introduction to Copyrights

Lecture 21 - Origin and Evolution of Copyrights

Lecture 22 - Copyrights in India

Lecture 23 - Geographical Indications

Lecture 24 - Designs

Lecture 25 - The Entrepreneurial University

Lecture 26 - Universities and IP

Lecture 27 - Publish or Patent

Lecture 28 - Managing IP at Universities

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Lecture 31 - How Inventions Look

[Lecture 32 - Where to Look for Inventions](#)

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[Lecture 36 - Outcome of search](#)

[Lecture 37 - What is a Patentability Search](#)

[Lecture 38 - Reasons for Ordering a Patentability Search](#)

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:English Literature of the Romantic Period, 1798-1832 (Humanities and Social Sciences)

Co-ordinators : Prof. Pramod K Nayar

Lecture 1 - Publishing, Literacy and Reading - I

Lecture 2 - Publishing, Literacy and Reading - II Literacy, Reading and the Audience

Lecture 3 - Empire

Lecture 4 - Empire - II

Lecture 5 - Science

Lecture 6 - European Romanticism Sensibility

Lecture 7 - Dissent and Revolution

Lecture 8 - The Debate on Rights

Lecture 9 - Nature and the Environment

Lecture 10 - The Self and Imagination

Lecture 11 - Fiction of the Romantic Period

Lecture 12 - Jane Austen

Lecture 13 - Criticism: Coleridge and Wordsworth

Lecture 14 - The Historical Novel

Lecture 15 - The Gothic Novel

Lecture 16 - Romantic Poetry 1 - William Blake (1757-1827)

Lecture 17 - Romantic Poetry 1 - Romanticism and sentiment - Introduction: Sensibility and Passion

Lecture 18 - Romantic Poetry 1 - Sensibility and Passion

Lecture 19 - Romantic Poetry 2 - William Wordsworth (1770-1850)

Lecture 20 - English Romantic Poetry 1:Samuel Taylor Coleridge

Lecture 21 - Introduction: Nature and the Environment

Lecture 22 - Wordsworth

Lecture 23 - Coleridge

Lecture 24 - Shelley

Lecture 25 - Keats and Byron

Lecture 26 - Romantic Poetry 3 - Aesthetics Introduction: Sublime and Picturesque Aesthetics

Lecture 27 - Romantic Poetry 3 - Visual arts and the Romantics

Lecture 28 - Romantic Poetry 3 - Aesthetics Wordsworth

Lecture 29 - Romantic Poetry 3 - Aesthetics Blake

Lecture 30 - Romantic Poetry 3 - Aesthetics Shelley

Lecture 31 - Romantic Poetry 4 - Politics Introduction Gender and Class

[Lecture 32 - Romantic Poetry 4 - Politics: Race, Empire, Tyranny](#)

[Lecture 33 - Romantic Poetry 4 - Politics Abolitionist Poetry](#)

[Lecture 34 - Romantic Poetry 4 - Politics Wordsworth and Shelley](#)

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[Lecture 36 - Romantic Literature - Empire and Orientalism Introduction 1: Romanticism, the Empire and the Other](#)

[Lecture 37 - Romantic Literature - Empire and Orientalism Introduction 2: Romanticism, the Empire and the Other](#)

[Lecture 38 - Romantic Literature - Empire and Orientalism 3 Prose: Thomas de Quincey](#)

[Lecture 39 - Romantic Literature - Empire and Orientalism 4 Byron](#)

[Lecture 40 - Romantic Literature - Empire and Orientalism 5 Felicia Hemans](#)

- Lecture 1 - Language and Linguistics
- Lecture 2 - Introductory concepts
- Lecture 3 - Goals of the course
- Lecture 4 - Introduction to Language Typology
- Lecture 5 - Linguistics as a discipline
- Lecture 6 - History of Linguistics
- Lecture 7 - Introduction to Morphology - Part 1
- Lecture 8 - Introduction to Morphology - Part 2
- Lecture 9 - Morphology (Continued...)
- Lecture 10 - Simple Compound and Complex Words
- Lecture 11 - Morphology - Prefixes, Suffixes and Infixes
- Lecture 12 - Introduction to Neologism
- Lecture 13 - Word formation rules and Neologism - Part 1
- Lecture 14 - Word formation rules and Neologism - Part 2
- Lecture 15 - Lexical Typology: An Introduction
- Lecture 16 - Lexical Typology (Continued...)
- Lecture 17 - Lexical Typology: Generalizations (Kinship terms and Personal Pronouns)
- Lecture 18 - Lexical Typology: Generalizations (Numerals)
- Lecture 19 - Lexical Typology: Generalizations (Antonymic Adjectives)
- Lecture 20 - Typology of Affixes
- Lecture 21 - Morphological Typology: A Cross Linguistic Study - Part 1
- Lecture 22 - Morphological Typology: A Cross Linguistic Study - Part 2
- Lecture 23 - Morphological Typology: Generalizations
- Lecture 24 - Morphological Typology: Generalizations continued - Part 1
- Lecture 25 - Morphological Typology: Generalizations continued - Part 2
- Lecture 26 - Introduction to Phonetics - Part 1
- Lecture 27 - Introduction to Phonetics - Part 2
- Lecture 28 - Introduction to Phonetics and Speech sounds - Part 1
- Lecture 29 - Introduction to Phonetics and Speech sounds - Part 2
- Lecture 30 - Phonological typology - Part 1
- Lecture 31 - Phonological typology - Part 2

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[Lecture 44 - Semantic Typology - Part 1](#)

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[Lecture 46 - Semantic Typology - Part 3](#)

[Lecture 47 - Semantic Typology - Part 4](#)

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[Lecture 49 - Goals of Language Typology - Part 2](#)

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[Lecture 53 - Pragmatic Typology](#)

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[Lecture 56 - Language Change : Word order](#)

[Lecture 57 - Word Order Typology - Part 1](#)

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[Lecture 63 - Typology and Universals](#)

[Lecture 64 - Typology and Universals \(Continued...\)](#)

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Inclusion and Technology Design (Humanities and Social Sciences)

Co-ordinators : Prof. Bidisha

Lecture 1 - Introduction: Inclusive Digital Societies

Lecture 2 - Missing Women in Tech: Why Lack of Female Technologists Matters for Technology Design and Development?

Lecture 3 - Are Technologies Gender Neutral?

Lecture 4 - ICTs and Gender: Field Concerns and Project Management Approaches for Technology Design

Lecture 5 - The Political Nature of Technology Design

Lecture 6 - Accessibility Fundamentals

Lecture 7 - Accessibility Fundamentals: Disabilities, Guidelines, and Laws

Lecture 8 - Accessibility Fundamentals: Disabilities, Guidelines, and Laws

Lecture 9 - Designing an Assistive Technology Ecosystem: STEM Education for the Visually Impaired

Lecture 10 - Inclusion in Designing ICT for Development Projects: Who Should Matter - Part 1

Lecture 11 - ICTs in Agricultural Markets: Are they Inclusive

Lecture 12 - Inclusion in Designing ICT for Development Projects: Who Should Matter - Part 2

Lecture 13 - Digital Labour, Platforms and the Future of Work

Lecture 14 - Assignment Video: Design Jam

Lecture 15 - Assignment Examples Video: Students Presentations

- Lecture 1 - Energy as an Economic Resource - Introduction
- Lecture 2 - Energy as an Economic Resource - Classification of Energy Resource
- Lecture 3 - Energy as an Economic Resource - Measurement of Energy
- Lecture 4 - Energy as an Economic Resource - Energy Accounting
- Lecture 5 - Energy as an Economic Resource - Problem Discussion on Module 1
- Lecture 6 - Energy Demand - Part I - Basic concepts in Economics
- Lecture 7 - Energy Demand - Part I - Descriptive Analysis of Energy Demand
- Lecture 8 - Energy Demand - Part I - Decomposition Analysis and Parametric Approach
- Lecture 9 - Energy Demand - Part II - Demand Side Management
- Lecture 10 - Energy Demand - Part II - Load Management
- Lecture 11 - Energy Demand - Part II - Demand Side Management - Energy Efficiency
- Lecture 12 - Energy Demand - Part II - Rebound Effect
- Lecture 13 - Energy Supply - Part I - Supply Behaviour of a Producer
- Lecture 14 - Energy Supply - Part I - Energy Investment
- Lecture 15 - Energy Supply - Part I - Economics of Non-renewable Resources
- Lecture 16 - Energy Supply - Part II - Economics of Renewable Energy Supply Setting the context
- Lecture 17 - Energy Supply - Part II - Economics of Renewable Energy Supply - Part 1
- Lecture 18 - Energy Supply - Part II - Economics of Renewable Energy Supply - Part 2
- Lecture 19 - Energy Supply - Part II - Economics of Electricity Supply
- Lecture 20 - Energy Market - Perfect Competition as a Market Form
- Lecture 21 - Energy Market - Why Energy Market is not Perfectly Competitive?
- Lecture 22 - Energy Market - Market Failure and Monopoly
- Lecture 23 - Energy Market - Oil Market: Pre OPEC Era - I
- Lecture 24 - Energy Market - Oil Market: Pre OPEC Era - II
- Lecture 25 - Energy Market - Oil Market: OPEC
- Lecture 26 - Special Topics on Energy - Energy Security
- Lecture 27 - Special Topics on Energy - Energy Access
- Lecture 28 - Special Topics on Energy - Energy, Environment and Climate Change

Lecture 1 - THE GOTHIC - Literary Genre

Lecture 2 - Charles Dickens 'THE SIGNAL - MAN' - I - Close reading and the anxieties of the age

Lecture 3 - Charles Dickens 'THE SIGNAL - MAN' - II - Close reading and the anxieties of the age

Lecture 4 - Charles Dickens 'THE SIGNAL - MAN' - III - Close reading and the anxieties of the age

Lecture 5 - Charles Dickens 'THE SIGNAL - MAN' - IV - Close Reading and the anxieties of the age

Lecture 7 - Rudyard Kipling - My own true ghost story

Lecture 8 - Imperial Gothic - Major Characteristics

Lecture 9 - Rudyard Kipling 'My own true ghost story' - Close reading for implications of the imperial Gothic - I

Lecture 10 - Rudyard Kipling 'My own true ghost story' - Close reading for implications of the imperial Gothic - II

Lecture 12 - Arthur Conan Doyle - The Red-Headed League - I

Lecture 13 - Arthur Conan Doyle - The Red-Headed League - II

Lecture 14 - Arthur Conan Doyle - The Red-Headed League - III

Lecture 15 - Arthur Conan Doyle 'The Red-Headed League' - A Conversation

Lecture 16 - Arthur Conan Doyle 'The Red-Headed League' - Summary and Interview of the Author

Lecture 17 - H.G. WELLS 'THE RED ROOM' - Close Reading And Its Implications

Lecture 18 - H.G. WELLS 'THE RED ROOM' - Victorian Gothic

Lecture 19 - H.G. WELLS 'THE RED ROOM' - Close Reading And Its Ideological Implications

- Lecture 1 - Was mochten Sie dieses Semester machen?
- Lecture 2 - Wiederholung : Dativ und Präpositionen
- Lecture 3 - Wir lernen das Perfekt
- Lecture 4 - Wir üben das Perfekt
- Lecture 5 - Was hast du in den Ferien gemacht ?
- Lecture 6 - Farben und Kleidung
- Lecture 7 - Wir lernen Präpositionen
- Lecture 8 - Wir üben Präpositionen
- Lecture 9 - Präpositionen Akkusativ oder Dativ?
- Lecture 10 - Was bringt mir der Postbote?
- Lecture 11 - Gesundheit: Was fehlt Ihnen?
- Lecture 12 - Jeder fährt sich
- Lecture 13 - Reflexiv - Akkusativ oder Dativ ?
- Lecture 14 - Lektion 1 und Witze und Faust
- Lecture 15 - Lektion 2, Präteritum von Modalverben, Ordinalzahlen
- Lecture 16 - Lektion 2; Detour -- Was ist Geschichte ? | Basic Tenses
- Lecture 17 - Was hast du nach der Schule gemacht?
- Lecture 18 - Lektion 3: Welche Medien hast du gestern benutzt?
- Lecture 19 - Komparativ und Superlativ
- Lecture 20 - dass-Sätze
- Lecture 21 - Wir wiederholen Komparativ und Superlativ
- Lecture 22 - Imperativ mit 'du' und 'ihr'
- Lecture 23 - Wir machen Lektion 5
- Lecture 24 - Adjektivdeklination
- Lecture 25 - Lektion 6 | Verkehr und Verkehrsmittel
- Lecture 26 - Welche Verkehrsmittel benutzt du ? | Indirekte Fragesätze
- Lecture 27 - Lektion 6 -- Aufgaben 4 und 6
- Lecture 28 - Lektion 7 -- Es geht ums Lernen
- Lecture 29 - Was hast du wann gelernt?
- Lecture 30 - Probleme beim Lernen | Verben mit dem Dativ
- Lecture 31 - Welche Probleme hast du beim Lernen ?

Lecture 32 - Perfekt von untrennbaren Verben | Wie löse ich meine Probleme beim Lernen ?

Lecture 33 - Ratschläge mit sollten | Sprache und Berufe | Wir lesen vor. (Lektion 7)

Lecture 34 - Exkurs ins Absurde! | Generationenprojekte (Lektion 7)

Lecture 35 - Generationenprojekte - wir hören die Texte

Lecture 36 - Welche Sportart möchtest du ausprobieren? | deshalb, trotzdem

Lecture 37 - Wiederholung Lektion 7 | Wir machen mit Lektion 8 weiter.

Lecture 38 - Woher entscheiden sich Sandra und Conny ? | Fragewort WO + Präposition

Lecture 39 - Alles über Fragewörter: mit und ohne Präpositionen

Lecture 40 - Eine Stadt entdecken | Wir beginnen Lektion 9

Lecture 41 - Lektion 9 | Interessante Häuser und Wohnungen

Lecture 42 - Lektion 9 | Die lieben Nachbarn

Lecture 43 - Lektion 9 | Höfliche Bitte | wenn und als

Lecture 44 - Lektion 9 | Wir üben als und wenn. | Sätze und Wortgruppen

Lecture 45 - Die Deutschen und ihre Haustiere

Lecture 46 - Wir beginnen Lektion 10 | Der Superlativ

Lecture 47 - Welche/r/s und Was für ein/e...

Lecture 48 - Lektion 10 | etwas, man, niemand, jemand...

Lecture 49 - Der Relativsatz | Wir machen Lektion 10 zu Ende

Lecture 50 - Wir machen Lektion 11. | K 2 - Verben und W-Fragen mit Präpositionen

Lecture 51 - Lektion 12 | Wir sind mit unserem Kurs fertig!

Lecture 1 - Herzlich willkommen!

Lecture 2 - Wie ist dein Name ?

Lecture 3 - Ich trinke gern Kaffee

Lecture 4 - Wir konjugieren die Verben

Lecture 5 - A bit of history and ZAHLEN

Lecture 6 - Verben, W-Fragen, Ja-Nein Fragen, Imperativ

Lecture 7 - das Alphabet, die Woche, das Jahr

Lecture 8 - Was sind deine Hobbys ? Formular ausfüllen

Lecture 9 - Mein Lehrbuch | Meine persönlichen Daten

Lecture 10 - Mein Arbeitsbuch

Lecture 11 - Wir beginnen Lektion 3

Lecture 12 - Wir lesen Lektion 3

Lecture 13 - Kein | Unregelmäßige Verben | Ein Lied

Lecture 14 - Wer ist das? | ich-mein; du-dein

Lecture 15 - Lektion 4 Guten Appetit!

Lecture 16 - Das Essen | Some revision

Lecture 17 - mag oder möchte | der Akkusativ

Lecture 18 - Ein Lesetext | die Uhr

Lecture 19 - die Uhrzeit | trennbare Verben

Lecture 20 - Familie und Possessiv

Lecture 21 - Wir machen Lektion 6 | Ordinalzahlen

Lecture 22 - Wie feierst du deinen Geburtstag?

Lecture 23 - der Akkusativ | ein Würfelspiel

Lecture 24 - das Kaffeehaus | die Kneipe | der Biergarten

Lecture 25 - Lektion 6: Freizeitprogramm

Lecture 26 - Sprache, Bundesländer, Städte | Wir beginnen Lektion 7

Lecture 27 - Akkusativ-Dativ | Annika im Büro | Wir machen Kaffee

Lecture 28 - Lektion 7 -- formeller Brief

Lecture 29 - Wie lernst du Deutsch ? Wir hören ein deutsches Lied

Lecture 30 - Wir lernen die Präpositionen

Lecture 31 - Hörverständnis | Wir beginnen Lektion 8

[Lecture 32 - Lektion 8 -- Haus-Wohnung-Möbel-Geräte](#)

[Lecture 33 - Extra Lektion on Modal Verbs](#)

[Lecture 34 - Eine E-Mail schreiben | Eine Wohnung beschreiben](#)

[Lecture 35 - Warum ist die Miete so hoch ? | Vorteile und Nachteile](#)

[Lecture 36 - Die neue Wohnung -- Was ist wo ? | Wechselpositionen](#)

[Lecture 37 - gefallen, gehen, passen, schmecken](#)

[Lecture 38 - Lektion 9 | Wir lernen das Perfekt](#)

[Lecture 39 - Lektion 9 | Wir üben das Perfekt](#)

[Lecture 40 - Was hast du in den Ferien gemacht ?](#)

[Lecture 41 - Lektion 9 | Die Jobsuche](#)

[Lecture 42 - Lektion 9 | Telefongespräche](#)

[Lecture 43 - Im Kaufhaus | Welche/Diese](#)

[Lecture 44 - Lektion 11 | Körper und Gesundheit](#)

[Lecture 45 - Gesund und munter | Wir machen Lektion 11 zu Ende](#)

[Lecture 46 - Ab in den Urlaub | Wir machen Lektion 12](#)

Lecture 1 - Disability Definition: An Evolving Phenomenon

Lecture 2 - Medical Model of Disability

Lecture 3 - Social Model of Disability - Part 1

Lecture 4 - Social Model of Disability - Part 2

Lecture 5 - Stigma: A Universal Phenomenon

Lecture 6 - Stigma and Disability: What can we learn?

Lecture 7 - Ableism - Part 1

Lecture 8 - Ableism - Part 2

Lecture 9 - Disability Activism

Lecture 10 - Models of Disability Activism

Lecture 11 - Dependency

Lecture 12 - Interdependence

Lecture 13 - Blindness

Lecture 14 - Blindness as metaphor

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- Lecture 27 - Wir bereiten uns auf eine PrÄœsentation vor.
- Lecture 28 - Relativsatz 1
- Lecture 29 - Relativsatz 2. Und wir lesen eine kleine Geschichte.
- Lecture 30 - Zukunftszeichen und VorsÄœtze fÄ¼rs neue Jahr: Wir lernen Futur I.
- Lecture 31 - Relativsatz - eine Wiederholung | Zukunft: Hamburg 2030

- Lecture 32 - Was kann ich für die Umwelt tun? (I)
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- Lecture 38 - Wir beginnen mit Kapitel 7.
- Lecture 39 - Thema Beziehungskisten. Wir lernen dabei temporale Nebensätze kennen.
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- Lecture 41 - Berühmte Paare. Wir machen Kapitel 7 zu Ende.
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- Lecture 44 - Wir wiederholen und üben das Reflexiv.
- Lecture 45 - Wofür interessierst du dich? | Reflexiv und zweiteilige Konnektoren: Wir machen Kapitel 8 zu Ende.
- Lecture 46 - Thema: Hotel Mama. Präsentationen der Lernenden. (I)
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- Lecture 50 - Präsentationen der Lernenden zum Thema Hotel Mama (IV)
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- Lecture 52 - Stellung von nicht im Satz. | Volkslieder
- Lecture 53 - Wir lernen das Passiv.
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- Lecture 55 - Wir üben das Passiv. (II) | Präpositionen mit dem Genitiv | Wir machen Kapitel 10 zu Ende.
- Lecture 56 - Adjektivdeklination - Wiederholung | Kapitel 11: Artikelwörter als Pronomen
- Lecture 57 - Kapitel 11: Adjektiv als Nomen | Sprichwörter | Ergänzung zu den Relativsätzen
- Lecture 58 - Kapitel 11: Städterankings | Relativsätze mit was und wo
- Lecture 59 - Wir machen Kapitel 11 zu Ende. | Sätze mit je...desto
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- Lecture 62 - Kapitel 12: Lesetexte zu den Themen Globalisierung und Wissensfragen
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Co-ordinators : Prof. Shiva Ji

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Co-ordinators : Dr. Varadraj Bapat

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Co-ordinators : Dr. Trupti Mishra

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[Lecture 60 - Ashtanga Yoga or Raj Yoga](#)

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[Lecture 62 - Three Pillars of Health](#)

[Lecture 63 - Spiritual Significance of Food](#)

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- Lecture 65 - Seasons with Revolving Sun and Impact on Physiology
- Lecture 66 - Contemporary Knowledge about Food and Mental Health
- Lecture 67 - Food and Activities during the Cycle of the Day
- Lecture 68 - Yogasanas to Integrate Body and Emotions
- Lecture 69 - Interoception, Asanas and Well-Being
- Lecture 70 - Characteristics of Asanas
- Lecture 71 - Process for Moving into Posture
- Lecture 72 - Asanas for Different Body Constitution
- Lecture 73 - Notes on Pranayama
- Lecture 74 - Contemporary Evidences of Prana
- Lecture 75 - Prana Vayu, Nadi System and Chakras
- Lecture 76 - Pranayama Practices and Conscious Breathing
- Lecture 77 - Process and Benefits of Diaphragmatic Breathing
- Lecture 78 - Guidelines for Pranayama
- Lecture 79 - Nadi Shodhana Pranayama (Alternate Nostril Breathing)
- Lecture 80 - Tranquilizing Pranayamas
- Lecture 81 - Organizational Suffering and Dysfunctional Behaviors
- Lecture 82 - Introduction to Pratyahara
- Lecture 83 - Indriya-Pratyahara: Control of the Senses
- Lecture 84 - Methods of Pratyahara
- Lecture 85 - Understanding Emotional Intelligence
- Lecture 86 - Emotional Intelligence and its Relation to Everyday Behavior
- Lecture 87 - How Yoga Helps in Emotional Balance
- Lecture 88 - Positive and Negative Emotions
- Lecture 89 - Dealing with Negative Emotions
- Lecture 90 - How Yoga Helps in Equanimity of Mind
- Lecture 91 - What are the 7 Stages of Wisdom
- Lecture 92 - What Yoga does for Balancing Emotions and Cognitions
- Lecture 93 - How Yoga Impacts Student's Performance: Empirical Studies

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NPTEL : Organisation Management (Management)

Co-ordinators : Prof. Vinayshil Gautam

- Lecture 1 - Introduction to Organization Management,Nature, Scope and Complexity
- Lecture 2 - Longitudinal thinking and legacy factor:Organizational Growth
- Lecture 3 - Longitudinal thinking and legacy factor:Organizational Growth (Continued...)
- Lecture 4 - Longitudinal thinking and legacy factor:Organizational Growth (Continued...)
- Lecture 5 - Theory and majors schools of Thought and Framework of Organizational Analysis
- Lecture 6 - Theory and majors schools of thought and framework of organizational analysis (Continued...)
- Lecture 7 - Theory and majors schools of thought and framework of organizational analysis (Continued...)
- Lecture 8 - Systems contingency approach to organization theory and practice; techniques of organizational diagnosis
- Lecture 9 - Systems contingency approach to organization theory and practice; techniques of organizational diagnosis (Continued...)
- Lecture 10 - Systems contingency approach to organization theory and practice; techniques of organizational diagnosis (Continued...)
- Lecture 11 - Theory of organizational structures - nature and consequence of structure
- Lecture 12 - Theory of organizational structures - nature and consequence of structure (Continued...)
- Lecture 13 - Socio-culture dimension of work and behavior
- Lecture 14 - Socio-culture dimension of work and behavior (Continued...)
- Lecture 15 - Socio-culture dimension of work and behavior (Continued...)
- Lecture 16 - Impact of environment and cultural variables on organization structure & style
- Lecture 17 - Impact of environment and cultural variables on organization structure & style (Continued...)
- Lecture 18 - Impact of environment and cultural variables on organization structure & style (Continued...)
- Lecture 19 - Organization Change and Organisation Development
- Lecture 20 - Organization Change and Organisation Development (Continued...)
- Lecture 21 - Intervention strategies for organization development - individual, Group and Interpersonal Interventions
- Lecture 22 - Intervention strategies for organization development - individual, Group & interpersonal interventions (Continued...)
- Lecture 23 - Intervention strategies for organization development - individual, Group & interpersonal interventions (Continued...)
- Lecture 24 - Total System Intervention & Stabilizing Change Management by Objectives
- Lecture 25 - Total System Intervention & Stabilizing Change Management by Objectives (Continued...)
- Lecture 26 - Total System Intervention & Stabilizing Change Management by Objectives (Continued...)
- Lecture 27 - Nature of Organisational Processes
- Lecture 28 - Nature of Organisational Processes (Continued...)
- Lecture 29 - Nature of Organisational Processes (Continued...)
- Lecture 30 - Environmental analysis Techniques and impact for organizational growth
- Lecture 31 - Environmental analysis Techniques and impact for organizational growth (Continued...)

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[Lecture 35 - Organisation Interdependence](#)

[Lecture 36 - Organisation Interdependence \(Continued...\)](#)

[Lecture 37 - Organisation Interdependence \(Continued...\)](#)

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[Lecture 39 - Organisation Evaluation \(Continued...\)](#)

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- Lecture 1 - Introduction to the subject and the course
- Lecture 2 - Understanding organizations: nature and functions
- Lecture 3 - Understanding organizations: nature and functions (Continued...)
- Lecture 4 - Concerns of organising engineering business and systems
- Lecture 5 - Concerns of organising engineering business and systems (Continued...)
- Lecture 6 - Concerns of organising engineering business and systems (Continued...)
- Lecture 7 - Structure and process issues in running organisations
- Lecture 8 - Structure and process issues in running organisations (Continued...)
- Lecture 9 - Design issues in running organisations
- Lecture 10 - Design issues in running organisations (Continued...)
- Lecture 11 - Operating organizations
- Lecture 12 - Operating organizations (Continued...)
- Lecture 13 - Operating organizations (Continued...)
- Lecture 14 - Cybernetics and systems framework
- Lecture 15 - Cybernetics and systems framework (Continued...)
- Lecture 16 - Socio-technical systems
- Lecture 17 - Socio-technical systems (Continued...)
- Lecture 18 - Socio-technical systems (Continued...)
- Lecture 19 - Dealing with efficiency and excellence
- Lecture 20 - Dealing with efficiency and excellence (Continued...)
- Lecture 21 - Dealing with efficiency and excellence (Continued...)
- Lecture 22 - Man-machine relationship
- Lecture 23 - Man-machine relationship (Continued...)
- Lecture 24 - Longitudinal Thinking
- Lecture 25 - Longitudinal Thinking (Continued...)
- Lecture 26 - Concerns of recruitment, selection, skill formation and redeployment
- Lecture 27 - Concerns of recruitment, selection, skill formation and redeployment (Continued...)
- Lecture 28 - Concerns of recruitment, selection, skill formation and redeployment (Continued...)
- Lecture 29 - Developing teams and leadership
- Lecture 30 - Developing teams and leadership (Continued...)
- Lecture 31 - Understanding motivation

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[Lecture 33 - Elements of human resources planning](#)

[Lecture 34 - Elements of human resources planning \(Continued...\)](#)

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[Lecture 36 - Indian Industrial Law and managing industrial](#)

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[Lecture 38 - Indian Industrial Law and managing industrial \(Continued...\)](#)

- Lecture 1 - Concepts of Economic Growth and Development
- Lecture 2 - Structural features of developed and underdeveloped countries
- Lecture 3 - The Global North and the Global South: Why the Divide?
- Lecture 4 - Growth versus Development - some indices of economic development
- Lecture 5 - Modern Economic Growth
- Lecture 6 - Strategies of economic development and growth - I
- Lecture 7 - Strategies of economic development and growth - II
- Lecture 8 - Strategies of economic development and growth - III
- Lecture 9 - Strategies of economic development and growth - IV
- Lecture 10 - Strategies of economic development and growth - V
- Lecture 11 - Strategies of economic development and growth - VI
- Lecture 12 - Growth and Inequality
- Lecture 13 - Economic Growth and Public Support
- Lecture 14 - Measures of Inequality
- Lecture 15 - Introduction to Human Development-Putting People First
- Lecture 16 - The Human Development and Capability Approach
- Lecture 17 - Utilitarianism, Basic Needs Approach and the Capability Approach
- Lecture 18 - Measuring Human Development - I
- Lecture 19 - Measuring Human Development - II
- Lecture 20 - Other Human Development Indices
- Lecture 21 - Multidimensional Poverty, MDGs and SDGs
- Lecture 22 - Gender mainstreaming and Gender budgeting
- Lecture 23 - In Conclusion

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Lecture 1 - Introduction Examples: Markets / Politics / Auctions

Lecture 2 - Prisonersâ€™ Dilemma

Lecture 3 - Best Response and Nash Equilibrium

Lecture 4 - Another Example: Markets

Lecture 5 - Dominant Strategies

Lecture 6 - Stag Hunt â€™ Coordination and Bank Runs

Lecture 7 - Battle of Sexes and Multiple Nash Equilibria

Lecture 8 - Tragedy of Commons

Lecture 9 - Tragedy of Commons

Lecture 10 - Cournot Duopoly

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Lecture 12 - Mixed Strategies

Lecture 13 - Battle of Sexes

Lecture 14 - Battle of Sexes: Best Response Dynamic

Lecture 15 - Paying Taxes

Lecture 16 - Portfolio Management Game

Lecture 17 - Rationality, Choice and Common Knowledge

Lecture 18 - Iterated Elimination of Domination Strategies

Lecture 19 - Auction

Lecture 20 - Auction: As a Normal Form Game

Lecture 21 - Traffic at Equilibrium and Braess Paradox

Lecture 22 - Linear Markets

Lecture 23 - Extensive Form Games

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Lecture 27 - Sub Game Perfect Equilibrium Part-I

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NPTEL : NOC:Managing Services (Management)

Co-ordinators : Prof. Jayanta Chatterjee

- Lecture 1 - What is Service?
- Lecture 2 - Evolving Service Markets
- Lecture 3 - The Service Customers
- Lecture 4 - Product Service Systems
- Lecture 5 - The Service Act
- Lecture 6 - Seamless Service
- Lecture 7 - Service Management Elements
- Lecture 8 - Core Vs. Supplementary Services
- Lecture 9 - Intangibility of Services
- Lecture 10 - Response to IHIP Challenges
- Lecture 11 - Process & Promotion
- Lecture 12 - Process Issues in Service
- Lecture 13 - Challenges of Services-1
- Lecture 14 - Service Uniqueness-2
- Lecture 15 - Consumer in the Services Flow-1
- Lecture 16 - Service Consumer Behavior-2
- Lecture 17 - Customer Co Creation of Services-1
- Lecture 18 - Customer Co Creation of Services-2
- Lecture 19 - Current Service Map to New Service Design
- Lecture 20 - Current Service Map to New Service Design.
- Lecture 21 - Case Study on Service Excellence-1
- Lecture 22 - Case Study on Service Excellence-2
- Lecture 23 - Services Excellence - Culture
- Lecture 24 - People in Services
- Lecture 25 - Position - Value Proposition-1
- Lecture 26 - Position - Value Proposition-2
- Lecture 27 - Branding Services-1
- Lecture 28 - Distributing Services
- Lecture 29 - Distributing Services
- Lecture 30 - Network of Services
- Lecture 31 - Strategy for Service Businesses

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Lecture 3 - Case Studies

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Lecture 5 - Evolution of Marketing

Lecture 6 - Contemporary Issues in Modern Marketing Practices

Lecture 7 - Introduction to Competitor Analysis

Lecture 8 - Marketing Objectives

Lecture 9 - Strategy and Core Competency

Lecture 10 - PESTEL Framework

Lecture 11 - Competitive Analysis

Lecture 12 - Case Study

Lecture 13 - Introduction To Marketing Information System

Lecture 14 - Components of a Marketing Information System

Lecture 15 - Marketing Research Process

Lecture 16 - MDP and MRP

Lecture 17 - Exploratory Research

Lecture 18 - Exploratory Research (Continued...)

Lecture 19 - Causal Research

Lecture 20 - Measurement and Scaling

Lecture 21 - Questionnaire and Sampling

Lecture 22 - Sampling Techniques

Lecture 23 - Data Collection, Preparation and Analysis

Lecture 24 - Multivariate Data Analysis

Lecture 25 - Introduction to Consumer Behaviour and Need Recognition

Lecture 26 - Information Search

Lecture 27 - Socio-Cultural Influences on the Consumer Buying Process

Lecture 28 - Psychological Influences on Consumer Buying Process

Lecture 29 - Evaluation of Alternatives

Lecture 30 - Purchase and Post Purchase Evaluation

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[Lecture 35 - Industrial Marketing Program and Buying Process](#)

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Lecture 3 - Product - An Important Component of the 4P

Lecture 4 - New Product Development - I

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Lecture 8 - Diffusion of Innovation

Lecture 9 - Product Life Cycle and Introduction to Strategy

Lecture 10 - Strategy for New Product Introduction - I

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Lecture 12 - Marketing Strategies for Different Stages in PLC

Lecture 13 - Introduction to Brand, Branding and Brand Equity

Lecture 14 - Strategic Brand Management Process

Lecture 15 - Brand Building - I

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Lecture 17 - Secondary Associations of a Brand and Advantages of Brand

Lecture 18 - Measuring Brand Equity and other Brand Related Constructs

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Lecture 20 - Brand Message and Advantage of Brand

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Lecture 23 - Strategic Brand Management

Lecture 24 - Creating a Powerful Brand

Lecture 25 - Introduction to Pricing

Lecture 26 - Considerations for Setting the Price

Lecture 27 - Determining the Demand and Cost Estimation

Lecture 28 - Cost Estimation and Break Even Analysis

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Lecture 30 - Different Methods of Pricing - II

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[Lecture 40 - Models of Communication](#)

[Lecture 41 - Designing and Implementing Marketing Communication](#)

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[Lecture 45 - Failure of Service and Solutions](#)

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[Lecture 47 - Recap of Important Concepts - I](#)

[Lecture 48 - Recap of Important Concepts - II](#)

NPTEL : NOC:Project Management (Management)

Co-ordinators : Prof. Raghunandan Sengupta

Lecture 1 - Introduction to Project Management

Lecture 2 - Introduction to Agile Project Management

Lecture 3 - Project Management Process for a Project - I

Lecture 4 - Project Management Process for a Project - II

Lecture 5 - Project Management Process for a Project - III

Lecture 6 - Project Stakeholder and Risk Management

Lecture 7 - Project Risk Management

Lecture 8 - Solving Project Management Decision Problems

Lecture 9 - Project Risk Management Analysis - I

Lecture 10 - Project Risk Management Analysis - II

Lecture 11 - Analytic Hierarchy Process for Project Selection

Lecture 12 - Decision Tree Analysis

Lecture 13 - Decision Tree Analysis and Risk Management

Lecture 14 - Application of Utility Theory in Project Management - I

Lecture 15 - Application of Utility Theory in Project Management - II

Lecture 16 - Application of Utility Theory in Project Management - III

Lecture 17 - Application of Utility Theory in Project Management - IV

Lecture 18 - Other Criteria used for Project Selection

Lecture 19 - Work Breakdown Structure in Project Management

Lecture 20 - Activity Networks used in Project Management

Lecture 21 - Concept of Critical Path Method (CPM) and Introduction to PERT

Lecture 22 - Program Evaluation Review Technique (PERT) - I

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Lecture 24 - Aspects and applications of CPM and PERT

Lecture 25 - Concepts of a Project Life Cycle

Lecture 26 - Discounting Rates and Project Pricing

Lecture 27 - Concept of Forward Rates and Payback Time

Lecture 28 - Important Example of PERT Network involving Probabilistic time and variance

Lecture 29 - Scheduling and Crashing of Jobs

Lecture 30 - Resource levelling and resource constraint

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Lecture 1 - Systems Engineering – What is, origin and examples

Lecture 2 - Systems Engineering as a profession

Lecture 3 - Systems Engineering Management (SEM)

Lecture 4 - SEM - Lifecycle Integration

Lecture 5 - Systems Engineering - Modern Version

Lecture 6 - Overview of Systems Engineering Process

Lecture 7 - System Design Process

Lecture 8 - Systems View Point

Lecture 9 - Complex Systems and System Development Process

Lecture 10 - System Environments

Lecture 11 - System Interfaces and Interactions

Lecture 12 - System Development Process

Lecture 13 - System Engineering Life Cycle Stages

Lecture 14 - System Engineering Life Cycle Stages (Continued...)

Lecture 15 - Requirement Analysis

Lecture 16 - Requirement Analysis (Continued...)

Lecture 17 - Unmanned Aerial Systems - A Systems Engineering Case Study

Lecture 18 - Discussion about Systems Engineering and System Thinking with Professor Ian Angell

Lecture 19 - Demonstration of real life systems by the Indian Army

Lecture 20 - Need Analysis

Lecture 21 - Functional Analysis

Lecture 22 - Functional Flow Block Diagram

Lecture 23 - Quality Function Deployment

Lecture 24 - Timeline Analysis Sheet and Requirement Allocation Sheet

Lecture 25 - Design Synthesis

Lecture 26 - Design Synthesis (Continued...)

Lecture 27 - Design Synthesis Tools

- Lecture 1 - Quality and its Dimensions
- Lecture 2 - Quality and Variability
- Lecture 3 - History of Quality Control
- Lecture 4 - Management Aspects of Quality - I
- Lecture 5 - Management aspects of Quality - II
- Lecture 6 - Introduction to Concepts of Probability
- Lecture 7 - Six Sigma Overview
- Lecture 8 - DMAIC for Problem Solving
- Lecture 9 - DMAIC examples and DMADV
- Lecture 10 - Quality Improvement
- Lecture 11 - 7 Old Tools for Quality Assurance
- Lecture 12 - 7 New Tools for Quality Assurance
- Lecture 13 - CPM, PDPC and Introduction To House of Quality
- Lecture 14 - Building the House of Quality
- Lecture 15 - Introduction to Acceptance Sampling
- Lecture 16 - The Operating Characteristic Curve
- Lecture 17 - The OC curve and Sampling Plans
- Lecture 18 - Double Sampling
- Lecture 19 - Sequential Sampling, Military Standard and Introduction to R
- Lecture 20 - Basic Understanding of R and Introduction to Control Charts
- Lecture 21 - Basics of X bar and R chart
- Lecture 22 - Usage of X bar chart and R chart
- Lecture 23 - Variable Sample Size in X bar and R chart
- Lecture 24 - Patterns in Charts
- Lecture 25 - S chart and OC curve
- Lecture 26 - S square chart and MR chart
- Lecture 27 - Attribute charts- The p chart
- Lecture 28 - np control chart
- Lecture 29 - Estimating control limits with varying sample size
- Lecture 30 - OC curve, c and u charts
- Lecture 31 - u, g and h chart

[Lecture 32 - Introduction to Process Capability Analysis](#)

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- Lecture 1 - Similarities and Differences
- Lecture 2 - Theoretical Foundations I Competitive Strategy
- Lecture 3 - Theoretical Foundations II Product Strategy
- Lecture 4 - Theoretical Foundations III Understanding Customer Behaviour
- Lecture 5 - Theoretical Foundations IV Product Life Cycle (PLC) and Chasm
- Lecture 6 - Theoretical Foundations V Product Platforms and Portfolios
- Lecture 7 - Theoretical Foundations VI Understanding Customers (STP)
- Lecture 8 - STP continued
- Lecture 9 - Understanding Product Platforms
- Lecture 10 - The Idea Generation process
- Lecture 11 - Creating Customer Value Proposition
- Lecture 12 - Lean Product Process
- Lecture 13 - Estimating Marketing and Sales Potential
- Lecture 14 - Introduction to New Product Forecasting Techniques
- Lecture 15 - Diffusion process and Product Life Cycle
- Lecture 16 - Technology Adoption Life Cycle and Crossing the Chasm
- Lecture 17 - Managing New Products in Large Organizations
- Lecture 18 - Introduction to the Stage Gate model
- Lecture 19 - What is a Lean Startup
- Lecture 20 - The Business Model Canvas
- Lecture 21 - Introduction to Intellectual Property Rights
- Lecture 22 - Taking the Product to the Market - Deployment Strategies

Lecture 1 - Introduction to Statistics

Lecture 2 - Introduction to Probability Theory

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Co-ordinators : Prof. Jayanta Chatterjee

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NPTEL : Econometric Modelling (Management)

Co-ordinators : Dr. Rudra P. Pradhan

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- Lecture 20 - Multicollinearity Problem
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- Lecture 22 - Autocorrelation Problem
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- Lecture 24 - Heteroscedasticity Problem
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- Lecture 26 - Dummy Modelling
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- Lecture 28 - LOGIT and PROBIT Model
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NPTEL : Organizational Behaviour (Management)

Co-ordinators : Dr. Susmita Mukhopadhyay

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- Lecture 4 - Social System and Organizational Culture (Continued...)
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- Lecture 12 - Perceptions and Attributions (Continued...)
- Lecture 13 - Motivation
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- Lecture 15 - Job Design, Work and Motivation
- Lecture 16 - Job Design, Work and Motivation (Continued...)
- Lecture 17 - Evaluation, Feedback and Rewards
- Lecture 18 - Evaluation, Feedback and Rewards (Continued...)
- Lecture 19 - Managing Misbehaviour
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- Lecture 21 - Counseling
- Lecture 22 - Informal and Formal Groups
- Lecture 23 - Teams and Teambuilding
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- Lecture 26 - Power and Politics
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- Lecture 28 - Assertive Behaviour and Transactional Analysis
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- Lecture 3 - Risk and Return
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- Lecture 5 - Organization and Function of Equity and Debt Markets
- Lecture 6 - Mutual Funds
- Lecture 7 - Market Efficiency - Concepts and forms of efficiency
- Lecture 8 - Testing Market Efficiency
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- Lecture 13 - Economic Analysis - I
- Lecture 14 - Economic Analysis - II
- Lecture 15 - Industry Analysis - I
- Lecture 16 - Industry Analysis - II
- Lecture 17 - Company Analysis - I
- Lecture 18 - Company Analysis - II
- Lecture 19 - Technical Analysis - I
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- Lecture 21 - Introduction to Portfolio Management
- Lecture 22 - Introduction to Portfolio Management (Continued...)
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Co-ordinators : Dr. Sangeeta Sahney

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NPTEL : International Finance (Management)

Co-ordinators : Dr. Arun K. Misra

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- Lecture 3 - Gold Standard
- Lecture 4 - Purchasing Power Parity
- Lecture 5 - Floating and Fixed Exchange Rate Regimes
- Lecture 6 - Currency Boards and Currency Basket Systems
- Lecture 7 - Features of Foreign Exchange Market
- Lecture 8 - Exchange Rate Arithmetic
- Lecture 9 - Understanding Merchant Rates
- Lecture 10 - Foreign Exchange Forward Contracts
- Lecture 11 - Value at Risk for Foreign Exchange Market
- Lecture 12 - International Parity Conditions and Movement Exchange Rate
- Lecture 13 - Exchange Rate Determination and Forecasting
- Lecture 14 - Development of Foreign Exchange Market in India
- Lecture 15 - Foreign Exchange Exposures : Transaction Exposure
- Lecture 16 - Transaction Exposure Management
- Lecture 17 - Foreign Exchange Futures Market for Transaction Exposure Management
- Lecture 18 - Foreign Currency Options : Transaction Exposure Management
- Lecture 19 - Interest Rate Swaps
- Lecture 20 - Currency Swaps
- Lecture 21 - Operating Exposure Assessment
- Lecture 22 - Operating Exposure Management
- Lecture 23 - International Capital Structure and Capital Assets Pricing Model
- Lecture 24 - International Capital Budgeting
- Lecture 25 - Evaluation of Foreign Direct Investment
- Lecture 26 - Cross Listing of Shares : Depository Receipts
- Lecture 27 - International Financial Integration
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- Lecture 29 - India's Forex Reserves Composition and Determinants of Optimum Reserves
- Lecture 30 - Movement of Exchange Rates in India
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- Lecture 4 - Sampling distribution
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- Lecture 8 - Multivariate descriptive statistics
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- Lecture 10 - Multivariate normal distribution
- Lecture 11 - Multivariate normal distribution (Continued...)
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- Lecture 16 - Multivariate Analysis of Variance (MANOVA)
- Lecture 17 - MANOVA (Continued...)
- Lecture 18 - Tutorial - ANOVA
- Lecture 19 - Tutorial ANOVA (Continued...)
- Lecture 20 - MANOVA - Case Study
- Lecture 21 - Multiple Regression – Introduction
- Lecture 22 - MLR - Sampling distribution of regression coefficients
- Lecture 23 - MLR - Model adequacy tests
- Lecture 24 - MLR - Test of assumptions
- Lecture 25 - MLR - Model diagnostics
- Lecture 26 - MLR - Case Study
- Lecture 27 - Multivariate Linear Regression
- Lecture 28 - Multivariate Linear Regression - Estimation
- Lecture 29 - Multivariate Linear Regression - Model Adequacy tests
- Lecture 30 - Principal Component Analysis (PCA)
- Lecture 31 - PCA - Model Adequacy & Interpretation

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Lecture 8 - Cost Management Systems and Activity Costing Systems

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Lecture 12 - Double - Entry Bookkeeping

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Lecture 23 - Comparison of Alternatives (Continued...)

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- Lecture 2 - Introduction to Commodity Derivatives and Risk Management (Continued...)
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- Lecture 6 - Commodity Options and Commodity Spreads
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- Lecture 28 - Introduction to Gold and Gold Derivatives
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NPTEL : NOC:Performance and Reward Management (Management)

Co-ordinators : Dr. Susmita Mukhopadhyay

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Lecture 3 - Understanding meaning of performance management and reward systems management with performance management process (Continued...)

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Lecture 5 - Understanding meaning of performance management and reward systems management with performance management process (Continued...)

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Lecture 7 - Developing an understanding as to why performance management and reward management are of strategic importance and their role in strategic planning (Continued...)

Lecture 8 - Developing an understanding as to why performance management and reward management are of strategic importance and their role in strategic planning (Continued...)

Lecture 9 - Developing an understanding as to why performance management and reward management are of strategic importance and their role in strategic planning (Continued...)

Lecture 10 - Developing an understanding as to why performance management and reward management are of strategic importance and their role in strategic planning (Continued...)

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Lecture 12 - Implementation of a performance management system, defining performance and choosing a measurement approach and understanding the meaning of results (Continued...)

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Lecture 17 - Implementing a performance management system in your organization (Continued...)

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Lecture 22 - Role of performance management in employee development, addressing performance management skills and team reward management (Continued...)

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Lecture 23 - Role of performance management in employee development, addressing performance management skills and team reward management (Continued...)

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Lecture 26 - Overview, reward system, understanding total, strategic and international reward

Lecture 27 - Overview, reward system, understanding total, strategic and international reward (Continued...)

Lecture 28 - Overview, reward system, understanding total, strategic and international reward (Continued...)

Lecture 29 - Overview, reward system, understanding total, strategic and international reward (Continued...)

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Lecture 31 - Understanding linkage between performance management and reward, an overview of various types of reward; financial reward, non-financial reward; contingent pay scheme; bonus scheme; team pay ; rewarding for business performance; recognition sc

Lecture 32 - Understanding linkage between performance management and reward, an overview of various types of reward; financial reward, non-financial reward; contingent pay scheme; bonus scheme; team pay ; rewarding for business performance; recognition sc

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Lecture 35 - Understanding linkage between performance management and reward, an overview of various types of reward; financial reward, non-financial reward; contingent pay scheme; bonus scheme; team pay ; rewarding for business performance; recognition sc

Lecture 36 - Understanding linkage between performance management and reward, an overview of various types of reward; financial reward, non-financial reward; contingent pay scheme; bonus scheme; team pay ; rewarding for business performance; recognition sc

Lecture 37 - Valuing and grading jobs, understanding pay levels, job evaluation schemes, equal pay, market rate analysis, designing of grade and pay structure

Lecture 38 - Valuing and grading jobs, understanding pay levels, job evaluation schemes, equal pay, market rate analysis, designing of grade and pay structure (Continued...)

Lecture 39 - Valuing and grading jobs, understanding pay levels, job evaluation schemes, equal pay, market rate analysis, designing of grade and pay structure (Continued...)

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Lecture 41 - Valuing and grading jobs, understanding pay levels, job evaluation schemes, equal pay, market rate analysis, designing of grade and pay structure (Continued...)

Lecture 42 - Rewarding Special Groups, rewarding directors and senior executives, sales and customer service staff, knowledge workers and manual workers

Lecture 43 - Rewarding Special Groups, rewarding directors and senior executives, sales and customer service staff, knowledge workers and manual workers (Continued...)

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Lecture 21 - Space calculation in a warehouse : Space calculation for racks

Lecture 22 - Order Picking; Material handling equipment's

Lecture 23 - Material Safety and Safety Equipment's

Lecture 24 - Automated storage and replenishment systems (AS/RS)

Lecture 25 - Managerial Decision making in the context of warehousing and materials management

Lecture 26 - Issues in HR; Employee Selection

Lecture 27 - Employee Selection, Promotion and Deployment Method - Lp Method

Lecture 28 - Employee Selection, Promotion and Deployment Method - Rating and ranking Method ; Clustering

Lecture 29 - Employee Selection, Promotion and Deployment Method - BCG

Lecture 30 - Strategizing for Business, the SWOT and Porter's Framework Revisited

Lecture 31 - Fortune at the Bottom of the Pyramid, GE, Rule of Three

- Lecture 32 - Self Actualisation Needs, Rural Marketing Challenges
- Lecture 33 - Rural Marketing; Balanced ScoreCard
- Lecture 34 - Evaluating Investment Proposals : NPV, IRR
- Lecture 35 - Costing and Pricing for Public Transport
- Lecture 36 - Costing and Pricing for Hospitals
- Lecture 37 - Decision Support Systems for Marketing : Decision Support Systems for Media Selection Model
- Lecture 38 - Decision Support Systems for Marketing : Decision Support Systems for Media Selection Model (Continued...)
- Lecture 39 - Decision Support Systems for Marketing : Decision Support Systems for Product Pricing Model
- Lecture 40 - Pricing : Model Selection Using Cross - Validation
- Lecture 41 - Taxation and the Distribution Network
- Lecture 42 - Transshipment; Flexibility and Six Sigma
- Lecture 43 - Flexibility and Total Cost of the Network
- Lecture 44 - Risk Analysis for the Distribution Network
- Lecture 45 - Echelons in the Network
- Lecture 46 - Concept of Variability and Six Sigma
- Lecture 47 - Concept of Variability and Six Sigma (Continued...)
- Lecture 48 - Roadmap to Six Sigma; Ishikawa Diagram and SIPOC
- Lecture 49 - Service Systems : Characteristics; Failure and Recovery
- Lecture 50 - Decision Support Systems for Inventory
- Lecture 51 - Decision Support Systems for Inventory (Continued...)
- Lecture 52 - Decision Support Systems for Inventory (Continued...)
- Lecture 53 - Decision Support Systems for Inventory (Continued...)
- Lecture 54 - Decision Support Systems for Inventory (Continued...)
- Lecture 55 - Decision Support Systems for Operations Management
- Lecture 56 - Decision Support Systems for Operations Management (Continued...)
- Lecture 57 - Decision Support Systems for Operations Management (Continued...)
- Lecture 58 - Decision Support Systems for Operations Management (Continued...)
- Lecture 59 - Decision Support Systems for Operations Management (Continued...)
- Lecture 60 - DSS for Multi - Item Production - Distribution Planning

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Lecture 2 - Introduction - Part 2

Lecture 3 - Dimensions of Information System

Lecture 4 - Information Management in the digital world

Lecture 5 - Class discussions and conclusion

Lecture 6 - Data bases and information management

Lecture 7 - Data warehouse and business intelligence

Lecture 8 - Introduction to data mining

Lecture 9 - Data analytics tools and techniques

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Lecture 11 - ERP - Evolution and Benefits

Lecture 12 - Business Benrfits of ERP

Lecture 13 - ERP project management: Challenge, risks and best practices

Lecture 14 - Change management and conclusion

Lecture 15 - Customer relationship management

Lecture 16 - Supply Chain Management - Part 1

Lecture 17 - Supply Chain Management - Part 2

Lecture 18 - Supplier relationship management

Lecture 19 - Product lifecycle maintenance

Lecture 20 - Information Systems for manufacturing management

Lecture 21 - Information Systems for manufacturing management (Continued...)

Lecture 22 - Information Systems for materials management

Lecture 23 - Information Systems for quality management

Lecture 24 - Information Systems for marketing

Lecture 25 - Information Systems for marketing (Continued...)

Lecture 26 - Information Systems for sales and distribution

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Lecture 28 - Information Systems for human resource management

Lecture 29 - Information Systems for human resource management (Continued...)

Lecture 30 - Information Systems (IS) strategy

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- Lecture 32 - Balanced Score Card
- Lecture 33 - Data Centers, Virtualization and cloud computing
- Lecture 34 - Cloud computing and selection of cloud vendor
- Lecture 35 - Introduction to E-Commerce
- Lecture 36 - B2C Business Models
- Lecture 37 - B2C Business Models (Continued...)
- Lecture 38 - Unique E-Commerce Business Models
- Lecture 39 - Social Commerce and M-Commerce
- Lecture 40 - Cloud Computing - Part I
- Lecture 41 - Cloud Computing - Part II
- Lecture 42 - Internet of Things - Part I
- Lecture 43 - Internet of Things - Part II
- Lecture 44 - Internet of Things - Part III
- Lecture 45 - Big Data and other Emerging Technologies
- Lecture 46 - Knowledge Management Systems (KMS)
- Lecture 47 - Decision Support Systems
- Lecture 48 - Executive Support Systems
- Lecture 49 - Expert Systems
- Lecture 50 - Learning Management Systems (LMS)
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- Lecture 52 - Ethical and Social Issues in MIS - II
- Lecture 53 - Security Issues in MIS - I
- Lecture 54 - Security Issues in MIS - II
- Lecture 55 - Security Issues in MIS - III
- Lecture 56 - Managing Global Organization - Globalization - Part 1
- Lecture 57 - Global Strategies and Business Organization
- Lecture 58 - Shared Services
- Lecture 59 - Offshoring/Transitioning Global IT Systems
- Lecture 60 - Globalization of Corporates in a Flat World

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Lecture 2 - Correlation and Causality

Lecture 3 - Correlation and Causality (Continued...)

Lecture 4 - Correlation and Causality (Continued...)

Lecture 5 - Probability Theory

Lecture 6 - Probability Theory (Continued...)

Lecture 7 - Probability Theory (Continued...)

Lecture 8 - Probability Theory (Continued...)

Lecture 9 - Posterior Probability

Lecture 10 - Bayesian Theorem

Lecture 11 - Bayesian Theorem (Continued...): Repeated Trial

Lecture 12 - Bayesian Theorem (Continued...): Example of Diamond Identification

Lecture 13 - Probability Distribution

Lecture 14 - Double Structure of Variable

Lecture 15 - Probability Distribution (Discrete/Continuous Variable) Random Variable

Lecture 16 - Probability Mass Function (PMF) Probability Density Function (PDF)

Lecture 17 - Expectation, Variance, Covariance

Lecture 18 - Expectation, Variance, Covariance (Continued...)

Lecture 19 - Covariance Rule

Lecture 20 - Bernoulli Distribution

Lecture 21 - Bernoulli Distribution (Continued...)

Lecture 22 - Normal Approximation of Bernoulli Distribution

Lecture 23 - Sampling

Lecture 24 - Sampling (Continued...)

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[Lecture 55 - Multicollinearity \(Continued...\)](#)

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[Lecture 57 - Dummy Variable](#)

[Lecture 58 - Dummy variable \(Continued...\)](#)

[Lecture 59 - Dummy variable \(Continued...\)](#)

[Lecture 60 - Dummy variable \(Continued...\)](#)

[Lecture 61 - Dummy variable \(Continued...\)](#)

[Lecture 62 - Dummy variable \(Continued...\)](#)

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[Lecture 64 - Heteroscedasticity](#)

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- Lecture 55 - Factors of Success, Advantages and Disadvantages of Virtual Teams
- Lecture 56 - Evaluating Teams
- Lecture 57 - Steps of Evaluation
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Lecture 4 - Product Design and Manufacturing Systems

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- Lecture 36 - Types and Definitions of of Flexibility in Manufacturing Systems
- Lecture 37 - Volume-Variety Relationships in Production Systems, What is FMS?
- Lecture 38 - Basic Features of FMS: PhysicalSubsystems
- Lecture 39 - Basic Features of FMS: Control Subsystems and Manufacturing Control Activities.
- Lecture 40 - Types of Problems in FMS
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- Lecture 42 - Operational Problems in FMS: Tools and Techniques - 2, Numerical Examples
- Lecture 43 - Tool Allocation Policies in FMS, Numerical Examples
- Lecture 44 - Fixture and Pallet Selection Problems: Numerical Examples
- Lecture 45 - Types of FMS Layout, Relative Advantages
- Lecture 46 - Fundamentals of Robotics and its Applications
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- Lecture 55 - CIN and CAPP, Process Optimization and CAPP
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NPTEL : NOC:Retail Management (Management)

Co-ordinators : Prof. Swagato Chatterjee

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- Lecture 10 - Corporate Governance a Way Forward
- Lecture 11 - Concept, Scope and Features of PIT
- Lecture 12 - Investigation and Prohibition on Dealing, Counselling
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- Lecture 15 - Insider trading examples, PIT Recent Cases and Insider Trading Initiatives
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- Lecture 17 - Concept of Offer, Valid Offer and Essentials of Valid Offer
- Lecture 18 - Concept of Fraud, Misrepresentation and Consideration
- Lecture 19 - Major Issues related to Contract
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- Lecture 21 - Background, Concept and Salient Features of Factories Act
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- Lecture 48 - Statistical Measures of Safety Program Effectiveness - II
- Lecture 49 - Statistical Measures of Safety Program Effectiveness - III
- Lecture 50 - Intervention Design
- Lecture 51 - Risk Based Decision Making - I
- Lecture 52 - Risk Based Decision Making - II
- Lecture 53 - Risk Based Maintenance - I
- Lecture 54 - Risk Based Maintenance - II
- Lecture 55 - Introduction to Behavioral Safety
- Lecture 56 - Behavioral Safety Data Collection and Preliminary Analysis
- Lecture 57 - Causal Modelling - I
- Lecture 58 - Causal Modelling - II: Application of Path Model
- Lecture 59 - Injury Epidemiology
- Lecture 60 - Occupational Safety, Health and Working Conditions Code, 2020 Analytics

Lecture 1 - Introduction and Concept - I

Lecture 2 - Introduction and Concept - II

Lecture 3 - Analysis of micro and macro environment - I

Lecture 4 - Analysis of micro and macro environment - II

Lecture 5 - Competition and Competitive Advantage - I

Lecture 6 - Competition and Competitive Advantage - II

Lecture 7 - Competition and Competitive Advantage - III

Lecture 8 - Framework for Internal Analysis of Firm - I

Lecture 9 - Framework for Internal Analysis of Firm - II

Lecture 10 - Value Chain Analysis

Lecture 11 - Resource-based view of firm and sustainability

Lecture 12 - Strategy Formulation - I

Lecture 13 - Strategy Formulation - II

Lecture 14 - Strategy Formulation - III

Lecture 15 - Diversification - I

Lecture 16 - Diversification - II

Lecture 17 - Mergers and Acquisitions - I

Lecture 18 - Mergers and Acquisitions - II

Lecture 19 - Portfolio Analysis and Display Matrices - I

Lecture 20 - Portfolio Analysis and Display Matrices - II

Lecture 21 - Operating and Financial Analysis

Lecture 22 - Complexities and Challenges of Competing in Global Markets - I

Lecture 23 - Complexities and Challenges of Competing in Global Markets - II

Lecture 24 - Entry Mode Strategies and Main Approaches for International Business

Lecture 25 - Building Competitive Advantage in International Markets

Lecture 26 - Strategies for competing in developing markets, and defending against global giants

Lecture 27 - Resource Allocation

Lecture 28 - 7-S Framework for Organizational Change

Lecture 29 - Strategy Implementation Issues

Lecture 30 - Matching organization structure to strategy

Lecture 31 - Forms of Organization

- Lecture 32 - Boundaryless Organization
- Lecture 33 - Strategic Leadership - I
- Lecture 34 - Strategic Leadership - II
- Lecture 35 - Universal Inner Structure of Effective Leaders
- Lecture 36 - Strategic Leadership - IV
- Lecture 37 - Business and Operational Excellence
- Lecture 38 - Strategic and Operational Control
- Lecture 39 - Balanced Scorecard Approach
- Lecture 40 - Roles and Responsibilities of Board of Directors
- Lecture 41 - Strategic Management Role and Style of the Board
- Lecture 42 - Composition, structure and other requirements of Board
- Lecture 43 - Improve Board Effectiveness, Board and Directorsâ€™ Performance Evaluation
- Lecture 44 - Corporate Governance Code
- Lecture 45 - Corporate Social Responsibility and Sustainability
- Lecture 46 - Social Auditing
- Lecture 47 - Innovation for Survival and Growth - I
- Lecture 48 - Innovation for Survival and Growth - II
- Lecture 49 - Entrepreneurship and Intrapreneurship
- Lecture 50 - Technology Management - I
- Lecture 51 - Technology Management - II
- Lecture 52 - In-house Development of Technology
- Lecture 53 - Strategic Importance of Knowledge and Organizational Learning
- Lecture 54 - Strategies for Knowledge Management
- Lecture 55 - Developing Strategic Plan of a Major Oil Company - I
- Lecture 56 - Developing Strategic Plan of a Major Oil Company - II
- Lecture 57 - Developing Strategic Plan of a Major Oil Company - III
- Lecture 58 - Summary of Modules 1-6
- Lecture 59 - Summary of Modules 7-11
- Lecture 60 - Summary of Modules 12-18

- Lecture 1 - Definition, purpose, and development of Human Factors and Ergonomics
- Lecture 2 - Types and components of worksystems, their interactions and evaluations
- Lecture 3 - Human components, machine components and environment components of worksystems
- Lecture 4 - Modern worksystems, FMJ vs FJM
- Lecture 5 - Contribution of human factors in systems design, engineering and management
- Lecture 6 - Anthropometry in product/process design, MHD, anthropometric design motto
- Lecture 7 - Types of anthropometric data, principles of applied anthropometry
- Lecture 8 - Examples of anthropometric design, numerical exercises
- Lecture 9 - Working Posture Analysis, Postural Triangle, Design for Seated and Standing Workers - Part 1
- Lecture 10 - Working Posture Analysis, Postural Triangle, Design for Seated and Standing Workers - Part 2
- Lecture 11 - Metabolism during work, Aerobic and anaerobic work, oxygen uptake
- Lecture 12 - Physical work capacity and energy expenditure, Individual differences, RWL, MOW
- Lecture 13 - MOE expenditure, Subjective measures of physical effort, Borg RPE scale, Factors
- Lecture 14 - EE of various operations in agriculture, construction and manufacturing industry - I
- Lecture 15 - EE of various operations in agriculture, construction and manufacturing industry - II
- Lecture 16 - Types of Injury Problems in Manual Handling Tasks, Types of Activities and Body Movements
- Lecture 17 - Biomechanical Modelling and Analysis of Manual Lifting
- Lecture 18 - Definitions and Standards of Lifting: NIOSH Lifting Equation
- Lecture 19 - EC Guidelines, UK Health and Safety Commission Guidelines
- Lecture 20 - Use of Material Handling Aids, Types of Material Handling Devices, Numerical Problems
- Lecture 21 - Ergonomic Problems in Computer Workstations, Design Elements of Computer Workstation
- Lecture 22 - Specifications of Computer Workstation Design Elements
- Lecture 23 - Methods to Reduce Glare/Reflection on Screen
- Lecture 24 - Design of Human-Computer Interaction
- Lecture 25 - Evolution of Technology in Computer Screen, Numerical Problems
- Lecture 26 - Work Postures and Related Complaints, Work Postures for Different Tasks, Task Analysis
- Lecture 27 - Power Law of Practice, Learning Curve, Numerical Pro
- Lecture 28 - Work Posture Assessment, Rapid Entire Body Assessment (REBA), MSDs/RMIs
- Lecture 29 - Hand tool design: Fitting the task, user and hand, Usage of hand tools and types of
- Lecture 30 - Design guidelines for hand tools
- Lecture 31 - Environment Component in Worksystems, Ergonomic Design of Physical Environment

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

- Lecture 32 - Ergonomic Design Framework for Environment, Importance of Illumination
- Lecture 33 - Measurement of Illuminance, Luminance, and Contrast
- Lecture 34 - Measures of Contrast, Contrast Ratio under Different Work Situations
- Lecture 35 - Direct and Indirect Glare or Reflection, Illumination for Inspection and Quality
- Lecture 36 - Problem of Heat Stress at Workplaces, Thermoregulation Process, Acclimation and
- Lecture 37 - Thermal Balance Equation and Heat Stress
- Lecture 38 - Quality of Thermal Environment, Evaluation of Thermal Environment
- Lecture 39 - Whole Body Vibration and Sources of Vibration Discomfort
- Lecture 40 - Design guidelines for hand tools
- Lecture 41 - Auditory Environment and Human Performance, Measurement of Sound and Noise Exposure
- Lecture 42 - Noise Exposure and Hearing Loss, Noise Analysis and Noise Reduction using Engineering
- Lecture 43 - Effects of Noise on Performance, Broadbent and Poulton Theories, Interference of Noise
- Lecture 44 - Octave bands and examples
- Lecture 45 - Ergonomic design of auditory environment in different workplaces
- Lecture 46 - Concepts of Design for Manufacturing (DFM), Design for Assembly (DHA), and Design
- Lecture 47 - Product Design Assessment and Important Measures, Manual Assembly Design Efficiency
- Lecture 48 - Assembly Time Determination with PMTS Methods, Human Factors Principles in DHA
- Lecture 49 - Maintenance in Manufacturing/Production System - Important Ergonomic Design Issues - Part I
- Lecture 50 - Maintenance in Manufacturing/Production System - Important Ergonomic Design Issues - Part II
- Lecture 51 - Definition of Shift Work, Problems with Shift Work, Effect on Circadian Rhythms
- Lecture 52 - Problems of shift workers, Shift Work and Human Performance
- Lecture 53 - Recommended Shift Work Schedules
- Lecture 54 - Major Ergonomic Issues and Problems in Shift Work Design - Part 1
- Lecture 55 - Major Ergonomic Issues and Problems in Shift Work Design - Part 2
- Lecture 56 - Concepts of Ergonomic Performance and its Indicators
- Lecture 57 - EPI Assessment Tool Development
- Lecture 58 - Factors and their level of assessment
- Lecture 59 - Application of EPI Model in Different Worksystems
- Lecture 60 - Epilogue

Lecture 1 - Introduction to Organizational Design

Lecture 2 - Introduction to Organizational Design

Lecture 3 - Introduction to Organizational Design

Lecture 4 - Introduction to Organizational Design

Lecture 5 - Introduction to Organizational Design

Lecture 6 - Organizational Environment

Lecture 7 - Organizational Environment

Lecture 8 - Organizational Environment

Lecture 9 - Organizational Environment

Lecture 10 - Organizational Environment

Lecture 11 - Organizational Structure

Lecture 12 - Organizational Structure

Lecture 13 - Organizational Structure

Lecture 14 - Organizational Structure

Lecture 15 - Organizational Structure

Lecture 16 - Organizational Design and Strategy in a changing Global environment

Lecture 17 - Organizational Design and Strategy in a changing Global environment

Lecture 18 - Organizational Design and Strategy in a changing Global environment

Lecture 19 - Organizational Design and Strategy in a changing Global environment

Lecture 20 - Organizational Design and Strategy in a changing Global environment

Lecture 21 - Organizational Change

Lecture 22 - Organizational Change

Lecture 23 - Organizational Change

Lecture 24 - Organizational Change

Lecture 25 - Organizational Change

Lecture 26 - Managing Conflict, Power, and Politics

Lecture 27 - Managing Conflict, Power, and Politics

Lecture 28 - Managing Conflict, Power, and Politics

Lecture 29 - Managing Conflict, Power, and Politics

Lecture 30 - Managing Conflict, Power, and Politics

Lecture 31 - Organizational culture

- Lecture 32 - Organizational culture and socialization
- Lecture 33 - Organizational culture and climate
- Lecture 34 - Managing organizational culture
- Lecture 35 - International aspects of organizational culture
- Lecture 36 - Organizational design and technology
- Lecture 37 - Technologies and organizational structure
- Lecture 38 - Technological theories and organizational design
- Lecture 39 - Organizational design and technology: Challenges
- Lecture 40 - Organizational competencies
- Lecture 41 - Decision making
- Lecture 42 - Learning
- Lecture 43 - Knowledge management
- Lecture 44 - IT and IS
- Lecture 45 - IT in Management and Organization
- Lecture 46 - Organizational Birth and Growth
- Lecture 47 - Organizational Decline and Death
- Lecture 48 - Organizational Inertia and Resilience
- Lecture 49 - Organizational Transformation
- Lecture 50 - Organizational Development and Intervention
- Lecture 51 - Innovation: Concept, Types
- Lecture 52 - Innovation Framework Model
- Lecture 53 - Intrapreneurship
- Lecture 54 - Creativity
- Lecture 55 - Creativity and Related Issues
- Lecture 56 - Creativity and Design Thinking
- Lecture 57 - Turnaround Situation: Strategic, Operational and Cultural
- Lecture 58 - IT and ICT Intervention
- Lecture 59 - Human Resource Intervention
- Lecture 60 - Organizational Culture, Transformation and Ethical Values
- Lecture 61 - Future Trends for Organizational Transformation

Lecture 1 - Introduction to Mergers and Acquisitions - I

Lecture 2 - Introduction to Mergers and Acquisitions - II

Lecture 3 - Theories of Mergers and Acquisitions

Lecture 4 - Legal Environment of M and A in India

Lecture 5 - Case Studies - DO M and A PAY ?

Lecture 6 - Takeover Tactics and Anti-takeover Defenses - 1

Lecture 7 - Takeover Tactics and Anti-takeover Defenses - 1

Lecture 8 - Takeover Tactics and Anti-takeover Defenses - 2

Lecture 9 - Takeover Tactics and Anti-takeover Defenses - 3

Lecture 10 - Acquisition Search and Due Diligence - 1

Lecture 11 - Acquisition Search and Due Diligence - 2

Lecture 12 - Valuation in M and A: Cash Flow Based Approach - 1

Lecture 13 - Valuation in M and A: Cash Flow Based Approach - 3 (Cost of Capital)

Lecture 14 - Valuation in M and A: Cash Flow Based Approach - 4 (Dividend Discount Model)

Lecture 15 - Valuation in M and A: Cash Flow Based Approach - 4 (Dividend Discount Model)

Lecture 16 - Valuation in M and A: Cash Flow Based Approach - 5 (Free Cash Flow Models)

Lecture 17 - Valuation in M and A: Cash Flow Based Approach - 6 (Free Cash Flow Models) (Continued...)

Lecture 18 - Valuation in M and A: Valuation of Synergies - 1

Lecture 19 - Valuation in M and A: Valuation of Synergies - 2

Lecture 20 - Valuation in M and A: Asset Based Valuation

Lecture 21 - Valuation in M and A: Relative Valuation - 1

Lecture 22 - Valuation in M and A: Relative Valuation - 2

Lecture 23 - Alternative Exit and Restructuring Strategies - 1

Lecture 24 - Alternative Exit and Restructuring Strategies - 2

Lecture 25 - Alternative Exit and Restructuring Strategies - 3

Lecture 26 - M and A Deal Structuring - 1

Lecture 27 - M and A Deal Structuring - 2

Lecture 28 - M and A Deal Structuring - 3

Lecture 29 - M and A Deal Structuring - 4

Lecture 30 - M and A Deal Structuring - 5

Lecture 31 - Legal Aspects of M and A - 1

[Lecture 32 - Legal Aspects of M and A - 2](#)

[Lecture 33 - Legal Aspects of M and A - 3](#)

[Lecture 34 - Accounting Aspects of M and A - I](#)

[Lecture 35 - Accounting Aspects of M and A - II](#)

[Lecture 36 - Alternative Exit and Restructuring Strategies - 1](#)

[Lecture 37 - Alternative Exit and Restructuring Strategies - 2](#)

[Lecture 38 - Alternative Exit and Restructuring Strategies - 3](#)

[Lecture 39 - Leveraged Buyouts](#)

[Lecture 40 - Alternative Exit and Restructuring Strategies - Insolvency and Bankruptcy](#)

- Lecture 1 - Investment Management as a Process
- Lecture 2 - Role of Financial Markets and Institutions
- Lecture 3 - Types of Investments
- Lecture 4 - Ecology of Financial Markets
- Lecture 5 - Investment Philosophies
- Lecture 6 - Present and Future Values of Investments
- Lecture 7 - Bonds as an Investment
- Lecture 8 - Pricing and Valuation of Bonds
- Lecture 9 - Pricing and Valuation of Bonds (Continued...)
- Lecture 10 - Prices, Yields, and Duration of Bonds
- Lecture 11 - Equity as an Asset Class
- Lecture 12 - Equity Valuation Models
- Lecture 13 - Equity Valuation Models (Continued...)
- Lecture 14 - Equity Valuation Ratios
- Lecture 15 - Equity Investment Strategies
- Lecture 16 - Portfolio Theory - Primer
- Lecture 17 - Capital Asset Pricing Model
- Lecture 18 - The CAPM and Index Models
- Lecture 19 - The CAPM and Index Models (Continued...)
- Lecture 20 - Consumption-Based Asset Pricing
- Lecture 21 - Two-fund Theorem
- Lecture 22 - Mutual Fund Basics
- Lecture 23 - Mutual Fund Basics (Continued...)
- Lecture 24 - Risk Indicator of a Mutual Fund
- Lecture 25 - Risk Indicator of a Mutual Fund (Continued...)
- Lecture 26 - Market Efficiency
- Lecture 27 - Market Efficiency (Continued...)
- Lecture 28 - Fundamental Analysis of Securities
- Lecture 29 - Value Investing using PV Models
- Lecture 30 - Asset Allocation and Portfolio Strategies
- Lecture 31 - Exchange Traded Funds (ETFs)

[Lecture 32 - Forming Portfolio with ETFs](#)

[Lecture 33 - Forming Portfolio with ETFs \(Continued...\)](#)

[Lecture 34 - Cryptocurrencies](#)

[Lecture 35 - Cryptocurrencies \(Continued...\)](#)

[Lecture 36 - Behavioral Anomalies in Investments](#)

[Lecture 37 - Behavioral Anomalies in Investments \(Continued...\)](#)

[Lecture 38 - Portfolio Evaluation](#)

[Lecture 39 - Portfolio Evaluation \(Continued...\)](#)

[Lecture 40 - Wrapping up](#)

- Lecture 1 - Basic Concepts and Introduction
- Lecture 2 - Drivers of Project Management
- Lecture 3 - Linkages between Organization Strategy and Projects
- Lecture 4 - Project Governance and Design of Project Portfolio System
- Lecture 5 - Non-Financial and Multi-Criteria Project Selection Models
- Lecture 6 - Organization Structure
- Lecture 7 - Organization Culture
- Lecture 8 - Project Scope of Work and Deliverables
- Lecture 9 - Responsibility Matrices and Project Communication Plan
- Lecture 10 - Estimating Guidelines and Methods, Top-down Estimation
- Lecture 11 - Level of Details, Type of Costs and Refining Estimates
- Lecture 12 - Concept of Project Network and Development Rules
- Lecture 13 - Construction of Network and Computation Process
- Lecture 14 - Extended Network Techniques to Represent Reality
- Lecture 15 - Probability of Completion of Project on Time
- Lecture 16 - Managing Risk and Risk Identification
- Lecture 17 - Risk Assessment
- Lecture 18 - Risk Response Development and Contingency Planning
- Lecture 19 - Risk Response Control and Change Control Management
- Lecture 20 - Risk Assessment of Capital projects
- Lecture 21 - Classification of Scheduling Problems: Time-constrained Project
- Lecture 22 - Resource-constrained Project
- Lecture 23 - Time-phased Budget, Critical Chain Project Management
- Lecture 24 - Rationale and Options for Project Crashing
- Lecture 25 - Crashing - Reducing Project Duration
- Lecture 26 - Reducing Project Duration - Solving Numerical
- Lecture 27 - Project Monitoring and Control Process
- Lecture 28 - Development of Performance Indexes for Monitoring
- Lecture 29 - Forecasting Project Completion Time and Cost
- Lecture 30 - Strategic Dimensions and Decision Logic of Outsourcing
- Lecture 31 - Best Practices in Outsourcing Project Work

[Lecture 32 - Partnering and Traditional Approaches for Managing Relations](#)

[Lecture 33 - The Art of Negotiating](#)

[Lecture 34 - Customer's Satisfaction and Managing Customer Relations](#)

[Lecture 35 - Types of Contract and their Salient Features](#)

[Lecture 36 - Preparation and Evaluation of RFP: Best Practices](#)

[Lecture 37 - Project Closure Activities and Post-Implementation Evaluation](#)

[Lecture 38 - Retrospectives](#)

[Lecture 39 - Oversight Activities and Levels](#)

[Lecture 40 - Phase Gate System, Project Management Maturity Model](#)

Lecture 1 - Introduction to Commodity Market

Lecture 2 - Commodity Spot Market and Different Types of Auction

Lecture 3 - Commodity Spot Market and Different Types of Auction

Lecture 4 - Introduction to forward contract

Lecture 5 - Introduction to Futures Contract

Lecture 6 - Futures Contract Specification

Lecture 7 - Futures Contract Specification (Continued...)

Lecture 8 - Futures Contract Specification (Continued...)

Lecture 9 - Futures Contract (Different Types of Margins)

Lecture 10 - Futures Contract (Mark-to-Market/MTM Margin)

Lecture 11 - Hedgers Vs. Speculators

Lecture 12 - Measures of Speculation

Lecture 13 - Spot Price, Futures Price and Basis Risk

Lecture 14 - Spot Price, Futures Price and Basis Risk (Continued...)

Lecture 15 - Pricing of Futures

Lecture 16 - Pricing of Futures (Continued...)

Lecture 17 - Convenience Yield, Minimum Variance Hedge Ratio

Lecture 18 - Hedge Effectiveness, Cross Hedge, Stack and Roll Vs. Strip Hedge

Lecture 19 - Calendar Spread, Valuation of Futures vs. Forwards, Commodity Swaps

Lecture 20 - Commodity Swaps

Lecture 21 - Commodity Index

Lecture 22 - Commodity Index (Continued...)

