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**Co-ordinators : Prof. Kishore Chatterjee, Prof. B.G. Fernandes**

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- Lecture 12 - Smith Chart and Impedance Matching - II: using Lumped Components
- Lecture 13 - Smith Chart and Impedance Matching - III: using Short and Open Circuited Stubs
- Lecture 14 - ABCD - Parameters
- Lecture 15 - S - Parameters
- Lecture 16 - Power Dividers - I: Two-way, Three-way and Four-way Equal Power Dividers
- Lecture 17 - Power Dividers - II: Unequal, Broadband and Compact Power Dividers
- Lecture 18 - Microwave Couplers - I: Coupled Line Directional Couplers
- Lecture 19 - Microwave Couplers - II: Branch Line Couplers
- Lecture 20 - Microwave Couplers - III: Rat race Coupler and Applications
- Lecture 21 - Microwave Filters - I: Filters and Low Pass Butterworth Filter
- Lecture 22 - Microwave Filters - II: Low Pass Chebyshev Filters
- Lecture 23 - Microwave Filters - III: Microstrip Realization, Transformation from LPF to other Filters
- Lecture 24 - Microwave Filters - IV: Band Pass Filters
- Lecture 25 - Microwave Filters - V: Coupled Line and Tunable Band Pass Filters
- Lecture 26 - Microwave Diodes: PN Junction , Varactor, Schottky, PIN, Tunnel, and GUNN Diodes
- Lecture 27 - Microwave Attenuators: Fixed and Variable Attenuators
- Lecture 28 - Microwave RF Switches: Series and Shunt SPST
- Lecture 29 - Series and Shunt SPDT Switches and Introduction to Phase Shifters
- Lecture 30 - Microwave Phase Shifters: Switched and Loaded Line
- Lecture 31 - Microwave Transistors: BJT, HBT, JFET, MOSFET, MESFET and HEMT

- Lecture 32 - Microwave Amplifiers - I: Basics and Power Gain Expressions
- Lecture 33 - Microwave Amplifiers - II: Stability and Constant Gain Circles
- Lecture 34 - Microwave Amplifiers - III: Design Example
- Lecture 35 - Low Noise Amplifiers - I: Noise Sources and Noise Figure
- Lecture 36 - Low Noise Amplifiers - II: NF Circles and LNA Design
- Lecture 37 - Power Amplifiers
- Lecture 38 - Microwave Tubes - I : Linear Beam Tubes- Two Cavity Klystron
- Lecture 39 - Microwave Tubes - II: Linear Beam Tubes- Reflex Klystron and TWT
- Lecture 40 - Microwave Tubes - III: Crossed Field Tubes- Magnetron
- Lecture 41 - Microwave Oscillators - I
- Lecture 42 - Microwave Oscillators - II
- Lecture 43 - Microwave Mixers - I: Fundamentals
- Lecture 44 - Microwave Mixers - II: Circuits
- Lecture 45 - Microwave Mixers - III: Design
- Lecture 46 - Fundamentals of Antennas
- Lecture 47 - Dipole, Monopole, loop and Slot Antennas
- Lecture 48 - Linear and Planar Arrays
- Lecture 49 - Microstrip Antennas
- Lecture 50 - Horn and Helical Antennas
- Lecture 51 - Yagi - Uda, Log-Periodic and Reflector Antennas
- Lecture 52 - RF MEMS and Microwave Imaging
- Lecture 53 - Microwave Systems
- Lecture 54 - Microwave Measurements and Lab Demonstration
- Lecture 55 - CST Software Introduction with Filter Design
- Lecture 56 - Power Divider and Combiner Design in CST
- Lecture 57 - Hybrid Coupler Design
- Lecture 58 - Antenna Design and Amplifier Simulation in CST
- Lecture 59 - Mixer Design in NI AWR Software - I
- Lecture 60 - Mixer Design in NI AWR Software - II



Lecture 1 - Course Overview

Lecture 2 - Introduction to Information Theory

Lecture 3 - Entropy and its properties

Lecture 4 - Lossless Source Coding Theorem

Lecture 5 - Prefix Codes and Kraft's Inequality

Lecture 6 - Huffman Coding

Lecture 7 - Discrete Memory-less Channels : Mutual Information

Lecture 8 - Channel Capacity - I

Lecture 9 - Channel Capacity - II

Lecture 10 - Channel Coding Theorem

Lecture 11 - Differential Entropy - I

Lecture 12 - Differential Entropy - II

Lecture 13 - Channel Capacity - III

Lecture 14 - Channel Capacity - IV

Lecture 15 - Summary of Information Theory

Lecture 16 - Signal Space Representations - I

Lecture 17 - Signal Space Representations - II

Lecture 18 - Vector Representation of a Random Process

Lecture 19 - AWGN Vector Channel

Lecture 20 - Basics of Signal Detection: ML,MAP Detection

Lecture 21 - ML,MAP Detectors for AWGN Channel

Lecture 22 - Optimal Receiver: Matched Filter

Lecture 23 - Probability of error for Optimal Receiver

Lecture 24 - Probability of Error for M-ary Scheme

Lecture 25 - Pulse Code Modulation: Quantization

Lecture 26 - Uniform Quantizer

Lecture 27 - Step Size and Quantization Noise

Lecture 28 - Non-uniform Quantizer (Lloyd-Max Quantizer)

Lecture 29 - Companded Quantization - I

Lecture 30 - Companded Quantization - II

Lecture 31 - Differential Pulse Code Modulation DPCM - I

- Lecture 32 - DPCM-II (Linear Prediction)
- Lecture 33 - Delta Modulation
- Lecture 34 - M-ary PCM/PAM - I
- Lecture 35 - M-ary PCM/PAM - II
- Lecture 36 - Line Coding - I
- Lecture 37 - Line Coding - II
- Lecture 38 - Line Coding - III
- Lecture 39 - Pulse Shaping for Zero ISI - I
- Lecture 40 - Pulse Shaping for Zero ISI - II
- Lecture 41 - Pulse Shaping for Zero ISI - III
- Lecture 42 - Partial Response Signaling - I
- Lecture 43 - Partial Response Signaling - II
- Lecture 44 - Principle of Invariance of Probability of Error
- Lecture 45 - Binary ASK and PSK
- Lecture 46 - Binary Frequency Shift Keying - I
- Lecture 47 - Binary Frequency Shift Keying - II
- Lecture 48 - Quadrature Phase Shift Keying - I
- Lecture 49 - Quadrature Phase Shift Keying - II
- Lecture 50 - Quadrature Phase Shift Keying - III
- Lecture 51 - Continuous Phase Frequency Shift Keying
- Lecture 52 - Minimum Shift Keying - I
- Lecture 53 - Minimum Shift Keying - II
- Lecture 54 - M-ary Coherent ASK (M-ASK)
- Lecture 55 - M-ary PSK
- Lecture 56 - M-ary Quadrature Amplitude Modulation (M-QAM)
- Lecture 57 - M-ary FSK
- Lecture 58 - Comparison of M-ary Schemes
- Lecture 59 - Non-coherent BFSK
- Lecture 60 - Differential Phase Shift Keying
- Lecture 61 - Channel Coding - I
- Lecture 62 - Channel Coding - II
- Lecture 63 - Channel Coding - III
- Lecture 64 - Channel Coding: Hamming Codes



Lecture 1 - Familiarization with Power Electronic Systems

Lecture 2 - Overview of Basic Power Electronic Circuits from Laymans Point of View

Lecture 3 - Applications, Definitions, and Nature of Power Electronic Circuits

Lecture 4 - Components of a Power Electronic System

Lecture 5 - Analysis of Switched Networks

Lecture 6 - Review of engineering maths for power electronic circuit analysis

Lecture 7 - Review of semiconductor physics

Lecture 8 - P-N Junction

Lecture 9 - Power Diodes

Lecture 10 - Thyristors

Lecture 11 - Motivation for rectifier capacitor filter

Lecture 12 - Circuit Operation

Lecture 13 - Designing the circuit

Lecture 14 - Simulation setup for NgSpice and gEDA schematic capture

Lecture 15 - Simulating the circuit

Lecture 16 - Practicals

Lecture 17 - Inrush current limiting - Intro

Lecture 18 - Inrush current limiting - Resistor solution

Lecture 19 - Inrush current limiting - Thermistor solution

Lecture 20 - Inrush current limiting - Transformer solution

Lecture 21 - Inrush current limiting - MOSFET solution

Lecture 22 - Inrush current limiting - Relay, contactor

Lecture 23 - Three phase rectifier capacitor filter

Lecture 24 - Simulation - 3 phase rectifier capacitor filter

Lecture 25 - Power factor - Motivation

Lecture 26 - Power factor - Discussion

Lecture 27 - Power factor - Sinusoidal

Lecture 28 - Power factor for rectifier cap filter

Lecture 29 - Passive power improvement circuit

Lecture 30 - Simulation - power factor improvement

Lecture 31 - Linear regulators - Intro

Lecture 32 - Shunt regulator

Lecture 33 - Example on shunt regulator

Lecture 34 - Non-ideality and solution

Lecture 35 - Applications of shunt regulator

Lecture 36 - Series regulator

Lecture 37 - Efficiency of series

Lecture 38 - Negative and dual voltage regulators

Lecture 39 - Over current limiting circuits

Lecture 40 - Improvements to series regulator

Lecture 41 - Regulator performance parameters

Lecture 42 - Datasheet of few IC regulators

Lecture 43 - Common IC regulator circuits

Lecture 44 - Practicals 1

Lecture 45 - Switched mode DC-DC converter intro

Lecture 46 - Volt-sec and Amp-sec balance

Lecture 47 - Input-output relationship

Lecture 48 - Buck converter - operation and waveforms

Lecture 49 - Buck converter - component selection

Lecture 50 - Primary configurations

Lecture 51 - Boost converter

Lecture 52 - Buck-Boost converter

Lecture 53 - Simulating the primary converters

Lecture 54 - Forward converter

Lecture 55 - Core reset in forward converter

Lecture 56 - Simulating with lossy core reset

Lecture 57 - Simulating with lossless core reset

Lecture 58 - Flyback converter

Lecture 59 - Simulating the flyback converter

Lecture 60 - Octave mfile for design

Lecture 61 - Magnetics design intro

Lecture 62 - Magnetics review

Lecture 63 - Permeance

Lecture 64 - Inductor value and energy storage

Lecture 65 - Inductor area product

Lecture 66 - Inductor design

Lecture 67 - Inductor example

Lecture 68 - Transformer design

Lecture 69 - Transformer example

Lecture 70 - Forward converter design mfile

Lecture 71 - Pushpull converter

Lecture 72 - Flux walking in pushpull

Lecture 73 - PWM generation

Lecture 74 - Simulation of pushpull converter

Lecture 75 - Half bridge converter

Lecture 76 - Simulation of halfbridge converter

Lecture 77 - Full bridge converter

Lecture 78 - Simulation of fullbridge converter

Lecture 79 - Area products and mfiles

Lecture 80 - Intro for drive circuits

Lecture 81 - BJT base drive

Lecture 82 - BJT base drive example

Lecture 83 - Multi-stage base drive

Lecture 84 - Base drive with speed-up circuit

Lecture 85 - Base drive with isolation

Lecture 86 - MOSFET gate drive

Lecture 87 - MOSFET drive with isolation

Lecture 88 - Over-current protection

Lecture 89 - Snubber circuits

Lecture 90 - Intro for close loop control

Lecture 91 - Close looping dc-dc converters

Lecture 92 - Simulation of close loop control

Lecture 93 - Current control for battery charger application

Lecture 94 - Instability in current control and slope compensation

Lecture 95 - Slope compensated current control

Lecture 96 - Simulation of current control

Lecture 97 - Single phase inverter with sinusoidal pwm

Lecture 98 - Simulation of sinusoidal PWM

Lecture 1 - Course Outline and Introduction

Lecture 2 - Analytical and Numerical Methods

Lecture 3 - Revisiting EM Concepts: Vector Algebra and Coordinate Systems

Lecture 4 - Revisiting EM Concepts: Vector Calculus and Electrostatics

Lecture 5 - Revisiting EM Concepts: Current Densities and Electric Fields in Materials

Lecture 6 - Revisiting EM Concepts: Electrostatic Boundary Conditions and Shielding

Lecture 7 - Revisiting EM Concepts: Magnetostatics

Lecture 8 - Revisiting EM Concepts: Magnetic Forces and Materials

Lecture 9 - Revisiting EM Concepts: Time Varying Fields

Lecture 10 - Revisiting EM Concepts: Theory of Eddy Currents

Lecture 11 - FEM: Variational Approach

Lecture 12 - Finding Functional for PDEs

Lecture 13 - Whole Domain Approximation

Lecture 14 - 1D FEM: Problem Definition and Shape Function

Lecture 15 - 1D FEM: Procedure

Lecture 16 - 1D FEM: Scilab Code

Lecture 17 - 2D FEM: Problem Definition and Shape Functions

Lecture 18 - 2D FEM: Procedure

Lecture 19 - 2D FEM Scilab Code: Manual Meshing

Lecture 20 - 2D FEM Code: Gmsh and Scilab

Lecture 21 - Computation of B and H Field and Method of Weighted Residuals

Lecture 22 - Galerkin Method

Lecture 23 - Calculation of Leakage Inductance of a Transformer

Lecture 24 - Calculation of Inductance of an Induction Motor and a Gapped-Core Shunt Reactor

Lecture 25 - Insulation Design Using FE Analysis

Lecture 26 - Quadratic Finite Elements

Lecture 27 - Time Harmonic FE Analysis

Lecture 28 - Calculation of Eddy Current Losses

Lecture 29 - Eddy Losses in Transformer Windings

Lecture 30 - Torque Speed Characteristics of an Induction Motor and FE Analysis of Axisymmetric Problem

Lecture 31 - Permanent Magnets: Theory



[Lecture 32 - Permanent Magnets: FEM Implementation](#)

[Lecture 33 - Periodic and Antiperiodic Boundary Conditions in Rotating Machines](#)

[Lecture 34 - FE Analysis of Rotating Machines](#)

[Lecture 35 - Voltage Fed Coupled Circuit Field Analysis](#)

[Lecture 36 - Current Fed Coupled Circuit Field Analysis](#)

[Lecture 37 - Transient FE Analysis](#)

[Lecture 38 - Nonlinear FE Analysis](#)

[Lecture 39 - Computation of Forces using Maxwell Stress Tensor](#)

[Lecture 40 - Computation of force using virtual work method](#)

Lecture 1 - Introduction: Digital signal processing and its objectives

Lecture 2 - Introduction to sampling and Fourier Transform

Lecture 3 - Sampling of sine wave and associate complication

Lecture 4 - Review of Sampling Theorem

Lecture 5 - Idealized Sampling, Reconstruction

Lecture 6 - Filters And Discrete System

Lecture 7 - Answering questions from previous lectures

Lecture 8 - Desired requirements for discrete system

Lecture 9 - Introduction to phasors

Lecture 10 - Advantages of phasors in discrete systems

Lecture 11 - What do we want from a discrete system?

