

Lecture 1 - Scalar field and its Gradient

Lecture 2 - Line and Surface Integrals

Lecture 3 - Divergence and Curl of Vector Fields

Lecture 4 - Conservative Field, Stoke's Theorem

Lecture 5 - Laplacian

Lecture 6 - Electric Field Potential

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 magnetized 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](#)

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[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
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- 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](#)

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[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

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[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](#)

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[Lecture 40 - Lagrangian Framework](#)

[Lecture 41 - Gauge Symmetry - U\(1\)](#)

[Lecture 42 - Electroweak Theory - 1](#)

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[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 32 - Current algebra

- 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

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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](#)

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- 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
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- [Lecture 37 - Electro-optic Modulators and Devices \(Continued...\)](#)
- [Lecture 38 - Electro-optic Modulators and Devices \(Continued...\)](#)
- [Lecture 39 - Electro-optic Modulators and Devices \(Continued...\)](#)
- [Lecture 40 - Electro-optic Modulators and Devices \(Continued...\)](#)
- [Lecture 41 - Acousto-optic Effect](#)
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- [Lecture 44 - Acousto-optic Effect \(Continued...\)](#)
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- [Lecture 52 - Acousto-optic Effect \(Continued...\)](#)
- [Lecture 53 - Acousto-optic Effect \(Continued...\)](#)
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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 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...)

Lecture 1 - Introduction

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 \(Experiment\)](#)

[Lecture 40 - Theory of diffraction](#)

[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](#)

[Lecture 46 - Plane transmission grating \(Continued...\)](#)

[Lecture 47 - Theory of polarization](#)

[Lecture 48 - Theory of polarization \(Continued...\)](#)

[Lecture 49 - Experiment for Verification of Malus law](#)

[Lecture 50 - Experiment for Brewster angle](#)

[Lecture 51 - Experiment for Brewster angle](#)

[Lecture 52 - Experiment on e-ray and o-ray](#)

[Lecture 53 - Polarimeter](#)

[Lecture 54 - Zone-plate Theory](#)

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[Lecture 56 - Theory of Photoelectric Effect](#)

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[Lecture 58 - Thomson experiment to determine the specific charge of an electron \(e/m\)](#)

[Lecture 59 - Frank-Hertz Experiment](#)

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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

Lecture 25 - Dielectric constant of non-conducting liquid

Lecture 26 - P-E Loop of Ferroelectric Material

Lecture 27 - Measurement of Ionic Conductivity

Lecture 28 - Measurement of Ionic Conductivity (Continued...)

Lecture 29 - Electron Spin Resonance (ESR)

Lecture 30 - Electron Spin Resonance (ESR) Experiment

Lecture 31 - Superconductivity

[Lecture 32 - Superconductivity \(Continued...\)](#)

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[Lecture 34 - Nuclear g-factor](#)

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[Lecture 36 - P-N Junction](#)

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[Lecture 47 - Determination of Wavelength of Spectral Lines using Constant Deviation Spectrometer](#)

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[Lecture 49 - Photoelastic Property of Materials](#)

[Lecture 50 - Photoelastic Property of Materials \(Continued...\)](#)

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[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](#)
- [Lecture 34 - Optical fiber mode morphology \(Continued...\)](#)
- [Lecture 35 - Effective area of mode, Fiber optics components](#)
- [Lecture 36 - Directional Coupler](#)
- [Lecture 37 - Coupled Mode Theory](#)
- [Lecture 38 - Coupled Mode Theory \(Continued...\)](#)
- [Lecture 39 - 3 dB power splitter](#)
- [Lecture 40 - Working principle of WDM coupler](#)
- [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](#)
- [Lecture 50 - Frequency mixing, Optical Kerr effect](#)
- [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)

[Lecture 32 - Pseudocapacitors](#)

[Lecture 33 - Electrochemical Techniques for Supercapacitors and Batteries](#)

[Lecture 34 - From material to a supercapacitor device](#)

[Lecture 35 - Effect of temperature on supercapacitor performance](#)

[Lecture 36 - Effect of external magnetic field and frequency on supercapacitors](#)

[Lecture 37 - Introduction to Fuel Cells](#)

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[Lecture 40 - Nanotechnology and Nanomaterials for Energy Applications](#)

[Lecture 41 - Synthesis of nanomaterials](#)

[Lecture 42 - Carbon- and metal-oxide based nanomaterials](#)

[Lecture 43 - Nanocatalysts](#)

[Lecture 44 - Characterization techniques for solid materials](#)

[Lecture 45 - X-ray diffraction method](#)

[Lecture 46 - UV-Visible Spectroscopy](#)

[Lecture 47 - Fourier Transform Infrared Spectroscopy](#)

[Lecture 48 - SEM, TEM and XPS](#)

[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 \(ii\)](#)

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Lecture 6 - Quantum Theory of collisions: Differential scattering cross section, Partial wave analysis

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- [Lecture 33 - Lippman Schwinger equation of potential scattering](#)
- [Lecture 34 - Born Approximation](#)
- [Lecture 35 - Coulomb scattering](#)
- [Lecture 36 - Scattering of partial waves](#)
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- [Lecture 41 - Discrete state embedded in the continuum](#)
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- [Lecture 44 - Photoionization and Photoelectron Angular Distributions](#)
- [Lecture 45 - Ionization and Excitation of Atoms by Fast Charged Particles](#)
- [Lecture 46 - Photo-absorption by Free and Confined Atoms and Ions: Recent Developments](#)

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NPTEL : Nuclear Reactors and Safety - An Introduction (Physics)

Co-ordinators : Dr.G.Vaidyanathan

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- Lecture 5 - Nuclear Reactors
- Lecture 6 - Reactors Generation
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- Lecture 11 - Safety Approach
- Lecture 12 - Risk and Probabilistic safety analysis (PSA)
- Lecture 13 - History of Events in Nuclear Power Plants and Radiation facilities
- Lecture 14 - Other Events
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- Lecture 24 - Safety Regulation in India (Continued...)
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- Lecture 26 - Safety Practices in Indian NPPs
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- Lecture 14 - Motion in a circle - Acceleration
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Lecture 12 - Plasmons - III

Lecture 13 - Plasmons - IV

Lecture 14 - Plasmons - V

Lecture 15 - Plasmons - VI

Lecture 16 - Multiple Optical Sensors of Different Mechanisms

Lecture 17 - Interference based Sensors

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)

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