Lecture 23 - Commodity options

Lecture 24 - Introduction to Commodity Options (Continued...), Hedgers vs. Speculators

Lecture 25 - Pricing of Commodity Options

Lecture 26 - Commodity Options (Continued...), Put-Call Parity and Put-Call Ratio

Lecture 27 - Put-Call Parity, Implied Volatility, Swaptions

Lecture 28 - Commodity Swaption (Continued...) and Asian Options on Commodities

Lecture 29 - Commodity Derivatives Market : Value Proposition

Lecture 30 - Commodity Derivatives Market : Value Proposition

Lecture 31 - Agricultural Commodity Price Risk Management

- [Lecture 32 - Agricultural Commodity Price Risk Management \(Continued...\)](#)
- [Lecture 33 - Agricommodities Price Risk, Seasonality, Crush Spread Futures](#)
- [Lecture 34 - Agri-commodity Seasonality, Crush Spread Futures, Salmon Futures](#)
- [Lecture 35 - Crush Spread Futures, Salmon Futures, Agri-commodity risk Management Practices](#)
- [Lecture 36 - Gold and other Precious Metal Derivatives](#)
- [Lecture 37 - Gold as Asset, LBMA Spot Price Fix](#)
- [Lecture 38 - Gold as Asset, ETF, Gold-Silver Ratio](#)
- [Lecture 39 - Gold Price Risk Management, Dehedge, Zero Cost Derivatives](#)
- [Lecture 40 - Gold Quanto Futures, Delta Hedge Trap](#)
- [Lecture 41 - Crude oil and Crude oil Derivatives Price Risk Management](#)
- [Lecture 42 - Crude oil and Crude oil Derivatives Price Risk Management \(Continued...\)](#)
- [Lecture 43 - Crack Spread Futures, Spread Options and Crude Oil Price Risk](#)
- [Lecture 44 - Crude Oil Price Risk Management: 3-Way Collar, Spread Options and Swaps](#)
- [Lecture 45 - Swaps, Calendar Spreads: Crude Oil and Natural Gas Risk Management](#)
- [Lecture 46 - Weather Derivatives](#)
- [Lecture 47 - Weather Derivatives \(Continued...\)](#)
- [Lecture 48 - Weather Derivatives \(Snowfall, Rainfall and Hurricane\)](#)
- [Lecture 49 - Weather Derivatives \(Rainfall and Hurricane\)](#)
- [Lecture 50 - Spot and Derivatives Contracts on Electricity](#)
- [Lecture 51 - Electricity Trading in Day Ahead Market \(DAM\)](#)
- [Lecture 52 - Spot and Derivatives in Electricity \(System Price and Area Clearing Price\)](#)
- [Lecture 53 - Spot and Derivatives in Electricity \(Green DAM, Duck Curve, Dark/Spark Spread\)](#)
- [Lecture 54 - Carbon Credits and Carbon Credit Derivatives Market](#)
- [Lecture 55 - Carbon Credits \(CDM, JI, RGGI, REC, ESCerts\)](#)
- [Lecture 56 - Carbon Credits \(REC, ESCerts, CORSIA\) and Carbon Derivatives](#)
- [Lecture 57 - Freight Rates Derivatives](#)
- [Lecture 58 - Freight Rates Derivatives \(Continued...\)](#)
- [Lecture 59 - Water Derivatives](#)
- [Lecture 60 - Real Estate Derivatives and Derivatives Losses](#)

NPTEL : Infrastructure Finance (Management)

Co-ordinators : Dr. A. Thillai Rajan

Lecture 1 - Introduction

Lecture 2 - Overview on Infrastructure Financing Sources

Lecture 3 - Basics of Financial Management - Part-1

Lecture 4 - Basics of Financial Management - Part-2

Lecture 5 - Basics of Financial Management - Part-3

Lecture 6 - Basics of Financial Management - Part-4

Lecture 7 - Analysis of company Performance - Part-1

Lecture 8 - Analysis of company Performance - Part-2

Lecture 9 - Analysis of Project Viability Time value of money

Lecture 10 - Analysis of Project Viability Cost of Capital

Lecture 11 - Analysis of Project Viability Capital Budgeting Techniques - I

Lecture 12 - Analysis of Project Viability Capital Budgeting Guidelines - II

Lecture 13 - Analysis of Project Viability Capital Budgeting Guidelines - III

Lecture 14 - Analysis of Project Viability Capital Budgeting Guidelines - IV

Lecture 15 - Overview and introduction to project finance

Lecture 16 - Project Financing Attributes and Motivations - I

Lecture 17 - Project Financing Attributes and Motivations - II

Lecture 18 - Project Finance Markets - I

Lecture 19 - Project Finance Markets - II

Lecture 20 - Project Finance Markets - III

Lecture 21 - Project Finance Markets Mezzanine / Sub-ordinated Debt

Lecture 22 - Project Finance Markets - Type of Debt and Leasing

Lecture 23 - Project Finance Markets - Financial Intermediation

Lecture 24 - Project Finance Markets - Loan Refinancing

Lecture 25 - Project Finance Markets - Project Bonds - I

Lecture 26 - Project Finance Markets - Project Bonds - II

Lecture 27 - Public Private Partnerships

Lecture 28 - Risk Management - I

Lecture 29 - Risk Management - II

Lecture 30 - Risk Management - III

Lecture 31 - Risk Management - Market Risks

[Lecture 32 - Risk Management - Country / Political risks - I](#)

[Lecture 33 - Risk Management - Country / Political risks - II](#)

[Lecture 34 - Risk Management - Country / Political risks - III](#)

[Lecture 35 - Risk Management - Country / Political risks - IV](#)

[Lecture 36 - Context of infrastructure development - I](#)

[Lecture 37 - Context of infrastructure development - II](#)

[Lecture 38 - Context of infrastructure development - III](#)

[Lecture 39 - Context of infrastructure development - IV](#)

[Lecture 40 - Context of infrastructure development - V](#)

- Lecture 1 - Introduction to Manufacturing Systems Management
- Lecture 2 - Different types of Manufacturing Systems
- Lecture 3 - Introduction to Cellular Manufacturing
- Lecture 4 - Cellular Manufacturing Applications, Production Flow Analysis
- Lecture 5 - Production Flow Analysis
- Lecture 6 - Cellular Manufacturing - Unidirectional flow, Capacity Planning, Layout
- Lecture 7 - Exercise on Production Flow Analysis
- Lecture 8 - Rank Order Clustering, Similarity Coefficient based algorithm
- Lecture 9 - Similarity Coefficient based clustering algorithm
- Lecture 10 - Hierarchical and Non hierarchical clustering algorithms
- Lecture 11 - Optimization based algorithms
- Lecture 12 - Optimization based algorithms, Assignment based algorithm
- Lecture 13 - Assignment model, Algorithm considering sequence of visit of machines
- Lecture 14 - Algorithm considering sequence of visit of machines
- Lecture 15 - Algorithm considering cell load data, alternate process plans
- Lecture 16 - Reducing Intercell moves
- Lecture 17 - Part subcontracting, Incremental cell formation
- Lecture 18 - Product based cells
- Lecture 19 - Branching algorithm for product based cells, Operator and task assignment
- Lecture 20 - Operator and task assignment
- Lecture 21 - Operator and task assignment continued
- Lecture 22 - Static and dynamic Operator allocation, Multiple products and incremental cells
- Lecture 23 - Cell scheduling and sequencing
- Lecture 24 - Cell scheduling and sequencing continued
- Lecture 25 - Single piece transportation
- Lecture 26 - Cell Layout, Introduction to Just-in-time manufacturing
- Lecture 27 - Cell control and JIT
- Lecture 28 - Basic elements of JIT, Kanban systems
- Lecture 29 - Role of basic elements, Critical success factors
- Lecture 30 - Models in JIT
- Lecture 31 - Models in JIT continued

- [Lecture 32 - CONWIP, Introduction to synchronous manufacturing](#)
- [Lecture 33 - Theory of constraints, Product mix problem](#)
- [Lecture 34 - Statistical Fluctuations, Random events, principles of SM](#)
- [Lecture 35 - Scheduling in SM](#)
- [Lecture 36 - Drum Buffer Rope system](#)
- [Lecture 37 - Flexible Manufacturing System, Part selection problem](#)
- [Lecture 38 - FMS Loading problem](#)
- [Lecture 39 - FMS Loading, multiple batches and changeover times](#)
- [Lecture 40 - FMS Loading and scheduling, Summary of the course contents](#)

NPTEL : Operations and Supply Chain Management (Management)

Co-ordinators : Prof. G. Srinivasan

- Lecture 1 - Introduction - (Challenges, Methodologies)
- Lecture 2 - Forecasting - Time series models - Simple Exponential smoothing
- Lecture 3 - Forecasting - Linear Models, Regression, Holt's , seasonality
- Lecture 4 - Forecasting - Winter's model, causal models, Goodness of forecast, Aggregate Planning, Tabular method
- Lecture 5 - Aggregate Planning, Tabular method, Linear Programming
- Lecture 6 - Aggregate Planning, Transportation model
- Lecture 7 - Aggregate Planning, Dynamic Programming, backordering
- Lecture 8 - Aggregate Planning, Quadratic model, Demand and capacity planning
- Lecture 9 - Inventory Models - Costs, EOQ model
- Lecture 10 - Inventory - EOQ model graphs, with backordering
- Lecture 11 - Inventory - Models for all quantity and marginal quantity Discount
- Lecture 12 - Multiple Quantity Discount, Multiple item inventory - Constraint on numbers of orders
- Lecture 13 - Multiple item inventory - Constraint on money value, space, equal number of orders
- Lecture 14 - Multiple item inventory - combining orders, production consumption model
- Lecture 15 - Inventory - Production consumption model with backordering, Economic lot scheduling problem
- Lecture 16 - Economic lot scheduling problem, Supply Chain inventory
- Lecture 17 - Lot sizing
- Lecture 18 - Lot sizing - heuristics
- Lecture 19 - Disaggregation
- Lecture 20 - Disaggregation - time varying demand, Safety stock - ROL for discrete demand distribution
- Lecture 21 - Safety stock - ROL for normal distribution of lead time demand
- Lecture 22 - Integrated model, ROL for normal distribution of LTD and given mean
- Lecture 23 - Safety stock reduction - delayed Product differentiation, substitution. MOM
- Lecture 24 - Sequencing and scheduling - Assumptions, objectives and shop settings
- Lecture 25 - Single machine sequencing. Two machine flow shop - Johnson's algorithm
- Lecture 26 - Flow shop scheduling - Three machines, Johnson's algorithm and Branch and bound algorithm
- Lecture 27 - Flow shop scheduling - heuristics - Palmer, Campbell Dudek Smith algorithm
- Lecture 28 - Job shop scheduling - Gantt chart, Different dispatching rules
- Lecture 29 - Job shop scheduling - Shifting bottleneck heuristic
- Lecture 30 - Job shop scheduling - Shifting bottleneck heuristic. Line Balancing
- Lecture 31 - Line Balancing

[Lecture 32 - Location problems - p median problem, Fixed charge problem](#)

[Lecture 33 - Location allocation problems in supply chain. Layout](#)

[Lecture 34 - Quantitative models for layout, Summary](#)

[Lecture 35 - Introduction to Supply Chain Management](#)

[Lecture 36 - Location Problems](#)

[Lecture 37 - Transportation and Distribution Models](#)

[Lecture 38 - Transportation and Distribution Models\(continued\)](#)

[Lecture 39 - Bin Packing and Travelling Salesman Problems](#)

[Lecture 40 - Vehicle Routeing Problems](#)

[Lecture 41 - Value of Information](#)

- Lecture 1 - Introduction to Business Analysis for Engineers
- Lecture 2 - Introduction to Accounting
- Lecture 3 - Accounting Principles - 1
- Lecture 4 - Balance Sheet Fundamentals
- Lecture 5 - Balance Sheet Fundamentals
- Lecture 6 - Accounting Principles - 2
- Lecture 7 - Introduction to Income Statement & Double Entry
- Lecture 8 - Double Entry Examples - 1
- Lecture 9 - Double Entry Examples - 2
- Lecture 10 - Preparation of Financial Statement
- Lecture 11 - Cash Flow Statement - 1
- Lecture 12 - Cash Flow Statement - 2
- Lecture 13 - Special Accounts Illustrations
- Lecture 14 - Final Illustrative Example
- Lecture 15 - Summary of Financial Accounting
- Lecture 16 - Introduction to Management Accounting & Behaviour of Cost
- Lecture 17 - Cost-Volume Relationship
- Lecture 18 - Cost-Objects & Variance
- Lecture 19 - Labour & Over Heads Variance Analysis
- Lecture 20 - Cash Conversion Cycle
- Lecture 21 - Inventory Management
- Lecture 22 - What is Strategy?
- Lecture 23 - Porter's Diamond Model
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- Lecture 76 - Tutorial - Profitability Ratios - Part 1
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- Lecture 78 - Efficiency Ratios
- Lecture 79 - Tutorial - Efficiency Ratios
- Lecture 80 - Validating the learning - Walkthrough of RIL's Annual Report
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- Lecture 82 - Practice Problem - Liquidity Position
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- Lecture 85 - Practice Problem - Profitability Position
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- Lecture 93 - Cash Flows from Operating Activities - Part 1
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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Technology Forecasting for Strategic Decision Making - An Introduction (Management)

Co-ordinators : Prof. Dmitry Kucharavy, Prof. Bala Ramadurai

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Lecture 3 - Why do we need technology forecasts? - Innovation vs Invention Efficiency vs Effectiveness

Lecture 5 - Why do we need technology forecasts? - Limiting Resources

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Lecture 11 - Quiz about Strategic, Tactical and Operational decision making

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Lecture 17 - Technology Lifecycle - Seasons, Clockspeed - Part 1

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Lecture 26 - System Operator

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Lecture 29 - System function - What's function 1 Energy for cooking

Lecture 30 - System function - What's the function 2 Mosquito repellent

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- Lecture 26 - Stature versus Title
- Lecture 27 - Vision, Strategy, Structure and Execution
- Lecture 28 - Organization Structures
- Lecture 29 - Effective Execution
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- Lecture 32 - Instilling Development Passion
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- Lecture 56 - Dr A P J Abdul Kalam President without Precedent
- Lecture 57 - Dr C K Prahalad Timeless in Strategy, Tireless in Creativity
- Lecture 58 - Steve Jobs Technology Visionary Par Excellence
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- Lecture 60 - J R D Tata Conglomerate Leadership Beyond Compare
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Lecture 7 - Factors affecting cross-cultural teams

Lecture 8 - Introduction to start-up teams

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Lecture 10 - Introduction to IPO model in teams

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Lecture 14 - Multiple Team Membership and Multi-team Systems

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Lecture 18 - Financial Statements with Adjustments (Part-7)

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Lecture 21 - Financial Statements with Adjustments (Part-10)

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- Lecture 45 - Profitability Ratios- Grasim Industries (Part-1)
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NPTEL : NOC:Supply Chain Analytics (Management)

Co-ordinators : Prof. Rajat Agrawal

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- Lecture 2 - Evolution of Supply Chain Management
- Lecture 3 - Analytics in Supply Chain Management
- Lecture 4 - Supply Chain Planning
- Lecture 5 - Different views of Supply Chain
- Lecture 6 - Supply Chain Strategy
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- Lecture 8 - Developing Supply Chain Strategy
- Lecture 9 - Strategic Fit in Supply Chain
- Lecture 10 - Demand Forecasting in Supply Chain
- Lecture 11 - Bullwhip Effect and Time Series Analysis
- Lecture 12 - Exponential Smoothing Method of Forecasting
- Lecture 13 - Measures of Forecasting Errors
- Lecture 14 - Tracking Signal and Seasonality Models
- Lecture 15 - Forecasting using multiple characteristics in Demand Data and Inventory Management in Supply Chain
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- Lecture 22 - Network Design in Supply Chain
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- Lecture 25 - Location Decisions in Supply Chain
- Lecture 26 - Network Optimization Models
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- Lecture 30 - Flexibility in Supply Chain
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Lecture 4 - Research Design: Conclusive

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Lecture 6 - Qualitative Research: Depth Interview, Focus Group Discussion

Lecture 7 - Projective Technique, Case Study

Lecture 8 - Case Study, Descriptive Research Design and Research Errors

Lecture 9 - Primary and Secondary Data, Research Error

Lecture 10 - Measurement and Scaling: Comparative and Non-comparative Scaling

Lecture 11 - Scale Development Process

Lecture 12 - Questionnaire and Form Design

Lecture 13 - Causal Research and Types

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Lecture 15 - Sampling Design and Procedure

Lecture 16 - Sampling and Sample Size Determination

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Lecture 19 - Hypothesis Testing: T-Test, Z-Test

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- Lecture 2 - Project Success
- Lecture 3 - Types of Structure Organizations
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- Lecture 7 - Project Life Cycle Phases and Project Appraisal
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- Lecture 16 - Capital Budgeting Techniques - I
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- Lecture 28 - Abandonment Analysis
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- Lecture 32 - HRM Issues and time Management
- Lecture 33 - Project Time Management - Introduction
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NPTEL : NOC:Working Capital Management (Management)

Co-ordinators : Prof. Anil K. Sharma

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Co-ordinators : Prof. Sourabh Arora

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Co-ordinators : Prof. N. Viswanadham

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Co-ordinators : Prof. Nilladri Chaterjee

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Lecture 4 - Linear Transformation, Isomorphism and Matrix Representation

Lecture 5 - System of Linear Equations, Eigenvalues and Eigenvectors

Lecture 6 - Method to Find Eigenvalues and Eigenvectors, Diagonalization of Matrices

Lecture 7 - Jordan Canonical Form, Cayley Hamilton Theorem

Lecture 8 - Inner Product Spaces, Cauchy-Schwarz Inequality

Lecture 9 - Orthogonality, Gram-Schmidt Orthogonalization Process

Lecture 10 - Spectrum of special matrices, positive/negative definite matrices

Lecture 11 - Concept of Domain, Limit, Continuity and Differentiability

Lecture 12 - Analytic Functions, C-R Equations

Lecture 13 - Harmonic Functions

Lecture 14 - Line Integral in the Complex

Lecture 15 - Cauchy Integral Theorem

Lecture 16 - Cauchy Integral Theorem (Continued.)

Lecture 17 - Cauchy Integral Formula

Lecture 18 - Power and Taylor's Series of Complex Numbers

Lecture 19 - Power and Taylor's Series of Complex Numbers (Continued.)

Lecture 20 - Taylor's, Laurent Series of $f(z)$ and Singularities

Lecture 21 - Classification of Singularities, Residue and Residue Theorem

Lecture 22 - Laplace Transform and its Existence

Lecture 23 - Properties of Laplace Transform

Lecture 24 - Evaluation of Laplace and Inverse Laplace Transform

Lecture 25 - Applications of Laplace Transform to Integral Equations and ODEs

Lecture 26 - Applications of Laplace Transform to PDEs

Lecture 27 - Fourier Series

Lecture 28 - Fourier Series (Continued.)

Lecture 29 - Fourier Integral Representation of a Function

Lecture 30 - Introduction to Fourier Transform

Lecture 31 - Applications of Fourier Transform to PDEs

[Lecture 32 - Laws of Probability - I](#)

[Lecture 33 - Laws of Probability - II](#)

[Lecture 34 - Problems in Probability](#)

[Lecture 35 - Random Variables](#)

[Lecture 36 - Special Discrete Distributions](#)

[Lecture 37 - Special Continuous Distributions](#)

[Lecture 38 - Joint Distributions and Sampling Distributions](#)

[Lecture 39 - Point Estimation](#)

[Lecture 40 - Interval Estimation](#)

[Lecture 41 - Basic Concepts of Testing of Hypothesis](#)

[Lecture 42 - Tests for Normal Populations](#)

NPTEL : Functional Analysis (Mathematics)

Co-ordinators : Prof. P.D. Srivastava

- Lecture 1 - Metric Spaces with Examples
- Lecture 2 - Holder Inequality and Minkowski Inequality
- Lecture 3 - Various Concepts in a Metric Space
- Lecture 4 - Separable Metrics Spaces with Examples
- Lecture 5 - Convergence, Cauchy Sequence, Completeness
- Lecture 6 - Examples of Complete and Incomplete Metric Spaces
- Lecture 7 - Completion of Metric Spaces + Tutorial
- Lecture 8 - Vector Spaces with Examples
- Lecture 9 - Normed Spaces with Examples
- Lecture 10 - Banach Spaces and Schauder Basis
- Lecture 11 - Finite Dimensional Normed Spaces and Subspaces
- Lecture 12 - Compactness of Metric/Normed Spaces
- Lecture 13 - Linear Operators-definition and Examples
- Lecture 14 - Bounded Linear Operators in a Normed Space
- Lecture 15 - Bounded Linear Functionals in a Normed Space
- Lecture 16 - Concept of Algebraic Dual and Reflexive Space
- Lecture 17 - Dual Basis & Algebraic Reflexive Space
- Lecture 18 - Dual Spaces with Examples
- Lecture 19 - Tutorial - I
- Lecture 20 - Tutorial - II
- Lecture 21 - Inner Product & Hilbert Space
- Lecture 22 - Further Properties of Inner Product Spaces
- Lecture 23 - Projection Theorem, Orthonormal Sets and Sequences
- Lecture 24 - Representation of Functionals on a Hilbert Spaces
- Lecture 25 - Hilbert Adjoint Operator
- Lecture 26 - Self Adjoint, Unitary & Normal Operators
- Lecture 27 - Tutorial - III
- Lecture 28 - Annihilator in an IPS
- Lecture 29 - Total Orthonormal Sets And Sequences
- Lecture 30 - Partially Ordered Set and Zorns Lemma
- Lecture 31 - Hahn Banach Theorem for Real Vector Spaces

[Lecture 32 - Hahn Banach Theorem for Complex V.S. & Normed Spaces](#)

[Lecture 33 - Baires Category & Uniform Boundedness Theorems](#)

[Lecture 34 - Open Mapping Theorem](#)

[Lecture 35 - Closed Graph Theorem](#)

[Lecture 36 - Adjoint Operator](#)

[Lecture 37 - Strong and Weak Convergence](#)

[Lecture 38 - Convergence of Sequence of Operators and Functionals](#)

[Lecture 39 - LP - Space](#)

[Lecture 40 - LP - Space \(Continued.\)](#)

- Lecture 1 - Motivation with few Examples
- Lecture 2 - Single - Step Methods for IVPs
- Lecture 3 - Analysis of Single Step Methods
- Lecture 4 - Runge - Kutta Methods for IVPs
- Lecture 5 - Higher Order Methods/Equations
- Lecture 6 - Error - Stability - Convergence of Single Step Methods
- Lecture 7 - Tutorial - I
- Lecture 8 - Tutorial - II
- Lecture 9 - Multi-Step Methods (Explicit)
- Lecture 10 - Multi-Step Methods (Implicit)
- Lecture 11 - Convergence and Stability of multi step methods
- Lecture 12 - General methods for absolute stability
- Lecture 13 - Stability Analysis of Multi Step Methods
- Lecture 14 - Predictor - Corrector Methods
- Lecture 15 - Some Comments on Multi - Step Methods
- Lecture 16 - Finite Difference Methods - Linear BVPs
- Lecture 17 - Linear/Non - Linear Second Order BVPs
- Lecture 18 - BVPS - Derivative Boundary Conditions
- Lecture 19 - Higher Order BVPs
- Lecture 20 - Shooting Method BVPs
- Lecture 21 - Tutorial - III
- Lecture 22 - Introduction to First Order PDE
- Lecture 23 - Introduction to Second Order PDE
- Lecture 24 - Finite Difference Approximations to Parabolic PDEs
- Lecture 25 - Implicit Methods for Parabolic PDEs
- Lecture 26 - Consistency, Stability and Convergence
- Lecture 27 - Other Numerical Methods for Parabolic PDEs
- Lecture 28 - Tutorial - IV
- Lecture 29 - Matrix Stability Analysis of Finite Difference Scheme
- Lecture 30 - Fourier Series Stability Analysis of Finite Difference Scheme
- Lecture 31 - Finite Difference Approximations to Elliptic PDEs - I

- [Lecture 32 - Finite Difference Approximations to Elliptic PDEs - II](#)
- [Lecture 33 - Finite Difference Approximations to Elliptic PDEs - III](#)
- [Lecture 34 - Finite Difference Approximations to Elliptic PDEs - IV](#)
- [Lecture 35 - Finite Difference Approximations to Hyperbolic PDEs - I](#)
- [Lecture 36 - Finite Difference Approximations to Hyperbolic PDEs - II](#)
- [Lecture 37 - Method of characteristics for Hyperbolic PDEs - I](#)
- [Lecture 38 - Method of characterisitcs for Hyperbolic PDEs - II](#)
- [Lecture 39 - Finite Difference Approximations to 1st order Hyperbolic PDEs](#)
- [Lecture 40 - Summary, Appendices, Remarks](#)

NPTEL : Optimization (Mathematics)

Co-ordinators : Prof. A. Goswami, Dr. Debjani Chakraborty

Lecture 1 - Optimization - Introduction

Lecture 2 - Formulation of LPP

Lecture 3 - Geometry of LPP and Graphical Solution of LPP

Lecture 4 - Solution of LPP : Simplex Method

Lecture 5 - Big - M Method

Lecture 6 - Two - Phase Method

Lecture 7 - Special Cases in Simple Applications

Lecture 8 - Introduction to Duality Theory

Lecture 9 - Dual Simplex Method

Lecture 10 - Post Optimality Analysis

Lecture 11 - Integer Programming - I

Lecture 12 - Integer Programming - II

Lecture 13 - Introduction to Transportation Problems

Lecture 14 - Solving Various types of Transportation Problems

Lecture 15 - Assignment Problems

Lecture 16 - Project Management

Lecture 17 - Critical Path Analysis

Lecture 18 - PERT

Lecture 19 - Shortest Path Algorithm

Lecture 20 - Travelling Salesman Problem

Lecture 21 - Classical optimization techniques : Single variable optimization

Lecture 22 - Unconstrained multivariable optimization

Lecture 23 - Nonlinear programming with equality constraint

Lecture 24 - Nonlinear programming KKT conditions

Lecture 25 - Numerical optimization : Region elimination techniques

Lecture 26 - Numerical optimization : Region elimination techniques (Continued.)

Lecture 27 - Fibonacci Method

Lecture 28 - Golden Section Methods

Lecture 29 - Interpolation Methods

Lecture 30 - Unconstrained optimization techniques : Direct search method

Lecture 31 - Unconstrained optimization techniques : Indirect search method

[Lecture 32 - Nonlinear programming : constrained optimization techniques](#)

[Lecture 33 - Interior and Exterior penalty Function Method](#)

[Lecture 34 - Separable Programming Problem](#)

[Lecture 35 - Introduction to Geometric Programming](#)

[Lecture 36 - Constrained Geometric Programming Problem](#)

[Lecture 37 - Dynamic Programming Problem](#)

[Lecture 38 - Dynamic Programming Problem \(Continued.\)](#)

[Lecture 39 - Multi Objective Decision Making](#)

[Lecture 40 - Multi attribute decision making](#)

NPTEL : Probability and Statistics (Mathematics)

Co-ordinators : Prof. Somesh Kumar

Lecture 1 - Algebra of Sets - I

Lecture 2 - Algebra of Sets - II

Lecture 3 - Introduction to Probability

Lecture 4 - Laws of Probability - I

Lecture 5 - Laws of Probability - II

Lecture 6 - Problems in Probability

Lecture 7 - Random Variables

Lecture 8 - Probability Distributions

Lecture 9 - Characteristics of Distribution

Lecture 10 - Special Distributions - I

Lecture 11 - Special Distributions - II

Lecture 12 - Special Distributions - III

Lecture 13 - Special Distributions - IV

Lecture 14 - Special Distributions - V

Lecture 15 - Special Distributions - VI

Lecture 16 - Special Distributions - VII

Lecture 17 - Functions of a Random Variable

Lecture 18 - Joint Distributions - I

Lecture 19 - Joint Distributions - II

Lecture 20 - Joint Distributions - III

Lecture 21 - Joint Distributions - IV

Lecture 22 - Transformations of Random Vectors

Lecture 23 - Sampling Distributions - I

Lecture 24 - Sampling Distributions - II

Lecture 25 - Descriptive Statistics - I

Lecture 26 - Descriptive Statistics - II

Lecture 27 - Estimation - I

Lecture 28 - Estimation - II

Lecture 29 - Estimation - III

Lecture 30 - Estimation - IV

Lecture 31 - Estimation - V

[Lecture 32 - Estimation - VI](#)

[Lecture 33 - Testing of Hypothesis - I](#)

[Lecture 34 - Testing of Hypothesis - II](#)

[Lecture 35 - Testing of Hypothesis - III](#)

[Lecture 36 - Testing of Hypothesis - IV](#)

[Lecture 37 - Testing of Hypothesis - V](#)

[Lecture 38 - Testing of Hypothesis - VI](#)

[Lecture 39 - Testing of Hypothesis - VII](#)

[Lecture 40 - Testing of Hypothesis - VIII](#)

NPTEL : Regression Analysis (Mathematics)

Co-ordinators : Dr. Soumen Maity

[Lecture 1 - Simple Linear Regression](#)

[Lecture 2 - Simple Linear Regression \(Continued...1\)](#)

[Lecture 3 - Simple Linear Regression \(Continued...2\)](#)

[Lecture 4 - Simple Linear Regression \(Continued...3\)](#)

[Lecture 5 - Simple Linear Regression \(Continued...4\)](#)

[Lecture 6 - Multiple Linear Regression](#)

[Lecture 7 - Multiple Linear Regression \(Continued...1\)](#)

[Lecture 8 - Multiple Linear Regression \(Continued...2\)](#)

[Lecture 9 - Multiple Linear Regression \(Continued...3\)](#)

[Lecture 10 - Selecting the BEST Regression model](#)

[Lecture 11 - Selecting the BEST Regression model \(Continued...1\)](#)

[Lecture 12 - Selecting the BEST Regression model \(Continued...2\)](#)

[Lecture 13 - Selecting the BEST Regression model \(Continued...3\)](#)

[Lecture 14 - Multicollinearity](#)

[Lecture 15 - Multicollinearity \(Continued...1\)](#)

[Lecture 16 - Multicollinearity \(Continued...2\)](#)

[Lecture 17 - Model Adequacy Checking](#)

[Lecture 18 - Model Adequacy Checking \(Continued...1\)](#)

[Lecture 19 - Model Adequacy Checking \(Continued...2\)](#)

[Lecture 20 - Test for Influential Observations](#)

[Lecture 21 - Transformations and Weighting to correct model inadequacies](#)

[Lecture 22 - Transformations and Weighting to correct model inadequacies \(Continued...1\)](#)

[Lecture 23 - Transformations and Weighting to correct model inadequacies \(Continued...2\)](#)

[Lecture 24 - Dummy Variables](#)

[Lecture 25 - Dummy Variables \(Continued...1\)](#)

[Lecture 26 - Dummy Variables \(Continued...2\)](#)

[Lecture 27 - Polynomial Regression Models](#)

[Lecture 28 - Polynomial Regression Models \(Continued...1\)](#)

[Lecture 29 - Polynomial Regression Models \(Continued...2\)](#)

[Lecture 30 - Generalized Linear Models](#)

[Lecture 31 - Generalized Linear Models \(Continued.\)](#)

[Lecture 32 - Non-Linear Estimation](#)

[Lecture 33 - Regression Models with Autocorrelated Errors](#)

[Lecture 34 - Regression Models with Autocorrelated Errors \(Continued.\)](#)

[Lecture 35 - Measurement Errors & Calibration Problem](#)

[Lecture 36 - Tutorial - I](#)

[Lecture 37 - Tutorial - II](#)

[Lecture 38 - Tutorial - III](#)

[Lecture 39 - Tutorial - IV](#)

[Lecture 40 - Tutorial - V](#)

Lecture 1 - Introduction and Motivation

Lecture 2 - Basic Concepts of Point Estimations - I

Lecture 3 - Basic Concepts of Point Estimations - II

Lecture 4 - Finding Estimators - I

Lecture 5 - Finding Estimators - II

Lecture 6 - Finding Estimators - III

Lecture 7 - Properties of MLEs

Lecture 8 - Lower Bounds for Variance - I

Lecture 9 - Lower Bounds for Variance - II

Lecture 10 - Lower Bounds for Variance - III

Lecture 11 - Lower Bounds for Variance - IV

Lecture 12 - Sufficiency

Lecture 13 - Sufficiency and Information

Lecture 14 - Minimal Sufficiency, Completeness

Lecture 15 - UMVU Estimation, Ancillarity

Lecture 16 - Invariance - I

Lecture 17 - Invariance - II

Lecture 18 - Bayes and Minimax Estimation - I

Lecture 19 - Bayes and Minimax Estimation - II

Lecture 20 - Bayes and Minimax Estimation - III

Lecture 21 - Testing of Hypotheses : Basic Concepts

Lecture 22 - Neyman Pearson Fundamental Lemma

Lecture 23 - Applications of NP lemma

Lecture 24 - UMP Tests

Lecture 25 - UMP Tests (Continued.)

Lecture 26 - UMP Unbiased Tests

Lecture 27 - UMP Unbiased Tests (Continued.)

Lecture 28 - UMP Unbiased Tests : Applications

Lecture 29 - Unbiased Tests for Normal Populations

Lecture 30 - Unbiased Tests for Normal Populations (Continued.)

Lecture 31 - Likelihood Ratio Tests - I

[Lecture 32 - Likelihood Ratio Tests - II](#)

[Lecture 33 - Likelihood Ratio Tests - III](#)

[Lecture 34 - Likelihood Ratio Tests - IV](#)

[Lecture 35 - Invariant Tests](#)

[Lecture 36 - Test for Goodness of Fit](#)

[Lecture 37 - Sequential Procedure](#)

[Lecture 38 - Sequential Procedure \(Continued.\)](#)

[Lecture 39 - Confidence Intervals](#)

[Lecture 40 - Confidence Intervals \(Continued.\)](#)

Lecture 1 - Rational Numbers and Rational Cuts

Lecture 2 - Irrational numbers, Dedekind's Theorem

Lecture 3 - Continuum and Exercises

Lecture 4 - Continuum and Exercises (Continued.)

Lecture 5 - Cantor's Theory of Irrational Numbers

Lecture 6 - Cantor's Theory of Irrational Numbers (Continued.)

Lecture 7 - Equivalence of Dedekind and Cantor's Theory

Lecture 8 - Finite, Infinite, Countable and Uncountable Sets of Real Numbers

Lecture 9 - Types of Sets with Examples, Metric Space

Lecture 10 - Various properties of open set, closure of a set

Lecture 11 - Ordered set, Least upper bound, greatest lower bound of a set

Lecture 12 - Compact Sets and its properties

Lecture 13 - Weiersstrass Theorem, Heine Borel Theorem, Connected set

Lecture 14 - Tutorial - II

Lecture 15 - Concept of limit of a sequence

Lecture 16 - Some Important limits, Ratio tests for sequences of Real Numbers

Lecture 17 - Cauchy theorems on limit of sequences with examples

Lecture 18 - Fundamental theorems on limits, Bolzano-Weiersstrass Theorem

Lecture 19 - Theorems on Convergent and divergent sequences

Lecture 20 - Cauchy sequence and its properties

Lecture 21 - Infinite series of real numbers

Lecture 22 - Comparison tests for series, Absolutely convergent and Conditional convergent series

Lecture 23 - Tests for absolutely convergent series

Lecture 24 - Raabe's test, limit of functions, Cluster point

Lecture 25 - Some results on limit of functions

Lecture 26 - Limit Theorems for functions

Lecture 27 - Extension of limit concept (one sided limits)

Lecture 28 - Continuity of Functions

Lecture 29 - Properties of Continuous Functions

Lecture 30 - Boundedness Theorem, Max-Min Theorem and Bolzano's theorem

Lecture 31 - Uniform Continuity and Absolute Continuity

- Lecture 32 - Types of Discontinuities, Continuity and Compactness
- Lecture 33 - Continuity and Compactness (Continued.), Connectedness
- Lecture 34 - Differentiability of real valued function, Mean Value Theorem
- Lecture 35 - Mean Value Theorem (Continued.)
- Lecture 36 - Application of MVT , Darboux Theorem, L Hospital Rule
- Lecture 37 - L'Hospital Rule and Taylor's Theorem
- Lecture 38 - Tutorial - III
- Lecture 39 - Riemann/Riemann Stieltjes Integral
- Lecture 40 - Existence of Reimann Stieltjes Integral
- Lecture 41 - Properties of Reimann Stieltjes Integral
- Lecture 42 - Properties of Reimann Stieltjes Integral (Continued.)
- Lecture 43 - Definite and Indefinite Integral
- Lecture 44 - Fundamental Theorems of Integral Calculus
- Lecture 45 - Improper Integrals
- Lecture 46 - Convergence Test for Improper Integrals

Lecture 1 - Foundations of Probability

Lecture 2 - Laws of Probability

Lecture 3 - Random Variables

Lecture 4 - Moments and Special Distributions

Lecture 5 - Moments and Special Distributions (Continued...)

Lecture 6 - Special Distributions (Continued...)

Lecture 7 - Special Distributions (Continued...)

Lecture 8 - Sampling Distributions

Lecture 9 - Parametric Methods - I

Lecture 10 - Parametric Methods - II

Lecture 11 - Parametric Methods - III

Lecture 12 - Parametric Methods - IV

Lecture 13 - Parametric Methods - V

Lecture 14 - Parametric Methods - VI

Lecture 15 - Parametric Methods - VII

Lecture 16 - Multivariate Analysis - I

Lecture 17 - Multivariate Analysis - II

Lecture 18 - Multivariate Analysis - III

Lecture 19 - Multivariate Analysis - IV

Lecture 20 - Multivariate Analysis - V

Lecture 21 - Multivariate Analysis - VI

Lecture 22 - Multivariate Analysis - VII

Lecture 23 - Multivariate Analysis - VIII

Lecture 24 - Multivariate Analysis - IX

Lecture 25 - Multivariate Analysis - X

Lecture 26 - Multivariate Analysis - XI

Lecture 27 - Multivariate Analysis - XII

Lecture 28 - Non parametric Methods - I

Lecture 29 - Non parametric Methods - II

Lecture 30 - Non parametric Methods - III

Lecture 31 - Non parametric Methods - IV

[Lecture 32 - Nonparametric Methods - V](#)

[Lecture 33 - Nonparametric Methods - VI](#)

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[Lecture 35 - Nonparametric Methods - VIII](#)

[Lecture 36 - Nonparametric Methods - IX](#)

[Lecture 37 - Nonparametric Methods - X](#)

[Lecture 38 - Nonparametric Methods - XI](#)

[Lecture 39 - Nonparametric Methods - XII](#)

[Lecture 40 - Nonparametric Methods - XIII](#)

Lecture 1 - Sets, Classes, Collection

Lecture 2 - Sequence of Sets

Lecture 3 - Ring, Field (Algebra)

Lecture 4 - Sigma-Ring, Sigma-Field, Monotone Class

Lecture 5 - Random Experiment, Events

Lecture 6 - Definitions of Probability

Lecture 7 - Properties of Probability Function - I

Lecture 8 - Properties of Probability Function - II

Lecture 9 - Conditional Probability

Lecture 10 - Independence of Events

Lecture 11 - Problems in Probability - I

Lecture 12 - Problems in Probability - II

Lecture 13 - Random Variables

Lecture 14 - Probability Distribution of a Random Variable - I

Lecture 15 - Probability Distribution of a Random Variable - II

Lecture 16 - Moments

Lecture 17 - Characteristics of Distributions - I

Lecture 18 - Characteristics of Distributions - II

Lecture 19 - Special Discrete Distributions - I

Lecture 20 - Special Discrete Distributions - II

Lecture 21 - Special Discrete Distributions - III

Lecture 22 - Poisson Process - I

Lecture 23 - Poisson Process - II

Lecture 24 - Special Continuous Distributions - I

Lecture 25 - Special Continuous Distributions - II

Lecture 26 - Special Continuous Distributions - III

Lecture 27 - Special Continuous Distributions - IV

Lecture 28 - Special Continuous Distributions - V

Lecture 29 - Normal Distribution

Lecture 30 - Problems on Normal Distribution

Lecture 31 - Problems on Special Distributions - I

- Lecture 32 - Problems on Special Distributions - II
- Lecture 33 - Function of a random variable - I
- Lecture 34 - Function of a random variable - II
- Lecture 35 - Joint Distributions - I
- Lecture 36 - Joint Distributions - II
- Lecture 37 - Independence, Product Moments
- Lecture 38 - Linearity Property of Correlation and Examples
- Lecture 39 - Bivariate Normal Distribution - I
- Lecture 40 - Bivariate Normal Distribution - II
- Lecture 41 - Additive Properties of Distributions - I
- Lecture 42 - Additive Properties of Distributions - II
- Lecture 43 - Transformation of Random Variables
- Lecture 44 - Distribution of Order Statistics
- Lecture 45 - Basic Concepts
- Lecture 46 - Chi-Square Distribution
- Lecture 47 - Chi-Square Distribution (Continued...), t-Distribution
- Lecture 48 - F-Distribution
- Lecture 49 - Descriptive Statistics - I
- Lecture 50 - Descriptive Statistics - II
- Lecture 51 - Descriptive Statistics - III
- Lecture 52 - Descriptive Statistics - IV
- Lecture 53 - Introduction to Estimation
- Lecture 54 - Unbiased and Consistent Estimators
- Lecture 55 - LSE, MME
- Lecture 56 - Examples on MME, MLE
- Lecture 57 - Examples on MLE - I
- Lecture 58 - Examples on MLE - II, MSE
- Lecture 59 - UMVUE, Sufficiency, Completeness
- Lecture 60 - Rao - Blackwell Theorem and Its Applications
- Lecture 61 - Confidence Intervals - I
- Lecture 62 - Confidence Intervals - II
- Lecture 63 - Confidence Intervals - III
- Lecture 64 - Confidence Intervals - IV

[Lecture 65 - Basic Definitions](#)

[Lecture 66 - Two Types of Errors](#)

[Lecture 67 - Neyman-Pearson Fundamental Lemma](#)

[Lecture 68 - Applications of N-P Lemma - I](#)

[Lecture 69 - Applications of N-P Lemma - II](#)

[Lecture 70 - Testing for Normal Mean](#)

[Lecture 71 - Testing for Normal Variance](#)

[Lecture 72 - Large Sample Test for Variance and Two Sample Problem](#)

[Lecture 73 - Paired t-Test](#)

[Lecture 74 - Examples](#)

[Lecture 75 - Testing Equality of Proportions](#)

[Lecture 76 - Chi-Square Test for Goodness Fit - I](#)

[Lecture 77 - Chi-Square Test for Goodness Fit - II](#)

[Lecture 78 - Testing for Independence in \$r \times c\$ Contingency Table - I](#)

[Lecture 79 - Testing for Independence in \$r \times c\$ Contingency Table - II](#)

Lecture 1 - Introduction to Multivariate Statistical Modeling

Lecture 2 - Introduction to Multivariate Statistical Modeling: Data types, models, and modeling

Lecture 3 - Statistical approaches to model building

Lecture 4 - Statistical approaches to model building (Continued...)

Lecture 5 - Univariate Descriptive Statistics

Lecture 6 - Univariate Descriptive Statistics (Continued...)

Lecture 7 - Normal Distribution and Chi-squared Distribution

Lecture 8 - t-distribution, F-distribution, and Central Limit Theorem

Lecture 9 - Univariate Inferential Statistics: Estimation

Lecture 10 - Univariate Inferential Statistics: Estimation (Continued...)

Lecture 11 - Univariate Inferential Statistics: Hypothesis Testing

Lecture 12 - Hypothesis Testing (Continued...): Decision Making Scenarios

Lecture 13 - Multivariate Descriptive Statistics: Mean Vector

Lecture 14 - Multivariate Descriptive Statistics: Covariance Matrix

Lecture 15 - Multivariate Descriptive Statistics: Correlation Matrix

Lecture 16 - Multivariate Descriptive Statistics: Relationship between correlation and covariance matrices

Lecture 17 - Multivariate Normal Distribution

Lecture 18 - Multivariate Normal Distribution (Continued...)

Lecture 19 - Multivariate Normal Distribution (Continued...): Geometrical Interpretation

Lecture 20 - Multivariate Normal Distribution (Continued...): Examining data for multivariate normal distribution

Lecture 21 - Multivariate Inferential Statistics: Basics and Hotelling T-square statistic

Lecture 22 - Multivariate Inferential Statistics: Confidence Region

Lecture 23 - Multivariate Inferential Statistics: Simultaneous confidence interval and Hypothesis testing

Lecture 24 - Multivariate Inferential Statistics: Hypothesis testing for equality of two population mean vectors

Lecture 25 - Analysis of Variance (ANOVA)

Lecture 26 - Analysis of Variance (ANOVA): Decomposition of Total sum of squares

Lecture 27 - Analysis of Variance (ANOVA): Estimation of Parameters and Model Adequacy tests

Lecture 28 - Two-way and Three-way Analysis of Variance (ANOVA)

Lecture 29 - Tutorial ANOVA

Lecture 30 - Tutorial ANOVA (Continued...)

Lecture 31 - Multivariate Analysis of Variance (MANOVA): Conceptual Model

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- Lecture 32 - Multivariate Analysis of Variance (MANOVA): Assumptions and Decomposition of total sum square and cross products (SSCP)
- Lecture 33 - Multivariate Analysis of Variance (MANOVA): Decomposition of total sum square and cross products (SSCP) (Continued...)
- Lecture 34 - Multivariate Analysis of Variance (MANOVA): Estimation and Hypothesis testing
- Lecture 35 - MANOVA Case Study
- Lecture 36 - Multiple Linear Regression: Introduction
- Lecture 37 - Multiple Linear Regression: Assumptions and Estimation of model parameters
- Lecture 38 - Multiple Linear Regression: Sampling Distribution of parameter estimates
- Lecture 39 - Multiple Linear Regression: Sampling Distribution of parameter estimates (Continued...)
- Lecture 40 - Multiple Linear Regression: Model Adequacy Tests
- Lecture 41 - Multiple Linear Regression: Model Adequacy Tests (Continued...)
- Lecture 42 - Multiple Linear Regression: Test of Assumptions
- Lecture 43 - MLR-Model diagnostics
- Lecture 44 - MLR-case study
- Lecture 45 - Multivariate Linear Regression: Conceptual model and assumptions
- Lecture 46 - Multivariate Linear Regression: Estimation of parameters
- Lecture 47 - Multivariate Linear Regression: Estimation of parameters (Continued...)
- Lecture 48 - Multiple Linear Regression: Sampling Distribution of parameter estimates
- Lecture 49 - Multivariate Linear Regression: Model Adequacy Tests
- Lecture 50 - Multiple Linear Regression: Model Adequacy Tests (Continued...)
- Lecture 51 - Regression modeling using SPSS
- Lecture 52 - Principal Component Analysis (PCA): Conceptual Model
- Lecture 53 - Principal Component Analysis (PCA): Extraction of Principal components (PCs)
- Lecture 54 - Principal Component Analysis (PCA): Model Adequacy and Interpretation
- Lecture 55 - Principal Component Analysis (PCA): Model Adequacy and Interpretation (Continued...)
- Lecture 56 - Factor Analysis: Basics and Orthogonal factor models
- Lecture 57 - Factor Analysis: Types of models and key questions
- Lecture 58 - Factor Analysis: Parameter Estimation
- Lecture 59 - Factor Analysis: Parameter Estimation (Continued...)
- Lecture 60 - Factor Analysis: Model Adequacy tests and factor rotation
- Lecture 61 - Factor Analysis: Factor scores and case study

Lecture 1 - Introduction to PDE

Lecture 2 - Classification of PDE

Lecture 3 - Principle of Linear Superposition

Lecture 4 - Standard Eigen Value Problem and Special ODEs

Lecture 5 - Adjoint Operator

Lecture 6 - Generalized Sturm - Liouville Problem

Lecture 7 - Properties of Adjoint Operator

Lecture 8 - Separation of Variables: Rectangular Coordinate Systems

Lecture 9 - Solution of 3 Dimensional Parabolic Problem

Lecture 10 - Solution of 4 Dimensional Parabolic problem

Lecture 11 - Solution of 4 Dimensional Parabolic Problem (Continued...)

Lecture 12 - Solution of Elliptical PDE

Lecture 13 - Solution of Hyperbolic PDE

Lecture 14 - Orthogonality of Bessel Function and 2 Dimensional Cylindrical Coordinate System

Lecture 15 - Cylindrical Co-ordinate System - 3 Dimensional Problem

Lecture 16 - Spherical Polar Coordinate System

Lecture 17 - Spherical Polar Coordinate System (Continued...)

Lecture 18 - Example of Generalized 3 Dimensional Problem

Lecture 19 - Example of Application Oriented Problems

Lecture 20 - Examples of Application Oriented Problems (Continued...)

Lecture 1 - Countable and Uncountable sets

Lecture 2 - Properties of Countable and Uncountable sets

Lecture 3 - Examples of Countable and Uncountable sets

Lecture 4 - Concepts of Metric Space

Lecture 5 - Open ball, Closed ball, Limit point of a set

Lecture 6 - Tutorial-I

Lecture 7 - Some theorems on Open and Closed sets

Lecture 8 - Ordered set, Least upper bound, Greatest lower bound of a set

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Lecture 28 - Equations with convolution type kernels - II

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- Lecture 33 - Cauchy type integral equations - III
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- Lecture 35 - Cauchy type integral equations - V
- Lecture 36 - Solution of integral equations using Fourier transform
- Lecture 37 - Solution of integral equations using Hilbert transform - I
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- Lecture 40 - Calculus of variations: Basic concepts - I
- Lecture 41 - Calculus of variations: Basic concepts - II
- Lecture 42 - Calculus of variations: Basic concepts and Euler equation
- Lecture 43 - Euler equation: Some particular cases
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- Lecture 49 - Variational problems of general type
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- Lecture 53 - Variational problem involving a conditional extremum - I
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Lecture 13 - Geometric Programming - III

Lecture 14 - Dynamic Programming - I

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Lecture 16 - Dynamic programming approach to find shortest path in any network

Lecture 17 - Dynamic Programming - IV

Lecture 18 - Search Techniques - I

Lecture 19 - Search Techniques - II

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Lecture 1 - Introduction to error analysis and linear systems

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Lecture 17 - Interpolation - Part II (Some basic operators and their properties)

Lecture 18 - Interpolation - Part III (Newton's Forward/ Backward difference and derivation of general error)

Lecture 19 - Interpolation - Part IV (Error in approximating a function by a polynomial using Newton's Forward and Backward difference formula)

Lecture 20 - Interpolation - Part V (Solving problems using Newton's Forward and Backward difference formula)

Lecture 21 - Interpolation - Part VI (Central difference formula)

Lecture 22 - Interpolation - Part VII (Lagrange interpolation formula with examples)

Lecture 23 - Interpolation - Part VIII (Divided difference interpolation with examples)

Lecture 24 - Interpolation - Part IX (Hermite's interpolation with examples)

Lecture 25 - Numerical differentiation - Part I (Introduction to numerical differentiation by interpolation formula)

Lecture 26 - Numerical differentiation - Part II (Numerical differentiation based on Lagrange's interpolation with examples)

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- Lecture 44 - Orthonormal Projections
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- Lecture 46 - SVD and their applications
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- Lecture 48 - Outer product expansion of a matrix
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- Lecture 51 - Householder matrices
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Lecture 9 - Stability of Crank-Nicoloson's scheme

Lecture 10 - Approximation of derivative boundary conditions

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Lecture 25 - Estimating Elastic Deformation

Lecture 26 - Thermo Hydrodynamic Lubrication

Lecture 27 - Application of Tribology

Lecture 28 - Rolling Element Bearings

Lecture 29 - Rolling Element Bearings (Continued...)

Lecture 30 - Rolling Element Bearings (Continued...)

Lecture 31 - Selection of Rolling Element Bearings

[Lecture 32 - Friction of Rolling Element Bearing](#)

[Lecture 33 - Bearing Clearance](#)

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[Lecture 35 - Tribology of Gears](#)

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[Lecture 37 - Friction and Lubrication of Gears \(Continued...\)](#)

[Lecture 38 - Surface Fatigue of Spur Gears](#)

[Lecture 39 - Journal Bearings](#)

[Lecture 40 - Hydrostatic Bearings](#)

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[Lecture 42 - Design of Hydrodynamic Journal Bearings](#)

Lecture 1 - An Introduction to CAD

Lecture 2 - Input Output Devices, Raster Graphics

Lecture 3 - Raster Graphics - I

Lecture 4 - Raster Graphics - II

Lecture 5 - Polygon Filling

Lecture 6 - Windowing and Clipping

Lecture 7 - Clipping of Polygons

Lecture 8 - 2D Transformations

Lecture 9 - 3D Transformations and Projection

Lecture 10 - Perspective Projections

Lecture 11 - Projections and Hidden Surface Removal

Lecture 12 - Hidden Surface Removal

Lecture 13 - Hidden Surface Removal

Lecture 14 - Hidden Surface Removal

Lecture 15 - Finite Element Method : An Introduction

Lecture 16 - Galerkin's Approach

Lecture 17 - Galerkin's Method : 1D Finite Element Method

Lecture 18 - 1D Finite Element Problems

Lecture 19 - 1D Finite Element Problems

Lecture 20 - FE Problems : Solving for Q

Lecture 21 - 1D - FE Problems : Galerkin's Approach

Lecture 22 - Penalty Approach and Multi Point Boundary

Lecture 23 - Quadratic Shape Functions

Lecture 24 - 2D - FE Problems

Lecture 25 - 2D - FE Problems (Continued.)

Lecture 26 - 3D - FE Problems

Lecture 27 - 3D - Tetrahedral and 2D - Quadrilateral Element

Lecture 28 - Mesh Preparation

Lecture 29 - Modeling of Curves

Lecture 30 - Modeling of Curves

Lecture 31 - Modeling of Curves

[Lecture 32 - Modeling of B-Spline Curves](#)

[Lecture 33 - Modeling of B-spline Curves](#)

[Lecture 34 - Surface Modeling](#)

[Lecture 35 - Surface Modeling](#)

[Lecture 36 - Display of Curves and Surfaces](#)

[Lecture 37 - Solid Modeling](#)

[Lecture 38 - Solid Modeling](#)

[Lecture 39 - Solid Modeling Using Octrees](#)

[Lecture 40 - \(Lecture Missing\)](#)

[Lecture 41 - Computer Aided Design](#)

[Lecture 42 - Computer Aided Manufacturing](#)

[Lecture 43 - What is CAD/CAM](#)

[Lecture 44 - An Overview of Geometric Modeling](#)

[Lecture 45 - Parametric Cubic Curve](#)

[Lecture 46 - Parametric Bezier Curve](#)

[Lecture 47 - B-Spline Curve](#)

[Lecture 48 - Parametric Surfaces - Part-1](#)

[Lecture 49 - Parametric Surfaces - Part-2](#)

[Lecture 50 - Solid Modeling](#)

[Lecture 51 - Geometric & Product Data Exchange](#)

[Lecture 52 - Reverse Engineering](#)

NPTEL : Project and Production Management (Mechanical Engineering)

Co-ordinators : Prof. Arun Kanda

Lecture 1 - Project and Production Management - An Overview

Lecture 2 - Project Management: An Overview

Lecture 3 - Project Identification and Screening

Lecture 4 - Project Appraisal - Part I

Lecture 5 - Project Appraisal - Part II

Lecture 6 - Project Selection

Lecture 7 - Project Representation

Lecture 8 - Consistency and Redundancy in Project Networks

Lecture 9 - Basic scheduling with A-O-A Networks

Lecture 10 - Basic Scheduling with A-O-N Networks

Lecture 11 - Project Scheduling with Probabilistic Activity

Lecture 12 - Linear Time-Cost Tradeoffs in Projects

Lecture 13 - Project Crashing with Multiple Objectives

Lecture 14 - Resource Profiles and Leveling

Lecture 15 - Limited Resource Allocation

Lecture 16 - Project Monitoring and Control with PERT/Cost

Lecture 17 - Team Building and Leadership in Projects

Lecture 18 - Organizational and Behavioral Issues

Lecture 19 - Computers in Project Management

Lecture 20 - Project Completion and Review

Lecture 21 - Life Cycle of a Production System

Lecture 22 - Role of Models in Production Management

Lecture 23 - Financial Evaluation of capital Decisions

Lecture 24 - Decision Trees and Risk Evaluation

Lecture 25 - Introducing New Products & Services

Lecture 26 - Economic Evaluation of New Products & Services

Lecture 27 - Product Mix Decisions

Lecture 28 - Product & Process Design

Lecture 29 - Issues in Location of Facilities

Lecture 30 - Mathematical Models for Facility Location

Lecture 31 - Layout planning

[Lecture 32 - Computerised Layout Planning](#)

[Lecture 33 - Product Layouts and Assembly Line Balancing](#)

[Lecture 34 - Forecasting](#)

[Lecture 35 - The Analysis of Time Series](#)

[Lecture 36 - Aggregate Production Planning: Basic Concepts](#)

[Lecture 37 - Modelling Approaches](#)

[Lecture 38 - Basic Inventory Principles](#)

[Lecture 39 - Inventory Modelling](#)

[Lecture 40 - Material Requirements Planning](#)

[Lecture 41 - Scheduling of Job Shops](#)

Lecture 1 - Introduction to Design

Lecture 2 - Design Considerations

Lecture 3 - Basic Concepts Psychrometry and Air-Conditioning

Lecture 4 - Refrigerants

Lecture 5 - Refrigerant Properties and Applications

Lecture 6 - Refrigeration Cycle and Components

Lecture 7 - Compressor Selection

Lecture 8 - Expansion Devices

Lecture 9 - Condensers and Evaporators

Lecture 10 - Types of Heat Exchangers and Air Conditioning Systems

Lecture 11 - Selection of Air Conditioning Systems for Hostels

Lecture 12 - Case Study on a Railway Air Conditioning System

Lecture 13 - Vibration and noise issues in railway AC systems

Lecture 14 - New product launch process

Lecture 15 - Case study on a telecom cooling system and Emerging technologies

Lecture 1 - Thermodynamic Concepts: Applications of thermodynamics

Lecture 2 - Thermodynamic Concepts: System definition, Heat, Work and Mass Flow

Lecture 3 - Thermodynamic Concepts: Questions and Answers

Lecture 4 - Thermodynamic Concepts: Properties, State and Equilibrium

Lecture 5 - Thermodynamic Concepts: Process, Cycles and Applications

Lecture 6 - Thermodynamic Concepts: Steady state, Reversible and Irreversible processes

Lecture 7 - Thermodynamic Concepts: Causes of irreversibility

Lecture 8 - Thermodynamic Concepts: Thermal reservoirs

Lecture 9 - Thermodynamic Concepts: Pressure and temperature

Lecture 10 - Thermodynamic Concepts: Revision and Summary

Lecture 11 - Laws Of Thermodynamics: Mass flow rate, Conservation of mass, Flow work

Lecture 12 - Laws Of Thermodynamics: Zeroth Law

Lecture 13 - Laws Of Thermodynamics: First Laws Of Thermodynamics, 1st law for Control Mass, Internal Energy, enthalpy

Lecture 14 - Laws Of Thermodynamics: 1st law for Control Volume

Lecture 15 - Laws Of Thermodynamics: Revision, Cycles, Second Law statements, Clausius inequality

Lecture 16 - Laws Of Thermodynamics: Introduction to Carnot Cycle

Lecture 17 - Laws Of Thermodynamics: Entropy, Entropy change for a system

Lecture 18 - Laws Of Thermodynamics: Thermodynamics relations, Bernoulli's equation

Lecture 19 - Laws Of Thermodynamics: Devices, Cycles

Lecture 20 - Properties of a Pure Substance: Thermodynamic behaviour of a pure substance

Lecture 21 - Properties of a Pure Substance: Saturated states, Subcooled liquid, Superheated vapour

Lecture 22 - Properties of a Pure Substance: Vapour pressure curve, Reference state

Lecture 23 - Properties of a Pure Substance: Saturated states

Lecture 24 - Properties of a Pure Substance: p-h diagram

Lecture 25 - Properties of a Pure Substance: T-s diagram, h-s diagram

Lecture 26 - Properties of a Pure Substance: Critical state, Compressibility factor

Lecture 27 - Properties of a Pure Substance: Ideal gas behaviour, Equations of state, Specific heat

Lecture 28 - Properties of a Pure Substance: Ideal gas processes

Lecture 29 - Properties of a Pure Substance: Gibbs energy, Helmholtz function, Property relations

Lecture 30 - Properties of a Pure Substance: Process analysis, Summary

Lecture 31 - Laws of Thermodynamics: Carnot Cycle Realization

Lecture 32 - Applications, Problem Solving: Devices, Schematic/Flow Diagrams

Lecture 33 - Applications, Problem Solving: Positive Displacement Devices

Lecture 34 - Applications, Problem Solving: Heat Exchangers

Lecture 35 - Applications, Problem Solving: Compressors, Fans and Blowers, Pumps

Lecture 36 - Applications, Problem Solving: Turbines

Lecture 37 - Applications, Problem Solving: Nozzle, Diffuser, Expansion Valve, Pipe/duct flow

Lecture 38 - Applications, Problem Solving: De-Superheater, Deaerator, Separation

Lecture 39 - Applications, Problem Solving: Unsteady processes, Filling, Evacuation

Lecture 40 - Applications, Problem Solving: Realization of Carnot cycle, Practical cycles, Air-standard cycles

Lecture 41 - Applications, Problem Solving: Materials, Compressible flow

Lecture 42 - Applications, Problem Solving: Otto cycle, Diesel cycle

Lecture 43 - Applications, Problem Solving: Closed system

Lecture 44 - Applications, Problem Solving: Open System

Lecture 45 - Properties of Ideal Gas Mixtures: Introduction to mixtures properties

Lecture 46 - Properties of Ideal Gas Mixtures: Equation of state, Conservation equations

Lecture 47 - Gas-Vapour Mixtures: Psychrometry, Moist air Properties,

Lecture 48 - Gas-Vapour Mixtures: Properties, Conservation of Mass and Energy

Lecture 49 - Gas-Vapour Mixtures: Psychrometric chart, Applications

Lecture 50 - Thermodynamics of Reacting systems: Introduction to reacting systems and combustion

Lecture 51 - Thermodynamics of Reacting systems: Flames, Stoichiometry

Lecture 52 - Thermodynamics of Reacting systems: Analysis of Closed and Open Systems, Enthalpy of Formation

Lecture 53 - Phase and Chemical Equilibrium: Introduction. Chemical equilibrium. Gibbs function

Lecture 54 - Phase and Chemical Equilibrium: Equilibrium constant. Phase equilibrium

- Lecture 1 - Mathematical Concepts: Working with Vectors and Tensors
- Lecture 2 - Traction Vector
- Lecture 3 - Stress Tensor and its Matrix Representation
- Lecture 4 - Transformation of Stress Matrix
- Lecture 5 - Stress Equilibrium Equations : Balance of Linear and Angular Momentum
- Lecture 6 - Balance of Angular Momentum (Continued...)
- Lecture 7 - Principal Planes and Principal stress components
- Lecture 8 - Maximizing the Shear Component of Traction
- Lecture 9 - Mohr's Circle
- Lecture 10 - Mohr's Circle (Continued...), Stress Invariants, Decomposition of the Stress Tensor
- Lecture 11 - Concept of Strain Tensor
- Lecture 12 - Longitudinal and Shear Strains
- Lecture 13 - Local Volumetric Strain and Local Infinitesimal Rotation
- Lecture 14 - Similarity in Properties of Stress and Strain Tensors
- Lecture 15 - Stress-Strain Relation
- Lecture 16 - Stress-Strain Relation for Isotropic Materials
- Lecture 17 - Linear Momentum Balance in Cylindrical Coordinate System
- Lecture 18 - Linear Momentum Balance in Cylindrical Coordinate System (Continued...)
- Lecture 19 - Strain Matrix Cylindrical Coordinate System
- Lecture 20 - Extension-Torsion-Inflation in a Hollow Cylinder
- Lecture 21 - Extension-Torsion-Inflation in a Hollow Cylinder (Continued...)
- Lecture 22 - Solving Problems Involving Torsion of Shafts
- Lecture 23 - Pure Bending of Rectangular Beams
- Lecture 24 - Bending of Beams (Continued...)
- Lecture 25 - Bending of Unsymmetrical Beams
- Lecture 26 - Concept of Shear Center
- Lecture 27 - Theory of Beams
- Lecture 28 - Theory of Beams (Continued...) and Beam Buckling
- Lecture 29 - Energy Methods
- Lecture 30 - Energy Methods (Continued...)
- Lecture 31 - Theories of Failure

[Lecture 32 - Theories of Failure \(Continued...\)](#)

- Lecture 1 - Course Outline, Introduction
- Lecture 2 - Experimentation Processes and Applications Overview
- Lecture 3 - Developments in Uncertainty Analysis, Approach
- Lecture 4 - Errors, Their Causes and Classification
- Lecture 5 - Errors to Uncertainty via Statistics
- Lecture 6 - Sources of Errors, Uncertainty Definitions
- Lecture 7 - Experimentation - I
- Lecture 8 - Experimentation Stages / Phases I
- Lecture 9 - Experimentation Stages / Phases II
- Lecture 10 - Uncertainty Analysis Processes
- Lecture 11 - Instrument ans DAS
- Lecture 12 - Basic procedure - I
- Lecture 13 - Basic procedure - II
- Lecture 14 - Evaluating systematic uncertainties
- Lecture 15 - Worksheets for uncertainty in a measurement, Examples
- Lecture 16 - Examples of uncertainty in a measurement
- Lecture 17 - Methodologies, Multiple tests method
- Lecture 18 - Single test, Basics of Taylor Series Method
- Lecture 19 - Sensitivity coefficient, Result uncertainty from TSM
- Lecture 20 - Result uncertainty TSM: Special cases
- Lecture 21 - Method selection, Worksheets for result uncertainty
- Lecture 22 - Examples for result uncertainty - 1
- Lecture 23 - Examples for result uncertainty - 2
- Lecture 24 - Regression Introduction
- Lecture 25 - Regression analysis - Linear, single variable
- Lecture 26 - Correlation, Related topics
- Lecture 27 - Reporting uncertainties
- Lecture 28 - Validation and verification aspects, Data archiving
- Lecture 29 - Course overview

Lecture 1 - Introduction

Lecture 2 - Examples of visualization - 1

Lecture 3 - Examples of visualization - 2

Lecture 4 - Visualization and drawing

Lecture 5 - Sketch to engineering drawing

Lecture 6 - Types of projections

Lecture 7 - Multiview projections

Lecture 8 - 1st and 3rd angle projections

Lecture 9 - Sketching

Lecture 10 - Visualization

Lecture 11 - Drawing sheet

Lecture 12 - Lines

Lecture 13 - Dimensioning

Lecture 14 - Projection of a point line and plane

Lecture 15 - Projection of simple objects

Lecture 16 - Example Projection of a solid

Lecture 17 - Example Projection of an object

Lecture 18 - Types of Solids

Lecture 19 - Polygons Construction and Projections

Lecture 20 - Rotation of Solids

Lecture 21 - Example Rotation of Solids

Lecture 22 - Section views

Lecture 23 - Sectioning practices

Lecture 24 - Auxiliary views

Lecture 25 - Example Section View

Lecture 26 - Example Auxiliary View

Lecture 27 - Pictorial Drawings

Lecture 28 - Construction of Isometric Drawings

Lecture 29 - Example Isometric drawings

Lecture 30 - Working Drawing

Lecture 31 - Example Sectional View of Assembly

[Lecture 32 - Computer Aided Design](#)

[Lecture 33 - Autodesk Inventor Environment](#)

[Lecture 34 - Sketching for Solid Modelling](#)

[Lecture 35 - Example 1 Extrude Hole Fillet Chamfer](#)

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[Lecture 38 - Revolve Loft Pattern](#)

[Lecture 39 - Example 4](#)

[Lecture 40 - Example 5](#)

[Lecture 41 - Spline Sweep Shell](#)

[Lecture 42 - Example 6](#)

[Lecture 43 - Example 7](#)

[Lecture 44 - Drawing from Solid Model](#)

[Lecture 45 - Assembly with constraints](#)

[Lecture 46 - Example 8](#)

[Lecture 47 - Example 9](#)

[Lecture 48 - Example 10](#)

[Lecture 49 - Example 11](#)

[Lecture 50 - Civil and architectural drawings](#)

Lecture 1 - Ideal fluids, Velocity potential, Potential flows

Lecture 2 - Stream function, Orthogonality of streamlines and equipotential lines

Lecture 3 - Complex variables, Analyticity, Cauchy - Riemann equations, Complex potential, Complex velocity

Lecture 4 - Elementary flows : Uniform flow, Source and Sink, Free vortex

Lecture 5 - Flow in a bend, Flow around a sharp edge

Lecture 6 - Superposition of source and sink : doublet flow

Lecture 7 - Superposition of uniform flow and doublet

Lecture 8 - Superposition of uniform flow, doublet and free vortex

Lecture 9 - Superposition of source and uniform flow

Lecture 10 - Problem solving session - 1

Lecture 11 - Problem solving session - 2

Lecture 12 - Method of images, Forces on a body, Blasius theorem

Lecture 13 - Calculation of forces using derived flow field

Lecture 14 - Introduction to conformal transformation

Lecture 15 - Singularities and their transformations

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- Lecture 1 - Introduction to polymers
- Lecture 2 - Polymer structure
- Lecture 3 - Polymer classification
- Lecture 4 - Polymer length, packing and tacticity
- Lecture 5 - Glass transition temperature
- Lecture 6 - Temperature effects, glassy regime
- Lecture 7 - Viscoelastic, rubbery, viscous, decomposition
- Lecture 8 - Relaxation and creep tests
- Lecture 9 - Failure of polymers
- Lecture 10 - Heaviside, Dirac delta, Laplace
- Lecture 11 - Introduction to linear viscoelasticity
- Lecture 12 - Phenomenological models for linear viscoelasticity
- Lecture 13 - Maxwell model
- Lecture 14 - Kelvin model
- Lecture 15 - Three and four parameter models
- Lecture 16 - Generalized Maxwell and Kelvin models
- Lecture 17 - Boltzman superposition principle
- Lecture 18 - Alfrey's correspondence principle
- Lecture 19 - Analysis of viscoelastic bars
- Lecture 20 - Analysis of viscoelastic beams
- Lecture 21 - Dynamic mechanical analysis (DMA)
- Lecture 22 - Dynamic mechanical thermal analysis (DMTA)
- Lecture 23 - Time temperature superposition principle (TTSP)
- Lecture 24 - Plastic design consideration and practices
- Lecture 25 - What are composites?
- Lecture 26 - Composite materials and types
- Lecture 27 - Composite advantages and applications
- Lecture 28 - Fabrication and other aspects of composites
- Lecture 29 - 3D stress and strain components
- Lecture 30 - Symmetry in stress, strain and stiffness matrix
- Lecture 31 - Monoclinic, orthotropic and isotropic materials

- Lecture 32 - 3D stress strain relation for orthotropic material
- Lecture 33 - Plane stress: Specially orthotropic material
- Lecture 34 - Plane stress: Generally orthotropic material
- Lecture 35 - Lamina engineering constants
- Lecture 36 - Lamina hygrothermal effects
- Lecture 37 - Lamina fundamental strengths
- Lecture 38 - Lamina failure criteria
- Lecture 39 - Tsai-Hill and Hoffman failure criteria
- Lecture 40 - Micromechanics: Assumptions, RVE
- Lecture 41 - Micromechanics: Stiffness prediction
- Lecture 42 - Micromechanics: Stiffness and strength
- Lecture 43 - Macromechanics of laminate
- Lecture 44 - Classical laminate theory
- Lecture 45 - Classical laminate theory - II
- Lecture 46 - Symmetric laminates, orthotropic laminates
- Lecture 47 - Angle-ply, cross-ply and quasi-isotropic laminates
- Lecture 48 - Hygrothermal stresses in laminates
- Lecture 49 - Laminate failure
- Lecture 50 - Design practices with laminates
- Lecture 51 - Sandwich structures
- Lecture 52 - Composites testing
- Lecture 53 - Joining of composites

Lecture 1 - Introduction of Nonlinear systems

Lecture 2 - Review of Linear vibrating systems

Lecture 3 - Phenomena associated with Nonlinear systems

Lecture 4 - Commonly observed Phenomena in Nonlinear systems

Lecture 5 - Force and Moment based Approach

Lecture 6 - Energy based approach Extended Hamilton's principle and Lagrange Principle

Lecture 7 - Derivation of Equation of motion of nonlinear discrete system (More examples)

Lecture 8 - Derivation of Equation of motion of nonlinear continuous system - 1

Lecture 9 - Derivation of Equation of motion of nonlinear continuous system - 2

Lecture 10 - Ordering of nonlinear Equation of motion

Lecture 11 - Qualitative Analysis Straight forward expansion

Lecture 12 - Numerical method Straight forward expansion

Lecture 13 - Lindstedt Poincaré technique

Lecture 14 - Method of multiple scales

Lecture 15 - Method of Harmonic balance

Lecture 16 - Method of averaging

Lecture 17 - Generalized Method of averaging

Lecture 18 - Krylov-Bogoliubov-Mitropolski technique

Lecture 19 - Incremental harmonic balance method and Intrinsic multiple scale harmonic balance method

Lecture 20 - Modified Lindstedt Poincaré technique

Lecture 21 - Stability and Bifurcation of Fixed-point response - 1

Lecture 22 - Stability and Bifurcation of Fixed-point response - 2

Lecture 23 - Stability and Bifurcation of Fixed-point response - 3

Lecture 24 - Stability and Bifurcation of Fixed-point response - 4

Lecture 25 - Stability Analysis of Periodic response

Lecture 26 - Bifurcation of Periodic response And Introduction to quasi-periodic and Chaotic response

Lecture 27 - Quasi-Periodic and Chaotic response

Lecture 28 - Numerical methods to obtain roots of characteristic equation and time response

Lecture 29 - Numerical methods to obtain time response

Lecture 30 - Numerical methods to obtain frequency response

Lecture 31 - Free Vibration of Single degree of freedom Nonlinear systems with Cubic and quadratic nonlinearities

[Lecture 32 - Free Vibration of Single degree of freedom Nonlinear systems with Cubic and quadratic nonlinearities: effect of damping](#)

[Lecture 33 - Free Vibration of multi- degree of freedom Nonlinear systems with Cubic and quadratic nonlinearities](#)

[Lecture 34 - Forced nonlinear Vibration Single degree of freedom Nonlinear systems with Cubic nonlinearities:](#)

[Lecture 35 - Forced nonlinear Vibration Single and multi- degree of freedom Nonlinear systems](#)

[Lecture 36 - Nonlinear Forced-Vibration of Single and Multi Degree-of-Freedom System](#)

[Lecture 37 - Analysis of Multi- degree of freedom system](#)

[Lecture 38 - Nonlinear Vibration of Parametrically excited system: Axially loaded sandwich beam](#)

[Lecture 39 - Nonlinear Vibration of Parametrically excited system: Elastic and Magneto-elastic beam](#)

[Lecture 40 - Nonlinear Vibration of Parametrically excited system with internal resonance](#)

Lecture 1 - Introduction

Lecture 2 - A Brief History of Rotor Dynamics

Lecture 3 - The State of the Art of Rotor Dynamics

Lecture 4 - Simple Rotor Models with Rigid Bearings

Lecture 5 - Jeffcott Rotor Model

Lecture 6 - Variant of Jeffcott Rotor Model

Lecture 7 - Rigid Rotor Mounted on Simple Anisotropic Springs as Bearings

Lecture 8 - Rigid Rotor Mounted on Complex Anisotropic Bearings

Lecture 9 - Flexible Shaft with a Rigid Disc Mounted on Anisotropic Supports

Lecture 10 - Gyroscopic Effects : Synchronous whirl of a Rotor Systems with a thin Disc

Lecture 11 - Gyroscopic Effects : Synchronous and Asynchronous pure wobbling motions

Lecture 12 - Gyroscopic Effects : Asynchronous whirl of a Rotor system with a thin Disc

Lecture 13 - Gyroscopic Effects : Asynchronous whirl analysis with Dynamic Approach

Lecture 14 - Torsional Vibrations: Simple Rotor Systems

Lecture 15 - Three Disc Rotor System

Lecture 16 - Transfer Matrix Approach - Part I

Lecture 17 - Transfer Matrix Approach - Part II

Lecture 18 - Transfer Matrix Approach - Part III

Lecture 19 - Geared and Branched Systems

Lecture 20 - Continuous System and Finite Element Method

Lecture 21 - Finite Element Method

Lecture 22 - Finite Element Analysis

Lecture 23 - Finite Element Analysis - Part III

Lecture 24 - Influence Coefficient Method

Lecture 25 - Transfer Matrix Method - Part I

Lecture 26 - Transfer Matrix Method - Part II

Lecture 27 - Transfer Matrix Method - Part III

Lecture 28 - Continuous System Approach

Lecture 29 - Finite Element Method - Part I

Lecture 30 - Finite Element Method - Part II

Lecture 31 - Finite Element Method - Part III

[Lecture 32 - Instability in Rotor Systems: Bearings](#)

[Lecture 33 - Fluid-Film Bearings](#)

[Lecture 34 - Internal Damping & Asymmetrical Shaft](#)

[Lecture 35 - Steam Whirl and Seals](#)

[Lecture 36 - Subcritical Speed Whirl](#)

[Lecture 37 - Introduction to Rigid Rotor Balancing](#)

[Lecture 38 - Dynamic Balancing of Rotors: Rigid Rotor Balancing](#)

[Lecture 39 - Dynamic Balancing of Rotors:Flexible Rotor Model Balancing](#)

[Lecture 40 - Dynamic Balancing of Rotors:Influence Coefficient Method for Flexible Rotor](#)

[Lecture 41 - Common Faults & Vibration signatures](#)

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Lecture 1 - Fundamentals Of Engineering Mechanics

Lecture 2 - Equations of Equilibrium

Lecture 3 - Truss Analysis - Part 1

Lecture 4 - Truss Analysis - Part 2

Lecture 5 - Analysis of Frames Machines

Lecture 6 - Internal Forces

Lecture 7 - Internal Forces in Beams

Lecture 8 - Cables

Lecture 9 - Friction

Lecture 10 - Application of Friction - Part 1

Lecture 11 - Application of Friction - Part 2

Lecture 12 - Application of Friction - Part 3

Lecture 13 - Centroids Center of Mass

Lecture 14 - Centroids Area of Moments

Lecture 15 - Product of Inertia, Rotation of Axis and Principle Moments of Inertia

Lecture 16 - Principle Mass Moments of Inertia

Lecture 17 - Second Moment of Mass

Lecture 18 - Virtual Work of Ideal System

Lecture 19 - Principle of Virtual Work

Lecture 20 - Systems with Friction

Lecture 21 - Potential Energy

Lecture 22 - Stability of Equilibrium

Lecture 23 - Kinematics of a Particles

Lecture 24 - Kinematics of a Particle Moving on a Curve

Lecture 25 - Relative Motion

Lecture 26 - Plane Kinematics of Rigid Bodies

Lecture 27 - Kinematics of a Particle

Lecture 28 - Work and Energy

Lecture 29 - Impulse and Momentum

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Lecture 31 - Plane Kinetics of Rigid Bodies

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[Lecture 38 - Vibration of Rigid Bodies - Part 1](#)

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[Lecture 40 - Some Problems of Vibration](#)

- Lecture 1 - Overview of the Course, Practical and Research Trends
- Lecture 2 - Harmonic and Periodic Motions, Vibration Terminology
- Lecture 3 - Vibration Model, Equation of Motion-Natural Frequency
- Lecture 4 - Energy Method, Principle of Virtual Work
- Lecture 5 - Viscously Damped Free Vibration Special Cases: Oscillatory
- Lecture 6 - Logarithmic Decrement Experimental Determination of Damping Coefficient Hysteresis Loop
- Lecture 7 - Coulomb Damping other Damping Models
- Lecture 8 - Forced Harmonic Vibration, Magnification Factor
- Lecture 9 - Laplace Transform, Superposition Theorem
- Lecture 10 - Rotor Unbalance and Whirling of Shaft, Transmissibility
- Lecture 11 - Support Motion, Vibration Isolation
- Lecture 12 - Sharpness of Resonance, Vibration Measuring Instruments
- Lecture 13 - Generalized and Principle Coordinates, Derivation of Equation of Motion
- Lecture 14 - Lagranges's Equation
- Lecture 15 - Coordinate Coupling
- Lecture 16 - Forced Harmonic Vibration
- Lecture 17 - Tuned Absorber, Determination of Mass Ratio
- Lecture 18 - Tuned and Damped Absorber, Untuned Viscous Damper
- Lecture 19 - Derivation of Equations of Motion, Influence Coefficient Method
- Lecture 20 - Properties of Vibrating Systems: Flexibility & Stiffness Matrices, Reciprocity Theorem
- Lecture 21 - Modal Analysis: Undamped
- Lecture 22 - Modal Analysis: Damped
- Lecture 23 - Simple Systems With One Two or Three Discs Geared System
- Lecture 24 - Multi-Degree of Freedom Systems-Transfer Matrix Method Branched Systems
- Lecture 25 - Derivation of Equations of Motion Part 1 - Newton
- Lecture 26 - Derivation of Equations of Motion Part 2 - Newton
- Lecture 27 - Vibration of Strings
- Lecture 28 - Longitudinal and Torsional Vibration of Rods
- Lecture 29 - Transverse Vibration of Beams, Equations of Motion and Boundary Conditions
- Lecture 30 - Transverse Vibration of Beams: Natural Frequencies and Mode Shapes
- Lecture 31 - Rayleigh's Energy Method

[Lecture 32 - Matrix Iteration Method](#)

[Lecture 33 - Durkerley, Rayleigh-Ritz and Galerkin Method](#)

[Lecture 34 - Finite Element Formulation for Rods, Gear Train and Branched System](#)

[Lecture 35 - Finite Element Formulation for Beams: Galerkin](#)

[Lecture 36 - Global Finite Element Assembly and Imposition of Boundary Conditions](#)

[Lecture 37 - Vibration Testing Equipments: Signal Measurements](#)

[Lecture 38 - Vibration Testing Equipments: Signal Analysis](#)

[Lecture 39 - Field Balancing of Rotors](#)

[Lecture 40 - Condition Monitoring](#)

Lecture 1 - Introduction to advanced machining processes

Lecture 2 - Ultrasonic machining - Part I

Lecture 3 - Ultrasonic machining - Part II

Lecture 4 - Abrasive jet machining

Lecture 5 - Water jet cutting and Abrasive water jet machining

Lecture 6 - Magnetic abrasive finishing

Lecture 7 - Abrasive Flow Finishing

Lecture 8 - Magnetorheological Finishing

Lecture 9 - Magnetorheological Abrasive Flow Finishing - Part I

Lecture 10 - Magnetorheological Abrasive Flow Finishing - Part II

Lecture 11 - Magnetorheological Abrasive Flow Finishing - Part III

Lecture 12 - Electric discharge machining (EDM)

Lecture 13 - Electric Discharge Grinding, Electric Discharge Diamond Grinding and Wire Electric Discharge Machining

Lecture 14 - Electrochemical Machining (ECM)

Lecture 15 - Electrochemical Grinding, Electrostream Drilling, Shaped Tube Electrolytic Machining

Lecture 16 - Plasma Arc Machining (PAM)

Lecture 17 - Electron Beam Machining (EBM) Edit Lesson

Lecture 18 - Laser Beam Machining (LBM)

Lecture 19 - Chemical Machining (ChM)

- Lecture 1 - Introduction of nuclear energy
- Lecture 2 - Binding energy and mass defect
- Lecture 3 - Radioactivity and radioactive decay
- Lecture 4 - Different types of nuclear transmutation
- Lecture 5 - Artificial radioactivity and neutron-nucleus interactions
- Lecture 6 - Energy and momentum conservation
- Lecture 7 - Fission and role of neutron energy
- Lecture 8 - Theory of elastic scattering
- Lecture 9 - Neutron multiplication factor
- Lecture 10 - Neutron diffusion theory
- Lecture 11 - Solution of one-group diffusion equation
- Lecture 12 - Simple reactor theory
- Lecture 13 - Nuclear fuel and simple energy consideration
- Lecture 14 - Axial temperature distribution and heat transfer coefficient
- Lecture 15 - Prompt and delayed neutrons
- Lecture 16 - Delayed neutron kinetics
- Lecture 17 - Different control mechanisms and various effects
- Lecture 18 - Classical reactor designs
- Lecture 19 - Evolution of reactors from Gen-I to Gen-IV
- Lecture 20 - The concept of breeding
- Lecture 21 - Fuel cycles and FBR
- Lecture 22 - Gen-IV FBR designs
- Lecture 23 - Hydrogen fusion reactions
- Lecture 24 - Coulomb barrier and other critical factors
- Lecture 25 - Radiation dose and gross biological effects
- Lecture 26 - Stochastic and deterministic effects of human cells
- Lecture 27 - Lessons from TMI and Chernobyl
- Lecture 28 - Defence-in-depth Philosophy
- Lecture 29 - Waste classification and Disposal of Mill Tailings
- Lecture 30 - Disposal methodologies for HLW and IMW

- Lecture 1 - Fundamentals of Welding and Joining - Part I
- Lecture 2 - Fundamentals of Welding and Joining - Part II
- Lecture 3 - Fundamentals of Welding and Joining - Part III
- Lecture 4 - Fundamentals of Welding and Joining - Part IV
- Lecture 5 - Fundamentals of Welding and Joining - Part V
- Lecture 6 - Laser and Electron Beam Welding - Part I
- Lecture 7 - Laser and Electron Beam Welding - Part II
- Lecture 8 - Solid State Welding Processes - Part I
- Lecture 9 - Solid State Welding Processes - Part II
- Lecture 10 - Solid State Welding Processes - Part III
- Lecture 11 - Computational Welding Mechanics - Part I
- Lecture 12 - Computational Welding Mechanics - Part II
- Lecture 13 - Computational Welding Mechanics - Part III
- Lecture 14 - Micro and Nano Joining Processes - Part I
- Lecture 15 - Micro and Nano Joining Processes - Part II
- Lecture 16 - Micro and Nano Joining Processes - Part III
- Lecture 17 - Welding Metallurgy - Part I
- Lecture 18 - Welding Metallurgy - Part II
- Lecture 19 - Welding Metallurgy - Part III
- Lecture 20 - Welding Metallurgy - Part IV
- Lecture 21 - Welding and Joining of Non-Metals - Part I
- Lecture 22 - Welding and Joining of Non-Metals - Part II
- Lecture 23 - Metal Transfer in Welding and Metal Printing

Lecture 1 - Introduction

Lecture 2 - Introduction and Importance of Machining

Lecture 3 - Principles of Machining or Metal Cutting

Lecture 4 - Cutting Tools

Lecture 5 - Forces in Machining

Lecture 6 - Tribology in Machining

Lecture 7 - Lubrication surface roughness in Machining

Lecture 8 - Machinability and Thermal Aspects

Lecture 9 - Tool Wear and Tool life - Part 1

Lecture 10 - Tool Wear and Tool life - Part 2

Lecture 11 - Tool Wear and Tool life - Part 3

Lecture 12 - Tool Materials and Coatings

Lecture 13 - Machining Fluids / Cutting Fluids and its Additives - Part 1

Lecture 14 - Machining Fluids / Cutting Fluids and its Additives - Part 2

Lecture 15 - Machining Fluids / Cutting Fluids and its Emissions

Lecture 16 - Eco Friendly Cutting Fluids - Part 1

Lecture 17 - Eco Friendly Cutting Fluids - Part 2

Lecture 18 - Rheology and Thermal Characterization of Machining / Cutting Fluids

Lecture 19 - Bio-degradation Studies of Machining / Cutting Fluids

Lecture 20 - Cutting Fluid Application in Machining Region

Lecture 21 - Practical Machining Processes - 1

Lecture 22 - Practical Machining Processes - 2

Lecture 23 - Introduction to Abrasive Processes - Grinding

Lecture 24 - Cutting fluids in Grinding Process

Lecture 25 - Unbonded Conventional Abrasive Processes

Lecture 26 - Advances in Metal Cutting_Machining Processes

Lecture 27 - Advances in Metal Cutting_Machining Processes - 2

Lecture 1 - Deformation of Metals

Lecture 2 - Mechanism of Plastic Deformation

Lecture 3 - Machining Processes: Single Edge Tool, Types of Chips

Lecture 4 - Tool Geometry: Single Point Cutting Tool Specifications

Lecture 5 - Tool Specifications, Conversion Of Tool Angles, Multi-Point Cutting Tools

Lecture 6 - Mechanics of Orthogonal Cutting, Force Relationships

Lecture 7 - Determination of Stress, Strain, and Strain Rate

Lecture 8 - Measurement of Shear Angle

Lecture 9 - Other Analysis for Force Relationships

Lecture 10 - Mechanics of Oblique Cutting

Lecture 11 - Measurement of Cutting Forces

Lecture 12 - Thermal Aspects Of Machining: Temperatures in Orthogonal Cutting

Lecture 13 - Tool Wear and Tool Life and Tool Life Equations

Lecture 14 - Economics in Machining

Lecture 15 - Practical Machining Operations: Turning And Shaping and Planning Operation

Lecture 16 - Practical Machining Operations: Milling And Drilling

Lecture 17 - Grinding of Metals and Mechanics of Grinding Process

Lecture 18 - Abrasive Machining and Finishing Operations

Lecture 19 - CNC Machines and CNC Programming

Lecture 20 - Introduction to Advanced Machining Processes

Lecture 1 - Introduction to hydraulic machines: classifications and operational principles

Lecture 2 - Euler equation for turbomachines: net head developed by the pump/turbines

Lecture 3 - Velocity triangles of pumps, effect of inlet swirl on pump operation

Lecture 4 - Velocity triangles of pumps, effect of inlet swirl on pump operation

Lecture 5 - Pump casings, Efficiencies and Problems - I

Lecture 6 - Pump casings, Efficiencies and Problems - II

Lecture 7 - Pump casings, Efficiencies and Problems - III

Lecture 8 - Axial flow pump, HQ curve, System Resistance Curve - I

Lecture 9 - Axial flow pump, HQ curve, System Resistance Curve - II

Lecture 10 - HQ Curve, System Resistance Curve - I

Lecture 11 - HQ Curve, System Resistance Curve - II

Lecture 12 - Introduction to Cavitation

Lecture 13 - Condition for Cavitation and NPSH

Lecture 14 - Net Positive Suction Head (NPSH)

Lecture 15 - Suction number and Introduction to off design condition

Lecture 16 - Cavitation: The effect of off-design Conditions

Lecture 17 - Cavitation: Preventive Measures

Lecture 18 - Cavitation: Preventive Measures, Effect on Pump Characteristic

Lecture 19 - Problems on Cavitation

Lecture 20 - Introduction to Slip : Stodola Slip Model

Lecture 21 - Departure from Euler theory

Lecture 22 - Slip Velocity - I

Lecture 23 - Slip Velocity - II

Lecture 24 - Problem on slip

Lecture 25 - Degree of reaction of pump

Lecture 26 - Degree of reaction and axial pump design

Lecture 27 - Testing of radial flow pump - I

Lecture 28 - Testing of radial flow pump - II

Lecture 29 - Problem on radial flow pump testing

Lecture 30 - Radial equilibrium of axial flow pump - I

Lecture 31 - Radial equilibrium of axial flow pump - II

- Lecture 32 - Pump operation: series and parallel connection
- Lecture 33 - Series and parallel operation of dissimilar pumps
- Lecture 34 - Pumping system design
- Lecture 35 - Design of parallel pumping system
- Lecture 36 - Numerical problem on pumps - I
- Lecture 37 - Numerical problem on pumps - II
- Lecture 38 - Numerical problem on pumps - III
- Lecture 39 - Working principle and Indicator diagram of PD pump
- Lecture 40 - Working principle and Indicator diagram of PD pump (Continued...)
- Lecture 41 - Modified indicator diagram and Head-Discharge curve
- Lecture 42 - Analysis and Head-Discharge curve of PD pump
- Lecture 43 - Analysis and efficiencies of PD pump
- Lecture 44 - Requirement of air chamber in PD pump
- Lecture 45 - Numerical problem on PD pump with air chamber
- Lecture 46 - Similarity and dimensional analysis of hydraulic machines
- Lecture 47 - Dimensional analysis of hydraulic machines: Buckingham's theorem
- Lecture 48 - Buckingham's theorem: Specific speed of hydraulic machines
- Lecture 49 - Turbine Classification and Operational principle of Pelton wheel
- Lecture 50 - Velocity Triangles and analysis
- Lecture 51 - Operational Principle of Reaction turbine
- Lecture 52 - Degree of Reaction and Introduction to axial flow turbine
- Lecture 53 - Kaplan Turbine: Operational Principle, Turbine efficiencies
- Lecture 54 - Draft Tube for Reaction Turbine and Cavitation
- Lecture 55 - Energy Balance and NPSH
- Lecture 56 - Thoma Cavitation Factor
- Lecture 57 - Reaction Turbine: Design aspects and Characteristic Curves
- Lecture 58 - Problems on Impulse and Reaction Turbines

- Lecture 1 - Introduction to Abrasive Machining and Finishing Processes
- Lecture 2 - Grinding Process
- Lecture 3 - Grinding Fluids and Its Additives
- Lecture 4 - Grinding Fluids and its Emissions
- Lecture 5 - Sustainable Grinding Process: Biodegradation of Grinding Fluids
- Lecture 6 - Sustainable Grinding Process: MQL in Grinding Process
- Lecture 7 - Honing Process
- Lecture 8 - Lapping Process
- Lecture 9 - Super Finishing and Sand Blasting
- Lecture 10 - Vibratory Bowl Finishing, Rotary Barrel Finishing or Tumbling
- Lecture 11 - Drag Finishing, Ice-bonded Abrasive Finishing, Pitch Polishing, Pad Polishing
- Lecture 12 - Introduction to Surface Texture in abrasive Process
- Lecture 13 - Representation of Surface Roughness
- Lecture 14 - Abrasive Jet Machining (AJM)
- Lecture 15 - Abrasive Water Jet Machining (AWJM)
- Lecture 16 - Ultrasonic Machining (USM)
- Lecture 17 - EDM, Wire-EDM, EDG, EDDG, AW-EDG
- Lecture 18 - Elastic Emission Machining
- Lecture 19 - PMEDM and ECD and ELID, ECH
- Lecture 20 - Abrasive Flow Finishing: Part 1
- Lecture 21 - Abrasive Flow Finishing: Part 2
- Lecture 22 - Magnetic Field Assisted Abrasive Finishing: MAF, MADe, MFP
- Lecture 23 - Magneto Rheological Finishing and BE-MRF
- Lecture 24 - Magnetic Field Assisted Abrasive Finishing: CNP, CMMRF, MRAFF, R-MRAFF
- Lecture 25 - Summary of the Course

Lecture 1 - Basic of Solid Mechanics

Lecture 2 - Energy Principles

Lecture 3 - Classification of Plate Theories and Some Basics

Lecture 4 - Tutorial: Transformation of Tensors

Lecture 5 - Governing Equation for Plate - 1

Lecture 6 - Governing Equation for Plate - 2

Lecture 7 - Tutorial: Reduced Stiffness and Plate Stiffness

Lecture 8 - Navier Solution + Levy solution

Lecture 9 - Levy Solution

Lecture 10 - Tutorial: Load Matrices Calculation

Lecture 11 - EKM and buckling of plates

Lecture 12 - 3D Solutions

Lecture 13 - Matlab Coding + ABAQUS

Lecture 14 - Tutorial: Levy Solutions

Lecture 1 - Introduction to measurement

Lecture 2 - Generalized measurement system and static characteristics

Lecture 3 - Uncertainties in measurement

Lecture 4 - Statistical treatment of random errors

Lecture 5 - System response to periodic inputs

Lecture 6 - Zeroth and first order systems

Lecture 7 - First and second order systems

Lecture 8 - Basics of digitization and number systems

Lecture 9 - Binary logic gates and binary codes

Lecture 10 - Analog-to-digital conversion

Lecture 11 - Digital-to-analog conversion

Lecture 12 - Electromagnetic indicators

Lecture 13 - Electronic amplifiers and filters

Lecture 14 - Resistive devices

Lecture 15 - Inductive, capacitive and optical devices

Lecture 16 - Piezoelectric and nozzle-flapper transducers

Lecture 17 - Resistive strain gages and associated circuitry

Lecture 18 - Strain gage rosettes and gage orientation

Lecture 19 - Elastic and strain gage load cells

Lecture 20 - Various load cells and dynamometers

Lecture 21 - Principles of manometry

Lecture 22 - Piezometer and elastic pressure transducer

Lecture 23 - Electric pressure transducer and high and low pressure measurement

Lecture 24 - Bernoulli's equation in obstruction meters

Lecture 25 - Obstruction meters and volume flowmeters

Lecture 26 - Mass flowmeters and velocity probes

Lecture 27 - Expansion-based devices

Lecture 28 - RTD, Thermistor and Thermocouple

Lecture 29 - Introduction to pyrometers

Lecture 30 - Basic seismic transducer

Lecture 31 - Vibro-, velo- and accelerometer

[Lecture 32 - Introduction to acoustic measurement](#)

[Lecture 33 - Radioactivity and its biological effects](#)

Lecture 1 - External and Internal combustion engines, Engine components, SI and CI engines

Lecture 2 - Four-stroke and Two-stroke engines, Comparison between SI and CI engines, and Four-stroke and Two-stroke engines

Lecture 3 - Classification of IC engines

Lecture 4 - Engine operating characteristics

Lecture 5 - Otto, Diesel and Dual cycles

Lecture 6 - Otto, Diesel and Dual cycles (Continued...)