Lecture 12 - Linearity - Homogeneity and Additivity

Lecture 13 - Shift Invariance and Characterization of LTI systems

Lecture 14 - Characterization of LSI system using its impulse response

Lecture 15 - Introduction to convolution

Lecture 16 - Convolution: Deeper ideas and understanding

Lecture 17 - Characterisation of LSI systems, Convolution-properties

Lecture 18 - Response of LSI Systems to Complex Sinusoids

Lecture 19 - Convergence of Convolution and Bibo Stability

Lecture 20 - Commutativity and Associativity

Lecture 21 - BIBO Stability of an LSI system

Lecture 22 - Causality and memory of an LSI system

Lecture 23 - Frequency response of an LSI system

Lecture 24 - Introduction and conditions of Stability

Lecture 25 - Vectors and Inner Product

Lecture 26 - Interpretation of Frequency Response as Dot Product

Lecture 27 - Interpretation of Frequency Response as Eigenvalues

Lecture 28 - Discrete time fourier transform

Lecture 29 - DTFT in LSI System and Convolution Theorem.

Lecture 30 - Definitions of sequences and Properties of DTFT

Lecture 31 - Introduction to DTFT, IDTFT

Lecture 32 - Dual to convolution property

Lecture 33 - Multiplication Property, Introduction to Parseval's theorem

Lecture 34 - Introduction and Property of DTFT

Lecture 35 - Review of Inverse DTFT

Lecture 36 - Parseval's Theorem and energy and time spectral density

Lecture 37 - Discussion on Unit Step

Lecture 38 - Introduction to Z transform

Lecture 39 - Example of Z transform

Lecture 40 - Region of Convergence

Lecture 41 - Properties of Z transform

Lecture 42 - Z- Transform

Lecture 43 - Rational System

Lecture 44 - Introduction and Examples of Rational Z Transform and their Inverses

Lecture 45 - Double Pole Examples and their Inverse Z Transform

Lecture 46 - Partial Fraction Decomposition

Lecture 47 - LSI System Examples

Lecture 48 - Why are Rational Systems so important?

Lecture 49 - Solving Linear constant coefficient difference equations which are valid over a finite range of time

Lecture 50 - Introduction to Resonance in Rational Systems

Lecture 51 - Characterization of Rational LSI system

Lecture 52 - Causality and stability of the ROC of the system function

Lecture 53 - Recap of Rational Systems and Discrete Time Filters

Lecture 54 - Specifications for Filter Design

Lecture 55 - Four Ideal Piecewise Constant Filters

Lecture 56 - Important Characteristics Of Ideal Filters

Lecture 57 - Synthesis of Discrete Time Filters, Realizable specifications

Lecture 58 - Realistic Specifications for low pass filter. Filter Design Process

Lecture 59 - Introduction to Filter Design. Analog IIR Filter, FIR discrete-time filter, IIR discrete-time filter

Lecture 60 - Analog to discrete transform

Lecture 61 - Intuitive transforms, Bilinear Transformation

Lecture 62 - Steps for IIR filter design

Lecture 63 - Analog filter design using Butterworth Approximation

Lecture 64 - Butterworth filter Derivation And Analysis of butterworth system function

Lecture 65 - Chebychev filter Derivation

Lecture 66 - Midsem paper review discussion

Lecture 67 - The Chebyshev Approximation

Lecture 68 - Next step in design: Obtain poles

Lecture 69 - Introduction to Frequency Transformations in the Analog Domain

Lecture 70 - High pass transformation

Lecture 71 - Band pass transformation

Lecture 72 - Frequency Transformation

Lecture 73 - Different types of filters

Lecture 74 - Impulse invariant method and ideal impulse response

Lecture 75 - Design of FIR of length  $(2N+1)$  by the truncation method, Plotting the function  $V(w)$

Lecture 76 - IIR filter using rectangular window, IIR filter using triangular window

Lecture 77 - Proof that frequency response of an fir filter using rectangular window function centred at 0 is real

Lecture 78 - Introduction to window functions

Lecture 79 - Examples of window functions

Lecture 80 - Explanation of Gibbs Phenomenon and its application

Lecture 81 - Comparison of FIR And IIR Filter

Lecture 82 - Comparison of FIR And IIR Filter

Lecture 83 - Comparison of FIR And IIR Filter

Lecture 84 - Introduction and approach to realization (causal rational system)

Lecture 85 - Comprehension of Signal Flow Graphs and Achievement of Pseudo Assembly Language Code

Lecture 86 - Introduction to IIR Filter Realization and Cascade Structure

Lecture 87 - Cascade Parallel Structure

Lecture 88 - Lattice Structure

Lecture 89 - Recap And Review of Lattice Structure, Realization of FIR Function

Lecture 90 - Backward recursion, Change in the recursive equation of lattice

Lecture 91 - Lattice structure for an arbitrary rational system

Lecture 92 - Example realization of lattice structure for rational system

Lecture 93 - Introductory Remarks of Discrete Fourier Transform and Frequency Domain Sampling

Lecture 94 - Principle of Duality, The Circular Convolution

Lecture 1 - Decision Making under Uncertainty

Lecture 2 - Expected Utility Theory - I

Lecture 3 - Expected Utility Theory - II

Lecture 4 - Expected Utility Theory - III

Lecture 5 - Role of Information in Decision Making

Lecture 6 - State Space Modelling of Sequential Decision Making, Example of Inventory Control

Lecture 7 - Inventory Control Problem (Continued...)

Lecture 8 - Policy-A Closed Loop Solution to Stochastic Control Problem

Lecture 9 - Introduction to Markov Decision Processes (MDP)

Lecture 10 - Types of Policy in MDP

Lecture 11 - Interpreting randomised decision rules

Lecture 12 - Stationary Transition Probability: State Diagram Representation and example of Markov policies

Lecture 13 - Example of History Dependent Policies

Lecture 14 - Complexity of the problem using brute force approach

Lecture 15 - Principle of Optimality

Lecture 16 - Dynamic Programming Algorithm

Lecture 17 - DP Algo applied to Inventory Control Problem

Lecture 18 - DP Algo applied to Inventory Control Problem (Continued...)

Lecture 19 - DP Algo applied to Inventory Control Problem (Continued...)

Lecture 20 - Optimal Stopping Problem

Lecture 21 - Optimal Stopping Example: Secretary Problem

Lecture 22 - Optimal Stopping Example: Secretary Problem (Continued...)

Lecture 23 - Optimal Stopping Example: Secretary Problem (Continued...)

Lecture 24 - Linear System Quadratic Cost Problem

Lecture 25 - Linear System Quadratic Cost Problem (Continued...)

Lecture 26 - Solving it via DP algorithm (Continued...)

Lecture 27 - Equivalence between Optimal HR Policy and optimal Markov Deterministic Policy

Lecture 28 - Stochastic Control under incomplete state information

Lecture 29 - Stochastic Control under incomplete state information (Continued...)

Lecture 30 - Stochastic Control under incomplete state information: Example

Lecture 31 - Stochastic Control under incomplete state information: Example (Continued...)

[Lecture 32 - Stochastic Control under incomplete state information: Example \(Continued...\)](#)

[Lecture 33 - Stochastic Control under incomplete state information: Example \(Continued...\)](#)

[Lecture 34 - LQ systems with Imperfect Information - I](#)

[Lecture 35 - LQ systems with Imperfect Information - II](#)

[Lecture 36 - LQ systems with Imperfect Information - III](#)

[Lecture 37 - LQ systems with Imperfect Information - IV](#)

[Lecture 38 - Filtering - I](#)

[Lecture 39 - Filtering - II](#)

[Lecture 40 - Kalman Filtering - I](#)

[Lecture 41 - Kalman Filtering - II](#)

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[Lecture 43 - Belief State Formulation - I](#)

[Lecture 44 - Belief State Formulation - II](#)

[Lecture 45 - Information Structures - I](#)

[Lecture 46 - Information Structures - II](#)

[Lecture 47 - Witsenhausen Problem - I](#)

[Lecture 48 - Witsenhausen Problem - II](#)

[Lecture 49 - Witsenhausen Problem - III](#)

[Lecture 50 - Witsenhausen Problem - IV](#)

[Lecture 51 - Witsenhausen Problem - V](#)

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[Lecture 53 - Witsenhausen Problem - VII](#)

[Lecture 54 - Team Decision Theory - I](#)

[Lecture 55 - Team Decision Theory - II](#)

[Lecture 56 - Team Decision Theory - III](#)

[Lecture 57 - Team Decision Theory - IV](#)

[Lecture 58 - Team Decision Theory - V](#)

[Lecture 59 - Team Decision Theory - VI](#)

[Lecture 60 - Team Decision Theory - VII](#)

[Lecture 61 - Communication Theory - I](#)

[Lecture 62 - Communication Theory - II](#)

[Lecture 63 - Communication Theory - III](#)

[Lecture 64 - Communication Theory - IV](#)



**NPTEL : Circuit Theory (Electrical Engineering)**

**Co-ordinators : Prof. S.C. Dutta Roy**

Lecture 1 - Review of Signals and Systems

Lecture 2 - Review of Signals and Systems

Lecture 3 - Network Equations; Initial and Final Conditions

Lecture 4 - Problem Session 1

Lecture 5 - Step, Impulse and Complete Responses

Lecture 6 - 2nd Order Circuits:Magnetically Coupled Circuits

Lecture 7 - Transformer Transform Domain Analysis

Lecture 8 - Problem Session 2 : Step,Impulse

Lecture 9 - Network Theorems and Network Functions

Lecture 10 - Network Functions (Continued.)

Lecture 11 - Amplitude and Phase of Network Functions

Lecture 12 - Problem Session 3 : Network Theorems Transform

Lecture 13 - Poles, Zeros and Network Response

Lecture 14 - Single Tuned Circuits

Lecture 15 - Single Tuned Circuits (Continued.)

Lecture 16 - Double Tuned Circuits

Lecture 17 - Double Tuned Circuits (Continued.)

Lecture 18 - Problem Session 4 : Network Functions, Analysis

Lecture 19 - Double Tuned Circuits (Continued.)

Lecture 20 - Concept of Delay and Introduction

Lecture 21 - Two-port Networks (Continued.)

Lecture 22 - Problem Session 5

Lecture 23 - Minor - 1

Lecture 24 - The Hybrid & Transmission Parameters of 2 ports

Lecture 25 - Problem Session 6 : Two - port networks

Lecture 26 - Two - port Network parameters

Lecture 27 - Two-port Interconnections

Lecture 28 - Interconnection of Two-port Networks (Continued.)

Lecture 29 - Problem Session 7 : Two-port Networks (Continued.)

Lecture 30 - Scattering Matrix

Lecture 31 - Scattering Parameters of a Two-port



Lecture 32 - Problem Session 8 : Two- port Parameters

Lecture 33 - Solutions of Minor - 2 Problems

Lecture 34 - Insertion Loss

Lecture 35 - Example of Insertion Loss and Elements

Lecture 36 - Elements of Realizability Theory (Continued.)

Lecture 37 - Positive Real Functions

Lecture 38 - Testing of Positive Real Functions

Lecture 39 - Problem Session 9

Lecture 40 - More on PRF's and their Synthesis

Lecture 41 - LC Driving Point Functions

Lecture 42 - LC Driving Point Synthesis (Continued.)

Lecture 43 - RC and RL Driving Point Synthesis

Lecture 44 - Problem Session 10 : LC Driving Point Synthesis

Lecture 45 - RC & RL One-port Synthesis (Continued.)

Lecture 46 - Elementary RLC One-port Synthesis

Lecture 47 - Properties and Synthesis of Transfer Parameters

Lecture 48 - Resistance Terminated LC Ladder

Lecture 49 - Resistance Terminated LC Ladder (Continued.)

Lecture 50 - Problem session 11: Two-port Synthesis

Lecture 51 - Network Transmission Criteria

Lecture 1 - Introduction to control problem

Lecture 2 - Basic Feedback Structure

Lecture 3 - Introduction to Control Problem (Continued.)

Lecture 4 - Dynamic Systems and Dynamic Response

Lecture 5 - Dynamic Systems and Dynamic Response (Continued.)

Lecture 6 - Dynamic Systems and Dynamic Response (Continued.)

Lecture 7 - Dynamic Systems and Dynamic Response (Continued.)

Lecture 8 - Dynamic Systems and Dynamic Response (Continued.)

Lecture 9 - Dynamic Systems and Dynamic Response (Continued.)

Lecture 10 - Models of Industrial Control Devices and Systems

Lecture 11 - Models of Industrial Control Devices and Systems (Continued.)

Lecture 12 - Models of Industrial Control Devices and Systems( Continued.)

Lecture 13 - Models of Industrial Control Devices and Systems( Continued.)

Lecture 14 - Models of Industrial Control Devices and Systems( Continued.)

Lecture 15 - Models of Industrial Control Devices and Systems( Continued.)

Lecture 16 - Models of Industrial Control Devices and Systems (Continued.)

Lecture 17 - Models of Industrial Control Devices and Systems (Continued.)

Lecture 18 - Models of Industrial Control Devices and Systems (Continued.)

Lecture 19 - Basic Principles of Feedback Control

Lecture 20 - Basic Principles of Feedback Control (Continued.)

Lecture 21 - Basic Principles of Feedback Control (Continued.)

Lecture 22 - Basic Principles of Feedback Control (Continued.)

Lecture 23 - Concepts of stability and Routh Stability Criterion

Lecture 24 - Concepts of stability and Routh Stability Criterion (Continued.)

Lecture 25 - Concepts of stability and Routh Stability Criterion (Continued.)

Lecture 26 - The Performance of Feedback Systems

Lecture 27 - The Performance of Feedback Systems (Continued.)

Lecture 28 - The Performance of Feedback Systems (Continued.)

Lecture 29 - The Performance of Feedback Systems (Continued.)

Lecture 30 - Compensator Design Using Root Locus Plots

Lecture 31 - Compensator Design Using Root Locus Plots (Continued.)