Lecture 7 - Otto, Diesel and Dual cycles (Continued...)

Lecture 8 - Otto, Diesel and Dual cycles (Continued...)

Lecture 9 - Comparison between the cycles, Actual cycles and their analysis

Lecture 10 - Carburetor, Mixture requirements

Lecture 11 - Carburetor, Mixture requirements (Continued...)

Lecture 12 - Idling, cruising and power ranges

Lecture 13 - Idling, cruising and power ranges (Continued...)

Lecture 14 - Classification, types of nozzles, Ignition system, Battery and Magneto ignition systems

Lecture 15 - Classification, types of nozzles, Ignition system, Battery and Magneto ignition systems (Continued...)

Lecture 16 - Classification, types of nozzles, Ignition system, Battery and Magneto ignition systems (Continued...)

Lecture 17 - Engine friction, Lubrication systems, forces on piston

Lecture 18 - Lubricating oils, Thermochemistry and Fuels, Self-ignition

Lecture 19 - Octane and Cetane Numbers, Alternative Fuels - Methanol, Ethanol, hydrogen, Natural Gas

Lecture 20 - Octane and Cetane Numbers, Alternative Fuels - Methanol, Ethanol, hydrogen, Natural Gas (Continued...)

Lecture 21 - Combustion in SI and CI Engines, Pressure Crank Angle Diagram

Lecture 22 - Combustion in SI and CI Engines, Pressure Crank Angle Diagram (Continued...)

Lecture 23 - Combustion in SI and CI Engines, Pressure Crank Angle Diagram (Continued...)

Lecture 24 - SI engine injection system, Energy distribution, Engine temperatures, Heat transfer in combustion chambers

Lecture 25 - SI engine injection system, Energy distribution, Engine temperatures, Heat transfer in combustion chambers (Continued...)

Lecture 26 - CI engine injection systems, Air-cooled and liquid-cooled engines, Modern trends

Lecture 27 - CI engine injection systems, Air-cooled and liquid-cooled engines, Modern trends (Continued...)

Lecture 28 - CI engine injection systems, Air-cooled and liquid-cooled engines, Modern trends (Continued...)

Lecture 29 - Problems on IC engine

Lecture 30 - Turbomachines, Gas Turbine theory

Lecture 31 - Open Cycle Gas Turbine Power Plant, Twin Shaft Arrangement

- Lecture 32 - Closed Cycle, Multi-Spool Arrangement, Steam Power Plant
- Lecture 33 - Basic Thermodynamics
- Lecture 34 - Brayton Cycle: Introduction and General Relationships
- Lecture 35 - Brayton Cycle: Efficiency, Work Ratio and Optimum Work Output Condition
- Lecture 36 - Brayton Cycle with Heat Exchanger/Reheater
- Lecture 37 - Brayton Cycle with Intercooler
- Lecture 38 - Real Brayton Cycle, Solved Example for Ideal Cycle
- Lecture 39 - Solved Examples for Real Brayton Cycle
- Lecture 40 - Introduction and Performance Parameters of Propulsion System
- Lecture 41 - Basics of Various Aircraft Engine
- Lecture 42 - Euler Turbomachinery Equation
- Lecture 43 - Introduction and Flow Analysis of Centrifugal Compressors
- Lecture 44 - Thermodynamics Analysis of Centrifugal Compressors
- Lecture 45 - Axial Compressor: Basics, Velocity triangles, T-S diagram and Work Interaction
- Lecture 46 - Axial Compressor: Different factors, Degree of Reaction and Free Vortex Condition
- Lecture 47 - Complete Analysis of Axial Flow Gas Turbine
- Lecture 48 - Solved Examples for Axial Compressors, Centrifugal Compressors and Turbine
- Lecture 49 - Radial Flow Turbine, Solved Example of Free vortex Condition
- Lecture 50 - Nozzles and Diffusers: Introduction, Intake efficiency, Nozzle efficiency

Lecture 1 - Introduction of welding

Lecture 2 - Classification of welding and joints

Lecture 3 - Parts of weld joint

Lecture 4 - Welding Symbol

Lecture 5 - welding power source - 1

Lecture 6 - Welding power source - 2

Lecture 7 - Welding Power sources characteristics - 1

Lecture 8 - Welding Power sources characteristics - 2

Lecture 9 - Physics of welding - 1

Lecture 10 - Physics of welding - 2

Lecture 11 - Physics of welding - 4 (Arc Stability and Arc Blow)

Lecture 12 - Physics of welding - 3

Lecture 13 - Physics of welding - 5 (Metal Transfer-1)

Lecture 14 - Physics of welding - 6 (Metal Transfer-2)

Lecture 15 - Physics of welding - 7 (Metal Transfer-3)

Lecture 16 - Physics of welding - 8 (Metal Transfer-4)

Lecture 17 - Physics of welding - 9 (Metal Transfer-5)

Lecture 18 - Physics of welding - 10 (Metalting Efficiency)

Lecture 19 - Oxy-Fuel Gas Welding

Lecture 20 - Shielded Metal Arc Welding

Lecture 21 - Gas Tungsten Arc Welding

Lecture 22 - Gas Metal Arc Welding

Lecture 23 - Submerged Arc Welding

Lecture 24 - Welding Defects and Inspection

Lecture 1 - Introduction to Polymer Assisted Abrasive Finishing Processes

Lecture 2 - Surface Integrity and Surface roughness representation - Part I

Lecture 3 - Surface Integrity and Surface roughness representation - Part II

Lecture 4 - Introduction to Grinding and Polymer assisted Grinding Wheels

Lecture 5 - Polymer medium for vibratory bowl finishing, Tumbling, Drag finishing

Lecture 6 - Polymer Pad and Chemo-mechanical Polishing

Lecture 7 - Elastic Emission Machining

Lecture 8 - Hydrodynamic Polishing, Elasto Abrasive Finishing

Lecture 9 - Abrasive Flow Machining and Finishing - Part I

Lecture 10 - Abrasive Flow Machining and Finishing - Part II

Lecture 11 - Advances in Abrasive Flow Finishing: DBGAFF, CFAAFM

Lecture 12 - Advances in Abrasive Flow Finishing: Spiral Polishing, R-AFF

Lecture 13 - AFF Processes: Magnetio AFF (MRAFF), UAA-AFF, EC-AFF

Lecture 14 - Finishing of Biomedical implants (Micro AFF: Micro holes, Micro slots, Bio Implants: Knee implants , Hip implants and Applications of one way, two way and orbital AFF)

Lecture 15 - Summary of the Course

- Lecture 1 - Materials and manufacturing Processes - 1
- Lecture 2 - Materials and manufacturing Processes - 2
- Lecture 3 - Physics based modeling approach at different scale
- Lecture 4 - Evaluation of properties and process modelling
- Lecture 5 - Thermofluid and electromagnetic analysis
- Lecture 6 - Solid-state deformation and residual stress - 1
- Lecture 7 - Solid-state deformation and residual stress - 2
- Lecture 8 - Melting, solidification and additive manufacturing
- Lecture 9 - Force and velocity diagram - 1
- Lecture 10 - Force and velocity diagram - 2
- Lecture 11 - Heat transfer analysis
- Lecture 12 - Principal and mechanism at different processes - 1
- Lecture 13 - Principal and mechanism at different processes - 2
- Lecture 14 - Mechanics of bulk metal forming
- Lecture 15 - Mechanics of sheet metal forming - 1
- Lecture 16 - Mechanics of sheet metal forming - 2
- Lecture 17 - Heat transfer and thermomechanical processing
- Lecture 18 - Fusion welding processes - 1
- Lecture 19 - Fusion welding processes - 2
- Lecture 20 - Physics of welding and metal transfer
- Lecture 21 - Heat source model in fusion welding
- Lecture 22 - Heat transfer and material flow
- Lecture 23 - Solidification in welding - 1
- Lecture 24 - Solidification in welding - 2
- Lecture 25 - Solid state welding - 1
- Lecture 26 - Solid state welding - 2
- Lecture 27 - Hybrid welding, residual stress and distortion
- Lecture 28 - Cooling and solidification at different casting processes
- Lecture 29 - Powder metallurgy
- Lecture 30 - Principle of surface and coating technologies
- Lecture 31 - Principle and development of additive manufacturing technologies - 1

[Lecture 32 - Principle and development of additive manufacturing technologies - 2](#)

[Lecture 33 - Fundamentals of heat treatment](#)

[Lecture 34 - Evaluation of microstructural properties and residual stress](#)

[Lecture 35 - Down-scaling of conventional manufacturing processes and Micro-to-nano manufacturing](#)

[Lecture 36 - Packaging, micro-finishing and micro-manufacturing processes](#)

[Lecture 37 - Processing and shaping of non-metals and bio-materials](#)

[Lecture 38 - Principle of glass and ceramics processing and their shaping](#)

[Lecture 1 - Introduction and Notation](#)

[Lecture 2 - Flow Regimes and Flow Regime Maps](#)

[Lecture 3 - The Homogeneous Model](#)

[Lecture 4 - The Separated Flow Model](#)

[Lecture 5 - The Separated Flow Model \(Continued...\)](#)

[Lecture 6 - The Drift Flux Model](#)

[Lecture 7 - Estimation of pressure drop in two phase flow](#)

[Lecture 8 - Two phase flow and pressure drop in miniature channels](#)

- Lecture 1 - Overview of thermodynamic system and state
- Lecture 2 - First and second laws of thermodynamics
- Lecture 3 - Concept of entropy and entropy generation
- Lecture 4 - Concept of exergy and exergy destruction
- Lecture 5 - Thermodynamic potentials and Maxwell relations
- Lecture 6 - Generalized relations for entropy and specific heats
- Lecture 7 - Joule-Thomson coefficient and Clapeyron equation
- Lecture 8 - Liquid-vapor phase-change process
- Lecture 9 - Use of property tables
- Lecture 10 - Equations-of-state and Compressibility factor
- Lecture 11 - Ideal cycles for reciprocating engines
- Lecture 12 - Otto, Diesel and Dual combustion cycles
- Lecture 13 - Stirling and Ericsson cycles
- Lecture 14 - Fuel-air cycle
- Lecture 15 - Numerical exercise on Fuel-air cycles
- Lecture 16 - Losses in actual cycle and valve-timing diagram
- Lecture 17 - Ideal Brayton cycle
- Lecture 18 - Intercooling and reheating in Brayton cycle
- Lecture 19 - Regeneration in Brayton cycle
- Lecture 20 - Ideal Rankine cycle
- Lecture 21 - Improvements and modifications in Rankine cycle
- Lecture 22 - Regenerative Rankine cycle
- Lecture 23 - Binary vapor power cycle
- Lecture 24 - Combined gas-steam power plant
- Lecture 25 - Different arrangements in combined cycles
- Lecture 26 - Vapor compression refrigeration cycle
- Lecture 27 - SSS cycles and refrigerants
- Lecture 28 - Modifications in VCR systems
- Lecture 29 - Vapor absorption refrigeration cycle
- Lecture 30 - P-v-T behavior of gas mixtures
- Lecture 31 - Numerical examples

[Lecture 32 - Properties of moist air](#)

[Lecture 33 - Psychrometric chart and various psychrometric processes](#)

[Lecture 34 - Sensible heat factor and bypass factor](#)

[Lecture 35 - Theoretical and actual combustion process](#)

[Lecture 36 - Thermodynamic analyses of reacting systems](#)

Lecture 1 - Relationship of Thermodynamics with Heat transfer

Lecture 2 - Modes of heat transfer

Lecture 3 - Fourier's law and thermal conductivity

Lecture 4 - Generalized heat diffusion equation

Lecture 5 - Heat diffusion equation in curvilinear coordinates

Lecture 6 - Concept of thermal resistance

Lecture 7 - Use of network of resistances in wall and cylinder

Lecture 8 - Critical thickness of insulation

Lecture 9 - Conduction with energy generation - I

Lecture 10 - Conduction with energy generation - II

Lecture 11 - General Heat Transfer Analysis

Lecture 12 - Fins with uniform cross-section area - I

Lecture 13 - Fins with uniform cross-section area - II

Lecture 14 - Fins with non-uniform cross-section area

Lecture 15 - Method of Separation of Variables

Lecture 16 - Graphical approach

Lecture 17 - Method of Superposition

Lecture 18 - Lumped capacitance approach - I

Lecture 19 - Lumped capacitance approach - II

Lecture 20 - Semi-infinite Solid

Lecture 21 - Steady Heat Conduction

Lecture 22 - Unsteady Heat Conduction

Lecture 23 - Problem solving using Energy Balance Method

Lecture 24 - Introduction to radiative heat fluxes

Lecture 25 - Spectral and directional definitions

Lecture 26 - Blackbody radiation

Lecture 27 - Emissivity

Lecture 28 - Irradiation of real surfaces

Lecture 29 - View factor

Lecture 30 - Blackbody radiation exchange

Lecture 31 - Radiation networks

[Lecture 32 - Gas radiation](#)

[Lecture 33 - Radiative Transfer Equation](#)

- Lecture 1 - Review of thermodynamics
- Lecture 2 - Rankine cycle
- Lecture 3 - Performance estimation of steam power cycles
- Lecture 4 - Carnot cycle examples
- Lecture 5 - Rankine cycle with superheat
- Lecture 6 - Rankine cycle with reheat theory and example
- Lecture 7 - Examples of Rankine cycle
- Lecture 8 - Examples of reheat Rankine cycle
- Lecture 9 - Rankine cycle with regeneration
- Lecture 10 - Feedwater heaters
- Lecture 11 - Cogeneration of power and process heat
- Lecture 12 - Examples of regeneration
- Lecture 13 - Examples of regenerative Rankine cycle
- Lecture 14 - Binary/multi-fluid cycles
- Lecture 15 - Low temperature power cycles
- Lecture 16 - Examples of binary cycles
- Lecture 17 - Types of boilers
- Lecture 18 - Boiler accessories
- Lecture 19 - Practice examples
- Lecture 20 - Stagnation conditions and Nozzle flow
- Lecture 21 - Nozzle flow
- Lecture 22 - Examples of Nozzle
- Lecture 23 - Impulse Turbine - 1
- Lecture 24 - Impulse Turbine - 2
- Lecture 25 - Examples on Impulse Turbine
- Lecture 26 - Reaction Turbine
- Lecture 27 - Reheat Factor
- Lecture 28 - Examples on Turbine - 1
- Lecture 29 - Examples on Turbine - 2
- Lecture 30 - Gas Mixture
- Lecture 31 - Psychrometry - 1

[Lecture 32 - Psychrometry - 2](#)

[Lecture 33 - Condensers](#)

- Lecture 1 - Introduction to Dynamic Behaviour of Materials - I
- Lecture 2 - Introduction to Dynamic Behaviour of Materials - II
- Lecture 3 - Introduction to Waves
- Lecture 4 - Quasi-static vs Dynamic Deformation
- Lecture 5 - Elastic Wave and its Classification
- Lecture 6 - Propagation of Elastic Waves in Continuum
- Lecture 7 - Wave Reflection, Refraction and Interaction
- Lecture 8 - General Solution of Elastic Wave Equation
- Lecture 9 - Additional Considerations of Elastic Wave in Cylindrical Bar
- Lecture 10 - Introduction to Plastic Waves
- Lecture 11 - Plastic Waves of Uniaxial Stress
- Lecture 12 - Plastic Waves of Combined Stress
- Lecture 13 - Taylor's Experiment for Plastic Wave Propagation - 1
- Lecture 14 - Taylor's Experiment for Plastic Wave Propagation - 2
- Lecture 15 - Taylor's Experiment: Wilkins-Guinan Analysis
- Lecture 16 - Introduction to Shock Waves - I
- Lecture 17 - Introduction to Shock Waves - II
- Lecture 18 - Shock Wave: Rankine Hugoniot Treatment
- Lecture 19 - Rankine Hugoniot Treatment and Shock Wave under Impact
- Lecture 20 - Shock Wave under Impact
- Lecture 21 - Equations of States (Shock Waves) : Experimental Methods
- Lecture 22 - Equations of States (Shock Waves) : Theoretical Calculations
- Lecture 23 - Complex Problems of Shock Waves and Temperature Rise under Shock Wave
- Lecture 24 - Shock Wave Attenuation, Interaction and Reflection - I
- Lecture 25 - Shock Wave Attenuation, Interaction and Reflection - II
- Lecture 26 - Shock Wave Interaction and Reflection
- Lecture 27 - Fundamentals of Materials Science and Engineering
- Lecture 28 - Shock Wave Induced Phase Transformations - 1
- Lecture 29 - Shock Wave Induced Phase Transformations - 2
- Lecture 30 - Shock Wave Induced Phase Transformations - 3
- Lecture 31 - Shock Wave Induced Phase Transformations - 4

[Lecture 32 - Experimental Techniques for Dynamic Deformation - 1](#)

[Lecture 33 - Experimental Techniques for Dynamic Deformation - 2](#)

[Lecture 34 - Plastic Deformation at High Strain Rates - 1](#)

[Lecture 35 - Plastic Deformation at High Strain Rates - 2](#)

[Lecture 36 - Plastic Deformation at High Strain Rates - 3](#)

[Lecture 37 - Plastic Deformation at High Strain Rates - 4](#)

[Lecture 38 - Plastic Deformation at High Strain Rates - 5](#)

[Lecture 39 - Plastic Deformation Under Shock Waves - 1](#)

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Lecture 8 - Dimensional measurement Gauge blocks, The pneumatic displacement gauge

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- Lecture 3 - Differential equation, Variational statement and Minimization problem; Rayleigh-Ritz method
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- Lecture 8 - Bar Element: Postprocessing; Comparison with Analytical Solution; Bar with linear springs
- Lecture 9 - Truss Element: Elemental equation; Matlab Implementation with Example
- Lecture 10 - Beam Element: Variational statement; Hermite shape function
- Lecture 11 - Beam Element: Elemental equation; Matlab implementation with Example
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- Lecture 13 - Frame Element: Derivation of elemental equation in global reference frame
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- Lecture 18 - Second order tensor; Gradient, Divergence, Curl and Laplacian in Indicjal notation
- Lecture 19 - Gauss Divergence theorem and its application in Heat transfer and Structural analysis
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Lecture 11 - Simulations and Algorithmic Implementation of Differential Evolution

Lecture 12 - Constrained Optimization: Introduction and Optimality

Lecture 13 - Penalty Function Methods for Evolutionary Computing Techniques

Lecture 14 - Evolutionary Computing Techniques: Separation of Objective Function and Constraints

Lecture 15 - Simulations of Constraint Handling Techniques - Part 1

Lecture 16 - Simulations of Constraint Handling Techniques - Part 2

Lecture 17 - Introduction to Multi-Objective Optimization - Part 1

Lecture 18 - Introduction to Multi-Objective Optimization - Part 2

Lecture 19 - Multi-Objective Optimization: Ranking and Diversity

Lecture 20 - Classical Multi-Objective Optimization Methods

Lecture 21 - Non-Dominated Genetic Algorithm: NSGA-II: Introduction

Lecture 22 - Non-Dominated Genetic Algorithm: NSGA-II: Simulations

Lecture 23 - Strength Pareto Evolutionary Algorithm: SPEA2: Introduction

Lecture 24 - Strength Pareto Evolutionary Algorithm: SPEA2: Simulations

Lecture 25 - Performance Assessment of Multi-Objective EC Techniques

Lecture 26 - Closure of EC for Single and Multi-Objective Optimization

Lecture 1 - Preliminary concepts

Lecture 2 - Fluid Kinematics

Lecture 3 - Derivation of incompressible Navier-Stokes equations

Lecture 4 - Initial and Boundary Conditions

Lecture 5 - Plane Couette Flow

Lecture 6 - Plane Poiseuille Flow

Lecture 7 - Plane Poiseuille Flow with Slip and Thin Film Flow

Lecture 8 - Combined Couette - Poiseuille Flow

Lecture 9 - Example Problems

Lecture 10 - Hagen - Poiseuille Flow

Lecture 11 - Thin Film Flow and Annular Flow

Lecture 12 - Steady Flow Between Rotating Cylinders

Lecture 13 - Flow near a plate suddenly set in motion

Lecture 14 - Flow due to an oscillating plate

Lecture 15 - Transient Plane Couette Flow

Lecture 16 - Transient Axisymmetric Poiseuille Flow

Lecture 17 - Flow Through Rectangular Duct

Lecture 18 - Flow Through Equilateral Triangular Duct

Lecture 19 - Flow Through Elliptical Duct

Lecture 20 - Example Problems

Lecture 21 - Creeping Flow Around a Sphere

Lecture 22 - Reynolds Equation for Lubrication

Lecture 23 - One-dimensional Slider Bearing

Lecture 24 - Journal Bearing and Piston-ring Lubrication

Lecture 25 - Derivation of Boundary Layer Equations

Lecture 26 - Blasius Flow Over A Flat Plate: Similarity Solution

Lecture 27 - Momentum Integral Equation For Flat Plate Boundary Layer

Lecture 28 - Falkner-Skan equation: Boundary layer flow over a wedge

Lecture 29 - Karman-Pohlhausen Method for Non-zero Pressure Gradient Flows

Lecture 30 - The Correlation Method by Thwaites

Lecture 31 - Separation of Boundary Layer

[Lecture 32 - Example Problems](#)

[Lecture 33 - Two-dimensional Laminar Jet](#)

[Lecture 34 - Flow in the Wake of a Flat Plate](#)

[Lecture 35 - Free Shear Layer Between Two Different Streams](#)

[Lecture 36 - Derivation of Orr-Sommerfeld Equation](#)

[Lecture 37 - Viscous Stability](#)

[Lecture 38 - Inviscid Analysis](#)

[Lecture 39 - Introduction to Turbulent Flows](#)

[Lecture 40 - Derivation of Reynolds Averaged Navier-Stokes Equations](#)

[Lecture 41 - External Turbulent Flows](#)

[Lecture 42 - Integral Solution for Turbulent Boundary Layer Flow](#)

[Lecture 43 - Internal Turbulent Flow](#)

[Lecture 44 - Turbulence Modelling](#)

Lecture 1 - Plasma Arc Welding (PAW)

Lecture 2 - Flux Cored Arc Welding (FCAW)

Lecture 3 - Thermit Welding

Lecture 4 - Resistance Welding - Part 1 (Resistance Spot Welding)

Lecture 5 - Resistance Welding - Part 2 (Types of Resistance Welding)

Lecture 6 - Friction Welding

Lecture 7 - Friction Stir Welding - Part 1

Lecture 8 - Friction Stir Welding - Part 2

Lecture 9 - Soldering

Lecture 10 - Brazing

Lecture 11 - Residual Stress - Part 1

Lecture 12 - Residual Stress - Part 2

Lecture 13 - Influencing Factors and Control of Residual Stresses

Lecture 14 - Residual Stress Measurement - 1

Lecture 15 - Residual Stress Measurement - 2

Lecture 16 - Residual Stress Measurement by NDT

Lecture 17 - Welding Induced Distortion

Lecture 18 - Welding Induced Distortion (Control and Measurement)

Lecture 19 - Welding Induced Distortion (Measurement and Prediction)

Lecture 20 - Welded Joint Analysis

Lecture 21 - Welded Joints Analysis (Strength of Parallel and Transverse Fillet Welds)

Lecture 22 - Welded Joints Analysis (Analysis of Eccentrically Loaded Welded Joint)

Lecture 23 - Welded Joints Static Analysis (Analysis of Eccentrically Loaded Welded Joint - Part 1)

Lecture 24 - Welded Joints Static Analysis (Analysis of Eccentrically Loaded Welded Joint - Part 2)

Lecture 25 - Welded Joints Static Analysis (Welded Joint Subjected to Bending Moment)

Lecture 26 - Welded Joints Static Analysis (Welded Joint Subjected to Bending Moment - Part 1)

Lecture 27 - Welded Joints Static Analysis (Welded Joint Subjected to Bending Moment - Part 2)

[Lecture 1 - Introduction to Additive Manufacturing](#)

[Lecture 2 - CAD Models for Additive Manufacturing](#)

[Lecture 3 - Manipulation of STL Files](#)

[Lecture 4 - Slicing Methods - Part A](#)

[Lecture 5 - Slicing Methods - Part B](#)

[Lecture 6 - Toolpath Planning](#)

[Lecture 7 - Demonstration of CAD-CAM Packages](#)

[Lecture 8 - Introduction to Liquid AM](#)

[Lecture 9 - Stereolithography Apparatus: Fundamentals of Photopolymerization - Part 1](#)

[Lecture 10 - Stereolithography Apparatus: Fundamentals of Photopolymerization - Part 2](#)

[Lecture 11 - Stereolithography Apparatus: Sub-systems - Part 1](#)

[Lecture 12 - Stereolithography Apparatus: Sub-systems - Part 2](#)

[Lecture 13 - Other Liquid AM Processes - 1](#)

[Lecture 14 - Other Liquid AM Processes - 2](#)

[Lecture 15 - Sheet Additive Manufacturing - Part 1](#)

[Lecture 16 - Sheet Additive Manufacturing - Part 2](#)

[Lecture 17 - Wire Additive Manufacturing](#)

[Lecture 18 - Fused Deposition Modeling](#)

[Lecture 19 - Metal Wire Additive Manufacturing](#)

[Lecture 20 - Metal Inert Gas-Wire Arc Additive Manufacturing \(MIG-WAAM\) - Part 1](#)

[Lecture 21 - Metal Inert Gas-Wire Arc Additive Manufacturing \(MIG-WAAM\) - Part 2](#)

[Lecture 22 - Tungsten Inert Gas/Plasma-Wire Arc Additive Manufacturing \(TIG/Plasma-WAAM\)](#)

[Lecture 23 - Electron beam-based Wire Beam Additive Manufacturing \(WBAM\)](#)

[Lecture 24 - Laser Metal Wire Additive Manufacturing](#)

[Lecture 25 - Powder-Feed Additive Manufacturing - Part 1](#)

[Lecture 26 - Powder-Feed Additive Manufacturing - Part 2](#)

[Lecture 27 - Process Modeling for Powder Feed Additive Manufacturing - Part 1](#)

[Lecture 28 - Process Modeling for Powder Feed Additive Manufacturing - Part 2](#)

[Lecture 29 - Laser Beam based Powder Bed Additive Manufacturing - Part 1](#)

[Lecture 30 - Laser Beam based Powder Bed Additive Manufacturing - Part 2](#)

[Lecture 31 - Electron Beam based Powder Bed Additive Manufacturing](#)

[Lecture 32 - Binder based Powder Bed Additive Manufacturing - Part 1](#)

[Lecture 33 - Binder based Powder Bed Additive Manufacturing - Part 2](#)

- Lecture 1 - Thermodynamic Systems and Pure Substance
- Lecture 2 - Heat and Work Transfer - First Law of Thermodynamics
- Lecture 3 - Second Law of Thermodynamics
- Lecture 4 - Entropy and Exergy
- Lecture 5 - Introduction to Steam Power Plant
- Lecture 6 - Thermodynamics aspects of Steam Power Plant-Efficiency and Work ratiom
- Lecture 7 - Rankine Cycle and its analysis
- Lecture 8 - Improvement in Rankine Cycle Efficiency: Superheating and Reheating
- Lecture 9 - Improvement in Rankine Cycle Efficiency: Reheating and Regenerative Methods
- Lecture 10 - Improvement in Rankine Cycle Efficiency: Regenerative Methods
- Lecture 11 - Regenerative Cycles
- Lecture 12 - Impulse Steam Turbine: Velocity Diagrams,Work Transfer,Blade Efficiency
- Lecture 13 - Impulse Steam Turbine: Velocity Diagrams,Work Transfer,Blade Efficiency (Continued...)
- Lecture 14 - Reaction Steam Turbine
- Lecture 15 - Reaction Steam Turbine: Velocity Diagram, Work transfer, Blade Efficiency
- Lecture 16 - Steam Nozzle: Analysis and Efficiency
- Lecture 17 - Steam Nozzle: Analysis and Efficiency (Continued...)
- Lecture 18 - Boilers and Condensers
- Lecture 19 - Condensers and Second Law Analysis of Steam Power cycle
- Lecture 20 - Exergy Analysis of a Steam Turbine
- Lecture 21 - Numerical Problems: Steam Power Cycle
- Lecture 22 - IC engine-Components, Nomenclature and Classifications
- Lecture 23 - Basic Engine Cycle and Engine Kinematic Analysis
- Lecture 24 - Engine Operating Characteristics
- Lecture 25 - Thermodynamics Analysis of Air Standard Cycles
- Lecture 26 - Valve Timing Diagram and Fuel-Air Cycle
- Lecture 27 - Thermochemistry and Fuel Characteristics
- Lecture 28 - Combustion Phenomena in Engines
- Lecture 29 - Heat Transfer Analysis in Engines
- Lecture 30 - Exergy Analysis and Engine Emission/Pollution
- Lecture 31 - Gas Turbine Engine-Components and Thermal Circuit

- [Lecture 32 - Gas Turbine Performance Cycle - I](#)
- [Lecture 33 - Gas Turbine Performance Cycle - II](#)
- [Lecture 34 - Real Gas Turbine Performance Cycle](#)
- [Lecture 35 - Aircraft Propulsion Cycle - I](#)
- [Lecture 36 - Aircraft Propulsion Cycle - II](#)
- [Lecture 37 - Vapour Compression Refrigeration System - I](#)
- [Lecture 38 - Vapour Compression Refrigeration System - II](#)
- [Lecture 39 - Absorption Refrigeration and Refrigerants](#)
- [Lecture 40 - Fundamentals of Psychrometrics](#)
- [Lecture 41 - Air-Conditioning Processes](#)
- [Lecture 42 - Cooling Tower and Air Washers](#)
- [Lecture 43 - Reciprocating Compressor - Analysis and Modelling](#)
- [Lecture 44 - Multistage Compression - Analysis and Modelling](#)

- Lecture 1 - Composite Materials - Introduction
- Lecture 2 - Composite Materials - Classification
- Lecture 3 - Anisotropic Elasticity
- Lecture 4 - Orthotropic Materials
- Lecture 5 - Hooke's Law for 2D Lamina
- Lecture 6 - Engineering Constants for 2D Lamina
- Lecture 7 - Strength Failure Criteria - Part I
- Lecture 8 - Strength Failure Criteria - Part II
- Lecture 9 - Hygrothermal Behavior of Lamina
- Lecture 10 - Introduction and Terminologies
- Lecture 11 - Evaluation of Elastic Moduli
- Lecture 12 - Evaluation of Longitudinal Strength
- Lecture 13 - Evaluation of Transverse and Shear Strengths
- Lecture 14 - Evaluation of Hygrothermal Properties
- Lecture 15 - Elasticity Approach
- Lecture 16 - Experimental Evaluation
- Lecture 17 - Laminate - Introduction
- Lecture 18 - Classical Lamination Theory - Part I
- Lecture 19 - Classical Lamination Theory - Part II
- Lecture 20 - Response of Laminate - Significance of ABBD
- Lecture 21 - Special Classes of Laminates
- Lecture 22 - Engineering Constants of Laminates
- Lecture 23 - Hygrothermal Behaviour of Laminates
- Lecture 24 - Analysis of Laminates
- Lecture 25 - Failure of Laminates
- Lecture 26 - Failure Analysis under Combined Loading
- Lecture 27 - Design Example - I
- Lecture 28 - Design Example - II
- Lecture 29 - Interlaminar Stresses- Delamination
- Lecture 30 - Prediction of Delamination
- Lecture 31 - Transverse Deflection

[Lecture 32 - Buckling and Free Vibration](#)

Lecture 1 - Lasers in Manufacturing: Importance and Applications

Lecture 2 - Fundamentals of Laser Technology

Lecture 3 - Laser System: Construction and Types

Lecture 4 - Principle of Operation, Types of Laser Cutting, and Kerf Geometry

Lecture 5 - Types of Lasers in Material Removal, Process and Performance Parameters

Lecture 6 - A Case-study on Cutting a Circular Part using CO2 Laser Machine

Lecture 7 - Mechanisms of Laser Welding - Part I

Lecture 8 - Mechanisms of Laser Welding - Part II

Lecture 9 - Effects of Process Parameters during Laser Welding and Study of Defects in Weld Beads

Lecture 10 - A Case Study on Welding of Mild Steel Sheets using 2.5 kW CO2 Laser Machine

Lecture 11 - Material Forming and Fundamentals of Laser Forming

Lecture 12 - Mechanisms of Laser Forming

Lecture 13 - Process Parameters and their Effects on the Performance of Laser Forming

Lecture 14 - Surface Treatment and Application of Lasers

Lecture 15 - Laser Surface Hardening

Lecture 16 - Laser Surface Alloying

Lecture 17 - Laser Cladding

Lecture 18 - Additive Manufacturing Techniques

Lecture 19 - Laser Scanning Stereolithography

Lecture 20 - Selective Laser Sintering and Selective Laser Melting

Lecture 21 - Process and Performance Parameters of Laser Based Additive Manufacturing Techniques

Lecture 22 - Lasers in Manufacturing Automation

Lecture 23 - CNC for Laser Based Manufacturing

Lecture 24 - CAD for Laser Based Manufacturing

Lecture 25 - Laser-assisted Material Forming

Lecture 26 - Effect of Coatings, 3D Laser Forming and Micro-forming

- Lecture 1 - Temperature and Zeroth Law of Thermodynamics
- Lecture 2 - Work and Heat Transfer - First Law of Thermodynamics
- Lecture 3 - Heat Engines and Refrigerators/Heat Pump - Second Law of Thermodynamics
- Lecture 4 - Entropy Analysis - Part I
- Lecture 5 - Entropy Analysis - Part II
- Lecture 6 - Entropy Analysis - Part III
- Lecture 7 - Exergy Analysis - Part I
- Lecture 8 - Exergy Analysis - Part II
- Lecture 9 - Exergy Analysis - Part III
- Lecture 10 - Thermodynamic Functions and Maxwell's Equations
- Lecture 11 - Property Relations for Phase Change Processes
- Lecture 12 - Property Relations for Single Phase Systems
- Lecture 13 - Heat Capacity Equations and its Applications
- Lecture 14 - Joule - Thomson Coefficient and Liquefaction of Gases
- Lecture 15 - Ideal Gas and Real Gas
- Lecture 16 - Gas Mixtures and Multi-Component System
- Lecture 17 - Ideal Gas Mixture
- Lecture 18 - Mixing Analysis of Thermodynamic Systems
- Lecture 19 - Thermodynamic Considerations of Combustion
- Lecture 20 - Conservation of Energy for Reacting Systems
- Lecture 21 - Adiabatic Flame Temperature, Entropy and Gibbs Function for Reacting System
- Lecture 22 - Equilibrium Products of Combustion and Effective Energy Utilization
- Lecture 23 - Fundamentals of Chemical Reactions
- Lecture 24 - Reaction Mechanisms - Part I
- Lecture 25 - Reaction Mechanisms - Part II
- Lecture 26 - Chemical and Thermal Analysis of Reacting Systems
- Lecture 27 - Simplified Conservation Equations for Reacting Flows
- Lecture 28 - Laminar Premixed Flame - Part I
- Lecture 29 - Laminar Premixed Flame - Part II
- Lecture 30 - Laminar Diffusion Flame
- Lecture 31 - Droplet Evaporation and Turbulent Flame

- Lecture 1 - First law of Thermodynamics for control mass and control volume systems
- Lecture 2 - First law of Thermodynamics for control volume system (Flow system)
- Lecture 3 - Steady State Steady Flow Processes, combination of First and Second Laws
- Lecture 4 - Second Law of Thermodynamics: A Brief Review
- Lecture 5 - Combined First and Second Laws Applied to Processes
- Lecture 6 - Combined First and Second Laws: Flow and Non-Flow Processes
- Lecture 7 - Description of Steam Power Plant: Application of 1st and 2nd Laws to Different Processes
- Lecture 8 - Second Law Applied to Processes of Power Plant and Ideal Cycle of Power Plant
- Lecture 9 - Steam Power Plant: Thermodynamic aspects, Efficiency, Work ratio and Ideal Cycle
- Lecture 10 - Ideal Power Cycle and its Limitations, Introduction to Actual Power Cycle
- Lecture 11 - Limitations of Carnot Cycle, Simple Rankine Cycle and Analysis
- Lecture 12 - Analysis of Simple Rankine Cycle and its Design Modifications
- Lecture 13 - Reheat Cycle and Analysis
- Lecture 14 - Reheat Cycle and Analysis (Continued...)
- Lecture 15 - Regenerative Principle of Steam Power Cycles
- Lecture 16 - Analysis of Regenerative Steam Power Cycles
- Lecture 17 - Regenerative Steam Power Cycle with Closed Feed-Water Heater, Ideal Working Fluid
- Lecture 18 - Multi-fluid Cycle and Analysis
- Lecture 19 - Analysis of Multi-fluid Cycle; Second Law Analysis of Steam Power Cycle
- Lecture 20 - Problems of Steam Power Cycle
- Lecture 21 - Problems of Steam Power Cycle (Continued...)
- Lecture 22 - Types of Boiler, Different Cycles in Boiler Operation, Boiler attachment
- Lecture 23 - Cochran Boiler Operation, Boiler attachment
- Lecture 24 - Boiler Attachments
- Lecture 25 - Superheaters and their Arrangements, Steam Temperature Control
- Lecture 26 - Characteristics of Convective and Radiant Superheaters; Steam Temperature Control
- Lecture 27 - Problems on Boiler/Steam Generator
- Lecture 28 - Use of nozzles in steam power plant, flow analysis of steam in nozzle
- Lecture 29 - Flow analysis of steam in nozzle: Mass flow rate
- Lecture 30 - Mass flow rate of steam in nozzle, Critical Pressure Ratio
- Lecture 31 - Critical Pressure Ratio and its Physical Significance

- Lecture 32 - Nozzle efficiency and factors that affect the efficiency
- Lecture 33 - Factors that affect the efficiency, problem on flow nozzle
- Lecture 34 - Problem on flow nozzle
- Lecture 35 - Steam Turbines: types and analysis using velocity triangles
- Lecture 36 - Analysis of Impulse Steam Turbine
- Lecture 37 - Compounding of Steam Turbine
- Lecture 38 - Analysis of Reaction Steam Turbine
- Lecture 39 - Problems on Steam Turbine
- Lecture 40 - The Role of Condenser in Power Plant
- Lecture 41 - Cooling Tower: Types and Analysis
- Lecture 42 - Cooling Tower Performance
- Lecture 43 - IC Engines, Classification, Different Parts, SI and CI Engines
- Lecture 44 - Comparison of 2-stroke and 4-stroke Engines
- Lecture 45 - Comparison of SI and CI Engines, Compression Ratio
- Lecture 46 - Introduction to Carburettor and Regimes of Engine Operation
- Lecture 47 - Regimes of Engine Operation and Simple Float Type Carburettor
- Lecture 48 - Simple Float Type Carburettor and its Analysis
- Lecture 49 - Mass Flow Rate of Fuel and limitations of Simple Float Type Carburettor
- Lecture 50 - Limitations of Simple Float Type Carburettor, Problem on Carburettion
- Lecture 51 - Engine Operating Characteristics: MEP and Indicator diagram
- Lecture 52 - Performance Analysis parameters of IC Engine
- Lecture 53 - Fuel of IC Engines
- Lecture 54 - Alternative Fuels and Self Ignition Characteristics of Fuel: Octane Number, Cetane Number
- Lecture 55 - Thermodynamic Analysis of SI Engine
- Lecture 56 - Thermodynamic Analysis of CI Engine
- Lecture 57 - Numerical Problems on Engine Performance
- Lecture 58 - Pressure-Crank angle diagram, Engine Efficiencies
- Lecture 59 - Numerical Problems on SI and CI Engines
- Lecture 60 - Vapour Compression Refrigeration Cycle and its analysis
- Lecture 61 - Problems on Vapour Compression Refrigeration Cycle
- Lecture 62 - Gas Turbine Units and Thermodynamic Cycles
- Lecture 63 - Gas Compressor and Optimum Pressure Ratio
- Lecture 64 - Compressor Efficiency and Multistage Compression with Intercooling

[Lecture 65 - Gas Turbine Unit: Combined Cycle](#)

[Lecture 66 - Problems On Gas Turbine Cycle](#)

NPTEL : Acoustics (Mechanical Engineering)

Co-ordinators : Prof. Nachiketa Tiwari

Lecture 1 - Intro, sound wave versus vibration, different types of waves, octave, music scales, sense of SPL

Lecture 2 - Review: Linearity, complex numbers, and spring mass system

Lecture 3 - Review: Poles and zeroes, phase and magnitude plots, transfer functions, Bode plots

Lecture 4 - Review: Transfer functions, and Bode plots

Lecture 5 - 1-D wave equation, and its solution

Lecture 6 - Solution for 1-D wave equation

Lecture 7 - Waveguides, transmission line equations, and standing waves

Lecture 8 - Waveguides, transmission line equations, and standing waves

Lecture 9 - Examples of 1-D waves in tubes, short tubes, Kundt's tube

Lecture 10 - Thermodynamic processes during sound transmission

Lecture 11 - Numerical examples

Lecture 12 - Sound transmission through walls

Lecture 13 - Sound transmission through walls

Lecture 14 - Leakage in walls, STC Ratings, Octave bands

Lecture 15 - Instantaneous power flow

Lecture 16 - Radial propagation of sound, monopoles, and dipoles

Lecture 17 - Radial propagation of sound, monopoles, and dipoles

Lecture 18 - Radial propagation of sound, monopoles, and dipoles

Lecture 19 - Numerical examples

Lecture 20 - Numerical examples

Lecture 21 - Directivity

Lecture 22 - Directivity

Lecture 23 - Directivity

Lecture 24 - Directivity

Lecture 25 - Generalized elements

Lecture 26 - Examples of electromechanical systems

Lecture 27 - Transformers, radiation impedance, and Helmholtz resonator

Lecture 28 - Radiation impedance

Lecture 29 - Radiation impedance

Lecture 30 - Models of electro-mechanical-acoustic systems

Lecture 31 - Solution for a loudspeaker model

[Lecture 32 - Microphones](#)

[Lecture 33 - Vibro-meter, seismometer, accelerometer, shaker table](#)

[Lecture 34 - Sound propagation in rooms, 1-D rooms, 2D rooms](#)

[Lecture 35 - Sound in 3-D rooms](#)

[Lecture 36 - Absorption coefficient, and irregular rooms](#)

[Lecture 37 - Room constant, and Sabine's coefficient](#)

[Lecture 38 - Design of a muffler](#)

[Lecture 39 - Noise in machines, basics of noise management](#)

[Lecture 1 - Advanced Machining Processes](#)

[Lecture 2 - Advanced Machining Processes](#)

[Lecture 3 - Advanced Machining Processes](#)

[Lecture 4 - Advanced Machining Processes](#)

[Lecture 5 - Advanced Machining Processes](#)

[Lecture 6 - Advanced Machining Processes](#)

[Lecture 7 - Advanced Machining Processes](#)

[Lecture 8 - Advanced Machining Processes](#)

[Lecture 9 - Advanced Machining Processes](#)

[Lecture 10 - Advanced Machining Processes](#)

[Lecture 11 - Advanced Machining Processes](#)

[Lecture 12 - Advanced Machining Processes](#)

[Lecture 13 - Advanced Machining Processes](#)

[Lecture 14 - Advanced Machining Processes](#)

[Lecture 15 - Advanced Machining Processes](#)

[Lecture 16 - Advanced Machining Processes](#)

[Lecture 17 - Advanced Machining Processes](#)

[Lecture 18 - Advanced Machining Processes](#)

[Lecture 19 - Advanced Machining Processes](#)

[Lecture 20 - Advanced Machining Processes](#)

[Lecture 21 - Advanced Machining Processes](#)

[Lecture 22 - Advanced Machining Processes](#)

[Lecture 23 - Advanced Machining Processes](#)

[Lecture 24 - Advanced Machining Processes](#)

[Lecture 25 - Advanced Machining Processes](#)

[Lecture 26 - Advanced Machining Processes](#)

[Lecture 27 - Advanced Machining Processes](#)

[Lecture 28 - Advanced Machining Processes](#)

[Lecture 29 - Advanced Machining Processes](#)

[Lecture 30 - Advanced Machining Processes](#)

[Lecture 31 - Advanced Machining Processes](#)

[Lecture 32 - Advanced Machining Processes](#)

[Lecture 33 - Advanced Machining Processes](#)

[Lecture 34 - Advanced Machining Processes](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10 \(same as 9\)](#)

[Lecture 11](#)

[Lecture 12 \(Lecture Missing\)](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

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[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

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[Lecture 12](#)

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[Lecture 39](#)

[Lecture 40](#)

Lecture 1 - Introduction

Lecture 2 - Basic Ideas of Applied Linear Algebra

Lecture 3 - Systems of Linear Equations

Lecture 4 - Square Non-Singular Systems

Lecture 5 - Ill-Conditioned and Ill-Posed Systems

Lecture 6 - The Algebraic Eigenvalue Problem

Lecture 7 - Canonical Forms, Symmetric Matrices

Lecture 8 - Methods of Plane Rotations

Lecture 9 - Householder Method, Tridiagonal Matrices

Lecture 10 - QR Decomposition, General Matrices

Lecture 11 - Singular Value Decomposition

Lecture 12 - Vector Space: Concepts

Lecture 13 - Multivariate Calculus

Lecture 14 - Vector Calculus in Geometry

Lecture 15 - Vector Calculus in Physics

Lecture 16 - Solution of Equations

Lecture 17 - Introduction to Optimization

Lecture 18 - Multivariate Optimization

Lecture 19 - Constrained Optimization: Optimality Criteria

Lecture 20 - Constrained Optimization: Further Issues

Lecture 21 - Interpolation

Lecture 22 - Numerical Integration

Lecture 23 - Numerical Solution of ODE's as IVP

Lecture 24 - Boundary Value Problems, Question of Stability in IVP Solution

Lecture 25 - Stiff Differential Equations, Existence and Uniqueness Theory

Lecture 26 - Theory of First Order ODE's

Lecture 27 - Linear Second Order ODE's

Lecture 28 - Methods of Linear ODE's

Lecture 29 - ODE Systems

Lecture 30 - Stability of Dynamic Systems

Lecture 31 - Series Solutions and Special Functions

[Lecture 32 - Sturm-Liouville Theory](#)

[Lecture 33 - Approximation Theory and Fourier Series](#)

[Lecture 34 - Fourier Integral to Fourier Transform, Minimax Approximation](#)

[Lecture 35 - Separation of Variables in PDE's, Hyperbolic Equations](#)

[Lecture 36 - Parabolic and Elliptic Equations, Membrane Equation](#)

[Lecture 37 - Analytic Functions](#)

[Lecture 38 - Integration of Complex Functions](#)

[Lecture 39 - Singularities and Residues](#)

[Lecture 40 - Calculus of Variations](#)

Lecture 1 - Rigid Body Motion - Part 1

Lecture 2 - Rigid Body Motion - Part 2

Lecture 3 - Dynamic Force Analysis of Mechanisms

Lecture 4 - Space Motion of Rigid Bodies

Lecture 5 - Inertia Tensor Angular Momentum

Lecture 6 - Euler's Equation of Motion

Lecture 7 - Gyroscopic Action in Machines

Lecture 8 - Unbalance in Machines

Lecture 9 - Rotary Balancing

Lecture 10 - Balancing Machines

Lecture 11 - Field Balancing of Rotors

Lecture 12 - Single-Cylinder Engine Balancing

Lecture 13 - Balancing of Single Slider Machines

Lecture 14 - In-Line Engine Balancing

Lecture 15 - V and Radial Engine Balancing

Lecture 16 - Turning Moment Diagram

Lecture 17 - Flywheel Analysis

Lecture 18 - Dynamics of Machines

Lecture 19 - Dynamics of Machines

Lecture 20 - Dynamics of Machines

Lecture 21 - Dynamics of Machines

Lecture 22 - Dynamics of Machines

Lecture 23 - Dynamics of Machines

Lecture 24 - Dynamics of Machines

Lecture 25 - Dynamics of Machines

Lecture 26 - Dynamics of Machines

Lecture 27 - Dynamics of Machines

Lecture 28 - Dynamics of Machines

Lecture 29 - Rotating Vector Approach

Lecture 30 - Equivalent viscous damping

Lecture 31 - Dynamics of Machines

[Lecture 32 - Systems with two degree of freedom](#)

[Lecture 33 - Tuned Vibration Absorber](#)

[Lecture 34 - Design of Vibration Absorbers](#)

[Lecture 35 - Flexibility Matrix Influence Coeff](#)

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Co-ordinators : Prof. C.S. Upadhyay

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Co-ordinators : Prof. Ashok K Mallik

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Lecture 2 - Recap - II

Lecture 3 - Recap - III

Lecture 4 - Determination of Phase Diagram (Experimentally) - I

Lecture 5 - Determination of Phase Diagram (Experimentally) - II

Lecture 6 - Determination of Phase Diagram (Thermodynamically)

Lecture 7 - Effect of pressure on phase transformation temperature and concept of equilibrium between condensed and vapor phase

Lecture 8 - Effect of different parameters on heat treatment and concept of saturation vapor pressure with examples

Lecture 9 - Title: Formation of ideal solid or liquid solution and (G-X) diagrams for ideal solutions (Part-I)

Lecture 10 - G-X diagrams (Part- II) and concept of chemical potential (Micro Sign) from G-X diagrams.

Lecture 11 - Concept of common tangent for equilibrium between two phases

Lecture 12 - Expressions for equilibrium of two phases - I

Lecture 13 - Expressions for equilibrium of two phases - II

Lecture 14 - Expressions for equilibrium of two phases - III

Lecture 15 - Determining nucleation of phases using G-X plot

Lecture 16 - $\hat{\Delta}G$ for nucleation and overall transformation, concepts of solid state transformation including precipitation and Quasi-Chemical Model (QCM)

Lecture 17 - Introduction to real solutions and expression of \hat{H}_{mix} based on the Quasi-Chemical Model (QCM)

Lecture 18 - Expression for \hat{H}_{mix} as a function of interaction energy and mole fraction, based on the QCM - Part I

Lecture 19 - Expression for \hat{H}_{mix} as a function of interaction energy and mole fraction, based on the QCM - Part II

Lecture 20 - Graphical representation of \hat{H}_{mix} , \hat{G}_{mix} , and $-T\hat{S}_{mix}$ for real solutions and evolution of eutectic phase diagram from the G-X plots

Lecture 21 - Effect of \hat{H}_{mix} on determination of phase diagrams (same crystal structure)

Lecture 22 - Effect of \hat{H}_{mix} on determination of phase diagrams (Continued...)

Lecture 23 - Importance of phase diagrams

Lecture 24 - Effect of heat treatment on microstructure evolution in steel - I

Lecture 25 - Effect of heat treatment on microstructure evolution in steel - II

Lecture 26 - Recap of homogeneous and heterogeneous nucleation for solid to solid transformation

Lecture 27 - Nucleation rate and its dependence on T (temp. of interest), \hat{I}^*T , \hat{I}^*G^* and \hat{I}^*G^* and, introduction to growth kinetics

Lecture 28 - Growth kinetics (Continued...)

Lecture 29 - Growth rate variation with undercooling and kinetics of overall phase transformation

Lecture 30 - Implication of Avrami's equation with example on excel spreadsheet

Lecture 31 - Experimental verification of Avrami Equation

Lecture 32 - Linear regression (least squares) method to find the value of n and k in Avrami equation

Lecture 33 - In this lecture, method to determine the goodness of fit has been explained. Procedure to estimate the values of n and k from experimental data have also been discussed.

Lecture 34 - Stereology and quantitative metallography - I

Lecture 35 - Stereology and quantitative metallography - II

Lecture 36 - Grain size measurements methods

Lecture 37 - Statistical tools for analysis and reporting of obtained data with examples

Lecture 38 - Evolution of TTT and CCT diagram from f vs. t plots

Lecture 39 - TTT, CCT continue and hardenability of steel

Lecture 40 - Importance of heat treatment practices in real life (with examples)

Lecture 1 - Brief Introduction

Lecture 2 - Define Phase, Equilibrium

Lecture 3 - Free Energy, Stability of Phases

Lecture 4 - Gibbs Free Energy of Binary Solution

Lecture 5 - Ideal Solution and Chemical Potential

Lecture 6 - Thermodynamics of solid solutions

Lecture 7 - G vs X curves

Lecture 8 - Solid solutions: Types

Lecture 9 - Heterogeneous phase equilibria

Lecture 10 - G vs X curves for eutectic system

Lecture 11 - G-X plot for peritectic system

Lecture 12 - Effect of temperature of solid solubility, Influence of interfaces on Equilibrium

Lecture 13 - Introduction of Diffusion

Lecture 14 - Mechanism of Diffusion, Fick's I law

Lecture 15 - Fick's II law

Lecture 16 - Fick's II law (Continued...), Diffusion and Temperature

Lecture 17 - Interfacial Free Energy, Solid/Vapor Interface

Lecture 18 - Boundaries in single phase solids

Lecture 19 - High angle grain boundaries, Equilibrium in poly-crystalline materials, Interphase interfaces in solids

Lecture 20 - Interphase interfaces in solids (Continued...)

Lecture 21 - CSL Boundaries

Lecture 22 - Types of Nucleations

Lecture 23 - Homogeneous Nucleation

Lecture 24 - Homogeneous Nucleation (Continued...)

Lecture 25 - Heterogeneous Nucleation

Lecture 26 - Heterogeneous nucleation (Continued...)

Lecture 27 - Growth

Lecture 28 - Atomic mechanism of growth

Lecture 29 - Dendritic Solidification

Lecture 30 - Growth rate for dendrite formation

Lecture 31 - Alloy solidification

- [Lecture 32 - Alloy solidification \(Continued...\)](#)
- [Lecture 33 - Eutectic: Solidification](#)
- [Lecture 34 - Eutectic: solidification \(Continued...\)](#)
- [Lecture 35 - Solidification of casting / ingot](#)
- [Lecture 36 - Precipitation hardenable alloy](#)
- [Lecture 37 - Precipitation age- hardening alloy \(Continued...\)](#)
- [Lecture 38 - Age hardening alloy](#)
- [Lecture 39 - Eutectoid transformation](#)
- [Lecture 40 - Eutectoid transformation \(Continued....\)](#)
- [Lecture 41 - Eutectoid transformation in steel \(Continued...\)](#)
- [Lecture 42 - Martensite](#)
- [Lecture 43 - Martensite \(Continued...\)](#)
- [Lecture 44 - Martensite \(Continued...\) and TTT curves](#)
- [Lecture 45 - TTT diagram](#)
- [Lecture 46 - Recovery, Recrystallization and Grain growth](#)
- [Lecture 47 - Recovery](#)
- [Lecture 48 - Recrystallization](#)
- [Lecture 49 - Recrystallization \(Continued...\)](#)
- [Lecture 50 - Introduction to spinodal decomposition](#)

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Lecture 2 - Matrices

Lecture 3 - Fiber reinforcements

Lecture 4 - Fiber reinforcements (Continued...)

Lecture 5 - Composites properties

Lecture 6 - Composites testing

Lecture 7 - Selection of material

Lecture 8 - Selection of material (Continued...)

Lecture 9 - Design for Manufacturing

Lecture 10 - Design for Manufacturing (Continued...)

Lecture 11 - Composite Manufacturing Processes

Lecture 12 - Filament winding Processes

Lecture 13 - Resin transfer moulding

Lecture 14 - Pultrusion

Lecture 15 - Compression Moulding Process

Lecture 16 - Vacuum Impregnation Methods

Lecture 17 - Stacking of Composites

Lecture 18 - Thermoplastic Composites Manufacturing Processes - Part 1

Lecture 19 - Thermoplastic Composites Manufacturing Processes - Part 2 (Continued...)

Lecture 20 - Non-destructive testing methods for composite materials

Lecture 21 - Metal Matrix Composites

Lecture 22 - Metal Matrix Composites applications (Continued...)

Lecture 23 - Processing of Metal Matrix Composites - Part 1

Lecture 24 - Processing of Metal Matrix Composites - Part 2

Lecture 25 - Ceramic Matrix Composites

Lecture 26 - Fabrication of Ceramic Matrix Composites (CMCs)

Lecture 27 - Carbon - Carbon Composites

Lecture 28 - Polymer Matrix and Nano Composites

Lecture 29 - Machining of Composites

Lecture 30 - Repair of Composites

Lecture 31 - Manufacturing Processes: Selection and Considerations

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Lecture 8 - Decibel Scale - Part 2

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Lecture 10 - Complex Numbers

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Lecture 13 - Transfer Functions

Lecture 14 - Introduction to One Dimensional Wave Equation

Lecture 15 - The Momentum Equation

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Lecture 17 - One Dimensional Wave Equation

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Lecture 19 - Transmission Line Equations

Lecture 20 - One Dimensional Example Problems

Lecture 21 - Impedance

Lecture 22 - Pressure Wave Travels in a Closed Tube

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Lecture 26 - 1-D sound wave propagation: Kundt's tube - II

Lecture 27 - Radially propagating sound waves in spherical coordinate system - I

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Lecture 30 - Volume velocity - I

Lecture 31 - Interference of 1-D spherically propagating sound waves - I

- Lecture 32 - Interference of 1-D spherically propagating sound waves - II
- Lecture 33 - Noise sources and introduction to microphones
- Lecture 34 - Classification of microphones - I
- Lecture 35 - Classification of microphones - II
- Lecture 36 - Classification of microphones - III
- Lecture 37 - Microphone Parameters
- Lecture 38 - Understanding microphone specifications
- Lecture 39 - Noise Source: Terminology
- Lecture 40 - Noise Source: Sound Attenuation
- Lecture 41 - Noise Source: Sound Pressure Level due to a noise source located outdoors
- Lecture 42 - Noise Source: Role of reflecting surfaces
- Lecture 43 - Noise Source: Sound Pressure Level due to a noise source located indoors - Part I
- Lecture 44 - Noise Source: Sound Pressure Level due to a noise source located indoors - Part II
- Lecture 45 - Measuring Sound Power Level - Understanding standard octave bands
- Lecture 46 - Measuring Sound Power Level - Fan noise - Part I
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- Lecture 49 - Weighting
- Lecture 50 - Noise coming from Motors
- Lecture 51 - Noise coming from Motors and Pumps
- Lecture 52 - Noise coming from Pump and Motor Working Simultaneously
- Lecture 53 - Noise coming from Compressors
- Lecture 54 - Example problems regarding Noise coming from Compressor
- Lecture 55 - Noise Spread Mechanisms
- Lecture 56 - Reverberation time
- Lecture 57 - Reverberation time example problem
- Lecture 58 - Noise from Adjacent Room
- Lecture 59 - Acoustic Enclosures
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Lecture 5 - Brain Storming

Lecture 6 - Design prototyping

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Lecture 9 - Concurrent Engineering

Lecture 10 - Concurrent Engineering - 2

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Lecture 12 - Concurrent Engineering Approaches - 2

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Lecture 15 - Concurrent engineering environment influencing dimensions - 2

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Lecture 17 - Product Development Methodology

Lecture 18 - Elements of concurrent engineering: Optimization in product development

Lecture 19 - Business relationships in concurrent engineering

Lecture 20 - Organizational elements in concurrent engineering

Lecture 21 - Techniques for the Implementation of concurrent engineering environment

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Lecture 23 - Robustness in Design

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Lecture 25 - Material selection in Engineering design

Lecture 26 - Material selection in Engineering Design.

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Lecture 30 - Axiomatic Design

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Lecture 2 - Composite materials and its applications

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Lecture 4 - What Makes fiber so strong?

Lecture 5 - Advantages and limitations of composite materials

Lecture 6 - Properties of the composite materials.

Lecture 7 - Different Types of Fiber

Lecture 8 - Production process and different types of Glass Fiber

Lecture 9 - Graphite Fibers

Lecture 10 - Aramid and Boron Fibers

Lecture 11 - Ceramic Fibers

Lecture 12 - Matrix - Properties and classifications

Lecture 13 - Polymers as matrix material and its classification

Lecture 14 - Thermosets and thermoplastics

Lecture 15 - Properties of thermosets and thermoplastics

Lecture 16 - Thermoset materials and its production methods

Lecture 17 - Thermoplastics and metals as matrix materials

Lecture 18 - Ceramic and carbon matrices

Lecture 19 - What is a good fabrication process of a composite?

Lecture 20 - Fabrication of Thermoset Composites

Lecture 21 - Hand Lay-Up Process

Lecture 22 - Bag Molding Process

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Lecture 24 - Fabrication of Thermoplastic, Metal and Ceramic Matrix based Composites

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Lecture 26 - Orthotropic material

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Lecture 28 - Composite density as a function of mass fraction and volume fraction

Lecture 29 - Calculation of longitudinal modulus for unidirectional composites

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Lecture 31 - Failure of Unidirectional Lamina

- Lecture 32 - Minimum Volume Fraction and Critical Volume Fraction
- Lecture 33 - Example based on Failure of Composite Material
- Lecture 34 - Example based on Minimum and Critical Volume Fraction
- Lecture 35 - Transverse Modulus of Unidirectional Composite
- Lecture 36 - Halpin-Tsai Relation for Transverse Modulus
- Lecture 37 - Transverse modulus of unidirectional composites
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- Lecture 39 - Poisson's ratio of unidirectional composites
- Lecture 40 - Failure modes of composite materials
- Lecture 41 - Failure modes of composite materials
- Lecture 42 - Other properties
- Lecture 43 - Concept of Tensor
- Lecture 44 - Stress Transformation (Two Dimensional)
- Lecture 45 - Analysis of Specially Orthotropic Lamina
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- Lecture 47 - Transformation of Engineering Constants - Part I
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- Lecture 49 - Variation of elastic constants with respect to fiber orientation for generally orthotropic lamina
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- Lecture 51 - Generalized Hooke's law for anisotropic materials
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- Lecture 54 - Elastic constants for Specially orthotropic materials in plane stress
- Lecture 55 - Relation Between Engineering Constants and Elements of Stiffness and Compliance Matrices - Part I
- Lecture 56 - Relation Between Engineering Constants and Elements of Stiffness and Compliance Matrices - Part II
- Lecture 57 - Stress Strain Relations for A Lamina With Arbitrary Orientation - Part I
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- Lecture 59 - Strength of An Orthotropic Lamina
- Lecture 60 - Importance of Sign of Shear Stress in context of Strength of A Unidirectional Lamina
- Lecture 61 - Strain displacement relations for a laminate
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- Lecture 63 - Resultant forces and moments
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[Lecture 66 - Lamination sequence \(standard laminate code\)](#)

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[Lecture 68 - Simplification of Stiffness Matrices - Part I](#)

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Lecture 5 - Engineering Design Process

Lecture 6 - Product design morphology

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Lecture 12 - Translating Customer Needs

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Lecture 14 - Value Engineering Methodology - Part 1

Lecture 15 - Value Engineering Methodology - Part 2, FAST diagramming

Lecture 16 - Value Engineering Methodology - Part 3

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- Lecture 2 - Basic Thermodynamics: Gibbs Free Energy
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- Lecture 5 - Clausius-Clapeyron Equation and Binary Solution
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- Lecture 11 - Free Energy Curves and Various Systems
- Lecture 12 - Solubility Limits 2-phase Co-existence
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- Lecture 15 - Phase Diagram Construction: Eutectic Phase
- Lecture 16 - Intermetallics and Phase Diagrams
- Lecture 17 - Phase Rule
- Lecture 18 - Gibb's Phase Rule: Unary and Binary System
- Lecture 19 - Gibb's Phase Rule: Eutectic Point and Lever Rule
- Lecture 20 - Phase Fraction Calculation in a Phase Diagram
- Lecture 21 - Microstructure evolution in Cu-Ni binary system
- Lecture 22 - Microstructure evolution (Continued...)
- Lecture 23 - Phase evolution in hypoeutectic region
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- Lecture 25 - Phase Diagrams of Cu-Ni and Al-Si
- Lecture 26 - Phase Diagrams of Pb-Sn and Fe-C
- Lecture 27 - Phase Diagram of Fe-C (Continued...)
- Lecture 28 - Fe-C Phase Diagram (Continued...)
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- Lecture 2 - Different type of Fibers
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- Lecture 11 - Stress and Strain Transformation
- Lecture 12 - Transformation of Stiffness and Compliance Matrices
- Lecture 13 - Strain - Displacement relations
- Lecture 14 - Relations for stress and strain along thickness of laminate
- Lecture 15 - Stress - Strain variation along Laminate thickness
- Lecture 16 - Force and Moment resultant - Part 1
- Lecture 17 - Force and Moment resultant - Part 2
- Lecture 18 - Important observation related to [A], [B] and [D] matrices
- Lecture 19 - Quasi-Isotropic Laminates
- Lecture 20 - Maximum Stress Theory
- Lecture 21 - Maximum Strain Theory
- Lecture 22 - Importance of Sign of Shear Stress.
- Lecture 23 - Failure Initiation in Composite Laminate.
- Lecture 24 - Progressive Failure of Laminae in A Laminate
- Lecture 25 - Governing equations for composite plates
- Lecture 26 - Force equilibrium in Z-direction
- Lecture 27 - Moment equilibrium equations
- Lecture 28 - Equilibrium equations for composite plates
- Lecture 29 - Boundary conditions associated with different edges of composite plate - Part 1
- Lecture 30 - Boundary conditions associated with different edges of composite plate - Part 2
- Lecture 31 - Generalized Solution for Semi-Infinite Plate - Part I

- Lecture 32 - Generalized Solution for Semi-Infinite Plate - Part II
- Lecture 33 - Particular Solution for Semi-Infinite Plate: Case A
- Lecture 34 - Particular Solution for Semi-Infinite Plate: Case B
- Lecture 35 - Particular Solution for Semi-Infinite Plate: Case C
- Lecture 36 - Particular Solution for Semi-Infinite Plate: Case D
- Lecture 37 - Solution for governing equation related to semi-infinite composite plate
- Lecture 38 - Nature of displacement $u_0(x)$ and how it gets influence by important parameters of lamination sequence
- Lecture 39 - Semi-infinite plate loaded in the x-direction - Part 1
- Lecture 40 - Semi-infinite plate loaded in the x-direction - Part 2
- Lecture 41 - Thermal effects in composite laminates - Part 1
- Lecture 42 - Thermal effects in composite laminates - Part 2
- Lecture 43 - Thermal effects in composite laminates - Part 3
- Lecture 44 - Finite Rectangular Plate
- Lecture 45 - Different Boundary Conditions in Finite Rectangular Plate
- Lecture 46 - Example Based On a Finite Rectangular Plate: Part-I
- Lecture 47 - Example Based On a Finite Rectangular Plate: Part-II
- Lecture 48 - Example Based On a Finite Rectangular Plate: Part-III
- Lecture 49 - Anticlastic curvature
- Lecture 50 - Principle of virtual work
- Lecture 51 - Virtual work method: apply to beam problem
- Lecture 52 - Virtual work method: apply to simply supported plate
- Lecture 53 - Beam (two term solution)
- Lecture 54 - 3rd Interpretation of special Galerkin method
- Lecture 55 - Role of D16 and D26 Terms On Laminated Plate Response: Part-I
- Lecture 56 - Role of D16 and D26 Terms On Laminated Plate Response: Part-II
- Lecture 57 - Role of D16 and D26 Terms On Laminated Plate Response: Part-III
- Lecture 58 - Role of D16 and D26 Terms On Laminated Plate Response: Part-IV
- Lecture 59 - Free Vibration in Composite Plate: Part-I
- Lecture 60 - Free Vibration in Composite Plate: Part-II
- Lecture 61 - Buckling of composite plates
- Lecture 62 - Force equilibrium in z-direction for buckling of composite plates
- Lecture 63 - Moment equilibrium around x, y and z-directions for buckling of composite plates
- Lecture 64 - Buckling of an infinitely long composite plate

[Lecture 65 - Buckling of a simply supported finite plate](#)

[Lecture 66 - Composite plate under bidirectional compression](#)

[Lecture 67 - Shear Buckling in Rectangular Composite Plate: Part-I](#)

[Lecture 68 - Shear Buckling in Rectangular Composite Plate: Part-II](#)

[Lecture 69 - Introduction to Short-Fiber Composites](#)

[Lecture 70 - Theories of Stress Transfer: Part-I](#)

[Lecture 71 - Theories of Stress Transfer: Part-II](#)

[Lecture 72 - Modulus of Short-Fiber Composites and Closure](#)

Lecture 1 - Introduction to measurements and metrology

Lecture 2 - Instruments in measurement systems

Lecture 3 - Instruments in measurement systems

Lecture 4 - General concepts and definitions in metrology

Lecture 5 - Standards of measurement

Lecture 6 - Limits, Fits, and Tolerances - Part 1

Lecture 7 - Limits, Fits, and Tolerances - Part 2

Lecture 8 - Limits, Fits, and Tolerances - Part 3

Lecture 9 - Limits, Fits, and Tolerances - Part 4

Lecture 10 - Linear Measurements - Part 1

Lecture 11 - Linear Measurements - Part 2

Lecture 12 - Laboratory demonstration, Vernier Caliper

Lecture 13 - Laboratory demonstration, Dial gauge and vernier, micrometer, surface plate, feeler gauge

Lecture 14 - Angular Measurements - Part 1

Lecture 15 - Angular Measurements - Part 2

Lecture 16 - Laboratory demonstration, Vernier height gauge

Lecture 17 - Laboratory demonstration, Thread gauge, spirit level

Lecture 18 - Laboratory demonstration, Combination set, slip gauges, sine bar

Lecture 19 - Comparators - Part 1

Lecture 20 - Comparators - Part 2

Lecture 21 - Transducers - Part 1

Lecture 22 - Transducers - Part 2

Lecture 23 - Screw thread metrology

Lecture 24 - Gears metrology - Part 1

Lecture 25 - Gears metrology - Part 2

Lecture 26 - Laboratory demonstration, Gear Vernier

Lecture 27 - Surface metrology

Lecture 28 - Temperature measurements

Lecture 29 - Pressure measurements - Part 1

Lecture 30 - Pressure measurements - Part 2

Lecture 31 - Strain measurements - Part 1

- Lecture 32 - Strain measurements - Part 2
- Lecture 33 - Optical measurements and Nanometrology - Part 1
- Lecture 34 - Optical measurements and Nanometrology - Part 2
- Lecture 35 - Optical measurements and Nanometrology - Part 3
- Lecture 36 - Statistics in Metrology, an introduction - Part 1
- Lecture 37 - Statistics in Metrology, an introduction - Part 2
- Lecture 38 - Data and scales in measurements
- Lecture 39 - Discrete and continuous data
- Lecture 40 - Statistics for metrology, fundamental concepts - Part 1
- Lecture 41 - Statistics for metrology, fundamental concepts - Part 2
- Lecture 42 - Statistics for metrology, fundamental concepts - Part 3
- Lecture 43 - Probability distributions for estimating measurement
- Lecture 44 - Normal distribution
- Lecture 45 - Statistics for proportions
- Lecture 46 - Chi square distribution, and Data outlier detection
- Lecture 47 - Quality Control, introduction
- Lecture 48 - Quality Control, control charts for variables
- Lecture 49 - Quality Control, control charts for attributes
- Lecture 50 - Quality Control, critical aspects
- Lecture 51 - 3D measurements, Coordinate Measuring Machine (CMM)
- Lecture 52 - Laboratory demonstration, Coordinate Measuring Machine (CMM))

Lecture 1 - Introduction to Smart Materials

Lecture 2 - Piezoelectric Material

Lecture 3 - Magnetostrictive Material

Lecture 4 - Active Smart Polymer

Lecture 5 - Shape Memory Alloys

Lecture 6 - Introduction to composites

Lecture 7 - Classification of Composites

Lecture 8 - Micromechanics and Macromechanics of Composites

Lecture 9 - Classical Laminated Plate Theory

Lecture 10 - ABD Matrices

Lecture 11 - Modelling of piezoelectric material 1

Lecture 12 - Modelling of piezoelectric material 2

Lecture 13 - Modelling of Magnetostrictive material

Lecture 14 - Modelling of Shape memory Alloys

Lecture 15 - Smart Actuators

Lecture 16 - Smart Materials based MEMS

Lecture 17 - Smart MEMS Applications

Lecture 18 - Energy Harvesting

Lecture 19 - Concept of Self Healing

Lecture 1 - Design concepts

Lecture 2 - Computer Aided Design (CAD)

Lecture 3 - Geometrical transformation

Lecture 4 - Composition of geometrical transformation

Lecture 5 - Geometric modeling

Lecture 6 - Representation of curves

Lecture 7 - Parametric representation of synthetic curves

Lecture 8 - Curve fitting problem (Hermite case)

Lecture 9 - Problem solving (based on Bezier curve)

Lecture 10 - Representation of Surfaces

Lecture 11 - Introduction to Micro-Electro mechanical Systems (MEMS)

Lecture 12 - Lab-on-Chip

Lecture 13 - Introduction to Sensors

Lecture 14 - Introduction to Transducers

Lecture 15 - Introduction to device fabrications

Lecture 16 - Introduction to Silicon as a MEMS material

Lecture 17 - Etching processes

Lecture 18 - Types of Photolithography

Lecture 19 - Introduction to actuators

Lecture 20 - Designing of the Micro-Valve

Lecture 21 - Electrochemical valves

Lecture 22 - Micropumps

Lecture 23 - Designing of peristaltic pumps

Lecture 24 - Different types of pumps and sensors

Lecture 25 - Gas Sensors

Lecture 26 - Computer Numerical Control

Lecture 27 - Numerical Control Programming

Lecture 28 - NC Part Programming

Lecture 29 - Canned Cycles

Lecture 30 - Introduction to Rapid Prototyping

Lecture 31 - Different Types of Rapid Prototyping Technologies

[Lecture 32 - LAB Demonstration of FDM Process](#)

[Lecture 33 & 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37, 38 & 39](#)

[Lecture 40](#)

- Lecture 1 - Introduction to Rapid Manufacturing - Part 1
- Lecture 2 - Introduction to Rapid Manufacturing - Part 2
- Lecture 3 - Introduction to Rapid Manufacturing - Part 3
- Lecture 4 - Product Development Process - Part 1
- Lecture 5 - Product Development Process - Part 2
- Lecture 6 - Product Development Process - Part 3
- Lecture 7 - Design for Modularity (Manufacturing)
- Lecture 8 - Design for Modularity (Assembly; Part 1)
- Lecture 9 - Design for Modularity (Assembly; Part 2)
- Lecture 10 - Design for Modularity
- Lecture 11 - Subtractive versus Rapid Manufacturing
- Lecture 12 - Reverse Engineering - Part 1
- Lecture 13 - Reverse Engineering - Part 2
- Lecture 14 - Laboratory Demonstration, Co-ordinate Measuring Machine - Part 1
- Lecture 15 - Laboratory Demonstration, Co-ordinate Measuring Machine - Part 2
- Lecture 16 - Laboratory Demonstration, 3D scanners - Part 1
- Lecture 17 - Laboratory Demonstration, 3D scanners - Part 2
- Lecture 18 - Polymerization Processes - Part 1
- Lecture 19 - Polymerization Processes - Part 2
- Lecture 20 - Powder based processes - Part 1
- Lecture 21 - Powder based processes - Part 2
- Lecture 22 - Powder based processes - Part 3
- Lecture 23 - Extrusion based processes - Part 1
- Lecture 24 - Extrusion based processes - Part 2
- Lecture 25 - Sheet Stacking processes
- Lecture 26 - 3D printing processes
- Lecture 27 - Laboratory Demonstration, 3D printing - Part 1
- Lecture 28 - Laboratory Demonstration, 3D printing - Part 2
- Lecture 29 - Laboratory Demonstration, 3D printing - Part 3
- Lecture 30 - Beam Deposition processes
- Lecture 31 - Materials in Rapid Manufacturing - Part 1

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[Lecture 33 - Post-processing concerns - Part 1](#)

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[Lecture 35 - Product costing for Rapid Manufacturing - Part 1](#)

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[Lecture 37 - Rapid Product Development, CAD/CAM - Part 1](#)

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[Lecture 39 - Rapid Product Development, CAD/CAM - Part 3](#)

[Lecture 40 - Rapid Product Development, CAE and CIM](#)

[Lecture 41 - Rapid Product Development, Technomatix, Plant Simulation 10 - Part 1](#)

[Lecture 42 - Rapid Product Development, Technomatix, Plant Simulation 10 - Part 2](#)

[Lecture 43 - Rapid Product Development, Technomatix, Plant Simulation 10 - Part 3](#)

[Lecture 44 - Rapid Manufacturing, case studies](#)

Lecture 1 - Introduction to Combustion

Lecture 2 - Introduction to Combustion (Continued...)

Lecture 3 - Introduction to Combustion (Continued...)

Lecture 4 - Introduction to Combustion (Continued...) + Combustion and Thermochemistry

Lecture 5 - Combustion and Thermochemistry

Lecture 6 - Combustion and Thermochemistry (Continued...)

Lecture 7 - Combustion and Thermochemistry (Continued...) + Chemical Kinetics

Lecture 8 - Chemical Kinetics (Continued...)

Lecture 9 - Chemical Kinetics (Continued...)

Lecture 10 - Chemical Kinetics (Continued...) + Combustion Chemistry

Lecture 11 - Combustion Chemistry (Continued...)

Lecture 12 - Heat and Mass Transfer

Lecture 13 - Heat and Mass Transfer + Coupling of Chemical Kinetics and Thermodynamics

Lecture 14 - Coupling of Chemical Kinetics and Thermodynamics (Continued...)

Lecture 15 - Coupling of Chemical Kinetics and Thermodynamics + Laminar Premixed Flames

Lecture 16 - Laminar Premixed Flames (Continued...)

Lecture 17 - Laminar Premixed Flames (Continued...)

Lecture 18 - Laminar Premixed Flames (Continued...) + Laminar Non-Premixed Flames

Lecture 19 - Laminar Non-Premixed Flames (Continued...)

Lecture 20 - Laminar Non-Premixed Flames (Continued...)

Lecture 21 - Laminar Non-Premixed Flames

Lecture 22 - Laminar Non-Premixed Flames (Continued...)

Lecture 23 - Laminar Non-Premixed Flames (Continued...)

Lecture 24 - Laminar Non-Premixed Flames (Continued...)

Lecture 25 - Laminar Non-Premixed Flames (Continued...)

Lecture 26 - Laminar Non-Premixed Flames + Turbulence

Lecture 27 - Turbulence : Introduction

Lecture 28 - Turbulence : Introduction (Continued...)

Lecture 29 - Turbulence : Flow Stability analysis

Lecture 30 - Turbulence : Flow Stability analysis (Continued...)

Lecture 31 - Turbulence : Stability and Burger's Equation

- Lecture 32 - Turbulence : Energy cascade, length scales and Statistical description
- Lecture 33 - Turbulence : Statistical analysis and free shear flows
- Lecture 34 - Turbulence : Free shear and wall bounded shear flows
- Lecture 35 - Turbulence : Turbulent boundary layer
- Lecture 36 - Turbulence
- Lecture 37 - Turbulence : Temperature effects and Modelling
- Lecture 38 - Turbulence : Modelling and statistics
- Lecture 39 - Turbulence : Modelling (Continued...)
- Lecture 40 - Turbulence : Modelling (Continued...)
- Lecture 41 - Turbulence : Chemistry Interaction
- Lecture 42 - Turbulence : Chemistry Interaction (Continued...)
- Lecture 43 - Turbulence : Chemistry Interaction (Continued...)
- Lecture 44 - Turbulence : Chemistry Interaction (Continued...)
- Lecture 45 - Turbulence : Chemistry Interaction (Continued...)
- Lecture 46 - Turbulent Combustion : Stochastic method of solution
- Lecture 47 - Turbulent Combustion : Transported scalar PDF model
- Lecture 48 - Turbulent Combustion : Transported joint velocity - scalar PDF model
- Lecture 49 - Turbulent Combustion : Modelling Turbulent Premixed Combustion
- Lecture 50 - Turbulent Combustion : Modelling Turbulent Premixed Combustion (Continued...)
- Lecture 51 - Turbulent Combustion : Modelling Turbulent Premixed Combustion (Continued...)
- Lecture 52 - Turbulent Combustion : Modelling Turbulent Premixed Combustion (Continued...)
- Lecture 53 - Turbulent Combustion : Modelling Turbulent Non-Premixed Combustion
- Lecture 54 - Turbulent Combustion : Modelling Turbulent Non-Premixed Combustion (Continued...)
- Lecture 55 - Turbulent Combustion : Modelling Turbulent Non-Premixed Combustion (Continued...)
- Lecture 56 - Turbulent Combustion : Modelling Turbulent Non-Premixed Combustion
- Lecture 57 - Turbulent Combustion : Modelling Turbulent Non-Premixed Combustion (Continued...)
- Lecture 58 - Multiphase Combustion : Introduction + Droplet Evaporation
- Lecture 59 - Multiphase Combustion : Droplet Combustion
- Lecture 60 - Multiphase Combustion : Spray Combustion

Lecture 1 - Introduction to Manufacturing Automation

Lecture 2 - Various Aspects of Manufacturing Automation

Lecture 3 - Part Transfer Mechanisms

Lecture 4 - Automated Flow Lines

Lecture 5 - Analysis of Automated Flow Lines

Lecture 6 - Vibratory Bowl Feeder

Lecture 7 - Analysis of Vibratory Bowl Feeder

Lecture 8 - Reciprocating Tube Hopper Feeder

Lecture 9 - Centreboard Hopper Feeder and its analysis

Lecture 10 - Reciprocating fork and External Gate Hopper Feeders

Lecture 11 - Rotary Disc Feeder and Centrifugal Hopper Feeder

Lecture 12 - Bladed Wheel and Tumbling Barrel Hopper Feeders

Lecture 13 - Rotary Centreboard and Magnetic Feeders

Lecture 14 - Part Orienting Devices

Lecture 15 - Feed Tracks and their analysis

Lecture 16 - Powered Feed Track and Escapements

Lecture 17 - Various Escapements and Part Placing Mechanisms

Lecture 18 - Design for Automatic Assembly

Lecture 19 - Performance and Economics of Assembly Systems

Lecture 20 - Performance of Indexing and Free Transfer Machines

Lecture 1 - Introduction to CIM - Part 1

Lecture 2 - Introduction to CIM - Part 2

Lecture 3 - Computers and Manufacturing Systems - Part 1

Lecture 4 - Computers and Manufacturing Systems - Part 2

Lecture 5 - Computers and Manufacturing Systems - Part 3

Lecture 6 - Computer Graphics - Part 1

Lecture 7 - Computer Graphics - Part 2

Lecture 8 - Computer Graphics - Part 3

Lecture 9 - Computer Graphics - Part 4

Lecture 10 - Geometric Modelling - Part 1

Lecture 11 - Geometric Modelling - Part 2

Lecture 12 - Computer Numerical Control - Part 1

Lecture 13 - Computer Numerical Control - Part 2

Lecture 14 - Computer Numerical Control - Part 3

Lecture 15 - Computer Numerical Control - Part 4

Lecture 16 - CNC Machining - Part 1

Lecture 17 - CNC Machining - Part 2

Lecture 18 - CNC Tooling

Lecture 19 - CNC Part Programming - Part 1

Lecture 20 - CNC Part Programming - Part 2

Lecture 21 - CNC Part Programming - Part 3

Lecture 22 - CNC Part Programming - Part 4

Lecture 23 - Laboratory Demonstration, Computer Aided Design - Part 1

Lecture 24 - Laboratory Demonstration, Computer Aided Design - Part 2

Lecture 25 - CAM softwares

Lecture 26 - Laboratory Demonstration, Computer Aided Manufacturing - Part 1

Lecture 27 - Laboratory Demonstration, Computer Aided Manufacturing - Part 2

Lecture 28 - Group Technology

Lecture 29 - Computer Aided Process Planning - Part 1

Lecture 30 - Computer Aided Process Planning - Part 2

Lecture 31 - Flexible Manufacturing System

- [Lecture 32 - Robotics](#)
- [Lecture 33 - Programmable Logic Controller](#)
- [Lecture 34 - Automatic Identification and Data Capture](#)
- [Lecture 35 - Computer Aided Quality Control - Part 1](#)
- [Lecture 36 - Computer Aided Quality Control - Part 2](#)
- [Lecture 37 - Laboratory Demonstration, Coordinate Measuring Machine](#)
- [Lecture 38 - Rapid Manufacturing - Part 1](#)
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- [Lecture 40 - Laboratory demonstration, Rapid Manufacturing - Part 1](#)
- [Lecture 41 - Laboratory demonstration, Rapid Manufacturing - Part 2](#)
- [Lecture 42 - Laboratory Demonstration, CAD using Fusion 360, an introduction](#)
- [Lecture 43 - Laboratory Demonstration, CAD using Fusion 360, Rendering and 3D printing](#)
- [Lecture 44 - Material Handling](#)
- [Lecture 45 - Laboratory Demonstration, Plant Simulation software - Part 1](#)
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- [Lecture 48 - Computers in Manufacturing Industry, current scenario - Part 1](#)
- [Lecture 49 - Computers in Manufacturing Industry, current scenario - Part 2](#)
- [Lecture 50 - Computers in Manufacturing Industry, current scenario - Part 3](#)

Lecture 1 - Introduction to Machining

Lecture 2 - Mechanism of plastic deformation

Lecture 3 - Basic machining parameters, Cutting Tools and Types of Machining

Lecture 4 - Types of Chips, Tool nomenclature and tool angles

Lecture 5 - Tool Nomenclature in Normal Rake System and conversion of angles

Lecture 6 - Selection of Tool angles

Lecture 7 - Forces in machining, Merchant's Circle Diagram

Lecture 8 - Stress, Strain and Strain Rate and Shear Plane Angle

Lecture 9 - Numerical Examples; Lee and Shaffer's model

Lecture 10 - Friction in metal cutting: Zorev's Friction Model

Lecture 11 - Practical Machining Operations

Lecture 12 - Slab Milling; Measurement of Cutting Forces

Lecture 13 - Dynamometers; Tool Wear and Tool Life

Lecture 14 - Factors affecting tool life; Abrasive Machining Processes

Lecture 15 - Mechanics of Grinding Process

Lecture 16 - Chip length and specific energy in Grinding

Lecture 17 - Grinding wheel wear; Oblique Cutting

Lecture 18 - Rake angles in oblique cutting; Economics of Machining

Lecture 19 - Economics of Machining (Continued...); Thermal aspects of machining

Lecture 20 - Surface finish

[Lecture 1 - Introduction to Cognitive Robotics \(Private\)](#)

[Lecture 2 - Smart Materials - I \(Private\)](#)

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[Lecture 4 - Smart Materials - III \(Private\)](#)

[Lecture 5 - Architecture of the Brain](#)

[Lecture 6 - Architecture of the Brain \(Continued...\)](#)

[Lecture 7 - Nerve Cells](#)

[Lecture 8 - Introduction to Synchronisation Models](#)

[Lecture 9 - Synchronisation models \(Continued...\)](#)

[Lecture 10 - Introduction to EEG](#)

[Lecture 11 - Theories of Intelligence - I](#)

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Lecture 1 - Introduction to Robotics

Lecture 2 - Robot Joints and Work Volume

Lecture 3 - Spatial transformations

Lecture 4 - Homogenous Transformtions

Lecture 5 - Practice Problems with MATLAB in Rotation matrices

Lecture 6 - Kinematics: Derivation of Link Transformations

Lecture 7 - Problem Solving DH Parameters

Lecture 8 - Forward Kinematics

Lecture 9 - Inverse Kinematics

Lecture 10 - Problems in Kinematics

Lecture 11 - Inverse Kinematics of PUMA Robot

Lecture 12 - Jacobian and Singularity

Lecture 13 - Velocity and Static Forces

Lecture 14 - Dynamics - Lagrangian Euler

Lecture 15 - Newton Euler Dynamics

Lecture 16 - Trajectory Planning

Lecture 17 - Inverse Dynamics using MATLAB

Lecture 18 - Sensors

Lecture 19 - Actuators and Basic Control System

Lecture 20 - Block Diagram Reduction and Position Regulator

Lecture 21 - Control of a single joint

Lecture 22 - Non Linear Control of Manipulators

Lecture 23 - Force Control

Lecture 24 - Manipulator Mechanism Design

Lecture 25 - Industrial Robots and Applications

Lecture 26 - Specifications and Programming

Lecture 27 - VAL programming

Lecture 28 - Experiment With PUMA Robot Using VAL- II

Lecture 1 - Introduction to Acoustic Wave Propagation

Lecture 2 - D'Alembert's solution and 1-D Continuity equation

Lecture 3 - Muffler Acoustics-Application to Automotive Exhaust Noise Control

Lecture 4 - Linearization of governing equations, and Development of 1-D Acoustic wave and Helmholtz equation

Lecture 5 - Solution of 1-D Helmholtz equation: Propagation in 1-D ducts/pipes

Lecture 6 - 1-D Acoustic Wave Equation in Ducts Carrying Uniform Mean Flow: Derivation

Lecture 7 - 1-D Acoustic Wave Equation in Ducts Carrying Uniform Mean Flow: Solution

Lecture 8 - 3-D Acoustic Wave Equation in Rectangular and Circular Waveguides: Derivation, Modal Solution and Concept of Cut-on Frequency

Lecture 9 - Sound Pressure Level, Intensity Level and Sound Power Level

Lecture 10 - Acoustic Impedance and Reflection Coefficient

Lecture 11 - Lumped System Analysis: Inertance and Compliance

Lecture 12 - Lumped Analysis of a Uniform Pipe Closed/Open at an End, Concept of End Correction

Lecture 13 - Helmholtz Resonator, Electro-Acoustic Analogy and Layout of a typical engine exhaust system

Lecture 14 - Muffler Performance Measures: Insertion Loss

Lecture 15 - Muffler Performance Measures: Transmission Loss and Level Difference

Lecture 16 - Lumped Analysis of a Tube, Simple Area Discontinuity and Transfer Matrices

Lecture 17 - Sudden area Discontinuity (Continued...)

Lecture 18 - Simple Expansion Chamber Analysis Using Transfer Matrix Method

Lecture 19 - Transmission Loss (TL) Graph for a Simple Expansion Muffler (MATLAB)

Lecture 20 - Extended-Inlet and Extended-Outlet Muffler Analysis

Lecture 21 - Extended-Inlet and Extended-Outlet Muffler Analysis (Continued...)

Lecture 22 - TL Analysis of Extended-Inlet and Extended-Outlet Muffler (MATLAB)

Lecture 23 - TL Analysis of Side-Inlet and Side-Outlet Muffler Using Transfer Matrix Method

Lecture 24 - Wave Propagation in Gradually Varying Area Ducts: Webster's Horn Equation

Lecture 25 - Webster's Horn Equation (Continued...) and Exponential Ducts

Lecture 26 - Solution of Webster's Horn Equation for Conical Ducts

Lecture 27 - TL analysis for Conical Muffler Configurations (MATLAB)

Lecture 28 - Segmentation Approach for Analysing Gradually Varying Area Ducts (MATLAB)

Lecture 29 - Acoustic Intensity (Energy Flux) in a Pipe with Mean Flow, and Transmission Loss Expression

Lecture 30 - Aeroacoustic State Variables Transfer Matrix for a Tubular Element (Uniform Pipe)

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

Lecture 31 - Transfer Matrix for Extended-Inlet and Outlet Element and Use of Perforated Elements in Commercial Mufflers

Lecture 32 - Two-interacting Duct Configurations: Development of Equations and Concentric Tube Resonators

Lecture 33 - Concentric Tube Resonator: Partially Perforated Pipe or Airway (MATLAB)

Lecture 34 - Review of Perforate Impedance Expressions

Lecture 35 - MATLAB Demonstration for Fully and Partially Perforated CTR

Lecture 36 - Cross-Flow elements: Setting-up the Equations

Lecture 37 - Cross-Flow elements: MATLAB Demonstration for Simple Configurations

Lecture 38 - Plug Mufflers, Three-pass Perforated Element Muffler (Commercial Configurations) - MATLAB

Lecture 39 - Multiply-Connected Mufflers: HQ Tubes

Lecture 40 - TL Analysis of HQ Tubes (MATLAB): Network Analysis and Analytical Formula

Lecture 41 - Transmission Loss in terms of Scattering and Impedance Matrix Parameters

Lecture 42 - Rectangular Chamber Muffler: Characterization and TL Analysis using 3-D Piston-driven Model

Lecture 43 - Circular Chambers: Characterization and TL Analysis Using 3-D Piston-driven Model

Lecture 44 - Analytical Mode-Matching for Extended-Inlet and Outlet Muffler: Setting-up of the Equations

Lecture 45 - MATLAB Demonstration for Transmission Loss Calculations

Lecture 46 - Dissipative Mufflers (Lined Circular duct) - A Brief Discussion

Lecture 47 - Summary of the Topics Covered in This Course, Topics to be Covered in a Future Course

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Lecture 1 - Casting: Introduction to Casting

Lecture 2 - Various aspects of Casting

Lecture 3 - Patterns and Moulds

Lecture 4 - Sand Mould and Gating System

Lecture 5 - Gating System Design

Lecture 6 - Aspiration Effects and Riser Design

Lecture 7 - Solidification of Metals and Alloys

Lecture 8 - Stress, Strain and Strain Rate and Shear Plane Angle

Lecture 9 - Steps in Sand Casting Processes

Lecture 10 - Expendable Mould Casting Processes

Lecture 11 - Permanent Mould Casting

Lecture 12 - Various Casting Processes and Cost Analysis

Lecture 13 - Cost analysis, Casting Defects and Product Design

Lecture 14 - Introduction to Joining Processes

Lecture 15 - Characteristic Features of Welding Processes

Lecture 16 - Various Welding Processes

Lecture 17 - Advanced Welding Processes

Lecture 18 - Characteristic Features of Arc Welding

Lecture 19 - Shielded metal arc welding, MIG and TIG Welding

Lecture 20 - Gas Welding, Brazing and Soldering, Welding Defects

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- Lecture 2 - Finite Difference Method - Basic Idea of Discretization
- Lecture 3 - Explicit and Implicit Formulations, Stability Analysis - Part 1
- Lecture 4 - Stability Analysis - Part 2
- Lecture 5 - Important Aspects of Flow Modelling - Part 1
- Lecture 6 - Important Aspects of Flow Modelling - Part 2
- Lecture 7 - Important Aspects of Flow Modelling - Part 3
- Lecture 8 - Applications of Our Knowledge to a Problem of Practical Interest and Setting up an Algorithm
- Lecture 9 - Finite Volume Method - Part 1
- Lecture 10 - Finite Volume Method - Part 2
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- Lecture 15 - Vorticity Stream Function Approach (Formulation and Algorithm)
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- Lecture 5 - Metal Machining-2: Mechanism of plastic deformation
- Lecture 6 - Metal Machining-3: Types of Chips, Tool nomenclature and tool angles
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- Lecture 6 - Euler Equation for Turbomachinery: Illustration
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Lecture 9 - Hydraulic Circuits and Valves

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NPTEL : Solar Energy Technology (Mechanical Engineering)

Co-ordinators : Prof. V.V. Satyamurty

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Lecture 8 - Chemical Vapour Deposition of Chromium

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NPTEL : Manufacturing Processes II (Mechanical Engineering)

Co-ordinators : Prof. S. Paul, Prof. A.B. Chattopadhyay, Prof. A.K. Chattopadhyay

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NPTEL : Refrigeration and Air Conditioning (Mechanical Engineering)

Co-ordinators : Prof. M. Ramgopal, Prof. R.C. Arora

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NPTEL : Fluid Mechanics (Mechanical Engineering)

Co-ordinators : Prof. S.K. Som

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NPTEL : Micro fluidics (Mechanical Engineering)

Co-ordinators : Prof. S. Chakraborty

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- Lecture 25 - Vibrations of Rings and Arches - I
- Lecture 26 - Vibrations of Rings and Arches - II
- Lecture 27 - Dynamics of Membranes
- Lecture 28 - Vibrations of Rectangular Membranes
- Lecture 29 - Vibrations of Circular Membranes - I
- Lecture 30 - Vibrations of Circular Membranes - II
- Lecture 31 - Dynamics of Plates

[Lecture 32 - Vibrations of Rectangular Plates](#)

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[Lecture 34 - Special Problems in Plate Vibrations - I](#)

[Lecture 35 - Special Problems in Plate Vibrations - II](#)

Lecture 1 - Definition of Fluid Machines and Energy Transfer in Fluid Machines - Part I

Lecture 2 - Energy Transfer in Fluid Machines - Part II

Lecture 3 - Impulse and Reaction Machines: Introductory Concepts

Lecture 4 - Principles of Similarity in Fluid Machine

Lecture 5 - Concept of Specific Speed

Lecture 6 - Basic Principles, Analysis of Force and Power Generation - Part I

Lecture 7 - Basic Principles, Analysis of Force and Power Generation - Part II

Lecture 8 - Specific Speed Governing and Limitations of Impulse Turbine

Lecture 9 - Tutorial - I

Lecture 10 - Tutorial - II

Lecture 11 - Introduction and Analysis of Force on Francis Turbine (Radial Flow) - Part I

Lecture 12 - Analysis of Force (Part-II) and Power Generation

Lecture 13 - Draft Tube

Lecture 14 - Tutorial - III

Lecture 15 - Tutorial - IV

Lecture 16 - Axial Flow Turbine

Lecture 17 - Governing of Reaction Turbine

Lecture 18 - Introduction to Rotodynamic Pumps

Lecture 19 - Flow and Energy Transfer to Centrifugal Pumps

Lecture 20 - Tutorial - V

Lecture 21 - Characteristics of a Centrifugal Pump

Lecture 22 - Matching of Pump and System Characteristics

Lecture 23 - Diffuser and Cavitation

Lecture 24 - Tutorial - VI

Lecture 25 - Tutorial - VIII

Lecture 26 - Axial Flow Pump

Lecture 27 - Reciprocating Pump - Part I

Lecture 28 - Reciprocating Pump - Part II

Lecture 29 - Tutorial - VIII

Lecture 30 - Basic Principles and Energy Transfer in Centrifugal Compressor - Part I

Lecture 31 - Basic Principles and Energy Transfer in Centrifugal Compressor - Part II

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[Lecture 34 - Performance Characteristics of Centrifugal Compressors - Part I](#)

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[Lecture 36 - Basic Principles and Energy Transfer in Axial Flow Compressor - Part I](#)

[Lecture 37 - Basic Principles and Energy Transfer in Axial Flow Compressor - Part II](#)

[Lecture 38 - Fans and Blowers - Part I](#)

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Lecture 1 - Introduction to computer control – role of computers in automation

Lecture 2 - Introduction (Continued...) - binary logic and logic gates

Lecture 3 - Classification of Computer numerical control (CNC) – Point to point and continuous control

Lecture 4 - Classification (Continued...) - Closed loop and open loop control

Lecture 5 - Tutorial involving simple calculations on different aspects of CNC controls

Lecture 6 - Questions, MCQ Discussions on Motors, Encoders, Decoders and Programming Practice

Lecture 7 - Stepper motors, Permanent magnet DC motors

Lecture 8 - Binary circuits and decoders

Lecture 9 - Tachogenerator, printed circuit motors, Encoders

Lecture 10 - Programming Practice - I

Lecture 11 - Programming Practice - II

Lecture 12 - Computer Aided Offline Programming

Lecture 13 - Interpolators - Linear

Lecture 14 - Interpolators - Curvilinear

Lecture 15 - Questions on Programming and Interpolation

Lecture 16 - 3-D Machining - Basic Concepts

Lecture 17 - Curved Surface Geometry

Lecture 18 - Cutter Path Generation for Curved Surfaces

Lecture 19 - Cutter Path Generation (Concluding Part) and Current Status - CNC Machining and Related Processes

Lecture 20 - Questions and Discussions on Curved Surface Machining

**NPTEL : NOC:Non Traditional Abrasive Machining Processes - Ultrasonic, Abrasive Jet and Abrasive Water Jet Machining
(Mechanical Engineering)**

Co-ordinators : Prof. Asimava Roy Choudhury

Lecture 1 - Non-traditional abrasive machining : Ultrasonic, Abrasive jet and abrasive water jet machining

Lecture 2 - Ultrasonic Machining

Lecture 3 - Ultrasonic Machining (Continued...)

Lecture 4 - Ultrasonic Machining - Free Impacts and Problem Solving

Lecture 5 - Ultrasonic Machining - Problems and MCQs

Lecture 6 - USM - Horn Design

Lecture 7 - USM - Horn Design (Continued...)

Lecture 8 - Ultrasonic Machining - Feed Mechanism, Head design and other aspects

Lecture 9 - Ultrasonic Machining - Effects of Various Inputs on the Output

Lecture 10 - Ultrasonic Machining - Numerical and MCQs

Lecture 11 - A JM (Abrasive jet machining)

Lecture 12

Lecture 13 - A JM - Numerical problems

Lecture 14 - A JM - Process Parameters and Response Characteristics take - home assignment discussing

Lecture 15 - A JM - MCQs

Lecture 16

Lecture 17 - AWJM - Equipment

Lecture 18 - AWJM - Numerical Problems

Lecture 19 - AWJM - Application Equipment Details

Lecture 20 - AWJM - MCQs

- Lecture 1 - Lagrangian and Eulerian Approach, Types of fluid flow
- Lecture 2 - Streamlines, Streakline and Pathline
- Lecture 3 - Acceleration of fluid flow
- Lecture 4 - Deformation and Conservation of mass of fluid a element
- Lecture 5 - Angular deformation of a fluid element, vorticity and streamfunction and velocity potential
- Lecture 6 - Euler's equation
- Lecture 7 - Bernoulli's Equation - Part I
- Lecture 8 - Bernoulli's Equation - Part II
- Lecture 9 - Reynolds Transport Theorem (RTT)
- Lecture 10 - Application of Conservation of Mass
- Lecture 11 - Application of RTT: Conservation of Linear Momentum
- Lecture 12 - Application of RTT in Accelerating Reference Frames
- Lecture 13 - Navier's Equation of Motion
- Lecture 14 - Derivation of Navier-Stokes Equation
- Lecture 15 - Derivation of Navier-Stokes Equation (Continued...)
- Lecture 16 - Derivation of Navier-Stokes Equation (Continued...)
- Lecture 17 - Fully developed flow between two parallel plates
- Lecture 18 - Force on a surface immersed in fluid - Part III, Stability of solid bodies in fluid - Part I
- Lecture 19 - Couette flow
- Lecture 20 - Flow with interfaces
- Lecture 21 - Thin film flow on an inclined plane and Hagen-Poiseuille flow
- Lecture 22 - Hagen-Poiseuille flow (Continued...)
- Lecture 23 - Flow between two rotating cylinders
- Lecture 24 - Stokes 1st problem
- Lecture 25 - Stokes 2nd problem
- Lecture 26 - Introduction to turbulence: basic concepts
- Lecture 27 - Eddies
- Lecture 28 - Eddies (Continued...) and Vortex shredding
- Lecture 29 - Statistical description of turbulent flows
- Lecture 30 - Reynolds stress
- Lecture 31 - Reynolds averaged Navier Stokes equation (RANS)

- Lecture 32 - Bernoulli's equation - Part I
- Lecture 33 - Bernoulli's equation - Part II
- Lecture 34 - Bernoulli's equation - Part III
- Lecture 35 - Euler's equation in streamline coordinates
- Lecture 36 - Flow over a flat plate: Blasius equation
- Lecture 37 - Momentum integral method for boundary layer analysis
- Lecture 38 - Approximate solution of the momentum integral equation
- Lecture 39 - Displacement and Momentum thickness
- Lecture 40 - Illustrative examples
- Lecture 41 - Boundary layer separation
- Lecture 42 - Resultant force on a body immersed in a fluid under motion
- Lecture 43 - Potential flow
- Lecture 44 - Examples of Potential flow
- Lecture 45 - Some more examples of Potential flows, Lift and Drag force
- Lecture 46 - Applications of lift and drag force
- Lecture 47 - Some examples of flow past immersed bodies
- Lecture 48 - Sports Ball aerodynamics
- Lecture 49 - Introduction to compressible flows
- Lecture 50 - Significance of Mach number
- Lecture 51 - Navier-Stokes equation - Part I
- Lecture 52 - Navier-Stokes equation - Part II
- Lecture 53 - Navier-Stokes equation - Part III
- Lecture 54 - Navier-Stokes equation - Part IV
- Lecture 55 - Pipe Flow - Part I
- Lecture 56 - Pipe Flow - Part II
- Lecture 57 - Pipe Flow - Part III
- Lecture 58 - Pipe Flow - Part IV
- Lecture 59 - Principle of Similarity and Dynamical Analysis - Part I
- Lecture 60 - Principle of Similarity and Dynamical Analysis - Part II

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Lecture 2 - Simple Gear Calculations

Lecture 3 - Gear Geometry

Lecture 4 - Helical Gear Problems

Lecture 5 - Numerical Problem MCQ

Lecture 6 - Numerical Problem Milling of Helical Gears

Lecture 7 - Simple and Compound Indexing

Lecture 8 - Differential Indexing

Lecture 9 - Helical Gear Cutting on Milling Machine

Lecture 10 - Numerical Problems on Gear Milling

Lecture 11 - Gear Shaping - I

Lecture 12 - Gear Shaping - II

Lecture 13 - Gear Shaping - III

Lecture 14 - Gear Shaping - IV

Lecture 15 - Gear Hobbing - I

Lecture 16 - Gear Hobbing - II

Lecture 17 - Gear Hobbing - III

Lecture 18 - Gear Hobbing - IV

Lecture 19 - Gear Hobbing - V

Lecture 20 - Gear Hobbing - VI

Lecture 1 - Introduction, Definition of System, Properties and State of a System

Lecture 2 - Properties of pure substances

Lecture 3 - Properties of pure substances (Continued...)

Lecture 4 - Heat and Work

Lecture 5 - Tutorial 1: Properties of pure substances, heat and work

Lecture 6 - Zeroth Law of Thermodynamics

Lecture 7 - First law of thermodynamics for closed systems - Part I

Lecture 8 - First law of thermodynamics for closed systems - Part II, some examples

Lecture 9 - Tutorial 2: First law of thermodynamics for closed systems

Lecture 10 - First law of thermodynamics for open systems

Lecture 11 - Tutorial 3: First law of thermodynamics for open systems

Lecture 12 - Second law and its corollaries - Part I

Lecture 13 - Second law and its corollaries - Part II

Lecture 14 - Second law and its corollaries - Part III

Lecture 15 - Definition of entropy and entropy change in closed systems

Lecture 16 - Entropy change in closed systems (Continued...)

Lecture 17 - Tutorial 4: Entropy

Lecture 18 - Entropy and its transport

Lecture 19 - Tutorial 5: Entropy and its transport

Lecture 20 - Introduction to Third Law

Lecture 21 - Review of learning concepts

Lecture 1 - Introduction to waste heat recovery

Lecture 2 - Introduction to waste heat recovery (Continued...)

Lecture 3 - Introduction to waste heat recovery (Continued...)

Lecture 4 - Introduction to waste heat recovery (Continued...)

Lecture 5 - Thermodynamic principles of waste heat recovery

Lecture 6 - Thermodynamic principles of waste heat recovery (Continued...)

Lecture 7 - Thermodynamic principles of waste heat recovery (Continued...)

Lecture 8 - Thermodynamic principles of waste heat recovery (Continued...)

Lecture 9 - Reversible Cycles

Lecture 10 - Reversible Cycles (Continued...)

Lecture 11 - Entropy

Lecture 12 - Entropy (Continued...)

Lecture 13 - Entropy (Continued...), Exergy

Lecture 14 - Exergy, Second Law efficiency

Lecture 15 - Second Law efficiency (Continued...)

Lecture 16 - Recapitulation of common power cycles

Lecture 17 - Recapitulation of common power cycles (Continued...)

Lecture 18 - Recapitulation of common power cycles (Continued...)

Lecture 19 - Recapitulation of common power cycles (Continued...)

Lecture 20 - Recapitulation of common power cycles (Continued...)

Lecture 21 - Recapitulation of common power cycles (Continued...)

Lecture 22 - Gas Turbine cycle

Lecture 23 - Combined cycle

Lecture 24 - Combined cycle (Continued...)

Lecture 25 - Combined Cycle (Continued...)

Lecture 26 - Heat recovery steam generator

Lecture 27 - Thermodynamic cycles for low temperature application

Lecture 28 - Thermodynamic cycles for low temperature application (Continued...), Cogeneration

Lecture 29 - Heat Exchanger

Lecture 30 - Heat Exchanger (Continued...)

Lecture 31 - Heat Exchanger (Continued...)

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[Lecture 38 - Heat Pipe - Part II](#)

[Lecture 39 - Heat Pipe - Part III](#)

[Lecture 40 - Direct Conversion - Introduction to TEG](#)

[Lecture 41 - Thermoelectric Generators - Functioning and Applications](#)

[Lecture 42 - TEG - performance analysis](#)

[Lecture 43 - TEG - performance optimization](#)

[Lecture 44 - Direct Conversion - Magneto Hydro dynamics \(MHD\)](#)

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[Lecture 48 - Heat Pumps - II](#)

[Lecture 49 - Heat Pumps - III](#)

[Lecture 50 - Waste Heat Recovery from Incinerator Plants](#)

[Lecture 51 - Energy Storage Systems - I](#)

[Lecture 52 - Energy Storage Systems - II](#)

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[Lecture 9 - Scaling laws \(Continued...\)](#)

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[Lecture 12 - Difference between micro and macro machining \(Continued...\)](#)

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[Lecture 15 - Difference between macro and micro machining \(Continued...\)](#)

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Lecture 3 - FMECA

Lecture 4 - Fault Diagnostics and Prognostics

Lecture 5 - Machine Learning in CBM

Lecture 6 - Basics of Vibration

Lecture 7 - Free and Forced Response

Lecture 8 - Vibration and Shock Isolation

Lecture 9 - Rotordynamics

Lecture 10 - Practical Examples of Vibration

Lecture 11 - Time Domain Analysis

Lecture 12 - Frequency Domain Analysis

Lecture 13 - Non Stationary Signal Analysis

Lecture 14 - Modulation and Beats

Lecture 15 - Orbit and Order Analysis

Lecture 16 - Computer aided data acquisition

Lecture 17 - Orbit and Order Analysis

Lecture 18 - Data Recording

Lecture 19 - Cepstrum Analysis

Lecture 20 - Hilbert Transform in Condition Monitoring

Lecture 21 - Introduction to MATLAB

Lecture 22 - Signal Processing using MATLAB

Lecture 23 - Numericals in Signal Processing and Data Acquisition

Lecture 24 - Signal Hetrodnying

Lecture 25 - Practical Signals

Lecture 26 - Basics Of Instrumentation

Lecture 27 - Signal Conditioning And Filtering

Lecture 28 - Errors In Measurements

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Lecture 30 - Overview Of Transducers For Cbm

Lecture 31 - Accelerometers

- Lecture 32 - Vibration Monitoring
- Lecture 33 - Rotational Speed Measurements
- Lecture 34 - Basics of Noise
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- Lecture 36 - Introduction to Faults in Rotating Machines
- Lecture 37 - Unbalance Detection
- Lecture 38 - Field Balancing
- Lecture 39 - Misalignment
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- Lecture 41 - Journal and Anti-Friction Bearings
- Lecture 42 - Gears
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- Lecture 46 - Principles of Motor Current Signature Analysis
- Lecture 47 - Faults in Electrical Machines
- Lecture 48 - Thermography
- Lecture 49 - Wear Debris Analysis
- Lecture 50 - Oil Analysis
- Lecture 51 - Ultrasonics
- Lecture 52 - Eddy Current and Acoustic Emission
- Lecture 53 - Radiography, Dye Penetrant Tests
- Lecture 54 - Tool Condition Monitoring
- Lecture 55 - Experimental Modal Analysis
- Lecture 56 - Introduction to Failure Analysis
- Lecture 57 - Railway Locomotive Noise and Vibration Monitoring
- Lecture 58 - Paper Mill Vibration Monitoring
- Lecture 59 - Overview of CBM facilities at IIT Kharagpur
- Lecture 60 - Future of Condition based Monitoring

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Lecture 3 - Geometry of turning tools - 2

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Lecture 5 - Geometry of cutting tools and numerical problems

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Lecture 8 - Mechanics of material removal

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Lecture 12 - Wear and life of cutting tools - 2

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Lecture 14 - Calculations on mechanisms in machine tools

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Lecture 17 - Milling machine - indexing

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Lecture 6 - Involute Straight Tooth Spur Gear

Lecture 7 - Helical Tooth Spur Gear and Loads on Gear Shaft

Lecture 8 - Design of Bevel Gear

Lecture 9 - Crossed Helical Gear - I

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Lecture 12 - Gear Unit Design - First Stage Pinion and Gear Design- I (Module on Beam Strength Basis)

Lecture 13 - Gear Unit Design - Failure of Gear Tooth (Probable Dynamic Load and Wear Load Capacity)

Lecture 14 - Gear Unit Design - 1st. Stage Pinion and Gear Design-II (Probable Dynamic Load and Wear Load Capacity and Finalizing 1st. Stage Pinion and Gear set)

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Lecture 16 - Bearing Arrangement - Gear Box Shafts

Lecture 17 - Bearing Load Calculation - Intermediate Shaft

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Lecture 19 - Design Verification of Gear Box Shafts

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Elements of Metal Cutting, Machine tools, Gear Cutting and CNC Machining (Mechanical Engineering)

Co-ordinators : Prof. Asimava Roy Choudhury

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Lecture 9 - Measurement Of Cutting Forces

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Co-ordinators : Prof. K. Ramamurthi

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- Lecture 5 - Energy Equation
- Lecture 6 - Reynolds Transport Theorem
- Lecture 7 - Entropy Generation and streamfunction-vorticity formulation
- Lecture 8 - Couette flow - Part 1
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- Lecture 10 - Couette flow - Part 3
- Lecture 11 - Boundary layer approximation
- Lecture 12 - Laminar External flow past flat plate (Blasius Similarity Solution)
- Lecture 13 - Numerical solution to the Blasius equation and similarity solution to heat transfer
- Lecture 14 - Pohlhausen similarity solution and flows including pressure gradient (Falkner-Skan)
- Lecture 15 - Falkner skan solutions for heat transfer
- Lecture 16 - Similarity solution for flow and heat transfer with transpiration at walls
- Lecture 17 - Thermal boundary layer in high speed flows
- Lecture 18 - Approximate(Integral) methods for laminar external flow and heat transfer
- Lecture 19 - Integral method for laminar external thermal boundary layer over isothermal surface
- Lecture 20 - Integral method for flows with pressure gradient (von Karman-Pohlhausen method)
- Lecture 21 - Integral method with pressure gradient: heat transfer
- Lecture 22 - Heat transfer across a circular cylinder: Walz approximation
- Lecture 23 - Duhamel's method for varying surface temperature
- Lecture 24 - Laminar External heat transfer with non uniform surface temperature
- Lecture 25 - Laminar internal forced convection - fundamentals
- Lecture 26 - Hydrodynamically and thermally fully developed internal laminar flows
- Lecture 27 - Fully developed laminar internal flow and heat transfer
- Lecture 28 - Shooting method for fully developed heat transfer and thermal entry length problem
- Lecture 29 - Thermal entry length problem with plug velocity profile: Graetz problem
- Lecture 30 - Extended Graetz problem for parabolic velocity profile
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Lecture 2 - Blast Wave in an Explosion: Predictions from Dimensional Considerations

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Lecture 4 - Shock Hugoniot and Rayleigh Line

Lecture 5 - Properties behind a Constant Velocity Shock

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Lecture 7 - Blast waves: Decay of a strong Blast wave, Explosion Length, Sach's Scaling, Over pressure, Cranz Hopkinson Scaling law of Overpressure

Lecture 8 - Blast Waves: Overpressure and Impulse in the Near and Far Field, Examples, Introduction to Impulse

Lecture 9 - Blast Waves: Non-dimensional Impulse, Cranz -Hopkinson Scaling, Missiles, Fragments and Shrapnel, Craters, Examples

Lecture 10 - Blast Waves: Interaction with Objects, Reflection and Transmission of Blast Waves, Impedance

Lecture 11 - Blast Waves: Amplification of Reflected Blast Waves; Role of Impedance, Spalling, Damage to Organs containing Air, Mushroom Cloud in an Explosion, Examples

Lecture 12 - Blast Waves: Damage from Blast Waves, Examples, Multiple Spikes in an Impulse, Iso-damage Curve on an Overpressure-Impulse Diagram, Complex Structures

Lecture 13 - Energy Release in a Chemical Reaction: Moles, Internal Chemical Energy, Standard Heats of Formation

Lecture 14 - Energy Release: Stoichiometry, Equivalence Ratio and Heat Release in Fuel Rich and Oxidizer Rich Compounds

Lecture 15 - Energy Release: Examples of Energy Release Calculations, Higher and Lower Calorific Values, Internal Energy of Formation

Lecture 16 - Rate of Energy Release: Concentration, Activation Energy, Energy Release Profile

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Lecture 25 - Realizable States in a Detonation

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- Lecture 3 - Measurement errors
- Lecture 4 - Linear measuring instruments \hat{A} - 1 (Angle plate, steel rule, spring calipers)
- Lecture 5 - Linear measuring instruments \hat{A} - 2 (Combination set, Vernier calipers)
- Lecture 6 - Linear measuring instruments \hat{A} - 3 (Height gauge, Micrometers \hat{A} - 1)
- Lecture 7 - Linear measuring instruments \hat{A} - 4 (Micrometers \hat{A} - 2, Bore gauge)
- Lecture 8 - Linear measuring instruments \hat{A} - 5 (Dial indicators, thickness gauges, depth gauges)
- Lecture 9 - Manufacturing tolerances and fits
- Lecture 10 - Terminologies of limits fits and tolerances
- Lecture 11 - Numerical problems on fit and tolerances
- Lecture 12 - Selection of fits, Geometrical tolerances
- Lecture 13 - Positional tolerances
- Lecture 14 - Limit gauging - 1
- Lecture 15 - Limit gauging - 2
- Lecture 16 - Design of limit gauges
- Lecture 17 - Measurement of straightness, flatness and squareness
- Lecture 18 - Perpendicularity measurement
- Lecture 19 - Basics of surface roughness
- Lecture 20 - Surface finish parameters
- Lecture 21 - Stylus type surface finish measuring instruments
- Lecture 22 - Non-contact type surface finish measuring instruments
- Lecture 23 - Screw thread production and terminology
- Lecture 24 - Measurement of screw thread elements
- Lecture 25 - Introduction to gears
- Lecture 26 - Measurement of gear elements
- Lecture 27 - Angle measurement - 1
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- Lecture 30 - Basics of interferometry
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[Lecture 37 - Universal measuring machine \(UMM\) and Coordinate measuring machine \(CMM\)](#)

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- Lecture 2 - Newton's laws
- Lecture 3 - Equilibrium
- Lecture 4 - Example 1 - Statics
- Lecture 5 - Example 2 - Rigid Body Systems
- Lecture 6 - Example 3 - Rigid Body Systems
- Lecture 7 - Structural Systems with rigid bodies
- Lecture 8 - Types of 1-D Structural Elements
- Lecture 9 - Axial members
- Lecture 10 - Analysis of the truss system
- Lecture 11 - Stability of Structural systems
- Lecture 12 - Beams - Example 1
- Lecture 13 - Beams - BMD and SFD
- Lecture 14 - Beams - Loading, Shear and Bending Moment Relations
- Lecture 15 - Static Friction
- Lecture 16 - Friction - Solving Problems
- Lecture 17 - Particle Kinematics - 1
- Lecture 18 - Particle Kinematics - 2 (Example)
- Lecture 19 - Particle Kinematics - Curvilinear Coordinates
- Lecture 20 - Rigid Body Kinematics
- Lecture 21 - Rotational Motion (Example 1)
- Lecture 22 - Rotational Motion (Example 2)
- Lecture 23 - Dynamics (Introduction)
- Lecture 24 - Dynamics - Example 1
- Lecture 25 - Dynamics - Example 2
- Lecture 26 - Dynamics - Example 3
- Lecture 27 - Dynamics - Example 4
- Lecture 28 - Center of Percussion - Example
- Lecture 29 - Impulse / Momentum - Example 1
- Lecture 30 - Impulse / Momentum - Example 2
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- Lecture 2 - Review of fundamentals of fluid mechanics - II
- Lecture 3 - Concept of a Boundary Layer (BL) - I
- Lecture 4 - Concept of a Boundary Layer (BL) - II
- Lecture 5 - Concepts of BL thickness (?)
- Lecture 6 - Concepts of BL displacement thickness (δ^*) and BL momentum thickness (θ)
- Lecture 7 - Control Volume approach to derive expressions for δ^* over a flat plate
- Lecture 8 - Control Volume approach to derive expressions for θ over a flat plate
- Lecture 9 - Concept of wall friction
- Lecture 10 - Concept of friction drag
- Lecture 11 - Skin Friction Coefficient - I
- Lecture 12 - Skin Friction Coefficient - II
- Lecture 13 - Derivation of Prandtl's Laminar BL Equations - I
- Lecture 14 - Derivation of Prandtl's Laminar BL Equations - II
- Lecture 15 - Derivation of Prandtl's Laminar BL Equations - III
- Lecture 16 - Derivation of Prandtl's Laminar BL Equations - IV
- Lecture 17 - Similarity Solutions to the BL Equations Applied to a Flat Plate - I
- Lecture 18 - Similarity Solutions to the BL Equations Applied to a Flat Plate - II
- Lecture 19 - Similarity Solutions to the BL Equations Applied to a Flat Plate - III
- Lecture 20 - Runge-Kutta Method to Numerically Solve the BL Equations Applied to a Flat Plate
- Lecture 21 - Description of the Numerical Code to Solve the BL Equations Applied to a Flat Plate
- Lecture 22 - Similarity Solutions to the BL Equations (other than flat plate) - I
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- Lecture 24 - Similarity Solutions to the BL Equations (other than flat plate) - III
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- Lecture 26 - Description of the Numerical Code to Solve the BL Equations (other than flat plate)
- Lecture 27 - The Energy Equation - I
- Lecture 28 - The Energy Equation - II
- Lecture 29 - Similarity Solutions to Thermal BL - I
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[Lecture 32 - BL Separation with Pressure-Gradient - I](#)

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[Lecture 34 - Effect of Prandtl Number in Thermal BL - I](#)

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Lecture 5 - Conservation Equations

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Lecture 8 - Concept of stagnation

Lecture 9 - Discussion on stagnation

Lecture 10 - Velocity of sound

Lecture 11 - Discussion on velocity of sound and mach number

Lecture 12 - Wave propagation

Lecture 13 - Mach wave

Lecture 14 - Mach number relations

Lecture 15 - Variable Area Adiabatic flow

Lecture 16 - Variable Area Adiabatic flow (Continued...)

Lecture 17 - * reference quantities and their relations

Lecture 18 - Importance of stagnation temperature in relation to v

Lecture 19 - Discussion on variable area adiabatic flow and * reference quantities

Lecture 20 - Gas tables

Lecture 21 - Converging nozzle

Lecture 22 - Condition of choked flow and associated properties

Lecture 23 - Area ratio and pressure ratio in converging nozzles

Lecture 24 - Discussion on converging nozzles

Lecture 25 - Converging - Diverging (C-D) nozzles

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Lecture 27 - Discussion on C-D nozzles - 1

Lecture 28 - Discussion on C-D nozzles - 2

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Lecture 2 - Flow field, Stresses on fluid element, Newtonian fluid

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Lecture 5 - Lecture 1 - Integral analysis, Control volume, Generalised conservation equation

Lecture 6 - Lecture 2 - Mass and linear momentum conservation in CV

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Lecture 8 - Lecture 4 - Tutorial

Lecture 9 - Lecture 1 - Differential Analysis

Lecture 10 - Lecture 2 - Navier-Stokes equation for 2D incompressible flow

Lecture 11 - Lecture 3 - Vorticity, Stream function, Bernoulli's equation

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Lecture 13 - Lecture 1 - External flows, Laminar and Turbulent Boundary Layer

Lecture 14 - Lecture 2 - Differential analysis of boundary layer, Blassius equation

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Lecture 18 - Lecture 2 - Turbomachines: Definition and classification

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Lecture 3 - Some applications of Micro/Nanoscale energy transport

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- Lecture 4 - Symmetry in 1-D crystals
- Lecture 5 - Symmetry in 2-D crystals
- Lecture 6 - Symmetry in 3-D crystals
- Lecture 7 - Understanding IUCr tables
- Lecture 8 - Symmetry in 3-D Crystals
- Lecture 9 - Reciprocal lattice
- Lecture 10 - Directions Planes and zone axes
- Lecture 11 - Interplanar distances and angles
- Lecture 12 - Diffraction - 1
- Lecture 13 - Diffraction - 2
- Lecture 14 - Diffraction - Structure and Shape Factor
- Lecture 15 - Transformation of Indices
- Lecture 16 - Microscope - 1
- Lecture 17 - Microscope - 2
- Lecture 18 - Kikuchi Diffraction
- Lecture 19 - Double Diffraction and CBED
- Lecture 20 - CBED and Precession Electron Diffraction
- Lecture 21 - Indexing Diffraction Pattern
- Lecture 22 - Correlation of Diffraction Spots to Microstructure
- Lecture 23 - 3-Index to 4-Index System
- Lecture 24 - Kinematical and Dynamical Theory of Diffraction and Imaging
- Lecture 25 - Contrast from Planar Defects
- Lecture 26 - Contrast from Strain Fields
- Lecture 27 - Atomic Scattering Factor
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- Lecture 30 - Phase Contrast Microscopy - 1
- Lecture 31 - Phase Contrast Microscopy - 2

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- Lecture 2 - Module 1 - Introduction - 2
- Lecture 3 - Module 2 - Governing Equation - 1
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- Lecture 5 - Module 3 - Plane Wave - 1
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- Lecture 7 - Module 4 - Reflection Of Plane Waves - 1
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- Lecture 9 - Module 5 - Frequency Analysis - 1
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- Lecture 11 - Module 6 - Harmonic Plane Waves
- Lecture 12 - Module 7 - Travelling And Standing Waves
- Lecture 13 - Module 8 - Acoustic Mode Shapes, Reflection
- Lecture 14 - Module 9 - Plane Waves : Reflection and Intermission
- Lecture 15 - Module 10 - Flexural Waves, evanescent Waves
- Lecture 16 - Module 11 - Near Field Acoustic Waves
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- Lecture 18 - Module 13 - Power Calculation
- Lecture 19 - Module 14 - Decibel Scale
- Lecture 20 - Module 15 - Db Arithmetic
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- Lecture 22 - Module 17 - Human factors in Acoustic Engineering
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- Lecture 25 - Module 20 - Muffler Analysis
- Lecture 26 - Module 21 - Transfer Matrix Method
- Lecture 27 - Module 22 - Electro Mechanical Analogies - Part 1
- Lecture 28 - Module 23 - Electro Mechanical Analogies Simple Example
- Lecture 29 - Module 24 - Electro Mechanical Analogies Example
- Lecture 30 - Module 25 - Helmholtz Resonator
- Lecture 31 - Module 26 - Source Impedance

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Lecture 1 - Concept of Steel Quality

Lecture 2 - Control of Residuals and Impact on Quality

Lecture 3 - Non-Metallic Inclusions

Lecture 4 - Evaluation of Residuals and Inclusions

Lecture 5 - Cleanliness Requirements for Different applications

Lecture 6 - Limitation of Primary Steelmaking and Importance of secondary Refining

Lecture 7 - Deoxidation

Lecture 8 - Prevention of Slag carryover

Lecture 9 - Desulphurisation

Lecture 10 - Degassing

Lecture 11 - Secondary Refining Processes

Lecture 12 - Injection of Calcium

Lecture 13 - Different Routes and Temperature Control

Lecture 14 - Decarburisation

Lecture 15 - Cleanliness Measures in Ladle and Tundish

Lecture 16 - Cleanliness Measures in Mould

Lecture 17 - Nature and Distribution of Entrapments in Casting

Lecture 18 - Genesis of Entrapment

Lecture 19 - Effect of Vertical vis-a-vis Curved Mould

Lecture 20 - Quality of Cast Product

Lecture 21 - Role of Concast Process, Caster Design and Steel Grade

Lecture 22 - Primary Cooling in Caster Mould

Lecture 23 - Heat Transfer in Mould

Lecture 24 - Role of Mould Oscillation

Lecture 25 - Cast Structure and Dendrite Size

Lecture 26 - Role of Chemistry - Part I

Lecture 27 - Role of Chemistry - Part II

Lecture 28 - Role of Segregation - Part I

Lecture 29 - Role of Segregation - Part II

Lecture 30 - Deleterious Effect of Phosphorus

Lecture 31 - Strength of Solidifying Strand

[Lecture 32 - Brittle Zone Near Solidus](#)

[Lecture 33 - Strength and Toughness of Solid Shell](#)

[Lecture 34 - Role of Chemistry on Solidification Behaviour](#)

[Lecture 35 - Sticking vis-a-vis Depression Behaviour](#)

[Lecture 36 - Role of Chemistry on Bulging or Depression Tendency - Part I](#)

[Lecture 37 - Role of Chemistry on Bulging or Depression Tendency - Part II](#)

[Lecture 38 - Effect of Cast Grain Size](#)

[Lecture 39 - Brittle Temperature Regions](#)

[Lecture 40 - Typical Cracks and Defects - Part I](#)

[Lecture 41 - Typical Cracks and Defects - Part II](#)

[Lecture 42 - Remedial Measures to Control Defects - Part I](#)

[Lecture 43 - Remedial Measures to Control Defects - Part II](#)

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[Lecture 45 - Grade - Specific Casting Parameters - Part I](#)

[Lecture 46 - Grade - Specific Casting Parameters - Part II](#)

[Lecture 47 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part I](#)

[Lecture 48 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part II](#)

[Lecture 49 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part III](#)

Lecture 1 - Geometry of Crystals

Lecture 2 - Geometry of Crystals (Continued...)

Lecture 3 - Tutorial-1

Lecture 4 - Reciprocal Lattice

Lecture 5 - Stereographic Projection

Lecture 6 - Tutorial-2

Lecture 7 - Point Groups and Space Groups

Lecture 8 - Point Groups and Space Groups (Continued...)

Lecture 9 - Tutorial-3

Lecture 10 - Point Groups and Space Groups (Continued...)

Lecture 11 - Basics of X-Rays

Lecture 12 - Production and Detection of X-Rays

Lecture 13 - Production and Detection of X-Rays (Continued...)

Lecture 14 - Principles of X-Ray Diffraction

Lecture 15 - X-Ray Diffraction Methods

Lecture 16 - Debye Sherrer Camera

Lecture 17 - Diffractometer Measurements

Lecture 18 - Tutorial-4

Lecture 19 - Intensity of Diffracted Beams

Lecture 20 - Intensity of Diffracted Beams (Continued...)

Lecture 21 - Determination of Crystal Structures

Lecture 22 - Precise Lattice Parameter Determination

Lecture 23 - XRD - Lab Demonstration

Lecture 24 - Discussion - Based on Forum Queries - 1

Lecture 25 - Phase Diagram Determination

Lecture 26 - Ordered Disordered Transformation

Lecture 27 - Ordered Disordered Transformation (Continued...)

Lecture 28 - Qualitative Phase Analysis

Lecture 29 - Quantitative Phase Analysis - 1

Lecture 30 - Precise Lattice Parameter Determination - 1

Lecture 31 - Chemical Analysis by X-Ray Fluorescence

[Lecture 32 - Chemical Analysis by X-Ray Absorption](#)

[Lecture 33 - Effect of Crystallite Size on Diffracted X-Ray Intensity](#)

[Lecture 34 - Texture Determination by XRD](#)

[Lecture 35 - Particle Size Determination by XRD](#)

[Lecture 36 - Effect of Crystallite Size on Diffracted X-Ray Intensity](#)

[Lecture 37 - Determination of Single Crystal Orientation by X-Rays](#)

[Lecture 38 - Stress Analysis by X-Rays](#)

[Lecture 39 - Factors Contributing to Peak Broadening](#)

[Lecture 40 - Residual Stress Measurement by X-Rays](#)

Lecture 1 - Subscript Notation - Part 1

Lecture 2 - Subscript Notation - Part 2

Lecture 3 - Coordinate Rotation

Lecture 4 - Introduction to Tensors

Lecture 5 - Symmetry of Properties

Lecture 6 - Material Derivative

Lecture 7 - Planar Flows

Lecture 8 - Reynolds Transport Theorem

Lecture 9 - Derivation of Navier-Stokes equation

Lecture 10 - Navier Stokes equations - Part 2

Lecture 11 - Flow problem statements

Lecture 12 - Simple cases in fluid flow : rectangular coordinate system

Lecture 13 - Simple cases in fluid flow : cylindrical coordinate system

Lecture 14 - Pipe flow and porous medium

Lecture 15 - Simple cases in fluid flow : spherical coordinate system

Lecture 16 - Friction factors and correlations

Lecture 17 - Energy Transport

Lecture 18 - Conduction cases - Steady state

Lecture 19 - Conduction cases - Transient state

Lecture 20 - Convective heat transfer

Lecture 21 - Mass Transfer Overview

Lecture 22 - Chemical Equilibrium

Lecture 23 - Reaction Equilibrium

Lecture 24 - Species Balance Equation

Lecture 25 - Solute Transfer Modelling - Part 1

Lecture 26 - Solute Transfer Modelling - Part 2

Lecture 27 - Solute Segregation Profile - Part 1

Lecture 28 - Solute Segregation Profile - Part 2

Lecture 29 - Problem Statements

Lecture 30 - Diffusion in Solid State

Lecture 31 - Transient Solute Diffusion in Solid State

[Lecture 32 - Mass Transfer in Fluids](#)

[Lecture 33 - Similarity Across Transport Phenomena](#)

Lecture 1 - Overview of Experimental Stress Analysis

Lecture 2 - Optical Methods Work as Optical Computers

Lecture 3 - Stress, Strain and Displacement Fields

Lecture 4 - Completeness of a numerical solution

Lecture 5 - Fringe Patterns - Richness of Qualitative Information

Lecture 6 - Multi-Scale Analysis in Experimental Mechanics

Lecture 7 - Selection of an Experimental Technique

Lecture 8 - Introduction to Transmission Photoelasticity

Lecture 9 - Ordinary and Extraordinary Rays

Lecture 10 - Light Ellipse, Passage of Light Through a Crystal Plate

Lecture 11 - Retardation Plates, Stress-optic Law

Lecture 12 - Plane Polariscopes

Lecture 13 - Jones Calculus

Lecture 14 - Circular Polariscopes

Lecture 15 - Determination of Photoelastic Parameters at an Arbitrary Point

Lecture 16 - Tardy's Method of Compensation

Lecture 17 - Calibration of Photoelastic Materials

Lecture 18 - Fringe Thinning Methodologies

Lecture 19 - Fringe Ordering in Photoelasticity

Lecture 20 - Miscellaneous Topics in Transmission Photoelasticity

Lecture 21 - Three Dimensional Photoelasticity

Lecture 22 - Overview of Digital Photoelasticity

Lecture 23 - Introduction to Photoelastic Coatings

Lecture 24 - Correction Factors for Photoelastic Coatings

Lecture 25 - Coating Materials, Selection of Coating Thickness, Industrial Application of Photoelastic Coatings

Lecture 26 - Calibration of Photoelastic Coatings, Introduction to Brittle Coatings

Lecture 27 - Analysis of Brittle Coatings

Lecture 28 - Introduction to Strain Gauges

Lecture 29 - Strain Sensitivity of a Strain Gauge, Bridge Sensitivity, Rosettes

Lecture 30 - Strain Gauge Alloys, Carriers and Adhesives

Lecture 31 - Performance of Strain Gauge System

[Lecture 32 - Temperature Compensation, Two-wire and Three-wire Circuits](#)

[Lecture 33 - Strain Gauge Selection](#)

[Lecture 34 - Bonding of a Strain Gauge](#)

[Lecture 35 - Soldering, Accounting for Transverse Sensitivity Effects](#)

[Lecture 36 - Correction Factors for Special Applications](#)

[Lecture 37 - Special Gauges](#)

Lecture 1 - Basic Terminologies

Lecture 2 - Skeletal System

Lecture 3 - Axial and Appendicular Skeleton

Lecture 4 - Bones in the Human Body

Lecture 5 - Types of Joints

Lecture 6 - Movements about Joints

Lecture 7 - Levers in the Human Body

Lecture 8 - Skeletal Muscles: Functions

Lecture 9 - Skeletal Muscles: Structure - Part I

Lecture 10 - Skeletal Muscles: Structure - Part II

Lecture 11 - Mechanics and Modeling of Muscles

Lecture 12 - Muscle Action - Part I

Lecture 13 - Muscle Action - Part II

Lecture 14 - Principles of Statics

Lecture 15 - Static Analysis of Elbow - Part I

Lecture 16 - Static Analysis of Elbow - Part II

Lecture 17 - Static Analysis of Shoulder - Part I

Lecture 18 - Static Analysis of Shoulder - Part II

Lecture 19 - Static Analysis of Spine - Part I

Lecture 20 - Static Analysis of Spine - Part II

Lecture 21 - Static Analysis of Spine - Part III

Lecture 22 - Static Analysis of Hip - Part I

Lecture 23 - Static Analysis of Hip - Part II

Lecture 24 - Static Analysis of the Knee

Lecture 25 - Static Analysis of the Knee and Ankle

Lecture 26 - Kinetics: Linear Motion - Part I

Lecture 27 - Kinetics: Linear Motion - Part II

Lecture 28 - Kinetics: Linear Motion - Part III

Lecture 29 - Kinetics: Angular Motion - Part I

Lecture 30 - Kinetics: Angular Motion - Part II

Lecture 31 - Kinetics: Angular Motion - Part III

- [Lecture 32 - Kinetics: Angular Motion - Part IV](#)
- [Lecture 33 - Kinetics of Arm Swinging during Walking](#)
- [Lecture 34 - Inverse Dynamics Analysis](#)
- [Lecture 35 - Biomechanics of Balance - Part I](#)
- [Lecture 36 - Biomechanics of Balance - Part II](#)
- [Lecture 37 - Biomechanics of Balance - Part III](#)
- [Lecture 38 - Human Gait](#)
- [Lecture 39 - Human Gait Terminologies](#)
- [Lecture 40 - Characteristics of Normal Gait - Part I](#)
- [Lecture 41 - Characteristics of Normal Gait - Part II](#)
- [Lecture 42 - Characteristics of Normal Gait - Part III](#)
- [Lecture 43 - Pathological Gait - Part I](#)
- [Lecture 44 - Pathological Gait - Part II](#)
- [Lecture 45 - Pathological Gait - Part III](#)
- [Lecture 46 - Introduction to Assistive Devices for Mobility](#)
- [Lecture 47 - Design Considerations: Prosthetic Foot](#)
- [Lecture 48 - Design Considerations: Prosthesis and Orthosis](#)
- [Lecture 49 - Design Considerations: Prosthetic Knee](#)
- [Lecture 50 - Journey of Standing Wheelchair Development](#)

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Design for Quality, Manufacturing and Assembly (Mechanical Engineering)

Co-ordinators : Prof. Palaniappaan Ramu

Lecture 1 - Introduction to DfX

Lecture 2 - Introduction to Quality

Lecture 3 - Introduction to Robustness

Lecture 4 - Introduction to Six Sigma Concept

Lecture 5 - Recap and clarifications of basic concepts

Lecture 6 - Review of Six Sigma and Quality Loss Function (QLF)

Lecture 7 - Types of QLF and SN Ratio

Lecture 8 - Linking Quality and Robustness

Lecture 9 - Design for Six Sigma - Stages, Design of Experiments

Lecture 10 - Introduction To Design Of Experiments

Lecture 11 - Need for DoE and basic DoE methods

Lecture 12 - Factorial Design

Lecture 13 - Orthogonal Array- L4 and L8 example

Lecture 14 - Setting up an Orthogonal Array

Lecture 15 - Confounding OA and Resolution Table

Lecture 16 - Confounding Logic and Randomization of Experiments

Lecture 17 - Paper Helicopter Case Study - Part I

Lecture 18 - Paper Helicopter Case Study - Part II

Lecture 19 - Introduction To Injection Molding Process, Materials, Terminologies Related To Plastic Parts and Design Guidelines

Lecture 20 - Estimation of Mold Cost for Injection Molding (Dixon and Poli's Method)

Lecture 21 - Estimation of Mold Cost for Injection Molding (Dixon and Poli's Method) (Continued...)

Lecture 22 - Mold Cost Estimation - Tutorial

Lecture 23 - Design for Additive Manufacturing

Lecture 24 - Demo

Lecture 25 - Introduction to Sustainable Development and Sustainability Indicators - Part 1

Lecture 26 - Introduction to Sustainable Development and Sustainability Indicators - Part 2

Lecture 27 - Introduction to design process

Lecture 28 - Accounting for manufacturability and assembly in design - An overview

Lecture 29 - DfMA in product design

Lecture 30 - General design guidelines for manual assembly

Lecture 31 - Systematic DFA methodology

[Lecture 32 - Alpha symmetry, Beta symmetry](#)

[Lecture 33 - Quantification of part size and thickness](#)

[Lecture 34 - Systematic DFA Case study - controller assembly](#)

[Lecture 35 - DFA examples and discussion](#)

[Lecture 36 - Xerox Producibility Index \(XPI\)](#)

[Lecture 37 - High Speed and Robotic Assembly](#)

[Lecture 38 - Sheet Metal Working](#)

[Lecture 39 - Overview of DoE Workflow](#)

[Lecture 40 - DFA Software](#)

[Lecture 41 - DFM Software and Case Studies](#)

Lecture 1 - Overview and Motivation of Course

Lecture 2 - Basic Optimization Problem Formulation

Lecture 3 - Problem Formulation Example

Lecture 4 - Calculus related to Optimization

Lecture 5 - The big picture - Overview

Lecture 6 - Introduction to DOE - 1

Lecture 7 - Introduction to DOE - 2

Lecture 8 - Types of DOE - 1

Lecture 9 - Types of DOE - 2 and some examples

Lecture 10 - Introduction to surrogate modeling

Lecture 11 - Types of surrogate - Polynomial models

Lecture 12 - Radial basis function - 1

Lecture 13 - Radial basis function - 2

Lecture 14 - Kriging - 1

Lecture 15 - Kriging - 2

Lecture 16 - Metamodels for Safe and Efficient Automotive Structures

Lecture 17 - Exploration and Exploitation in Surrogates

Lecture 18 - Errors Based Exploration

Lecture 19 - Ensemble of Surrogates

- Lecture 1 - Concept of Steel Quality
- Lecture 2 - Typical Examples of Surface Defects
- Lecture 3 - Origin of Common Quality Problems
- Lecture 4 - Present Scenario on Quality Demands
- Lecture 5 - Control of Residuals and Impact on Quality
- Lecture 6 - Non-Metallic Inclusions
- Lecture 7 - Evaluation of Residuals and Inclusions
- Lecture 8 - Cleanliness Requirements for Different applications
- Lecture 9 - Limitation of Primary Steelmaking and Importance of secondary Refining
- Lecture 10 - Deoxidation
- Lecture 11 - Prevention of Slag carryover
- Lecture 12 - Desulphurisation
- Lecture 13 - Degassing
- Lecture 14 - Secondary Refining Processes
- Lecture 15 - Injection of Calcium
- Lecture 16 - Decarburisation
- Lecture 17 - Cleanliness Measures in Ladle and Tundish
- Lecture 18 - Cleanliness Measures in Mould
- Lecture 19 - Different Routes and Temperature Control
- Lecture 20 - Nature and Distribution of Entrapments in Casting
- Lecture 21 - Sources of Exogenous Entrapments
- Lecture 22 - Effect of Vertical vis-a-vis Curved Mould
- Lecture 23 - Quality of Cast Product
- Lecture 24 - Role of Concast Process, Caster Design and Steel Grade
- Lecture 25 - Primary Cooling in Caster Mould
- Lecture 26 - Heat Transfer in Mould
- Lecture 27 - Cast Structure and Dendrite Size
- Lecture 28 - Role of Mould Oscillation
- Lecture 29 - Role of Chemistry - Part I
- Lecture 30 - Role of Chemistry - Part II
- Lecture 31 - Role of Segregation - Part I

[Lecture 32 - Role of Segregation - Part II](#)

[Lecture 33 - Deleterious Effect of Phosphorus](#)

[Lecture 34 - Strength of Solidifying Strand](#)

[Lecture 35 - Brittle Zone Near Solidus](#)

[Lecture 36 - Strength and Toughness of Solid Shell](#)

[Lecture 37 - Role of Chemistry on Solidification Behaviour](#)

[Lecture 38 - Sticking vis-a-vis Depression Behaviour](#)

[Lecture 39 - Role of Chemistry on Bulging or Depression Tendency - Part I](#)

[Lecture 40 - Role of Chemistry on Bulging or Depression Tendency - Part II](#)

[Lecture 41 - Effect of Cast Grain Size](#)

[Lecture 42 - Brittle Temperature Regions](#)

[Lecture 43 - Role of Secondary Cooling - Part 1](#)

[Lecture 44 - Role of Secondary Cooling - Part 2](#)

[Lecture 45 - Typical Cracks and Defects - Part I](#)

[Lecture 46 - Typical Cracks and Defects - Part II](#)

[Lecture 47 - Remedial Measures to Control Defects - Part I](#)

[Lecture 48 - Remedial Measures to Control Defects - Part II](#)

[Lecture 49 - Remedial Measures to Control Defects - Part III](#)

[Lecture 50 - Grade - Specific Casting Parameters - Part I](#)

[Lecture 51 - Grade - Specific Casting Parameters - Part II](#)

[Lecture 52 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part I](#)

[Lecture 53 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part II](#)

[Lecture 54 - Identification of Genesis of Quality Problems Through Metallographic Investigation - Part III](#)

[Lecture 55 - Some Examples of Quality Problems](#)

- Lecture 1 - Review of Kinematics Fundamentals-I
- Lecture 2 - Links, Pairs, Kinematic Chains; Planar Mobility Criterion
- Lecture 3 - Mobility of Mechanisms, Grubler's Criterion and Applications
- Lecture 4 - Inversions, Grashof Criterion, Kinematic equivalence
- Lecture 5 - Linkage Synthesis Classification, 2-position Motion Generation
- Lecture 6 - Driver dyad, Quick-return synthesis - I
- Lecture 7 - Quick-return synthesis - II, 3-position Motion Generation
- Lecture 8 - Specified fixed pivots, Path generation
- Lecture 9 - Function generation
- Lecture 10 - Function generation using relative poles
- Lecture 11 - Structural Error, and Chebyshev Spacing
- Lecture 12 - Chebyshev Spacing
- Lecture 13 - Analytical Linkage Synthesis-I: Vector Loop Closure, Freudenstein's method
- Lecture 14 - Analytical Linkage Synthesis-II: Bloch's method, Driver Dyad
- Lecture 15 - Four-bar Position Analysis, Dyad or Standard Form Synthesis
- Lecture 16 - Dyad Form Synthesis: Motion Generation
- Lecture 17 - Dyad Form Synthesis: Path and Function Generation
- Lecture 18 - Dyad Form Synthesis: Multi loop linkages
- Lecture 19 - Dyad Form Synthesis: Four Position Motion Generation
- Lecture 20 - Coupler Curves - I
- Lecture 21 - Coupler Curves - II, Fixed and Moving Centroids
- Lecture 22 - Coupler Curves - III, Symmetrical Coupler Curves
- Lecture 23 - Roberts-Chebyshev Theorem
- Lecture 24 - Cognates
- Lecture 25 - Velocity Analysis: Review of Velocity Polygons
- Lecture 26 - Velocity Analysis: Velocity Polygons (Continued...) and Instant Centres
- Lecture 27 - Velocity Analysis: Auxiliary Point Method
- Lecture 28 - Auxiliary Point Method: (Continued...)
- Lecture 29 - Velocity and Acceleration Analysis: Analytical Method
- Lecture 30 - Acceleration Analysis: Analytical Method (Continued...)
- Lecture 31 - Acceleration Analysis: Auxiliary Point Method

[Lecture 32 - Force Analysis of Mechanisms, Mechanical Advantage](#)

[Lecture 33 - Force Analysis of Mechanisms - II](#)

[Lecture 34 - Balancing of Mechanisms using Counterweights](#)

[Lecture 35 - Balancing of Mechanisms using Springs](#)

[Lecture 36 - Spatial Mechanisms](#)

[Lecture 37 - Introduction to the Kinematics of Spatial Mechanisms](#)

Lecture 1 - Introduction to Engineering Mechanics - I

Lecture 2 - Introduction to Engineering Mechanics - II

Lecture 3 - Force Systems - I

Lecture 4 - Force Systems - II

Lecture 5 - Equilibrium of Rigid bodies - I

Lecture 6 - Equilibrium of Rigid bodies - II

Lecture 7 - Trusses - I

Lecture 8 - Trusses - II

Lecture 9 - Trusses - III

Lecture 10 - Beams - I

Lecture 11 - Beams - II

Lecture 12 - Beams - III

Lecture 13 - Beams - IV

Lecture 14 - Virtual Work - I

Lecture 15 - Virtual Work - II

Lecture 16 - Energy Relations

Lecture 17 - Review Before Quiz - I

Lecture 18 - Friction - I

Lecture 19 - Friction - II

Lecture 20 - Friction - III

Lecture 21 - Particle Dynamics

Lecture 22 - Circular Motion

Lecture 23 - Absolute Motion

Lecture 24 - Relative Motion - I

Lecture 25 - Relative Motion - II

Lecture 26 - Relative Motion - III and Instantaneous Center

Lecture 27 - Rotating frame of reference I - Velocity

Lecture 28 - Rotating frame of reference II - Acceleration

Lecture 29 - Rotating frame of reference III - Choice of rotating frame of reference

Lecture 30 - RFR- IV Crank and slotted bar

Lecture 31 - RFR-V Understanding Coriolis Acceleration

[Lecture 32 - Kinetics - I](#)

[Lecture 33 - Kinetics - II](#)

[Lecture 34 - Kinetics - III](#)

[Lecture 35 - 3D Kinematics - I](#)

[Lecture 36 - 3D Kinematics - II](#)

[Lecture 37 - 3D Kinematics - III](#)

- Lecture 1 - Introduction to the course
- Lecture 2 - Some applications of MD simulations
- Lecture 3 - Introduction to Bravais lattices and constructing simple crystals with MATLAB
- Lecture 4 - Introduction to symmetry - 1
- Lecture 5 - Symmetry Elements - 1
- Lecture 6 - Symmetry elements - 2
- Lecture 7 - Plane groups and their Hermann-Mauguin (HM) symbols
- Lecture 8 - Glide reflection; Examples of writing point group symbols; Wyckoff positions
- Lecture 9 - Generating 2D crystal with MATLAB using Bilbao crystallography website
- Lecture 10 - Symmetry of space groups
- Lecture 11 - Hermann mauguin symbols of space groups
- Lecture 12 - Translational symmetry operators
- Lecture 13 - The Space groups
- Lecture 14 - Generation of crystals
- Lecture 15 - Generation of monoclinic lattice
- Lecture 16 - Introduction to Statistical Mechanics - 1
- Lecture 17 - Introduction to Statistical Mechanics - 2
- Lecture 18 - Introduction to Statistical Mechanics - 3
- Lecture 19 - Statistical mechanics - 1
- Lecture 20 - Statistical mechanics - 2
- Lecture 21 - Basic introduction to mechanics
- Lecture 22 - Introduction to phase space
- Lecture 23 - Introduction to phase average and time average
- Lecture 24 - Canonical ensemble; Partition function
- Lecture 25 - Basic introduction to MD
- Lecture 26 - Input script for LAMMPS - 1
- Lecture 27 - Input script for LAMMPS - 2
- Lecture 28 - Input script for LAMMPS - 3
- Lecture 29 - Input script for LAMMPS - 4
- Lecture 30 - LAMMPS exercises - 1
- Lecture 31 - LAMMPS exercises - 2

[Lecture 32 - LAMMPS exercises - 3](#)

[Lecture 33 - LAMMPS exercises - 4](#)

[Lecture 34 - LAMMPS exercises - 5](#)

Lecture 1 - Introduction

Lecture 2 - Combustion processes in ICE and Gas turbine engines

Lecture 3 - Combustion in solid and liquid rocket motors

Lecture 4 - Equilibrium

Lecture 5 - Chemical kinetics, Equilibrium vs rate controlled

Lecture 6 - Demonstration of NASA-CEA

Lecture 7 - Premixed and diffusion flames: principal features and differences - Part I

Lecture 8 - Premixed and diffusion flames: principal features and differences - Part II

Lecture 9 - Quenching, flammability and other limit phenomena

Lecture 10 - Conservation equations

Lecture 11 - Integral Analysis of flame

Lecture 12 - Solid propellant combustion

Lecture 13 - Erosive burning

Lecture 14 - Instability in solid rockets

Lecture 15 - Analysis of p-t traces - Part II

Lecture 16 - Statistical representation of composite propellants in HeQu1D - geometry and thermochemistry

Lecture 17 - HeQu1D model - Parameter estimation

Lecture 18 - Effects of Al - extended HeQu1D model

Lecture 19 - Instability in solid rockets - II

Lecture 20 - Tutorial

Lecture 21 - Liquid propellant rockets - Part I

Lecture 22 - Liquid propellant rockets - Part II

Lecture 23 - Combustion in liquid rockets

Lecture 24 - Instabilities in liquid rockets and gas turbine after burners

Lecture 25 - CFD modeling aspects - Fundamentals

Lecture 26 - CFD modeling aspects - Modeling approaches

Lecture 27 - Effect of turbulence on flames

Lecture 28 - Scramjets - Part I

Lecture 29 - Scramjets - Part II

Lecture 30 - Summary - Premixed flames

Lecture 31 - Summary - Non-premixed flames

[Lecture 32 - Summary - Solid rocket propulsion](#)

[Lecture 33 - Additional Insights](#)

Lecture 1 - Introduction

Lecture 2 - Material Property Landscape

Lecture 3 - Crystal Structure-1 (Platonic Solids)

Lecture 4 - Crystal Structure-2 (Unit Cell, Lattice, Crystal)

Lecture 5 - Crystal Structure-3 (Bravais lattice, Symmetry in Crystals)

Lecture 6 - Crystal Structure-4 (Miller Indices for Crystallographic Points and Directions)

Lecture 7 - Crystal Structure-5 (Miller-Bravais Indices, Linear and Planar Density)

Lecture 8 - Crystal Structure-6 (Planar density, Close-Packed Structures, Stacking Faults)

Lecture 9 - Crystal Structure-7 (Single Crystal and Polycrystalline Materials)

Lecture 10 - Crystal Structure-8 (X-Ray Diffraction and Determination of Structure)

Lecture 11 - Defects in Crystalline Materials-1 (Types of Crystalline Defects)

Lecture 12 - Defects in Crystalline Materials-1 (Point Defects)

Lecture 13 - Defects in Crystalline Materials-1 (Equilibrium Concentration of Vacancies)

Lecture 14 - Defects in Crystalline Materials-1 (Theoretical Shear Strength)

Lecture 15 - Defects in Crystalline Materials-2 (Effect of Point Defects)

Lecture 16 - Defects in Crystalline Materials-2 (Point Defects and Solid Solutions)

Lecture 17 - Defects in Crystalline Materials-3 (Line Defects, Types of Dislocations and their Characteristics)

Lecture 18 - Defects in Crystalline Materials-4 (Slip Systems, Burger's Vector and Dislocation Motion)

Lecture 19 - Defects in Crystalline Materials-4 (Slip in Single Crystals and Resolved Shear Stress)

Lecture 20 - Defects in Crystalline Materials-5 (Different Stages of Slip in Single Crystalline Materials)

Lecture 21 - Defects in Crystalline Materials-5 (Geometry and Slip, Stress Field Around a Dislocation and Deformation Twinning)

Lecture 22 - Defects in Crystalline Materials-6 (Twinning, Interfacial Defects and Volume Defects)

Lecture 23 - Defects in Crystalline Materials-6 (Strengthening Mechanisms)

Lecture 24 - Defects in Crystalline Materials-7 (Plastic deformation in polycrystalline materials, Softening Mechanisms)

Lecture 25 - Mechanical Properties of Materials (Concept of Stress Tensor)

Lecture 26 - Mechanical Properties (Tension Test-Elastic Deformation)

Lecture 27 - Mechanical Properties (Tension Test - Plastic Deformation)

Lecture 28 - Mechanical Properties (Tension Test - Plastic Deformation)

Lecture 29 - Mechanical Properties (Hardness Test)

Lecture 30 - Static Failure Theories (Introduction, Definition of Failure)

Lecture 31 - Static Failure Theories (General form of failure theory, Stress tensor, Principal stress)

[Lecture 32 - Static Failure Theories \(Distortion Energy Theory\)](#)

[Lecture 33 - Static Failure Theories \(Maximum Shear Stress Theory\)](#)

[Lecture 34 - Static Failure Theories \(Design Problems\)](#)

[Lecture 35 - Static Failure Theories \(Failure of Brittle Materials\)](#)

[Lecture 36 - Static Failure Theories \(Coulomb-Mohr and Modified Coulomb-Mohr\)](#)

[Lecture 37 - Static Failure Theories \(Notches and Stress Concentration\)](#)

[Lecture 38 - Introduction to Fracture Mechanics, Griffith's Analysis of a Cracked Body](#)

[Lecture 39 - Fracture Mechanics \(Energy Release Rate\)](#)

[Lecture 40 - Fracture Mechanics \(Crack Resistance, Stress Intensity Factor, Fracture Toughness\)](#)

[Lecture 41 - Fatigue Failure of Materials \(Introduction, Historical Events, S-N Diagram\)](#)

[Lecture 42 - Fatigue Failure of Materials \(S-N Diagram, Types of Time Varying Loads\)](#)

[Lecture 43 - Fatigue Failure of Materials \(High Cycle Fatigue, Low Cycle Fatigue, Stress Ratio, Amplitude Ratio\)](#)

[Lecture 44 - Fatigue Failure of Materials \(Rotating Beam Bending Test, Estimated S-N diagram\)](#)

[Lecture 45 - Fatigue Failure Theories \(Fatigue strength correction factors\)](#)

[Lecture 46 - Problems on Fatigue Failure-1 \(S-N diagram and Corrected endurance strength\)](#)

[Lecture 47 - Fatigue Failure of Materials \(Features of Fatigue Failure; Factor of Safety in Life and Stress\)](#)

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Co-ordinators : Prof. Babu Viswanathan

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Co-ordinators : Dr. D. B. Karunakar

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : Micro and Smart Systems (Mechanical Engineering)

Co-ordinators : Dr. K.J. Vinoy, Prof. S. Gopalakrishnan, Prof. K.N. Bhat, Prof. G.K. Anathasuresh

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Lecture 21 - Micromachined Gyroscopes: Part-2 Modelling of Coupled Electrostatic Microsystems: Part-1

Lecture 22 - Modelling of Coupled Electrostatic Microsystems: Part-2

Lecture 23 - Coupled Electrothermal-elastic Modelling

Lecture 24 - Modelling of Microsystems: Scaling Effects

Lecture 25 - Finite Element Method and Microsystems

Lecture 26 - Theoretical Basis for the Finite Element Method

Lecture 27 - Energy Theorems and Weak Form of the Governing Equation

Lecture 28 - Finite Element Equation Development and Shape Functions

Lecture 29 - Isoparametric FE Formulation and some Examples

Lecture 30 - Finite Element for Structures with Piezoelectric Materials

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[Lecture 39 - Pressure Sensor Design Concepts, Processing, and Packaging: Part-3 Capacitive Micro-accelerometer: Part-1](#)

[Lecture 40 - Capacitive Micro-accelerometer: Part-2](#)

Lecture 1 - Classification of optimization problems and the place of Calculus of Variations in it - Part I

Lecture 2 - Classification of optimization problems and the place of Calculus of Variations in it - Part II

Lecture 3 - Genesis of Calculus of Variations - Part I

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Lecture 5 - Formulation of Calculus of Variations problems in geometry and mechanics and design - Part I

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Lecture 11 - Sufficient conditions for constrained minimization - Part I

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Lecture 19 - Extension of Euler-Lagrange equations to multiple derivatives

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Lecture 21 - Global Constraints in calculus of variations - Part I

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Lecture 25 - Size optimization of a bar for maximum stiffness for given volume - Part I

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Lecture 27 - Size optimization of a bar for maximum stiffness for given volume - Part III

Lecture 28 - Calculus of variations in functionals involving two and three independent variables - Part I

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Lecture 30 - General variation of a functional, transversality conditions. Broken extremals, Weierstrass-Erdmann corner conditions - Part I

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Lecture 31 - General variation of a functional, transversality conditions. Broken extremals, Wierstrass-Erdmann corner conditions - Part II

Lecture 32 - Variational (energy) methods in statics; principles of minimum potential energy and virtual work

Lecture 33 - General framework of optimal structural designs - Part I

Lecture 34 - General framework of optimal structural designs - Part II

Lecture 35 - Optimal structural design of bars and beams using the optimality criteria method

Lecture 36 - Invariants of Euler-Lagrange equations and canonical forms

Lecture 37 - Noether's theorem

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Lecture 39 - Rayleigh quotient for natural frequencies and mode shapes of elastic systems

Lecture 40 - Stability analysis and buckling using calculus of variations

Lecture 41 - Strongest (most stable) column

Lecture 42 - Dynamic compliance optimization

Lecture 43 - Electro-thermal-elastic structural optimization

Lecture 44 - Formulating the extremization problem starting from the differential equation, self-adjointness of the differential operator, and methods to deal with conservative and dissipative system

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Lecture 2 - Spirit of compliant design

Lecture 3 - A glimpse of applications

Lecture 4 - Mobility and degrees of freedom in compliant mechanisms

Lecture 5 - Maxwell's rule and Grubler's formula

Lecture 6 - Using compatibility and force equilibrium matrices to identify degrees of freedom and states of self-stress in trusses

Lecture 7 - Empirical formula for flexure joints

Lecture 8 - Types of elastic pairs (flexures)

Lecture 9 - Linear finite element analysis of compliant mechanisms with beam elements

Lecture 10 - A compliant mechanism kit

Lecture 11 - Linear and nonlinear finite element analyses using continuum elements

Lecture 12 - Subtleties in finite element analysis: geometric nonlinearity and contact

Lecture 13 - Deformation of a cantilever under a tip-load, using elliptic integrals

Lecture 14 - Elliptic integrals and their use in elastica analysis

Lecture 15 - Frisch-Fay's approach to large deformation of beam

Lecture 16 - Burns-Crossley's kinematic model

Lecture 17 - Howell-Midha's elastic model

Lecture 18 - Putting together the pseudo rigid-body model

Lecture 19 - Modeling a partially compliant mechanism

Lecture 20 - Kinematic coefficients of a four-bar linkage with and without springs

Lecture 21 - Solving equations of PRB modeling and comparing with finite element analysis

Lecture 22 - Loop-closure equations for PRB models of compliant mechanisms

Lecture 23 - Burmester theory for compliant mechanisms

Lecture 24 - PRB-based Synthesis Examples

Lecture 25 - Structural optimization approach

Lecture 26 - Early works on design for compliance

Lecture 27 - Design for deflection of trusses

Lecture 28 - Design for deflection of beams and frames

Lecture 29 - Design of elastic continua for desired deflection

Lecture 30 - Continuum element-based topology optimization of compliant mechanisms

Lecture 31 - YinSyn; synthesis of nonlinear responses with compliant mechanisms

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[Lecture 46 - Designing with kinetoelastic maps](#)

[Lecture 47 - Non-dimensinalization of stress, frequency, and other measures](#)

[Lecture 48 - Designing compliant suspensions using kinetoelastic maps](#)

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[Lecture 53 - Aspects of Mechanical advantage of compliant mechanisms](#)

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[Lecture 58 - Static balancing and zero-free-length springs](#)

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Lecture 2 - Thermodynamics of Multiphase systems

Lecture 3 - Thermodynamics of Interface - I

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Lecture 5 - Interfacial phenomena key concepts - I

Lecture 6 - Interfacial phenomena key concepts - II

Lecture 7 - Interfacial heat and mass transfer - I - Interfacial mass, momentum and energy balance, Surface tension, WettingL07

Lecture 8 - Interfacial heat and mass transfer - II - Interfacial dynamics, Instabilities of the interface

Lecture 9 - Interfacial heat and mass transfer - III - Evaporation from thin films

Lecture 10 - Governing equations and interfacial conditions

Lecture 11 - Governing equations : Averaging techniques - I

Lecture 12 - Governing equations : Averaging techniques - II

Lecture 13 - Governing equations : Averaging techniques - III

Lecture 14 - Interface shapes

Lecture 15 - Transport processes at interface with key concepts - I

Lecture 16 - Transport processes at interface with key concepts - II

Lecture 17 - Interfacial transport

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Lecture 19 - Interface behavior

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Lecture 23 - Droplet vaporization dynamics - I

Lecture 24 - Droplet vaporization dynamics - II

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Lecture 26 - Comprehensive droplet vaporization model and correlations - I

Lecture 27 - Comprehensive droplet vaporization model and correlations - II

Lecture 28 - Comparison of droplet vaporization models

Lecture 29 - Species transport in droplet

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[Lecture 38 - Boiling - I](#)

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- Lecture 1 - Introduction to convective heat transfer
- Lecture 2 - Governing equations I - Momentum Conservation
- Lecture 3 - Governing equations II - Energy Conservation
- Lecture 4 - Introduction to external forced convection
- Lecture 5 - Scaling Analysis - Momentum
- Lecture 6 - Scaling Analysis - Energy I
- Lecture 7 - Scaling Analysis - Energy II
- Lecture 8 - Similarity solution - Momentum
- Lecture 9 - Similarity solution - Energy
- Lecture 10 - Integral solutions - Momentum
- Lecture 11 - Integral solutions - Energy
- Lecture 12 - Suction and Blowing
- Lecture 13 - Falkner-Skan solution
- Lecture 14 - Arbitrary Wall temperature
- Lecture 15 - Internal forced convection - Developing flow
- Lecture 16 - Hydrodynamic fully developed flow
- Lecture 17 - Mean temperature in fully developed flow
- Lecture 18 - Uniform heat flux
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- Lecture 20 - Tube surrounded by isothermal flow
- Lecture 21 - Heat transfer to fully developed flow - I
- Lecture 22 - Heat transfer to fully developed flow - II
- Lecture 23 - Laminar slug flow
- Lecture 24 - Power law fluids
- Lecture 25 - Forced convection - Tutorial I
- Lecture 26 - Forced convection - Tutorial II
- Lecture 27 - Forced convection - Tutorial III
- Lecture 28 - Introduction to external natural convection
- Lecture 29 - Scaling analysis - I
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- Lecture 31 - Integral solution

- Lecture 32 - Similarity solution
- Lecture 33 - Uniform wall heat flux
- Lecture 34 - Thermal stratification
- Lecture 35 - Mixed convection
- Lecture 36 - Internal natural convection - Scaling analysis
- Lecture 37 - Heat transfer regimes
- Lecture 38 - Regime III
- Lecture 39 - Regime IV - Shallow enclosure limit - I
- Lecture 40 - Regime IV - Shallow enclosure limit - II
- Lecture 41 - Partially divided enclosures
- Lecture 42 - Inclined enclosures
- Lecture 43 - Natural convection - Tutorial I
- Lecture 44 - Natural convection - Tutorial II
- Lecture 45 - Introduction to Turbulence
- Lecture 46 - Reynolds-Averaged Navier Stokes equation - I
- Lecture 47 - Reynolds-Averaged Navier Stokes equation - II
- Lecture 48 - Turbulent boundary layer - Viscous sub layer
- Lecture 49 - Turbulent boundary layer - Fully turbulent sub layer
- Lecture 50 - Heat transfer in turbulent boundary layer
- Lecture 51 - Turbulent internal flow - I
- Lecture 52 - Turbulent internal flow - II
- Lecture 53 - Turbulent internal flow - III
- Lecture 54 - $k - \epsilon$ model
- Lecture 55 - Turbulence - Tutorial
- Lecture 56 - Experimental techniques - Thermochromic liquid crystals
- Lecture 57 - Experimental techniques - IR thermography
- Lecture 58 - Droplet evaporation - Sessile I
- Lecture 59 - Droplet evaporation - Sessile II
- Lecture 60 - Droplet evaporation - Contact free

- Lecture 1 - Introduction to complex variables
- Lecture 2 - Cauchy Riemann Equations
- Lecture 3 - Analytic Functions
- Lecture 4 - Simple definitions
- Lecture 5 - Definition of sets, domains, theorem on antiderivative
- Lecture 6 - Cauchy Goursat Theorem
- Lecture 7 - Implications of Cauchy Goursat Theorem, Cauchy Integral Formula
- Lecture 8 - Implications of CIF, converse of CG theorem
- Lecture 9 - Examples in contour integrals, ratios of polynomials
- Lecture 10 - Contour integration of sinc function
- Lecture 11 - Method of path deformation
- Lecture 12 - Method of path deformation (Continued...)
- Lecture 13 - Infinite and finite branch cuts
- Lecture 14 - Finite Branch Cut
- Lecture 15 - Infinite branch cut example
- Lecture 16 - Contour integration: rectangular contour
- Lecture 17 - Finite square root branch cut
- Lecture 18 - Example on finite branch cut
- Lecture 19 - Pole on a branch cut
- Lecture 20 - L shaped branch cut
- Lecture 21 - L shaped branch cut continued
- Lecture 22 - Inverse Laplace Transform
- Lecture 23 - Inverse Laplace Transform (Continued...)
- Lecture 24 - Additional material or corrections to lectures
- Lecture 25 - Summary of the total course

Lecture 1 - Introduction

Lecture 2 - Deborah number

Lecture 3 - Response of Elastic solid

Lecture 4 - Response of Viscous fluid

Lecture 5 - Viscoelastic material

Lecture 6 - Creep and stress relaxation

Lecture 7 - Creep and stress relaxation functions

Lecture 8 - Linearity

Lecture 9 - Mechanical Analogues

Lecture 10 - Tutorial

Lecture 11 - Atoms and bonds

Lecture 12 - Interatomic bonds

Lecture 13 - Polymers

Lecture 14 - Polymers (Continued...)