[Lecture 32 - Compensator Design Using Root Locus Plots \(Continued.\)](#)

[Lecture 33 - Compensator Design Using Root Locus Plots \(Continued.\)](#)

[Lecture 34 - Compensator Design Using Root Locus Plots \(Continued.\)](#)

[Lecture 35 - The Nyquist Stability Criterion and Stability Margins](#)

[Lecture 36 - The Nyquist Stability Criterion and Stability Margins \(Continued.\)](#)

[Lecture 37 - The Nyquist Stability Criterion and Stability Margins \(Continued.\)](#)

[Lecture 38 - The Nyquist Stability Criterion and Stability Margins \(Continued.\)](#)

[Lecture 39 - Feedback System Performance Based on the Frequency Response](#)

[Lecture 40 - Feedback System Performance Based on the Frequency Response \(Continued.\)](#)

[Lecture 41 - Compensator Design Using Frequency Response Plots](#)

Lecture 1 - Embedded Systems: Introduction

Lecture 2 - Embedded Hardware

Lecture 3 - PIC: Instruction Set

Lecture 4 - PIC Peripherals On Chip

Lecture 5 - ARM Processor

Lecture 6 - More ARM Instructions

Lecture 7 - ARM: Interrupt Processing

Lecture 8 - Digital Signal Processors

Lecture 9 - More on DSP Processors

Lecture 10 - System On Chip (SOC)

Lecture 11 - Memory

Lecture 12 - Memory Organization

Lecture 13 - Virtual Memory and Memory Management Unit

Lecture 14 - Bus Structure

Lecture 15 - Bus Structure - 2

Lecture 16 - Bus Structure - 3 Serial Interfaces

Lecture 17 - Serial Interfaces

Lecture 18 - Power Aware Architecture

Lecture 19 - Software for Embedded Systems

Lecture 20 - Fundamentals of Embedded Operating Systems

Lecture 21 - Scheduling Policies

Lecture 22 - Resource Management

Lecture 23 - Embedded - OS

Lecture 24 - Networked Embedded Systems - I

Lecture 25 - Networked Embedded Systems - II

Lecture 26 - Networked Embedded Systems - III

Lecture 27 - Networked Embedded Systems - IV

Lecture 28 - Designing Embedded Systems - I

Lecture 29 - Designing Embedded Systems - II

Lecture 30 - Designing Embedded Systems- III

Lecture 31 - Embedded System Design - IV

[Lecture 32 - Designing Embedded Systems - V](#)

[Lecture 33 - Platform Based Design](#)

[Lecture 34 - Compilers for Embedded Systems](#)

[Lecture 35 - Developing Embedded Systems](#)

[Lecture 36 - Building Dependable Embedded Systems](#)

[Lecture 37 - Pervasive and Ubiquitous Computing](#)

- Lecture 1 - Electric Energy Systems A Perspective
- Lecture 2 - Structure of Power Systems
- Lecture 3 - Conventional Sources of Electric Energy
- Lecture 4 - Hydroelectric Power Generation
- Lecture 5 - Non Conventional Energy Sources
- Lecture 6 - Renewable Energy (Continued.)
- Lecture 7 - Energy Storage
- Lecture 8 - Deregulation
- Lecture 9 - Air Pollutants
- Lecture 10 - Transmission Line Parameters
- Lecture 11 - Capacitance of Transmission Lines
- Lecture 12 - Characteristics and Performance of Transmission Lines
- Lecture 13 - Voltage Regulation (VR)
- Lecture 14 - Power Flow through a Line
- Lecture 15 - Methods of Voltage Control
- Lecture 16 - Compensation of Transmission Lines
- Lecture 17 - Compensation of Transmission Lines (Continued.)
- Lecture 18 - Underground Cables
- Lecture 19 - Cables (Continued.)
- Lecture 20 - Insulators for Overhead Lines
- Lecture 21 - HVDC
- Lecture 22 - HVDC (Continued.)
- Lecture 23 - Distribution Systems
- Lecture 24 - Automatic Generation Control
- Lecture 25 - Automatic Generation Control (Continued.)
- Lecture 26 - Load Flow Studies
- Lecture 27 - Load Flow Problem
- Lecture 28 - Load Flow Analysis (Continued.), Gauss Siedel Method
- Lecture 29 - Newton Raphson (NR), Load Flow Method
- Lecture 30 - Fast Decoupled Load Flow
- Lecture 31 - Control of Voltage Profile

[Lecture 32 - Optimal System Operation \(Economic Operation\)](#)

[Lecture 33 - Optimal Unit Commitment](#)

[Lecture 34 - Optimal Generation Scheduling](#)

[Lecture 35 - Optimal Load Flow \(Continued.\) and Hydro Thermal Scheduling](#)

- Lecture 1 - Introduction to Power System Stability Problem - Part-1
- Lecture 2 - Introduction to Power System Stability Problem - Part-2
- Lecture 3 - Introduction to Power System Stability Problem - Part-3
- Lecture 4 - Solution of Switching Equation
- Lecture 5 - The Equal Area Criterion for Stability - Part-1
- Lecture 6 - The Equal Area Criterion for Stability - Part-2
- Lecture 7 - Transient Stability Analysis of a Multi Machine System
- Lecture 8 - Modeling of Synchronous Machine - Part-1
- Lecture 9 - Modeling of Synchronous Machine - Part-2
- Lecture 10 - Modeling of Synchronous Machine - Part-3
- Lecture 11 - Modeling of Synchronous Machine - Part-4
- Lecture 12 - Synchronous Machine Representation for Stability Studies - Part-1
- Lecture 13 - Synchronous Machine Representation for Stability Studies - Part-2
- Lecture 14 - Excitation Systems - Part-1
- Lecture 15 - Excitation Systems - Part-2
- Lecture 16 - Modeling of Excitation Systems - Part-1
- Lecture 17 - Modeling of Excitation Systems - Part-2
- Lecture 18 - Small Signal Stability of a Single Machine Infinite Bus System - Part-1
- Lecture 19 - Small Signal Stability of a Single Machine Infinite Bus System - Part-2
- Lecture 20 - Small Signal Stability of a Single Machine Infinite Bus System - Part-3
- Lecture 21 - Small Signal Stability of a Single Machine Infinite Bus System - Part-4
- Lecture 22 - Small Signal Stability of a Single Machine Infinite Bus System - Part-5
- Lecture 23 - Dynamic Modeling of Steam turbines and Governors
- Lecture 24 - Dynamic modeling of Hydro Turbines and Governors
- Lecture 25 - Load modeling for Stability Studies
- Lecture 26 - Numerical Integration Methods for Solving a Set of Ordinary Nonlinear Differential Equation
- Lecture 27 - Simulation of Power System Dynamic Response
- Lecture 28 - Dynamic Equivalents for Large Scale Systems - Part-1
- Lecture 29 - Dynamic Equivalents for Large Scale Systems - Part-2
- Lecture 30 - Dynamic Equivalents for Large Scale Systems - Part-3
- Lecture 31 - Direct Method of Transient Stability Analysis - Part-1



[Lecture 32 - Direct Method of Transient Stability Analysis - Part-2](#)

[Lecture 33 - Sub Synchronous Oscillations - Part-1](#)

[Lecture 34 - Sub Synchronous Oscillations - Part-2](#)

[Lecture 35 - Voltage Stability - Part-1](#)

[Lecture 36 - Voltage Stability - Part-2](#)

[Lecture 37 - Voltage Stability - Part-3](#)

[Lecture 38 - Voltage Stability - Part-4](#)

[Lecture 39 - Methods of Improving Stability - Part-1](#)

[Lecture 40 - Methods of Improving Stability - Part-2](#)

Lecture 1 - Review of DC Models of Diodes & BJT's

Lecture 2 - Review of DC Models of BJT (Continued...) and FET

Lecture 3 - FET Characteristics and Models

Lecture 4 - Problem Session-1 on DC Analysis of BJT Circuits

Lecture 5 - BJT Biasing and Bias Stability

Lecture 6 - BJT Bias Stability (Continued...)

Lecture 7 - FET Biasing, Current Sources

Lecture 8 - Problem Session-2 on FET and BJT Characteristics and Biasing

Lecture 9 - Current Mirrors; BJT Small Signal Models

Lecture 10 - Small Signal Amplifiers: Mid Frequency Analysis

Lecture 11 - Mid Frequency Analysis of the CE and CB Amplifier

Lecture 12 - Problem Session-3 on Mid- Frequency Analysis of CE Amplifiers

Lecture 13 - Midband Analysis of CB and CC Amplifiers

Lecture 14 - Midband Analysis of FET Amplifiers

Lecture 15 - Problem Session-4 on Midband Analysis of Amplifiers

Lecture 16 - High Frequency Response of Small Signal Amplifiers

Lecture 17 - High Frequency Response of Small Signal Amplifiers (Continued...)

Lecture 18 - Low Frequency Response of Small Signal Amplifiers

Lecture 19 - Problem Session-5 on Frequency Response of Small Signal Amplifiers

Lecture 20 - Differential Amplifiers

Lecture 21 - Differential Amplifiers (Continued...)

Lecture 22 - Discussion on Minor-1 Problems and Differential Amplifiers (Continued...)

Lecture 23 - Problem Session-6 on Frequency Response of Small Signal Amplifiers (Continued...) and Differential Amplifiers

Lecture 24 - Use of Current Mirrors in Differential Amplifiers

Lecture 25 - FET Differential Amplifiers and Introduction to Power Amplifiers

Lecture 26 - Class B, Class AB and Class A Power Amplifiers

Lecture 27 - Class A Power Amplifiers; Efficiency Considerations

Lecture 28 - Problem Session-7 on Deferential and Power Amplifiers

Lecture 29 - Introduction to Feedback Amplifiers

Lecture 30 - Advantages of Negative Feedback Amplifiers

Lecture 31 - Analysis of Feedback Amplifiers

- Lecture 32 - Analysis of the Series - Series and Other Feedback Configurations
- Lecture 33 - Problem Session-8 on Feedback Amplifiers
- Lecture 34 - Sinusoidal Oscillators : An Example of Positive Feedback
- Lecture 35 - More on Oscillators
- Lecture 36 - Solutions to Minor-2 Exam and Concluding Discussions on Oscillators
- Lecture 37 - Problem Session-9 on Oscillators
- Lecture 38 - Tuned (or Narrowband) Amplifiers
- Lecture 39 - Widebanding Techniques : Introduction & Use of Inductors
- Lecture 40 - Widebanding By Using an Inductance
- Lecture 41 - Problem Session-10 on Tuned Amplifiers
- Lecture 42 - Widebanding by Using Compound Devices
- Lecture 43 - Cascode Configuration as Wideband Amplifier
- Lecture 44 - Widebanding by Local Feedback
- Lecture 45 - Problem Session-11 on Minor-3 Problems & Widebanding by Compound Devices
- Lecture 46 - Widebanding by Local Feedback and Feedback Cascades
- Lecture 47 - Widebanding by Overall Feedback and Dual Loop Feedback
- Lecture 48 - The Differential Pair and the Gilbert Cell as Wideband Amplifiers
- Lecture 49 - Correction to Gilbert Cell Analysis and Operational Amplifier Imperfections
- Lecture 50 - Op-Amp offsets, Compensation and Slew Rate
- Lecture 51 - Op-Amp Compensation, Slew Rate and Some Problems

Lecture 1 - Introduction to the Course

Lecture 2 - Digital Representation of Analog Signals, Delta Modulation

Lecture 3 - Digital Representation of Analog Signals, Pulse Code Modulation

Lecture 4 - Digital Representation of Analog Signals

Lecture 5 - Quantization Noise in Delta Modulation (Continued...) and Time Division Multiplexing

Lecture 6 - Introduction to Line Coding

Lecture 7 - Spectral Properties of Line Codes: General Relations

Lecture 8 - Spectral Properties of Line Codes: On-off / Polar / Bipolar Signalling

Lecture 9 - Spectral Properties of Line Codes: Duobinary Manchester and HDB Codes

Lecture 10 - Baseband Pulse Shaping: Nyquist's First Criterion

Lecture 11 - Baseband Pulse Shaping; Raised Cosine Family of Pulses

Lecture 12 - Partial Response Signalling: Duobinary and Modified Duobinary Pulse Shaping

Lecture 13 - Precoding for Duobinary and Modified Duobinary Systems

Lecture 14 - Precoding for Modified Duobinary Systems (Continued...) and General Partial Response Signalling

Lecture 15 - Binary Baseband Digital Modulation Techniques

Lecture 16 - M-ary Baseband Digital Modulation Techniques

Lecture 17 - Passband Digital Modulations - I : PSK and QPSK

Lecture 18 - Passband Digital Modulations - II : Offset QPSK

Lecture 19 - Passband Digital Modulations - III : Minimum Shift Keying (MSK)

Lecture 20 - Passband Digital Modulations - IV : MSK (Continued...) : Passband Waveforms for M-ary Signalling

Lecture 21 - Passband Modulations for Band Limited Channels

Lecture 22 - Baseband and Passband Digital Demodulations : General Issues and Concepts

Lecture 23 - Digital Modulation Part - II Matched Filters

Lecture 24 - Matched Filters and Coherent Demodulation-I

Lecture 25 - Coherent Demodulation for Binary Wave Form

Lecture 26 - Demodulators for Binary Waveforms (Continued...) : Coherent and Noncoherent Receivers for Orthogonal Signalling (OOK and FSK)

Lecture 27 - Performance Analysis of Binary Digital Modulations: Signal and Noise Statistics in Coherent and Noncoherent Receivers

Lecture 28 - Error Rates for Binary Signalling : Coherent Receivers

Lecture 29 - Performance of Non Coherent FSK and Differential Phase Shift Keying

Lecture 30 - Demodulation of DPSK and M-ary Signals

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[Lecture 31 - Performance of M'ary Digital Modulations](#)

[Lecture 32 - Performance of M'ary Digital Modulations \(Continued...\)](#)

[Lecture 33 - Introduction to Information Theory, Part-1](#)

[Lecture 34 - Source Coding](#)

[Lecture 35 - Error Free Communication Over a Noisy Channel](#)

[Lecture 36 - The Concept of Channel Capacity](#)

[Lecture 37 - Error Correcting Codes](#)

[Lecture 38 - Error Correcting Codes \(Continued...\)](#)

**NPTEL : Introduction To Electronic Circuits (Electrical Engineering)**

**Co-ordinators : Prof. S.C. Dutta Roy**

- Lecture 1 - Introduction to the Course and Basic Electrical Quantity
- Lecture 2 - R.L.C. Components, Energy Considerations, Sources and Circuit Laws
- Lecture 3 - KCL, KVL and Network Analysis
- Lecture 4 - Networks Theorems ( Thevenin's Norton's )
- Lecture 5 - Source Transformation; Super Position Theorem and Non-Linear One-Ports
- Lecture 6 - Signal Wave Forms
- Lecture 7 - Periodic Wave Forms and Elements of Amplifiers
- Lecture 8 - Operational Amplifiers and Diodes
- Lecture 9 - Rectifiers and Power Supplies
- Lecture 10 - Wave Shaping Circuits
- Lecture 11 - More on Wave Shaping Circuits and Introduction to Natural Response of Circuits
- Lecture 12 - Natural Response (Continued...)
- Lecture 13 - Natural Response of 2nd Order Circuit
- Lecture 14 - Natural Response of 2nd Order Circuit (Continued...)
- Lecture 15 - Impedance Functions, Poles, Zeros and their Applications
- Lecture 16 - Natural Response and Poles and Zeros and Introduction to Forced Response
- Lecture 17 - Phasors and their Applications in AC Ckts, analysis
- Lecture 18 - More About Phasors and Introduction to Complete Response
- Lecture 19 - Complete Response of Electrical Circuits
- Lecture 20 - AC Circuit Analysis
- Lecture 21 - Filter Circuits and Resonance
- Lecture 22 - Resonance (Continued...)
- Lecture 23 - General Network Analysis
- Lecture 24 - Two-Port Networks
- Lecture 25 - Semiconductor Physics
- Lecture 26 - Semiconductor Physics (Continued...)
- Lecture 27 - More About Diodes Including Zener Diodes
- Lecture 28 - Bipolar Junction Transistors
- Lecture 29 - Transistors Characteristics and Biasing
- Lecture 30 - BJT Biasing and Introduction to Power Amplifiers
- Lecture 31 - BJT Power Amplifiers

[Lecture 32 - Power Amplifier](#)

[Lecture 33 - Power Amplifiers \(Continued...\) and an Introduction to Small Signal Modelling of BJT](#)

[Lecture 34 - Small Signal Model and Small Signal Amplifiers](#)

[Lecture 35 - Small Signal Amplifiers \(Continued...\)](#)

[Lecture 36 - Small Signal Amplifier \(Continued...\)](#)

[Lecture 37 - Small Signal Amplifiers \(Continued...\)](#)

[Lecture 38 - Negative Feedback](#)

[Lecture 39 - Digital Circuits](#)

[Lecture 40 - Digital Circuits \(Continued...\)](#)

Lecture 1 - Introduction to Analog Circuits Introduction to the Diode

Lecture 2 - Diodes, Introduction to The Transistor

Lecture 3 - MOS Device, Characteristics

Lecture 4 - DC operating point

Lecture 5 - DC operating point, amplifier design

Lecture 6 - Common source amplifier, small signal analysis

Lecture 7 - Common gate, common drain

Lecture 8 - Common gate circuit

Lecture 9 - Source degenerated amplifier

Lecture 10 - Swing limits

Lecture 11 - Swing limits (Continued...), multi transistor amplifiers

Lecture 12 - Multi-transistor amplifiers

Lecture 13 - Introduction to current sources

Lecture 14 - Current sources/mirrors (Continued...)