Lecture 15 - Polymers (Continued...)

Lecture 16 - Freely jointed model

Lecture 17 - Constitutive equations

Lecture 18 - Constitutive equations (Continued...)

Lecture 19 - Constitutive equations (Continued...)

Lecture 20 - Viscoelastic effects

Lecture 21 - Lab Session

Lecture 22 - Polymer concentrations

Lecture 23 - Lagrangian and Eulerian perspectives

Lecture 24 - Maxwell model

Lecture 25 - Maxwell model (Continued...)

Lecture 26 - Kelvin-Meyer-Voigt model

Lecture 27 - Three parameter model

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Lecture 29 - Three parameter model (Continued...)

Lecture 30 - Jefferey's model

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Lecture 1 - Introduction, Types and Classification of Robots

Lecture 2 - Main Elements of a Robot

Lecture 3 - Modelling and Analysis of Robots

Lecture 4 - Mathematical Preliminaries, Homogeneous Transformations

Lecture 5 - Elements of robot - Joints, Elements of robots - Links

Lecture 6 - Examples of D-H parameters and Link transformation matrices

Lecture 7 - Introduction, Direct Kinematics of Serial Robots

Lecture 8 - Inverse Kinematics of Serial Robots

Lecture 9 - Inverse Kinematics of Serial Robots with $n < 6$, Inverse Kinematics of Serial Robots with $n > 6$

Lecture 10 - Elimination Theory and Solution of Non-linear Equations, Inverse Kinematics of a General 6R Robot

Lecture 11 - Introduction, Loop-closure Equations

Lecture 12 - Direct Kinematics of Parallel Manipulators

Lecture 13 - Mobility of Parallel Manipulators

Lecture 14 - Inverse Kinematics of Parallel Manipulators

Lecture 15 - Direct Kinematics of Stewart Platform Manipulators

Lecture 16 - Sun tracking using 3-DOF parallel manipulator

Lecture 17 - Stewart-Gough platform-based force-torque sensor

Lecture 18 - Vibration isolation using a Stewart-Gough platform

Lecture 19 - Introduction, Linear and Angular Velocity of Links

Lecture 20 - Serial Manipulator Jacobian Matrix

Lecture 21 - Parallel Manipulator Jacobian Matrix

Lecture 22 - Singularities in Serial and Parallel Manipulators

Lecture 23 - Statics of Serial and Parallel Manipulators

Lecture 24 - Hyper-redundant robots

Lecture 25 - Redundancy resolution in human arm

Lecture 26 - Flexible robots

Lecture 27 - Introduction, Lagrangian formulation

Lecture 28 - Examples of Equations of Motion

Lecture 29 - Inverse Dynamics and Simulation of Equations of Motion

Lecture 30 - Recursive Formulations of Dynamics of Manipulators

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[Lecture 37 - Advanced topics in non-linear control of manipulators](#)

[Lecture 38 - Wheeled Mobile Robots \(WMR\) on Flat Terrain](#)

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Lecture 2 - Harmonically excited systems

Lecture 3 - The concept of coincidence frequency

Lecture 4 - A classical problem in sound-structure interaction

Lecture 5 - Classical problem (Continued...)

Lecture 6 - Uncoupled solution to the classical problem

Lecture 7 - Uncoupled solution (Continued...).

Lecture 8 - Introduction to the coupled problem.

Lecture 9 - The coupled roots

Lecture 10 - Physical meaning of terms

Lecture 11 - Derivation of coupled roots using asymptotic method

Lecture 12 - Coupled roots derivation (Continued...)

Lecture 13 - Regions of heavy and light fluid loading

Lecture 14 - Light and heavy fluid loading (Continued...)

Lecture 15 - The coupled vibration field

Lecture 16 - The coupled acoustic field and stationary phase

Lecture 17 - The 2-D structural-acoustic waveguide

Lecture 18 - The coupled partial differential equations

Lecture 19 - Derivation of the coupled dispersion equation

Lecture 20 - A schematic of coupled waves

Lecture 21 - Derivation of coupled waves using asymptotic method

Lecture 22 - Asymptotic method (Continued...) and Maple demo

Lecture 23 - Physics of the coupled waves

Lecture 24 - Critical points

Lecture 25 - Heavy fluid loading

Lecture 26 - Summary of the rectangular waveguide

Lecture 27 - Impedance and mobility

Lecture 28 - Derivation of acoustic and vibration response

Lecture 29 - Derivation of vibro-acoustic response (Continued...)

Lecture 30 - Derivation of vibro-acoustic response (Continued...)

Lecture 31 - Numerical example

- Lecture 32 - Coupled resonance analysis using matrices
- Lecture 33 - Coupled resonance analysis (Continued...)
- Lecture 34 - Sound radiation from a baffled panel
- Lecture 35 - Derivation of pressure response.
- Lecture 36 - Radiation efficiency
- Lecture 37 - Physics of volume velocity cancellation
- Lecture 38 - Derivations in the frequency domain: 1-D
- Lecture 39 - Physics of the vibration spectrum in 2-D
- Lecture 40 - Modal character across the frequency range
- Lecture 41 - Simultaneous radiation from several modes
- Lecture 42 - Panel radiation model using monopoles
- Lecture 43 - Physics of panel radiation using monopole model
- Lecture 44 - Physics of panel radiation using monopole model (Cointinued...)
- Lecture 45 - Radiation resistance derivation from Maidanikâ€™s work (Continued...)
- Lecture 46 - Radiation resistance derivation from Maidanikâ€™s work (Continued...)
- Lecture 47 - Radiation resistance derivation from Maidanikâ€™s work (Continued...)
- Lecture 48 - Modal average radiation efficiency
- Lecture 49 - Modal average radiation efficiency (Cointinued...)
- Lecture 50 - Transmission of sound through a rigid panel with flexible mounts
- Lecture 51 - Frequency dependence of sound transmission
- Lecture 52 - Sound transmission through a flexible partition
- Lecture 53 - Transmission loss in different situations
- Lecture 54 - Cylindrical shell vibration
- Lecture 55 - Behavior of uncoupled shell waves
- Lecture 56 - Fluid waves in rigid-walled cylindrical shells
- Lecture 57 - Wave propagation characteristics in flexible cylindrical shells carrying fluid: Fullers paper
- Lecture 58 - Wave impedance of an infinite plate: fluid loading
- Lecture 59 - Fluid loading in a finite plate
- Lecture 60 - Summary of the entire course

- Lecture 1 - Introduction to differential geometry
- Lecture 2 - Properties of surfaces: First fundamental form
- Lecture 3 - Properties of surfaces: Second fundamental form
- Lecture 4 - Surfaces of revolution
- Lecture 5 - Gauss Codazzi relations
- Lecture 6 - Gauss Codazzi (Continued...)
- Lecture 7 - Differential element length in a thin shell
- Lecture 8 - Strain of a differential element
- Lecture 9 - Explicit strain expressions
- Lecture 10 - Love simplifications and inconsistencies Of the theory
- Lecture 11 - Euler Bernoulli Beam equation using the Hamilton's Law
- Lecture 12 - Euler Bernoulli Beam and Hamilton's Law (Continued...)
- Lecture 13 - Beta definition, force and moment resultants
- Lecture 14 - Hamilton's Law for a general shell
- Lecture 15 - The Hamilton's law (Continued...)
- Lecture 16 - Final Dynamical Equations and boundary conditions
- Lecture 17 - Physics of each term in the dynamic equations
- Lecture 18 - Physics of each term (Continued...)
- Lecture 19 - The sixth equation of motion
- Lecture 20 - The sixth equation of motion (Continued...)
- Lecture 21 - Equations of motion for a rectangular plate using Hamilton's law
- Lecture 22 - Equations of motion for a rectangular Plate (Continued...)
- Lecture 23 - Rectangular plate boundary conditions
- Lecture 24 - Rectangular plate equation using force balance
- Lecture 25 - Modeshapes and resonances of a vibrating beam
- Lecture 26 - Modeshapes and resonances of a vibrating Rectangular plate
- Lecture 27 - Modeshapes and resonances of a vibrating Circular plate
- Lecture 28 - Vibrating circular plate (Continued...)
- Lecture 29 - Modeshapes and resonances of a vibrating Circular ring
- Lecture 30 - Details of vibrating rings
- Lecture 31 - Insights into vibrations of ring

- Lecture 32 - Cylindrical shell equations of motion using Force balance
- Lecture 33 - Cylindrical shell: Transverse equation of motion
- Lecture 34 - Orthogonality of modeshapes
- Lecture 35 - Orthogonality of Modes (Continued...)
- Lecture 36 - The Rayleigh Quotient
- Lecture 37 - Rayleigh Quotient Example: Simply-supported beam
- Lecture 38 - The Rayleigh Ritz method
- Lecture 39 - The Rayleigh Ritz method applied to a Complicated system
- Lecture 40 - The Lagrange Multiplier method
- Lecture 41 - The penalty method
- Lecture 42 - Orthogonal polynomials of RB Bhat
- Lecture 43 - Rayleigh Ritz paper by RB Bhat
- Lecture 44 - Numerical examples of the Rayleigh Ritz method
- Lecture 45 - Numerical examples of Rayleigh Ritz method And animations
- Lecture 46 - Rayleigh Ritz applied to curved structures
- Lecture 47 - Forced response of plates and shells
- Lecture 48 - Forced response (Continued...)
- Lecture 49 - Simply-supported plate response to various forces
- Lecture 50 - Simply-supported plate response to various Forces (Continued...)
- Lecture 51 - Simply-supported cylindrical shell response to a Point harmonic force
- Lecture 52 - Cylindrical shell response (Continued...)
- Lecture 53 - Cylindrical shell response (Continued...)
- Lecture 54 - Cylindrical shell response to a traveling load using Only transverse modes
- Lecture 55 - The Receptance method
- Lecture 56 - The receptance method (Continued...)
- Lecture 57 - Stiffening a cylindrical shell using rings
- Lecture 58 - Stiffening of a cylindrical shell (Continued...)
- Lecture 59 - Damping in structures
- Lecture 60 - Loss factor and Complex Young modulus

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Lecture 2 - Position and Orientation of a Rigid Body

Lecture 3 - Homogenous Transformation

Lecture 4 - Linear and angular velocity of rigid body

Lecture 5 - Motion of Rigid Body and Particles

Lecture 6 - Introduction to multi-body systems

Lecture 7 - Joints, Degrees of Freedom and Constraints

Lecture 8 - Position, Velocity and Acceleration in Multi-body Systems

Lecture 9 - Mass and Inertia of a Rigid Body

Lecture 10 - External forces and moments

Lecture 11 - Angular momentum, Spinning tops and Gyroscopes

Lecture 12 - Free-body diagram and Equations of motion

Lecture 13 - Newton-Euler Formulation for Serial Chains

Lecture 14 - Lagrangian Formulation

Lecture 15 - Examples of Equations of Motion

Lecture 16 - Equations of Motion Using Computer Tools

Lecture 17 - Introduction and Examples of equations of motion

Lecture 18 - Inverse dynamics and Simulations of equations Of motion

Lecture 19 - Simulation using Computer Tools

Lecture 20 - Introduction and Goal of control

Lecture 21 - State Space Formulation

Lecture 22 - Solution of State Equations

Lecture 23 - Stability of Dynamical Systems

Lecture 24 - Controllability and Observability of Linear Systems

Lecture 25 - Examples of Controllability and Observability

Lecture 26 - Introduction to Classical Control

Lecture 27 - Root Locus

Lecture 28 - Frequency Domain Approach

Lecture 29 - PID Control

Lecture 30 - Root Locus based Controller Design

Lecture 31 - State Space Design

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- Lecture 4 - Lagrangian and Eulerian Perspectives
- Lecture 5 - Mathematical Preliminaries - II
- Lecture 6 - Image Processing Preliminaries
- Lecture 7 - Image Processing Operations
- Lecture 8 - Light Matter Interaction - I
- Lecture 9 - Lab Demo I: Optical Microscope
- Lecture 10 - Optical System: Lenses
- Lecture 11 - Lab Demo II: Lenses and Camera
- Lecture 12 - Light Matter Interaction - II (Lab Demonstration)
- Lecture 13 - Light Matter Interaction - II (Lab Demonstration)
- Lecture 14 - Tracer Particles for Flow Visualisation
- Lecture 15 - Particle Tracking Velocimetry
- Lecture 16 - Particle Image Velocimetry - I
- Lecture 17 - Particle Image Velocimetry - II
- Lecture 18 - Particle Image Velocimetry - III
- Lecture 19 - Particle Image Velocimetry - IV
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- Lecture 22 - Schlieren and Shadowgraphy
- Lecture 23 - Lab Demo III: PIV and Schlieren
- Lecture 24 - Introduction to optical methods for solids
- Lecture 25 - Basics of Digital Image Correlation
- Lecture 26 - Iterative implementation of DIC
- Lecture 27 - Example implementations
- Lecture 28 - How is a DIC experiment set up ?
- Lecture 29 - DIY(C)!
- Lecture 30 - Introduction to Photoelasticity
- Lecture 31 - Why do we see fringes ?

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NPTEL : Electroceramics (Metallurgy and Material Science)

Co-ordinators : Dr. Ashish Garg

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NPTEL : Steel Making (Metallurgy and Material Science)

Co-ordinators : Prof. Satish Ch. Koria, Prof. Dipak Mazumdar

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- Lecture 52 - Introduction to Direct Reduction (DR) and smelting Reduction (SR) Processes (Continued...)
- Lecture 53 - Coal Based DR Processes
- Lecture 54 - Coal Based DR Processes (Continued...)
- Lecture 55 - Gas based DR Processes
- Lecture 56 - Gas based DR Processes (Continued...)
- Lecture 57 - Smelting Reduction (SR) Processes
- Lecture 58 - Smelting Reduction (SR) Processes (Continued...)
- Lecture 59 - Ironmaking and Steelmaking in India
- Lecture 60 - Ironmaking and Steelmaking in India (Continued...)

Lecture 1 - Classification and applications of non-metallic materials

Lecture 2 - Understanding on polymer structures

Lecture 3 - Characteristics of polymers and advanced polymeric materials

Lecture 4 - Processing of polymers

Lecture 5 - Polymer composites and issues related to recycling

Lecture 6 - Defects in crystalline materials: point, line, planar and three dimensional defects

Lecture 7 - Non- stoichiometry in non-metallic materials

Lecture 8 - Laws of thermodynamics, reaction kinetics - Part 1

Lecture 9 - Laws of thermodynamics, reaction kinetics - Part 2

Lecture 10 - Phase diagram and microstructure evolution in non-metallic materials

Lecture 11 - Carbonaceous materials

Lecture 12 - Fundamental of diffusion, Fick's laws, their solution and applications - Part 1

Lecture 13 - Fundamental of diffusion, Fick's laws, their solution and applications - Part 2

Lecture 14 - Phase transformation of non-metallic materials

Lecture 15 - Introduction to glass and amorphous solids

Lecture 16 - Understanding on conventional glass and amorphous solids

Lecture 17 - Glass-ceramics and specialty glasses

Lecture 18 - Mechanical properties of non-metallic materials, stress-strain response, elastic, and plastic deformation

Lecture 19 - Brittle and ductile materials, introduction to fracture mechanics, strength of brittle materials

Lecture 20 - Strengthening of materials, fatigue, and creep

Lecture 21 - Composite materials: Particle-reinforced composites, and fiber reinforced composites

Lecture 22 - Structural Composite

Lecture 23 - Dielectric and piezoelectric behavior

Lecture 24 - Ferroelectric Behaviour of Non-Metallic Materials and Ferroelectric thin film for Non-Volatile Memory Applications

Lecture 25 - Magnetic Properties : Origin of Magnetism, Para, Dia, Ferro, and Ferrimagnetism

Lecture 26 - Ceramic Magnets and their Applications

Lecture 27 - Thermal Properties : Specific Heat, Heat Conduction, Thermal Diffusivity, Thermal expansion

Lecture 28 - Thermoelectric Effect and Magnetocaloric Effect

Lecture 29 - Optical properties: Refractive index, absorption and transmission of electromagnetic radiation, LASERS

Lecture 30 - Introduction to electrochemistry, Galvanic cells, Cell potentials and Gibbs Energy, Concentration dependence

Lecture 31 - Electrochemical storage, rechargeable batteries

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- Lecture 32 - Introduction to electrochemical methods; cyclic voltammetry and other related techniques
- Lecture 33 - Fuel Cell and Energy harvesting
- Lecture 34 - Preparation of ceramic powders: auto-combustion, sol-gel synthesis, microwave assisted hydrothermal synthesis
- Lecture 35 - Introduction to sintering, sintering mechanism
- Lecture 36 - Solid-state sintering and microstructure development
- Lecture 37 - Solid-state sintering and microstructure development (Continued...)
- Lecture 38 - Liquid phase sintering and microstructure development, speciality sintering, reactive sintering
- Lecture 39 - Processing of glass and amorphous/non-crystalline solids
- Lecture 40 - Fundamental of thin film growth, growth mechanism and kinetics
- Lecture 41 - Thin film growth techniques, thermal evaporation, CVD, sputtering, CSD
- Lecture 42 - Fundamentals and processing of conducting and semiconducting ceramic devices
- Lecture 43 - Processing of ceramics devices
- Lecture 44 - Organic electronic materials: conducting polymers, semi-conducting organic materials, applications
- Lecture 45 - Thermal analyses
- Lecture 46 - Introduction of spectroscopic technique : UV-VIS spectroscopy
- Lecture 47 - Infra-red and Raman spectroscopy
- Lecture 48 - Optical and scanning electron microscopy
- Lecture 49 - X-ray photoelectron spectroscopy
- Lecture 50 - Measurement of mechanical properties, fracture toughness, MOR, hardness
- Lecture 51 - Ferroelectric thin film: synthesis and characterization
- Lecture 52 - Thermal analysis techniques: Differential scanning calorimetry and thermogravimetry
- Lecture 53 - Measurement of optical properties
- Lecture 54 - Novel ferroic composites: Synthesis and measurement
- Lecture 55 - Fundamentals of corrosion, corrosion of materials
- Lecture 56 - Oxidation, corrosion of ceramic materials, degradation of polymers: swelling and dissolution, bond rupture, weathering
- Lecture 57 - Ceramics in biology and medicine
- Lecture 58 - Design of Ceramics
- Lecture 59 - Finishing of Ceramics
- Lecture 60 - Fly-ash based glazed wall tiles: A case study

Lecture 1 - Introduction to Microscopy

Lecture 2 - Scanning Electron Microscopy

Lecture 3 - SEM and Its Capabilities

Lecture 4 - Main Components of SEM - Electron Guns

Lecture 5 - Main Components of SEM - Electron Guns and Electromagnetic Lenses

Lecture 6 - Electron Probe Diameter Verses Electron Probe Current

Lecture 7 - Electron Beam - Specimen Interaction

Lecture 8 - Detectors

Lecture 9 - BSE Detector and Sample Preparation for SEM

Lecture 10 - Parameters Need to be Considered to obtain a Good SEM Image

Lecture 11 - How to Get a Good SEM Image

Lecture 12 - Additional Capabilities of SEM

Lecture 13 - Additional Capabilities of SEM (Continued...)

Lecture 14 - Additional Capabilities of SEM (Continued...)

Lecture 15 - Scanning Ion Microscopy - An Introduction

Lecture 16 - Ions Versus Electrons as Source for Microscopy

Lecture 17 - Ions Source in HIM

Lecture 18 - GFIS Properties and Ion Optical Column

Lecture 19 - Ion Optical Column

Lecture 20 - Ion-Solid Interactions and Signal Generation

Lecture 21 - Signal Generation and Contrast Mechanism

Lecture 22 - Contrast Mechanism and Imaging Modes

Lecture 23 - Scanning Transmission Ion Microscopy and Microanalysis with HIM

Lecture 24 - Creation and Modification of Materials by HIM

Lecture 25 - Introduction to Scanning Probe Microscopy

Lecture 26 - STM Instrumentation

Lecture 27 - Main Components of STM

Lecture 28 - Main Components of STM (Continued...)

Lecture 29 - Main Components of STM (Continued...)

Lecture 30 - Working Principle of STM

Lecture 31 - Operating Modes

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[Lecture 33 - SPM - Atomic Force Microscopy \(AFM\)](#)

[Lecture 34 - Force Between Tip and Sample in AFM](#)

[Lecture 35 - Atomic Force Microscope - Parts](#)

[Lecture 36 - Modes of AFM Operation](#)

[Lecture 37 - Modes of AFM Operation \(Continued...\)](#)

[Lecture 38 - AFM Imaging](#)

[Lecture 39 - Phase Imaging, Noises and Resolution](#)

[Lecture 40 - Surface Properties Measurements using Other Forces](#)

[Lecture 41 - Surface Properties Measurements using AFM](#)

[Lecture 42 - Manipulation of Atoms, Molecules and Industrial Applications](#)

[Lecture 43 - Summary](#)

- Lecture 1 - Introduction to the course and basic principles of image formation
- Lecture 2 - Image formation, resolution, magnification, depth of field and depth of focus
- Lecture 3 - Aberrations in microscopy: General concepts
- Lecture 4 - Introduction, types and image formation in Optical microscopy
- Lecture 5 - Components of optical microscope
- Lecture 6 - Bright field and Dark field modes
- Lecture 7 - Phase contrast optical microscopy
- Lecture 8 - Polarized light microscopy
- Lecture 9 - Differential interference contrast
- Lecture 10 - Fluorescence microscopy
- Lecture 11 - Basic components of electron microscope
- Lecture 12 - Basic components of electron microscope (Continued...)
- Lecture 13 - Basic components of electron microscope (Continued...)
- Lecture 14 - Electron-material interaction
- Lecture 15 - Electron-material interaction (Continued...)
- Lecture 16 - Electron-material interaction (Continued...) and Image formation and contrast generation
- Lecture 17 - Modes of TEM (BF and DF)
- Lecture 18 - Modes of TEM
- Lecture 19 - Modes of TEM (Continued...) and Electron diffraction in TEM
- Lecture 20 - Electron diffraction in TEM
- Lecture 21 - Electron diffraction in TEM (Continued...)
- Lecture 22 - Electron diffraction in TEM (Continued...)
- Lecture 23 - Electron diffraction in TEM (Continued...)
- Lecture 24 - Electron diffraction in TEM (Continued...)
- Lecture 25 - Application of Electron diffraction
- Lecture 26 - Signal generation in SEM
- Lecture 27 - Signal generation in SEM (Continued...)
- Lecture 28 - Signal generation in SEM (Continued...)
- Lecture 29 - Signal generation in SEM (Continued...)
- Lecture 30 - Signal generation in SEM (Continued...)
- Lecture 31 - Basic components of SEM

- [Lecture 32 - Basic components of SEM \(Continued...\)](#)
- [Lecture 33 - Optics of SEM](#)
- [Lecture 34 - Optics of SEM \(Continued...\)](#)
- [Lecture 35 - Optics of SEM \(Continued...\) and analytical detectors](#)
- [Lecture 36 - Analytical detectors in SEM](#)
- [Lecture 37 - Analytical \(WDS\) detector and contrast formation in SEM](#)
- [Lecture 38 - Imaging in SEM](#)
- [Lecture 39 - Imaging in SEM \(Continued...\)](#)
- [Lecture 40 - Imaging in SEM \(Continued...\)](#)
- [Lecture 41 - Imaging in SEM and X-ray diffraction](#)
- [Lecture 42 - Continuous and characteristics X-ray spectrum](#)
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- [Lecture 44 - Characteristics X-ray radiation \(Continued...\) and X-ray absorption](#)
- [Lecture 45 - X-ray absorption \(Continued...\)](#)
- [Lecture 46 - X-ray absorption and filters](#)
- [Lecture 47 - Intensity of diffracted beam](#)
- [Lecture 48 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 49 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 50 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 51 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 52 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 53 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 54 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 55 - Intensity of diffracted beam \(Continued...\)](#)
- [Lecture 56 - Intensity of diffracted beam \(Continued...\) and X-ray diffraction profile and analysis](#)
- [Lecture 57 - X-ray diffraction profile and analysis](#)
- [Lecture 58 - X-ray diffraction profile and analysis \(Continued...\)](#)
- [Lecture 59 - X-ray diffraction profile and analysis \(Continued...\)](#)
- [Lecture 60 - Electron backscatter diffraction \(EBSD\)](#)

Lecture 1 - Fundamentals of electrochemistry, definition of primary and secondary batteries

Lecture 2 - Primary batteries and Secondary batteries

Lecture 3 - Supercapacitors

Lecture 4 - Concepts of thermodynamics pertinent to electrochemical cells

Lecture 5 - Kinetics of electrochemical cells and structural characteristics of electrodes

Lecture 6 - Introduction to EMF, redox potential, Faraday law and Nernst's law

Lecture 7 - Terminology related to secondary battery : half-cell, full-cell, redox couple, positive

Lecture 8 - Measurements: Cyclic voltammetry, nominal voltage, capacity, rate performance

Lecture 9 - Impedance spectroscopy measurement and analyses

Lecture 10 - Measurement of rechargeable cell: Case study

Lecture 11 - History and categories of lithium batteries

Lecture 12 - Operational mechanisms for lithium batteries: Intercalation materials, alloys

Lecture 13 - Differences of voltage profiles between intercalation materials, alloys, and conversion

Lecture 14 - Properties of electrode materials (Case study: alloy as anode)

Lecture 15 - Properties of electrode materials (conversion type oxide as case study)

Lecture 16 - Positive electrodes: Lithiated transition metal oxides, lithiated iron oxyphosphates etc

Lecture 17 - Negative electrodes: Carbonaceous materials, lithium titanium oxides etc

Lecture 18 - Electrolyte :Liquid Electrolyte, Polymer Electrolyte

Lecture 19 - Current Collector, Conductive Agents, Separator and Other Accessories

Lecture 20 - Novel materials for lithium ion rechargeable cells

Lecture 21 - Principle of Operation of Commercial Cells : viz. C - NMC, C - NCA etc

Lecture 22 - Principle of operation of commercial cells

Lecture 23 - Major characteristics of commercial Li ion cells: Cell performance, degradation phenomena

Lecture 24 - Fabrication of Li ion cell: Cylindrical configuration

Lecture 25 - Fabrication of Li ion cell: Pouch and prismatic cell

Lecture 26 - Positive electrodes: Layered oxide, polyanionic compounds (phosphates, sulphates etc)

Lecture 27 - Negative electrodes: Carbonaceous materials, alloy based and other materials

Lecture 28 - Electrolytes: Roles and requirements, organic electrolyte, ionic liquid electrolyte

Lecture 29 - Performance of Na ion rechargeable cell

Lecture 30 - Future perspective of Na ion cells

Lecture 31 - Introduction to battery module, BMS, thermal management and pack design

- Lecture 32 - Degradation and safety issues of Li ion rechargeable cells
- Lecture 33 - Introduction to battery management system: BMS topologies, hardware, concept of active
- Lecture 34 - Introduction to thermal management: Active thermal management system, passive thermal
- Lecture 35 - Packaging of battery pack and battery testing: Material selection, sealing of enclosure
- Lecture 36 - Classification of supercapacitors: EDLC and pseudocapacitive type
- Lecture 37 - Pseudocapacitor
- Lecture 38 - Asymmetric supercapacitor and BATCAP: Battery supercapacitor hybrid electrochemical
- Lecture 39 - Electrolytes for supercapacitors: Aqueous/organic liquid electrolytes/ionic liquid
- Lecture 40 - Current collectors, separators etc. and their effect on performance
- Lecture 41 - Operational principles of aqueous and Li - O₂ batteries
- Lecture 42 - Electrolytes for Li - O₂ batteries
- Lecture 43 - Limitations of Li - Air batteries
- Lecture 44 - State of the art Li - Air batteries : Carbonaceous materials
- Lecture 45 - State of the art Li - Air batteries: Case study
- Lecture 46 - The element sulfur, principle of operation
- Lecture 47 - Advantages and disadvantages of Li - S batteries, positive electrodes
- Lecture 48 - Electrolyte and negative electrode for Li - S battery
- Lecture 49 - State of the art Li - S batteries : Case study - I
- Lecture 50 - State of the art Li - S batteries : Case study - II
- Lecture 51 - Global Geographic Distribution of Raw Lithium Resources
- Lecture 52 - Nature and geological origin of all potential lithium resources
- Lecture 53 - State of the art extraction techniques and known production reserves
- Lecture 54 - Recycling of lithium and other battery constituents from used battery
- Lecture 55 - Recycling of lithium and other battery constituents from used battery (Continued...)
- Lecture 56 - Lead Acid Batteries: Operational principles, main characteristics and applications
- Lecture 57 - Lead Acid Batteries: Operational principles, main characteristics and applications (Continued...)
- Lecture 58 - Ni-Cd and Ni-MeH Batteries: Operational principles, main characteristics and applications
- Lecture 59 - Redox flow battery vanadium redox battery, operational principle, and main characteristics
- Lecture 60 - Other Redox Flow Battery Technologies

Lecture 1 - Introduction

Lecture 2 - Texture and Anisotropy

Lecture 3 - Processing - Texture - Anisotropic Properties

Lecture 4 - Crystal Structure and Stereographic Projections

Lecture 5 - Utilization of Stereographic Projections

Lecture 6 - Diffraction and Bragg's Law

Lecture 7 - Structure Factor and Diffraction Extinction Criteria

Lecture 8 - Structure factor and diffraction extinction criteria (Continued...)

Lecture 9 - Pole figures

Lecture 10 - Pole figures (Continued...)

Lecture 11 - Inverse Pole Figures

Lecture 12 - Three Dimensional Texture Analysis

Lecture 13 - Euler Angles and ODFs

Lecture 14 - Euler Angles and ODFs (Continued...)

Lecture 15 - Euler Angles and ODFs (Continued...)

Lecture 16 - Euler Angles and ODFs (Continued...)

Lecture 17 - Symmetry Effects on Orientation Matrix

Lecture 18 - Euler Space and Orientation Matrices

Lecture 19 - Texture Fibre, Periodicity in Euler Space, Incomplete Pole Figures

Lecture 20 - Crystal Structures and Symmetry

Lecture 21 - Size of Euler Space in Relation to Crystal and Sample Symmetry

Lecture 22 - Macrotexture and Microtexture Measurements

Lecture 23 - Penetration Depth of X-ray, Neutron, e-1 and Basics of X-ray Generation

Lecture 24 - Characteristic X-ray, Absorption and Filters

Lecture 25 - Principles of pole figure measurements by X-ray diffraction

Lecture 26 - Texture Goniometer Components

Lecture 27 - Limitations and Errors in X-ray Texture Measurement and Corrections

Lecture 28 - Basics of Electron Microscopy - I

Lecture 29 - Basics of Electron Microscopy - II

Lecture 30 - Kikuchi Diffraction Pattern - I

Lecture 31 - Kikuchi Diffraction Pattern - II

- Lecture 32 - Quantitative Evaluation of Kikuchi Diffraction Pattern - I
- Lecture 33 - Quantitative evaluation of Kikuchi Diffraction Pattern - II
- Lecture 34 - Quantitative evaluation of Kikuchi Diffraction Pattern - III
- Lecture 35 - Analysis using the TSL-OIM software
- Lecture 36 - Analysis using the AZtec Crystal software
- Lecture 37 - Analysis using the ATEX software
- Lecture 38 - Introduction to solidification texture
- Lecture 39 - Solidification texture in Alloys
- Lecture 40 - Solidification texture in FCC, BCC, and HCP structures
- Lecture 41 - Phase Transformation Texture and Bain Strain
- Lecture 42 - Orientation Relationships between FCC and BCC / BCT
- Lecture 43 - Various Orientation Relationships and Variants
- Lecture 44 - Basic Mechanics of Polycrystal Plasticity
- Lecture 45 - Basic Mechanics of Polycrystal Plasticity (Continued...)
- Lecture 46 - A Metallurgist Point of View
- Lecture 47 - A Metallurgist Point of View (Continued...)
- Lecture 48 - Texture in FCC polycrystals
- Lecture 49 - Texture in BCC polycrystals - I
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- Lecture 51 - Texture in HCP polycrystals - I
- Lecture 52 - Texture in HCP polycrystals - II
- Lecture 53 - Texture in HCP polycrystals - III
- Lecture 54 - Static recrystallization
- Lecture 55 - Dynamic recrystallization and recrystallization texture
- Lecture 56 - Dynamic recrystallization and grain refinement during hot large strain shear

- Lecture 1 - Classification of Mining and Bulk Solid Handling Systems
- Lecture 2 - Properties of bulk material vis-a-vis different bulk handling operations
- Lecture 3 - Fundamentals of BMH and Transport: Capacity and Productivity Concepts
- Lecture 4 - Bulk material handling in Processing plants: Crushing and Screening Flow Charts
- Lecture 5 - Introduction to Bulk Material Transport and Autonomous Vehicles
- Lecture 6 - Constructional Components: Trends of Developments
- Lecture 7 - Belt Conveyor Construction: Belting for Bulk Material Conveyor
- Lecture 8 - Idlers and Belt Cleaners
- Lecture 9 - Feeding and Discharging Devices
- Lecture 10 - Safety and Troubleshooting
- Lecture 11 - Size Selection and Power Calculation
- Lecture 12 - Principle of operations and applicability
- Lecture 13 - Basic Design Calculations
- Lecture 14 - Introduction to Pneumatic Conveying systems
- Lecture 15 - Design Calculations for Pneumatic Conveying
- Lecture 16 - Exercise with Basic Design Calculations
- Lecture 17 - Stackers and Reclaimers: Classification and Selection Criteria
- Lecture 18 - Stackers and Reclaimers: Comparison of Different Types
- Lecture 19 - Principles of Blending and Reclaiming
- Lecture 20 - Case studies of stacker and reclaimers application
- Lecture 21 - System Layout
- Lecture 22 - Introduction to Bin Bunker and Silo
- Lecture 23 - Introduction to Bunker
- Lecture 24 - Introduction to Silo
- Lecture 25 - Silo Failures and Maintenance
- Lecture 26 - Basics of Silo Design
- Lecture 27 - Feeder Selection and Design
- Lecture 28 - Crushers: Classification and selection
- Lecture 29 - Secondary Crushers
- Lecture 30 - Screen: Classification and Selection
- Lecture 31 - Monitoring and Maintenance of Processing Plant Equipment

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- Lecture 33 - Fine Size Classification: Desliming and Cycloning
- Lecture 34 - Froth Flotation Techniques, Magnetic Separation, Jigs and Thickeners
- Lecture 35 - Jigs and Thickeners
- Lecture 36 - Coal Washery Equipment and Practices
- Lecture 37 - Classification and Selection
- Lecture 38 - Crusher Selection and Application
- Lecture 39 - Off-Highway trucks and Haul Roads - 1
- Lecture 40 - Off-Highway trucks and Haul Roads - 2
- Lecture 41 - Recent Developments in Truck Transportation
- Lecture 42 - RopeCon Transportation
- Lecture 43 - Aerial Ropeways: Introduction
- Lecture 44 - Aerial Ropeways Calculation
- Lecture 45 - Pipe Conveyor Belt: Enclosed Material Transport
- Lecture 46 - Underground Mine Transport System
- Lecture 47 - Rope Haulage for Underground Mine Transport
- Lecture 48 - Main and Tail and Endless Rope Haulage
- Lecture 49 - Pit Top and Pit Bottom Layout
- Lecture 50 - Haulage calculation
- Lecture 51 - Locomotive
- Lecture 52 - Low Profile Dumper
- Lecture 53 - Load Haul Dumper
- Lecture 54 - Introduction to Cage and Skip Winding
- Lecture 55 - Winding Calculations
- Lecture 56 - Safety Aspects in Bulk Solid Handling and Transportation
- Lecture 57 - Safety Aspects in Bulk Solid Handling and Transportation
- Lecture 58 - Basic Introduction of Automatic Control
- Lecture 59 - Automating Bulk Solids Processes
- Lecture 60 - Online Monitoring

- Lecture 1 - Introduction to Materials and Environment
- Lecture 2 - Genesis of Materials Degradation
- Lecture 3 - Classification of degradation and Parameters Influencing it - Part I
- Lecture 4 - Parameters Influencing Degradation - Part II
- Lecture 5 - Engineering Solution to Combat Environmental Degradation of Materials
- Lecture 6 - Aqueous corrosion-thermodynamics of Wet Corrosion
- Lecture 7 - Aqueous corrosion-Classification - Part I
- Lecture 8 - Aqueous corrosion-Classification - Part II
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- Lecture 10 - Classification of Aqueous corrosion - Part IV
- Lecture 11 - Friction and Wear-Part - I
- Lecture 12 - Friction and Wear-Part - II
- Lecture 13 - Wear- Classification of wear - Part I
- Lecture 14 - Wear- Classification of wear - Part II
- Lecture 15 - Fatigue – Surface Dependent Property
- Lecture 16 - Failure Analysis - Part I
- Lecture 17 - Failure Analysis - Part II
- Lecture 18 - Characteristics of Failure - Part I
- Lecture 19 - Characteristics of Failure - Part II
- Lecture 20 - Characteristics of Failure - Part III
- Lecture 21 - Prevention
- Lecture 22 - Prevention of Chemical/Electrochemical Degradation
- Lecture 23 - Prevention of Chemical/Electrochemical Degradation (Continued...)
- Lecture 24 - Prevention of Chemical/Electrochemical Degradation (Continued...)
- Lecture 25 - Prevention of Mechanical Degradation
- Lecture 26 - Non Destructive Testing
- Lecture 27 - Mechanical and Electrochemical Testing - Part I
- Lecture 28 - Mechanical and Electrochemical Testing - Part II
- Lecture 29 - Mechanical and Electrochemical Testing - Part III
- Lecture 30 - Characterization
- Lecture 31 - Surface/Interface

- Lecture 32 - Scope, Classification and Objectives of Surface Engineering
- Lecture 33 - Shot Peening
- Lecture 34 - Grinding and Polishing
- Lecture 35 - Ultrasonic Peening and Laser Shock Peening
- Lecture 36 - Conventional Surface Hardening (Flame and induction)
- Lecture 37 - Pack Carburizing
- Lecture 38 - Fluidized Bed Carburizing
- Lecture 39 - Fused bath and Gas Nitriding
- Lecture 40 - Plasma Nitriding
- Lecture 41 - Diffusion Based Coatings - Solid State
- Lecture 42 - Chemical Conversion Coatings
- Lecture 43 - Electrodeposition
- Lecture 44 - Electrophoretic and Electroless deposition
- Lecture 45 - Galvanizing and Hot Dipping
- Lecture 46 - Thick Coatings by Weld Overlay and Cladding
- Lecture 47 - Introduction to thin film deposition
- Lecture 48 - Physical Vapor Deposition including Sputtering
- Lecture 49 - Chemical Vapor Deposition (CVD) and Composite Coating
- Lecture 50 - Chemical Vapor Deposition (CVD) and Composite Coating
- Lecture 51 - Spray Coating Techniques II - Plasma Spray and Cold Spray
- Lecture 52 - Ion Implantation
- Lecture 53 - Electron Beam Assisted Surface Engineering
- Lecture 54 - Laser Material Processing
- Lecture 55 - Laser Surface Engineering
- Lecture 56 - Laser Assisted Additive Manufacturing, LAM
- Lecture 57 - Strengthening Mechanisms in Surface Engineering
- Lecture 58 - Microstructural Characterization after Surface Engineering
- Lecture 59 - Compositional Characterization after Surface Engineering
- Lecture 60 - Summary of surface engineering and Conclusion

Lecture 1 - Modes of Fracture

Lecture 2 - Theoretical Strengths and Defects

Lecture 3 - Stress Concentration

Lecture 4 - Griffith Criterion

Lecture 5 - Griffith Criteria - Modification

Lecture 6 - Stress Intensity Factor

Lecture 7 - Fracture Toughness and Plane Stress-Plane Strain

Lecture 8 - Plastic Zone Size

Lecture 9 - Plane stress and plane strain fracture toughness

Lecture 10 - Plane stress and plane strain fracture toughness (Continued...)

Lecture 11 - Plane Strain Fracture Toughness Testing

Lecture 12 - Plane Strain-Plane Stress Fracture Toughness Testing

Lecture 13 - Plane Stress Fracture Toughness

Lecture 14 - Plane Stress fracture toughness-J integral

Lecture 15 - Experimental determination of JIC

Lecture 16 - J-integral and JIC

Lecture 17 - Impact Toughness

Lecture 18 - Impact Toughness (Continued...)

Lecture 19 - Impact Toughness (Continued...)

Lecture 20 - Impact Toughness (Continued...)

Lecture 21 - Impact Toughness (Continued...)

Lecture 22 - Fracture Toughness

Lecture 23 - Fracture Toughness (Continued...)

Lecture 24 - Fracture Toughness (Continued...)

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Lecture 26 - Fracture Toughness (Continued...)

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- [Lecture 35 - Strain Controlled Fatigue \(Continued...\)](#)
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- [Lecture 46 - Fatigue Crack Propagation \(Continued...\)](#)
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- [Lecture 48 - Fatigue in Materials](#)
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- Lecture 1 - Introduction to closure concept
- Lecture 2 - Mine Closure Objectives and Regulatory Aspects
- Lecture 3 - Mining Footprint and Regulatory Aspects
- Lecture 4 - Mine Closure Costs and Financing Approaches
- Lecture 5 - Decommissioning of Mines
- Lecture 6 - Demolition Techniques
- Lecture 7 - Post Closure Liabilities and Activities
- Lecture 8 - Post Closure Community Concerns and Sustainable Development Plans
- Lecture 9 - Closure oriented Resource Development-Post Mining Land Uses
- Lecture 10 - Post mining site monitoring
- Lecture 11 - Planning inputs, tools and techniques
- Lecture 12 - Tools and Techniques for Closure Plan Development and Procedures
- Lecture 13 - Closure Plan Development Procedures
- Lecture 14 - Monitoring, Review and Feedback of Closure Plan Implementation-Closure Criteria
- Lecture 15 - Failure Mode and Effect Analysis Framework for Mine Closure Planning
- Lecture 16 - Multiple Accounts Analysis (MAA) for Assessment of Closure Alternatives
- Lecture 17 - Provisioning of capital
- Lecture 18 - Closure costs and Rehabilitation Costs
- Lecture 19 - Finance and Accounting: Closure cost estimate
- Lecture 20 - Closure Economics and Audit
- Lecture 21 - Application of Remote Sensing for Mine Closure-Introduction
- Lecture 22 - Remote Sensing Sensors
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- Lecture 25 - GIS for Mine Closure: Mapping and Geo-Spatial Data Analysis
- Lecture 26 - Integration of phase operations
- Lecture 27 - Integration of Interdepartmental work and phase operations - Part 1
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- Lecture 32 - Introduction to Asset Management
- Lecture 33 - Principle of Asset Management and Decommissioning of Assets for Site Restoration
- Lecture 34 - Brownfield Redevelopment and Value Addition to Assets
- Lecture 35 - Landform Design and Post Mining Asset Creation
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- Lecture 37 - Sustainability Measurement and Reporting
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- Lecture 39 - Sustainable Mineral Industry
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- Lecture 44 - Case studies on Sustainability initiatives in Mining Industry
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- Lecture 46 - Cleaner Production Based Closure Management
- Lecture 47 - Regenerative environment design for sustainable Mine Closure
- Lecture 48 - Reusable resource identification in post closure mine site
- Lecture 49 - Optimization of Residual Value of Assets
- Lecture 50 - Post Mining Site for Community wealth
- Lecture 51 - Management of water resources
- Lecture 52 - Soil Treatment and Revegetation
- Lecture 53 - Bio-diversity: Post Land reclamation and plantation
- Lecture 54 - Physical and Chemical Stability issues
- Lecture 55 - Economic Utilization of Post Mining Structures and assets
- Lecture 56 - Techniques for closing underground workings
- Lecture 57 - Application of Industry 4.0 for Mine
- Lecture 58 - Best mining practices for Sustainable mining - Case studies
- Lecture 59 - Stability Monitoring and Enhancing tools
- Lecture 60 - VR and AR Technology for Post Mining Mine site Visualization and Design

- Lecture 1 - Fundamental aspects of hybrid materials
- Lecture 2 - Materials selection basics for design with hybrid materials
- Lecture 3 - Classes of materials and material property charts
- Lecture 4 - Material property charts and concept of material indices
- Lecture 5 - Material property chart-indices and concept of hybridization
- Lecture 6 - Hybrid materials - Composite
- Lecture 7 - Cellular solids - Applications of metal foams
- Lecture 8 - Cellular solids - Applications of porous ceramics and polymer foams
- Lecture 9 - Basics of Composite Materials and Classification
- Lecture 10 - Composite Classification - Matrix and Reinforcement
- Lecture 11 - Fibers - Fundamentals, Glass fiber
- Lecture 12 - Fibers - Boron and Carbon Fibers
- Lecture 13 - Fibers - Aramid and Ceramic fibers, Alumina fiber
- Lecture 14 - Fibers - SiC fiber and Whiskers
- Lecture 15 - Metal matrix composites (MMCs) - Basic concept, Liquid state processing
- Lecture 16 - Metal matrix composites (MMCs) - Liquid and Solid state processing
- Lecture 17 - Ceramic Matrix Composites (CMCs) - Basic concept, Processing techniques
- Lecture 18 - Ceramic Matrix Composites (CMCs) - Processing techniques
- Lecture 19 - CMCs and PMCs - Processing and Application
- Lecture 20 - Fabrication of cellular ceramics
- Lecture 21 - Sintering of ceramics - Aspects and mechanisms
- Lecture 22 - Fabrication of cellular ceramics
- Lecture 23 - Processing of metal foams - Foaming techniques
- Lecture 24 - Processing of metal foams (Continued...)
- Lecture 25 - Processing of metal foams (Continued...)
- Lecture 26 - Polymer foams - Processing and properties
- Lecture 27 - Additive manufacturing - Definition and Prospects
- Lecture 28 - Cellular solids classification and Structure description
- Lecture 29 - Structure of cellular solids - Pore structure characterization
- Lecture 30 - Interfacial phenomena - Basic concept, Adhesion and Wettability
- Lecture 31 - Interfacial phenomena - Factors affecting wettability

- Lecture 32 - Interfacial phenomena - Interfacial bonding
- Lecture 33 - Interfacial phenomena - Interfacial strength measurement
- Lecture 34 - Interfacial phenomena - Case study - Al-MWCNT nanocomposite
- Lecture 35 - Interfacial phenomena - Case studies: MMCs and CMCs
- Lecture 36 - Interfacial phenomena - Case studies: MMCs and CMCs (Continued...)
- Lecture 37 - Mechanics of Composites - Unidirectional Lamina
- Lecture 38 - Mechanics: Fiber-reinforced composites - Transverse Loading
- Lecture 39 - Mechanics: Fiber-reinforced composites - Problem Solving
- Lecture 40 - Mechanics: Fiber-reinforced composites - Discontinuous fibers
- Lecture 41 - Mechanics of Composites - Discontinuous fibers
- Lecture 42 - Dependence of properties on pore structure
- Lecture 43 - Mechanics of cellular solids
- Lecture 44 - Mechanics of cellular solids (Continued...)
- Lecture 45 - Deformation behavior of honeycomb and foams
- Lecture 46 - Deformation behaviour of Foams
- Lecture 47 - Deformation behaviour of Foams (Continued...)
- Lecture 48 - Deformation behaviour of Foams (Continued...)
- Lecture 49 - Thermal properties of foams
- Lecture 50 - Other important properties of foams (Continued...)
- Lecture 51 - Advanced composites - MMCs
- Lecture 52 - Advanced composites - MMCs (Continued...)
- Lecture 53 - Advanced composites - CMCs
- Lecture 54 - Advanced composites - Advanced Processing Techniques
- Lecture 55 - Advanced composites - Advanced Processing Techniques (Continued...)
- Lecture 56 - Advanced composites - Advanced Processing Techniques (Continued...)
- Lecture 57 - Advanced composites - Application oriented advanced composites
- Lecture 58 - Microstructure and properties of natural cellular solid - wood
- Lecture 59 - Advanced hybrid material - Functionally graded composite materials (FGMs)
- Lecture 60 - Advanced hybrid material - Functionally graded composite materials (FGMs) (Continued...)

Lecture 1 - Basic definitions

Lecture 2 - Free energy, Stability, equilibrium in a unary system

Lecture 3 - Effect of Pressure on equilibrium transformations: Clausius Clapeyron equation, phase diagram for unary system

Lecture 4 - Free energy of solutions, free energy-composition diagrams

Lecture 5 - Solution models, chemical potential

Lecture 6 - Phase rule, free energy-composition diagrams and phase diagrams

Lecture 7 - Evolution of phase diagrams

Lecture 8 - Evolution of phase diagrams, miscibility gap

Lecture 9 - To concept, partition less solidification

Lecture 10 - To concept, partition less solidification (Continued...)

Lecture 11 - Eutectic solidification, glass formation

Lecture 12 - Kauzmann paradox, order of a transformation, glass forming ability

Lecture 13 - Eutectic solidification, coupled growth, heterogeneous nucleation

Lecture 14 - Peritectic solidification, metastable phase diagrams

Lecture 15 - Errors in drawing phase diagrams, Fe-C vs. Fe-Fe₃C phase diagram

Lecture 16 - Free energy of undercooled liquid, shape of nucleus

Lecture 17 - Solid state phase transformations - Precipitation

Lecture 18 - Precipitation

Lecture 19 - Precipitation - quasicrystals

Lecture 20 - Precipitate coarsening, stability of a phase, spinodal decomposition

Lecture 21 - Spinodal decomposition

Lecture 22 - Eutectoid reaction

Lecture 23 - Eutectoid reaction (Continued...)

Lecture 24 - Bainitic transformation

Lecture 25 - Kinetics of eutectoid transformations

Lecture 26 - Martensitic Transformation

Lecture 27 - Martensitic transformation, order-disorder transformation

Lecture 28 - Miscibility gap in phase diagrams

Lecture 29 - Phase diagram calculations

Lecture 30 - Thermodynamics of heterogeneous systems

Lecture 31 - Thermodynamics of heterogeneous systems (Continued...)

Lecture 1 - Properties of light, Image formation

Lecture 2 - Magnification and resolution

Lecture 3 - Depth of field, focus and field of view

Lecture 4 - Lens defects, filters and light microscopy introduction

Lecture 5 - Optical microscope demo., Bright field imaging, opaque specimen illumination

Lecture 6 - Opaque stop microscopy, Phase contrast microscopy

Lecture 7 - Dark field microscopy, Polarization microscopy

Lecture 8 - Differential interference contrast and fluorescence microscopy

Lecture 9 - Sample preparation techniques for optical microscopy

Lecture 10A - Tutorial problems (Continuation...)

Lecture 10 - Tutorial problems

Lecture 11 - Introduction to scanning electron Microscopy

Lecture 12 - Lens aberrations, Object resolution, Image quality

Lecture 13 - Interaction between electrons and sample, Imaging capabilities, Structural analysis, Elemental analysis

Lecture 14 - SEM and its mode of operation, Effect of aperture size, Working distance, condenser lens strength

Lecture 15 - SEM and its mode of operation- continuation, Relation between probe current and probe diameter, Summary

Lecture 16 - Factors affecting Interaction volume, Demonstration of SEM

Lecture 17 - Image formation and interpretation

Lecture 18 - Image formation and interpretation continued, EDS, WDS

Lecture 19 - Special contrast mechanisms, Monte Carlo simulations of Interaction volume

Lecture 20 - Electron channeling contrast imaging (ECCI), Electron back scattered diffraction (EBSD)-Theory & instrument demonstration

Lecture 21 - Tutorial Problems on SEM

Lecture 22 - Basics of X-ray emission from source, electron excitation and X-ray interaction with materials in general

Lecture 23 - Properties of X-rays

Lecture 24 - Bragg's Law Derivation

Lecture 25 - Diffraction relationship with reciprocal space

Lecture 26 - X-ray scattering

Lecture 27 - Factors affecting intensities of X-ray peaks

Lecture 28 - Factors affecting intensities of X-ray peaks- continuation

Lecture 29 - Effect of crystallite size and strain on intensity of X-rays

- Lecture 30 - Profile fit, Factors affecting peak broadening
- Lecture 31 - Indexing of diffraction pattern, Quantitative analysis
- Lecture 32 - Indexing, Quantitative analysis-continuation, Residual stress measurements
- Lecture 33 - XRD and Residual stress measurement- lab demonstration
- Lecture 34 - Introduction to Transmission Electron Microscopy (TEM)
- Lecture 35 - Fundamentals of Transmission Electron Microscopy (TEM)
- Lecture 36 - Basics of Diffraction-1
- Lecture 37 - Basics of Diffraction-2
- Lecture 38 - TEM imaging-1
- Lecture 39 - TEM imaging-2
- Lecture 40 - TEM instrument demonstration
- Lecture 41 - TEM sample preparation-1
- Lecture 42 - TEM sample preparation-2
- Lecture 43 - XRD Tutorial - 1
- Lecture 44 - XRD tutorial - 2
- Lecture 45 - TEM Tutorial - 1
- Lecture 46 - TEM Tutorial - 2
- Lecture 47 - Quantitative metallography - Tutorial 1
- Lecture 48 - Quantitative metallography - Tutorial 2
- Lecture 49 - Quantitative metallography - Tutorial 3
- Lecture 50 - Quantitative metallography - Tutorial 4
- Lecture 51 - Quantitative metallography - Tutorial 5
- Lecture 52 - Quantitative metallography - Tutorial 6
- Lecture 53 - Quantitative metallography - Tutorial 7

Lecture 1 - Introduction

Lecture 2 - Properties of Materials

Lecture 3 - Thermal Expansion

Lecture 4 - Measuring Electrical Conductivity: DC and AC

Lecture 5 - Free Electron Gas

Lecture 6 - The Ideal Gas

Lecture 7 - Drude Model: Electrical Conductivity

Lecture 8 - Drude Model: Thermal Conductivity

Lecture 9 - Drude Model: Successes and Limitations

Lecture 10 - Drude Model: Source of Shortcomings

Lecture 11 - Large Systems and Statistical Mechanics

Lecture 12 - Maxwell Boltzmann Statistics

Lecture 13 - Classical Particles and Quantum Particles

Lecture 14 - History of Quantum Mechanics - 1

Lecture 15 - History of Quantum Mechanics - 2

Lecture 16 - Introduction to Drude Sommerfeld model

Lecture 17 - Fermi-Dirac Statistics - Part 1

Lecture 18 - Fermi-Dirac Statistics - Part 2

Lecture 19 - Features of the Fermi Dirac Distribution Function

Lecture 20 - Maxwell-Boltzmann Distribution Vs Fermi-Dirac Distribution

Lecture 21 - Anisotropy and Periodic Potential in a Solid

Lecture 22 - Confinement and Quantization - Part 1

Lecture 23 - Confinement and Quantization - Part 2

Lecture 24 - Density of States

Lecture 25 - Fermi Energy, Fermi Surface, Fermi Temperature

Lecture 26 - Electronic Contribution to Specific Heat at Constant Volume

Lecture 27 - Reciprocal Space-1: Introduction to Reciprocal Space

Lecture 28 - Reciprocal Space-2: Condition for Diffraction

Lecture 29 - Reciprocal Space-3: Ewald sphere, Simple Cubic, FCC and BCC in Reciprocal Space

Lecture 30 - Wigner Seitz Cell and Introduction to Brillouin Zones

Lecture 31 - Brillouin Zones, Diffraction, and Allowed Energy Levels

[Lecture 32 - E Vs k, Brillouin Zones and the Origin of Bands](#)

[Lecture 33 - Calculating Allowed Energy Bands and Forbidden Band Gaps](#)

[Lecture 34 - Bands; Free Electron Approximation, Tight Binding Approximation](#)

[Lecture 35 - Semiconductors](#)

[Lecture 36 - Magnetic Properties](#)

[Lecture 37 - Electron Compounds; Phonons, Optoelectronic Materials](#)

[Lecture 38 - Superconductivity](#)

[Lecture 39 - Bose-Einstein Statistics](#)

[Lecture 40 - Physics of Nano Scale Materials; Course Summary](#)

- Lecture 1 - Metals, semiconductors and insulators
- Lecture 2 - Introduction to semiconductors
- Lecture 3 - Density of states and Fermi-Dirac statistics
- Lecture 4 - Assignment 1 - Bonding, DOS, and Fermi statistics
- Lecture 5 - Intrinsic semiconductors
- Lecture 6 - Intrinsic semiconductors - conductivity
- Lecture 7 - Assignment 2 - Intrinsic semiconductors
- Lecture 8 - Extrinsic semiconductors
- Lecture 9 - Extrinsic semiconductors - Fermi level
- Lecture 10 - Extrinsic semiconductors - conductivity
- Lecture 11 - Assignment 3 - Extrinsic semiconductors
- Lecture 12 - Metal-semiconductor junctions
- Lecture 13 - Assignment 4 - Metal-semiconductor junctions
- Lecture 14 - pn junctions in equilibrium
- Lecture 15 - pn junctions under bias
- Lecture 16 - pn junction breakdown and heterojunctions
- Lecture 17 - Assignment 5 - pn junctions
- Lecture 18 - Transistors
- Lecture 19 - MOSFETs
- Lecture 20 - Assignment 6 - transistors
- Lecture 21 - Optoelectronic devices: Introduction
- Lecture 22 - Optoelectronic devices: LEDs
- Lecture 23 - Optoelectronic devices: LASERS
- Lecture 24 - Optoelectronic devices: photodetector
- Lecture 25 - Optoelectronic devices: solar cells
- Lecture 26 - Assignment 7 - optical properties
- Lecture 27 - Assignment 8 - optoelectronic devices
- Lecture 28 - Semiconductor manufacturing: Introduction
- Lecture 29 - Si wafer manufacturing
- Lecture 30 - IC device manufacturing: overview
- Lecture 31 - Layering: thermal oxidation

[Lecture 32 - Doping: thermal and ion implantation](#)

[Lecture 33 - Lithography](#)

[Lecture 34 - Etching and deposition \(growth\)](#)

[Lecture 35 - Metallization and polishing](#)

[Lecture 36 - Process and device evaluation](#)

[Lecture 37 - Productivity and process yield](#)

[Lecture 38 - Clean room design and contamination control](#)

[Lecture 39 - Devices and IC formation](#)

[Lecture 40 - IC circuit logic and packaging](#)

Lecture 1 - Properties of light, Image formation

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Lecture 6 - Opaque stop microscopy, Phase contrast microscopy

Lecture 7 - Dark field microscopy, Polarization microscopy

Lecture 8 - Differential interference contrast and fluorescence microscopy

Lecture 9 - Sample preparation techniques for optical microscopy

Lecture 10 - Tutorial problems

Lecture 11 - Tutorial problems (Continued...)

Lecture 12 - Introduction to scanning electron Microscopy

Lecture 13 - Lens aberrations, Object resolution, Image quality

Lecture 14 - Interaction between electrons and sample, Imaging capabilities, Structural analysis, Elemental analysis

Lecture 15 - SEM and its mode of operation, Effect of aperture size, Working distance, condenser lens strength

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Lecture 19 - Image formation and interpretation continued, EDS, WDS

Lecture 20 - Special contrast mechanisms, Monte Carlo simulations of Interaction volume

Lecture 21 - Electron channeling contrast imaging (ECCI), Electron back scattered diffraction (EBSD)-Theory & instrument demonstration

Lecture 22 - Tutorial Problems on SEM

- Lecture 1 - Electronic Materials
- Lecture 2 - Semiconductors - Introduction
- Lecture 3 - Electron statistics in a solid
- Lecture 4 - Worked numericals on week 1 lessons
- Lecture 5 - Intrinsic semiconductors
- Lecture 6 - Intrinsic semiconductors - conductivity
- Lecture 7 - Optional - worked assignment on intrinsic semiconductors
- Lecture 8 - Extrinsic semiconductors - Introduction
- Lecture 9 - Extrinsic semiconductors - Fermi level
- Lecture 10 - Extrinsic semiconductors - Mobility
- Lecture 11 - Worked assignment on extrinsic semiconductors
- Lecture 12 - Metal-semiconductor junctions
- Lecture 13 - pn junctions in equilibrium
- Lecture 14 - Optional - worked assignment on metal-semiconductor junctions
- Lecture 15 - pn junctions under bias
- Lecture 16 - Junction breakdown and heterojunctions
- Lecture 17 - Worked assignment on pn junctions
- Lecture 18 - Transistors - overview
- Lecture 19 - MOSFETs
- Lecture 20 - Worked assignment on transistors
- Lecture 21 - Optoelectronic devices - Introduction
- Lecture 22 - Light emitting diodes
- Lecture 23 - Solid state semiconductor lasers
- Lecture 24 - Optional - worked assignment on optical properties
- Lecture 25 - Photodetectors
- Lecture 26 - Solar cells
- Lecture 27 - Worked assignment on optoelectronic devices

Lecture 1 - Reciprocal space; Definition and Properties

Lecture 2 - Condition for Diffraction

Lecture 3 - Worked out examples

Lecture 4 - Ewald Sphere and lattices in reciprocal space

Lecture 5 - Wigner Sietz cells and Brillouin Zones

Lecture 6 - Worked out exmaples

Lecture 7 - Brillouin Zones, Diffraction and allowed energy levels

Lecture 8 - E Vs K, Brillouin zones and the Origin of Bands

Lecture 9 - Week 3 Worked out examples

Lecture 10 - Reciprocal space as Fourier transform of real lattice

Lecture 11 - Alternate notation of reciprocal space

Lecture 1 - Introduction to fusion welding processes: Part 1/2

Lecture 2 - Introduction to fusion welding processes: Part 2/2

Lecture 3 - Heat sources - Part 1/2

Lecture 4 - Heat sources - Part 2/2

Lecture 5 - Heat removal

Lecture 6 - Thermal Modelling - Part 1/2

Lecture 7 - Thermal Modelling - Part 2/2

Lecture 8 - Zones in a weldment

Lecture 9 - Analytical Solutions to Weld Thermal Field

Lecture 10 - Conduction to Keyhole mode

Lecture 11 - Fluid flow modelling - Part 1/2

Lecture 12 - Fluid flow modelling - Part 2/2

Lecture 13 - Solute transfer modelling - Part 1/2

Lecture 14 - Solute transfer modelling - Part 2/2

Lecture 15 - Solute segregation profile - Part 1/2

Lecture 16 - Solute segregation profile - Part 2/2

Lecture 17 - Microstructure Formation in Fusion Welds

Lecture 18 - Numerical Solutions to Thermal Field and Fluid Flow in Welding - Part 1

Lecture 19 - Numerical Solutions to Thermal Field and Fluid Flow in Welding - Part 2

Lecture 20 - Dissimilar Welding

Lecture 1 - Basics of X-ray emission from source, electron excitation and X-ray interaction with materials in general

Lecture 2 - Properties of X-rays

Lecture 3 - Bragg's law derivation

Lecture 4 - Diffraction relationship with reciprocal space

Lecture 5 - X-ray scattering

Lecture 6 - Factors affecting intensities of X-ray peaks

Lecture 7 - Factors affecting intensities of X-ray peaks (Continued...)

Lecture 8 - Effect of crystallite size and strain on intensity of X-rays

Lecture 9 - Profile fit, Factors affecting peak broadening

Lecture 10 - Indexing of diffraction pattern, Quantitative analysis

Lecture 11 - Indexing and Quantitative analysis-continuation, Residual stress measurements

Lecture 12 - XRD and Residual stress measurement - lab demonstration

Lecture 13 - XRD Tutorial - 1

Lecture 14 - XRD tutorial - 2

Lecture 15 - Introduction to Transmission Electron Microscopy (TEM)

Lecture 16 - Fundamentals of Transmission Electron Microscopy (TEM)

Lecture 17 - Basics of Diffraction - 1

Lecture 18 - Basics of Diffraction - 2

Lecture 19 - TEM Imaging - 1

Lecture 20 - TEM Imaging - 2

Lecture 21 - TEM instrument demonstration

Lecture 22 - TEM sample preparation - 1

Lecture 23 - TEM sample preparation - 2

Lecture 24 - TEM Tutorial - 1

Lecture 25 - TEM Tutorial - 2

Lecture 26 - TEM Tutorial - 3

Lecture 27 - TEM Tutorial - 4

Lecture 1 - Visual optical method

Lecture 2 - Dye Penetrant Testing - 1

Lecture 3 - Dye Penetrant Testing - 2

Lecture 4 - Dye Penetrant Testing - 3

Lecture 5 - Dye Penetrant Testing - 4

Lecture 6 - Magnetic particle testing - 1

Lecture 7 - Magnetic particle testing - 2

Lecture 8 - Magnetic particle testing - 3

Lecture 9 - Magnetic particle testing - 4

Lecture 10 - Magnetic particle testing - 5

Lecture 11 - Eddy current testing - 1

Lecture 12 - Eddy current testing - 2

Lecture 13 - Eddy current testing - 3

Lecture 14 - Eddy current testing - 4

Lecture 15 - Eddy current testing - 5

Lecture 16 - Ultrasonic testing - 1

Lecture 17 - Ultrasonic testing - 2

Lecture 18 - Ultrasonic testing - 3

Lecture 19 - Ultrasonic testing - 4

Lecture 20 - Ultrasonic testing - 5

Lecture 21 - Ultrasonic testing - 6

Lecture 22 - Ultrasonic testing - 7

Lecture 23 - Ultrasonic testing - 8

Lecture 24 - Ultrasonic testing - 9

Lecture 25 - Ultrasonic testing - 10

Lecture 26 - Acoustic Emission Testing - 1

Lecture 27 - Acoustic Emission Testing - 2

Lecture 28 - Acoustic Emission Testing - 3

Lecture 29 - Acoustic Emission Testing - 4

Lecture 30 - Acoustic Emission Testing - 5

Lecture 31 - Radiography - 1

[Lecture 32 - Radiography - 2](#)

[Lecture 33 - Radiography - 3](#)

[Lecture 34 - Radiography - 4](#)

[Lecture 35 - Radiography - 5](#)

[Lecture 36 - Radiography - 6](#)

[Lecture 37 - Radiography - 7](#)

[Lecture 38 - Radiography - 8](#)

[Lecture 39 - Radiography - 9](#)

[Lecture 40 - Radiography - 10](#)

Lecture 1 - Introduction to defects in materials

Lecture 2 - 1-D Lattice

Lecture 3 - 2-D Lattice

Lecture 4 - 3-D Lattice - a

Lecture 5 - 3-D Lattice - b

Lecture 6 - 3-D Lattice - c

Lecture 7 - 3-D Crystals

Lecture 8 - Types of Point Defects

Lecture 9 - Vacancy Concentration Determination - 1

Lecture 10 - Vacancy Concentration Determination - 2

Lecture 11 - Point Defect Interstitial

Lecture 12 - Transformation of co-ordinates

Lecture 13 - Tensor - 1

Lecture 14 - Tensor - 2

Lecture 15 - Strain

Lecture 16 - Stress

Lecture 17 - Description of Dislocation - 1

Lecture 18 - Description of Dislocation - 2

Lecture 19 - Stress field around Dislocation

Lecture 20 - Self Energy of Dislocation

Lecture 21 - Force on Dislocation

Lecture 22 - Forces Between Dislocation

Lecture 23 - Chemical Force on Dislocation

Lecture 24 - Perfect Dislocation in FCC Structures

Lecture 25 - Intrinsic Stacking Faults in FCC

Lecture 26 - Extrinsic Faults and Thompson Tetrahedron in FCC

Lecture 27 - Dislocations in BCC and HCP

Lecture 28 - Dislocations in Ordered Alloys and Dislocation Dislocation Interaction

Lecture 29 - Twinning - 1

Lecture 30 - Twinning - 2

Lecture 31 - Martensitic Transformation - 1

[Lecture 32 - Martensitic Transformation - 2](#)

[Lecture 33 - Interfaces - 1](#)

[Lecture 34 - Interfaces - 2](#)

[Lecture 35 - Defect Interaction and Strength](#)

Lecture 1 - Method of Stereology

Lecture 2 - Volume Fraction and Particle Size - Part 1

Lecture 3 - Volume Fraction and Particle Size - Part 2

Lecture 4 - Geometric Probability - Part 1

Lecture 5 - Geometric Probability - Part 2

Lecture 6 - Probability Distributions

Lecture 7 - Volume Fraction and Particle Size - Part 3

Lecture 8 - Volume Fraction and Particle Size - Part 4

Lecture 9 - Geometrical Probability - I

Lecture 10 - Geometrical Probability - II

Lecture 11 - Basic Stereological Parameters - Part 1

Lecture 12 - Basic Stereological Parameters - Part 2

Lecture 13 - Counting of grains and particles - Part 1

Lecture 14 - Description of Polycrystalline Microstructures derived measures

Lecture 15 - Counting of grains and particles - Part 2

Lecture 16 - Counting of Grains and Particles - Part 3

Lecture 17 - Counting of Grains and Particles - Part 4

Lecture 18 - Other Applications of the Disector

Lecture 19 - Stereology of Anisotropic Microstructures

- Lecture 1 - Introduction to the course, Introduction to physical metallurgy of steels
- Lecture 2 - Martensitic transformation, Introduction to modern automotive steels
- Lecture 3 - Introduction to modern automotive steels
- Lecture 4 - Introduction to advanced high strength steels
- Lecture 5 - Introduction to Dual Phase Steel and TRIP Steel Heat Treatments
- Lecture 6 - Thermal and Mechanical Processing of TRIP and Hot Forming Steels
- Lecture 7 - Introduction to Welding Processes in Automotive Industries
- Lecture 8 - Principles of Resistance Spot Welding (RSW)
- Lecture 9 - Process Characteristics of Resistance Spot Welding - Part I
- Lecture 10 - Process Characteristics of Resistance Spot Welding - Part II
- Lecture 11 - Introduction to Laser Beam Welding - Part I
- Lecture 12 - Introduction to Laser Beam Welding - Part II
- Lecture 13 - Principles of Gas Metal Arc Welding - Part I
- Lecture 14 - Principles of Gas Metal Arc Welding - Part II
- Lecture 15 - Welding Metallurgy of Advanced High Strength Steels - Part I
- Lecture 16 - Microstructural Evolution During Welding of Advanced High Strength Steels
- Lecture 17 - Elemental Behaviour During Welding of Advanced High Strength Steels
- Lecture 18 - Quantification of Microstructural Constituents in Automotive Steel Welds - Part I
- Lecture 19 - Quantification of Microstructural Constituents in Automotive Steel Welds - Part II and Mechanical Properties
- Lecture 20 - Methodologies to Improve the Weldability of Advanced High Strength Steels

- Lecture 1 - Introduction to the course
- Lecture 2 - Classification of welding processes and definition of welding arc
- Lecture 3 - Physics of welding arc - Part 1
- Lecture 4 - Physics of welding arc - Part 2
- Lecture 5 - Physics of welding arc - Part 3
- Lecture 6 - Physics of welding arc - Part 4
- Lecture 7 - Fundamentals of ionisation in welding arc
- Lecture 8 - Electrical conductivity of welding arc
- Lecture 9 - Electrical resistivity of welding arc
- Lecture 10 - Heat transfer inside the arc
- Lecture 11 - Arc ignition mechanisms Part - I
- Lecture 12 - Arc ignition mechanisms Part - II
- Lecture 13 - Principles of Gas Tungsten Arc Welding
- Lecture 14 - Shielding gases for arc welding
- Lecture 15 - Selection of shielding gases for engineering alloys
- Lecture 16 - Arc welding power sources - Part 1
- Lecture 17 - Arc welding power sources - Part 2
- Lecture 18 - Arc welding power sources - Part 3
- Lecture 19 - Variations in GTAW process
- Lecture 20 - Square wave, variable polarity, GTAW with filler, hot wire GTAW
- Lecture 21 - Dual gas GTAW and Plasma Welding processes
- Lecture 22 - Multi cathode GTAW and Activated GTAW
- Lecture 23 - Buried GTAW and Rate controlling parameters of GTAW
- Lecture 24 - Introduction to consumable welding processes
- Lecture 25 - Melting rate of consumable wires
- Lecture 26 - Physics of droplet transfer in consumable welding
- Lecture 27 - Modes of droplet transfer - Part 1
- Lecture 28 - Modes of droplet transfer - Part 2
- Lecture 29 - Modes of droplet transfer - Part 3
- Lecture 30 - Shielded Metal Arc Welding
- Lecture 31 - Flux cored arc welding - Introduction

- Lecture 32 - Electrode fluxes and process characteristics of flux cored arc welding
- Lecture 33 - Flux cored arc welding - Process characteristics
- Lecture 34 - Advances in gas metal arc welding - Pulsed GMAW
- Lecture 35 - Advances in gas metal arc welding - Controlled dip short circuiting processes
- Lecture 36 - Submerged arc welding
- Lecture 37 - Resistance welding - Fundamentals
- Lecture 38 - Resistance spot welding - Part 1
- Lecture 39 - Resistance spot welding - Part 2
- Lecture 40 - Resistance spot welding - Part 3
- Lecture 41 - Resistance spot welding - Part 4
- Lecture 42 - Variants in resistance welding - Part 1
- Lecture 43 - Variants in resistance welding - Part 2
- Lecture 44 - Laser welding process - Introduction - Part 1
- Lecture 45 - Laser welding process - Part 2
- Lecture 46 - Laser welding process - Part 3
- Lecture 47 - Laser welding process - Part 4
- Lecture 48 - Electron beam welding process
- Lecture 49 - Other welding processes - Electroslag welding
- Lecture 50 - Magnetically Impelled Arc Butt (MIAB) welding
- Lecture 51 - Aluminothermic (thermit) welding
- Lecture 52 - Introduction to solid state welding processes - Friction welding
- Lecture 53 - Friction stir welding - Part 1
- Lecture 54 - Friction stir welding - Part 2
- Lecture 55 - Other solid state welding processes
- Lecture 56 - Joining processes for Plastics - Part 1
- Lecture 57 - Joining processes for Plastics - Part 2
- Lecture 58 - Adhesive bonding of plastics
- Lecture 59 - Welding nomenclatures

- Lecture 1 - Importance of studying creep
- Lecture 2 - Basics of plastic deformation and characteristics of dislocations - Part 1
- Lecture 3 - Basics of plastic deformation and characteristics of dislocations - Part 2
- Lecture 4 - Basics of plastic deformation and characteristics of dislocations - Part 3
- Lecture 5 - Creep and different factors that influence creep deformation - Part 1
- Lecture 6 - Creep and different factors that influence creep deformation - Part 2
- Lecture 7 - Creep and different factors that influence creep deformation - Part 3
- Lecture 8 - Creep and different factors that influence creep deformation - Part 4
- Lecture 9 - Creep and different factors that influence creep deformation - Part 5
- Lecture 10 - Creep and different factors that influence creep deformation - Part 6
- Lecture 11 - Mechanisms of Creep - Part 1
- Lecture 12 - Mechanisms of Creep - Part 2
- Lecture 13 - Mechanisms of Creep - Part 3
- Lecture 14 - Mechanisms of Creep - Part 4
- Lecture 15 - Mechanisms of Creep - Part 5
- Lecture 16 - Transitions in Creep Mechanisms and Creep Constitutive Equation
- Lecture 17 - Deformation Mechanism Maps - Part 1
- Lecture 18 - Deformation Mechanism Maps - Part 2
- Lecture 19 - Modeling the Useful Creep Life of Materials/Components - Part 1
- Lecture 20 - Modeling the Useful Creep Life of Materials/Components - Part 2
- Lecture 21 - Modeling the Useful Creep Life of Materials/Components - Part 3
- Lecture 22 - Creep Testing Methods - Part 1
- Lecture 23 - Creep Testing Methods - Part 2
- Lecture 24 - Improving Creep Resistance of Materials

- Lecture 1 - Nanotechnology Science and Applications - Introduction
- Lecture 2 - Nanotechnology : A Walk through History
- Lecture 3 - Discussion on Feynman's talk on Nanotechnology - Part I
- Lecture 4 - Discussion on Feynman's talk on Nanotechnology - Part II
- Lecture 5 - Impact of the nanoscale on thermodynamic considerations
- Lecture 6 - Phase Diagrams and Stable Phases
- Lecture 7 - Calorimetry
- Lecture 8 - Zirconia - ZrO₂
- Lecture 9 - Experimentally Investigating the Hall-Petch relationship
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[Lecture 34 - Analysis of Fluid Flow and Mixing in Tundish](#)

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Lecture 2 - Biomaterial

Lecture 3 - Biocompatibility

Lecture 4 - Host response

Lecture 5 - Tissue Eng

Lecture 6 - Scaffold

Lecture 7 - Bone structure

Lecture 8 - Bone properties

Lecture 9 - Implant - I

Lecture 10 - Implant - II

Lecture 11 - Proteins

Lecture 12 - Cell structure

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Lecture 14 - Antibacterial assay

Lecture 15 - Cell fate processes

Lecture 16 - Cell division

Lecture 17 - Cell differentiation

Lecture 18 - Stem cells

Lecture 19 - Osseointegration

Lecture 20 - In vivo testing

Lecture 21 - Cell-material interaction

Lecture 22 - Cell-signalling

Lecture 23 - In vitro testing

Lecture 24 - Cytotoxicity assays

Lecture 25 - Biocompatibility assay

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Lecture 27 - Clinical trials - II

Lecture 28 - Metal manufacturing

Lecture 29 - Ceramics manufacturing

Lecture 30 - Polymers manufacturing

Lecture 31 - Additive manufacturing

[Lecture 32 - HA-Ti-Toughness, Cell functionality](#)

[Lecture 33 - HA-CaTiO₃ development](#)

[Lecture 34 - HA- BaTiO₃ Functional Prop](#)

[Lecture 35 - HA-Ag antimicrob and cell viability](#)

[Lecture 36 - HA-ZnO, Cell fate and antimicrobial](#)

[Lecture 37 - Dental ceramics processing](#)

[Lecture 38 - Sr-based glass Ceramics](#)

[Lecture 39 - Acetabular socket \(Compression mold\)](#)

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[Lecture 39 - Live Session](#)

Lecture 1 - Tribology: Introduction

Lecture 2 - Surfaces and contacts

Lecture 3 - Friction: Laws and mechanisms

Lecture 4 - Contact temperature

Lecture 5 - Lubrication

Lecture 6 - Wear mechanisms: Adhesive wear

Lecture 7 - Wear mechanisms: Abrasive wear

Lecture 8 - Wear mechanisms: Tribochemical wear and Oxidative wear

Lecture 9 - Wear mechanisms: Fatigue wear and Fretting wear

Lecture 10 - Wear mechanisms: Erosive wear

Lecture 11 - Overview of tribological materials

Lecture 12 - Friction and wear of metal matrix composites

Lecture 13 - Overview: Bioceramics and Biocomposites

Lecture 14 - Fabrication of engineering polymers

Lecture 15 - Polymer Ceramic Composites for Orthopedic Applications

Lecture 16 - Processing concepts of ceramics

Lecture 17 - Mechanical properties of ceramics

Lecture 18 - Fracture and toughening of brittle solids

Lecture 19 - Sliding wear of SiC Ceramics

Lecture 20 - Sliding wear of SiC-WC Composites

Lecture 21 - Friction and wear of HDPE-HA-Al₂O₃

Lecture 22 - Wear behavior of bioceramics and biocomposites

Lecture 23 - Tribological behavior of dental restorative materials

Lecture 24 - Wear of transformation toughened zirconia

Lecture 25 - Fretting wear of SiAlON Ceramics

Lecture 26 - Tribochemistry in wear of cermets

Lecture 27 - Overview: nanoceramic composites

Lecture 28 - Wear of YSZ nanoceramics

Lecture 29 - Wear behavior of nanostructured WC-ZrO₂ nanocomposites

Lecture 30 - Erosive wear of SiC-WC composites

Lecture 31 - Overview: Cryogenic wear properties of materials

[Lecture 32 - Sliding wear of alumina ceramics and zirconia ceramics in cryogenic environment](#)

[Lecture 33 - Sliding wear of silicon carbide in cryogenic environment](#)

[Lecture 34 - Wear of TiB₂ Ceramic Composites](#)

[Lecture 35 - Erosive wear of ultra-high temperature NbB₂-based ceramic composites](#)

[Lecture 36 - Erosive wear of ultra-high temperature ZrB₂-based ceramic composites](#)

[Lecture 37 - Computational analysis in assessing wear](#)

[Lecture 38 - Basics of ceramics coating techniques](#)

[Lecture 39 - Erosive wear of WC-Co coating](#)

[Lecture 40 - Abrasive wear of WC-Co coating](#)

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[Lecture 5 - Water Pollutants \(Continued...\)](#)

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[Lecture 19 - Wetland Treatment and Bio-Technology Applications](#)

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[Lecture 23 - Soil Acidity](#)

[Lecture 24 - Soil Erosion](#)

[Lecture 25 - Mechanical Soil Erosion Control](#)

[Lecture 26 - Soil Erosion Prediction](#)

[Lecture 27 - Universal Soil Loss Equation](#)

[Lecture 28 - Air Pollutants](#)

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[Lecture 31 - Air Pollutants and Meteorology - Part 1](#)

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[Lecture 34 - Ground Level Concentration](#)

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[Lecture 36 - EIA, EMP & EA](#)

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Lecture 2 - Introduction to Blasting Technology

Lecture 3 - Rock Formation

Lecture 4 - Rock Formation (Continued...)