Lecture 15 - Current sources, biasing

Lecture 16 - Differential circuits

Lecture 17 - Differential amplifiers-I

Lecture 18 - Differential amplifiers-II

Lecture 19 - Differential amplifiers-III

Lecture 20 - Self biased active load diff. amp

Lecture 21 - Diff. Cascode amplifier, two stage amplifiers

Lecture 22 - Two stage diff. amps, op-amps

Lecture 23 - Op-amps, OTAs

Lecture 24 - Circuits with op-amps

Lecture 25 - Capacitance in MOS devices

Lecture 26 - Common source, drain, gate-revisited

Lecture 27 - Common gate, common drain with capacitances

Lecture 28 - Cascode, cascade-revisit with capacitance

Lecture 29 - Cascade amplifier (with capacitance)

Lecture 30 - Diversion: 2-pole systems phase margin

Lecture 31 - Diversion Continued: Two Pole Systems



[Lecture 32 - Compensation](#)

[Lecture 33 - Op-amp Design with Compensation](#)

[Lecture 34 - Unity Gain Bandwidth](#)

[Lecture 35 - Power Amplification](#)

[Lecture 36 - Power Amplifiers-2](#)

[Lecture 37 - Power Amplifiers- Class A,B,AB,C ClassD](#)

[Lecture 38 - Class D Amplifiers, Push-pull Amplifiers](#)

[Lecture 39 - Introduction to Voltage Regulators](#)

[Lecture 40 - Voltage Regulators- line, load; Conclusion Regulation](#)

[Lecture 1 - Introduction](#)

[Lecture 2 - Preliminaries](#)

[Lecture 3 - Model Reference Adaptive Control - Part 1](#)

[Lecture 4 - Model Reference Adaptive Control - Part 2](#)

[Lecture 5 - Model Reference Adaptive Control - Part 3](#)

[Lecture 6 - Adaptive Command Tracking](#)

[Lecture 7 - Robust Model Reference Adaptive Control - Part 1](#)

[Lecture 8 - Robust Model Reference Adaptive Control - Part 2](#)

[Lecture 9 - Robust Model Reference Adaptive Control - Part 3](#)

[Lecture 10 - Robust Model Reference Adaptive Control - Part 4](#)

Lecture 1 - Introduction to Information Theory

Lecture 2 - Entropy, Mutual Information, Conditional and Joint Entropy

Lecture 3 - Measures for Continuous, Random Variable, Relative Entropy

Lecture 4 - Variable Length Codes, Prefix Codes

Lecture 5 - Source Coding Theorem

Lecture 6 - various source coding Techniques: Huffman, Arithmetic, Lempel Ziv, Run Length

Lecture 7 - Optimum Quantizer, Practical Application of Source Coding: JPEG Compression

Lecture 8 - Introduction to Super Information

Lecture 9 - Channel Models and Channel Capacity

Lecture 10 - Noisy Channel Coding Theorem

Lecture 11 - Gaussian Channel and Information Capacity Theorem

Lecture 12 - Capacity of MIMO Channels

Lecture 13 - Introduction to Error Control Coding

Lecture 14 - Introduction to Galois Field

Lecture 15 - Equivalent Codes, Generator Matrix and Parity Check Matrix

Lecture 16 - Systematic Codes, Error Detections and Correction

Lecture 17 - Erasure and Errors, Standard Array and Syndrome Decoding

Lecture 18 - Probability of Error, Coding Gain and Hamming Bound

Lecture 19 - Hamming Codes, LDPC Codes and MDS Codes

Lecture 20 - Introduction to Cyclic Codes

Lecture 21 - Generator Polynomial, Syndrome Polynomial and Matrix Representation

Lecture 22 - Fire Code, Golay Code, CRC Codes and Circuit Implementation of Cyclic Codes

Lecture 23 - Introduction to BCH Codes: Generator Polynomials

Lecture 24 - Multiple Error Correcting BCH Codes, Decoding of BCH Codes

Lecture 25 - Introduction to Reed Solomon (RS) Codes

Lecture 26 - Introduction to Convolutional Codes

Lecture 27 - Trellis Codes: Generator Polynomial Matrix and Encoding using Trellis

Lecture 28 - Vitrebi Decoding and Known good Convolutional Codes

Lecture 29 - Introduction to Turbo Codes

Lecture 30 - Introduction to Trellis Coded Modulation (TCM)

Lecture 31 - Ungerboeck's Design Rules and Performance Evaluation of TCM Schemes

[Lecture 32 - TCM for Fading Channel and Space Time Trellis Codes \(STTC\)](#)

[Lecture 33 - Introduction to Space Time Block Codes \(STBC\)](#)

[Lecture 34 - Space Time Codes](#)

[Lecture 35 - Space Time Codes \(Continued...\)](#)

[Lecture 36 - Introduction to Cryptography: Symmetric key and Asymmetric Key Cryptography](#)

[Lecture 37 - Some Well-Known Algorithms: DES, IDEA, PGP, DH Protocol](#)

[Lecture 38 - Introduction to Physical Layer Security: Notion of Secrecy Capacity](#)

[Lecture 39 - Secrecy Outage Capacity, Secrecy Outage Probability, Cooperative Jamming](#)

Lecture 1 - Introduction

Lecture 2 - Transmission Lines : Wave Propagation

Lecture 3 - Transmission Lines : Reflection,Transmission; Travelling Waves

Lecture 4 - Transmission Lines : Travelling Waves (Continued...); Sinusoidal Signals; Impedance Transformation

Lecture 5 - Transmission Lines : Standing Wave Ratio:Measurement of Impedance

Lecture 6 - Transmission Lines : General Transmission Lines Equations,Low loss,Transmission Lines,Transmission Lines as Circuit Elements

Lecture 7 - Transmission Lines : Section as Circuit Elements

Lecture 8 - Transmission Lines : Velocities of Propagation, Transmission Lines Charts

Lecture 9 - Transmission Lines : Smith Chart

Lecture 10 - Transmission Lines : Impedance Matching using Stub-Lines

Lecture 11 - Transmission Lines : Transmission Lines Parameters; (primary Constants)

Lecture 12 - Wave Propagation

Lecture 13 - Wave Propagation (Continued...)

Lecture 14 - Wave Propagation : Polarisation,Poynting Vector

Lecture 15 - Wave Propagation : Power Flow,Complex Poynting vector,wave equation for a conducting Medium

Lecture 16 - Wave Propagation : Conducting Medium;Conductors and Dielectrics Depth of Penetration;Surface Impedance

Lecture 17 - Wave Propagation : Surface Impedance; Power Loss in a Conductor Reflection at a Perfect conductor (Normal Inc.)

Lecture 18 - Reflection and Refraction of waves : Reflection at the Surface of a Conducting Medium,Reflection at a Perfect Conductor (Oblique Inc.)

Lecture 19 - Reflection and Refraction of waves (Continued...)

Lecture 20 - Reflection and Refraction of waves (Continued...) - 1

Lecture 21 - Reflection and Refraction of waves (Continued...); The Plane slab

Lecture 22 - Reflection and Refraction of waves (Continued...); Transmission Line Analogy for Planes Waves

Lecture 23 - Wave Guides

Lecture 24 - Wave Guides (Continued...) Parallel plane Guide,Transverse Electric Waves,Field Distribution,Superposition of Plane Waves

Lecture 25 - Wave Guides (Continued...)

Lecture 26 - Wave Guides (Continued...) Parallel plane Guide,Characteristics of TE and Tm Waves,TEM Waves,Wave Impedances

Lecture 27 - Wave Guides (Continued...) - 1

Lecture 28 - Wave Guides (Continued...) - 2

Lecture 29 - Wave Guides (Continued...) Rectangular Wave Guides

[Lecture 30 - Wave Guides \(Continued...\)](#)

[Lecture 31 - Wave Guides \(Continued...\) Rectangular Wave Guides - 1](#)

[Lecture 32 - Resonators General Properties](#)

[Lecture 33 - Resonators \(Continued...\) Transmission Line Resonators](#)

[Lecture 34 - Resonators \(Continued...\) Wave Guide Resonators](#)

[Lecture 35 - Radiation](#)

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

[Lecture 37 - Radiation \(Continued...\) - 1](#)

[Lecture 38 - Radiation \(Continued...\) - 2](#)

[Lecture 39 - Radiation \(Continued...\) Monopole Antennas half Wave Dipole Antenna](#)

[Lecture 40 - Radiation \(Continued...\)](#)

[Lecture 41 - Radiation \(Continued...\) 2 - Element Arrays, Yagi-Uda Array](#)

Lecture 1 - Introduction

Lecture 2 - Signal Spaces : Waveforms and Vector Spaces

Lecture 3 - Inner Product and Orthogonal Expansion

Lecture 4 - Signal Spaces : Gram Schmidt Orthogonalization and Receiver Structures

Lecture 5 - Signal Spaces : Fourier Series and Related expansions

Lecture 6 - Signal Spaces : Bandwidth and Degree of Freedom

Lecture 7 - Random Variables and Random Processes : Discrete Random Variable

Lecture 8 - Random Variables and Random Processes : Continuous Random Variable

Lecture 9 - Random Variables and Random Processes : Multiple Random Variable

Lecture 10 - Random Variables and Random Processes : Random Vectors

Lecture 11 - Random Variables and Random Processes : Introduction to Random Process

Lecture 12 - Random Variables and Random Processes : Properties of Random Process

Lecture 13 - Random Variables and Random Processes : Gaussian Random Process - Part 1

Lecture 14 - Random Variables and Random Processes : Gaussian Random Process - Part 2

Lecture 15 - Random Variables and Random Processes : Types of Random Process

Lecture 16 - Random Variables and Random Processes : Random Process through an LTI system

Lecture 17 - Random Variables and Random Processes : Spectral description of Random Process

Lecture 18 - Waveform Coding

Lecture 19 - Modulation : Complex Baseband Representation of Passband Signals - Part 1

Lecture 20 - Modulation : Complex Baseband Representation of Passband Signals - Part 2

Lecture 21 - Modulation : Complex Baseband Representation of Passband Signals - Part 3

Lecture 22 - Modulation : Spectral Description of Sources - Part 1

Lecture 23 - Modulation : Spectral Description of Sources - Part 2

Lecture 24 - Modulation : Spectral Description of Sources using Markov Chains and Cyclostationary Random Processes

Lecture 25 - Modulation : Nyquist Pulses

Lecture 26 - Modulation : Pulse Amplitude Modulation and Quadrature Amplitude Modulation - Part 1

Lecture 27 - Modulation : Pulse Amplitude Modulation and Quadrature Amplitude Modulation - Part 2

Lecture 28 - Modulation : Orthogonal Modulation Schemes

Lecture 29 - Modulation : Differential Modulation Schemes

Lecture 30 - Detection : Maximum A posteriori Probability (MAP) Detector and Maximum Likelihood (ML) Detector

Lecture 31 - Detection : Vector Detection

[Lecture 32 - Detection : Theorem of Irrelevance and Waveform Detection](#)

[Lecture 33 - Detection : Sequence Detection](#)

[Lecture 34 - Detection : Performance of Binary Signalling Schemes](#)

[Lecture 35 - Detection : Performance of M-ary Signaling Schemes](#)

[Lecture 36 - Detection : Performance of Orthogonal Modulation Schemes and Bit-Level Demodulation](#)

[Lecture 37 - Detection : Performance of Non-Coherent Systems Systems](#)

[Lecture 38 - Detection : Fading Channel](#)



Lecture 1 - Intro EV Historical\_Background

Lecture 2 - Intro EV Benefits of Using Evs

Lecture 3 - Intro EV Overview of types of Evs and its Challenges

Lecture 4 - Intro EV Motor Drive Technologies

Lecture 5 - Intro EV Energy Source Technologies

Lecture 6 - Intro EV Battery Charging Technologies

Lecture 7 - Intro EV Vehicle to Grid

Lecture 8 - Intro EV Subsystems and Configurations

Lecture 9 - Intro HEV Subsystems and Configurations

Lecture 10 - Intro HEV Subsystems and Modes of Operation

Lecture 11 - Vehicle\_Dynamics\_intro\_and\_tractive\_effort

Lecture 12 - Vehicle\_Dynamics\_and\_dynamic\_equation

Lecture 13 - Vehicle Dynamics simulation dynamic equation constant  $F_t$

Lecture 14 - Vehicle Dynamics dynamic equation variable  $F_t$

Lecture 15 - Vehicle Dynamics simulation dynamic equation variable  $F_t$

Lecture 16 - Vehicle Dynamics Modelling and simulation in Simulink

Lecture 17 - Summary Electric Vehicles Part 1 Course

- Lecture 1 - Introduction to Power Electronics
- Lecture 2 - Power Devices: Diodes and SCR
- Lecture 3 - Power Devices: SCR, Triac, GTO and BJT
- Lecture 4 - Power Devices: BJT, MOSFET and IGBT
- Lecture 5 - Single-phase Uncontrolled Rectifiers
- Lecture 6 - Single-phase Controlled Rectifiers - I
- Lecture 7 - Single-phase Controlled Rectifiers - II
- Lecture 8 - Three Phase Rectifiers - I
- Lecture 9 - Numericals on devices and Single-phase Rectifiers
- Lecture 10 - Three Phase Rectifiers - II
- Lecture 11 - Dual Converter and Communication Overlap
- Lecture 12 - Communication Overlap - II and AC-AC Converter-Introduction
- Lecture 13 - Single-Phase and Three-Phase AC Voltage Controllers
- Lecture 14 - Three-Phase AC Voltage Controllers and Cycloconverters
- Lecture 15 - Non-Isolated DC-DC Converters - I
- Lecture 16 - Non-Isolated DC-DC Converters - II
- Lecture 17 - Isolated DC-DC Converters - I
- Lecture 18 - Isolated DC-DC Converters - II and Cuk Converters
- Lecture 19 - Voltage Source Inverters
- Lecture 20 - VSI PWM Techniques - I
- Lecture 21 - VSI PWM Techniques - II
- Lecture 22 - SPWM and SVM Technique
- Lecture 23 - Current Source Inverter
- Lecture 24 - Power Electronics Applications

Lecture 1 - Introduction to Electrical Machines - I

Lecture 2 - Single-phase and Three-phase AC Circuits, Magnetic circuits

Lecture 3 - Magnetic Circuit - II

Lecture 4 - Magnetic Circuit - III

Lecture 5 - Transformers - Introduction

Lecture 6 - Transformers - Amp-Turn Balance, Ideal and practical transformers

Lecture 7 - Transformer Equivalent circuit and Reducing leakage

Lecture 8 - Transformer equivalent circuit parameter determination

Lecture 9 - Transformers - Voltage regulation and efficiency

Lecture 10 - Auto-transformers

Lecture 11 - PU notation and Introduction to Instrument transformers

Lecture 12 - Instrument Transformers and All Day Efficiency

Lecture 13 - Three Phase Transformers - I

Lecture 14 - Three Phase Transformers - II

Lecture 15 - Electromechanical Energy Conversion - I

Lecture 16 - Electromechanical Energy Conversion - II

Lecture 17 - Electromechanical Energy Conversion - III

Lecture 18 - DC Machines-Introduction, Constructional Features

Lecture 19 - DC Machines - EMF and Torque Equations and Generator Operation

Lecture 20 - DC Machines - OCC and Load Characteristics Classification

Lecture 21 - DC Machines - Armature Reaction

Lecture 22 - DC Machines - Voltage Build-up and Load Characteristics

Lecture 23 - DC Generator Characteristics and Introduction to DC Motors

Lecture 24 - DC Motors: Basics and Speed-Torque Relationship

Lecture 25 - DC Motor: Speed Control (Shunt and Separately Excited Motor)

Lecture 26 - DC Motor: Speed Control (Series and Compound Motor)

Lecture 27 - DC Machine: Starting and Braking

Lecture 28 - DC Machine: Commutation

Lecture 29 - 3 Phase Induction Machine: Constructional Features and Principle of Operation

Lecture 30 - 3 Phase Induction Machine: Equivalent Circuit

Lecture 31 - 3 Phase Induction Machine: Speed Torque Characteristics

[Lecture 32 - Testing of Induction Motor: OC and SC Test](#)

[Lecture 33 - 3 Phase Induction Machine: Starting Methods](#)

[Lecture 34 - Synchronous Machines: Introduction](#)

[Lecture 35 - Synchronous Machines: Constructional Features](#)

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[Lecture 37 - Synchronization of Alternators](#)

[Lecture 38 - Synchronous Machines: Equivalent Circuit and Phasor Diagram](#)

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[Lecture 40 - Synchronous Machines: Power Angle Relationship, V and Inverted V Curves](#)

[Lecture 41 - Single Phase Induction Motors](#)

Lecture 1 - Special Electromechanical Systems (Introduction)

Lecture 2 - Classification of Machines

Lecture 3 - Single and Two-Phase Motors

Lecture 4 - Single-Phase Induction Motors-Analysis

Lecture 5 - Starting of Single-Phase Induction Motors

Lecture 6 - Single-Phase Induction Motors Analysis

Lecture 7 - Induction Motors Analysis by Symmetrical Components

Lecture 8 - Modelling of 1-Phase Induction Motor (One and Two Windings)

Lecture 9 - Asymmetrical Induction Motor Generalized Rotating Field Theory

Lecture 10 - Generalized Rotating Field Theory (Continued...)

Lecture 11 - Generalized Rotating Field Theory (Continued...)

Lecture 12 - Generalized Rotating Field Theory (Continued...)

Lecture 13 - Analysis of Asymmetrical Machine by Generalized Rotating Field Theory

Lecture 14 - Analysis of Asymmetrical Machine

Lecture 15 - Analysis of Asymmetrical Induction Machine

Lecture 16 - Generalised Rotating-Field Theory of Wound Rotor Ind. Machine Having Asymmetry in Stator and Rotor Windings

Lecture 17 - Generalised Rotating-Field Theory of Wound Rotor Ind. Machine Having Asymmetry in Stator and Rotor Windings (Continued...)

Lecture 18 - Testing of Small Electrical Machines

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Lecture 20 - Variable Reluctance (VR) Motors

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- Lecture 2 - High-level Synthesis (HLS) flow with an example
- Lecture 3 - Automation of High-level Synthesis Steps
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**Co-ordinators : Dr. S.P. Das**

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**Co-ordinators : Dr. S.N. Singh**

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Lecture 53 - Trellis Representation of Convolutional Code and Valid Code Words

Lecture 54 - Decoding of the Convolutional Code, Minimum Hamming distance and Maximum Likelihood Codeword Estimate

Lecture 55 - Principle of Decoding of Convolutional code

Lecture 56 - Viterbi Decoder for Maximum Likelihood Decoding of Convolutional Code Using Trellis Representation, Branch Metric Calculation, State Metric Calculation and Example



- Lecture 1 - Introduction to Applied Electromagnetics
- Lecture 2 - Introduction to Transmission lines
- Lecture 3 - Sinusoidal waves on Transmission lines
- Lecture 4 - Terminating T-lines: Reflection and Transmission coefficient
- Lecture 5 - Circuit parameters of a T-line
- Lecture 6 - Lossy Transmission lines and primary constants
- Lecture 7 - When to apply T-line Theory?
- Lecture 8 - Standing Waves on T-lines
- Lecture 9 - Lumped equivalent circuits of T-lines
- Lecture 10 - Impedance transformation and power flow on T-lines
- Lecture 11 - Graphical aid: Smith Chart Derivation
- Lecture 12 - Smith chart applications
- Lecture 13 - Further applications of Smith chart - Part 1
- Lecture 14 - Further applications of Smith chart - Part 2
- Lecture 15 - Impedance matching techniques - Part 1
- Lecture 16 - Impedance matching techniques - Part 2
- Lecture 17 - Impedance matching techniques - Part 3
- Lecture 18 - T-lines in time domain: Lattice diagrams
- Lecture 19 - Further examples of use of lattice diagrams
- Lecture 20 - High-speed digital signal propagation on T-lines
- Lecture 21 - Transient analysis with reactive termination and Time-domain reflectometry
- Lecture 22 - Fault detection using TDR
- Lecture 23 - Why Electromagnetics?
- Lecture 24 - Rectangular coordinate systems
- Lecture 25 - Cylindrical coordinate systems
- Lecture 26 - Review of vector fields and Gradient
- Lecture 27 - Divergence, Curl, and Laplacian operations
- Lecture 28 - Towards Maxwells equations - Part 1
- Lecture 29 - Towards Maxwells equations - Part 2
- Lecture 30 - Faradays law
- Lecture 31 - Completing Maxwells equations and Boundary conditions

- Lecture 32 - Boundary conditions for Electromagnetic fields
- Lecture 33 - Electrostatics-I: Laplace and Poissons equations
- Lecture 34 - Electrostatics-II: Solving Laplaces equation in 1D
- Lecture 35 - Electrostatics-III: Solving Laplaces equation in 2D
- Lecture 36 - Electrostatics-IV: Finite Difference method for solving Laplaces equation
- Lecture 37 - Magnetostatic fields-I: Biot-Savart Law
- Lecture 38 - Magnetostatic fields-II: Calculation of magnetic fields
- Lecture 39 - Inductance calculations
- Lecture 40 - From Maxwells equations to uniform plane waves
- Lecture 41 - Plane wave propagation in lossless dielectric media
- Lecture 42 - Polarization of plane waves
- Lecture 43 - Can an Ideal capacitor exist?
- Lecture 44 - Skin effect in conductors
- Lecture 45 - Skin effect in round wires
- Lecture 46 - Finite difference method
- Lecture 47 - Reflection of uniform plane waves
- Lecture 48 - Application: Reflection from multiple media and anti-reflection coating.
- Lecture 49 - Oblique incidence of plane waves
- Lecture 50 - Total internal reflection
- Lecture 51 - Application: Matrix analysis of reflection from multiple boundaries
- Lecture 52 - Application: Fabry-Perot cavity and Multi-layer films
- Lecture 53 - Introduction to waveguides
- Lecture 54 - Rectangular waveguides
- Lecture 55 - Attenuation and Dispersion in rectangular waveguides
- Lecture 56 - Planar optical waveguides
- Lecture 57 - Application: Optical Fibers
- Lecture 58 - Application: WDM Optical Components
- Lecture 59 - Mach-Zehnder Modulator
- Lecture 60 - Wave Propagation in Anisotropic Medium
- Lecture 61 - Wave Propagation in Ferrites
- Lecture 62 - Magnetic Vector Potential - Part 1
- Lecture 63 - Magnetic Vector Potential - Part 2
- Lecture 64 - Fields of a Dipole Antenna

[Lecture 65 - Antenna Parameters and Long wire Antenna](#)

[Lecture 66 - Friis Transmission Formula](#)

Lecture 1 - Principles of Signals and Systems- Introduction to Signals and Systems, Signal Classification - Continuous and Discrete Time Signals

Lecture 2 - Analog and Digital Signals

Lecture 3 - Energy and Power Signals

Lecture 4 - Real Exponential Signals

Lecture 5 - Memory/Memory-less and Causal/Non-Causal Systems

Lecture 6 - Properties of Linear Systems

Lecture 7 - Example Problems - 1

Lecture 8 - Example Problems - 2

Lecture 9 - Example Problems - 3

Lecture 10 - Properties and Analysis of LTI Systems - I

Lecture 11 - Properties and Analysis of LTI Systems - II

Lecture 12 - Properties and Analysis of LTI Systems - III

Lecture 13 - Properties of Discrete Time LTI Systems

Lecture 14 - Example Problems LTI Systems - I

Lecture 15 - Example Problems LTI Systems - II

Lecture 16 - Example Problems DT-LTI Systems

Lecture 17 - Laplace Transform

Lecture 18 - Laplace Transform Properties - I

Lecture 19 - Laplace Transform Properties - II

Lecture 20 - Laplace Transform of LTI Systems

Lecture 21 - Laplace Transform Example Problems - I

Lecture 22 - Laplace Transform Example Problems - II

Lecture 23 - Laplace Transform of RL, RC Circuit

Lecture 24 - Z-Transform

Lecture 25 - Z-Transform Properties - I

Lecture 26 - Z-Transform Properties - II

Lecture 27 - Z-Transform of LTI Systems

Lecture 28 - Z-Transform Examples - I

Lecture 29 - Z-Transform Examples - II

Lecture 30 - Z-Transform Examples - III

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Lecture 31 - Z-Transform Examples - IV

Lecture 32 - Inverse Z-Transform

Lecture 33 - Fourier Analysis Introduction

Lecture 34 - Complex Exponential and Trigonometric FS

Lecture 35 - Conditions for Existence of FS

Lecture 36 - Fourier Transform (FT) Introduction

Lecture 37 - Properties of Fourier Transform - I

Lecture 38 - Properties of Fourier Transform - II

Lecture 39 - Fourier Transform - Parseval's Relation

Lecture 40 - Fourier Transform of LTI Systems

Lecture 41 - FT- Ideal and Non-Ideal Filters

Lecture 42 - Fourier Analysis Examples - I

Lecture 43 - Fourier Analysis Examples - II

Lecture 44 - Fourier Analysis Examples - III

Lecture 45 - Fourier Analysis Examples - IV

Lecture 46 - Fourier Analysis Examples - V

Lecture 47 - Fourier Analysis Examples - VI

Lecture 48 - Fourier Analysis Bode Plot - I

Lecture 49 - Fourier Analysis Bode Plot - II

Lecture 50 - Fourier Transform Examples: Filtering - Ideal Low Pass Filter

Lecture 51 - Fourier Transform Problems: Unit Step Response of RC Circuit, Sampling of Continuous Signal

Lecture 52 - Sampling: Spectrum of Sampled Signal, Nyquist Criterion

Lecture 53 - Sampling: Reconstruction from Sampled Signal

Lecture 54 - Fourier Analysis of Discrete Time Signals and Systems - Introduction

Lecture 55 - Fourier Analysis of Discrete Time Signals - Duality, Parseval's Theorem

Lecture 56 - Discrete Time Fourier Transform: Definition, Inverse DTFT, Convergence, Relation between DTFT and z-Transform, DTFT of Common Signals

Lecture 57 - Discrete Time Fourier Transform: Properties of DTFT - Linearity, Time Shifting, Frequency Shifting, Conjugation, Time-Reversal, Duality

Lecture 58 - Discrete Time Fourier Transform: Properties of DTFT - Differentiation in Frequency, Difference in Time, Convolution, Multiplication, Parseval's Relation

Lecture 59 - DTFT: Discrete Time LTI Systems - LTI Systems Characterized by Difference Equations

Lecture 60 - Discrete Fourier Transform - Definition, Inverse DFT, Relation between DFT and DFS, Relation between DFT and DTFT, Properties - Linearity, Time Shifting

Lecture 61 - Discrete Fourier Transform: Properties - Conjugation, Frequency Shift, Duality, Circular Convolution, Multiplication, Parseval's Relation, Example Problems for Fourier Analysis of Discrete Time Signals

**HTML Links for 108,400+ NPTEL Video Lectures, Created by LinuXpert Systems, Chennai**

[Lecture 62 - Example Problems: DFS Analysis of Discrete Time Signals, Problems on DTFT](#)

[Lecture 63 - Example Problems: DTFT of Cosine, Unit Step Signals](#)

[Lecture 64 - DTFT Example Problems - III](#)

[Lecture 65 - DTFT Example Problems - IV](#)

[Lecture 66 - DTFT Example Problems - V](#)

[Lecture 67 - DFT Example Problems - I](#)

[Lecture 68 - Example Problems: DFT, IDFT in Matrix form](#)

[Lecture 69 - Group/Phase Delay - Part I](#)

[Lecture 70 - Group/Phase Delay - Part II](#)

[Lecture 71 - IIR Filter Structures: DF-I, DF-II](#)

[Lecture 72 - IIR Filter Structures: Transpose Form](#)

[Lecture 73 - IIR Filter Structures: Example](#)

[Lecture 74 - IIR Filter Structures: Cascade Form](#)

[Lecture 75 - IIR Filter: Parallel Form-I and II](#)