Lecture 5 - Rock Formation (Continued...)

Lecture 6 - Rock Properties and Testing - 1

Lecture 7 - Rock Properties and Testing - 2

Lecture 8 - Drilling Mechanism

Lecture 9 - Drillability of Rock

Lecture 10 - Drilling Machines - 1

Lecture 11 - Drilling Machines - 2

Lecture 12 - Drilling Pattern - 1

Lecture 13 - Drilling Pattern - 2

Lecture 14 - Special Drilling Methods - I

Lecture 15 - Special Drilling Methods - II

Lecture 16 - Explosives - 1

Lecture 17 - Explosives - 2

Lecture 18 - Explosives accessories - 1

Lecture 19 - Explosives accessories - 2

Lecture 20 - Explosives accessories - 3

Lecture 21 - Explosives properties - 1

Lecture 22 - Explosives properties - 2

Lecture 23 - Explosives properties - 3

Lecture 24 - Basics of blasting - 1

Lecture 25 - Basics of blasting - 2

Lecture 26 - Explosive storage and transportation - 1

Lecture 27 - Explosive storage and transportation - 2

Lecture 28 - Surface blasting - 1

Lecture 29 - Surface blasting - 2

Lecture 30 - Surface blast design

Lecture 31 - Underground blast design - 1

[Lecture 32 - Underground blast design - 2](#)

[Lecture 33 - Blasting results - 1](#)

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[Lecture 37 - Problems - 1](#)

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Lecture 1 - Introduction to Network Analysis

Lecture 2 - Introduction to network and some terminology

Lecture 3 - Construction of network

Lecture 4 - Introduction to activity on node diagram and comparison with arrow diagram

Lecture 5 - Rules of dummy job, redundancy and cycles

Lecture 6 - Critical path and its calculation

Lecture 7 - Algorithm for critical path early start and early finish times

Lecture 8 - Late start and late finish times algorithm

Lecture 9 - Understanding the slack

Lecture 10 - Examples of slacks and calculation of AON network

Lecture 11 - Project due dates and earliest completion time examples

Lecture 12 - CPM model and cost modelling

Lecture 13 - Lowest cost schedule and optimum schedule

Lecture 14 - Crashing and stretching of jobs

Lecture 15 - Crashing and stretching of jobs (Continued...)

Lecture 16 - Introduction to PERT

Lecture 17 - Expected length of critical path calculation with examples

Lecture 18 - Probability of completion of a project

Lecture 19 - Event oriented project management

Lecture 20 - Algorithm and computer program

Lecture 1 - Introduction to Mining Machinery - Part A

Lecture 2 - Introduction to Mining Machinery - Part B

Lecture 3 - Introduction to Machine Elements

Lecture 4 - Mechanical Transmission of Power

Lecture 5 - Shafts, Pulleys, Gears, and Geartrains Bearing and Brakes

Lecture 6 - Belt Drives, Chain Drives

Lecture 7 - Prime Movers

Lecture 8 - Fluid Power for Mining Machinery

Lecture 9 - Pneumatic Power for Mining Machinery

Lecture 10 - Steel Wire Rope : Types and Basic Calculation

Lecture 11 - Steel Wire Rope Maintenance

Lecture 12 - Principle of Rock - Tool Interaction

Lecture 13 - Site and Rock Preparation Equipment : Dozer Ripper

Lecture 14 - Site and Rock Preparation Equipment : Ripper

Lecture 15 - Drilling Machines for Mining

Lecture 16 - Site and Rock Preparation Equipment : Scraper

Lecture 17 - Site and Rock Preparation Equipment : Motor Grader

Lecture 18 - Surface Mining Machinery : Machinery for Cyclic Excavation : Electric Rope Shovel

Lecture 19 - Surface Mining Machinery : Machinery for Cyclic Excavation : Hydraulic Excavators and Back Hoe

Lecture 20 - Surface Mining Machinery : Machinery for Cyclic Excavation : Front End Loader

Lecture 21 - Surface Mining Machinery : Machinery for Cyclic Excavation : Dragline

Lecture 22 - Surface Mining Machinery : Machinery for Continuous Excavation : Bucket Wheel Excavator

Lecture 23 - Surface Mining Machinery : Machinery for Continuous Excavation : Bucket Chain Excavators

Lecture 24 - Surface Mining Machinery : Machinery for Continuous Excavation : Continuous Surface Miner

Lecture 25 - Surface Mining Machinery : Machinery for Continuous Excavation : Dredger

Lecture 26 - Underground Mining Machinery Loaders : Gathering Arm Loader

Lecture 27 - Underground Mining Machinery Loaders : Rocker Shovel and Side Discharge Loader

Lecture 28 - Underground Mining Machinery Loaders : Load Haul Dump (LHD) Loader

Lecture 29 - Underground Mining Machinery : Road Header

Lecture 30 - Underground Mining Machinery Underground Drills and Roof Bolter

Lecture 31 - Underground Mining Machinery Continuous Miner

[Lecture 32 - Underground Mining Machinery Shuttle Car](#)

[Lecture 33 - Longwall Mining Machinery Shearer](#)

[Lecture 34 - Longwall Mining Machinery Armored Face Conveyor](#)

[Lecture 35 - Longwall Mining Machinery Power Support](#)

[Lecture 36 - Mine Pumps](#)

[Lecture 37 - Mine Pumps : Special Pumps](#)

[Lecture 38 - Basic Pumping Theory](#)

[Lecture 39 - Air Compressor](#)

[Lecture 40 - Fans for Mining](#)

[Lecture 41 - Transportation Machinery for Surface Mines](#)

[Lecture 42 - Automobiles in Mines and Mining Truck](#)

[Lecture 43 - Off-highway Trucks](#)

[Lecture 44 - Off-highway Trucks : Rimpull Curves and Tires](#)

[Lecture 45 - Off-highway Trucks : Performance](#)

[Lecture 46 - Belt Conveyor](#)

[Lecture 47 - Belt Conveyor Design Criteria](#)

[Lecture 48 - Power Requirements for Belt Conveyor](#)

[Lecture 49 - Belt Conveyor Maintenance](#)

[Lecture 50 - Aerial Rope Ways](#)

[Lecture 51 - Machinery for Underground Mine Transport](#)

[Lecture 52 - Endless Rope Haulage](#)

[Lecture 53 - Rope Haulage in Underground Mines](#)

[Lecture 54 - Locomotive](#)

[Lecture 55 - Equipment for Shaft : Winding Machines](#)

[Lecture 56 - Mechanics of Hoisting](#)

[Lecture 57 - Low Profile Dumper](#)

[Lecture 58 - Maintenance of Mining Machinery](#)

[Lecture 59 - Maintenance Management Information System](#)

[Lecture 60 - Non Destructive Testing](#)

Lecture 1 - Metals and Civilisation

Lecture 2 - Mine Life Cycle

Lecture 3 - Present Status of Mineral Deposits

Lecture 4 - Present Status of Underground Mining

Lecture 5 - Terminology - I

Lecture 6 - Terminology - II

Lecture 7 - Determination of Cut Off Grade - I

Lecture 8 - Determination of Cut Off Grade - II

Lecture 9 - Determination of Cut Off Grade - III

Lecture 10 - Dilution

Lecture 11 - Recovery

Lecture 12 - Adit - I

Lecture 13 - Adit - II

Lecture 14 - Incline Shaft

Lecture 15 - Shaft - I

Lecture 16 - Shaft - II

Lecture 17 - Shaft - III

Lecture 18 - Horizontal Drivages - I

Lecture 19 - Horizontal Drivages - II

Lecture 20 - Horizontal Drivages - III

Lecture 21 - Horizontal Drivages - IV

Lecture 22 - Raising and Winzing - I

Lecture 23 - Raising and Winzing - II

Lecture 24 - Raising and Winzing - III

Lecture 25 - Raising and Winzing - IV

Lecture 26 - Selection of Mining Methods - I

Lecture 27 - Selection of Mining Methods - II

Lecture 28 - Selection of Mining Methods - III

Lecture 29 - Selection of Mining Methods - IV

Lecture 30 - Selection of Mining Methods - V

Lecture 31 - Breast Stopping

- Lecture 32 - Sampling Practices
- Lecture 33 - Stope and Pillar - I
- Lecture 34 - Stope and Pillar - II
- Lecture 35 - Room and Pillar Mining - I
- Lecture 36 - Room and Pillar Mining - II
- Lecture 37 - Tributary area method
- Lecture 38 - Pillar Failure
- Lecture 39 - Shrinkage Stopping - I
- Lecture 40 - Shrinkage Stopping - II
- Lecture 41 - Cut and Fill stoping - I
- Lecture 42 - Cut and Fill stoping - II
- Lecture 43 - Cut and Fill stoping - III [Post Pillar Method]
- Lecture 44 - Backfill Materials
- Lecture 45 - Backfill Materials - II
- Lecture 46 - Rock Bolting - I
- Lecture 47 - Rock Bolting - II
- Lecture 48 - Cable Bolting
- Lecture 49 - Sublevel Stopping
- Lecture 50 - Long Hole Stopping
- Lecture 51 - Resuing Method of Stopping
- Lecture 52 - Square Set Stopping
- Lecture 53 - Vertical Crater Retreat Method - I
- Lecture 54 - Vertical Crater Retreat Method - II
- Lecture 55 - Sublevel Caving - I
- Lecture 56 - Sublevel Caving - II
- Lecture 57 - Block Caving - I
- Lecture 58 - Block Caving - II
- Lecture 59 - Safety in U/G Metal Mines - I
- Lecture 60 - Safety in U/G Metal Mines - II

- Lecture 1 - Rocks Mineral and Ore
- Lecture 2 - Current Status of Surface Mining
- Lecture 3 - Stripping Ratios and Pit Layouts - I
- Lecture 4 - Stripping Ratios and Pit Layouts - II
- Lecture 5 - Stripping Ratios and Pit Layouts - III
- Lecture 6 - Phases of Surface Mining - I
- Lecture 7 - Phases of Surface Mining - II
- Lecture 8 - Phases of Surface Mining - III
- Lecture 9 - Opening Through Box Cut - I
- Lecture 10 - Opening Through Box Cut - II
- Lecture 11 - Drilling Technology for Surface Blasting - I
- Lecture 12 - Drilling Technology for Surface Blasting - II
- Lecture 13 - Drilling Technology for Surface Blasting - III
- Lecture 14 - Drilling Technology for Surface Blasting - IV
- Lecture 15 - Technology for Surface Blasting - I
- Lecture 16 - Technology for Surface Blasting - II
- Lecture 17 - Technology for Surface Blasting - III
- Lecture 18 - Technology for Surface Blasting - IV
- Lecture 19 - Technology for Surface Blasting - V
- Lecture 20 - Technology for Surface Blasting - VI
- Lecture 21 - Excavation by Ripper - I
- Lecture 22 - Excavation by Ripper - II
- Lecture 23 - Excavation by Ripper - III
- Lecture 24 - Excavation with Shovel - I
- Lecture 25 - Excavation with Shovel - II
- Lecture 26 - Excavation with Shovel - III
- Lecture 27 - Excavation with Shovel - IV
- Lecture 28 - Transportation in Surface Mines - I
- Lecture 29 - Transportation in Surface Mines - II
- Lecture 30 - Transportation in Surface Mines - III
- Lecture 31 - Excavation with Surface Miner - I

- Lecture 32 - Excavation with Surface Miner - II
- Lecture 33 - Excavation with Surface Miner - III
- Lecture 34 - Excavation with Surface Miner - IV
- Lecture 35 - Excavation with Surface Miner - V
- Lecture 36 - Excavation with Dragline - I
- Lecture 37 - Excavation with Dragline - II
- Lecture 38 - Excavation with Dragline - III
- Lecture 39 - Highwall Mining - I
- Lecture 40 - Highwall Mining - II
- Lecture 41 - Highwall Mining - III
- Lecture 42 - Excavation with Bucket Wheel Excavator - I
- Lecture 43 - Excavation with Bucket Wheel Excavator - II
- Lecture 44 - Excavation with Bucket Wheel Excavator - III
- Lecture 45 - Some Auxiliary Operations
- Lecture 46 - Haul Road - I
- Lecture 47 - Haul Road - II
- Lecture 48 - Haul Road - III
- Lecture 49 - Inland Transportation System - I
- Lecture 50 - Inland Transportation System - II
- Lecture 51 - Dimensional Stone Mining - I
- Lecture 52 - Dimensional Stone Mining - II
- Lecture 53 - Dimensional Stone Mining - III
- Lecture 54 - Seabed Mining -I
- Lecture 55 - Seabed Mining - II
- Lecture 56 - Stability Of Bench Slopes - I
- Lecture 57 - Stability Of Bench Slopes - II
- Lecture 58 - Stability Of Bench Slopes - III
- Lecture 59 - Closure Of Surface Mines - I
- Lecture 60 - Closure Of Surface Mines - II

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Designing Learner-Centric MOOCs (Multi-Disciplinary)

Co-ordinators : Dr.Sameer Sahasrabudhe, Prof.Sahana Murthy, Prof.Sridhar Iyer, Dr.Jayakrishnan M.

Lecture 1 - Perceptions of MOOC

Lecture 2 - Learner Expectation

Lecture 3 - Learner Engagement

Lecture 4 - Course Introduction

Lecture 5 - Evolution of MOOCs

Lecture 6 - Known Challenges

Lecture 7 - Why LCM?

Lecture 8 - The LCM Model

Lecture 9 - What is an LeD?

Lecture 10 - Chunking a Lecture into LeD

Lecture 11 - Introducing Reflection Spot

Lecture 12 - Making Your Own LeD

Lecture 13 - Doâ€™s and Donâ€™ts - Part 1

Lecture 14 - Doâ€™s and Donâ€™ts - Part 2

Lecture 15 - LeDs Takeaway

Lecture 16 - Reflection Spot - Part 1

Lecture 17 - Reflection Spot - Part 2

Lecture 18 - What is an LbD?

Lecture 19 - Creating LbDs

Lecture 20 - Constructive Customized Feedback in LbDs

Lecture 21 - Giving Feedback for Open Ended Questions

Lecture 22 - Recommendations for effective LbDs

Lecture 23 - What is an LxT?

Lecture 24 - Creating LxTs

Lecture 25 - Creating an Assimilation Quiz

Lecture 26 - What is an LxI?

Lecture 27 - Creating LxIs with Reflection Quiz

Lecture 28 - LxI- Sharing Experiences

Lecture 29 - LxI- How to Achieve Learner-Learner Interaction?

Lecture 30 - LxI- Types of focus questions - 1

Lecture 31 - LxI- Types of focus questions - 2

[Lecture 32 - Orchestrating your MOOC](#)

[Lecture 33 - Orchestration Dynamics in LCM](#)

[Lecture 34 - Assessment](#)

[Lecture 35 - From Regular course to LCM](#)

[Lecture 36 - Course Design in MOOC](#)

[Lecture 37 - Maintaining Learner Connect](#)

[Lecture 38 - Implementing the Learner-Centric Approach](#)

Lecture 1 - Introduction to Learning Analytics

Lecture 2 - LA, EDM and Academic Analytics

Lecture 3 - Types of Learning Analytics - I

Lecture 4 - Types of Learning Analytics - II

Lecture 5 - Data Collection

Lecture 6 - Data Collection in TELE

Lecture 7 - Data collection in MOOC

Lecture 8 - Multichannel Data

Lecture 9 - Ethics and Data Privacy in LA

Lecture 10 - Descriptive Analytics

Lecture 11 - Data Visualization

Lecture 12 - YouTube Analytics Dashboard

Lecture 13 - MOOCs Analytics Dashboard

Lecture 14 - Predictive Analytics

Lecture 15 - Linear Regression

Lecture 16 - Weka demo and how to read the results

Lecture 17 - MOOC data for Course Project

Lecture 18 - Summary of the Course

Lecture 1 - Course Preview

Lecture 2 - What is this course about?

Lecture 3 - Course Format_ Learner Centric MOOC (LCM)

Lecture 4 - E-Learning in STEM

Lecture 5 - Making online Teaching Decisions

Lecture 6 - Challenges in e-learning

Lecture 7 - What is Learner-centric Approach?

Lecture 8 - Promoting Learner Engagement with Content

Lecture 9 - Why and How to Design Interactive PDF?

Lecture 10 - What is an LeD?

Lecture 11 - Learning by Doing (LbD)

Lecture 12 - Articulation and Reflection

Lecture 13 - Construct your Own Understanding

Lecture 14 - Contextualized Learning

Lecture 15 - Feedback to Learners

Lecture 16 - Collaboration and Peer Learning

Lecture 17 - Addressing Diversity

Lecture 18 - Putting it All Together

Lecture 19 - Selection and Analysis of Effective Technology

Lecture 20 - Effective Integration of Technology

Lecture 21 - Instructional Design in e-learning

Lecture 22 - ADDIE Process of Instructional Design

Lecture 23 - Constructive Alignment

Lecture 24 - Implementing constructive alignment

Lecture 25 - Multimedia Principle and Contiguity Principle

Lecture 26 - Modality Principle and Redundancy Principle

Lecture 27 - Coherence Principle

Lecture 28 - Segmenting and Personalization Principles

Lecture 29 - Visual Communication Strategies for E-content

Lecture 30 - Forms of Learning

Lecture 31 - Integrating LC Elements in E-content

[Lecture 32 - E-learning Design Process](#)

[Lecture 33 - Closing](#)

NPTEL : NOC:Sustainable and Affordable Sanitation Solutions for Small Towns: Policy, Planning and Practice (Multi-Disciplinary)

Co-ordinators : Prof. N.C Narayanan

Lecture 1 - Introduction to the Issue of Sanitation

Lecture 2 - Overview of Sanitation in the country

Lecture 3 - Centralised or Decentralised?

Lecture 4 - Need for Participatory Planning

Lecture 5 - Context setting for the Alappuzha Project

Lecture 6 - Environmental Policy

Lecture 7 - Environmental Impact Assessment 2006 and National Urban Sanitation Plan

Lecture 8 - Environmental Governance - Challenges and Alternatives

Lecture 9 - Municipal Solid Waste Management

Lecture 10 - MSWM - Status, Policy, governance structure

Lecture 11 - Integrated Municipal Solid Waste Management

Lecture 12 - Plastic Waste Management

Lecture 13 - Municipal Solid Waste Management in Alappuzha

Lecture 14 - Liquid Waste Management - an Overview

Lecture 15 - Introduction to Faecal Sludge Management

Lecture 16 - Faecal Sludge Management for Alappuzha town

Lecture 17 - Introduction to liquid waste treatment technologies

Lecture 18 - Decentralized Waste Water Treatment system - An Introduction

Lecture 19 - Case studies - Decentralised waste water treatment

Lecture 20 - Decentralized waste water treatment systems plan for Alappuzha

Lecture 21 - History of Sanitation in Alappuzha

Lecture 22 - Organic waste management in Alappuzha

Lecture 23 - Inorganic waste management - Role of Kudumbashree and Haritha Karma Sena

Lecture 24 - Youth engagement for reclaiming canals

Lecture 25 - Significance of institution building in reclaiming canals

- Lecture 1 - Introduction to Probability
- Lecture 2 - Consequences of Axioms
- Lecture 3 - Interpretation of Probability
- Lecture 4 - Total Probability law and Baye's Theorem - I
- Lecture 5 - Total Probability law and Baye's Theorem - II
- Lecture 6 - Random variables and Cumulative Density Function
- Lecture 7 - Discrete and Continuous random variables - I
- Lecture 8 - Discrete and Continuous random variables - II
- Lecture 9 - Expectation and Variance
- Lecture 10 - Function of Random variables
- Lecture 11 - Generating RVs, Joint Distribution of RVs
- Lecture 12 - Joint Distribution of RVs and Marginal densities
- Lecture 13 - Covariance of Random variables
- Lecture 14 - Moment Generating Functions
- Lecture 15 - Conditional PMF and PDF
- Lecture 16 - Law of Large numbers, Central Limit Theorem
- Lecture 17 - Application of Central Limit Theorem - I
- Lecture 18 - Application of Central Limit Theorem - II
- Lecture 19 - Gamma and Chi-square distributions
- Lecture 20 - Beta distributions and Exponential families
- Lecture 21 - Random Sampling, Sample mean and Sample variance
- Lecture 22 - Sampling from Gaussian distribution and t-distribution
- Lecture 23 - Student's t- distribution
- Lecture 24 - F-distribution and its properties
- Lecture 25 - Convergence of Random variables and Consistency
- Lecture 26 - Order statistics, Median and Percentiles
- Lecture 27 - Generating random sample-Direct method
- Lecture 28 - Generating random sample-Indirect method
- Lecture 29 - Introduction to python
- Lecture 30 - Python- Loops and Numpy library
- Lecture 31 - Sufficiency Principles and Sufficient Statistics

- Lecture 32 - Sufficient Statistics and Characterization of Sufficient Statistics
- Lecture 33 - Characterization of Sufficient Statistics and Factorization Theorem
- Lecture 34 - Example of Factorization Theorem, Minimal Sufficient Statistics
- Lecture 35 - Minimal sufficient statistics
- Lecture 36 - Test for minimal sufficient statistics with examples, Ancillary Statistics
- Lecture 37 - Likelihood Functions, Maximum Likelihood Estimator
- Lecture 38 - Method of moments, Baye's Estimator
- Lecture 39 - Evaluating Estimator, Cramer Rao Bound, Fisher Information
- Lecture 40 - Evaluating Estimator, Cramer Rao Bound, Fisher Information (Continued...)
- Lecture 41 - Hypothesis Testing, Likelihood Ratio Test
- Lecture 42 - Hypothesis Testing, Bayes Test
- Lecture 43 - Type I and II errors, Power Functions
- Lecture 44 - Type I and II errors, Power Functions (Continued...)
- Lecture 45 - Calculations of Power Functions
- Lecture 46 - Unbiased Test, Uniformly Most Powerful Test, Neyman- Pearson Lemma, Interval Estimation
- Lecture 47 - Interval Estimation
- Lecture 48 - Interval Estimation (Continued...)
- Lecture 49 - Construction of Confidence Intervals from tests
- Lecture 50 - Python- numpy and pandas functions II
- Lecture 51 - Tutology of tests and confidence intervals
- Lecture 52 - Tutology of tests and confidence intervals (Continued...)
- Lecture 53 - p-value, p-test of significance of a statistical test
- Lecture 54 - t-test and F-test, ANOVA
- Lecture 55 - Non-parametric test, Goodness of fit, Chi- squared test
- Lecture 56 - Distribution of Chi-squared test statistics
- Lecture 57 - Kolmogrov-Smirnov test
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Lecture 23 - Patent timelines - India and PCT

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DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Accreditation and Outcome based Learning (Multi-Disciplinary)

Co-ordinators : Prof. Shyamal Kumar Das Mandal

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Lecture 2 - Challenges and Needs of 21st Century Education

Lecture 3 - Accreditation

Lecture 4 - Accreditation (Continued...)

Lecture 5 - Outcome based Learning

Lecture 6 - Important Steps in Outcome based education

Lecture 7 - Introduction to Taxonomies of Learning and Cognitive Domains of Learning

Lecture 8 - Psychomotor Domain and Affective Domain of Learning

Lecture 9 - Instructional Objectives or Outcome

Lecture 10 - Need and Use of Instructional Objectives or Outcome

Lecture 11 - Example of Different Instructional Objectives or Outcome and their Cognitive Level

Lecture 12 - Outcome-based Curriculum Design

Lecture 13 - Outcome-based Curriculum Design (Continued...)

Lecture 14 - Outcome-based Curriculum Design software framework

Lecture 15 - Course outcome, Module outcome and lecture/unit outcome and teaching learning process

Lecture 16 - Mapping of outcome based curriculum with Graduate attribute

Lecture 17 - Introduction to Assessment and Evaluation

Lecture 18 - Formative Assessment and Summative Assessments

Lecture 19 - Test Item analysis

Lecture 20 - Test Item analysis (Continued...)

Lecture 21 - Evaluation Rubrics

Lecture 22 - Mission and Vision, Program Educational Objectives (PEOs), Program Outcome (PO) and their Consistency

Lecture 23 - Mapping of course outcome and Program Outcome

Lecture 24 - Attainment of Program outcome and course outcome

Lecture 25 - Calculation of direct attainment

Lecture 26 - Calculation of Indirect Attainment

Lecture 27 - Introduction to Tutored Video Instruction (TVI)

Lecture 28 - TVI Learning Improvement Data - as reported in literature

Lecture 29 - Use of TVI as ELNET-3L program

Lecture 30 - Lessons on Good Teaching from ELNET-3L

Lecture 31 - Evaluation of Teaching Quality

- [Lecture 32 - Evaluation of Teaching Quality - A Research Proposal](#)
- [Lecture 33 - Evaluation of Teaching Quality - A Research Proposal \(Continued...\)](#)
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- [Lecture 37 - Learning Styles and Learning Approaches](#)
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- [Lecture 41 - Teaching Learning Process using Outcome based Education](#)

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Introduction to Environmental Engineering and Science - Fundamental and Sustainability Concepts (Multi-Disciplinary)

Co-ordinators : Prof. Brajesh Kumar Dubey

- Lecture 1 - Sustainability Concepts - Innovations and Challenges
- Lecture 2 - Sustainability Concepts - Innovations and Challenges
- Lecture 3 - Basics and Sustainability Concepts and Evolution
- Lecture 4 - Engineering for Sustainability
- Lecture 5 - Life Cycle Thinking and Circular Economy
- Lecture 6 - Mass Concentration Units
- Lecture 7 - Partial Pressure Units
- Lecture 8 - Other Types of Units
- Lecture 9 - Units (Continued...), Qualitative and Quantitative Measurements
- Lecture 10 - Quantative Measurements Basics
- Lecture 11 - Ecology
- Lecture 12 - Energy Flow and Ecological Concepts
- Lecture 13 - Population
- Lecture 14 - Population, Consumption and Biodiversity
- Lecture 15 - Environmental Chemistry
- Lecture 16 - Mass Balance and Reactor Systems
- Lecture 17 - Mass Balance in Continuous Reactor / Continuous Stirred Tank Reactor (CSTR) and Plug Flow Reactor
- Lecture 18 - Plug Flow Reactor and Energy Flow
- Lecture 19 - Energy Balance and Earth Overshot Day
- Lecture 20 - Mass Transport Processes
- Lecture 21 - Oxygen Demand in Environmental Systems
- Lecture 22 - BOD Examples, Oxygen Levels in Surface Waters, COD
- Lecture 23 - Environmental Health Basics and SDGs
- Lecture 24 - Field Applications
- Lecture 25 - Nutrient Cycle
- Lecture 26 - Environmental Risk
- Lecture 27 - Risk Assessment Steps and EIA Introduction
- Lecture 28 - Environmental Risk Assessments with Concepts of EIA and LCA
- Lecture 29 - Environmental Risk Assessments with Concepts of EIA and LCA (Continued...)
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[Lecture 38 - Review of Sedimentation and Rapid Sand Filtration](#)

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Lecture 5 - Nature of Light - Part II (As Particle)

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Lecture 8 - Basic of Light-Matter Interaction

Lecture 9 - Molecular Materials

Lecture 10 - Introduction to Fluorescence

Lecture 11 - The Cell

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Lecture 15 - Remaining Topics

Lecture 16 - Light-Matter Interactions in Molecules (Basic of Spectroscopy)

Lecture 17 - Light-Matter Interactions in Molecules (Basic of Spectroscopy) (Continued...)

Lecture 18 - Interaction of Light with Cells

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Lecture 21 - Laser Principles and Operation

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Lecture 23 - Nonlinear Optical Processes

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Lecture 25 - Examples and Applications

Lecture 26 - Introduction

Lecture 27 - Microscopy Techniques

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Lecture 30 - The Future: AFM-IR

Lecture 31 - Biosensing Background

- Lecture 32 - Optical Fiber Sensors
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- Lecture 34 - Metamaterials as Biosensors
- Lecture 35 - Biosensing with Optical Nano-antennas
- Lecture 36 - Introduction to Photodynamic Therapy (PDT)
- Lecture 37 - Application of Photodynamic Therapy (PDT)
- Lecture 38 - Light Irradiation for Photodynamic Therapy (PDT)
- Lecture 39 - Real Life Examples of Photodynamic Therapy (PDT)
- Lecture 40 - Future of PDT and Photothermal Therapy (PTT)
- Lecture 41 - Laser Based Tissue Engineering
- Lecture 42 - Laser Tissue Contouring: Dermatological Application
- Lecture 43 - Laser Tissue Welding and Tissue Regeneration
- Lecture 44 - Laser Tissue Contouring: Ophthalmic Application
- Lecture 45 - Laser in Dentistry
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- Lecture 54 - Thin Film Deposition
- Lecture 55 - Bionanophotonics Applications
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- Lecture 60 - Summary and Revisiting Few topics

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- Lecture 3 - Kinetic Theory of Gases, Physical Parameters of Vacuum and Regions of Vacuum
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- Lecture 17 - Ion Pumping-Sputter Ion Pump
- Lecture 18 - Turbomolecular Pump
- Lecture 19 - Cryopumps
- Lecture 20 - Selection Criteria of Vacuum Pumps
- Lecture 21 - Primary vs Secondary Gauges, U Tube/McLeod gauges (Primary)
- Lecture 22 - Bourdon/Capacitance Gauges (Mechanical Deflection)
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- Lecture 25 - Penning/ Inverted Magnetron gauges, Gauge calibration
- Lecture 26 - Vacuum Materials (Metals, Glasses, Ceramics, Greases and Oils)
- Lecture 27 - Vacuum Components (Flanges, Couplings, Seals, Valves)
- Lecture 28 - Vacuum Chamber Design
- Lecture 29 - Fabrication Techniques for Vacuum Systems
- Lecture 30 - Testing of Vacuum Systems for Mechanical Failures, Gas Leaks and Outgassing
- Lecture 31 - Gas Flow at Low Pressures, Conductance and Effective Pumping Speed Concepts

- Lecture 32 - Conductance Calculations in Viscous Flow Region
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- Lecture 34 - Transition and Choked Flows
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- Lecture 42 - Vacuum for Food Processing
- Lecture 43 - Vacuum Technology in the Packaging Industry
- Lecture 44 - Vacuum in Wood Industry
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- Lecture 46 - Vacuum for Desalination of Sea Water and Treatment of Waste Water
- Lecture 47 - Vacuum Technology for Power Sector
- Lecture 48 - Vacuum Technology In Oil and Gas Industries
- Lecture 49 - Vacuum Technology in LNG industry
- Lecture 50 - Vacuum Technology for Cryogenic Applications
- Lecture 51 - Vacuum Technology in High Speed Transportation (Hyperloop and Maglev)
- Lecture 52 - Vacuum technology for Metallurgical applications
- Lecture 53 - Vacuum Technology for Analytical Instruments
- Lecture 54 - Vacuum based coating units for thin film deposition
- Lecture 55 - Vacuum for solar energy (Thermal and PV)
- Lecture 56 - Vacuum Technology for semiconductor chip manufacturing
- Lecture 57 - Vacuum Technology for Display Systems
- Lecture 58 - Vacuum Technology for Nuclear Applications - Part I
- Lecture 59 - Vacuum Technology for Nuclear Applications - Part II
- Lecture 60 - Vacuum technology for Space Applications

- Lecture 1 - Brief history of public health
- Lecture 2 - Scope and Evolution of Health Promotion and Education
- Lecture 3 - Ottawa Charter
- Lecture 4 - Principles of health promotion
- Lecture 5 - Settings and audiences for health promotion
- Lecture 6 - Concepts of Health Behavior
- Lecture 7 - Health Risk Behavior Vs Health Promotion Behavior
- Lecture 8 - Concepts of Health Communication - Part I
- Lecture 9 - Concepts of Health Communication - Part II
- Lecture 10 - Health Literacy
- Lecture 11 - Information Education and Communication (IEC)
- Lecture 12 - Behavior Change Communication (BCC) - Part I
- Lecture 13 - Behavior Change Communication (BCC) - Part II
- Lecture 14 - Social and Behavior Change Communication (SBCC) - Part I
- Lecture 15 - Social and Behavior Change Communication (SBCC) - Part II
- Lecture 16 - Need Assessment for Health Promotion
- Lecture 17 - Approaches for Health Promotion and Behavior Change
- Lecture 18 - Models of Individual Health Behavior
- Lecture 19 - Models of Inter-Personal Health Behaviour
- Lecture 20 - Community and Group Models of Health Behavior Change
- Lecture 21 - Planning HPE Intervention - Part I
- Lecture 22 - Planning HPE Intervention - Part II
- Lecture 23 - Implementing HPE Intervention - Part I
- Lecture 24 - Implementing HPE Intervention - Part II
- Lecture 25 - Monitoring HPE Intervention
- Lecture 26 - Principles of Designing Messages
- Lecture 27 - Processes and Approaches of Designing Messages - Part I
- Lecture 28 - Processes and Approaches of Designing Messages - Part II
- Lecture 29 - Overview of Pretesting
- Lecture 30 - Pretesting of Health Promotion and Education Tools
- Lecture 31 - Health Education Methods - Part I

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[Lecture 36 - Evaluation of Theory-based HPE Interventions - Part I](#)

[Lecture 37 - Evaluation of Theory-based HPE Interventions - Part II](#)

[Lecture 38 - Analyzing Health Behavior Change Data](#)

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Lecture 2 - Cerebellum

Lecture 3 - Basal Ganglia

Lecture 4 - Thalamus and Hypothalamus

Lecture 5 - Cerebral Cortex

Lecture 6 - Synapse and Neurotransmitters - 1

Lecture 7 - Synapse and Neurotransmitters - 2

Lecture 8 - Limbic System

Lecture 9 - Physiology of Emotions

Lecture 10 - Reticular Formation

Lecture 11 - Electrical activity of brain

Lecture 12 - Descriptive Psychopathology

Lecture 13 - Principles of Personality Development

Lecture 14 - Schizophrenia

Lecture 15 - Mood Disorders - 1

Lecture 16 - Mood Disorders - 2

Lecture 17 - Anxiety Disorders - I

Lecture 18 - Anxiety Disorders - II

Lecture 19 - Eating Disorders

Lecture 20 - Physiology of sleep

Lecture 21 - Sleep Disorders

Lecture 22 - Learning and Memory - 1

Lecture 23 - Learning and Memory - 2

Lecture 24 - Neurocognitive Disorders - I

Lecture 25 - Neurocognitive Disorders - II

Lecture 26 - Substance - I

Lecture 27 - Substance - II

Lecture 28 - Physiology of sensations

Lecture 29 - Psychosomatic Illness

Lecture 30 - Emergency Psychiatry

Lecture 31 - Child Psychiatry - I

[Lecture 32 - Child Psychiatry - II](#)

[Lecture 33 - Psychotherapy - I](#)

[Lecture 34 - Psychotherapy - II](#)

[Lecture 35 - Psychological Tests](#)

[Lecture 36 - Anti-psychotic drugs](#)

[Lecture 37 - Antidepressants](#)

[Lecture 38 - Mood Stabilizer](#)

[Lecture 39 - Anti-anxiety drugs](#)

[Lecture 40 - Forensic Psychiatry](#)

Lecture 1 - Introduction to Reliability Engineering

Lecture 2 - Introduction to Reliability Engineering

Lecture 3 - Introduction to Reliability Engineering

Lecture 4 - Probability Basics

Lecture 5 - Probability Basics (Continued...)

Lecture 6 - Constant Failure Rate Model - I

Lecture 7 - Constant Failure Rate Model - II

Lecture 8 - Constant Failure Rate Model - III

Lecture 9 - Two Parameter Exponential Distribution

Lecture 10 - Weibull Distribution (2 Parameter)

Lecture 11 - Burn-in Screening for Weibull

Lecture 12 - Weibull Distribution

Lecture 13 - Normal Distribution

Lecture 14 - Lognormal Distribution

Lecture 15 - System Reliability Modelling

Lecture 16 - System Reliability Modelling (Continued...)

Lecture 17 - System Reliability Modelling (Continued...)

Lecture 18 - System Reliability Modelling (Continued...)

Lecture 19 - System Reliability Modelling (Continued...)

Lecture 20 - System Reliability Modelling (Continued...)

Lecture 21 - Markov Analysis

Lecture 22 - Markov Analysis (Continued...)

Lecture 23 - Markov Analysis (Continued...)

Lecture 24 - Markov Analysis (Continued...)

Lecture 25 - Markov Analysis (Continued...)

Lecture 26 - Failure Data Analysis: Non-Parametric Approach

Lecture 27 - Failure Data Analysis: Non-Parametric Approach (Continued...)

Lecture 28 - Failure Data Analysis: Non-Parametric Approach (Continued...)

Lecture 29 - Failure Data Analysis: Non-Parametric Approach (Continued...)

Lecture 30 - Failure Data Analysis (Parametric)

Lecture 31 - Failure data analysis (Parametric) (Continued...)

[Lecture 32 - Failure data analysis \(Parametric\) \(Continued...\)](#)

[Lecture 33 - Goodness of fit](#)

[Lecture 34 - Goodness of Fit \(GoF\) Tests](#)

[Lecture 35 - Goodness of Fit \(GoF\) Tests \(Continued...\)](#)

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[Lecture 37 - Maintainability and Availability \(Continued...\)](#)

[Lecture 38 - Maintainability and Availability \(Continued...\)](#)

[Lecture 39 - Maintainability and Availability \(Continued...\)](#)

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Lecture 3 - Translational Research and Nano Biosensing

Lecture 4 - Nanomaterials for Healthcare Biosensing

Lecture 5 - Signal Amplification for Ultrasensitive Biosensors

Lecture 6 - Signal Amplification for Ultrasensitive Biosensors (Continued...)

Lecture 7 - Signal Amplification for Ultrasensitive Biosensors (Continued...)

Lecture 8 - Signal Amplification for Ultrasensitive Biosensors (Continued...)

Lecture 9 - Different Measurement Techniques for Electrochemical Biosensors

Lecture 10 - Limit of Detection and Wash-Free Detection for Biosensors

Lecture 11 - Wash-Free Detection for Biosensors (Continued...)

Lecture 12 - Label-Free Detection for Biosensors

Lecture 13 - Label-free detection and Multiplex Biosensors

Lecture 14 - Multiplex Biosensors (Continued...)

Lecture 15 - Strategy for Electrochemical Detection and Tuning of Electrocatalytic Activities

Lecture 16 - Enhanced electrocatalytic activity for biosensors

Lecture 17 - Strategy for Electrochemical Detection and Tuning of Electrocatalytic Activities

Lecture 18 - Strategy for Electrochemical Detection and Tuning of Electrocatalytic Activities

Lecture 19 - Strategy for Electrochemical Detection and Tuning of Electrocatalytic Activities

Lecture 20 - Strategy for Electrochemical Detection and Tuning of Electrocatalytic Activities

Lecture 21 - Strategy for Electrochemical Detection and Tuning of Electrocatalytic Activities

Lecture 22 - Strategy for Electrochemical Detection and Tuning of Electrocatalytic Activities

Lecture 23 - Effect of pretreatment on PCB and biosensor development

Lecture 24 - Impact of surface Roughness of PCB and PCB for Glucose sensors

Lecture 25 - Tutorial on Biosensors Fabrication

Lecture 26 - Tutorial on Biosensors Fabrication (Continued...)

Lecture 27 - Tutorial on Biosensors Fabrication (Continued...)

Lecture 28 - Tutorial on Biosensors Fabrication (Continued...)

Lecture 29 - Tutorial on Biosensors Fabrication (Continued...)

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Lecture 31 - Self-Powered Biosensors

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[Lecture 33 - Research Proposal and Ethical Clearance](#)

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[Lecture 39 - Lab Demonstration - 2](#)

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- Lecture 1 - Adolescent Health Statistics
- Lecture 2 - Introduction to Nutrition and Dietetics
- Lecture 3 - Role of Macronutrients
- Lecture 4 - Role of Micronutrients
- Lecture 5 - Basics of Adolescent Mental Health
- Lecture 6 - Physiological and Psychological changes during Adolescence
- Lecture 7 - Special Nutritional Requirements in Adolescents
- Lecture 8 - Malnutrition in Adolescents and their effects in Adult life
- Lecture 9 - Adolescent Immunization
- Lecture 10 - High risk behaviour in Adolescents
- Lecture 11 - Nutrition Care Process
- Lecture 12 - Dietary Counseling and Nutrition Planning
- Lecture 13 - Common Micronutrient Deficiency in Adolescents
- Lecture 14 - Eating Disorders in Adolescents
- Lecture 15 - National Initiatives related to Adolescents
- Lecture 16 - Behavior Modification for Weight Management
- Lecture 17 - Adolescents And Physical Activity
- Lecture 18 - Combating Special Situations
- Lecture 19 - Legislations for Adolescents
- Lecture 20 - Innovations for Holistic Well-being of Adolescents

- Lecture 1 - Basics of Health Promotion
- Lecture 2 - Basic Principles of Health Promotion
- Lecture 3 - The Health Promotion Research Process
- Lecture 4 - Process of Health Promotion Research: Integrity and Rigor
- Lecture 5 - Ethics in Health Promotion Research
- Lecture 6 - Health Behavior and Health Behavior Change
- Lecture 7 - Theory, Research and Behavior Change Techniques
- Lecture 8 - Intervention Mapping
- Lecture 9 - Ecological Models of Health Behavior
- Lecture 10 - Social Science Techniques
- Lecture 11 - Precede-Proceed Model
- Lecture 12 - Models of Individual Health Behavior - I
- Lecture 13 - Models of Individual Health Behavior - II
- Lecture 14 - Models of Interpersonal Health Behavior
- Lecture 15 - Community and Group Models of Health Behavior Change
- Lecture 16 - Research design and techniques
- Lecture 17 - Observational research designs
- Lecture 18 - Experimental Research Designs
- Lecture 19 - Experimental Research Designs: Issues and Challenges
- Lecture 20 - Measurements in Health promotion
- Lecture 21 - Qualitative methods in Health Promotion - Part I
- Lecture 22 - Qualitative Methods in Health Promotion - Part II
- Lecture 23 - Qualitative Methods in Health Promotion - Part III
- Lecture 24 - Qualitative Methods in Health Promotion - Part IV
- Lecture 25 - Qualitative Methods in Health Promotion - Part V
- Lecture 26 - Introduction to Mixed Methods Research
- Lecture 27 - The Convergent Design
- Lecture 28 - The Explanatory Sequential Design
- Lecture 29 - The Exploratory Sequential Design (Continued...)
- Lecture 30 - The Embedded Design
- Lecture 31 - Different study tools and their application in health promotion research

- Lecture 32 - Formulating an appropriate study tool (Quantitative data collection tools)
- Lecture 33 - Validity and reliability of study tools in quantitative research - Part I
- Lecture 34 - Validity and reliability of study tools in quantitative research - Part II
- Lecture 35 - Formulating an appropriate study tool(Qualitative data collection tools)
- Lecture 36 - Designing messages - Part I
- Lecture 37 - Designing messages - Part II
- Lecture 38 - Materials and Methods of Intervention Delivery - Part I
- Lecture 39 - Materials and Methods of Intervention Delivery - Part II
- Lecture 40 - Pretesting of an intervention tool
- Lecture 41 - BCC and SBCC - Part I
- Lecture 42 - BCC and SBCC - Part II
- Lecture 43 - BCC and SBCC - Part III
- Lecture 44 - BCC and SBCC - Part IV
- Lecture 45 - BCC and SBCC - Part V
- Lecture 46 - Community-Based Participatory Research in context to Health Promotion - Part I
- Lecture 47 - Community-Based Participatory Research in context to Health Promotion - Part II
- Lecture 48 - Community-Based Participatory Research in context to Health Promotion - Part III
- Lecture 49 - Community-Based Participatory Research in context to Health Promotion - Part IV
- Lecture 50 - Community-Based Participatory Research in context to Health Promotion - Part V
- Lecture 51 - Quantitative analytical methods - Part I
- Lecture 52 - Quantitative analytical methods - Part II
- Lecture 53 - Quantitative analytical methods - Part III
- Lecture 54 - Analysis of Qualitative data
- Lecture 55 - Analyzing Mixed Methods data
- Lecture 56 - Developing a research proposal in health promotion
- Lecture 57 - Report writing in health Promotion: An Overview
- Lecture 58 - Report writing: quantitative research in health promotion - Part I
- Lecture 59 - Report writing: quantitative research in health promotion - Part II
- Lecture 60 - Report Writing: Qualitative and Mixed Methods research

Lecture 0 - Neuroscience of Human Movement

Lecture 1 - Membrane Physiology - Part 1

Lecture 2 - Membrane Physiology - Part 2

Lecture 3 - Nernst Equation

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Lecture 5 - Action Potential - Part 1

Lecture 6 - Action Potential - Part 2

Lecture 7 - Action Potential - Part 3

Lecture 8 - Action Potential - Part 4

Lecture 9 - Action Potential - Part 5

Lecture 10 - Review of Action Potential and Neurotransmitters

Lecture 11 - Neuromuscular Junction

Lecture 12 - Disorders of Neuromuscular Junction

Lecture 13 - Skeletal Muscles - Part 1

Lecture 14 - Skeletal Muscles - Part 2

Lecture 15 - Skeletal Muscles - Part 3

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Lecture 17 - Muscle force production

Lecture 18 - Motor Units - Part 1

Lecture 19 - Motor Units - Part 2

Lecture 20 - Motor Units - PIC and EMG

Lecture 21 - Receptors - Part 1

Lecture 22 - Receptors - Part 2

Lecture 23 - Spine and Spinal Cord

Lecture 24 - Excitation and Inhibition within Spinal Cord - Part 1

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[Lecture 36 - Terminology : Directional Terms and Planes \(Primary Motor Cortex - Part - 1\)](#)

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Lecture 1 - How is TB affecting public health Globally and Nationally

Lecture 2 - Epidemiology of TB-Session - 1

Lecture 3 - Epidemiology of TB-Session - 2

Lecture 4 - Pathogenesis of TB-Session - 1

Lecture 5 - Pathogenesis of TB-Session - 2

Lecture 6 - Clinical manifestations of TB-Session - 1

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Lecture 9 - Bacteriological Diagnosis of Tuberculosis - Smear and Culture

Lecture 10 - Demonstration of processing of sputum specimen for culture for diagnosis of tuberculosis

Lecture 11 - Demonstration of sputum smear examination for diagnosis of tuberculosis

Lecture 12 - Demonstration of solid culture method for diagnosis of tuberculosis

Lecture 13 - Demonstration of liquid culture method for diagnosis of tuberculosis in sputum

Lecture 14 - Phenotypic drug susceptibility testing in Tuberculosis

Lecture 15 - Demonstration of drug susceptibility testing of first line anti-TB drugs by liquid culture

Lecture 16 - Molecular Diagnosis of Tuberculosis-Session - 1

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Lecture 18 - Demonstration of Xpert MTB-RIF assay for diagnosis of tuberculosis from sputum specimens

Lecture 19 - Demonstration of Line Probe Assay (LPA) (Direct detection of tuberculosis and resistance to isoniazid and rifampicin) in sputum

Lecture 20 - Radiology in diagnosis of Tuberculosis-Session - 1

Lecture 21 - Radiology in diagnosis of Tuberculosis-Session - 2

Lecture 22 - Radiology in diagnosis of Tuberculosis-Session - 3

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Lecture 24 - Approach to diagnosis of Pulmonary TB

Lecture 25 - Case Discussion-Approach to diagnosis of TB in a person with presumptive pulmonary TB

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Lecture 27 - Approach to diagnosis of Extra-pulmonary TB

Lecture 28 - Case Discussion-Approach to diagnosis of TB in a person with swelling in the neck

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Lecture 30 - Diagnosis of Childhood Tuberculosis-Session - 1

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Lecture 32 - Video demonstration of gastric fluid aspiration technique in a child

Lecture 33 - Case Discussion-Approach to diagnosis of TB in a child with presumptive pulmonary TB

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Lecture 38 - Case discussion-Approach to treatment of drug sensitive TB

Lecture 39 - Management of drug resistant Tuberculosis-Session - 1

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Lecture 41 - Case discussion-Approach to treatment of Multi-drug resistant TB (MDR-TB)/ Extensively drug resistant TB (XDR-TB)

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Lecture 43 - Management of Extra-pulmonary Tuberculosis-Session - 2

Lecture 44 - Panel discussion-Practical difficulties in the management of Extra-pulmonary TB

Lecture 45 - Management of patients with HIV-TB coinfection-Session - 1

Lecture 46 - Management of patients with HIV-TB coinfection-Session - 2

Lecture 47 - Case discussion-Approach to management of HIV-TB

Lecture 48 - Management of TB in special situations

Lecture 49 - Case discussion-Approach to management of TB in pregnancy

Lecture 50 - Treatment of Pediatric Tuberculosis-Session - 1

Lecture 51 - Treatment of Pediatric Tuberculosis-Session - 2

Lecture 52 - Management of Adverse effects to anti-TB drugs-Session - 1

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Lecture 54 - Case discussion-Approach to management of jaundice during anti-TB treatment

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Lecture 56 - Non-tuberculous Mycobacteria- Diagnosis and Clinical management-Session - 1

Lecture 57 - Non-tuberculous Mycobacteria - Diagnosis and Clinical Management Session - 2

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Lecture 3 - Dams

Lecture 4 - Adayar River

Lecture 5 - Adayar River

Lecture 6 - Urbanisation in Western Ghats and Biodiesel

Lecture 7 - Use And Throw Plastic

Lecture 8 - Nano Materials Information Technology

Lecture 9 - Definition of Health Risk

Lecture 10 - Transport Of Pollutants in the Environment

Lecture 11 - Assesment of Risk

Lecture 12 - Remediation and Liability

Lecture 13 - Remendiation and Liability

Lecture 14 - Life Cycle Analysis

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Lecture 16 - Energy and Environment module - 2

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Lecture 22 - Drinking Water Supply: Need and Challenges

Lecture 23 - Drinking Water Supply: Need and Challenges

Lecture 24 - Water Quality Standards And Philosophy of Water Treatment

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Lecture 27 - Wastewater Recycling: A Sustainable Option For Water Management

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- Lecture 45 - Multi-Variable Newton-Raphson
- Lecture 46 - Out of Syllabus: Improvements to NR Methods
- Lecture 47 - Out of Syllabus: Roots of a polynomial
- Lecture 48 - Summary
- Lecture 49 - Introduction: Regression and Interpolation
- Lecture 50 - Linear Regression in One Variable
- Lecture 51 - Recap: Formula for Linear Regression
- Lecture 52 - Bonus: Linear Regression using MS-Excel
- Lecture 53 - Linear Regression in Multiple Variables
- Lecture 54 - Matrix Method for Multi-Linear Regression
- Lecture 55 - Polynomial Regression
- Lecture 56 - Functional Regression
- Lecture 57 - Bonus: X-Y versus Y-X data (Using MS Excel)
- Lecture 58 - Interpolation: Introduction and A Na^{ve} Extension
- Lecture 59 - Bonus: MS-Excel for Na^{ve} Interpolation
- Lecture 60 - Lagrange Interpolating Polynomials
- Lecture 61 - Newton's Forward Difference Polynomial
- Lecture 62 - Newton's Divided Differences: Derivation
- Lecture 63 - Interpolation Examples
- Lecture 64 - Bonus: MS-Excel for Newton's Polynomial

Lecture 65 - Summary: Regression and Interpolation

Lecture 66 - Numerical Differentiation: Introduction

Lecture 67 - Numerical Differentiation Formula and Analysis

Lecture 68 - Derivation using Method of undetermined coefficients

Lecture 69 - Three-point differentiation formulae

Lecture 70 - Bonus: Differentiation using MS-Excel

Lecture 71 - Truncation vs. Round-Off Errors

Lecture 72 - Numerical Differentiation Examples

Lecture 73 - Summary of Numerical Differentiation

Lecture 74 - Numerical Integration: Introduction

Lecture 75 - Trapezoidal rule and Derivation

Lecture 76 - Simpson's Rules for Integration

Lecture 77 - Bonus: MS-Excel for Numerical Integration

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Lecture 79 - Numerical Integration Examples

Lecture 80 - Bonus: Integration using MS-Excel

Lecture 81 - Summary of Newton Cotes Formulae

Lecture 82 - Richardson's Extrapolation

Lecture 83 - Gauss Quadrature

Lecture 84 - Summary of Numerical Integration

Lecture 85 - Introduction to ODE-IVP

Lecture 86 - Motivation using an Example (Bonus)

Lecture 87 - Euler's Methods and Second-Order Methods

Lecture 88 - Second-Order Runge-Kutta Methods

Lecture 89 - Summary of RK-2

Lecture 90 - Higher order RK Methods

Lecture 91 - Bonus: ODE-IVP using MS-Excel

Lecture 92 - Bonus: RK-2 and RK-4 Methods using MS-Excel

Lecture 93 - Summary and Recap

Lecture 94 - Introduction to Predictor-Corrector Methods

Lecture 95 - Stability of Implicit Methods: Overview

Lecture 96 - Stability Analysis of Euler's Methods

Lecture 97 - Extension to multiple variables

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[Lecture 105 - Introduction to ODE-BVP](#)

[Lecture 106 - Shooting Method: An Overview](#)

[Lecture 107 - Finite Difference Method: An Overview](#)

[Lecture 108 - Solution using Shooting Method](#)

[Lecture 109 - Algorithm for Shooting Method](#)

[Lecture 110 - Problems with Shooting Method](#)

[Lecture 111 - Solving ODE-BVP using Finite Difference Method](#)

[Lecture 112 - Microsoft Excel based Solution](#)

[Lecture 113 - Recap of Week-12 \(ODE-BVP\)](#)

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- Lecture 2 - Formulating research question
- Lecture 3 - Literature review
- Lecture 4 - Measures of disease frequency
- Lecture 5 - Descriptive study designs
- Lecture 6 - Analytical study designs
- Lecture 7 - Experimental study designs: Clinical trials
- Lecture 8 - Validity of epidemiological studies
- Lecture 9 - Qualitative research methods: An overview
- Lecture 10 - Measurement of study variables
- Lecture 11 - Sampling methods
- Lecture 12 - Calculating sample size and power
- Lecture 13 - Selection of study population
- Lecture 14 - Study plan and project management
- Lecture 15 - Designing data collection tools
- Lecture 16 - Principles of data collection
- Lecture 17 - Data management
- Lecture 18 - Overview of data analysis
- Lecture 19 - Ethical framework for health research
- Lecture 20 - Conducting clinical trails
- Lecture 21 - Preparing a concept paper for research projects
- Lecture 22 - Elements of a protocol for research studies

Lecture 1 - Basic concepts and definitions - Part 1

Lecture 2 - Basic concepts and definitions - Part 2

Lecture 3 - Basic concepts and definitions - Part 3

Lecture 4 - Tutorial problems on exact and inexact differential

Lecture 5 - Basic concepts and definitions - Part 4

Lecture 6 - Work - Part 1

Lecture 7 - Work - Part 2

Lecture 8 - Work - Part 3

Lecture 9 - Work - Part 4

Lecture 10 - Work - Part 5

Lecture 11 - Tutorial problem on 'Work' - Part 1

Lecture 12 - Tutorial problem - Part 2

Lecture 13 - Tutorial problem on 'Work' - Part 3

Lecture 14 - Tutorial problem on 'Work' - Part 4

Lecture 15 - Zeroth law of thermodynamics

Lecture 16 - Methods of temperature measurement

Lecture 17 - Modes of heat transfer

Lecture 18 - Tutorial problem on 'Modes of heat transfer'

Lecture 19 - Tutorial problem on 'Methods of temperature measurement'

Lecture 20 - First law of thermodynamics

Lecture 21 - Tutorial problem - Part 1

Lecture 22 - Tutorial problem - Part 2

Lecture 23 - Heat and work interactions for a system

Lecture 24 - Tutorial problem - Part 1

Lecture 25 - Pure substance

Lecture 26 - Tutorial problem - Part 2

Lecture 27 - Ideal gas - Part 1

Lecture 28 - Ideal gas - Part 2

Lecture 29 - Tutorial problem - Part 3

Lecture 30 - Tutorial problem - Part 4

Lecture 31 - Tutorial problem - Part 5

- Lecture 32 - Specific heats at constant pressure and constant volume
- Lecture 33 - Tutorial problem - Part 6
- Lecture 34 - Tutorial problem - Part 7
- Lecture 35 - Ideal gas - Part 3
- Lecture 36 - Ideal gas - Part 4
- Lecture 37 - Ideal gas - Part 5
- Lecture 38 - Tutorial problem - Part 1
- Lecture 39 - Tutorial problem - Part 2
- Lecture 40 - Tutorial problem - Part 3
- Lecture 41 - Tutorial problem - Part 4
- Lecture 42 - Beyond ideal gases - Part 1
- Lecture 43 - Beyond ideal gases - Part 2
- Lecture 44 - Two phase system - Part 1
- Lecture 45 - Two phase system - Part 2
- Lecture 46 - Two phase system: water and steam
- Lecture 47 - Tutorial problems (2 numbers)
- Lecture 48 - Tutorial problem - Part 1
- Lecture 49 - Tutorial problem - Part 2
- Lecture 50 - Tutorial problem - Part 3
- Lecture 51 - Tutorial problems on two-phase systems (2 numbers)
- Lecture 52 - Tutorial problem (1 number)
- Lecture 53 - Rate equation of the first law of thermodynamics for a control mass and a control volume
- Lecture 54 - Energy equation for a steady-state, steady-flow process in selected engineering devices
- Lecture 55 - Tutorial problems (3 numbers)
- Lecture 56 - Tutorial problem - Part 1
- Lecture 57 - Tutorial problem - Part 2
- Lecture 58 - Quasi-static process revisited: Work against an external force
- Lecture 59 - Second law of thermodynamics: limitations of the first law of thermodynamics
- Lecture 60 - Second law of thermodynamics: direct and reverse heat engine
- Lecture 61 - Second law of thermodynamics: Kelvin-Planck and Clausius statements
- Lecture 62 - Second law of thermodynamics: reversible process
- Lecture 63 - Second law of thermodynamics: Carnot's cycle and theorems
- Lecture 64 - Second law of thermodynamics: absolute temperature scale

- Lecture 65 - Tutorial problems (2 numbers)
- Lecture 66 - Tutorial problem (1 number)
- Lecture 67 - Tutorial problem (1 number)
- Lecture 68 - Tutorial problem (2 numbers)
- Lecture 69 - Second law of thermodynamics: Clausius's inequality
- Lecture 70 - Entropy - Part 1
- Lecture 71 - Tutorial problem (1 number)
- Lecture 72 - Entropy - Part 2
- Lecture 73 - Entropy - Part 3
- Lecture 74 - Entropy - Part 4
- Lecture 75 - Tutorial problem (1 number)
- Lecture 76 - Tutorial problem (1 number)
- Lecture 77 - Tutorial problems (2 numbers)
- Lecture 78 - Entropy - Part 5
- Lecture 79 - Entropy - Part 6
- Lecture 80 - Entropy - Part 7
- Lecture 81 - Exergy - Part 1
- Lecture 82 - Exergy - Part 2
- Lecture 83 - Exergy - Part 3
- Lecture 84 - Thermodynamics cycles: Rankine cycle
- Lecture 85 - Tutorial problem (1 number)
- Lecture 86 - Thermodynamics cycles: Brayton cycle
- Lecture 87 - Tutorial problem (1 number)
- Lecture 88 - Thermodynamics cycles: vapor compression refrigeration cycle
- Lecture 89 - Tutorial problem (1 number)

Lecture 1 - Courses Overview

Lecture 2 - Medical device and in vitro diagnostics: Introduction and types of devices including combination devices

Lecture 3 - Medical Device Rules, 2017: Implications on medical devices

Lecture 4 - Classification of medical devices

Lecture 5 - Labelling of medical devices and in vitro diagnostics

Lecture 6 - Standards of medical device, quality assurance and testing

Lecture 7 - Regulatory requirements of biocompatibility of medical devices and ISO 10993

Lecture 8 - Clinical investigation of medical devices, regulation of investigational medical devices

Lecture 9 - Quality assurance and quality management system

Lecture 10 - How to obtain a licence to manufacture a medical device?

Lecture 11 - ISO 14971 (Medical devices: Application of risk management to medical devices)

Lecture 12 - Inspection of medical device and IVD establishments

Lecture 13 - Import and export of medical devices and IVDs

Lecture 14 - Medical device regulation: International practices

**NPTEL : NOC:Current Regulatory Requirements for Conducting Clinical Trials in India for Investigational New Drugs
(Version 2.0) (Multi-Disciplinary)**

Co-ordinators : Prof. Nandini K Kumar, Prof. Y. K. Gupta, Prof. D. K. Sable, Prof. Arun B. Ramteke, Prof. Rubina Bose, Prof. Sucheta Banerjee Kurundkar, Prof. Vishnu Rao

Lecture 1 - Courses Overview

Lecture 2 - Overview of Indian regulatory system

Lecture 3 - Overview of Drugs and Cosmetics Act and Rules thereunder

Lecture 4 - Overview of New Drugs and Clinical Trials Rules, 2019

Lecture 5 - Pre-Clinical Data Requirements

Lecture 6 - Rules Governing Clinical Trials

Lecture 7 - Phases of clinical trial, forms, and fees

Lecture 8 - Regulatory pathway and data requirements for NDCT, 2019

Lecture 9 - BA/BE study and study centers: Legal provisions

Lecture 10 - Guidelines to conduct BA/BE studies

Lecture 11 - Ethics Committee registration and re-registration

Lecture 12 - Ethical Considerations

Lecture 13 - Good Clinical Practice

Lecture 14 - Requirements for import/manufacture of new drug/IND for conducting clinical trials in India

Lecture 15 - Requirements for import/manufacture of new drug/IND for sale/ distribution and unapproved new drug for patients

Lecture 16 - Important issues

Lecture 17 - Special concern

Lecture 18 - Clinical trial related guidelines (NDCT Rules)

Lecture 19 - Content of Proposed Clinical Trial Protocol

Lecture 20 - Content of a Clinical Trial Report

Lecture 21 - Post Marketing Assessment and Clinical Trial Compensation

Lecture 22 - Common observations during submission of CT/BA/BE protocol

Lecture 23 - Common observations during CT/BA/BE centre inspections

Lecture 24 - Drug development process: Overview

Lecture 25 - Salient feature of NDCT 2019 - what's new in NDCT?

Lecture 26 - Online Submission 23A: Sugam

Lecture 27 - Online Submission (CTRI)

Lecture 28 - Tables Given in NDCT 2019 and its Content

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[Lecture 2 - Course Outline](#)

[Lecture 3 - Additional MATLAB Video - Array Operations](#)

[Lecture 4 - Additional MATLAB Video - Array Operations](#)

[Lecture 5 - Recap: Linear Algebra](#)

[Lecture 6 - Recap: Differential and Difference Equations](#)

[Lecture 7 - Recap: Process Control Basics](#)

[Lecture 8 - Introduction to Model Predictive Control](#)

[Lecture 9 - MPC: Salient Features](#)

[Lecture 10 - MPC: Historical Perspective](#)

[Lecture 11 - Vectors and Matrices](#)

[Lecture 12 - Vector Spaces](#)

[Lecture 13 - Linear Operation](#)

[Lecture 14 - Null and Image Spaces](#)

[Lecture 15 - Eigenvalues and Eigenvectors](#)

[Lecture 16 - Eigenvalue Decomposition and Tutorial](#)

[Lecture 17 - Recap of Week-2](#)

[Lecture 18 - Model Classification](#)

[Lecture 19 - Discrete-Time Models Overview](#)

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[Lecture 21 - Finite Impulse Response Models](#)

[Lecture 22 - Finite Step Response Models](#)

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[Lecture 24 - State Space and Step Response Models](#)

[Lecture 25 - Nonlinear Models and Model Linearization](#)

[Lecture 26 - Model Types and Model Conversion](#)

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[Lecture 28 - Model Conversion: TF to SS](#)

[Lecture 29 - How to handle MIMO systems](#)

[Lecture 30 - Discretization of State-Space Models](#)

[Lecture 31 - Introduction to Dynamic Matrix Control \(DMC\)](#)

[Lecture 32 - The DMC Algorithm: Future Predictions](#)

[Lecture 33 - The DMC Algorithm: Objective and Constraints](#)

[Lecture 34 - The DMC Algorithm: Optimization](#)

[Lecture 35 - Coding for DMC Algorithm: Setup](#)

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[Lecture 37 - Recap of DMC Algorithm](#)

[Lecture 38 - Extensions of DMC Algorithm](#)

[Lecture 39 - LTI Models and Coordinate Transform](#)

[Lecture 40 - LTI Models: Stability](#)

[Lecture 41 - LTI Models: Controllability](#)

[Lecture 42 - LTI Models: Conditions for controllability](#)

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[Lecture 47 - Linear Quadratic Regulator: Batch Solution](#)

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[Lecture 49 - State Estimation: Introduction](#)

[Lecture 50 - Stochastic Processes and Random Variables](#)

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[Lecture 52 - Kalman Filter: Terminology](#)

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[Lecture 57 - LQG Derivation and Separation Principle](#)

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[Lecture 63 - State-Space MPC: Deterministic case](#)

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[Lecture 66 - Comparison of State-Space MPC with DMC](#)

[Lecture 67 - State-Space MPC: Disturbance Modeling](#)

[Lecture 68 - Disturbance Modeling: Background and Setup](#)

[Lecture 69 - Stochastic Output-Feedback State-Space MPC](#)

[Lecture 70 - Bonus Video: Disturbance Modeling for State Space MPC](#)

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[Lecture 73 - Recap of LQ Control and Linear MPC](#)

[Lecture 74 - Linear MPC - Key Features and Results](#)

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Lecture 2 - What is Science? - Part 2

Lecture 3 - Subjective Thinking Versus Objective Thinking

Lecture 4 - Idealism Versus Materialism

Lecture 5 - Causality - Part 1

Lecture 6 - Causality - Part 2

Lecture 7 - Logical Reasoning: Inductive Logic

Lecture 8 - Logical Reasoning: Deductive Logic - Part 1

Lecture 9 - Logical Reasoning: Deductive Logic - Part 2

Lecture 10 - Logical Reasoning: Syllogistic Logic - Part 1

Lecture 11 - Logical Reasoning: Syllogistic Logic - Part 2

Lecture 12 - Logical Reasoning: Syllogism Logic, Truth and Validity

Lecture 13 - Historical Perspective: Emergence of Materialism and Idealism - Part 1

Lecture 14 - Historical Perspective: Emergence of Materialism and Idealism - Part 2

Lecture 15 - Historical Perspective:Renaissance to the Development of Mechanical Materialism - Part 1

Lecture 16 - Historical Perspective:Renaissance to the Development of Mechanical Materialism - Part 2

Lecture 17 - Historical Perspective: The Advent of Empiricism and the Idea of Evolution

Lecture 18 - Historical Perspective: Science in Ancient India

Lecture 19 - Historical Perspective: The Advent of Scientific Materialism - Part 1

Lecture 20 - Historical Perspective: The Advent of Scientific Materialism - Part 2

Lecture 21 - Historical Perspective: The Rise and Fall of Positivism - Part 1

Lecture 22 - Historical Perspective: The Rise and Fall of Positivism - Part 2

Lecture 23 - What Scientists Actually Do - Part 1

Lecture 24 - What Scientists Actually Do - Part 2

Lecture 25 - Falsifiability and Reproducibility - Part 1

Lecture 26 - Falsifiability and Reproducibility - Part 2

Lecture 27 - Proposing a Hypothesis - Part 1

Lecture 28 - Proposing a Hypothesis - Part 2

Lecture 29 - Elements of Scientific Measurement - Part 1

Lecture 30 - Elements of Scientific Measurement - Part 2

Lecture 31 - The Central Limit Theorem and its Applications - Part 1

- Lecture 32 - The Central Limit Theorem and its Applications - Part 2
- Lecture 33 - Error Bars and Confidence Interval - Part 1
- Lecture 34 - Error Bars and Confidence Interval - Part 2
- Lecture 35 - Measurement of a Proportion - Part 1
- Lecture 36 - Measurement of a Proportion - Part 2
- Lecture 37 - Examples of Proportion Measurement
- Lecture 38 - Box and Whisker Plot
- Lecture 39 - Propagation of Errors - Part 1
- Lecture 40 - Propagation of Errors - Part 2
- Lecture 41 - Issues in Hypothesis Testing - Part 1
- Lecture 42 - Issues in Hypothesis Testing - Part 2
- Lecture 43 - Statistical Methods in Hypothesis Testing: Z-Test and T-Test - Part 1
- Lecture 44 - Statistical Methods in Hypothesis Testing: Z-Test and T-Test - Part 2
- Lecture 45 - Hypothesis Testing: The Chi-Square Test - Part 1
- Lecture 46 - Hypothesis Testing: The Chi-Square Test - Part 2
- Lecture 47 - Hypothesis Testing: The Chi-Square Test - Part 3
- Lecture 48 - Hypothesis Testing: The Chi-Square Test - Part 4
- Lecture 49 - Theoretical Research: Functional Relationships from Experimental Data - Part 1
- Lecture 50 - Theoretical Research: Functional Relationships from Experimental Data - Part 2
- Lecture 51 - Theoretical Research: Mathematical Models of Physical Systems
- Lecture 52 - Order of Magnitude Calculations
- Lecture 53 - Theoretical Research: Modeling Using Dimensional Analysis - Part 1
- Lecture 54 - Theoretical Research: Modeling Using Dimensional Analysis - Part 2
- Lecture 55 - An Example of Mathematical Modeling
- Lecture 56 - Importance of Theory-Building in Science
- Lecture 57 - Scientific Writing: Journal Papers - Part 1
- Lecture 58 - Scientific Writing: Journal Papers - Part 2
- Lecture 59 - Scientific Writing: Journal Papers - Part 3
- Lecture 60 - Scientific Writing: Journal Papers - Part 4
- Lecture 61 - Scientific Writing: PhD Thesis
- Lecture 62 - Scientific Writing: Text Stylistics
- Lecture 63 - Presentation in Scientific Conferences - Part 1
- Lecture 64 - Presentation in Scientific Conferences - Part 2

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[Lecture 67 - Ethical Conduct in Science: Aspects of Scientific Ethics](#)

[Lecture 68 - Ethical Conduct in Science: Research Misconduct](#)

[Lecture 69 - Ethical Conduct in Science: Ethics in Scientific Publication - Part 1](#)

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[Lecture 71 - Ethical Conduct in Science: Cases of Scientific Misconduct - Part 1](#)

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Lecture 1 - Vasovagal Syncope

Lecture 2 - Vasovagal Syncope - Clinical Scenario

Lecture 3 - Postural Hypotension

Lecture 4 - Postural Hypotension - Clinical Scenario

Lecture 5 - Hyperventilation

Lecture 6 - Hyperventilation - Clinical Scenario

Lecture 7 - Asthma - Status Asthmaticus - Part 1

Lecture 8 - Asthma - Status Asthmaticus - Part 2

Lecture 9 - Asthma - Clinical Scenario

Lecture 10 - Chest Pain Of Cardiac Origin - Myocardial Infarction And Anigina Pectoris - Part 1

Lecture 11 - Chest Pain Of Cardiac Origin - Myocardial Infarction And Anigina Pectoris - Part 2

Lecture 12 - Chest Pain - Clinical Scenario

Lecture 13 - Acute Adrenal Insufficiency

Lecture 14 - Acute Adrenal Insufficiency - Clinical Scenario

Lecture 15 - Diabetes Mellitus

Lecture 16 - Diabetes Mellitus - Clinical Scenario

Lecture 17 - Throid Dysfunction

Lecture 18 - Allergies/Hypersensitivity Reaction - Part 1

Lecture 19 - Allergies/Hypersensitivity Reaction - Part 2

Lecture 20 - Epilepsy- Status Epilepticus

Lecture 21 - Chronic Kidney Disease

Lecture 22 - Hepatic Dysfunction

Lecture 23 - Basic Life Support - Part 1

Lecture 24 - Basic Life Support - Part 2

Lecture 1 - Introduction to Ornithology

Lecture 2 - Diversity and Classification - Part 1

Lecture 3 - Diversity and Classification - Part 2

Lecture 4 - Evolution and Speciation - Part 1

Lecture 5 - Evolution and Speciation - Part 2

Lecture 6 - Anatomy

Lecture 7 - Physiology

Lecture 8 - Colour

Lecture 9 - Life History

Lecture 10 - Foraging Behaviour

Lecture 11 - Mating and Breeding Behaviour

Lecture 12 - Social Behaviour

Lecture 13 - Methods of Science and Research Questions

Lecture 14 - Vocal Behaviour: Mechanisms - Part 1

Lecture 15 - Vocal Behaviour: Mechanisms - Part 2

Lecture 16 - Vocal Behaviour: Ecology and Evolution - Part 1

Lecture 17 - Vocal Behaviour: Ecology and Evolution - Part 2

Lecture 18 - Vocal Mimicry in Birds

Lecture 19 - Basics of Research Design

Lecture 20 - Bird Migration - LIVE Guest Lectuer

Lecture 21 - Bird Populations: Concepts

Lecture 22 - Bird Communities: Concepts - Part 1

Lecture 23 - Bird Communities: Concepts - Part 2

Lecture 24 - Interactive Session by Dr Mousumi Ghosh (NCF) and Dr Umesh Srinivasan (IISc)

Lecture 25 - Studying bird populations and communities - Part 1

Lecture 26 - Studying bird populations and communities - Part 2

Lecture 27 - Mixed Species Flocks - Live Session

Lecture 28 - Interactive session with Dr. Priti Bangal (NCF) and Dr. Umesh Srinivasan (IISc)

Lecture 29 - Introduction to Data Visualisation Analysis - Part 1

Lecture 30 - Introduction to Data Visualisation Analysis - Part 2

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

[Lecture 31 - Basic Course in Ornithology - Guest Session on Avian Diseases](#)

[Lecture 32 - Biogeography](#)

[Lecture 33 - Macroecology](#)

[Lecture 34 - Macroecology - Case Study - LIVE](#)

[Lecture 35 - Week 10 Interactive session with Dr VV Robin and Dr Umesh Srinivasan](#)

[Lecture 36 - Bird Conservation - Concepts](#)

[Lecture 37 - Avian Conservation: Case study 1](#)

[Lecture 38 - Avian Conservation: Case study 2](#)

[Lecture 39 - Avian Conservation: Case study 3](#)

[Lecture 40 - Avian Conservation: Case study 4](#)

[Lecture 41 - Avian Conservation: Case study 5](#)

[Lecture 42 - LIVE - Citizen Science - Guest faculty by Dr Ashwin Viswanathan \(NCF\)](#)

[Lecture 43 - Molecular Techniques - Part 1](#)

[Lecture 44 - Molecular Techniques - Part 2](#)

- Lecture 1 - Craniofacial anatomy - Part 1
- Lecture 2 - Craniofacial anatomy - Part 2
- Lecture 3 - Tooth and It's Supporting Structures - Part 1
- Lecture 4 - Tooth and It's Supporting Structures - Part 2
- Lecture 5 - Specialised mucosa
- Lecture 6 - Saliva-Composition and functions
- Lecture 7 - Saliva Diagnostics
- Lecture 8 - Stem cells in the oro-dental region
- Lecture 9 - Stem cell isolation
- Lecture 10 - Mineralization dynamics - Part 1
- Lecture 11 - Mineralization dynamics - Part 2
- Lecture 12 - TMJ Anatomy and Function
- Lecture 13 - Oral defense mechanisms
- Lecture 14 - Mucosal and regional immunology
- Lecture 15 - Oral microbiome
- Lecture 16 - Evaluation of Oral microbiome
- Lecture 17 - Dysbiosis
- Lecture 18 - Molecular mechanisms in oral cancer
- Lecture 19 - Flow cytometry in cell and molecular biology
- Lecture 20 - Basics of Biomaterial science and engineering
- Lecture 21 - Biomimetics - Part 1
- Lecture 22 - Biomimetics - Part 2
- Lecture 23 - Biomaterials - Polymers
- Lecture 24 - Biomaterials - Metals
- Lecture 25 - Biomaterials - Ceramics and Colloids
- Lecture 26 - 3-D Bioprinting
- Lecture 27 - Protein mediated biomaterials
- Lecture 28 - Immune response to biomaterials
- Lecture 29 - Biomaterial Applications
- Lecture 30 - Biocompatible assays
- Lecture 31 - Immunoassay

Lecture 1 - Course overview

Lecture 2 - What is biomimicry ?

Lecture 3 - Why is biomimicry important ?

Lecture 4 - Nature's unifying patterns - Introduction

Lecture 5 - Case study

Lecture 6 - How to do biomimicry ?

Lecture 7 - Learning resources - Biomimicry Institute

Lecture 8 - Skills, attitudes and mindset for a biomimic

Lecture 9 - Course activity

Lecture 10 - Recap of Week 1

Lecture 11 - What are we mimicking ?

Lecture 12 - Function and Strategy

Lecture 13 - Approaches to biomimicry

Lecture 14 - From Problem to Solution

Lecture 15 - Using the UNSDG to identify challenges

Lecture 16 - Recap of Week 2

Lecture 17 - Step 1 - Define the problem

Lecture 18 - Step 2 - Biologize the problem

Lecture 19 - Step 3 - Discover strategies in nature

Lecture 20 - Applying the Biomimicry Design Spiral

Lecture 21 - Step 4 - Abstract design strategies from nature

Lecture 22 - Step 5 - Emulate nature's strategies in your solution

Lecture 23 - Step 6 - Evaluate feasibility

Lecture 24 - How to apply the biomimicry process ?

Lecture 25 - Recap of Week 4

Lecture 26 - Nature's Unifying Patterns I

Lecture 27 - Systems Thinking - Introduction

Lecture 28 - Systems Thinking - Understanding consequences

Lecture 29 - Nature's Unifying Patterns II

Lecture 30 - Tools - Mind mapping

Lecture 31 - Using biomimicry to design a solution

[Lecture 32 - Recap of Week 6](#)

[Lecture 33 - Developing creative confidence](#)

[Lecture 34 - Learning from the biomimicry process](#)

[Lecture 35 - The need for creativity in our lives](#)

[Lecture 36 - Unlocking your creativity](#)

[Lecture 37 - Taking your biomimicry ideas to market](#)

[Lecture 38 - The journey so far](#)

[Lecture 39 - Finding the hero in you](#)

[Lecture 40 - Course wrap-up](#)

Lecture 1 - Introduction - Electrocardiogram - Interpretation and application in clinical practice

Lecture 2 - Basic Conduction of Heart

Lecture 3 - ECG Lead system

Lecture 4 - Recording of a Standard ECG (Lead placements and measurements)

Lecture 5 - Waveforms, Intervals and Segments

Lecture 6 - Vector Electrocardiography

Lecture 7 - From Action Potentials to Arrhythmias

Lecture 8 - Pathophysiology, Myocardial Ischemia / Injury

Lecture 9 - Myocardial Infarction (MI), Pathophysiology

Lecture 10 - Drug effects on ECG

Lecture 11 - Patient identification, preparation and interpretation of ECG

Lecture 12 - Sinus rhythms and Bradyarrhythmias

Lecture 13 - Approach to tachyarrhythmias

Lecture 14 - AV Blocks and Bundle Branch Block

Lecture 15 - Chamber enlargement and Heart Failure

Lecture 16 - Electrolyte Abnormalities on ECG

Lecture 17 - Recognizing signs and ECG changes in Myocardial Ischemia/Injury

Lecture 18 - ECG changes in myocardial infarction

Lecture 19 - Miscellaneous ECG findings and cardiac arrest

Lecture 20 - Pacemaker Rhythms

Lecture 1 - Introduction to the One Health Concept and National and International health/public health agencies

Lecture 2 - Global Health vs One Health

Lecture 3 - Basics of Research Ethics

Lecture 4 - Integrated human and animal disease surveillance systems

Lecture 5 - Emerging infectious diseases

Lecture 6 - Process of disease emergence and assessment of the risk factors

Lecture 7 - Mechanisms of pathogen cross over across species boundaries

Lecture 8 - Importance of disease detection, Identification and monitoring in public health

Lecture 9 - Introduction to disease vectors and basics of Medical Entomology

Lecture 10 - The factors influencing an emerging disease

Lecture 11 - Antimicrobial resistance a global threat and Importance of antibiotic stewardship program

Lecture 12 - Introduction of Food safety and food borne diseases

Lecture 13 - What are zoonotic diseases and its role in our changing world

Lecture 14 - The integration of human, animal and ecosystem health in control and prevention of these diseases

Lecture 15 - Community engagement for zoonotic disease control in humans and animals through One Health

Lecture 16 - Basics of Epidemiological Studies

Lecture 17 - Rapid Response system, Disaster Management and Outbreak Investigation Plans

Lecture 18 - Basic statistical methods and their application and the measurement of disease frequency

Lecture 19 - Principles of survey design and the concepts of sampling and Mixed method research

Lecture 20 - Introduction to health policy

Lecture 21 - Risk Communication and Pandemic Preparedness

Lecture 22 - Role of community in disease control and ways for community engagement

Lecture 23 - Uses of different types of media for communication

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Canning Technology, Value Addition of Seafood (Fish Processing) (Multi-Disciplinary)

Co-ordinators : Dr. Abhilash Sasidharan, Dr. Maya Raman

- Lecture 1 - Course overview Canning technology and Value addition of sea food
- Lecture 2 - Introduction and the concept of canning technology
- Lecture 3 - History of canning technology - Part 1
- Lecture 4 - History of canning technology - Part 2
- Lecture 5 - Canning Technology and Value Addition Containers and their Properties - Part 1
- Lecture 6 - Canning Technology and Value Addition Containers and their Properties - Part 2
- Lecture 7 - Canning Technology and Value Addition Containers and their Properties - Part 3
- Lecture 8 - Canning Technology and Value Addition Containers and their Properties - Part 4
- Lecture 9 - Canning Technology and Value Addition - Canning process - Part 1
- Lecture 10 - Canning Technology and Value Addition - Canning process - Part 2
- Lecture 11 - Canning Technology and Value Addition - Thermal process calculations - Part 1
- Lecture 12 - Canning Technology and Value Addition - Thermal process calculations - Part 2
- Lecture 13 - Microbiology and spoilage of canned food - Part 1
- Lecture 14 - Microbiology and spoilage of canned food - Part 2
- Lecture 15 - Process of seafood canning - Part 1
- Lecture 16 - Process of seafood canning - Part 2
- Lecture 17 - Seafood pre-processing - Part 1
- Lecture 18 - Seafood pre-processing - Part 2
- Lecture 19 - Additives - Part 1
- Lecture 20 - Additives - Part 2
- Lecture 21 - SOP for seafood canning - Part 1
- Lecture 22 - SOP for seafood canning - Part 2
- Lecture 23 - SOP for seafood canning - Part 3
- Lecture 24 - Nutritional quality of seafood
- Lecture 25 - Muscle structure of seafood
- Lecture 26 - Spoilage in seafood
- Lecture 27 - Preservation methods
- Lecture 28 - Value addition in thermally processed foods
- Lecture 29 - Quality standards for seafood value added products - Part 1
- Lecture 30 - Quality standards for seafood value added products - Part 2
- Lecture 31 - Quality standards for seafood value added products - Part 3

Lecture 1 - Course overview

Lecture 2 - Introduction

Lecture 3 - Paper as packaging material - Part 1

Lecture 4 - Paper as packaging material - Part 2

Lecture 5 - Paper as packaging material - Part 3

Lecture 6 - Glass as packaging material

Lecture 7 - Metal as packaging material - Part 1

Lecture 8 - Metal as packaging material - Part 2

Lecture 9 - Plastic as packaging material - Part 1

Lecture 10 - Plastic as packaging material - Part 2

Lecture 11 - Introduction to packaging system

Lecture 12 - Product characteristics and packaging requirements

Lecture 13 - Rigid, semi-rigid, flexible packaging forms - Part 1

Lecture 14 - Rigid, semi-rigid, flexible packaging forms - Part 2

Lecture 15 - Designing of packaging material

Lecture 16 - Testing of packaging material - Part 1

Lecture 17 - Testing of packaging material - Part 2

Lecture 18 - Testing of packaging material - Part 3

Lecture 19 - Testing of packaging material - Part 4

Lecture 20 - Testing of package performance

Lecture 21 - Principles developing safe and protective packing

Lecture 22 - Transport worthiness test - Part 1

Lecture 23 - Transport worthiness test - Part 2

Lecture 24 - Transport worthiness test - Part 3

Lecture 25 - Safety aspects of food packaging

Lecture 26 - Packaging accessories and advances in packaging

Lecture 27 - Active packaging - Part 1

Lecture 28 - Active packaging - Part 2

Lecture 29 - MA and Aseptic packaging

Lecture 30 - Edible packaging - Part 1

Lecture 31 - Edible packaging - Part 2

[Lecture 32 - Vacuum packing machine](#)

[Lecture 33 - CA and MA packing machine](#)

[Lecture 34 - Gas packing machine](#)

[Lecture 35 - Seal and shrink packing machine](#)

[Lecture 36 - Form fill sealing machine](#)

[Lecture 37 - Aseptic packaging systems](#)

[Lecture 38 - Retort pouches](#)

[Lecture 39 - Bottling machine - Part 1](#)

[Lecture 40 - Bottling machine - Part 2](#)

[Lecture 41 - Carton making machine](#)

[Lecture 42 - Package printing machines - Part 1](#)

[Lecture 43 - Package printing machines - Part 2](#)

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[Lecture 3 - Learning, Instruction and Assessment](#)

[Lecture 4 - What is OBE?](#)

[Lecture 5 - Accreditation](#)

[Lecture 6 - Outcomes](#)

[Lecture 7 - Program Outcomes - 1](#)

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[Lecture 10 - Cognitive Levels](#)

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[Lecture 18 - Course Outcomes - POs and PSOs](#)

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[Lecture 20 - Attainment of POs and PSOs](#)

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:Teaching and Learning in General Programs (Multi-Disciplinary)

Co-ordinators : Prof. N.J. Rao

Lecture 1 - Teaching and Learning in General Programs (TALG)

Lecture 2 - Education and Teaching

Lecture 3 - Learning, Assessment and Instruction

Lecture 4 - Outcome Based Education (OBE)

Lecture 5 - Accreditation

Lecture 6 - Program Outcomes

Lecture 7 - POs and PSOs

Lecture 8 - Taxonomy of Learning: Cognitive Levels - 1

Lecture 9 - Taxonomy of Learning: Cognitive Levels - 2

Lecture 10 - Taxonomy of Learning: Knowledge Categories

Lecture 11 - Taxonomy of Learning: Metacognitive Knowledge

Lecture 12 - Affective Domain

Lecture 13 - Psychomotor Domain

Lecture 14 - Taxonomy Tables

Lecture 15 - Course Outcomes - 1

Lecture 16 - Course Outcomes - 2

Lecture 17 - Tagging the Course Outcomes

Lecture 18 - Attainment of Course Outcomes

Lecture 19 - Attainment of POs and PSOs

Lecture 1 - Engineering Programs, NBA Accreditation and Engineering Courses

Lecture 2 - Course Design

Lecture 3 - ISD and ADDIE

Lecture 4 - Analysis Phase - 1

Lecture 5 - Analysis Phase - 2

Lecture 6 - Design Phase

Lecture 7 - Technology and Targets

Lecture 8 - Assessment Pattern and Assessment Instruments

Lecture 9 - Item Banks

Lecture 10 - Development Phase

Lecture 11 - Instruction Material and Learning Material

Lecture 12 - Implement Phase - 1

Lecture 13 - Implement Phase - 2

Lecture 14 - Evaluate Phase

Lecture 15 - Course Exit Survey

Lecture 16 - Evaluating Laboratories and Electives

Lecture 17 - Exit Surveys for Projects

Lecture 18 - Summary Feedback

Lecture 19 - Instruction: An Overview

Lecture 20 - Instructional Situations

Lecture 21 - How Brains Learn - 1

Lecture 22 - How Brains Learn - 2

Lecture 23 - How Brains Learn - 3

Lecture 24 - Instructional Components - 1

Lecture 25 - Instructional Components - 2

Lecture 26 - Merrill's Principles of Learning

Lecture 27 - ID based on Merrill's Principles

Lecture 28 - Direct Approach to Instruction

Lecture 29 - Project Based Approach to Instruction

Lecture 30 - Problem Based Approach to Instruction

Lecture 31 - Experiential Approach to Instruction

[Lecture 32 - Simulation Approach to Instruction](#)

[Lecture 33 - Instruction for Design](#)

[Lecture 34 - Instruction for Metacognitive Learning](#)

[Lecture 35 - So, what should a teacher do?](#)

DIGIMAT - The No.1 Autonomous Learning Platform for Creative Learning

NPTEL : NOC:NBA Accreditation and Teaching Learning in Engineering (NATE) (Multi-Disciplinary)

Co-ordinators : Prof. N J Rao, Prof. K. Rajanikanth

Lecture 1 - NATE

Lecture 2 - NBA Accreditation

Lecture 3 - Outcome Based Education

Lecture 4 - Self Assessment Report

Lecture 5 - Education, Teaching, Learning, Instruction, and Assessment

Lecture 6 - PEOs and POs (1-5)

Lecture 7 - POs (6-9)

Lecture 8 - POs (10-12)

Lecture 9 - PSOs

Lecture 10 - Taxonomy of Learning

Lecture 11 - Cognitive Processes - 1

Lecture 12 - Cognitive Processes - 2

Lecture 13 - Categories of Knowledge - 1

Lecture 14 - Categories of Knowledge - 2

Lecture 15 - Taxonomy Table

Lecture 16 - Affective and Psychomotor Domains

Lecture 17 - Course Outcomes - 1

Lecture 18 - Course Outcomes - 2

Lecture 19 - Tagging Course Outcomes

Lecture 20 - Computing Attainment of COs

Lecture 21 - Computing PO and PSO Attainment

Lecture 22 - Course Design Component of Teaching as per Fink's Model

Lecture 23 - ISD and ADDIE Models

Lecture 24 - ADDIE - Analysis Phase 1

Lecture 25 - ADDIE - Analysis Phase 2

Lecture 26 - ADDIE - Design Phase

Lecture 27 - Technology for Assessment; Setting Targets

Lecture 28 - Assessment Plan and Assessment Instruments

Lecture 29 - Item Banks

Lecture 30 - ADDIE- Development Phase

Lecture 31 - ADDIE - Implement Phase 1

[Lecture 32 - ADDIE - Implement Phase 2](#)

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Lecture 2 - Introduction to Nanotechnology (Continued...)