- Lecture 1 - Vectors and Matrices - Linear Independence and Rank
- Lecture 2 - Eigenvectors and Eigenvalues of Matrices and their Properties
- Lecture 3 - Positive Semidefinite (PSD) and Positive Definite (PD) Matrices and their Properties
- Lecture 4 - Inner Product Space and its Properties: Linearity, Symmetry and Positive Semi-definite
- Lecture 5 - Inner Product Space and its Properties: Cauchy Schwarz Inequality
- Lecture 6 - Properties of Norm, Gaussian Elimination and Echelon form of matrix
- Lecture 7 - Gram Schmidt Orthogonalization Procedure
- Lecture 8 - Null Space and Trace of Matrices
- Lecture 9 - Eigenvalue Decomposition of Hermitian Matrices and Properties
- Lecture 10 - Matrix Inversion Lemma (Woodbury identity)
- Lecture 11 - Introduction to Convex Sets and Properties
- Lecture 12 - Affine Set Examples and Application
- Lecture 13 - Norm Ball and its Practical Applications
- Lecture 14 - Ellipsoid and its Practical Applications
- Lecture 15 - Norm Cone, Polyhedron and its Applications
- Lecture 16 - Applications: Cooperative Cellular Transmission
- Lecture 17 - Positive Semi Definite Cone And Positive Semi Definite (PSD) Matrices
- Lecture 18 - Introduction to Affine functions and examples
- Lecture 19 - norm balls and Matrix properties: Trace, Determinant
- Lecture 20 - Inverse of a Positive Definite Matrix
- Lecture 21 - Example Problems: Property of Norms, Problems on Convex Sets
- Lecture 22 - Problems on Convex Sets (Continued...)
- Lecture 23 - Introduction to Convex and Concave Functions
- Lecture 24 - Properties of Convex Functions with examples
- Lecture 25 - Test for Convexity: Positive Semidefinite Hessian Matrix
- Lecture 26 - Application: MIMO Receiver Design as a Least Squares Problem
- Lecture 27 - Jensen's Inequality and Practical Application
- Lecture 28 - Jensen's Inequality application
- Lecture 29 - Properties of Convex Functions
- Lecture 30 - Conjugate Function and Examples to prove Convexity of various Functions
- Lecture 31 - Examples on Operations Preserving Convexity

Lecture 32 - Examples on Test for Convexity, Quasi-Convexity

Lecture 33 - Examples on Convex Functions

Lecture 34 - Practical Application: Beamforming in Multi-antenna Wireless Communication

Lecture 35 - Practical Application: Maximal Ratio Combiner for Wireless Systems

Lecture 36 - Practical Application: Multi-antenna Beamforming with Interfering User

Lecture 37 - Practical Application: Zero-Forcing (ZF) Beamforming with Interfering User

Lecture 38 - Practical Application: Robust Beamforming With Channel Uncertainty for Wireless Systems

Lecture 39 - Practical Application: Robust Beamformer Design for Wireless Systems

Lecture 40 - Practical Application: Detailed Solution for Robust Beamformer Computation in Wireless Systems Text

Lecture 41 - Linear modeling and Approximation Problems: Least Squares

Lecture 42 - Geometric Intuition for Least Squares

Lecture 43 - Practical Application: Multi antenna channel estimation

Lecture 44 - Practical Application: Image deblurring

Lecture 45 - Least Norm Signal Estimation

Lecture 46 - Regularization: Least Squares + Least Norm

Lecture 47 - Convex Optimization Problem representation: Canonical form, Epigraph form

Lecture 48 - Linear Program Practical Application: Base Station Co-operation

Lecture 49 - Stochastic Linear Program, Gaussian Uncertainty

Lecture 50 - Practical Application: Multiple Input Multiple Output (MIMO) Beamforming

Lecture 51 - Practical Application: Multiple Input Multiple Output (MIMO) Beamformer Design

Lecture 52 - Practical Application: Co-operative Communication, Overview and various Protocols used

Lecture 53 - Practical Application: Probability of Error Computation for Co-operative Communication

Lecture 54 - Practical Application: Optimal power allocation factor determination for Co-operative Communication

Lecture 55 - Practical Application: Compressive Sensing

Lecture 56 - Practical Application

Lecture 57 - Practical Application- Orthogonal Matching Pursuit (OMP) algorithm for Compressive Sensing

Lecture 58 - Example Problem: Orthogonal Matching Pursuit (OMP) algorithm

Lecture 59 - Practical Application : L1 norm minimization and regularization approach for Compressive Sensing Optimization problem

Lecture 60 - Practical Application of Machine Learning and Artificial Intelligence: Linear Classification, Overview and Motivation

Lecture 61 - Practical Application: Linear Classifier (Support Vector Machine) Design

Lecture 62 - Practical Application: Approximate Classifier Design

Lecture 63 - Concept of Duality

Lecture 64 - Relation between optimal value of Primal and Dual Problems, concepts of Duality gap and Strong Duality



[Lecture 65 - Example problem on Strong Duality](#)

[Lecture 66 - Karush-Kuhn-Tucker \(KKT\) conditions](#)

[Lecture 67 - Application of KKT condition:Optimal MIMO power allocation \(Waterfilling\)](#)

[Lecture 68 - Optimal MIMO Power allocation \(Waterfilling\)-II](#)

[Lecture 69 - Example problem on Optimal MIMO Power allocation \(Waterfilling\)](#)

[Lecture 70 - Linear objective with box constraints, Linear Programming](#)

[Lecture 71 - Example Problems II](#)

[Lecture 72 - Examples on Quadratic Optimization](#)

[Lecture 73 - Examples on Duality: Dual Norm, Dual of Linear Program \(LP\)](#)

[Lecture 74 - Examples on Duality: Min-Max problem, Analytic Centering](#)

[Lecture 75 - Semi Definite Program \(SDP\) and its application:MIMO symbol vector decoding](#)

[Lecture 76 - Application:SDP for MIMO Maximum Likelihood \(ML\) Detection](#)

[Lecture 77 - Introduction to big Data: Online Recommender System \(Netflix\)](#)

[Lecture 78 - Matrix Completion Problem in Big Data: Netflix-I](#)

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Lecture 1 - Overview of fiber-optic communication systems

Lecture 2 - Review of Maxwell's equations

Lecture 3 - Uniform plane waves (UWPs) in free-space

Lecture 4 - Properties of UWPs (propagation constant, polarization, and Poynting vector)

Lecture 5 - Boundary conditions and reflection from a PEC

Lecture 6 - Obliquely incident waves-I (TE and TM waves, Snell's laws)

Lecture 7 - Obliquely incident waves-II (Reflection and transmission coefficients, Brewster angle)

Lecture 8 - Total internal reflection

Lecture 9 - Ray theory of dielectric slab waveguides

Lecture 10 - Transverse resonance condition for slab waveguides

Lecture 11 - Introduction to optical fibers

Lecture 12 - Ray theory of light propagation in optical fibers

Lecture 13 - Concept of waveguide modes

Lecture 14 - Systematic procedure to obtain modes of a waveguide

Lecture 15 - Systematic analysis of parallel plate metallic waveguide

Lecture 16 - Systematic analysis of dielectric slab waveguides

Lecture 17 - Further discussion on slab waveguides

Lecture 18 - Modal analysis of step index optical fiber

Lecture 19 - Properties of modes of step-index optical fiber - I

Lecture 20 - Properties of modes of step-index optical fiber - II

Lecture 21 - Linearly polarized modes

Lecture 22 - Attenuation and power loss in fibers

Lecture 23 - Introduction to dispersion in fibers

Lecture 24 - Mathematical modelling of dispersion: Transfer function approach

Lecture 25 - Pulse propagation equation and its solution

Lecture 26 - Pre-chirped pulses and Inter and Intra-modal dispersion in optical fibers

Lecture 27 - Beam Propagation Method

Lecture 28 - Polarization Effects on Pulse Propagation

Lecture 29 - Modes in Optical Fibres and Pulse Propagation in Optical Fibres

Lecture 30 - Graded Index Fibers

Lecture 31 - Light Sources, Detectors and Amplifiers

- Lecture 32 - Basics of Lasers-I (Structure of Lasers, Process of Photon Emission)
- Lecture 33 - Basics of Lasers-II (Einstein's Theory of Radiation)
- Lecture 34 - Basics of Lasers-III (Population Inversion and Rate Equation for Lasers)
- Lecture 35 - Basic Properties of Semiconductor Laser-I (Energy Gap, Intrinsic and Extrinsic Semiconductors)
- Lecture 36 - Basic Properties of Semiconductor Laser-II (Fermi Level)
- Lecture 37 - Optical Properties of Semiconductors-I (Direct Bandgap and Indirect Bandgap, Density of States)
- Lecture 38 - Optical Properties of Semiconductors-II (Gain, Absorption, Recombination rate) Homojunction Lasers
- Lecture 39 - Double Heterostructure Lasers, Introduction to Quantum Well Lasers
- Lecture 40 - Semiconductor Optical Amplifier
- Lecture 41 - Erbium-doped fiber amplifier
- Lecture 42 - Photodetectors
- Lecture 43 - Noise in Photodetectors
- Lecture 44 - Introduction to WDM components
- Lecture 45 - Couplers, Circulators, FRM and Filters
- Lecture 46 - Filter, MUX/DEMUX, Diffraction grating (FBG and Long period grating)
- Lecture 47 - Optical Modulators-I (Current modulation)
- Lecture 48 - Optical Modulators-II (Electro-optic modulators)
- Lecture 49 - Review of Communication Concepts-I (Deterministic and Random Signals, Baseband and Passband Signals)
- Lecture 50 - Review of Communication Concepts-II (Signal and vectors, Signal energy, Orthonormal basis functions)
- Lecture 51 - Intensity modulation/ Direct Detection
- Lecture 52 - BER discussion for OOK systems
- Lecture 53 - Higher order modulation and Coherent Receiver
- Lecture 54 - Coherent receiver for BPSK systems and BER calculation
- Lecture 55 - Recovering Polarization
- Lecture 56 - DSP algorithms for Chromatic dispersion mitigation
- Lecture 57 - DSP algorithms for Carrier phase estimation - I
- Lecture 58 - DSP algorithms for Carrier phase estimation - II
- Lecture 59 - Nonlinear effects in fiber
- Lecture 60 - Four wave mixing, Loss measurement, Dispersion measurement
- Lecture 61 - Lab Demonstration (Laser diode characteristics, Loss measurement, Optical Intensity Modulation)

Lecture 1 - Introduction and Types of Transmission Lines

Lecture 2 - Distributed Circuit Model of Uniform Transmission Line

Lecture 3 - Voltage and Current Equation of the Transmission line

Lecture 4 - Sinusoidal Excitation of Transmission Line (Propagation constant, Characteristic Impedance)

Lecture 5 - Properties of Transmission Line (Reflection Coefficient, Input Impedance, Standing Wave Ratio)

Lecture 6 - Power Calculations and Introduction to Smith Chart

Lecture 7 - Smith Chart

Lecture 8 - Additional Applications of Smith Chart

Lecture 9 - Time domain Analysis of Transmission Line - I

Lecture 10 - Time domain Analysis of Transmission Line - II

Lecture 11 - Usage of Lattice Diagrams

Lecture 12 - TDR analysis of Transmission Lines

Lecture 13 - Introduction to Propagation of Electromagnetic Waves

Lecture 14 - Uniform Plane Waves - I

Lecture 15 - Uniform Plane Waves - II

Lecture 16 - Poynting Vector, Average Power, Polarization

Lecture 17 - Uniform Plane Waves in Lossy Medium

Lecture 18 - Normal Incidence of Plane Waves

Lecture 19 - Oblique Incidence of Plane Waves - I

Lecture 20 - Oblique Incidence of Plane Waves - II

Lecture 21 - Total Internal Reflection

Lecture 22 - Slab Waveguides

Lecture 23 - Optical Fibers

Lecture 24 - Parallel Plate Waveguides

Lecture 25 - Rectangular Waveguides

Lecture 26 - Modes of Rectangular Waveguides

Lecture 27 - Waveguides summary and Introduction to Radiation

Lecture 28 - Solution to Electric Scalar Potential and Magnetic Vector Potential Equations

Lecture 29 - Further discussion on Magnetic Vector Potential and Elementary Hertzian Dipole

Lecture 30 - Near field and Far-field Antenna and Properties of Antennas

Lecture 31 - Linear antenna - I

[Lecture 32 - Linear antenna - II and Properties of Transmitting and Receiving Antenna](#)

[Lecture 33 - Friis Transmission Formula](#)

[Lecture 34 - Antenna Array](#)

[Lecture 35 - Wireless Channel](#)

[Lecture 36 - Further discussion on Wireless Channel Modelling](#)

[Lecture 37 - Diffraction - I](#)

[Lecture 38 - Diffraction - II](#)

[Lecture 39 - Distribution of Laser Beam](#)

[Lecture 40 - Interference \(Double slit experiment, Fabry Perot Interferometer\)](#)

[Lecture 41 - Summary](#)

Lecture 1 - Basic Concepts

Lecture 2 - Sinusoids and Phasors

Lecture 3 - Circuit Elements - Part 1

Lecture 4 - Circuit Elements - Part 2

Lecture 5 - AC Power Analysis

Lecture 6 - RMS Voltage and Current

Lecture 7 - Topology

Lecture 8 - Star-Delta Transformation and Mesh Analysis

Lecture 9 - Mesh Analysis.

Lecture 10 - Nodal Analysis

Lecture 11 - Linearity Property and Superposition Theorem

Lecture 12 - Source Transformation

Lecture 13 - Duality

Lecture 14 - Thevenin's Theorem - 1

Lecture 15 - Thevenin's Theorem - 2

Lecture 16 - Norton's Theorem - 1

Lecture 17 - Norton's Theorem - 2

Lecture 18 - Maximum Power Transfer Theorem - 1

Lecture 19 - Maximum Power Transfer Theorem - 2

Lecture 20 - Reciprocity and Compensation Theorem

Lecture 21 - First Order RC Circuits

Lecture 22 - First Order RL Circuits

Lecture 23 - Singularity Functions

Lecture 24 - Step Response of RC and RL Circuits

Lecture 25 - Second Order Response

Lecture 26 - Step Response of Second Order Circuits-First Order and Second Order Circuits (Continued...)

Lecture 27 - Step Response of Parallel RLC Circuit-First Order and Second Order Circuits (Continued...)

Lecture 28 - Definition of the Laplace Transform

Lecture 29 - Properties of the Laplace Transform

Lecture 30 - Inverse Laplace Transform

Lecture 31 - Laplace Transform of Circuit Elements

[Lecture 32 - Transfer Function](#)

[Lecture 33 - Convolution Integral](#)

[Lecture 34 - Graphical Approach of Convolution Integral](#)

[Lecture 35 - Network Stability and Network Synthesis](#)

[Lecture 36 - Impedance Parameters](#)

[Lecture 37 - Admittance Parameters](#)

[Lecture 38 - Hybrid Parameters](#)

[Lecture 39 - Transmission Parameters](#)

[Lecture 40 - Interconnection of Networks](#)

[Lecture 41 - Nodal and Mesh Analysis](#)

[Lecture 42 - Superposition Theorem and Source Transformation](#)

[Lecture 43 - Thevenin's, Norton's and, Maximum Power Transfer Theorem](#)

[Lecture 44 - Magnetically Coupled Circuits](#)

[Lecture 45 - Energy in Coupled Circuits and Ideal Transformer](#)

[Lecture 46 - Ideal Transformer and Introduction to Three-Phase Circuits](#)

[Lecture 47 - Balanced Three-Phase Connections](#)

[Lecture 48 - Balanced Wye-Delta and Delta-Delta Connections](#)

[Lecture 49 - Balanced Delta-Wye Connection and Power in Balanced Three-Phase System](#)

[Lecture 50 - Unbalanced Three-Phase System and Three-Phase Power Measurement](#)

[Lecture 51 - Introduction to Graphical Models](#)

[Lecture 52 - State Equations](#)

[Lecture 53 - State Diagram](#)

[Lecture 54 - State Transition Matrix](#)

[Lecture 55 - State Variable Method to Circuit Analysis](#)

[Lecture 56 - Characteristic Equation, Eigenvalues, and Eigenvectors-State Variable Analysis \(Continued...\)](#)

[Lecture 57 - Modeling of Mechanical Systems](#)

[Lecture 58 - Modeling of The Rotational Motion of Mechanical Systems](#)

[Lecture 59 - Modeling of Electrical Systems](#)

[Lecture 60 - Solving Analogous Systems](#)

Lecture 1 - Introduction to Electric Drives

Lecture 2 - Dynamics of Electric Drives, Four Quadrant Operation, Equivalent Drive Parameters

Lecture 3 - Equivalent Drive Parameters, Friction Components, Nature of Load Torque

Lecture 4 - Steady State Stability, Load Equalization

Lecture 5 - Load Equalization, Characteristics of DC Motor

Lecture 6 - Speed Torque Characteristics of Separately Excited DC Motor and Series DC Motor

Lecture 7 - Field Control of Series Motor, Motoring and Braking of Separately Excited and Series DC motors

Lecture 8 - Speed Control of Separately Excited DC Motor Using Controlled Rectifiers

Lecture 9 - Analysis of Single Phase Full Controlled Converter-fed Separately Excited DC Motor

Lecture 10 - Speed Torque Characteristics of Full Controlled Converter-fed Separately Excited DC Motor, Analysis of Single Phase Half Controlled Converter-fed Separately Excited DC Motor

Lecture 11 - Analysis of Single Phase Half Controlled Converter-fed Separately Excited DC Motor.

Lecture 12 - Three Phase Full Controlled Converter-fed Separately Excited DC Motor, Multi-quadrant Operation of DC Motor

Lecture 13 - Dual Converter-fed DC Motor, Multi-quadrant Operation Using Field Current Reversal

Lecture 14 - DC Chopper-fed Separately Excited DC Motor for Motoring and Braking

Lecture 15 - Two-quadrant DC Chopper, Four-quadrant DC Chopper

Lecture 16 - Dynamic Braking of DC Motor by Chopper Controlled Resistor, Closed-loop Operation of DC Drives, Induction Motor Drives

Lecture 17 - Speed Torque Characteristics of Induction Motor, Operation of Induction Motor from Non-sinusoidal Supply

Lecture 18 - Operation of Induction Motor from Non-sinusoidal Supply

Lecture 19 - Stator Current of Induction Motor with Non-sinusoidal Supply, Operation of Induction Motor with Unbalanced Voltage Supply

Lecture 20 - Single Phasing of Induction Motor, Braking of Induction Motor

Lecture 21 - Dynamic braking of induction motor, AC dynamic braking, DC dynamic braking

Lecture 22 - Analysis of DC dynamic braking of induction motor

Lecture 23 - Self-excited dynamic braking of induction motor, Speed control of induction motor using stator voltage regulator, Variable voltage variable frequency control

Lecture 24 - Variable voltage variable frequency control of induction motor, Open loop V/F control

Lecture 25 - Slip speed control of induction motor, Constant Volt/Hz control with slip speed regulation

Lecture 26 - Closed-loop Volt/Hz control of induction motor with slip speed regulation, Multi-quadrant operation of induction motor drive

Lecture 27 - Current Source Inverter (CSI) fed induction motor drive

Lecture 28 - Closed-loop operation of current source inverter (CSI) fed induction motor drive, Control of slip ring induction motor - Static rotor resistance control



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Lecture 29 - Closed-loop operation of slip ring induction motor with static rotor resistance control, Slip power recovery in slip ring induction motor - Static Kramer drive

Lecture 30 - Static Kramer drive and its closed-loop control, Introduction to synchronous motor

Lecture 31 - Various types of synchronous motors, Equivalent circuit and phasor diagram of cylindrical synchronous motor, Speed-torque characteristics of cylindrical synchronous motor

Lecture 32 - Phasor diagram of salient pole synchronous motor, Expression of power and torque for a salient pole synchronous motor, Synchronous reluctance motor, Open-loop V/f control of synchronous motor

Lecture 33 - Open-loop V/f control, Torque-speed characteristics, Self controlled synchronous motor drive employing load commutated thyristor inverter

Lecture 34 - Detailed analysis of commutation of load commutated thyristor inverter, Derivation of overlap angle and margin angle, Closed-loop speed control scheme for load commutated inverter-fed synchronous motor drive

Lecture 35 - Low cost brushless DC motor (BLDCM), Trapezoidal permanent magnet AC motor

Lecture 36 - Trapezoidal permanent magnet AC motor, Derivation of power and torque, Closed-loop control of trapezoidal BLDC motor, Introduction to switched reluctance motor

Lecture 37 - Construction and operating principle of switched reluctance motor

Lecture 38 - Current/ voltage control for switched reluctance motor, operating modes of switched reluctance motor, Introduction to traction drives

Lecture 39 - Current collector for mainline trains, Nature of traction load, Duty cycle of traction drives

Lecture 40 - Duty cycle of traction drives, Distance between two stops, Calculation of total tractive effort and drive rating

Lecture 1 - Introduction: Fuzzy Sets, Logic and Systems and Applications

Lecture 2 - Introduction: Real Life Applications of Fuzzy Systems

Lecture 3 - Fuzzy Sets and Fuzzy Logic Toolbox in MATLAB - I

Lecture 4 - Fuzzy Sets and Fuzzy Logic Toolbox in MATLAB - II

Lecture 5 - Membership Functions - I

Lecture 6 - Membership Functions - II

Lecture 7 - Nomenclatures used in Fuzzy Set Theory - I

Lecture 8 - Nomenclatures used in Fuzzy Set Theory - II

Lecture 9 - Nomenclatures used in Fuzzy Set Theory - III

Lecture 10 - Set Theoretic Operations on Fuzzy Sets - I

Lecture 11 - Set Theoretic Operations on Fuzzy Sets - II

Lecture 12 - Properties of Fuzzy Sets - I

Lecture 13 - Properties of Fuzzy Sets - II

Lecture 14 - Properties of Fuzzy Sets - III

Lecture 15 - Properties of Fuzzy Sets - IV

Lecture 16 - Properties of Fuzzy Sets - V

Lecture 17 - Distance between Fuzzy Sets - I

Lecture 18 - Distance between Fuzzy Sets - II

Lecture 19 - Distance between Fuzzy Sets - III

Lecture 20 - Arithmetic Operations on Fuzzy Numbers - I

Lecture 21 - Arithmetic Operations on Fuzzy Numbers - II

Lecture 22 - Arithmetic Operations on Fuzzy Numbers - III

Lecture 23 - Complement of Fuzzy Sets

Lecture 24 - T-norm Operators

Lecture 25 - S-norm Operators

Lecture 26 - Parameterized T-Norm Operators

Lecture 27 - Parameterized S-Norm Operators

Lecture 28 - Fuzzy Relation - I

Lecture 29 - Fuzzy Relation - II

Lecture 30 - Operations on Crisp and Fuzzy Relations

Lecture 31 - Projection of Fuzzy Relation Set

Lecture 32 - Cylindrical Extension of Fuzzy Set

Lecture 33 - Properties of Fuzzy Relation - I

Lecture 34 - Properties of Fuzzy Relation - II

Lecture 35 - Extension Principle

Lecture 36 - Composition of Fuzzy Relations

Lecture 37 - Properties of Composition of Fuzzy Relations

Lecture 38 - Fuzzy Tolerance and Equivalence Relations - I

Lecture 39 - Fuzzy Tolerance and Equivalence Relations - II

Lecture 40 - Fuzzy Tolerance and Equivalence Relations - III

Lecture 41 - Linguistic Hedges

Lecture 42 - Linguistic Hedges and Negation/ Complement and Connectives

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

**NPTEL : NOC:Applied Linear Algebra for Signal Processing, Data Analytics and Machine Learning (Electrical Engineering)**

**Co-ordinators : Prof. Aditya K. Jagannatham**

- Lecture 1 - Vector Properties: Addition, Linear Combination, Inner Product, Orthogonality, Norm
- Lecture 2 - Vectors: Unit Norm Vector, Cauchy-Schwarz inequality, Radar Application
- Lecture 3 - Inner Product Application: Beamforming in Wireless Communication Systems
- Lecture 4 - Matrices, Definition, Addition and Multiplication of Matrices
- Lecture 5 - Matrix: Column Space, Linear Independence, Rank of Matrix, Gaussian Elimination
- Lecture 6 - Matrix: Determinant, Inverse Computation, Adjoint, Cofactor Concepts
- Lecture 7 - Applications of Matrices: Solution of System of Linear equations, MIMO Wireless Technology
- Lecture 8 - Applications of Matrices: Electric Circuits, Traffic flows
- Lecture 9 - Applications of Matrices: Graph Theory, Social Networks, Dominance Directed Graph, Influential Node
- Lecture 10 - Null Space of Matrix: Definition, Rank-Nullity Theorem, Application in Electric Circuits
- Lecture 11 - Gram-Schmidt Orthogonalization
- Lecture 12 - Gaussian Random Variable: Definition, Mean, Variance, Multivariate Gaussian, Covariance Matrix
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- Lecture 14 - Machine Learning Application: Gaussian Classification
- Lecture 15 - Eigenvalue: Definition, Characteristic Equation, Eigenvalue Decomposition
- Lecture 16 - Special Matrices: Rotation and Unitary Matrices, Application: Alamouti Code
- Lecture 17 - Positive Semi-definite (PSD) Matrices: Definition, Properties, Eigenvalue Decomposition
- Lecture 18 - Positive Semidefinite Matrix: Example and Illustration of Eigenvalue Decomposition
- Lecture 19 - Machine Learning Application: Principle Component Analysis (PCA)
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- Lecture 21 - Least Squares (LS) Solution, Pseudo-Inverse Concept
- Lecture 22 - Least Squares (LS) via Principle of Orthogonality, Projection Matrix, Properties
- Lecture 23 - Application: Pseudo-Inverse and MIMO Zero Forcing (ZF) Receiver
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- Lecture 25 - Machine Learning Application: Linear Regression
- Lecture 26 - Computation Mathematics Application: Polynomial Fitting
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- Lecture 28 - Wireless Application: Multi-user Beamforming
- Lecture 29 - Singular Value Decomposition (SVD): Definition, Properties, Example
- Lecture 30 - SVD Application in MIMO Wireless Technology: Spatial-Multiplexing and High Data Rates
- Lecture 31 - SVD for MIMO wireless optimization, water-filling algorithm, optimal power allocation

**HTML Links for 108,400+ NPTEL Video Lectures, Created by LinuXpert Systems, Chennai**

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- Lecture 33 - Multiple signal classification (MUSIC) algorithm: system model
- Lecture 34 - MUSIC algorithm for Direction of Arrival (DoA) estimation
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- Lecture 41 - Recommender system: Illustration via movie rating prediction example
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Lecture 7 - Energy Economics : Input-Output Analysis

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**NPTEL : Illumination Engineering (Electrical Engineering)**

**Co-ordinators : Prof. N.K. Kishore**

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

**NPTEL : NOC:Fundamentals of Electric Vehicles: Technology and Economics (Electrical Engineering)**

**Co-ordinators : Prof. Ashok Jhunjunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha, Prof. L Kannan**

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Lecture 3 - Can India Drive its EV program Innovatively and Differently and scale? - Part 2

Lecture 4 - A bit about batteries

Lecture 5 - Charging and Swapping Infrastructure

Lecture 6 - Where will we get Lithium for batteries?

Lecture 7 - EV Subsystems

Lecture 8 - Forces acting when a vehicle move

Lecture 9 - Aerodynamic drag, Rolling Resistance and Uphill Resistance

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Lecture 27 - Battery Pack Development - Part 1

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Lecture 29 - Computation of Effective cost of battery - Part 1

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- Lecture 49 - Power and Efficiency
- Lecture 50 - Torque Production - Part 1
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- Lecture 11 - Invertible maps, Isomorphism, Operators
- Lecture 12 - Solving Linear Equations
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Lecture 6 - Kirchoff's voltage law (KVL)

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Lecture 8 - Current source

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Lecture 10 - Capacitor

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Lecture 12 - Mutual inductor

Lecture 13 - Linearity of elements

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Lecture 15 - Series connection of R, L, C, current source

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Lecture 32 - Power and energy in a current source

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- Lecture 6 - Energy band formation
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- Lecture 32 - Forward and reverse biased PN junctions
- Lecture 33 - Minority carrier injection in PN junctions
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- Lecture 39 - Schottky barrier in metal-semiconductor junction
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- Lecture 57 - Introduction to MOSFET
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**NPTEL : Phase-locked loops (Electrical Engineering)**

**Co-ordinators : Dr. Saurabh Saxena**

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**NPTEL : NOC:DC Microgrid (Electrical Engineering)**

**Co-ordinators : Prof. Avik Bhattacharya**

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- Lecture 8 - Current based Relaying Scheme - III
- Lecture 9 - Current based Relaying Scheme - IV
- Lecture 10 - Current based Relaying Scheme - V
- Lecture 11 - Current based Relaying Scheme - VI
- Lecture 12 - Current based Relaying Scheme - VII
- Lecture 13 - Current based Relaying Scheme - VIII
- Lecture 14 - Protection of Transmission Lines using Distance Relays - I
- Lecture 15 - Protection of Transmission Lines using Distance Relays - II
- Lecture 16 - Protection of Transmission Lines using Distance Relays - III
- Lecture 17 - Protection of Transmission Lines using Distance Relays - IV
- Lecture 18 - Protection of Transmission Lines using Distance Relays - V
- Lecture 19 - Carrier Aided Schemes for Transmission Lines - I
- Lecture 20 - Carrier Aided Schemes for Transmission Lines - II
- Lecture 21 - Carrier Aided Schemes for Transmission Lines - III
- Lecture 22 - Carrier Aided Schemes for Transmission Lines - IV
- Lecture 23 - Auto-reclosing and Synchronizing - I
- Lecture 24 - Auto-reclosing and Synchronizing - II
- Lecture 25 - Auto-reclosing and Synchronizing - III
- Lecture 26 - Protection of Transformers - I
- Lecture 27 - Protection of Transformers - II
- Lecture 28 - Protection of Generators - I
- Lecture 29 - Protection of Generators - II
- Lecture 30 - Protection of Induction Motors
- Lecture 31 - Protection of Busbars