Lecture 3 - Synthetic Methodologies

Lecture 4 - Synthetic Methodologies (Continued...)

Lecture 5 - Synthetic Methodologies (Continued...)

Lecture 6 - Synthetic Methodologies (Continued...)

Lecture 7 - Synthetic Methodologies (Continued...)

Lecture 8 - Synthetic Methodologies (Continued...)

Lecture 9 - Template Methods - I

Lecture 10 - Template Methods - II

Lecture 11 - Spray Pyrolysis

Lecture 12 - V-L-S Method

Lecture 13 - Lithography - I

Lecture 14 - Lithography - II

Lecture 15 - Fullerenes and Carbon Nanotubes - I

Lecture 16 - Fullerenes and Carbon Nanotubes - II

Lecture 17 - Fullerenes and Carbon Nanotubes - III

Lecture 18 - Metal and Metal Oxide Nanowires - I

Lecture 19 - Metal and Metal Oxide Nanowires - II

Lecture 20 - Metal and Metal Oxide Nanowires - III

Lecture 21 - Self Assembly of Nanostructures - I

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[Lecture 16 - Defect Structure & Mechanical Behaviour of Nanomaterials](#)

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Lecture 3 - Physical Oceanography - II

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Lecture 7 - Open Ocean - I

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Lecture 10 - Water and Waves

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Lecture 12 - Waves - II

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Lecture 16 - Waves - IV

Lecture 17 - The Wave Spectra

Lecture 18 - The Wave Spectra (Continued...1)

Lecture 19 - The Wave Spectra (Continued...2)

Lecture 20 - Offshore Structures - I

Lecture 21 - Offshore Structures - II

Lecture 22 - Offshore Structures - III

Lecture 23 - Floating Offshore Structures

Lecture 24 - Drilling from Platforms

Lecture 25 - Drilling and Topsides

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Lecture 27 - Mooring Systems

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Lecture 29 - Static Analysis of Mooring Cable

Lecture 30 - Static Analysis of Mooring Cable (Continued...)

Lecture 31 - Mooring Systems (Continued...2)

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Lecture 5 - Problems in Stability - I

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Lecture 9 - Free Surface Effect

Lecture 10 - Inclining Experiment

Lecture 11 - Hydrostatic Curves - I

Lecture 12 - Hydrostatic Curves - II

Lecture 13 - Stability Curve

Lecture 14 - Dynamical Stability - I

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Lecture 16 - Healing Moment - I

Lecture 17 - Healing Moment - II

Lecture 18 - Healing Moment - III

Lecture 19 - Dynamical Stability - III

Lecture 20 - Discussion

Lecture 21 - Righting Stability - I

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Lecture 23 - Trim Calculations - I

Lecture 24 - Trim Calculations - II

Lecture 25 - Trim Stability - I

Lecture 26 - Trim Stability - II

Lecture 27 - Dry Docking - I

Lecture 28 - Dry Docking - II

Lecture 29 - Bilging - I

Lecture 30 - Bilging - II

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Lecture 2 - Characteristics of shipbuilding industry

Lecture 3 - Structural Requirement

Lecture 4 - Basic Structural Components

Lecture 5 - Structural Subassemblies

Lecture 6 - Bulkheads

Lecture 7 - Decks & Shells

Lecture 8 - Structural Assemblies Double Bottom Construction

Lecture 9 - Wing Tanks & Duct Keels

Lecture 10 - Fore & Aft Construction

Lecture 11 - General Cargo Carrier

Lecture 12 - Bulk Carrier

Lecture 13 - Structural Details

Lecture 14 - Container Ship

Lecture 15 - RO-RO Ship

Lecture 16 - Oil Tanker

Lecture 17 - Structural Alignment & Continuity

Lecture 18 - Steel Material Preparation

Lecture 19 - Shot Blasting

Lecture 20 - Acid Pickling

Lecture 21 - Plate Cutting

Lecture 22 - Plate & Section Forming - I

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Lecture 24 - Line Heating

Lecture 25 - Fusion Welding & Power Source

Lecture 26 - Welding Parameters & their Effects

Lecture 27 - Welding Methods

Lecture 28 - Shielded Metal Arc Welding

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Lecture 7 - Applications of Equations of Motion (Continued...)

Lecture 8 - Two Dimensional Flows

Lecture 9 - Two Dimensional Flows (Continued...)

Lecture 10 - Source, Sink and Doublet

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Lecture 13 - Uniform Flow Past an Elliptic Cylinder

Lecture 14 - Aerofoil theory

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Lecture 17 - Schwarz - Christoffel Transformation

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Lecture 19 - Vertex Motion

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Lecture 21 - Introduction to Water Waves

Lecture 22 - Basic Equation and Conditions of Water Waves

Lecture 23 - Water particle kinematics in wave motion

Lecture 24 - Capillary Gravity Waves

Lecture 25 - Linearised Long Wave Equation

Lecture 26 - Linearised Long Wave Equation (Continued...)

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Lecture 28 - Worked Examples on Wave Motion

Lecture 29 - Worked Examples on Wave Motion (Continued...)

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- Lecture 2 - Regular Water Waves - II
- Lecture 3 - Definition of Ship Motions & Encounter Frequency
- Lecture 4 - Single Degree of Freedom Motions in Regular Waves
- Lecture 5 - Uncoupled Heave, Pitch and Roll - I
- Lecture 6 - Uncoupled Heave, Pitch and Roll - II
- Lecture 7 - Uncoupled Heave, Pitch and Roll - III
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- Lecture 10 - Coupled Motions
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- Lecture 12 - Description of Irregular Waves by Spectrum
- Lecture 13 - Theoretical Wave Spectrum
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- Lecture 15 - Ship Motion in Irregular Waves - II
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- Lecture 17 - Description of Short-Crested Sea
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- Lecture 2 - First Law of Thermodynamics (Closed System)
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- Lecture 4 - Second Law of Thermodynamics
- Lecture 5 - Second Law and Carnot Principle
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- Lecture 7 - Ideal Gas Laws, Different Processes
- Lecture 8 - Introduction to Vapour Power Cycle
- Lecture 9 - Vapour Power Cycle
- Lecture 10 - Steam Power Cycle, Steam Nozzle
- Lecture 11 - Basic Concept of Turbine, Velocity Diagram
- Lecture 12 - Steam Turbine-Impulse
- Lecture 13 - Reaction Turbine Compounding
- Lecture 14 - Comparison of Different Staging Arrangement
- Lecture 15 - Basics Laws of Fluid Mechanics
- Lecture 16 - Pipe Friction, Major Loss, Minor Loss
- Lecture 17 - Pipeline & Pipe Network
- Lecture 18 - Refrigeration Vapour Compression Cycle
- Lecture 19 - Psychometrics
- Lecture 20 - Psychometrics (Continued...)
- Lecture 21 - Psychometric Processes
- Lecture 22 - Psychometric Processes (Continued...), Air Conditioning
- Lecture 23 - Summer & Winter Air Conditioning
- Lecture 24 - Gas Power Cycles, Cycles for IC Engines
- Lecture 25 - Gas Turbine Cycles
- Lecture 26 - Modification of Brayton Cycle
- Lecture 27 - Introduction to Convective Heat Transfer Forced & Free Convection

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Co-ordinators : Dr. S. Nallayarasu

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- Lecture 7 - Gauss's Law, Potential
- Lecture 8 - Electric Field and Potential
- Lecture 9 - Potential and Potential Energy - I
- Lecture 10 - Potential and Potential Energy - II
- Lecture 11 - Potential and Potential Energy - III
- Lecture 12 - Coefficients of Potential and Capacitance
- Lecture 13 - Poission and Laplace Equation
- Lecture 14 - Solutions of Laplace Equation - I
- Lecture 15 - Solutions of Laplace Equation - II
- Lecture 16 - Solutions of Laplace Equation - III
- Lecture 17 - Special Techniques - I
- Lecture 18 - Special Techniques - II
- Lecture 19 - Special Techniques - III
- Lecture 20 - Dielectrics - I
- Lecture 21 - Dielectrics - II
- Lecture 22 - Dielectrics - III
- Lecture 23 - Equation of Continuity
- Lecture 24 - a) Force between current loops b) Magnetic Vector Potential
- Lecture 25 - Magnetic Vector Potential
- Lecture 26 - Boundary Conditions
- Lecture 27 - Magnetized Material
- Lecture 28 - Magentostatics (Continued...), Time Varying Field (Introduction)
- Lecture 29 - Faraday's Law and Inductance
- Lecture 30 - Maxwell's Equations
- Lecture 31 - Maxwell's Equations and Conservation Laws

[Lecture 32 - Conservation Laws](#)

[Lecture 33 - a\) Angular Momentum Conservation b\) Electromagnetic Waves](#)

[Lecture 34 - Electromagnetic Waves](#)

[Lecture 35 - Propagation of Electromagnetic Waves in a metal](#)

[Lecture 36 - Waveguides - I](#)

[Lecture 37 - Waveguides - II](#)

[Lecture 38 - Resonating Cavity](#)

[Lecture 39 - Radiation - I](#)

[Lecture 40 - Radiation - II](#)

NPTEL : Special Theory of Relativity (Physics)

Co-ordinators : Prof. Shiva Prasad

Lecture 1 - Problem with Classical Physics

Lecture 2 - Michelson-Morley Experiment

Lecture 3 - Postulates of Special Theory of Relativity and Galilean Transformation

Lecture 4 - Look out for a New Transformation

Lecture 5 - Lorentz Transformation

Lecture 6 - Length Contraction and Time Dilation

Lecture 7 - Examples of Length Contraction and Time Dilation

Lecture 8 - Velocity Transformation and Examples

Lecture 9 - A Three Event Problem

Lecture 10 - A Problem involving Light and Concept of Casuality

Lecture 11 - Problems involving Casuality and Need to Redefine Momentum

Lecture 12 - Minkowski Space and Four Vectors

Lecture 13 - Proper Time a Four Scalar

Lecture 14 - Velocity Four Vector

Lecture 15 - Momentum Energy Four Vector

Lecture 16 - Relook at Collision Problems

Lecture 17 - Zero Rest Mass Particle and Photon

Lecture 18 - Doppler Effect in Light

Lecture 19 - Example in C-Frame

Lecture 20 - Force in Relativity

Lecture 21 - Force Four-Vector

Lecture 22 - Electric & Magnetic Field Transformation

Lecture 23 - Example of EM Field Transformation

Lecture 24 - Current Density Four Vector and Maxwell Equation

- Lecture 1 - Why Quantum Computing?
- Lecture 2 - Postulates of Quantum Mechanics - I
- Lecture 3 - Postulates of Quantum Mechanics - II
- Lecture 4 - Qubit - The smallest unit
- Lecture 5 - Qubit - Bloch sphere representation
- Lecture 6 - Multiple Qubit States and Quantum Gates
- Lecture 7 - Quantum Gates
- Lecture 8 - Quantum Circuits
- Lecture 9 - No-Cloning Theorem and Quantum Teleportation
- Lecture 10 - Super Dense Coding
- Lecture 11 - Density Matrix - I
- Lecture 12 - Density Matrix - II
- Lecture 13 - Bloch Sphere and Density Matrix
- Lecture 14 - Measurement Postulates - I
- Lecture 15 - Measurement Postulates - II
- Lecture 16 - Simple Algorithms-Deutsch Algorithm
- Lecture 17 - Deutsch-Josza and Bernstein - Vazirani Algorithms
- Lecture 18 - Simon Problem
- Lecture 19 - Grover's Search Algorithm - I
- Lecture 20 - Grover's Search Algorithm - II
- Lecture 21 - Grover's Search Algorithm - III
- Lecture 22 - Grover's Search Algorithm - IV
- Lecture 23 - Quantum Fourier Transform
- Lecture 24 - Period Finding and QFT
- Lecture 25 - Implementing QFT
- Lecture 26 - Implementing QFT-3 qubits (and more)
- Lecture 27 - Shor's Factorization Algorithm
- Lecture 28 - Shor's Factorization Algorithm-Implementation
- Lecture 29 - Shor's Algorithm-Continued Fraction
- Lecture 30 - Quantum Error Correction - I
- Lecture 31 - Quantum Error Correction - II Three Qubit Code

[Lecture 32 - Quantum Error Correction - III Shor's 9 Qubit Code - I](#)

[Lecture 33 - Quantum Error Correction - IV Shor's 9 Qubit Code - II](#)

[Lecture 34 - Classical Information Theory](#)

[Lecture 35 - Shannon Entropy](#)

[Lecture 36 - Shannon's Noiseless Coding Theorem](#)

[Lecture 37 - Von Neumann Entropy](#)

[Lecture 38 - EPR and Bell's Inequalities - I](#)

[Lecture 39 - EPR and Bell's Inequalities - II](#)

[Lecture 40 - EPR and Bell's Inequalities - III](#)

[Lecture 41 - Cryptography-RSA Algorithm - I](#)

[Lecture 42 - Cryptography-RSA Algorithm - II](#)

[Lecture 43 - Quantum Cryptography - I](#)

[Lecture 44 - Quantum Cryptography - II](#)

[Lecture 45 - Experimental Aspects of Quantum Computing - I](#)

[Lecture 46 - Experimental Aspects of Quantum Computing - II](#)

Lecture 1 - Introduction

Lecture 2 - Algebraic Preliminaries

Lecture 3 - Basic Group Concepts and Low Order Groups - I

Lecture 4 - Basic Group Concepts and Low Order Groups - II

Lecture 5 - Lagrange's Theorem and Cayley's Theorem - I

Lecture 6 - Lagrange's Theorem and Cayley's Theorem - II

Lecture 7 - Factor Group Conjugacy Classes - I

Lecture 8 - Factor Group Conjugacy Classes - II

Lecture 9 - Cycle Structures and Molecular Notation - I

Lecture 10 - Cycle Structures and Molecular Notation - II

Lecture 11 - Cycle Structures and Classification - I

Lecture 12 - Cycle Structures and Classification - II

Lecture 13 - Point Group Notation and Factor Group - I

Lecture 14 - Point Group Notation and Factor Group - II

Lecture 15 - Representation Theory - I

Lecture 16 - Representation Theory - II

Lecture 17 - Representation Theory - III

Lecture 18 - Representation Theory - IV

Lecture 19 - Schur's Lemma and Orthogonality Theorem - I

Lecture 20 - Schur's Lemma and Orthogonality Theorem - II

Lecture 21 - Orthogonality For Characters - I

Lecture 22 - Orthogonality For Characters - II

Lecture 23 - Character Tables and Molecular Applications - I

Lecture 24 - Character Tables and Molecular Applications - II

Lecture 25 - Preliminaries About The Continuum - I

Lecture 26 - Preliminaries About The Continuum - II

Lecture 27 - Classical Groups - I

Lecture 28 - Classical Groups - II

Lecture 29 - Classical Groups-Topology - I

Lecture 30 - Classical Groups-Topology - II

Lecture 31 - $SO(3)$ And Matrix Exponent - I

- Lecture 32 - $SO(3)$ And Matrix Exponent - II
- Lecture 33 - Generators, Discussion Of Lie's Theorems - I
- Lecture 34 - Generators, Discussion Of Lie's Theorems - II
- Lecture 35 - Group Algebras; $SO(3)$ - $SU(2)$ Correspondence - I
- Lecture 36 - Group Algebras; $SO(3)$ - $SU(2)$ Correspondence - II
- Lecture 37 - $SO(3)$, $SU(2)$ Representations - I
- Lecture 38 - $SO(3)$, $SU(2)$ Representations - II
- Lecture 39 - Representation On Function Spaces - I
- Lecture 40 - Representation On Function Spaces - II
- Lecture 41 - Lorentz Boosts, $SO(3,1)$ Algebra - I
- Lecture 42 - Lorentz Boosts, $SO(3,1)$ Algebra - II
- Lecture 43 - Representation Of Lorentz Group And Clifford Algebra - I
- Lecture 44 - Representation Of Lorentz Group And Clifford Algebra - II
- Lecture 45 - $SU(3)$ And Lie's Classification - I
- Lecture 46 - $SU(3)$ And Lie's Classification - II
- Lecture 47 - Fundamental Symmetries Of Physics - I
- Lecture 48 - Fundamental Symmetries Of Physics - II

Lecture 1 - Introduction to Quantum Mechanics - I

Lecture 2 - Introduction to Quantum Mechanics - II

Lecture 3 - Review of Particle in Box, Potential Well, Barrier, Harmonic Oscillator - I

Lecture 4 - Review of Particle in Box, Potential Well, Barrier, Harmonic Oscillator - II

Lecture 5 - Tutorial 1 - Part I

Lecture 6 - Tutorial 1 - Part II

Lecture 7 - Bound States - I

Lecture 8 - Bound States - II

Lecture 9 - Conditions and Solutions for one Dimensional Bound States - I

Lecture 10 - Conditions and Solutions for one Dimensional Bound States - II

Lecture 11 - Tutorial 2

Lecture 12 - Linear Vector Space (LVS) - I

Lecture 13 - Linear Vector Space (LVS) - II

Lecture 14 - Linear Vector Space (LVS) - III

Lecture 15 - Basis for Operators and States in LVS - I

Lecture 16 - Basis for Operators and States in LVS - II

Lecture 17 - Tutorial 3 - Part I

Lecture 18 - Tutorial 3 - Part II

Lecture 19 - Function Spaces - I

Lecture 20 - Function Spaces - II

Lecture 21 - Postulates of Quantum Mechanics - I

Lecture 22 - Postulates of Quantum Mechanics - II

Lecture 23 - Tutorial 4 - Part I

Lecture 24 - Tutorial 4 - Part II

Lecture 25 - Classical vs Quantum Mechanics - I

Lecture 26 - Classical vs Quantum Mechanics - II

Lecture 27 - Compatible vs Incompatible Observable - I

Lecture 28 - Compatible vs Incompatible Observable - II

Lecture 29 - Tutorial 5 - Part I

Lecture 30 - Tutorial 5 - Part II

Lecture 31 - Tutorial 5 - Part III

[Lecture 32 - Schrodinger and Heisenberg Pictures - I](#)

[Lecture 33 - Schrodinger and Heisenberg Pictures - II](#)

[Lecture 34 - Solutions to other Coupled Potential Energies - I](#)

[Lecture 35 - Solutions to other Coupled Potential Energies - II](#)

[Lecture 36 - Tutorial 6 - Part I](#)

[Lecture 37 - Tutorial 6 - Part II](#)

[Lecture 38 - Hydrogen Atom and Wave Functions, Angular Momentum Operators, Identical Particles - I](#)

[Lecture 39 - Hydrogen Atom and Wave Functions, Angular Momentum Operators, Identical Particles - II](#)

[Lecture 40 - Identical Particles and Quantum Computer - I](#)

[Lecture 41 - Identical Particles and Quantum Computer - II](#)

[Lecture 42 - Tutorial 7 - Part I](#)

[Lecture 43 - Tutorial 7 - Part II](#)

[Lecture 44 - Harmonic Oscillator - I](#)

[Lecture 45 - Harmonic Oscillator - II](#)

[Lecture 46 - Ladder Operators - I](#)

[Lecture 47 - Ladder Operators - II](#)

[Lecture 48 - Tutorial 8 - Part I](#)

[Lecture 49 - Tutorial 8 - Part II](#)

[Lecture 50 - Stern-Gerlach Experiment - I](#)

[Lecture 51 - Stern-Gerlach Experiment - II](#)

[Lecture 52 - Oscillator Algebra](#)

[Lecture 53 - Tutorial 9 - Part I](#)

[Lecture 54 - Tutorial 9 - Part II](#)

[Lecture 55 - Angular Momentum - I](#)

[Lecture 56 - Angular Momentum - II](#)

[Lecture 57 - Rotations Groups - I](#)

[Lecture 58 - Rotations Groups - II](#)

[Lecture 59 - Tutorial 10 - Part I](#)

[Lecture 60 - Tutorial 10 - Part II](#)

[Lecture 61 - Addition of Angular Momentum - I](#)

[Lecture 62 - Addition of Angular Momentum - II](#)

[Lecture 63 - Clebsch-Gordan Coefficients - I](#)

[Lecture 64 - Clebsch-Gordan Coefficients - II](#)

[Lecture 65 - Tutorial 11 - Part I](#)

[Lecture 66 - Tutorial 11 - Part II](#)

[Lecture 67 - Clebsch-Gordan Coefficients - III](#)

[Lecture 68 - Tensor Operators and Wigner-Eckart Theorem - I](#)

[Lecture 69 - Tensor Operators and Wigner-Eckart Theorem - II](#)

[Lecture 70 - Tensor Operators and Wigner-Eckart Theorem - III](#)

[Lecture 71 - Tutorial 12](#)

- Lecture 1 - Quantum Theory Fundamental Quantisation - I
- Lecture 2 - Quantum Theory Fundamental Quantisation - II
- Lecture 3 - Path Integral Formulation - I
- Lecture 4 - Path Integral Formulation - II
- Lecture 5 - Path Integral Formulation - III
- Lecture 6 - Path Integral Formulation - IV
- Lecture 7 - Correlation Functions - I
- Lecture 8 - Correlation Functions - II
- Lecture 9 - Generating Functional, Forced Harmonic Oscillator - I
- Lecture 10 - Generating Functional, Forced Harmonic Oscillator - II
- Lecture 11 - Generating Function in Field Theory - I
- Lecture 12 - Generating Function in Field Theory - II
- Lecture 13 - Effective Potential - I
- Lecture 14 - Effective Potential - II
- Lecture 15 - Effective Potential - III
- Lecture 16 - Effective Potential - IV
- Lecture 17 - Asymptotic Theory - I
- Lecture 18 - Asymptotic Theory - II
- Lecture 19 - Asymptotic Condition Kallen-Lehmann representation - I
- Lecture 20 - Asymptotic Condition Kallen-Lehmann representation - II
- Lecture 21 - Gauge Invariance - Minimal Coupling
- Lecture 22 - Gauge Invariance - Geometric Picture
- Lecture 23 - Gauge Invariance - Abelian Case
- Lecture 24 - Gauge Invariance - Non-abelian case
- Lecture 25 - Yang Mills Theory - Coupling to Matter
- Lecture 26 - Yang Mills Theory - Physical Content
- Lecture 27 - Yang Mills Theory Constraint Dynamics - I
- Lecture 28 - Yang Mills Theory Constraint Dynamics - II
- Lecture 29 - Gauge Fixing and Faddeev Popov Ghosts - I
- Lecture 30 - Gauge Fixing and Faddeev Popov Ghosts - II
- Lecture 31 - Topological Vacuum of Yang Mills Theories - I

Lecture 32 - Topological Vacuum of Yang Mills Theories - II

Lecture 1 - Introduction

Lecture 2 - DNA packing and structure

Lecture 3 - Shape and function

Lecture 4 - Numbers and sizes

Lecture 5 - Spatial scales and System variation

Lecture 6 - Timescales in Biology

Lecture 7 - Random walks and Passive diffusion

Lecture 8 - Random walks to model Biology

Lecture 9 - Derivation of FRAP equations

Lecture 10 - Drift-diffusion equations

Lecture 11 - Solutions of the drift-diffusion equations

Lecture 12 - The cell signaling problem

Lecture 13 - Cell Signalling and Capture Probability of absorbing sphere

Lecture 14 - Capture probability of reflecting sphere

Lecture 15 - Mean capture time

Lecture 16 - Introduction to fluids, viscosity and reynolds number

Lecture 17 - Introduction to the navier stokes equation

Lecture 18 - Understanding reynolds number

Lecture 19 - Life at low reynolds number

Lecture 20 - Various phenomena at low reynolds number

Lecture 21 - Bacterial flagellar motion

Lecture 22 - Rotating flagellum

Lecture 23 - Energy and equilibrium

Lecture 24 - Binding problems

Lecture 25 - Transcription and translation

Lecture 26 - Internal states of macromolecules

Lecture 27 - Protein modification problem

Lecture 28 - Haemoglobin-Oxygen binding problem

Lecture 29 - Freely jointed polymer model

Lecture 30 - Entropic springs and persistence length

Lecture 31 - Freely rotating chain model and radius of gyration

- Lecture 32 - The hierarchical chromatin packing model
- Lecture 33 - FISH and DNA looping
- Lecture 34 - Nucleosomes as barriers, Hi-C, and contact probabilities
- Lecture 35 - Deriving the full force extension curve
- Lecture 36 - Random walk models for proteins
- Lecture 37 - Hydrophobic polar protein model
- Lecture 38 - Diffusion in crowded environments
- Lecture 39 - Depletion interactions
- Lecture 40 - Examples and implications of depletion interactions
- Lecture 41 - Introduction to Biological dynamics
- Lecture 42 - Introduction to rate equations
- Lecture 43 - Separation of timescales in enzyme kinetics
- Lecture 44 - Structure and treadmilling of actins and microtubules
- Lecture 45 - Average length of polymers in equilibrium
- Lecture 46 - Growth rate of polymers
- Lecture 47 - Dynamic treadmilling in microtubules
- Lecture 48 - Introduction to molecular motors
- Lecture 49 - Force generation by molecular motors
- Lecture 50 - Models of motor motion
- Lecture 51 - molecular motors
- Lecture 52 - Free energies of motor for stepping
- Lecture 53 - Two state models
- Lecture 54 - cooperative transport of cargo
- Lecture 55 - Cytoskeleton as a motor
- Lecture 56 - translocation ratchet
- Lecture 57 - Spatial pattern in biology
- Lecture 58 - Some common spatial patterns in biology
- Lecture 59 - reaction diffusion and spatial pattern
- Lecture 60 - Pattern formation in reaction diffusion system with stability
- Lecture 61 - Condition for destabilization in pattern formation
- Lecture 62 - Schnakenberg kinetics

Lecture 1 - Introduction - I

Lecture 2 - Introduction - II

Lecture 3 - Normal subgroup, Coset, Conjugate group

Lecture 4 - Factor group, Homomorphism, Isomorphism

Lecture 5 - Factor group, Homomorphism, Isomorphism

Lecture 6 - Conjugacy Classes

Lecture 7 - Permutation Groups

Lecture 8 - Cycle Structure

Lecture 9 - Cycle Structure (Continued...)

Lecture 10 - Young Diagram and Molecular Symmetry

Lecture 11 - Point Groups

Lecture 12 - Symmetries of Molecules, Schoenflies Notation

Lecture 13 - Symmetries of Molecules, Stereographic Projection

Lecture 14 - Examples of Molecular Symmetries and Proof of Cayley Theorem

Lecture 15 - Matrix Representation of Groups - I

Lecture 16 - Matrix Representation of Groups - II

Lecture 17 - Reducible and Irreducible Representation - I

Lecture 18 - Reducible and Irreducible Representation - II

Lecture 19 - Great Orthogonality Theorem and Character Table - I

Lecture 20 - Great Orthogonality Theorem and Character Table - II

Lecture 21 - Mulliken Notation, Character Table and Basis

Lecture 22 - Tensor Product of Representation

Lecture 23 - Tensor Product and Projection Operator - I

Lecture 24 - Tensor Product and Projection Operator - II

Lecture 25 - Tensor Product and Projection Operator with an example

Lecture 26 - Binary Basis and Observables

Lecture 27 - Selection Rules

Lecture 28 - Selection Rules and Molecular Vibrations

Lecture 29 - Molecular vibration normal modes: Classical Mechanics approach

Lecture 30 - Molecular vibration normal modes: Group Theory approach

Lecture 31 - Molecular vibration modes using projection operator

Lecture 32 - Vibrational representation of character

Lecture 33 - Infrared Spectra and Raman Spectra

Lecture 34 - Introduction to continuous group

Lecture 35 - Generators of translational and rotational transformation

Lecture 36 - Generators of Lorentz transformation

Lecture 37 - Introduction to $O(3)$ and $SO(3)$ group

Lecture 38 - $SO(n)$ and Lorentz group

Lecture 39 - Generalised orthogonal group and Lie algebra

Lecture 40 - Subalgebra of Lie algebra

Lecture 41 - $gl(2,C)$ and $sl(2,C)$ group

Lecture 42 - $U(n)$ and $SU(n)$ group

Lecture 43 - Symplectic group

Lecture 44 - $SU(2)$ and $SU(3)$ groups

Lecture 45 - Rank, weight and weight vector

Lecture 46 - Weight vector, root vector, comparison between $SU(2)$ and $SU(3)$ algebra

Lecture 47 - Root diagram, simple roots, adjoint representation

Lecture 48 - $SU(2)$ sub-algebra, Dynkin diagrams

Lecture 49 - Fundamental weights, Young diagrams, dimension of irreducible representation

Lecture 50 - Young diagrams and tensor products

Lecture 51 - Tensor product, Wigner - Eckart theorem

Lecture 52 - Tensor product of irreducible representation 1: Composite objects from fundamental particles

Lecture 53 - Tensor product of irreducible representation 2: Decimet and octet diagrams in the Quark Model

Lecture 54 - Clebsch - Gordan coefficients

Lecture 55 - 1) Quadrupole moment tensor (Wigner-Eckart theorem) 2) Decimet Baryon wavefunction

Lecture 56 - Higher dimensional multiplets in the quark model

Lecture 57 - Symmetry breaking in continuous groups

Lecture 58 - Dynamical symmetry in hydrogen atom: $SO(4)$ algebra

Lecture 59 - Hydrogen atom energy spectrum and degeneracy using Runge-Lenz vector

Lecture 1 - Neutrons as Probe of Condensed Matter

Lecture 2 - Sources for thermal neutrons used in neutron scattering

Lecture 3

Lecture 4 - Calculating Neutron Scattering cross-section

Lecture 5

Lecture 6 - Scattering theory and introducing dynamics in the formalism

Lecture 7 - Scattering theory and introducing dynamics in the formalism

Lecture 8 - Scattering theory and introducing dynamics in the formalism

Lecture 9 - Scattering law's correlation with double-Fourier transform of real space correlation function

Lecture 10 - Scattering law's correlation with double-Fourier transform of real space correlation function

Lecture 11 - Correlation function to resolution and accessible($Q, \Delta\theta$). Introducing experimental facilities

Lecture 12 - Correlation function to resolution and accessible($Q, \Delta\theta$). Introducing experimental facilities

Lecture 13 - Correlation function to resolution and accessible($Q, \Delta\theta$). Introducing experimental facilities

Lecture 14 - Correlation function to resolution and accessible($Q, \Delta\theta$). Introducing experimental facilities

Lecture 15 - Introducing resolution and components of neutron scattering facilities.

Lecture 16 - Introducing resolution and components of neutron scattering facilities.

Lecture 17 - Continue with neutron scattering set up and its components like collimators, filters, detectors etc

Lecture 18 - Continue with neutron scattering set up and its components like collimators, filters, detectors etc

Lecture 19 - Describe the operation of various kinds of neutron detectors

Lecture 20 - Describe the operation of various kinds of neutron detectors

Lecture 21 - Introducing neutron choppers, velocity selectors and polarizers, some important components of beam tailoring devices

Lecture 22 - Introducing neutron choppers, velocity selectors and polarizers, some important components of beam tailoring devices

Lecture 23 - Neutron polarizers and spin-flippers

Lecture 24 - Neutron polarizers and spin-flippers

Lecture 25 - Diffraction at various length scales at a reactor and at a spallation neutron source

Lecture 26 - Diffraction at various length scales at a reactor and at a spallation neutron source

Lecture 27 - Application of neutron crystallography

Lecture 28 - Application of neutron crystallography

Lecture 29 - Magnetism in solids

Lecture 30 - Magnetism in solids

Lecture 31 - Magnetic interaction in solids and magnetic neutron diffraction

[Lecture 32 - Magnetic interaction in solids and magnetic neutron diffraction](#)

[Lecture 33 - Magnetic interaction in solids and magnetic neutron diffraction](#)

[Lecture 34 - Magnetic neutron diffraction](#)

[Lecture 35 - Magnetic neutron diffraction](#)

[Lecture 36 - Neutron diffraction from liquid and amorphous systems](#)

[Lecture 37 - Neutron diffraction from liquid and amorphous systems](#)

[Lecture 38 - Small Angle Neutron Scattering \(SANS\) for mesoscopic structure](#)

[Lecture 39 - Small Angle Neutron Scattering \(SANS\) for mesoscopic structure](#)

[Lecture 40 - Small Angle Neutron Scattering \(SANS\) for mesoscopic structure](#)

[Lecture 41 - Small Angle Neutron Scattering \(SANS\) for mesoscopic structure](#)

[Lecture 42 - SANS for soft condensed matter](#)

[Lecture 43 - SANS for soft condensed matter](#)

[Lecture 44 - SANS for polymers, biological systems, nanoparticle aggregates, rocks, Superconducting vortex lattice](#)

[Lecture 45 - SANS for polymers, biological systems, nanoparticle aggregates, rocks, Superconducting vortex lattice](#)

[Lecture 46 - Neutron reflectometry for thin films](#)

[Lecture 47 - Neutron reflectometry for thin films](#)

[Lecture 48 - Neutron reflectometry for thin films](#)

[Lecture 49 - Details formalism to evaluate specular neutron reflectivity and comparison with x-ray reflectometry](#)

[Lecture 50 - Details formalism to evaluate specular neutron reflectivity and comparison with x-ray reflectometry](#)

[Lecture 51 - Neutron reflectometry data analysis and reflectometers at various sources](#)

[Lecture 52 - Neutron reflectometry data analysis and reflectometers at various sources](#)

[Lecture 53 - Neutron reflectometry data analysis and reflectometers at various sources](#)

[Lecture 54 - Examples of PNR with and without spin analysis and introduction to off-specular reflectometry](#)

[Lecture 55 - Examples of PNR with and without spin analysis and introduction to off-specular reflectometry](#)

[Lecture 56 - Examples of PNR with and without spin analysis and introduction to off-specular reflectometry](#)

[Lecture 57 - Off-specular neutron reflectometry and introduction to inelastic neutron scattering](#)

[Lecture 58 - Off-specular neutron reflectometry and introduction to inelastic neutron scattering](#)

[Lecture 59 - Off-specular neutron reflectometry and introduction to inelastic neutron scattering](#)

[Lecture 60 - Phonon measurements with neutrons](#)

[Lecture 61 - Phonon measurements with neutrons](#)

[Lecture 62 - Phonon measurements; single crystals](#)

[Lecture 63](#)

[Lecture 64 - Phonon: Density of States measurements](#)

[Lecture 65 - Stochastic dynamics with neutrons](#)

[Lecture 66 - Stochastic motion and various types of diffusion](#)

[Lecture 67 - Stochastic motion and various types of diffusion](#)

[Lecture 68 - Spin echo spectrometer, Summary of the course](#)

[Lecture 69 - Spin echo spectrometer, Summary of the course](#)

Lecture 1 - Why accelerators

Lecture 2 - Accelerator as a microscope

Lecture 3 - Charging and Discharging of capacitors

Lecture 4 - Charging and Discharging of capacitors (Continued...)

Lecture 5 - Introduction to DC accelerators

Lecture 6 - Cockcroft Walton Accelerator (1929)

Lecture 7 - Van-de-Graaff accelerator and Tandem and Pelletron accelerators

Lecture 8 - Van-de-Graaff accelerator and Tandem and Pelletron accelerators

Lecture 9 - Voltage measurement and stabilisation

Lecture 10 - Voltage measurement and stabilisation

Lecture 11 - Beam energy calibration/measurement

Lecture 12 - Beam energy calibration/measurement

Lecture 13 - Beam focussing using electrostatic and magnetic lenses and beam optics

Lecture 14 - Beam focussing using electrostatic and magnetic lenses and beam optics

Lecture 15 - Beam focussing using electrostatic and magnetic lenses and beam optics

Lecture 16 - Ion Sources

Lecture 17 - Ion Sources

Lecture 18 - Introduction and Basic concepts of linear accelerators

Lecture 19 - Introduction and Basic concepts of linear accelerators

Lecture 20 - RF Acceleration - 1

Lecture 21 - RF Acceleration - 1

Lecture 22 - RF Acceleration - 2

Lecture 23 - RF Acceleration - 2

Lecture 24 - RF Acceleration - 3 - Waveguides and cavities

Lecture 25 - RF Acceleration - 3 - Waveguides and cavities

Lecture 26 - Accelerating structures - Pillbox cavity and DTL

Lecture 27 - Accelerating structures - Pillbox cavity and DTL

Lecture 28 - Accelerating structures - Travelling wave linacs and periodic accelerating structures

Lecture 29 - Accelerating structures - Travelling wave linacs and periodic accelerating structures

Lecture 30 - Superconducting cavities

Lecture 31 - Superconducting cavities

Lecture 32 - Transverse Dynamics - 1
Lecture 33 - Transverse Dynamics - 1
Lecture 34 - Transverse Dynamics - 2
Lecture 35 - Transverse Dynamics - 2
Lecture 36 - Transverse Dynamics - 3
Lecture 37 - Transverse Dynamics - 3
Lecture 38 - Longitudinal Dynamics - 1
Lecture 39 - Longitudinal Dynamics - 1
Lecture 40 - Longitudinal Dynamics - 2
Lecture 41 - Longitudinal Dynamics - 2
Lecture 42 - Radio Frequency Quadrupole
Lecture 43 - Radio Frequency Quadrupole
Lecture 44 - Cyclic accelerators: Some basic principles
Lecture 45 - Cyclic accelerators: Some basic principles
Lecture 46 - About the cyclotron
Lecture 47 - About the cyclotron
Lecture 48 - Microtron
Lecture 49 - Equation of motion, Focusing
Lecture 50 - Equation of motion, Focusing
Lecture 51 - Strong focusing, Edge focusing, AG principle
Lecture 52 - Strong focusing, Edge focusing, AG principle
Lecture 53 - Matrix methods
Lecture 54 - Matrix methods
Lecture 55 - Hill's equation and parameterization - 1
Lecture 56 - Hill's equation and parameterization - 1
Lecture 57 - Hill's equation and parameterization - 2
Lecture 58 - Hill's equation and parameterization - 2
Lecture 59 - Hill's equation and parameterization - 3
Lecture 60 - Hill's equation and parameterization - 3
Lecture 61
Lecture 62
Lecture 63
Lecture 64

[Lecture 65](#)

[Lecture 66](#)

[Lecture 67 - Proton synchrotron for spallation source](#)

[Lecture 68 - Proton synchrotron for spallation source](#)

[Lecture 69 - Colliders](#)

[Lecture 70 - Colliders](#)

[Lecture 71 - Laser Plasma accelerators and Accelerator Driven Systems \(ADS\)](#)

[Lecture 72 - Laser Plasma accelerators and Accelerator Driven Systems \(ADS\)](#)

- Lecture 1 - p-n diode
- Lecture 2 - p-n Junction/Diode (Continued...)
- Lecture 3 - p-n diode (Continued...)
- Lecture 4 - Diode Application
- Lecture 5 - Transistors
- Lecture 6 - Reverse - bias (Continued...)
- Lecture 7 - Transistors (Continued...)
- Lecture 8 - Transistors (Continued...)
- Lecture 9 - Biasing a transistor unit 2 (Continued...)
- Lecture 10 - Biasing of transistor
- Lecture 11 - H and R Parameters and their use in small amplifiers
- Lecture 12 - Small signal amplifiers analysis using H - Parameters
- Lecture 13 - Small signal amplifiers analysis using R - Parameters
- Lecture 14 - R - analysis (Continued...)
- Lecture 15 - Common Collector(CC) amplifier (Continued...)
- Lecture 16 - Feedback in amplifiers, Feedback Configurations and multi stage amplifiers
- Lecture 17 - Reduction in non-linear distortion
- Lecture 18 - Input/Output impedances in negative feedback amplifiers (Continued...)
- Lecture 19 - RC Coupled Amplifiers
- Lecture 20 - RC Coupled Amplifiers (Continued...)
- Lecture 21 - RC Coupled Amplifiers (Continued...)
- Lecture 22 - FETs ans MOSFET
- Lecture 23 - FETs ans MOSFET (Continued...)
- Lecture 24 - Depletion - MOSFET
- Lecture 25 - Drain and transfer characteristic of E - MOSFET
- Lecture 26 - Self Bias (Continued...) Design Procedure
- Lecture 27 - FET/MOSFET Amplifiers and their Analysis
- Lecture 28 - CMOS Inverter
- Lecture 29 - CMOS Inverter (Continued...)
- Lecture 30 - Power Amplifier
- Lecture 31 - Power Amplifier (Continued...)

[Lecture 32 - Power Amplifier \(Continued...\)](#)

[Lecture 33 - Power Amplifier \(Continued...\)](#)

[Lecture 34 - Differential and Operational Amplifier](#)

[Lecture 35 - Differential and Operational Amplifier \(Continued...\) dc and ac analysis](#)

[Lecture 36 - Differential and Operational Amplifier dc and ac analysis \(Continued...\)](#)

[Lecture 37 - Operational Amplifiers](#)

[Lecture 38 - Operational amplifiers in open loop \(Continued...\)](#)

[Lecture 39 - Summing Amplifiers](#)

[Lecture 40 - Frequency response of an integration](#)

[Lecture 41 - Filters](#)

[Lecture 42 - Specification of OP Amplifiers](#)

Lecture 1 - Introduction to Plasmas

Lecture 2 - Plasma Response to fields: Fluid Equations

Lecture 3 - DC Conductivity and Negative Differential Conductivity

Lecture 4 - RF Conductivity of Plasma

Lecture 5 - RF Conductivity of Plasma (Continued...)

Lecture 6 - Hall Effect, Cowling Effect and Cyclotron Resonance Heating

Lecture 7 - Electromagnetic Wave Propagation in Plasma

Lecture 8 - Electromagnetic Wave Propagation in Plasma (Continued...)

Lecture 9 - Electromagnetic Wave Propagation Inhomogeneous Plasma

Lecture 10 - Electrostatic Waves in Plasmas

Lecture 11 - Energy Flow with an Electrostatic Wave

Lecture 12 - Two Stream Instability

Lecture 13 - Relativistic electron Beam- Plasma Interaction

Lecture 14 - Cerenkov Free Electron Laser

Lecture 15 - Free Electron Laser

Lecture 16 - Free Electron Laser: Energy gain

Lecture 17 - Free Electron Laser: Wiggler Tapering and Compton Regime Operation

Lecture 18 - Weibel Instability

Lecture 19 - Rayleigh Taylor Instability

Lecture 20 - Single Particle Motion in Static Magnetic and Electric Fields

Lecture 21 - Plasma Physics Grad B and Curvature Drifts

Lecture 22 - Adiabatic Invariance of Magnetic Moment and Mirror confinement

Lecture 23 - Mirror machine

Lecture 24 - Thermonuclear fusion

Lecture 25 - Tokamak

Lecture 26 - Tokamak operation

Lecture 27 - Auxiliary heating and current drive in tokamak

Lecture 28 - Electromagnetic waves propagation in magnetised plasma

Lecture 29 - Longitudinal electromagnetic wave propagation cutoffs, resonances and Faraday rotation

Lecture 30 - Electromagnetic propagation at oblique angles to magnetic field in a plasma

Lecture 31 - Low frequency EM waves magnetized plasma

[Lecture 32 - Electrostatic waves in magnetized plasma](#)

[Lecture 33 - Ion acoustic, ion cyclotron and magneto sonic waves in magnetized plasma](#)

[Lecture 34 - Vlasov theory of plasma waves](#)

[Lecture 35 - Landau damping and growth of waves](#)

[Lecture 36 - Landau damping and growth of waves \(Continued...\)](#)

[Lecture 37 - Anomalous resistivity in a plasma](#)

[Lecture 38 - Diffusion in plasma](#)

[Lecture 39 - Diffusion in magnetized plasma](#)

[Lecture 40 - Surface plasma wave](#)

[Lecture 41 - Laser interaction with plasmas embedded with clusters](#)

[Lecture 42 - Current trends and epilogue](#)

Lecture 1 - Introduction

Lecture 2 - Anisotropic Media

Lecture 3 - Anisotropic Media (Continued...)

Lecture 4 - Anisotropic Media (Continued...)

Lecture 5 - Nonlinear optical effects and nonlinear polarization

Lecture 6 - Non - Linear Optics (Continued...)

Lecture 7 - Non - Linear Optics (Continued...)

Lecture 8 - Non - Linear Optics (Continued...)

Lecture 9 - Non - Linear Optics (Continued...)

Lecture 10 - Non - Linear Optics - Quasi Phase Matching

Lecture 11 - Non - Linear Optics

Lecture 12 - Non Linear Optics (Continued...)

Lecture 13 - Non Linear Optics (Continued...)

Lecture 14 - Non Linear Optics (Continued...)

Lecture 15 - Non Linear Optics (Continued...)

Lecture 16 - Non Linear Optics (Continued...)

Lecture 17 - Non Linear Optics (Continued...)

Lecture 18 - Non Linear Optics (Continued...)

Lecture 19 - Non Linear Optics (Continued...)

Lecture 20 - Third Order Non - Linear Effects

Lecture 21 - Third Order Non - Linear Effects (Continued...)

Lecture 22 - Third Order Non - Linear Effects (Continued...)

Lecture 23 - Third Order Non - Linear Effects (Continued...)

Lecture 24 - Review of Quantum Mechanics

Lecture 25 - Review of Quantum Mechanics (Continued...)

Lecture 26 - Review of Quantum Mechanics (Continued...)

Lecture 27 - Quantization of EM Field

Lecture 28 - Quantization of EM Field (Continued...)

Lecture 29 - Quantization of EM Field (Continued...)

Lecture 30 - Quantum States of EM Field

Lecture 31 - Quantum States of EM Field (Continued...)

[Lecture 32 - Quantization of EM Field \(Continued...\)](#)

[Lecture 33 - Quantization of EM Field \(Continued...\)](#)

[Lecture 34 - Quantization of EM Field \(Continued...\)](#)

[Lecture 35 - Quantization of EM Field \(Continued...\)](#)

[Lecture 36 - Quantization of EM Field \(Continued...\)](#)

[Lecture 37 - Beam Splitter](#)

[Lecture 38 - Beam Splitter \(Continued...\)](#)

[Lecture 39 - Beam Splitter and Balanced Homodyning](#)

[Lecture 40 - Balanced Homodyning](#)

[Lecture 41 - Quantum Picture of Parametric Down Conversion](#)

[Lecture 42 - Questions](#)

NPTEL : Quantum Mechanics and Applications (Physics)

Co-ordinators : Prof. Ajoy Ghatak

Lecture 1 - Basic Quantum Mechanics I: Wave Particle Duality

Lecture 2 - Basic Quantum Mechanics II: The Schrodinger Equation and The Dirac Delta Function

Lecture 3 - Dirac Delta Function & Fourier Transforms

Lecture 4 - The Free Particle

Lecture 5 - Physical Interpretation of The Wave Function

Lecture 6 - Expectation Values & The Uncertainty Principle

Lecture 7 - The Free Particle (Continued...)

Lecture 8 - Interference Experiment & The Particle in a Box Problem

Lecture 9 - On Eigen Values and Eigen Functions of the 1 Dimensional Schrodinger Equation

Lecture 10 - Linear Harmonic Oscillator

Lecture 11 - Linear Harmonic Oscillator (Continued...1)

Lecture 12 - Linear Harmonic Oscillator (Continued...2)

Lecture 13 - Linear Harmonic Oscillator (Continued...3)

Lecture 14 - Tunneling through a Barrier

Lecture 15 - The 1-Dimensional Potential Wall & Particle in a Box

Lecture 16 - Particle in a Box and Density of States

Lecture 17 - The Angular Momentum Problem

Lecture 18 - The Angular Momentum Problem (Continued...)

Lecture 19 - The Hydrogen Atom Problem

Lecture 20 - The Two Body Problem

Lecture 21 - The Two Body Problem: The Hydrogen atom, The Deuteron and The Diatomic Molecule

Lecture 22 - Two Body Problem: The Diatomic molecule (Continued...) and the 3 Dimensional Oscillator

Lecture 23 - 3d Oscillator & Dirac's Bra and Ket Algebra

Lecture 24 - Dirac's Bra and Ket Algebra

Lecture 25 - Dirac's Bra and Ket Algebra : The Linear Harmonic Oscillator

Lecture 26 - The Linear Harmonic Oscillator using Bra and Ket Algebra (Continued...)

Lecture 27 - The Linear Harmonic Oscillator: Coherent State and Relationship with the Classical Oscillator

Lecture 28 - Coherent State and Relationship with the Classical Oscillator

Lecture 29 - Angular Momentum Problem using Operator Algebra

Lecture 30 - Angular Momentum Problem (Continued...)

Lecture 31 - Pauli Spin Matrices and The Stern Gerlach Experiment

[Lecture 32 - The Larmor Precession and NMR Spherical Harmonics using Operator Algebra](#)

[Lecture 33 - Addition of Angular Momentum: Clebsch Gordon Coefficient](#)

[Lecture 34 - Clebsch Gordon Coefficients](#)

[Lecture 35 - The JWKB Approximation](#)

[Lecture 36 - The JWKB Approximation: Use of Connection Formulae to solve Eigen value Problems.](#)

[Lecture 37 - The JWKB Approximation: Use of Connection Formulae to calculate Tunneling Probability.](#)

[Lecture 38 - The JWKB Approximation: Tunneling Probability Calculations and Applications.](#)

[Lecture 39 - The JWKB Approximation: Justification of the Connection Formulae](#)

[Lecture 40 - Time Independent Perturbation Theory](#)

[Lecture 41 - Time Independent Perturbation Theory \(Continued...1\)](#)

[Lecture 42 - Time Independent Perturbation Theory \(Continued...2\)](#)

NPTEL : Semiconductor Optoelectronics (Physics)

Co-ordinators : Prof. M.R. Shenoy

- Lecture 1 - Context and Scope of the Course
- Lecture 2 - Energy Bands in Solids
- Lecture 3 - E-K Diagram
- Lecture 4 - The Density of States
- Lecture 5 - The Density of States (Continued...)
- Lecture 6 - The Density of states in a Quantum well Structure
- Lecture 7 - Occupation Probability and Carrier Concentration
- Lecture 8 - Carrier Concentration and Fermi Level
- Lecture 9 - Quasi Fermi Levels
- Lecture 10 - Semiconductor Materials
- Lecture 11 - Semiconductor Hetrostructures-Lattice-Matched Layers
- Lecture 12 - Strained -Layer Epitaxy and Quantum Well Structures
- Lecture 13 - Bandgap Engineering
- Lecture 14 - Hetrostructure p-n junctions
- Lecture 15 - Schottky Junction and Ohmic Contacts
- Lecture 16 - Fabrication of Heterostructure Devices
- Lecture 17 - Interaction od Photons with Electrons and Holes in a Semiconductor
- Lecture 18 - Optical Joint Density of States
- Lecture 19 - Rates of Emission and Absorption
- Lecture 20 - Amplication by Stimulated Emission
- Lecture 21 - The Semiconductor (Laser) Amplifier
- Lecture 22 - Absorption Spectrum of Semiconductor
- Lecture 23 - Gain and Absorption Spectrum of Quantum Well Structures
- Lecture 24 - Electro-absorption Modulator
- Lecture 25 - Electro-absorption Modulator - II Device Configuration
- Lecture 26 - Mid-Term Revision Question and Discussion
- Lecture 27 - Part - III Semiconductor Light Sources
- Lecture 28 - Light Emitting Diode-I Device Structure and Parameters
- Lecture 29 - Light Emitting Diode-II Device Chracteristics
- Lecture 30 - Light Emitting Diode-III Output Characteristics
- Lecture 31 - Light Emitting Diode-IV Modulation Bandwidth

[Lecture 32 - Light Emitting Diode-V materials and Applications](#)

[Lecture 33 - Laser Basics](#)

[Lecture 34 - Semiconductor Laser-I Device Structure](#)

[Lecture 35 - Semiconductor Laser-II Output Characteristics](#)

[Lecture 36 - Semiconductor Laser-III Single Frequency Lasers](#)

[Lecture 37 - Vertical Cavity Surface Emitting Laser \(VCSEL\)](#)

[Lecture 38 - Quantum Well Laser](#)

[Lecture 39 - Practical Laser Diodes and Handling](#)

[Lecture 40 - General Characteristics of Photodetectors](#)

[Lecture 41 - Responsivity and Impulse Response](#)

[Lecture 42 - Photoconductors](#)

[Lecture 43 - Semiconductor Photo-Diodes](#)

[Lecture 44 - Semiconductor Photo-Diodes-II : APD](#)

[Lecture 45 - Other Photodectors](#)

[Lecture 46 - Photonic Integrated Circuits](#)

- Lecture 1 - Context, Scope and Contents of the Course
- Lecture 2 - Energy Bands in Solids
- Lecture 3 - E-k Diagram - The Band Structure
- Lecture 4 - The Density of States
- Lecture 5 - The Density of States $\tilde{I}(k)$, $\tilde{I}(E)$
- Lecture 6 - Density of States in a Quantum Well Structure
- Lecture 7 - Occupation Probability and Carrier Concentration
- Lecture 8 - Carrier Concentration and Fermi Level
- Lecture 9 - Quasi Fermi Levels
- Lecture 10 - Semiconductor Materials
- Lecture 11 - Semiconductor Heterostructures-Lattice-Matched Layers
- Lecture 12 - Strained-Layer Epitaxy and Quantum Well Structures
- Lecture 13 - Bandgap Engineering
- Lecture 14 - Heterostructure p-n junctions
- Lecture 15 - Schottky Junctions and Ohmic Contacts
- Lecture 16 - Fabrication of Heterostructure Devices
- Lecture 17 - Interaction of Photons with Electrons and Holes in a Semiconductor
- Lecture 18 - Optical Joint Density of States, and Probabilities of Emission and Absorption
- Lecture 19 - Rates of Emission and Absorption
- Lecture 20 - Amplification by Stimulated Emission
- Lecture 21 - The Semiconductor (Laser) Amplifier
- Lecture 22 - Absorption Spectrum of Semiconductors
- Lecture 23 - Gain and Absorption Spectrum of Quantum Well Structures
- Lecture 24 - Electro-absorption Modulator-I Principle of Operation
- Lecture 25 - Electro-absorption Modulator-II Device Configuration
- Lecture 26 - Injunction Electroluminescence
- Lecture 27 - Light emitting diode-I Device structure and parameters
- Lecture 28 - Light emitting diode-II Device Characteristics
- Lecture 29 - Light emitting diode-III Output Characteristics
- Lecture 30 - Light emitting diode-IV Modulation Bandwidth
- Lecture 31 - Light emitting diode-V Material and Applications

[Lecture 32 - Laser Basics](#)

[Lecture 33 - Semiconductor Laser-I Device Structure](#)

[Lecture 34 - Semiconductor Laser-II Output Characteristics](#)

[Lecture 35 - Semiconductor Laser-III Single Frequency Lasers](#)

[Lecture 36 - Vertical cavity Surface Emitting Laser \(VCSEL\)](#)

[Lecture 37 - Quantum Well Laser](#)

[Lecture 38 - Practical Laser Diodes and Handling](#)

[Lecture 39 - General Characteristics of Photodetectors](#)

[Lecture 40 - Responsivity and Impulse Response](#)

[Lecture 41 - Photoconductors](#)

[Lecture 42 - Semiconductor Photo-Diodes-I: PIN Diode](#)

[Lecture 43 - Semiconductor Photo-Diodes-II: APD](#)

[Lecture 44 - Other Photodetectors](#)

[Lecture 45 - Photonic Integrated Circuits](#)

- Lecture 1 - General Introduction, Scope and Contents
- Lecture 2 - Interaction of Radiation with Matter
- Lecture 3 - The Einstein Coefficients
- Lecture 4 - Atomic Lineshape Function, $g(\nu)$
- Lecture 5 - Amplification by Stimulated Emission
- Lecture 6 - Line Broadening Mechanisms - 1
- Lecture 7 - Line Broadening Mechanisms - 2
- Lecture 8 - Laser Rate Equations: 2-Level System
- Lecture 9 - Laser Rate Equations: 3-Level System
- Lecture 10 - Laser Rate Equations: 4-Level System
- Lecture 11 - Laser Amplifiers
- Lecture 12 - Er-Doped Fiber Amplifier
- Lecture 13 - Resonance Frequencies
- Lecture 14 - Spectral Response of an Optical Resonator
- Lecture 15 - Resonator Loss and Cavity Lifetime
- Lecture 16 - Spherical Mirror Resonators
- Lecture 17 - Resonator Stability Condition
- Lecture 18 - Ray Paths in Spherical Mirror Resonators
- Lecture 19 - Transverse Modes of a Spherical Mirror Resonator
- Lecture 20 - Gaussian Mode of the Spherical Mirror Resonator
- Lecture 21 - Longitudinal Modes of a Spherical Mirror Resonator
- Lecture 22 - Laser Oscillations and The Threshold Condition
- Lecture 23 - Spectral Hole Burning
- Lecture 24 - Variation of Laser Power around Threshold
- Lecture 25 - Optimum Output Coupling
- Lecture 26 - Laser Output Characteristics
- Lecture 27 - Laser Beam Properties
- Lecture 28 - Ultimate Linewidth of a Laser
- Lecture 29 - Pulsed Lasers
- Lecture 30 - Q-Switching
- Lecture 31 - Mode Locking

[Lecture 32 - Methods of Mode Locking](#)

[Lecture 33 - Some Common Lasers](#)

[Lecture 34 - Fiber Lasers](#)

[Lecture 35 - Semiconductor Lasers](#)

[Lecture 36 - Lasers and Laser Amplifiers in Optical Fiber Communication](#)

[Lecture 37 - Lasers in Nonlinear Optics](#)

[Lecture 38 - Laser Safety](#)

Lecture 1 - Introduction

Lecture 2 - Nuclear Properties

Lecture 3 - Properties of Nuclear Force

Lecture 4 - Deuteron

Lecture 5 - Nucleons Scattering

Lecture 6 - Nuclear Models - I

Lecture 7 - Nuclear Models - II

Lecture 8 - Radioactive Decay - General Properties

Lecture 9 - Nuclear Alpha Decay

Lecture 10 - Nuclear Beta decay

Lecture 11 - Beta-decay details

Lecture 12 - Gamma decay

Lecture 13 - Nuclear Scattering - Preliminaries

Lecture 14 - Types of Reactions

Lecture 15 - Particle Accelerators - I

Lecture 16 - Particle Accelerators - II

Lecture 17 - Detectors

Lecture 18 - Elementary Particles - Introduction and Overview

Lecture 19 - Quark Model - I

Lecture 20 - Quark Model - II

Lecture 21 - Quark Model - III

Lecture 22 - Structure of the Hadron - Nucleus

Lecture 23 - Structure of the Hadron - Proton

Lecture 24 - Deep Inelastic Scattering

Lecture 25 - Relativistic Kinematics

Lecture 26 - Klein-Gordon Equation

Lecture 27 - Interaction of charged scalar with EM field

Lecture 28 - Relativistic Electrodynamics

Lecture 29 - Quantum Electrodynamics

Lecture 30 - Interaction between charged scalars

Lecture 31 - Dirac Equation - 1

[Lecture 32 - Dirac Equation - 2](#)

[Lecture 33 - Interacting charged fermions - 1](#)

[Lecture 34 - Interacting charged fermions - 2](#)

[Lecture 35 - Interacting charged fermions - 3](#)

[Lecture 36 - Scattering Cross Section Revisited - 1](#)

[Lecture 37 - Scattering Cross Section Revisited - 2](#)

[Lecture 38 - Weak Interactions - 1](#)

[Lecture 39 - Weak Interactions - 2](#)

[Lecture 40 - Lagrangian Framework](#)

[Lecture 41 - Gauge Symmetry - U\(1\)](#)

[Lecture 42 - Electroweak Theory - 1](#)

[Lecture 43 - Electroweak Theory - 2](#)

[Lecture 44 - SSB and the Higgs Mechanism](#)

- Lecture 1 - Propagators - I
- Lecture 2 - Propagators - II
- Lecture 3 - Second quantization - I
- Lecture 4 - Second quantization - II
- Lecture 5 - Second quantized Hamiltonian
- Lecture 6 - Tight Binding Hamiltonian, Hubbard model
- Lecture 7 - Magnetism
- Lecture 8 - Singlet and Triplet State: Magnetic Hamiltonian
- Lecture 9 - Antiferromagnetism in Hubbard model
- Lecture 10 - Green's function and representations in quantum mechanics
- Lecture 11 - S matrix and free electron Green's function
- Lecture 12 - Wick's theorem and normal ordering
- Lecture 13 - Green's function and Feynman diagrams
- Lecture 14 - Feynman diagram
- Lecture 15 - phonon Green' function and Hartree Fock approximation
- Lecture 16 - Finite temperature Green's function and Matsubara frequencies
- Lecture 17 - Dyson's equation and disorder in electronic systems
- Lecture 18 - Introduction to electrodynamics, Meissner effect
- Lecture 19 - London penetration depth, Type I and II superconductors
- Lecture 20 - Cooper's problem, BCS gap equation
- Lecture 21 - BCS theory, Transition temperature
- Lecture 22 - Ginzburg Landau Theory, Coherence length and penetration depth
- Lecture 23 - Quantum Hall Effect
- Lecture 24 - Spin Hall effect, 2D topological insulator
- Lecture 25 - Bose-Einstein condensation

Lecture 1 - Introduction, Postulates of Quantum Mechanics

Lecture 2 - Stern Gerlach Experiment, Spin Quantization, Young's Double Slit Experiment

Lecture 3 - The Mathematical Formalism of Quantum Mechanics, Uncertainty Principle

Lecture 4 - The Density Matrix Formalism, Expectation values of Operators

Lecture 5 - Quantum Harmonic Oscillator, Creation and annihilation Operators

Lecture 6 - Coherent States and their Properties

Lecture 7 - Applications of Coherent States, squeezed states

Lecture 8 - Symmetries and Conservation Principles in Quantum Mechanics

Lecture 9 - Rotation Operator and Invariance of Angular Momentum, Parity

Lecture 10 - Spherically Symmetric System and Applications to quantum dots

Lecture 11 - Spin Angular Momentum, Addition of Angular Momentum, Clebsch gordan coefficients

Lecture 12 - Magnetic Hamiltonian, Heisenberg Model

Lecture 13 - Nuclear Magnetic Resonance (NMR)

Lecture 14 - Applications of NMR, time evolution of Magnetic Moments

Lecture 15 - Introduction to Quantum Computing

Lecture 16 - Qubits,EPR Paradox

Lecture 17 - Quantum Entanglement (QE)

Lecture 18 - Teleportation, Quantum Teleportation for one spin

Lecture 19 - Entangled state for two spins

Lecture 20 - Quantum Gates, Walsh Hadamard Transformation, No cloning theorem

Lecture 21 - Perturbation Theory

Lecture 22 - Stark Effect: First order in ground state

Lecture 23 - Stark Effect: Second order in ground state

Lecture 24 - Variational method, Variation of constants, Upper bound on ground state energy

Lecture 25 - Application of Variational method,Hydrogen,Helium atom,Comparison with perturbation theory

Lecture 26 - WKB Approximation, Bohr Sommerfeld quantization condition

Lecture 27 - Summary of Approximation methods, Time dependent Perturbation Theory

Lecture 28 - Time dependent Perturbation Theory, Fermi's Golden rule, Einstein's A and B coefficients

Lecture 29 - Scattering Theory

Lecture 30 - Linear Response Theory: Derivation of Kubo formula

Lecture 31 - Quantum Dynamics: Two level system

[Lecture 32 - Examples](#)

[Lecture 33 - Interaction of Radiation with matter, Landau levels](#)

Lecture 1 - Historical introduction of superconductivity

Lecture 2 - Meissner effect, Electrodynamics of Superconductors, coherence length and penetration depth

Lecture 3 - Electron Pairing, Basics of BCS Theory

Lecture 4 - BCS ground state, variational calculation, expression for T_c

Lecture 5 - Order parameter, Free energy functional, Ginzburg-Landau (GL) Theory, GL equations

Lecture 6 - London Equations, Flux quantization

Lecture 7 - Thermodynamic properties of superconductors, specific heat

Lecture 8 - Experimental determination of Superconducting properties

Lecture 9 - Unconventional Superconductivity, Uemura plot, High- T_c superconductivity, d-wave pairing, ARPES

Lecture 10 - Singlet and triplet states of two $s=1/2$, magnetic Hamiltonian

Lecture 11 - t-J model, discrete symmetry groups, example square lattice

Lecture 12 - Cuprate Superconductors, electron vs hole doped superconductors

Lecture 13 - Non-Fermi Liquid Theory, Adiabatic continuity

Lecture 14 - Quasiparticle lifetime, breakdown of Fermi Liquid Theory in cuprate superconductors

Lecture 15 - Josephson junctions, Josephson equations

Lecture 16 - Numerical Differentiation

Lecture 17 - Richardson's extrapolation

Lecture 1 - Prerequisites and Introduction

Lecture 2 - Combinatorics and Entropy

Lecture 3 - Method of steepest descent

Lecture 4 - Bose and Fermi gases

Lecture 5 - Maxwell Boltzmann distribution

Lecture 6 - Thermodynamic potentials

Lecture 7 - Legendre transformation

Lecture 8 - Specific heats of quantum gases

Lecture 9 - Low and high temperature equations of state

Lecture 10 - Chandrasekhar Limit

Lecture 11 - Radiation thermodynamics

Lecture 12 - Thermodynamics of black holes

Lecture 13 - Van der Waals fluid

Lecture 14 - Landau Diamagnetism

Lecture 15 - Relations between ensembles and Pauli paramagnetism

Lecture 16 - Ferromagnetism

Lecture 17 - Correlations and Mean Field

Lecture 18 - Theories of Specific Heat of Solids

Lecture 19 - Tutorial - I

Lecture 20 - Tutorial - II

Lecture 21 - Tutorial - III

Lecture 22 - Tutorial - IV

Lecture 23 - Tutorial - V

Lecture 24 - RG method Ising model

Lecture 25 - Introduction to Second Quantisation: Harmonic Oscillator

Lecture 26 - Quantum Theory of EM Field - I

Lecture 27 - Quantum Theory of EM Field - II

Lecture 28 - Creation and Annihilation in Fock Space - I

Lecture 29 - Creation and Annihilation in Fock Space - II

Lecture 30 - Green functions in many particle systems

Lecture 31 - Second quantised hamiltonians

- Lecture 1 - Error analysis and estimates, significant digits, convergence
- Lecture 2 - Roots of Non-linear equations, Bisection method
- Lecture 3 - Newton Raphson method, Secant method
- Lecture 4 - Newton Raphson Method
- Lecture 5 - Newton Raphson Method (example), Curve fitting and interpolation of data
- Lecture 6 - Newton's interpolation formula, statistical interpolation of data
- Lecture 7 - Linear and Polynomial regression
- Lecture 8 - Numerical differentiation
- Lecture 9 - Numerical differentiation, Error analysis
- Lecture 10 - Numerical integration, Trapezoidal rule
- Lecture 11 - Simpson's 1/3rd rule
- Lecture 12 - Simpson's 1/3rd rule, Gaussian integration
- Lecture 13 - Ordinary Differential equations
- Lecture 14 - Solution of differential equation, Taylor series and Euler method
- Lecture 15 - Heun's method
- Lecture 16 - Runge Kutta method
- Lecture 17 - Examples of differential equation: Heat conduction equation
- Lecture 18 - Introduction to Monte Carlo technique
- Lecture 19 - Details of the Monte Carlo method
- Lecture 20 - Importance sampling
- Lecture 21 - Applications: Ising model
- Lecture 22 - Introduction to Molecular Dynamics
- Lecture 23 - Verlet algorithm
- Lecture 24 - Applications of Molecular dynamics

- Lecture 1 - Introduction, Constraints
- Lecture 2 - Generalized Coordinates, Configuration Space
- Lecture 3 - Principle of Virtual Work
- Lecture 4 - D'Alembert's Principle
- Lecture 5 - Lagrange's Equations
- Lecture 6 - Hamilton's Principle
- Lecture 7 - Variational Calculus, Lagrange's Equations
- Lecture 8 - Conservation Laws and Symmetries
- Lecture 9 - Velocity Dependent Potentials, Non-holonomic Constraints
- Lecture 10 - An Example: Hoop on a ramp
- Lecture 11 - Phase Space
- Lecture 12 - Legendre Transforms
- Lecture 13 - Hamilton's Equations
- Lecture 14 - Conservation Laws, Routh's procedure
- Lecture 15 - An Example: Bead on Spinning Ring
- Lecture 16 - Canonical Transformations
- Lecture 17 - Symplectic Condition
- Lecture 18 - Canonical Invariants, Harmonic Oscillator
- Lecture 19 - Poisson Bracket Formulation
- Lecture 20 - Infinitesimal Canonical Transformations
- Lecture 21 - Symmetry Groups of Mechanical Systems
- Lecture 22 - Hamilton Jacobi Theory
- Lecture 23 - Action-Angle Variables
- Lecture 24 - Separation of Variables and Examples
- Lecture 25 - Continuous Systems and Fields
- Lecture 26 - The Stress-Energy Tensor
- Lecture 27 - Hamiltonian Formulation

Lecture 1 - Energy Scenarios

Lecture 2 - Overview of solar energy conversion devices and applications

Lecture 3 - Physics of propagation of solar radiation from the sun to the earth

Lecture 4 - Solar radiation and sunshine measuring instruments

Lecture 5 - Geometry, angles and measurement - I

Lecture 6 - Geometry, angles and measurement - II

Lecture 7 - Estimation of radiation under different climatic conditions

Lecture 8 - Estimation of radiation in horizontal and inclined surface

Lecture 9 - Fundamentals of PV cells

Lecture 10 - Semiconductor physics

Lecture 11 - Performance characterization of PV cells

Lecture 12 - Photovoltaic modules and arrays

Lecture 13 - Components of standalone PV system

Lecture 14 - Design of standalone PV system

Lecture 15 - Functioning and components of PV system

Lecture 16 - Design of a grid connected PV system

Lecture 17 - Performance analysis of a grid connected PV system

Lecture 18 - Basics of thermal collectors

Lecture 19 - Basics of heat transfer

Lecture 20 - Solar collector losses and loss estimation

Lecture 21 - Analysis of flat plate collector

Lecture 22 - Influence of various parameters on the performance of LFPC

Lecture 23 - Testing and application of LFPC

Lecture 24 - Basics and performance analysis of solar air heaters

Lecture 25 - Testing and application of solar air heaters

Lecture 26 - Fundamentals of concentrating collectors

Lecture 27 - Concentrating collector technologies and working principle

Lecture 28 - Tutorial: Concentrating Collector

Lecture 29 - Sensible heat, latent heat and thermochemical energy storage

Lecture 30 - Solar pond

Lecture 31 - Tutorial: Solar pond power plant design

[Lecture 32 - Emerging technologies](#)

[Lecture 33 - Solar energy applications in cooking, desalination, refrigeration and electricity generation](#)

[Lecture 34 - Tutorial: COP of VARS and performance analysis of PVT collector](#)

- Lecture 1 - Introduction and Basic Quantum Mechanics
- Lecture 2 - Problem Solving Session - 1
- Lecture 3 - Two-level System - I
- Lecture 4 - Bloch Sphere: Supplementary Lectuer - I
- Lecture 5 - Two-level Systems - II
- Lecture 6 - Two-level Systems - III
- Lecture 7 - Dressed States;Introduction to Density Matrix
- Lecture 8 - Problem Solving Session - 2
- Lecture 9 - Density-matrix formalism
- Lecture 10 - Quantum Harmonic Oscillators
- Lecture 11 - Quantization of Electromagnetic Radiation
- Lecture 12 - Quantization of Standing EM Waves;Quantum States of Radiation Fields - I
- Lecture 13 - Problem Solving Session - 3
- Lecture 14 - Quantum States of Radiation Fields-II: Squeezed States
- Lecture 15 - Problem Solving Session - 4
- Lecture 16 - Introduction and Basics of Superconductivity
- Lecture 17 - Cooper Pair Box as TLS;Introduction to Transmission Line
- Lecture 18 - Quantization of Transmission Line - I
- Lecture 19 - Quantization of Transmission Line - II
- Lecture 20 - The Jaynes Cummings Model - I
- Lecture 21 - Problem Solving Session - 5
- Lecture 22 - The Jaynes Cummings Model - II
- Lecture 23 - Josephson Junctions - I
- Lecture 24 - Josephson Junctions - II
- Lecture 25 - Problem Solving Session - 6
- Lecture 26 - Transmon;Introduction to Dissipation in Quantum Systems
- Lecture 27 - Quantum Master Equation
- Lecture 28 - Pure dephasing and Dissipative Bloch Equations
- Lecture 29 - Derivation of Fermi-Golden Rule
- Lecture 30 - Introduction to Cavity Optomechanics;Fabry-Perot Cavity
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Co-ordinators : Prof. Mahendra K. Verma

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- [Lecture 44 - Acousto-optic Effect \(Continued...\)](#)
- [Lecture 45 - Acousto-optic Effect \(Continued...\)](#)
- [Lecture 46 - Acousto-optic Effect \(Continued...\)](#)
- [Lecture 47 - Acousto-optic Effect \(Continued...\)](#)
- [Lecture 48 - Acousto-optic Effect \(Continued...\)](#)
- [Lecture 49 - Acousto-optic Effect \(Continued...\)](#)
- [Lecture 50 - Acousto-optic Effect \(Continued...\)](#)
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- [Lecture 54 - Acousto-optic Modulators and Devices](#)
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- [Lecture 56 - Acousto-optic Modulators and Devices \(Continued...\)](#)
- [Lecture 57 - Acousto-optic Modulators and Devices \(Continued...\)](#)
- [Lecture 58 - Magneto-optic Effect](#)
- [Lecture 59 - Magneto-optic Effect \(Continued...\)](#)

- Lecture 1 - Basic Linear Optics
- Lecture 2 - Basic Linear Optics (Continued...)
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- Lecture 4 - Basic Linear Optics (Continued...)
- Lecture 5 - Basic Linear Optics (Continued...)
- Lecture 6 - Basic Linear Optics (Continued...)
- Lecture 7 - Basic Linear Optics (Continued...)
- Lecture 8 - Basic Linear Optics (Continued...)
- Lecture 9 - Basic Linear Optics (Continued...)
- Lecture 10 - Nonlinear Optics : An Introduction
- Lecture 11 - Classical origin of optical nonlinearity
- Lecture 12 - Miller's Rule
- Lecture 13 - Second Harmonic Generation (SHG)
- Lecture 14 - Optical Rectification, Linear electro-optic effect
- Lecture 15 - Sum and Difference frequency generation
- Lecture 16 - Nonlinear Maxwell's equation
- Lecture 17 - Theory of SHG
- Lecture 18 - Phase matching
- Lecture 19 - Phase matching of SHG, Gain band width calculation
- Lecture 20 - Manley-Rowe Relation, Energy conservation in SHG,
- Lecture 21 - Birefringence phase-matching (BPM), Type I and Type II phase matching
- Lecture 22 - Type II phase matching, Symmetry in nonlinear susceptibility
- Lecture 23 - Kleinman's Symmetry, Neumann's Principle
- Lecture 24 - Neumann's Principle (Continued...) Centrosymmetric system
- Lecture 25 - Matrix form : SHG, SFG, DFG , SHG in KDP Crystal
- Lecture 26 - SHG in KDP crystal, Calculation of d_{eff}
- Lecture 27 - SHG in LiNbO₃
- Lecture 28 - Quasi phase matching (QPM)
- Lecture 29 - Quasi phase matching (QPM) (Continued...), Periodic d function
- Lecture 30 - 1st, 2nd, 3rd order QPM, SHG under depleted pump
- Lecture 31 - Realistic calculation of SHG, 3 wave interaction

- Lecture 32 - 3 wave interaction, Equation for pump, signal and idler wave, Non-collinear phase matching
- Lecture 33 - Manley-Rowe Relation (3 wave mixing), Parametric down conversion
- Lecture 34 - Parametric down conversion (Continued...), Optical Parametric Amplification (OPA)
- Lecture 35 - Optical Parametric Amplification (OPA), Difference frequency generation under OPA
- Lecture 36 - Sum frequency generation under OPA
- Lecture 37 - OPA under non-phase matching condition, Expression of gain
- Lecture 38 - Optical parametric Oscillator (OPO), Singly resonant oscillator
- Lecture 39 - Doubly Resonant Oscillator (DRO)
- Lecture 40 - Doubly Resonant Oscillator (DRO) (Continued...)
- Lecture 41 - 3rd order nonlinear effect
- Lecture 42 - Optical Kerr effect and Self-focusing, Symmetry in 3rd order susceptibility
- Lecture 43 - Symmetry in 3rd order susceptibility (Continued...), Self Phase Modulation (SPM)
- Lecture 44 - Self Phase Modulation (Continued...), Frequency Shift
- Lecture 45 - Third Harmonic Generation(3HG), Energy conservation
- Lecture 46 - Third Harmonic Generation (Continued...)
- Lecture 47 - Third Harmonic Generation (Continued...), Cross Phase Modulation (XPM)
- Lecture 48 - Cross Phase Modulation (Continued...), Nonlinear Absorption
- Lecture 49 - Four Wave Mixing
- Lecture 50 - Four Wave mixing (Continued...)
- Lecture 51 - Parametric Amplification under FWM
- Lecture 52 - Parametric Amplification under FWM (Continued...)
- Lecture 53 - Optical Phase Conjugation
- Lecture 54 - Raman Scattering
- Lecture 55 - Stimulated Raman Scattering
- Lecture 56 - Raman Amplification
- Lecture 57 - Raman Amplification (Continued...)
- Lecture 58 - Linear pulse propagation
- Lecture 59 - Nonlinear Pulse propagation
- Lecture 60 - Optical Soliton

Lecture 1 - Introduction

Lecture 2 - Concentration

Lecture 3 - Sources and Process Overview of Natural Gas

Lecture 4 - Pure Component Phase Behavior

Lecture 5 - Mixture Phase Behavior

Lecture 6 - Phase Behaviour of Natural Gas

Lecture 7 - Dew Point and Bubble Point Calculations

Lecture 8 - Vapor Liquid Equilibrium

Lecture 9 - Problems on Vapor Pressure, Gibb's Phase Rule, Dew Point Bubble Point Temperatures

Lecture 10 - Thermophysical Properties of Natural Gas - I

Lecture 11 - Thermophysical Properties of Natural Gas - II

Lecture 12 - Thermodynamic and Chemical Properties

Lecture 13 - Combustion Properties

Lecture 14 - Flow in Natural Gas Systems

Lecture 15 - Flow Measurement In Natural Gas - I

Lecture 16 - Flow Measurement In Natural Gas - II

Lecture 17 - Temperature and Quality Measurement in Natural Gas Systems

Lecture 18 - Pressure measurement in natural gas systems

Lecture 19 - Tutorial on the estimation of thermophysical properties

Lecture 20 - Tutorial on the combustion and thermodynamic properties of natural gas

Lecture 21 - Tutorial on fluid mechanics

Lecture 22 - Tutorial on flow and pressure measurement in natural gas systems

Lecture 23 - Tutorial on temperature and quality measurement in natural gas

Lecture 24 - Heat transfer in natural gas systems

Lecture 25 - Tutorial on heat transfer in natural gas systems

Lecture 26 - Heat exchangers in natural gas systems

Lecture 27 - Analysis of heat exchangers in natural gas systems

Lecture 28 - Tutorial on heat exchanger analysis

Lecture 29 - Equilibrium vapour-liquid separation

Lecture 30 - Equilibrium in multicomponent systems

Lecture 31 - Separation by distillation

- Lecture 32 - Design of distillation column
- Lecture 33 - Equilibrium fluid solid separation
- Lecture 34 - Membrane separation in natural gas systems
- Lecture 35 - Estimation of water content in natural gas
- Lecture 36 - Multistage single component equilibrium separation
- Lecture 37 - Tutorial on vapour liquid separation
- Lecture 38 - Tutorial on ideal binary distillation
- Lecture 39 - Tutorial on equilibrium gas- solid separation
- Lecture 40 - Tutorial on membrane gas separation
- Lecture 41 - Dehydration of natural gas
- Lecture 42 - Natural gas Processing - hydrate removal
- Lecture 43 - Acid gas removal in natural gas system - I
- Lecture 44 - Acid gas removal in natural gas system - II
- Lecture 45 - Nitrogen removal in natural gas system - I
- Lecture 46 - Nitrogen removal in natural gas system - II
- Lecture 47 - Compression in natural gas systems
- Lecture 48 - Compressors used in natural gas systems
- Lecture 49 - Tutorial on hydrate removal
- Lecture 50 - Multicomponent distillation column design: Approximate method
- Lecture 51 - Sulfur recovery in natural gas systems - I
- Lecture 52 - Tutorial on compression
- Lecture 53 - Pigging
- Lecture 54 - Sulfur recovery in natural gas systems - II
- Lecture 55 - Trace components in natural gas
- Lecture 56 - Helium recovery, upgradation and purification
- Lecture 57 - Fundamentals of absorption and stripping for natural gas processing
- Lecture 58 - Tutorial on absorption and stripping
- Lecture 59 - Gas liquid separation in natural gas systems - I
- Lecture 60 - Gas liquid separation in natural gas systems - II
- Lecture 61 - Tutorial on equilibrium in multicomponent systems
- Lecture 62 - Tutorial on multicomponent distillation - I
- Lecture 63 - Tutorial on multicomponent distillation - II
- Lecture 64 - Pumps in natural gas systems - I

- Lecture 65 - Pumps in natural gas systems - II
- Lecture 66 - Pumps in natural gas systems - III
- Lecture 67 - Tutorial on pumps - I
- Lecture 68 - Tutorial on pumps - II
- Lecture 69 - Cryogenic refrigeration and liquefaction in natural gas systems - I
- Lecture 70 - Cryogenic refrigeration and liquefaction in natural gas systems - II
- Lecture 71 - Tutorial on refrigeration - I
- Lecture 72 - Tutorial on refrigeration - II
- Lecture 73 - Cryogenic refrigeration and liquefaction in natural gas systems - III
- Lecture 74 - Cryogenic refrigeration and liquefaction in natural gas systems - IV
- Lecture 75 - Cryogenic refrigeration and liquefaction in natural gas systems - V
- Lecture 76 - Tutorial on refrigeration - III
- Lecture 77 - Tutorial on refrigeration and liquefaction - IV
- Lecture 78 - Tutorial on refrigeration and liquefaction - V
- Lecture 79 - Hydrocarbon recovery in natural gas system - I
- Lecture 80 - Hydrocarbon recovery in natural gas system - II
- Lecture 81 - Hydrocarbon recovery in natural gas system - III
- Lecture 82 - Tutorial on hydrocarbon recovery in natural gas
- Lecture 83 - Piping in natural gas systems - I
- Lecture 84 - Piping in natural gas systems - II
- Lecture 85 - Tutorial on piping in natural gas systems - I
- Lecture 86 - Tutorial on piping in natural gas systems - II

Lecture 1 - Introduction

Lecture 2 - Basic tools and apparatus

Lecture 3 - Basic tools and apparatus (Continued...)

Lecture 4 - Basic tools and apparatus (Continued...)

Lecture 5 - Basic tools and apparatus (Continued...)

Lecture 6 - Basic tools and apparatus (Continued...)

Lecture 7 - Basic components

Lecture 8 - Basic apparatus

Lecture 9 - Basic apparatus (Continued...)

Lecture 10 - Basic analysis

Lecture 11 - Basics analysis (Continued...)

Lecture 12 - Basics analysis (Continued...)

Lecture 13 - Basics analysis (Continued...)

Lecture 14 - Basics analysis (Continued...)

Lecture 15 - Basics analysis (Continued...)

Lecture 16 - Basics analysis (Continued...)

Lecture 17 - Basics analysis (Continued...)

Lecture 18 - Basics analysis (Continued...)

Lecture 19 - Basics analysis (Continued...)

Lecture 20 - Determination of Young's modulus

Lecture 21 - Demonstration on the experiment of Young's modulus of mettalic bar and data collection

Lecture 22 - Calculate the value of young's modulus of given metallic bar form the recorded datas

Lecture 23 - Experimental demonstration to calculate the spring constant of a given spring

Lecture 24 - Calculate the value of calculate the spring constant of a given spring form the recorded datas

Lecture 25 - Theory regarding Moment of inertia of a flywheel

Lecture 26 - Experimental demonstration to calculate the moment of inertia of a given flywheel

Lecture 27 - How to calculate the value of moment of inertia of a flywheelform the recorded data

Lecture 28 - Theory regarding surface tension of the liquid

Lecture 29 - Demonstration on the experiment of surface tension and data collection

Lecture 30 - How to calculate the value of surface tension of water from the recorded data

Lecture 31 - Theory regarding viscosity of liquid

Lecture 32 - Demonstration on the experiment of viscosity

Lecture 33 - Data analysis of recorded data on viscosity

Lecture 34 - Forced Oscillations Pohls pendulum

Lecture 35 - Coupled Pendulum

Lecture 36 - Demonstration on the experiment of compound pendulum

Lecture 37 - Theory regarding compound pendulum has been discussed

Lecture 38 - Experimental demonstration on the standing Waves on a String has been shown clearly how to determine the linear mass density of the string.

Lecture 39 - Linear expansion of metal

Lecture 40 - Expt. to study linear expansion

Lecture 41 - Determine the coefficient of thermal conductivity of a bad conductor

Lecture 42 - Determination of electrical equivalent of heat

Lecture 43 - Determination of specific heat of the given solid metals using Dulong-Petit's law

Lecture 44 - Determination of the calibration curve of a given (Type K chromel- α alumel) thermocouple and hence determination of Seebeck coefficient

Lecture 45 - Theory and Demonstration Platinum Resistance thermometer

Lecture 46 - Experiment on Platinum Resistance thermometer

Lecture 47 - To study the current-voltage relationship of an L-R circuit

Lecture 48 - To study the variation in current and voltage in a series LCR circuit

Lecture 49 - Sensitivity of Blastic Galvanometer

Lecture 50 - Expt. for Sensitivity of Blastic Galvanometer

Lecture 51 - Theory on RC Circuit

Lecture 52 - Expt. on RC Circuit

Lecture 53 - Theory regarding the magnetic field along the axis of a circular coil

Lecture 54 - Experiment regarding the magnetic field along the axis of a circular coil

Lecture 55 - Study the induced e.m.f of inductance coil

Lecture 56 - Mutual inductance

Lecture 57 - Theory regarding permeability of air

Lecture 58 - Experiment to determination the permeability of air

Lecture 59 - Devices around us

Lecture 60 - Devices around us (Continued...)

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Lecture 2 - Summary of Experimental Physics - I

Lecture 3 - Summary of Experimental Physics - I (Continued...)

Lecture 4 - Summary of Experimental Physics - I (Continued...)

Lecture 5 - Summary of Experimental Physics - I (Continued...)

Lecture 6 - Basic analysis

Lecture 7 - Basic analysis (Continued...)

Lecture 8 - Basic components

Lecture 9 - Basic components (Continued...)

Lecture 10 - Basic components (Continued...)

Lecture 11 - Basic idea on mirrors and lenses and their applications

Lecture 12 - Determination of focal length of concave mirror

Lecture 13 - Determination of focal length of concave mirror (Continued...)

Lecture 14 - Determination of focal length of convex mirror

Lecture 15 - Determination of focal length of convex lens

Lecture 16 - Determination of focal length of concave lens

Lecture 17 - Determination of focal length of convex lens by displacement method

Lecture 18 - Applications of mirrors and lenses

Lecture 19 - Determination of refractive index of liquid using travelling microscope

Lecture 20 - Basic discussion on spectrometer and prism

Lecture 21 - Basic discussion on spectrometer and prism (Continued...)

Lecture 22 - Basic discussion on spectrometer and prism (Continued...)

Lecture 23 - Schuster's method

Lecture 24 - Discussion on angle of the prism, angular dispersion and dispersive power of given prism

Lecture 25 - Determination of the angle of prism

Lecture 26 - Determination of the angle of minimum deviation for a given prism and hence to determine the refractive index of the given prism

Lecture 27 - Discussion on the angle of incidence and corresponding deviation of light through a prism and determination of the angle of minimum deviation for a given prism from the plot of the angle of incidence versus deviation.

Lecture 28 - Determination of the angle of minimum deviation from (i-D) plot for a given prism and hence to determine the refractive index of the given prism.

Lecture 29 - Determination of the calibration plot of deviation versus wavelength for a given prism and hence determination of the wavelength of the unknown light source using the calibration plot

[Lecture 30 - Determination of the dispersive power, Cauchy constant and resolving power of a given prism.](#)

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[Lecture 32 - Interference Phenomena \(Continued...\)](#)

[Lecture 33 - Interference Phenomena \(Continued...\)](#)

[Lecture 34 - Bi-prism](#)

[Lecture 35 - Bi-prism \(Continued...\)](#)

[Lecture 36 - Interference phenomena by Newton ring \(Theory\)](#)

[Lecture 37 - Interference phenomena by Newton ring \(Experiment\)](#)

[Lecture 38 - Michelson interferometer \(Theory\)](#)

[Lecture 39 - Michelson interferometer \(Experiment\)](#)

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[Lecture 41 - Theory of diffraction \(Continued...\)](#)

[Lecture 42 - Theory of diffraction \(Continued...\)](#)

[Lecture 43 - Single slit diffraction](#)

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[Lecture 45 - Plane transmission grating](#)

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[Lecture 47 - Theory of polarization](#)

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[Lecture 49 - Experiment for Verification of Malus law](#)

[Lecture 50 - Experiment for Brewster angle](#)

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[Lecture 56 - Theory of Photoelectric Effect](#)

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[Lecture 61 - Experiment on Rydberg constant \(Continued...\)](#)

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Lecture 2 - Basic Tools and Instruments in the Laboratory (Continued...)

Lecture 3 - Cathode Ray Oscilloscope (CRO)

Lecture 4 - Cathode Ray Oscilloscope (CRO) (Continued...)

Lecture 5 - Electro Magnet and Constant Current Power Supply

Lecture 6 - Electro Magnet and Constant Current Power Supply (Continued...)

Lecture 7 - Electro Magnet and Constant Current Power Supply (Continued...)

Lecture 8 - Gaussmeter/Teslameter

Lecture 9 - Gaussmeter/Teslameter (Continued...)

Lecture 10 - Lock in Amplifier

Lecture 11 - Lock in Amplifier (Continued...)

Lecture 12 - Measurement of magneto resistance

Lecture 13 - Magneto resistance for Semiconductor

Lecture 14 - Hall Effect

Lecture 15 - Hall Effect as a function of magnetic Field

Lecture 16 - Hall Effect as a function of temperature

Lecture 17 - To study the variation of resistivity of metal and semiconductor at low temperature region (Continued...)

Lecture 18 - To study the variation of resistivity of metal and semiconductor at low temperature region (Continued...)

Lecture 19 - Measurement of magnetisation of ferromagnetic material

Lecture 20 - Measurement of magnetisation of ferromagnetic material (Continued...)

Lecture 21 - Susceptibility of paramagnetic substance by Quincke's tube method

Lecture 22 - Experiment of Quincke's Tube Method

Lecture 23 - Susceptibility of paramagnetic substance by Gouy's method

Lecture 24 - Dielectric constant of solid

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Lecture 26 - P-E Loop of Ferroelectric Material

Lecture 27 - Measurement of Ionic Conductivity

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Lecture 29 - Electron Spin Resonance (ESR)

Lecture 30 - Electron Spin Resonance (ESR) Experiment

Lecture 31 - Superconductivity

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[Lecture 47 - Determination of Wavelength of Spectral Lines using Constant Deviation Spectrometer](#)

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[Lecture 50 - Photoelastic Property of Materials \(Continued...\)](#)

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[Lecture 59 - X-Ray Diffraction and Crystal Structure \(Continued...\)](#)

[Lecture 60 - X-Ray Diffraction and Crystal Structure \(Continued...\)](#)

[Lecture 61 - X-Ray Diffraction and Crystal Structure \(Continued...\)](#)

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Lecture 1 - Free electrons: Drude Theory

Lecture 2 - Weidemann Franz Law

Lecture 3 - Drude Model continued: Hall Effect

Lecture 4 - Schrodinger Equation: Boundary Conditions

Lecture 5 - Density of States

Lecture 6 - Properties of Degenerate Fermi Gas

Lecture 7 - Statistics Fermi-Dirac distribution and Maxwell-Boltzmann Distribution: comparison and Specific Heat

Lecture 8 - Sommerfeld Expansion and Band Formation: Temperature dependent densities, Chemical Potential, Specific Heat

Lecture 9 - Bonding and Band Formation: N=2 solid Molecular Orbitals, Linear combinations of Atomic Orbitals (LCAO)

Lecture 10 - Variational Method: Molecular Orbitals, Bonding and anti-bonding Orbitals

Lecture 11 - Bonding and Band Formation (LCAO)

Lecture 12 - Bonding and Band Formation (LCAO) (Continued...)

Lecture 13 - Bloch's Theorem

Lecture 14 - Proof of Bloch's Theorem

Lecture 15 - N atoms Solid

Lecture 16 - Brillouin Zones

Lecture 17 - Tight binding: lattice with a basis

Lecture 18 - Fermi Surfaces

Lecture 19 - Lattice with basis:Energy Spectrum

Lecture 20 - Energy spectrum (Continued...)

Lecture 21 - Graphene and Fermi Surfaces

Lecture 22 - Fermi Surfaces Instabilities

Lecture 23 - Low Dimensional Systems

Lecture 24 - Integer Quantum Hall Effect (IQHE)

Lecture 25 - Integer Quantum Hall Effect (Continued...)

Lecture 26 - Electron in a Strong Magnetic Field and IQHE

Lecture 27 - Spintronics: Introduction and Applications

Lecture 28 - Magnetism

Lecture 29 - Magnetism: Quantum Theory

Lecture 30 - Hund's Rule

Lecture 31 - Curie's Law and Van Vleck Paramagnetism

- Lecture 32 - Curie's law for any J, Susceptibility
- Lecture 33 - Susceptibility and Thermal Properties
- Lecture 34 - Adiabatic Demagnetisation
- Lecture 35 - Pauli Paramagnetism
- Lecture 36 - Paramagnetism of metals
- Lecture 37 - Exchange interaction for 2 electrons
- Lecture 38 - Exchange interactions of different types
- Lecture 39 - Magnetic Order
- Lecture 40 - Magnetic Order of different types and Heisenberg model
- Lecture 41 - Ising Model
- Lecture 42 - Mean Field Theory
- Lecture 43 - Spontaneous magnetisation and 1D Ising Model
- Lecture 44 - Symmetries of Ising model, Exact Solution
- Lecture 45 - Ferromagnetic Heisenberg Model
- Lecture 46 - Ground State and Magnons/Excitations
- Lecture 47 - Superconductivity
- Lecture 48 - London Equation
- Lecture 49 - Meisner Effect from London Equation
- Lecture 50 - Cooper problem
- Lecture 51 - Instability of the Fermi Surface
- Lecture 52 - BCS Theory Introduction
- Lecture 53 - BCS Theory, Excitation Spectrum
- Lecture 54 - BCS
- Lecture 55 - Tunneling and Ginzberg Landau Theory
- Lecture 56 - Electrodynamics of Superconductivity
- Lecture 57 - Type II superconductors
- Lecture 58 - Josephson junction
- Lecture 59 - Vortices, SQUID, Quantum Supremacy and Qubits
- Lecture 60 - Topological state of matter, XY Model, Topological Insulators

- Lecture 1 - Wave Equation, Maxwell's equation, Plane wave
- Lecture 2 - EM wave in vacuum, Poynting vector, Maxwell's equation in Dielectric Medium
- Lecture 3 - Poynting Vector, Maxwell's equation in dielectric medium (Continued...)
- Lecture 4 - Total Internal reflection, Evanescent wave
- Lecture 5 - Step-index fiber (SIF), Light guidance in SIF
- Lecture 6 - Light guidance in SIF (Skew Ray), V-Parameter, Discrete Ray
- Lecture 7 - Cutoff wavelength, Fiber characteristics
- Lecture 8 - Fiber Loss, dB units, Dispersion
- Lecture 9 - Dispersion, Ray Path constant
- Lecture 10 - Ray path constant, Ray equation
- Lecture 11 - Ray equation (Continued...)
- Lecture 12 - Ray transit time
- Lecture 13 - Ray transit time (Continued...)
- Lecture 14 - Material dispersion
- Lecture 15 - Material dispersion (Continued...)
- Lecture 16 - Material Dispersion (Continued...), Dispersion Coefficient
- Lecture 17 - Pulse Broadening
- Lecture 18 - Pulse Propagation in Dispersive Medium
- Lecture 19 - Pulse Propagation in Dispersive Medium (Continued...)
- Lecture 20 - Concept of Modes
- Lecture 21 - TE and TM Modes
- Lecture 22 - TE and TM Modes (Continued...)
- Lecture 23 - Modes in Slab waveguide
- Lecture 24 - Modes in Slab waveguide (Continued...)
- Lecture 25 - Modes in Slab waveguide (Continued...)
- Lecture 26 - Modes in Slab Waveguide (Continued...)
- Lecture 27 - Waveguide Dispersion
- Lecture 28 - Physical Understanding of Modes
- Lecture 29 - Power Associated with a Modes
- Lecture 30 - Modes in an Optical Fiber
- Lecture 31 - Modes in an optical fiber (Continued...)

- [Lecture 32 - Modes in an optical fiber \(Continued...\)](#)
- [Lecture 33 - LPlm mode structure](#)
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- [Lecture 35 - Effective area of mode, Fiber optics components](#)
- [Lecture 36 - Directional Coupler](#)
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- [Lecture 38 - Coupled Mode Theory \(Continued...\)](#)
- [Lecture 39 - 3 dB power splitter](#)
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- [Lecture 41 - Fiber Bragg Grating](#)
- [Lecture 42 - Fiber Bragg Grating \(Continued...\)](#)
- [Lecture 43 - Reflectivity Calculation](#)
- [Lecture 44 - Reflectivity Calculation \(Continued...\)](#)
- [Lecture 45 - Reflectivity calculation of FBG \(Continued...\)](#)
- [Lecture 46 - Reflectivity calculation of FBG \(Continued...\)](#)
- [Lecture 47 - Reflectivity calculation of FBG \(Continued...\)](#)
- [Lecture 48 - Bandwidth of reflectivity](#)
- [Lecture 49 - Basic nonlinear optics](#)
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- [Lecture 51 - Optical Kerr effect \(Continued...\)](#)
- [Lecture 52 - Self Phase Modulation](#)
- [Lecture 53 - Self Phase Modulation \(Continued...\)](#)
- [Lecture 54 - Self Phase Modulation \(Continued...\)](#)
- [Lecture 55 - Pulse propagation in nonlinear waveguide](#)
- [Lecture 56 - Pulse propagation in nonlinear waveguide \(Continued...\)](#)
- [Lecture 57 - Pulse propagation in nonlinear dispersive waveguide](#)
- [Lecture 58 - Pulse propagation in nonlinear dispersive waveguide \(Continued...\)](#)
- [Lecture 59 - Concept of optical soliton](#)
- [Lecture 60 - Concept of optical soliton \(Continued...\)](#)

Lecture 1 - Introduction and relevance of the course

Lecture 2 - Energy sources

Lecture 3 - Solar Radiation

Lecture 4 - Solar Photovoltaic Systems

Lecture 5 - Origin of Band Structure and Energy Band Gap

Lecture 6 - Basics of Semiconductors

Lecture 7 - Construction of Solar Cells

Lecture 8 - Characterization of Solar Cells and Future Direction

Lecture 9 - Solar Heaters

Lecture 10 - Introduction to Wind Energy

Lecture 11 - Continuity Equation and its applications

Lecture 12 - Betz Criteria for extracting wind power

Lecture 13 - Wind turbines and their operation

Lecture 14 - Materials Aspects and future direction

Lecture 15 - Introduction to Hydroelectric Power

Lecture 16 - Hydroelectric Power Station and Turbines

Lecture 17 - Wave power and converters

Lecture 18 - Introduction to Tidal Power

Lecture 19 - Tidal Power and Geothermal Energy

Lecture 20 - Introduction to Energy Storage Systems

Lecture 21 - Thermal Energy Storage

Lecture 22 - Basics of Mechanical Energy Storage

Lecture 23 - Pumped Hydroelectric to Flywheels (Mechanical Energy Storage Systems)

Lecture 24 - Introduction to Li-ion battery

Lecture 25 - Characteristics and Parameters of Li-ion batteries

Lecture 26 - Cathode Materials for Li-ion batteries

Lecture 27 - Anode Materials for Li-ion batteries

Lecture 28 - Electrolytes and Separators for Li-batteries

Lecture 29 - From battery to supercapacitors

Lecture 30 - Construction, development and classification of Supercapacitors

Lecture 31 - Electric double layer capacitors (EDLCs)

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[Lecture 34 - From material to a supercapacitor device](#)

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[Lecture 49 - Particle size and zeta potential analysis](#)

[Lecture 50 - BET analysis](#)

[Lecture 51 - Electrochemical Impedance Spectroscopy](#)

- Lecture 1 - Foundation of kinetic theory of gasses
- Lecture 2 - Maxwell's law for speed distribution of gas molecules
- Lecture 3 - Average speeds in an ideal gas assembly
- Lecture 4 - Principle of equipartition of energy
- Lecture 5 - Maxwell's law for energy distribution of gas molecules
- Lecture 6 - The mean free path of a gas assembly
- Lecture 7 - Expression for mean free path
- Lecture 8 - Experimental determination of mean free path
- Lecture 9 - Pressure and molecular flux from mean free path
- Lecture 10 - Problems on mean free path
- Lecture 11 - Transport in fluids: introduction
- Lecture 12 - Viscosity: transport of momentum
- Lecture 13 - Thermal conductivity: transport of thermal energy
- Lecture 14 - Diffusion coefficient: transport of mass
- Lecture 15 - Molecular effusion: theory and applications
- Lecture 16 - Brownian motion: concept, features, theory of fluctuation
- Lecture 17 - Brownian motion: mean square displacement and vertical distribution of particles
- Lecture 18 - Perrin's experiment on Brownian motion - Part 1
- Lecture 19 - Perrin's experiment on Brownian motion - Part 2
- Lecture 20 - Problems on Brownian motion, Rotational brownian motion
- Lecture 21 - Specific heat of solids: Dulong-Petit law and Einstein theory
- Lecture 22 - Limitation of Einstein theory of specific heat
- Lecture 23 - Debye theory of specific heat
- Lecture 24 - Behavior of real gasses
- Lecture 25 - Van der Waals equation of state
- Lecture 26 - Critical parameters from Van der Waal's equation
- Lecture 27 - Determination of Van der Waals' constants and Boyle temperature
- Lecture 28 - Other equations of state
- Lecture 29 - Measurement of temperature: Celsius scale, ideal gas scale, absolute zero
- Lecture 30 - The platinum resistance thermometer
- Lecture 31 - Basic concepts of classical thermodynamics

[Lecture 32 - Basic concepts of classical thermodynamics \(Continued...\)](#)

[Lecture 33 - First law of thermodynamics](#)

[Lecture 34 - General description of work done and specific heat](#)

[Lecture 35 - General discussion on Heat conduction and elastic properties](#)

[Lecture 36 - Cyclic processes](#)

[Lecture 37 - The reversible heat engine: Carnot cycle](#)

[Lecture 38 - Refrigerator and Carnot Theorem](#)

[Lecture 39 - 2nd law and Clausius theorem](#)

[Lecture 40 - Concept of Entropy and mathematical form of 2nd law](#)

[Lecture 41 - The entropy principle](#)

[Lecture 42 - Efficiency of a cycle from T-S diagram](#)

[Lecture 43 - The Otto cycle](#)

[Lecture 44 - The Diesel cycle](#)

[Lecture 45 - Entropy and available energy](#)

[Lecture 46 - Thermodynamic relations](#)

[Lecture 47 - Application of thermodynamic relation](#)

[Lecture 48 - The free energy functions](#)

[Lecture 49 - Condition for thermodynamic equilibri](#)

[Lecture 50 - Thermodynamics of chemical reaction](#)

[Lecture 51 - Equilibrium between phases: The Clapeyron equation](#)

[Lecture 52 - 1st order phase transition along liquid-vapor equilibrium](#)

[Lecture 53 - Phase diagram and triple point](#)

[Lecture 54 - The 2nd latent heat equation](#)

[Lecture 55 - Gibbs phase rule and basics of second order phase transition](#)

[Lecture 56 - Basic concepts of radiation](#)

[Lecture 57 - Diffused radiation and Kirchhoff's law](#)

[Lecture 58 - Cavity radiation as a thermodynamic system: Stefan-Boltzmann law](#)

[Lecture 59 - Thermodynamics of cavity radiation](#)

[Lecture 60 - 3rd law of thermodynamics](#)

- Lecture 1 - Introduction: Magnetism and superconductivity as macroscopic quantum phenomena
- Lecture 2 - Bohr magneton, BvL theorem
- Lecture 3 - An electron in a magnetic field, magnetism of isolated atoms
- Lecture 4 - Magnetism of isolated atoms (Continued...), Diamagnetism
- Lecture 5 - Magnetism of atoms-dia and paramagnetic susceptibilities. Hund's rules, Van Vleck paramagnetism
- Lecture 6 - Van Vleck paramagnetism (Continued...), Paramagnetism
- Lecture 7 - Curie's law for arbitrary J, adiabatic demagnetization
- Lecture 8 - Paramagnetism of conduction electrons - Pauli paramagnetism
- Lecture 9 - Ions in a solid: crystal field, orbital quenching, Jahn-Teller effect
- Lecture 10 - Jahn-Teller effect (Continued...), Magnetic resonance techniques NMR, ESR
- Lecture 11 - Resonance techniques (Continued...), Recapitulation and overview
- Lecture 12 - Recapitulation, interacting moments and long range order, dipolar exchange
- Lecture 13 - Interacting moments, 2-electron system, origin of exchange and spin Hamiltonian
- Lecture 14 - Spin Hamiltonian, Heisenberg model, Exchange interactions: direct
- Lecture 15 - GMR, spin model and mean-field theory, Ising model
- Lecture 16 - Ising model and its properties
- Lecture 17 - Ising model and its properties (Continued...), absence of LRO in $d=1$, mean-field theory
- Lecture 18 - Ising model recap, applications, exact solutions
- Lecture 19 - Exact solution of Ising model in $d=1$, exact results in $d=2$. Mermin-Wagner theorem
- Lecture 20 - Recap - Exact solution of Ising model. Mermin-Wagner theorem on the absence
- Lecture 21 - Ferromagnetic Heisenberg model ground state
- Lecture 22 - Ferromagnetic Heisenberg model, spin-waves and magnons
- Lecture 23 - Antiferromagnetic Heisenberg model, AF magnetic structures
- Lecture 24 - AF magnetic structures, susceptibility and excitations
- Lecture 25 - Antiferromagnets and frustration, spin glass
- Lecture 26 - Superconductivity: discovery, properties
- Lecture 27 - Superconductivity: Meissner effect, London Equation
- Lecture 28 - Electron-phonon interaction, Cooper problem
- Lecture 29 - Cooper problem, setting up the BCS theory
- Lecture 30 - BCS wave function, the Superconducting state and calculations of various properties
- Lecture 31 - BCS theory (Continued...), energy gap, transition temperature

[Lecture 32 - Consequences of BCS theory, gap vs T, Transition temperature, specific heat, tunnelling](#)

[Lecture 33 - Transition temperature, specific heat, tunnelling](#)

[Lecture 34 - Andreev reflection, Ginzburg-Landau Theory and electrodynamics of superconductors](#)

[Lecture 35 - Ginzburg-Landau theory, coherence length and Type I and II superconductors](#)

[Lecture 36 - Flux lattice, Flux quantization, Josephson junctions](#)

[Lecture 37 - Josephson effect and Josephson junctions](#)

[Lecture 38 - SQUID, Quantum computers and Josephson junction Qubits](#)

[Lecture 39 - High-Temperature Superconductivity: an enduring enigma](#)

[Lecture 40 - Overview and conclusion](#)

- Lecture 1 - Vector analysis, Scalar and vector fields, vector identities
- Lecture 2 - Vector Analysis (Continued...)
- Lecture 3 - Use of Levi-Civita Symbol, Coordinate system
- Lecture 4 - Coordinate system, Orthogonal Transformation
- Lecture 5 - Spherical Coordinate system, Line, surface and volume element
- Lecture 6 - Line, surface and volume element (Continued...)
- Lecture 7 - Line, surface and volume integral
- Lecture 8 - Differential calculus, Gradient
- Lecture 9 - Gradient operator, Concept of divergence
- Lecture 10 - Divergence operator, Divergence Theorem
- Lecture 11 - Curl operator, Stokes Theorem
- Lecture 12 - Gradient, Divergence and Curl (A recap), Vector identities
- Lecture 13 - Curvilinear coordinate system
- Lecture 14 - Curvilinear coordinate system (Continued...)
- Lecture 15 - Curvilinear coordinate system (Continued...)
- Lecture 16 - Delta Function
- Lecture 17 - Delta Function (Continued...)
- Lecture 18 - Helmholtz's Theorem
- Lecture 19 - Helmholtz's Theorem(Recap), Tutorial
- Lecture 20 - Tutorial (Continued...)
- Lecture 21 - Concept of charge, Charge density
- Lecture 22 - Coulomb's Law
- Lecture 23 - Coulomb's Law (Continued...), Charge distribution
- Lecture 24 - Charge distribution problem, Gauss's Law
- Lecture 25 - Topics More on Gauss's Law
- Lecture 26 - Application of Gauss's Law
- Lecture 27 - Electrostatic potential
- Lecture 28 - Electrostatic potential (Continued...)
- Lecture 29 - Electrostatic energy
- Lecture 30 - Electrostatic energy (Continued...)
- Lecture 31 - Electrostatic energy calculation

- Lecture 32 - Electrostatic dipole
- Lecture 33 - Electric dipole (Continued...)
- Lecture 34 - Multipole expansion
- Lecture 35 - Monopole and Dipole moment
- Lecture 36 - Quadrupole moment
- Lecture 37 - Dipole and Quadrupole moment (Continued...)
- Lecture 38 - Conductor
- Lecture 39 - Conductor (Continued...)
- Lecture 40 - Boundary condition
- Lecture 41 - Electrostatic pressure, Capacitor
- Lecture 42 - Energy of the Capacitor, Dielectric
- Lecture 43 - Dielectric (Continued...)
- Lecture 44 - Displacement Vector
- Lecture 45 - Electrostatic boundary value problem
- Lecture 46 - Electrostatic boundary value problem (Continued...)
- Lecture 47 - Electrostatic boundary value problem (Continued...), Image method
- Lecture 48 - Image method (Continued...)
- Lecture 49 - Charge particle in magnetic field
- Lecture 50 - Biot-Savart Law
- Lecture 51 - Application of Biot-Savart Law
- Lecture 52 - Ampere's Law
- Lecture 53 - Application of Ampere's Law
- Lecture 54 - Magnetic vector potential
- Lecture 55 - Magnetic vector potential (Continued...)
- Lecture 56 - Magnetic dipole moment
- Lecture 57 - Magnetic dipole moment (Continued...)
- Lecture 58 - Torque and potential energy of magnetic dipole, Magnetization
- Lecture 59 - Bound Current
- Lecture 60 - Magnetic materials
- Lecture 61 - Electromagnetic Induction
- Lecture 62 - Self and mutual inductance
- Lecture 63 - Wave equation, Maxwell's Equations
- Lecture 64 - Maxwell's Equation (Continued...)

[Lecture 65 - Maxwells Equation: a complete overview](#)

[Lecture 66 - Maxwells Equation: a complete overview \(Continued...\)](#)

[Lecture 67 - Lorentz Gauge, Maxwell's wave equation](#)

[Lecture 68 - Maxwell's wave equation \(Coninued...\)](#)

[Lecture 69 - Maxwell's Equation in matter](#)

[Lecture 70 - Maxwell's Equation in matter \(Continued...\)](#)

[Lecture 71 - Tutorial 2 \(Electrostatic\)](#)

[Lecture 72 - Tutorial 3 \(Magnetostatic\)](#)

[Lecture 73 - Tutorial 4 \(Magnetostatic and EM Wave\)](#)

Lecture 1 - Introduction to solid state materials - From conventional to functional

Lecture 2 - Ceramics and Composites - I

Lecture 3 - Ceramics and Composites - II

Lecture 4 - Polymers

Lecture 5 - Introduction to Nanomaterials and functionality

Lecture 6 - Synthesis protocols - I

Lecture 7 - Synthesis protocols - II

Lecture 8 - Synthesis protocols - III

Lecture 9 - Crystal structure - I

Lecture 10 - Crystal structure - II

Lecture 11 - Crystal structure - III

Lecture 12 - Crystal imperfections

Lecture 13 - Alloys and Melts

Lecture 14 - Theory of Solids

Lecture 15 - Nearly free electron model

Lecture 16 - Bonds in molecules and solids

Lecture 17 - Transformations kinetics and reaction rates

Lecture 18 - Thermodynamics

Lecture 19 - Phase and phase transitions

Lecture 20 - Diffusion and various properties

Lecture 21 - Mechanical properties of solids

Lecture 22 - Thermal Properties of Solids

Lecture 23 - Negative and Zero Expansion Ceramics

Lecture 24 - Heat Capacity

Lecture 25 - Thermogravimetric (TGA) analysis

Lecture 26 - Introduction to magnetism and Magnetic properties of solids

Lecture 27 - From magnetic to multiferroic materials

Lecture 28 - Magnetic materials and their applications

Lecture 29 - Magnetism at nanoscale

Lecture 30 - GMR materials

Lecture 31 - CMR materials

[Lecture 32 - Ferrofluids](#)

[Lecture 33 - Spintronics and devices](#)

[Lecture 34 - Introduction to the basic properties of liquids and melts](#)

[Lecture 35 - Heat capacity and diffusion of liquids and melts](#)

[Lecture 36 - Viscosity, electric and thermal conduction of liquids and melts](#)

[Lecture 37 - Sensors](#)

[Lecture 38 - Electrochemical Sensors](#)

[Lecture 39 - Introduction to energy storage devices and basics of supercapacitors](#)

[Lecture 40 - Supercapacitors - II](#)

[Lecture 41 - Magnetic supercapacitors](#)

[Lecture 42 - Battery - I](#)

[Lecture 43 - Battery - II](#)

[Lecture 44 - Solar Cells - I](#)

[Lecture 45 - Solar Cells - II](#)

[Lecture 46 - X-ray Diffraction \(XRD\)](#)

[Lecture 47 - Fourier Transform Infrared Spectroscopy](#)

[Lecture 48 - UV- Vis Spectroscopy](#)

[Lecture 49 - Scanning and Transmission Electron Microscopy](#)

[Lecture 50 - Summary](#)

NPTEL : Special Topics in Atomic Physics (Physics)

Co-ordinators : Prof. P.C. Deshmukh

Lecture 1 - Introductory lecture about this course

Lecture 2 - Quantum Mechanics and Symmetry of the Hydrogen Atom

Lecture 3 - Hydrogen atom: Rotational and Dynamical Symmetry of the $1/r$ Potential

Lecture 4 - Hydrogen atom: Dynamical Symmetry of the $1/r$ Potential

Lecture 5 - Degeneracy of the Hydrogen Atom: $SO(4)$

Lecture 6 - Wavefunctions of the Hydrogen Atom

Lecture 7 - Angular Momentum in Quantum Mechanics

Lecture 8 - Angular Momentum in Quantum Mechanics: half-odd-integer and integer quantum numbers: $SU(2)$ & $SO(3)$

Lecture 9 - Angular Momentum in Quantum Mechanics: Addition Theorem for Spherical Harmonics - Coupling of Angular Momenta

Lecture 10 - Angular Momentum in Quantum Mechanics Dimensionality of the Direct-Product (Composite) Vector Space CGC recursion relations

Lecture 11 - Angular Momentum in Quantum Mechanics CGC matrix, Wigner D Rotation Matrix, Irreducible Tensor Operators

Lecture 12 - Angular Momentum in Quantum Mechanics - more on ITO, and the Wigner-Eckart Theorem

Lecture 13 - Angular Momentum in Quantum Mechanics Wigner-Eckart Theorem - 2

Lecture 14 - Relativistic Quantum Mechanics of the Hydrogen Atom - 1

Lecture 15 - Relativistic Quantum Mechanics of the Hydrogen Atom - 2

Lecture 16 - Relativistic Quantum Mechanics of the Hydrogen Atom - PAULI Equation - Foldy - Wouthysen Transformations - 1

Lecture 17 - Relativistic Quantum Mechanics of the Hydrogen Atom - Foldy - Wouthysen Transformations - 2

Lecture 18 - Relativistic Quantum Mechanics of the Hydrogen Atom - Foldy - Wouthysen Transformations - 3

Lecture 19 - Relativistic Quantum Mechanics of the Hydrogen Atom - Spherical Symmetry of the Coulomb Potential

Lecture 20 - Hartree-Fock Self-Consistent Field formalism - 1

Lecture 21 - Hartree-Fock Self-Consistent Field formalism - 2

Lecture 22 - Hartree-Fock Self-Consistent Field formalism - 3

Lecture 23 - Hartree-Fock Self-Consistent Field formalism - 4

Lecture 24 - Hartree-Fock Self-Consistent Field formalism - 5

Lecture 25 - Perturbative treatment of relativistic effectsâ€| Schrodinger's and Dirac QM

Lecture 26 - Perturbative treatment of relativistic effectsâ€| Schrodinger's and Dirac QM

Lecture 27 - Probing the atom - Collisions and Spectroscopy - boundary conditions - 1

Lecture 28 - Atomic Probes - Collisions and Spectroscopy - boundary conditions - 2

Lecture 29 - Atomic Probes - Collisions and Spectroscopy - Scattering phase shifts and boundary conditions

Lecture 30 - Atomic Probes - Time reversal symmetry - applications in atomic collisions and photoionization processes

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[Lecture 31 - Atomic Photoionization cross sections, angular distributions of photoelectrons - 1](#)

[Lecture 32 - Atomic Photoionization cross sections, angular distributions of photoelectrons - 2](#)

[Lecture 33 - Atomic Photoionization cross sections, angular distributions of photoelectrons - 3](#)

[Lecture 34 - Atomic Photoionization cross sections, angular distributions of photoelectrons - 4](#)

[Lecture 35 - Atomic Photoionization cross sections, angular distributions of photoelectrons Cooper Zare Formula](#)

[Lecture 36 - Stark- Zeeman Spectroscopy - Stark effect](#)

[Lecture 37 - Stark- Zeeman Spectroscopy - Stark effect on \$n=2\$ excited state of the H atom Zeeman effect](#)

[Lecture 38 - Stark- Zeeman Spectroscopy - Normal, Anomalous Zeeman effect; Paschen- Back effect](#)

[Lecture 39 - Stark- Zeeman Spectroscopy - Anomalous Zeeman effect](#)

[Lecture 40 - Zeeman effect Fine structure, Hyperfine structure - Elemental, rudimentary introduction to Laser Cooling, BEC, Atomic Clock / Attosecond metrology](#)

Lecture 1 - What is Classical Field Theory?

Lecture 2 - Symmetries and Invariances - I

Lecture 3 - Symmetries and Invariances - II

Lecture 4 - Group Theory in Physics - I

Lecture 5 - Group Theory in Physics - II

Lecture 6 - Finite Groups - I

Lecture 7 - Finite Groups - II

Lecture 8 - Basics of CFT - I

Lecture 9 - Basics of CFT - II

Lecture 10 - Basics of CFT - III

Lecture 11 - Green Functions - I

Lecture 12 - Green Functions - II

Lecture 13 - Noether's Theorem - I

Lecture 14 - Noether's Theorem - II

Lecture 15 - Kink Soliton

Lecture 16 - Hidden Symmetry

Lecture 17 - Local Symmetries

Lecture 18 - The Abelian Higgs model

Lecture 19 - Lie Algebras - I

Lecture 20 - Lie Algebras - II

Lecture 21 - Magnetic Vortices - I

Lecture 22 - Magnetic Vortices - II

Lecture 23 - Non-abelian gauge theories - I

Lecture 24 - Non-abelian gauge theories - II

Lecture 25 - Irreps of Lie algebras - I

Lecture 26 - Irreps of Lie algebras - II

Lecture 27 - The Standard Model - I

Lecture 28 - The Standard Model - II

Lecture 29 - Irreps of the Lorentz/Poincare algebras

Lecture 30 - The Dirac monopole

Lecture 31 - The 't Hooft-Polyakov monopole

[Lecture 32 - Revisiting Derrick's Theorem](#)

[Lecture 33 - The Julia-Zee dyon](#)

[Lecture 34 - Instantons - I](#)

[Lecture 35 - Instantons - II](#)

[Lecture 36 - Instantons - III](#)

[Lecture 37 - Instantons - IV](#)

[Lecture 38 - Dualities](#)

[Lecture 39 - Geometrization of Field Theory](#)

NPTEL : Topics in Nonlinear Dynamics (Physics)

Co-ordinators : Prof. V. Balakrishnan

Lecture 1 - Overview

Lecture 2 - Critical points of a dynamical system

Lecture 3 - Two-dimensional flows

Lecture 4 - Stable and unstable manifolds

Lecture 5 - Hamiltonian dynamics - Part I

Lecture 6 - Hamiltonian dynamics - Part II

Lecture 7 - Hamiltonian dynamics - Part III

Lecture 8 - Hamiltonian dynamics - Part IV

Lecture 9 - Hamiltonian dynamics - Part V

Lecture 10 - Elementary bifurcations

Lecture 11 - Limit cycles

Lecture 12 - Poincaré index

Lecture 13 - Illustrative examples

Lecture 14 - Quiz 1. Questions and answers

Lecture 15 - Bead on a rotating hoop

Lecture 16 - Types of dynamical behaviour

Lecture 17 - Discrete time dynamics - Part I

Lecture 18 - Discrete time dynamics - Part II

Lecture 19 - Discrete time dynamics - Part III

Lecture 20 - Discrete time dynamics - Part IV

Lecture 21 - Coarse-grained dynamics in phase space - Part I

Lecture 22 - Coarse-grained dynamics in phase space - Part II & Stochastic dynamics - Part I

Lecture 23 - Stochastic dynamics - Part II

Lecture 24 - Stochastic dynamics - Part III

Lecture 25 - Coarse-grained dynamics in phase space - Part IV & Stochastic dynamics - Part IV

Lecture 26 - Discrete time dynamics - Part V

Lecture 27 - Quiz 2. Questions and answers

Lecture 28 - Stochastic dynamics - Part V

Lecture 29 - Stochastic dynamics - Part VI

Lecture 1 - Principles of Condensed Matter Physics

Lecture 2 - Symmetry in Perfect Solids

Lecture 3 - Symmetry in Perfect Solids (Continued...)

Lecture 4 - Symmetry in Perfect Solids - Worked Examples

Lecture 5 - Diffraction Methods For Crystal Structures

Lecture 6 - Diffraction Methods For Crystal Structures (Continued...)

Lecture 7 - Diffraction Methods For Crystal Structures - Worked Examples

Lecture 8 - Physical Properties of Crystals

Lecture 9 - Physical Properties of Crystals (Continued...)

Lecture 10 - Physical Properties of Crystals - Worked Examples

Lecture 11 - Cohesion in Solids

Lecture 12 - Cohesion in Solids - Worked Examples

Lecture 13 - The Free Electron Theory of Metals

Lecture 14 - The Free Electron Theory of Metals - Worked Examples

Lecture 15 - The Free Electron Theory of Metals - Electrical Conductivity

Lecture 16 - The Free Electron Theory of Metals - Electrical Conductivity - Worked Examples

Lecture 17 - Thermal Conductivity of Metals

Lecture 18 - Thermal Conductivity of Metals - Worked Examples

Lecture 19 - The Concept of Phonons

Lecture 20 - Debye Theory of Specific Heat, Lattice Vibrations

Lecture 21 - Debye Theory of Specific Heat, Lattice Vibrations - Worked Examples

Lecture 22 - Lattice Vibrations (Continued) Phonon thermal conductivity

Lecture 23 - Lattice Vibrations (Continued) Phonon Thermal Conductivity - Worked Examples

Lecture 24 - Anharmonicity and Thermal Expansion

Lecture 25 - Dielectric (Insulating) Solids

Lecture 26 - Dispersion and Absorption of Electromagnetic Waves in Dielectric Media, Ferro-and Antiferroelectrics

Lecture 27 - Optical Properties of Metals; Ionic Polarization in Alkali Halides; Piezoelectricity

Lecture 28 - Dielectric Solids - Worked Examples

Lecture 29 - Dia - and Paramagnetism

Lecture 30 - Paramagnetism of Transition Metal and Rare Earth Ions

Lecture 31 - Quenching of Orbital Angular Momentum; Ferromagnetism

- Lecture 32 - Exchange Interactions, Magnetic Order, Neutron Diffraction
- Lecture 33 - Hysteresis and Magnetic Domains; Spin Waves and Magnons
- Lecture 34 - Magnetic Resonance
- Lecture 35 - Magnetism and Magnetic Resonance - Worked Examples
- Lecture 36 - Magnetism - Worked Examples (Continued...)
- Lecture 37 - Pauli Paramagnetism and Landau Diamagnetism
- Lecture 38 - Band Magnetism; Itinerant Electrons; Stoner Model
- Lecture 39 - Superconductivity - Perfect Electrical Conductivity and Perfect Diamagnetism
- Lecture 40 - Type I and Type II Superconductors
- Lecture 41 - Ginsburg - Landau Theory, Flux Quantization
- Lecture 42 - Cooper Pairs
- Lecture 43 - Microscopic (BCS) Theory of Superconductivity
- Lecture 44 - BCS Theory (Continued...): Josephson Tunneling: Quantum Interference
- Lecture 45 - Josephson Effect (Continued...); High Temperature Superconductors
- Lecture 46 - Superconductors - Worked Examples
- Lecture 47 - Energy Bands in Solids
- Lecture 48 - Electron Dynamics in a Periodic Solid
- Lecture 49 - Semiconductors
- Lecture 50 - Semiconductors (Continued...)
- Lecture 51 - Semiconductors - Worked Examples
- Lecture 52 - Defects in Solids - Point Defects
- Lecture 53 - Point Defects in Solids - Worked Examples
- Lecture 54 - Defects in Solids - Line and Surface Defects
- Lecture 55 - Dislocations in Solids - Worked Examples
- Lecture 56 - Quantum Fluids and Quantum Solids
- Lecture 57 - Quantum Liquids and Quantum Solids - Worked Examples
- Lecture 58 - Epilogue

Lecture 1 - Introduction

Lecture 2 - Introduction to Classical Field Theory

Lecture 3 - Quantization of Real Scalar Field - I

Lecture 4 - Quantization of Real Scalar Field - II

Lecture 5 - Quantization of Real Scalar Field - III

Lecture 6 - Quantization of Real Scalar Field - IV

Lecture 7 - Quantization of Complex Scalar Field

Lecture 8 - Interacting Field Theory - I

Lecture 9 - Interacting Field Theory - II

Lecture 10 - Interacting Field Theory - III

Lecture 11 - Interacting Field Theory - IV

Lecture 12 - Interacting Field Theory - V

Lecture 13 - Interacting Field Theory - VI

Lecture 14 - Interacting Field Theory - VII

Lecture 15 - Quantization of Electromagnetic Field - I

Lecture 16 - Quantization of Electromagnetic Field - II

Lecture 17 - Fermion Quantization - I

Lecture 18 - Fermion Quantization - II

Lecture 19 - Fermion Quantization - III

Lecture 20 - Fermion Quantization - IV

Lecture 21 - Fermion Quantization - V

Lecture 22 - Fermion Quantization - VI

Lecture 23 - The S-Matrix Expansion in QED - I

Lecture 24 - The S-Matrix Expansion in QED - II

Lecture 25 - Feynman Rules in QED - I

Lecture 26 - Feynman Rules in QED - II

Lecture 27 - Compton Scattering - I

Lecture 28 - Compton Scattering - II

Lecture 29 - Compton Scattering - III

Lecture 30 - Moller Scattering - I

Lecture 31 - Moller Scattering - II

[Lecture 32 - Vertex Correction - I](#)

[Lecture 33 - Vertex Correction - II](#)

[Lecture 34 - Vertex Correction - III](#)

[Lecture 35 - Vertex Correction - IV](#)

[Lecture 36 - Electron Selfenergy](#)

[Lecture 37 - Photon Selfenergy - I](#)

[Lecture 38 - Photon Selfenergy - II](#)

- Lecture 1 - Quantum Mechanics " An Introduction
- Lecture 2 - Linear Vector Spaces - I
- Lecture 3 - Linear Vector Spaces - II: The two-level atom
- Lecture 4 - Linear Vector Spaces - III: The three-level atom
- Lecture 5 - Postulates of Quantum Mechanics - I
- Lecture 6 - Postulates of Quantum Mechanics - II
- Lecture 7 - The Uncertainty Principle
- Lecture 8 - The Linear Harmonic Oscillator
- Lecture 9 - Introducing Quantum Optics
- Lecture 10 - An Interesting Quantum Superposition: The Coherent State
- Lecture 11 - The Displacement and Squeezing Operators
- Lecture 12 - Exercises in Finite Dimensional Linear Vector Spaces
- Lecture 13 - Exercises on Angular Momentum Operators and their algebra
- Lecture 14 - Exercises on Quantum Expectation Values
- Lecture 15 - Composite Systems
- Lecture 16 - The Quantum Beam Splitter
- Lecture 17 - Addition of Angular Momenta - I
- Lecture 18 - Addition of Angular Momenta - II
- Lecture 19 - Addition of Angular Momenta - III
- Lecture 20 - Infinite Dimensional Linear Vector Spaces
- Lecture 21 - Square-Integrable Functions
- Lecture 22 - Ingredients of Wave Mechanics
- Lecture 23 - The Schrodinger equation
- Lecture 24 - Wave Mechanics of the Simple Harmonic Oscillator
- Lecture 25 - One-Dimensional Square Well Potential: The Bound State Problem
- Lecture 26 - The Square Well and the Square Potential Barrier
- Lecture 27 - The Particle in a one-dimensional Box
- Lecture 28 - A Charged Particle in a Uniform Magnetic Field
- Lecture 29 - The Wavefunction: Its Single-valuedness and its Phase
- Lecture 30 - The Central Potential
- Lecture 31 - The Spherical Harmonics

[Lecture 32 - Central Potential: The Radial Equation](#)

[Lecture 33 - Illustrative Exercises - I](#)

[Lecture 34 - Illustrative Exercises - II](#)

[Lecture 35 - Ehrenfest's Theorem](#)

[Lecture 36 - Perturbation Theory - I](#)

[Lecture 37 - Perturbation Theory - II](#)

[Lecture 38 - Perturbation Theory - III](#)

[Lecture 39 - Perturbation Theory - IV](#)

[Lecture 40 - Time-dependent Hamiltonians](#)

[Lecture 41 - The Jaynes-Cummings model](#)

Lecture 1 - Course Overview

Lecture 2 - Equations of Motion (i)

Lecture 3 - Equations of Motion (ii)

Lecture 4 - Equations of Motion (iii)

Lecture 5 - Equations of Motion (iv)

Lecture 6 - Equations of Motion (v)

Lecture 7 - Oscillators, Resonances, Waves (i)

Lecture 8 - Oscillators, Resonances, Waves (ii)

Lecture 9 - Oscillators, Resonances, Waves (iii)

Lecture 10 - Oscillators, Resonances, Waves (iv)

Lecture 11 - Polar Coordinates (i)

Lecture 12 - Polar Coordinates (ii)

Lecture 13 - Dynamical Symmetry in the Kepler Problem (i)

Lecture 14 - Dynamical Symmetry in the Kepler Problem (ii)

Lecture 15 - Real Effects of Pseudo-Forces (i)

Lecture 16 - Real Effects of Pseudo-Forces (ii)

Lecture 17 - Real Effects of Pseudo-Forces (iii)

Lecture 18 - Real Effects of Pseudo-Forces (iv)

Lecture 19 - Special Theory of Relativity (i)

Lecture 20 - Special Theory of Relativity (ii)

Lecture 21 - Special Theory of Relativity (iii)

Lecture 22 - Special Theory of Relativity (iv)

Lecture 23 - Potentials Gradients Fields (i)

Lecture 24 - Potentials Gradients Fields (ii)

Lecture 25 - Potentials Gradients Fields (iii)

Lecture 26 - Gauss Law Eq of continuity (i)

Lecture 27 - Gauss Law Eq of continuity (ii)

Lecture 28 - Gauss Law Eq of continuity (iii)

Lecture 29 - Fluid Flow Bernoulli Principle (i)

Lecture 30 - Fluid Flow Bernoulli Principle (ii)

Lecture 31 - Classical Electrodynamics (i)

[Lecture 32 - Classical Electrodynamics \(ii\)](#)

[Lecture 33 - Classical Electrodynamics \(iii\)](#)

[Lecture 34 - Classical Electrodynamics \(iv\)](#)

[Lecture 35 - Chaotic Dynamical Systems \(i\)](#)

[Lecture 36 - Chaotic Dynamical Systems \(ii\)](#)

[Lecture 37 - Chaotic Dynamical Systems \(iii\)](#)

[Lecture 38 - Chaotic Dynamical Systems \(iv\)](#)

[Lecture 39 - Chaotic Dynamical Systems \(v\)](#)

[Lecture 40 - The Scope and Limitations of Classical Mechanics](#)

Lecture 1 - Introduction to the STiTACS course

Lecture 2 - Quantum Theory of collisions

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Lecture 18 - Interference, Diffraction and Optical Fiber Sensors

Lecture 19 - Review of Biomaterial Optics

Lecture 20 - Terahertz Based Detection and Circular Dichroism

- Lecture 1 - Atmospheric Forces and Dynamics - Part 1
- Lecture 2 - Atmospheric Forces and Dynamics - Part 2
- Lecture 3 - Total Derivative (Introduction)
- Lecture 4 - Total Derivative of a Vector in a Rotating Frame of Reference
- Lecture 5 - Momentum Equations and its Vectorial Form in Spherical Polar Coordinates - Part 1
- Lecture 6 - Momentum Equations and its Vectorial Form in Spherical Polar Coordinates - Part 2
- Lecture 7 - Momentum Equations and its Vectorial Form in Spherical Polar Coordinates - Part 3
- Lecture 8 - Total Derivative and Lagrangian
- Lecture 9 - Continuity Equation: Eulerian
- Lecture 10 - Energy Equations - Part 1
- Lecture 11 - Energy Equations - Part 2
- Lecture 12 - Scaling analysis - Part 1
- Lecture 13 - Scaling analysis - Part 2
- Lecture 14 - Scaling Analysis of Governing Equations - Part 1
- Lecture 15 - Scaling Analysis of Governing Equations - Part 2
- Lecture 16 - Scaling Analysis - Part 3, A Tutorial
- Lecture 17 - Scaling Analysis - Part 4, A Tutorial
- Lecture 18 - Introduction of Atmospheric Waves - Part 1
- Lecture 19 - Introduction of Atmospheric Waves - Part 2
- Lecture 20 - Problems based on Total Derivative - Part 1
- Lecture 21 - Problems based on Total Derivative - Part 2
- Lecture 22 - Shallow Water Gravity Waves - Part 1
- Lecture 23 - Shallow Water Gravity Waves - Part 2
- Lecture 24 - Acoustic Waves
- Lecture 25 - Internal Gravity Waves - Part 1
- Lecture 26 - Internal Gravity Waves - Part 2
- Lecture 27 - Internal Gravity Waves - Part 3
- Lecture 28 - Pressure as a vertical coordinate - Part 1
- Lecture 29 - Pressure as a vertical coordinate - Part 2
- Lecture 30 - Pressure as a vertical coordinate - Part 3
- Lecture 31 - General circulation and global winds

- Lecture 32 - Introduction to different types of Fronts
- Lecture 33 - Geostrophic winds
- Lecture 34 - Natural coordinate and Inertial flows
- Lecture 35 - Cyclostrophic winds and Rossby number
- Lecture 36 - Gradient winds
- Lecture 37 - Thermal winds
- Lecture 38 - Problems on thermal winds
- Lecture 39 - Ionosphere introduction (Basics)- Part 1
- Lecture 40 - Ionosphere introduction (Different layers) - Part 2
- Lecture 41 - Ionosphere introduction (Photochemistry) - Part 3
- Lecture 42 - Ionosphere introduction (Recombination) - Part 4
- Lecture 43 - Composite F layer - Part 1
- Lecture 44 - Composite F layer - Part 2
- Lecture 45 - Composite F layer H/He ions - Part 3
- Lecture 46 - The Sun - Earth Energetics and Aurora
- Lecture 47 - Airglows and Aurora
- Lecture 48 - Sun's magnetic field, Formation of Aurora, and Solar cycle
- Lecture 49 - Sun's internal structure, Prominences
- Lecture 50 - Solar wind - Magnetosphere interactions
- Lecture 51 - Solar wind interactions with different planets
- Lecture 52 - Solar wind properties and its interaction with different planets
- Lecture 53 - Static Model of Corona
- Lecture 54 - Parker's Theory of Solar Wind Acceleration - Part 1
- Lecture 55 - Parker's Theory of Solar Wind Acceleration - Part 2
- Lecture 56 - Parker's Theory of Solar Wind Acceleration - Part 3
- Lecture 57 - Parker's Theory of Solar Wind Acceleration - Part 4
- Lecture 58 - Introduction to Space Weather - Part 1
- Lecture 59 - Introduction to Space Weather - Part 2
- Lecture 60 - Introduction to Space Weather - Part 3

Lecture 1 - Historical Background, Observational Astronomy, Properties of Sun and of Stars

Lecture 2 - Properties of Galaxies and Universe

Lecture 3 - Background of elemental abundance curve

Lecture 4 - Evidences of Nucleosynthesis - I

Lecture 5 - Evidences of Nucleosynthesis - II

Lecture 6 - Evidences of Nucleosynthesis - III and Mass gaps

Lecture 7 - H-R Diagram

Lecture 8 - M-L relation, Hubble's Law and Echo of Big Bang

Lecture 9 - Thermonuclear reactions and Reaction cross-section

Lecture 10 - Reaction rate

Lecture 11 - Reaction rate and Neutron induced reactions

Lecture 12 - Gamma induced reactions and Inverse reactions

Lecture 13 - Inverse reactions

Lecture 14 - Inverse reactions and Mean life time of a nuclei

Lecture 15 - Mean life time of a nuclei and Time dependent abundance evolution

Lecture 16 - Non-resonant charged particle induced reactions

Lecture 17 - Astrophysical S-factor and Non-resonant charged particle induced reactions

Lecture 18 - Gamow peak and Electron screening effect

Lecture 19 - Resonant reactions

Lecture 20 - Resonant reactions

Lecture 21 - Neutron induced non-resonant reactions

Lecture 22 - Burning stages of stars and Hydrogen burning

Lecture 23 - pp chain

Lecture 24 - pp chain and CN cycle

Lecture 25 - CNO cycle, Shell model and Gamma decay

Lecture 26 - Formation of ^{12}C

Lecture 27 - Survival of ^{12}C

Lecture 28 - Carbon, Neon, Oxygen and Silicon burning

Lecture 29 - Nucleosynthesis beyond Iron

Lecture 30 - s-, r- and p-process

Lecture 31 - Charged particle and Neutron beams

[Lecture 32 - Accelerators and Targets](#)

[Lecture 33 - Backing materials and Target preparation](#)

[Lecture 34 - Contaminants and Radiation sources](#)

[Lecture 35 - Detectors - I](#)

[Lecture 36 - Detectors - II](#)

[Lecture 37 - Activity method](#)

[Lecture 38 - Kinematics - I](#)

[Lecture 39 - Kinematics - II](#)

[Lecture 40 - Time of flight method and Indirect methods](#)

Lecture 1 - Course Overview

Lecture 2 - Introduction to Geometrical Optics

Lecture 3 - Ray Theory, Fermat's Principle

Lecture 4 - Refraction from Single Interface

Lecture 5 - Refraction from double interface

Lecture 6 - Matrix method in paraxial optics - I

Lecture 7 - Matrix Method in Paraxial Optics - II

Lecture 8 - Thick and Thin Lenses, Unit Planes

Lecture 9 - Nodal Planes, System of Thin Lenses

Lecture 10 - Problems on Geometrical Optics

Lecture 11 - Concept of Wavefront, Huygens Principle - I

Lecture 12 - Concept of Wavefront, Huygens Principle - II

Lecture 13 - Superposition of Waves

Lecture 14 - Introduction to Polarization, Linear and Circular Polarization

Lecture 15 - Elliptical Polarization

Lecture 16 - Interference of Light Waves, Interference of Polarized Light - I

Lecture 17 - Interference of Light Waves, Interference of Polarized Light - II

Lecture 18 - Young's Double Slit Experiment - I

Lecture 19 - Young's Double Slit Experiment - II

Lecture 20 - Interference with White Light, Displacement of Fringes, Fresnel's Biprism

Lecture 21 - Interference by Division of Amplitude

Lecture 22 - Thin Parallel Films, Wedge Shaped Films

Lecture 23 - Newton's Rings

Lecture 24 - Michelson Interferometer and Its Applications - I

Lecture 25 - Michelson Interferometer and Its Applications - II

Lecture 26 - Multiple Beam Interference

Lecture 27 - Fabry-Perot Interferometer and Etalon - I

Lecture 28 - Fabry-Perot Interferometer and Etalon - II

Lecture 29 - Concept of Coherence - I

Lecture 30 - Concept of Coherence - II

Lecture 31 - Introduction to Diffraction

- [Lecture 32 - Fraunhofer Diffraction](#)
- [Lecture 33 - Single Slit Diffraction](#)
- [Lecture 34 - Double Slit Diffraction](#)
- [Lecture 35 - Multiple Slit Diffraction](#)
- [Lecture 36 - Diffraction at a Rectangular Aperture](#)
- [Lecture 37 - Diffraction at a Circular Aperture](#)
- [Lecture 38 - Diffraction Grating](#)
- [Lecture 39 - Grating Spectrum and Resolving Power](#)
- [Lecture 40 - Fresnel Diffraction](#)
- [Lecture 41 - Fresnel Half Period Zones](#)
- [Lecture 42 - Vibration Curve](#)
- [Lecture 43 - Circular Obstacle, Zone Plates](#)
- [Lecture 44 - Rectangular Aperture](#)
- [Lecture 45 - Diffraction of a Plane Wave by a Long Narrow Slit](#)
- [Lecture 46 - Brewster's Law, Malus' Law](#)
- [Lecture 47 - Phenomenon of Double Refraction](#)
- [Lecture 48 - Normal and Oblique Incidence](#)
- [Lecture 49 - Production of Polarized Light](#)
- [Lecture 50 - Quarter and Half Wave Plates](#)
- [Lecture 51 - Analysis of Polarized Light and Optical Activity](#)
- [Lecture 52 - Plane Wave Propagation in Anisotropic Media - I](#)
- [Lecture 53 - Plane Wave Propagation in Anisotropic Media - II](#)
- [Lecture 54 - Antireflecting Coating](#)
- [Lecture 55 - Basic Concepts of Holography - I](#)
- [Lecture 56 - Basic Concepts of Holography - II](#)
- [Lecture 57 - Basic Concepts and Ray Optics Consideration of Optical Fiber](#)
- [Lecture 58 - Introduction to Lasers - I](#)
- [Lecture 59 - Introduction to Lasers - II](#)
- [Lecture 60 - Trifle](#)

- Lecture 1 - Scalars vectors, and tensors - basic definitions
- Lecture 2 - Scalars, vectors and tensors - most general definition
- Lecture 3 - Elementary vector algebra - I (unit vector, dot product)
- Lecture 4 - Elementary vector algebra - II (cross product, triple product)
- Lecture 5 - Review of Newton's laws of motion - tools for analysis
- Lecture 6 - Newton's laws of motion - third and second law
- Lecture 7 - Newton's laws of motion - first law
- Lecture 8 - Solving mechanics problems - how to draw free body diagram correctly
- Lecture 9 - Mechanical equilibrium (statics) using force and torque balance
- Lecture 10 - Mechanical equilibrium (statics) using force and torque balance - more examples
- Lecture 11 - Mechanical equilibrium of rope like structures, nature of tension force
- Lecture 12 - Massless, flexible suspension cable in mechanical equilibrium
- Lecture 13 - Massive flexible suspension cable in mechanical equilibrium
- Lecture 14 - Mechanical equilibrium of truss (framework) - nature of internal forces
- Lecture 15 - Mechanical equilibrium of truss (framework) - examples
- Lecture 16 - Mechanical equilibrium of truss - uniqueness of solution, beam with distributed load
- Lecture 17 - Mechanical equilibrium of truss - more on beam with distributed load
- Lecture 18 - Mechanical equilibrium - more examples, principle of virtual work, constrained motion
- Lecture 19 - Mechanical equilibrium: constraints, degrees of freedom, work done by constrained force
- Lecture 20 - d'Alembert - Lagrange principle of virtual work - statement and examples
- Lecture 21 - Equivalence of principles of force, torque balance and virtual work, stability analysis
- Lecture 22 - Mechanical equilibrium: stability analysis, energy diagram technique
- Lecture 23 - Friction between solids - Amonton-Coulomb laws, common misconceptions
- Lecture 24 - Friction between solids - worked out examples
- Lecture 25 - Friction between solid and fluid - drag force
- Lecture 26 - Friction examples - projectile motion with drag force, tying a rope
- Lecture 27 - Work-energy theorem in one dimension, importance of conservation laws
- Lecture 28 - Work-energy theorem in higher dimensions, conservative forces
- Lecture 29 - Momentum balance principle, critical review: projectile motion in real-life
- Lecture 30 - Projectile motion - effect of lift and thrust force by examples
- Lecture 31 - More on rocket motion - comparing effect of thrust in deep space and at lift off

Lecture 32 - Collisions in daily life - application of energy and momentum balance principles

Lecture 33 - Collision at micro-meter, atomic and sub-atomic scales - Brownian motion, Compton effect

Lecture 34 - Concepts necessary for translation and rotation of rigid bodies - centre of mass

Lecture 35 - Centre of mass of composite objects

Lecture 36 - Concepts necessary for translation and rotation of rigid bodies - moment of inertia

Lecture 37 - More on moment of inertia - 3D objects, composite objects, engineering applications

Lecture 38 - Symmetry of mass distribution - product of inertia

Lecture 39 - Determining the principal axes of rotation and moment of inertia about them

Lecture 40 - Example of finding principal axes, introduction to rotation, the angular velocity vector

Lecture 41 - Rotation of rigid bodies - the angular momentum vector

Lecture 42 - Rotation of rigid bodies - torque

Lecture 43 - Translation and rotation of rigid bodies - computing rules

Lecture 44 - Translation and rotation of rigid bodies - examples (rolling, collision with rotation)

NPTEL : Relativistic Quantum Mechanics (Physics)

Co-ordinators : Prof. Apoorva D Patel

Lecture 1 - Introduction, The Klein-Gordon equation

Lecture 2 - Particles and antiparticles, Two component framework

Lecture 3 - Coupling to electromagnetism, Solution of the Coulomb problem

Lecture 4 - Bohr-Sommerfeld semiclassical solution of the Coulomb problem, The Dirac equation and the Clifford algebra

Lecture 5 - Dirac matrices, Covariant form of the Dirac equation, Equations of motion, Spin, Free particle solutions

Lecture 6 - Electromagnetic interactions, Gyromagnetic ratio

Lecture 7 - The Hydrogen atom problem, Symmetries, Parity, Separation of variables

Lecture 8 - The Frobenius method solution, Energy levels and wavefunctions

Lecture 9 - Non-relativistic reduction, The Foldy-Wouthuysen transformation

Lecture 10 - Interpretation of relativistic corrections, Reflection from a potential barrier

Lecture 11 - The Klein paradox, Pair creation process and examples

Lecture 12 - Zitterbewegung, Hole theory and antiparticles

Lecture 13 - Charge conjugation symmetry, Chirality, Projection operators, The Weyl equation

Lecture 14 - Weyl and Majorana representations of the Dirac equation, Unitary and antiunitary symmetries

Lecture 15 - Time reversal symmetry, The PCT invariance

Lecture 16 - Arrow of time and particle-antiparticle asymmetry, Band theory for graphene

Lecture 17 - Dirac equation structure of low energy graphene states, Relativistic signatures in graphene properties

Lecture 18 - Groups and symmetries, The Lorentz and Poincare groups

Lecture 19 - Group representations, generators and algebra, Translations, rotations and boosts

Lecture 20 - The spinor representation of $SL(2,C)$, The spin-statistics theorem

Lecture 21 - Finite dimensional representations of the Lorentz group, Euclidean and Galilean groups

Lecture 22 - Classification of one particle states, The little group, Mass, spin and helicity

Lecture 23 - Massive and massless one particle states

Lecture 24 - P and T transformations, Lorentz covariance of spinors

Lecture 25 - Lorentz group classification of Dirac operators, Orthogonality and completeness of Dirac spinors, Projection operators

Lecture 26 - Propagator theory, Non-relativistic case and causality

Lecture 27 - Relativistic case, Particle and antiparticle contributions, Feynman prescription and the propagator

Lecture 28 - Interactions and formal perturbative theory, The S-matrix and Feynman diagrams

Lecture 29 - Trace theorems for products of Dirac matrices

Lecture 30 - Photons and the gauge symmetry

Lecture 31 - Abelian local gauge symmetry, The covariant derivative and invariants

Lecture 32 - Charge quantisation, Photon propagator, Current conservation and polarisations

Lecture 33 - Feynman rules for Quantum Electrodynamics, Nature of perturbative expansion

Lecture 34 - Dyson's analysis of the perturbation series, Singularities of the S-matrix, Elementary QED processes

Lecture 35 - The T-matrix, Coulomb scattering

Lecture 36 - Mott cross-section, Compton scattering

Lecture 37 - Klein-Nishina result for cross-section

Lecture 38 - Photon polarisation sums, Pair production through annihilation

Lecture 39 - Unpolarised and polarised cross-sections

Lecture 40 - Helicity properties, Bound state formation

Lecture 41 - Bound state decay, Non-relativistic potentials

Lecture 42 - Lagrangian formulation of QED, Divergences in Green's functions, Superficially divergent 1-loop diagrams and regularisation

Lecture 43 - Infrared divergences due to massless particles, Renormalisation and finite physical results

Lecture 44 - Symmetry constraints on Green's functions, Furry's theorem, Ward-Takahashi identity, Spontaneous breaking of gauge symmetry and superconductivity

Lecture 45 - Status of QED, Organisation of perturbative expansion, Precision tests

Lecture 1 - Introduction

Lecture 2 - Linear Systems

Lecture 3 - Homogeneous linear time invariant ordinary differential equations

Lecture 4 - In-homogeneous linear time invariant ordinary differential equations

Lecture 5 - Fourier transforms - Part 1

Lecture 6 - Fourier transforms - Part 2

Lecture 7 - Laplace transforms - Part 1

Lecture 8 - Laplace transforms - Part 2

Lecture 9 - Introduction to feedback control - Part 1

Lecture 10 - Introduction to feedback control - Part 2

Lecture 11 - Nyquist stability theory - Part 1

Lecture 12 - Nyquist stability theory - Part 2

Lecture 13 - Nyquist stability theory - Part 3

Lecture 14 - Bode plots

Lecture 15 - Steps for performing control design - Part 1

Lecture 16 - Steps for performing control design - Part 2

Lecture 17 - General controllers - Part 1

Lecture 18 - General controllers - Part 2

Lecture 19 - General controllers - Part 3

Lecture 20 - Bode plot-based control design - Part 1

Lecture 21 - Bode plot-based control design - Part 2

Lecture 22 - Introduction to root-locus

Lecture 23 - Control system design using root-locus

Lecture 24 - Control of systems with some known parameters - Part 1

Lecture 25 - Control of systems with some known parameters - Part 2

Lecture 26 - Limitations of 1-degree of freedom control

Lecture 27 - Introduction to 2-degree of freedom control

Lecture 28 - 2-Degree of freedom robust control design for plants with gain uncertainty - Part 1

Lecture 29 - 2-Degree of freedom robust control design for plants with uncertain gain - Part 2

Lecture 30 - 2-Degree of freedom robust control design for plants with uncertain pole

Lecture 31 - 2-Degree of freedom robust control design for plants with multiple uncertainties in their structure

[Lecture 32 - Issues connected with 2-Degree of freedom control design using root-locus](#)

[Lecture 33 - Introduction to Nichols plot](#)

[Lecture 34 - Feedback control design using Nichols plot](#)

[Lecture 35 - Robust control design using Quantitative feedback theory - Part 1](#)

[Lecture 36 - Robust control design using Quantitative feedback theory - Part 2](#)

[Lecture 37 - Tutorial on QFT Toolbox software - Part 1](#)

[Lecture 38 - Tutorial on QFT Toolbox software - Part 2](#)

[Lecture 39 - Tutorial on QFT Toolbox software - Part 3](#)

[Lecture 40 - Fundamental properties of the loop gain - Part 1](#)

[Lecture 41 - Fundamental properties of the loop gain - Part 2](#)

[Lecture 42 - Ideal Bode Characteristic - Part 1](#)

[Lecture 43 - Ideal Bode Characteristic - Part 2](#)

[Lecture 44 - Introduction to nonminimum phase systems](#)

[Lecture 45 - Fundamental properties of nonminimum phase systems - Part 1](#)

[Lecture 46 - Fundamental properties of nonminimum phase systems - Part 2](#)

[Lecture 47 - Fundamental properties of unstable systems](#)

[Lecture 48 - Consequences of actuator bandwidth limitations while controlling unstable systems](#)

[Lecture 49 - Describing functions - Part 1](#)

[Lecture 50 - Describing functions - Part 2](#)

- Lecture 1 - Born-Oppenheimer approximation
- Lecture 2 - Self-consistent field (SCF) method
- Lecture 3 - Simple MO Theory of Hydrogen Molecule
- Lecture 4 - Bloch's theorem
- Lecture 5 - Tight binding approximation
- Lecture 6 - Energy band theory - 1
- Lecture 7 - Energy band theory - 2
- Lecture 8 - Density of states
- Lecture 9 - Energy band theory - 3
- Lecture 10 - Energy band theory - 4
- Lecture 11 - Drude's classical free electron model - 1
- Lecture 12 - Drude's classical free electron model - 2
- Lecture 13 - Drude's classical free electron model - 3
- Lecture 14 - Drude's classical free electron model - 4
- Lecture 15 - Sommerfeld's quantum free electron model
- Lecture 16 - Specific heat of Fermi gas
- Lecture 17 - Energy dispersion relation in a periodic potential - 1
- Lecture 18 - Energy dispersion relation in a periodic potential - 2
- Lecture 19 - Brief overview of space groups and constant energy surface in 2D
- Lecture 20 - Energy band and effective mass
- Lecture 21 - Effective mass
- Lecture 22 - $k \cdot p$ perturbation method
- Lecture 23 - Revisiting Bloch's theorem and tight binding functions
- Lecture 24 - Symmetries in crystal Hamiltonian - 1
- Lecture 25 - Symmetries in crystal Hamiltonian - 2
- Lecture 26 - Tight binding method - 1
- Lecture 27 - Tight binding method - 2
- Lecture 28 - Tight binding method - 3
- Lecture 29 - Plane wave method
- Lecture 30 - Pseudo potential method
- Lecture 31 - Cellular method of energy band calculation

- Lecture 32 - Muffin tin potential and APW functions
- Lecture 33 - Augmented plane wave method of energy band calculation - 1
- Lecture 34 - Augmented plane wave method of energy band calculation - 2
- Lecture 35 - Greenâ€™s function method of energy band calculation - 1
- Lecture 36 - Greenâ€™s function method of energy band calculation - 2
- Lecture 37 - Cyclotron resonance technique
- Lecture 38 - De Haas-van Alphen effect
- Lecture 39 - De Haas-van Alphen effect conclusion.Introduction to point impurity effect on band structure
- Lecture 40 - Point impurity in crystal
- Lecture 41 - Friedel Oscillations
- Lecture 42 - Lindhard dielectric constant
- Lecture 43 - Dielectric anomaly. Crystal momentum
- Lecture 44 - Spatial and time reversal symmetries in crystals
- Lecture 45 - Time reversal symmetry (Continued...)
- Lecture 46 - Spin orbit interaction
- Lecture 47 - Disordered solids and transport in disordered solids
- Lecture 48 - Optical properties of semiconductors
- Lecture 49 - Excitonic states in semiconductors
- Lecture 50 - Excitonic states in semiconductors (Continued...)
- Lecture 51 - Molecular orbital calculation - I
- Lecture 52 - Mott-Hubbard transition
- Lecture 53 - Hubbard model
- Lecture 54 - Electron repulsion and magnetic exchange
- Lecture 55 - Beyond on-site electron repulsions;Pariser-Parr-Pople model
- Lecture 56 - Electron-hole symmetry and Pairing theorem. Solitons
- Lecture 57 - Density waves in 1-d systems and Lattice vibrations - I
- Lecture 58 - Lattice vibrations - II
- Lecture 59 - Lattice vibrations - III
- Lecture 60 - Lattice vibrations - IV

Lecture 1 - Introduction to NMR

Lecture 2 - NMR concepts and spin physics - I

Lecture 3 - NMR concepts and spin physics - II

Lecture 4 - Internal interaction parameters and chemical shifts

Lecture 5 - Chemical shifts

Lecture 6 - Scalar couplings

Lecture 7 - Multiplicity patterns of coupled spins and analysis of ^1H NMR spectrum

Lecture 8 - Multiplicity pattern and analysis of NMR spectra - II

Lecture 9 - Analysis of NMR spectra and their analysis

Lecture 10 - Heteronuclear NMR

Lecture 11 - Introduction to Fourier series

Lecture 12 - Complex form of Fourier series

Lecture 13 - Fourier theorems

Lecture 14 - Fourier transformation in NMR

Lecture 15 - Pople notation, construction of spin Hamiltonian

Lecture 16 - Quantum mechanical analysis of AX spectra

Lecture 17 - Quantum mechanical analysis of AB spin system

Lecture 18 - Quantum mechanical analysis of coupled spin systems

Lecture 19 - RF pulses and their phases

Lecture 20 - Receiver phase and phase cycling

Lecture 21 - Evolution of chemical shift

Lecture 22 - Evolution of J couplings: polarization transfer

Lecture 23 - selective saturation in homo and heteronuclear spin systems, coupled and decoupled INEPT

Lecture 24 - INEPT and DEPT

Lecture 25 - Coherence transfer pathway

Lecture 26 - Examples of coherence pathway selection

Lecture 27 - Pulse field gradients - I

Lecture 28 - Pulse field gradients - II

Lecture 29 - Selective excitation, selective inversion

Lecture 30 - Relaxation phenomenon

Lecture 31 - T1 relaxation concepts and measurements

Lecture 32 - Spectral density function and relaxation mechanisms

Lecture 33 - T1 Relaxation mechanisms

Lecture 34 - T1 Relaxation mechanisms and T2 relaxation

Lecture 35 - Measurement of T1 and T2

Lecture 36 - Decoupling and NOE concepts

Lecture 37 - DQ and ZQ relaxation pathways

Lecture 38 - Positive and Negative NOE and spectral density functions

Lecture 39 - NOE and correlation time

Lecture 40 - Product operators

Lecture 41 - Product operator analysis

Lecture 42 - Product operator analysis of pulse sequences

Lecture 43 - Product operators for two J coupled spins

Lecture 44 - Spin echo sequences

Lecture 45 - Introduction to 2D NMR

Lecture 46 - 2D NMR concepts, 2D experiments

Lecture 47 - 2D COSY experiment

Lecture 48 - 2D COSY and its variants

Lecture 49 - TOCSY Heteronuclear 2D experiments

Lecture 50 - coupled and decoupled HSQC, HMBC, INADEQUATE, 2D Jresolved

Lecture 51 - Introduction to multiple quantum NMR

Lecture 52 - DQ and ZQ of coupled spins

Lecture 53 - MQ and relative signs of couplings

Lecture 54 - MQ and spin system filtering

Lecture 55 - Introduction to solid state NMR

Lecture 56 - CSA and dipolar couplings

Lecture 57 - Magic Angle Spinning

Lecture 58 - WAHUHA and Cross Polarization

Lecture 59 - Cross Polarization

Lecture 60 - CP at high speeds, Side band suppression, TOSS

[Lecture 1 - Introduction to Graph Theory - Part 1](#)

[Lecture 2 - Introduction to Graph Theory - Part 2](#)

[Lecture 3 - Introduction to Graph Algorithms - Part 1](#)

[Lecture 4 - Introduction to Graph Algorithms - Part 2](#)

[Lecture 5 - Havel Hakimi Theorem - Part 1](#)

[Lecture 6 - Havel Hakimi Theorem - Part 2](#)

[Lecture 7 - Havel Hakimi Theorem - Part 3](#)

[Lecture 8 - Graph Traversals - Part 1](#)

[Lecture 9 - Graph Traversals - Part 2](#)

[Lecture 10 - Topological Sort and Mengers Theorem - Part 1](#)

[Lecture 11 - Topological Sort and Mengers Theorem - Part 2](#)

[Lecture 12 - Topological Sort and Mengers Theorem - Part 3](#)

[Lecture 13 - Hamiltonian Graphs - Part 1](#)

[Lecture 14 - Hamiltonian Graphs - Part 2](#)

[Lecture 15 - Shortest path Algorithms 1 - Part 1](#)

[Lecture 16 - Shortest path Algorithms 1 - Part 2](#)

[Lecture 17 - Shortest path Algorithms 1 - Part 3](#)

[Lecture 18 - Shortest path Algorithms 1 - Part 4](#)

[Lecture 19 - Matching in Graphs - Part 1](#)

[Lecture 20 - Matching in Graphs - Part 2](#)

[Lecture 21 - Some Graph Theoretic Puzzles - Part 1](#)

[Lecture 22 - Some Graph Theoretic Puzzles - Part 2](#)

[Lecture 23 - Network Flow Algorithms - Part 1](#)

[Lecture 24 - Network Flow Algorithms - Part 2](#)

[Lecture 25 - Network Flow Algorithms - Part 3](#)

[Lecture 26 - Network Flow Algorithms - Part 4](#)

[Lecture 27 - Network Flow Algorithms - Part 5](#)

[Lecture 28 - Network Flow Algorithms - Part 6](#)

[Lecture 29 - Network Flows - Part 1](#)

[Lecture 30 - Network Flows - Part 2](#)

[Lecture 31 - Network Flows - Part 3](#)

[Lecture 32 - Network Flows - Part 4](#)

[Lecture 33 - Turan's and Mader's theorem - Part 1](#)

[Lecture 34 - Turan's and Mader's theorem - Part 2](#)

[Lecture 35 - NP Computations - Part 1](#)

[Lecture 36 - NP Computations - Part 2](#)

[Lecture 37 - Spectral Graph Theory-I - Part 1](#)

[Lecture 38 - Spectral Graph Theory-I - Part 2](#)

[Lecture 39 - Spectral Graph Theory-I - Part 3](#)

[Lecture 40 - NP Computations II - Part 1](#)

[Lecture 41 - NP Computations II - Part 2](#)

[Lecture 42 - Graph Coloring - Part 1](#)

[Lecture 43 - Graph Coloring - Part 2](#)

[Lecture 44 - Spectral Graph Theory-II - Part 1](#)

[Lecture 45 - Spectral Graph Theory-II - Part 2](#)

[Lecture 46 - NP Computations Reductions - Part 1](#)

[Lecture 47 - NP Computations Reductions - Part 2](#)

[Lecture 48 - NP Computations Reductions - Part 3](#)

[Lecture 49 - Spectral Graph Theory-III - Part 1](#)

[Lecture 50 - Planar Graphs - Part 1](#)

[Lecture 51 - Planar Graphs - Part 2](#)

[Lecture 52 - NP Computations and Approximation Algorithms - Part 1](#)

[Lecture 53 - NP Computations and Approximation Algorithms - Part 2](#)

[Lecture 54 - Spectral Graph Theory-IV - Part 1](#)

[Lecture 55 - Spectral Graph Theory-IV - Part 2](#)

[Lecture 56 - Approximation Algorithms I - Part 1](#)

[Lecture 57 - Approximation Algorithms I - Part 2](#)

[Lecture 58 - Social Network Analysis - Part 1](#)

[Lecture 59 - Social Network Analysis - Part 2](#)

[Lecture 60 - Spectral Graph Theory-V - Part 1](#)

[Lecture 61 - Spectral Graph Theory-V - Part 2](#)

[Lecture 62 - Approximation Algorithms II - Part 1](#)

[Lecture 63 - Approximation Algorithms II - Part 2](#)

[Lecture 64 - Spectral Graph Theory-VI - Part 1](#)

[Lecture 65 - Spectral Graph Theory-VI - Part 2](#)

[Lecture 66 - RSA Crypto - Part 1](#)

[Lecture 67 - RSA Crypto - Part 2](#)

[Lecture 68 - Approximation Algorithms III - Part 1](#)

[Lecture 69 - Approximation Algorithms III - Part 2](#)

[Lecture 70 - Spectral Graph Theory-VII - Part 1](#)

[Lecture 71 - Spectral Graph Theory-VII - Part 2](#)

[Lecture 72 - Exact Exponential Algorithms - Part 1](#)

[Lecture 73 - Exact Exponential Algorithms - Part 2](#)

[Lecture 74 - Interconnection Networks - Part 1](#)

[Lecture 75 - Interconnection Networks - Part 2](#)

[Lecture 76 - Kernelization - Part 1](#)

[Lecture 77 - Kernelization - Part 2](#)

[Lecture 78 - Kernelization - Part 3](#)

[Lecture 79 - Introduction to Parameterized Algorithms - Part 1](#)

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Co-ordinators : Meenakshi D'Souza

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Co-ordinators : Prof. Meenakshi DSouza

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Co-ordinators : Prof. Bohuslav Neckar

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NPTEL : Natural Dyes (Textile Engineering)

Co-ordinators : Dr. Padma S Vankar

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