[Lecture 32 - Protection against Transients and Surges along with System Response to Severe Upsets - I](#)

[Lecture 33 - Protection against Transients and Surges along with System Response to Severe Upsets - II](#)

[Lecture 34 - Arc Interruption Theory in Circuit Breaker - I](#)

[Lecture 35 - Arc Interruption Theory in Circuit Breaker - II](#)

[Lecture 36 - Arc Interruption Theory in Circuit Breaker - III](#)

[Lecture 37 - Arc Interruption Theory in Circuit Breaker - IV](#)

[Lecture 38 - Types of Circuit Breakers](#)

[Lecture 39 - Testing, Commissioning and Maintenance of Relays - I](#)

[Lecture 40 - Testing, Commissioning and Maintenance of Relays - II](#)



Lecture 1 - Introduction and Objectives of the course

Lecture 2 - Definition of a system and history of semiconductors

Lecture 3 - Products and levels of packaging

Lecture 4 - Packaging aspects of handheld products; Case studies in applications

Lecture 5 - Case Study (continued); Definition of PWB, summary and Questions for review

Lecture 6 - Basics of Semiconductor and Process flowchart; Video on "Sand-to-Silicon"

Lecture 7 - Wafer fabrication, inspection and testing

Lecture 8 - Wafer packaging; Packaging evolution; Chip connection choices

Lecture 9 - Wire bonding, TAB and flipchip-1

Lecture 10 - Wire bonding, TAB and flipchip-2; Tutorials

Lecture 11 - Why packaging? & Single chip packages or modules (SCM)

Lecture 12 - Commonly used packages and advanced packages; Materials in packages

Lecture 13 - Advances packages (continued); Thermal mismatch in packages; Current trends in packaging

Lecture 14 - Multichip modules (MCM)-types; System-in-package (SIP); Packaging roadmaps; Hybrid circuits; Quiz on packages

Lecture 15 - Electrical Issues " I; Resistive Parasitic

Lecture 16 - Electrical Issues " II; Capacitive and Inductive Parasitic

Lecture 17 - Electrical Issues " III; Layout guidelines and the Reflection problem

Lecture 18 - Electrical Issues " IV; Interconnection

Lecture 19 - Quick Tutorial on packages; Benefits from CAD; Introduction to DFM, DFR & DFT

Lecture 20 - Components of a CAD package and its highlights

Lecture 21 - Design Flow considerations; Beginning a circuit design with schematic work and component layout

Lecture 22 - Demo and examples of layout and routing; Technology file generation from CAD; DFM check list and design rules; Design for Reliability

Lecture 23 - Review of CAD output files for PCB fabrication; Photo plotting and mask generation

Lecture 24 - Process flow-chart; Vias; PWB substrates

Lecture 25 - Substrates continued; Video highlights; Surface preparation

Lecture 26 - Photoresist and application methods; UV exposure and developing; Printing technologies for PWBs

Lecture 27 - PWB etching; Resist stripping; Screen-printing technology

Lecture 28 - Through-hole manufacture process steps; Panel and pattern plating methods

Lecture 29 - Video highlights on manufacturing; Solder mask for PWBs; Multilayer PWBs; Introduction to microvias

Lecture 30 - Microvia technology and Sequential build-up technology process flow for high-density interconnects

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

Lecture 31 - Conventional Vs HDI technologies; Flexible circuits; Tutorial session

Lecture 32 - SMD benefits; Design issues; Introduction to soldering

Lecture 33 - Reflow and Wave Soldering methods to attach SMDs

Lecture 34 - Solders; Wetting of solders; Flux and its properties; Defects in wave soldering

Lecture 35 - Vapour phase soldering, BGA soldering and Desoldering/Repair; SMT failures

Lecture 36 - SMT failure library and Tin Whiskers

Lecture 37 - Tin-lead and lead-free solders; Phase diagrams; Thermal profiles for reflow soldering; Lead-free alloys

Lecture 38 - Lead-free solder considerations; Green electronics; RoHS compliance and e-waste recycling issues

Lecture 39 - Thermal Design considerations in systems packaging

Lecture 40 - Introduction to embedded passives; Need for embedded passives; Design Library; Embedded resistor processes

Lecture 41 - Embedded capacitors; Processes for embedding capacitors; Case study examples; Summary of materials in packaging

Lecture 42 - Chapter-wise summary

Lecture 1 - Course introduction and overview

Lecture 2 - Distributed generation technologies

Lecture 3 - Distributed storage technologies

Lecture 4 - Distribution system protection

Lecture 5 - Circuit breaker coordination

Lecture 6 - Symmetrical component analysis and sequence excitation

Lecture 7 - Modeling of distribution system components

Lecture 8 - Protection components

Lecture 9 - Impact of distributed generation of distribution protection

Lecture 10 - Consumption and distribution grounding

Lecture 11 - Islanding of distribution systems

Lecture 12 - Modeling of islanded distribution systems

Lecture 13 - Distribution system problems and examples

Lecture 14 - Distribution system problems and examples continued

Lecture 15 - Anti-islanding methods

Lecture 16 - Solid state circuit switching

Lecture 17 - Relaying for distributed generation

Lecture 18 - Feeder voltage regulation

Lecture 19 - Grounding, distribution protection coordination problems and examples

Lecture 20 - Ring and network distribution

Lecture 21 - Economic evaluation of DG systems

Lecture 22 - Design for effective initial cost

Lecture 23 - Single phase inverters

Lecture 24 - DC bus design in voltage source inverter

Lecture 25 - Electrolytic capacitor reliability and lifetime

Lecture 26 - Inverter switching and average model

Lecture 27 - Common mode and differential mode model of inverters

Lecture 28 - Two leg single phase inverter

Lecture 29 - Distribution system problems, and examples

Lecture 30 - DG evaluation problems and examples

Lecture 31 - Switch selection in two level voltage source inverters and loss evaluation

Lecture 32 - Thermal model, management and cycling failure of IGBT modules

Lecture 33 - Semiconductor switch design reliability considerations

Lecture 34 - AC filters for grid connected inverters

Lecture 35 - AC inductor design and need for LCL filter

Lecture 36 - LCL filter design

Lecture 37 - Examples in power electronic design for DG systems

Lecture 38 - Examples in power electronic design for DG systems continued

Lecture 39 - Higher order passive damping design for LCL filters

Lecture 40 - Balance of hardware component for inverters in DG systems

Lecture 1 - Electronic switches

Lecture 2 - DC - DC converters

Lecture 3 - DC - AC converters

Lecture 4 - Multilevel converters - I

Lecture 5 - Multilevel converters - II

Lecture 6 - Applications of voltage source converter - I

Lecture 7 - Applications of voltage source converter - II

Lecture 8 - Applications of voltage source converter - III

Lecture 9 - Purpose of PWM - I

Lecture 10 - Purpose of PWM - II

Lecture 11 - Low switching frequency PWM - I

Lecture 12 - Low switching frequency PWM - II

Lecture 13 - Selective harmonic elimination

Lecture 14 - Off-line optimized pulsewidth modulation

Lecture 15 - Sine-triangle pulsewidth modulation

Lecture 16 - Harmonic injection pulsewidth modulation

Lecture 17 - Bus-clamping pulsewidth modulation

Lecture 18 - Triangle-comparison based PWM for three-phase inverter

Lecture 19 - Concept of space vector

Lecture 20 - Conventional space vector PWM

Lecture 21 - Space vector based bus-clamping PWM

Lecture 22 - Space vector based advanced bus-clamping PWM

Lecture 23 - Harmonic analysis of PWM techniques

Lecture 24 - Analysis of RMS line current ripple using the notion of stator flux ripple

Lecture 25 - Evaluation of RMS line current ripple using the notion of stator flux ripple

Lecture 26 - Analysis and design of PWM techniques from line current ripple perspective

Lecture 27 - Instantaneous and average dc link current in a voltage source inverter

Lecture 28 - DC link current and DC capacitor current in a voltage source inverter

Lecture 29 - Analysis of torque ripple in induction motor drives - I

Lecture 30 - Analysis of torque ripple in induction motor drives - II

Lecture 31 - Evaluation of conduction loss in three-phase inverter

[Lecture 32 - Evaluation of switching loss in three-phase inverter](#)

[Lecture 33 - Design of PWM for reduced switching loss in three-phase inverter](#)

[Lecture 34 - Effect of dead-time on inverter output voltage for continuous PWM schemes](#)

[Lecture 35 - Effect of dead-time on inverter output voltage for bus-clamping PWM schemes](#)

[Lecture 36 - Analysis of overmodulation in sine-triangle PWM from space vector perspective](#)

[Lecture 37 - Overmodulation in space vector modulated inverter](#)

[Lecture 38 - PWM for three-level neutral-point-clamped inverter - I](#)

[Lecture 39 - PWM for three-level neutral-point-clamped inverter - II](#)

[Lecture 40 - PWM for three-level neutral-point-clamped inverter - III](#)

Lecture 1 - Introduction to DC-DC converter

Lecture 2 - Diode

Lecture 3 - Controlled Switches

Lecture 4 - Prior Art

Lecture 5 - Inductor

Lecture 6 - Transformer

Lecture 7 - Capacitor

Lecture 8 - Issues related to switches

Lecture 9 - Energy storage - Capacitor

Lecture 10 - Energy storage - Inductor

Lecture 11 - Primitive Converter

Lecture 12 - Non-Isolated converter - I

Lecture 13 - Non-Isolated converter - II

Lecture 14 - Isolated Converters - I

Lecture 15 - Isolated Converters - II

Lecture 16 - Conduction Mode

Lecture 17 - Problem set - I

Lecture 18 - Problem set - II

Lecture 19 - Modeling DC-DC converters

Lecture 20 - State space representation - I

Lecture 21 - State Space representation - II

Lecture 22 - Circuit Averaging - I

Lecture 23 - Circuit Averaging - II

Lecture 24 - State Space Model of Boost Converter

Lecture 25 - DC-DC converter controller

Lecture 26 - Controller Structure

Lecture 27 - PID Controller - I

Lecture 28 - PID Controller - II

Lecture 29 - PID Controller - III

Lecture 30 - Implementation of PID controller

Lecture 31 - Pulse Width Modulator

[Lecture 32 - Controller Design - I](#)

[Lecture 33 - Controller Design - II](#)

[Lecture 34 - Controllers and Sensing Circuit](#)

[Lecture 35 - Regulation of Multiple outputs - I](#)

[Lecture 36 - Regulation of Multiple outputs - II](#)

[Lecture 37 - Current Control](#)

[Lecture 38 - Unity Power Factor Converter](#)

[Lecture 39 - Magnetic Design](#)

[Lecture 40 - DC-DC Converter Design](#)



Lecture 1 - Basic Electrical Technology

Lecture 2 - Passive Components

Lecture 3 - Sources

Lecture 4 - Kirchoff's Law

Lecture 5 - Modelling of Circuit - Part 1

Lecture 6 - Modelling of Circuit - Part 2

Lecture 7 - Analysis Using MatLab

Lecture 8 - Sinusoidal steady state

Lecture 9 - Transfer Function and Pole Zero domain

Lecture 10 - Transfer function & pole zero

Lecture 11 - The Sinusoid

Lecture 12 - Phasor Analysis - Part 1

Lecture 13 - Phasor Analysis - Part 2

Lecture 14 - Power Factor

Lecture 15 - Power ports

Lecture 16 - Transformer Basics - Part 1

Lecture 17 - Transformer Basics - Part 2

Lecture 18 - Transformer Basics - Part 3

Lecture 19 - The Practical Transformer - Part 1

Lecture 20 - The Practical Transformer - Part 2

Lecture 21 - The Practical Transformer - Part 3

Lecture 22 - DC Machines - Part 1

Lecture 23 - DC Machines - Part 2

Lecture 24 - DC Generators - Part 1

Lecture 25 - DC Generators - Part 2

Lecture 26 - DC Motors - Part 1

Lecture 27 - DC Motors - Part 2

Lecture 28 - DC Motors - Part 3

Lecture 29 - Three Phase System - Part 1

Lecture 30 - Three Phase System - Part 2

Lecture 31 - Three Phase System - Part 3

[Lecture 32 - Three Phase System - Part 4](#)

[Lecture 33 - Three Phase Transformer - Part 1](#)

[Lecture 34 - Three Phase Transformer - Part 2](#)

[Lecture 35 - Induction Motor - Part 1](#)

[Lecture 36 - Induction Motor - Part 2](#)

[Lecture 37 - Induction Motor - Part 3](#)

[Lecture 38 - Induction Motor - Part 4](#)

[Lecture 39 - Synchronous Machine](#)

Lecture 1 - Electric Drive

Lecture 2 - Controlled Rectifier - Part-1

Lecture 3 - Controlled Rectifier - Part-2 (Three phase)

Lecture 4 - Controlled Rectifier - Part-3 (Three phase)

Lecture 5 - Controlled Rectifier - Part-4 (Three Phase)

Lecture 6 - Controlled Rectifier - Part-5 (Three Phase)

Lecture 7 - Power Electronics Improvements

Lecture 8 - Four Quadrant Dc to Dc Converter

Lecture 9 - Sine Triangle PWM Control of Converter

Lecture 10 - Front-end Ac-Dc Converter with harmonic control

Lecture 11 - Ac to Dc Converter Close Loop Control Schematic

Lecture 12 - Ac-Dc Converter Close loop Control Block Diagram

Lecture 13 - Design of the Converter Controller & AC to DC

Lecture 14 - Front-End Ac to Dc Converter-Design

Lecture 15 - Front-End Ac to Dc Converter - Simulation study

Lecture 16 - Dc Motor Speed Control - Introduction

Lecture 17 - Dc Motor Speed Control - Block Diagram

Lecture 18 - Dc Motor Speed Control Current Control & S C L

Lecture 19 - Dc-Motor Speed Control Controller Design - Part-1

Lecture 20 - Dc Motor Speed Control Controller Design - Part-2

Lecture 21 - Dc Motor Speed Control Controller Design - Part-3

Lecture 22 - Basics of DC to AC Converter - Part-1

Lecture 23 - Basics of DC to AC Converter - Part-2

Lecture 24 - Inverter Sine Triangle PWM

Lecture 25 - Inverter - Current Hysteresis Controlled PWM

Lecture 26 - C H controlled & Basics of space vector PWM

Lecture 27 - Space Vector PWM - Part-2

Lecture 28 - Space Vector PWM - Part-3

Lecture 29 - Space Vector PWM Signal Generation

Lecture 30 - Speed Control of Induction Motor - Part-1

Lecture 31 - Speed Control of Induction Motor - Part-2

[Lecture 32 - High dynamic performance of I M Drive](#)

[Lecture 33 - Dynamic Model of Induction Motor - Part-1](#)

[Lecture 34 - Dynamic Model of Induction Motor - Part-2](#)

[Lecture 35 - Vector Control of Induction Motor](#)

[Lecture 36 - Effect of Switching Time lag in Inverter](#)

[Lecture 37 - Power Switch Protection - Snubbers](#)

Lecture 1 - Introduction to IOTs - Part I

Lecture 2 - Introduction to IOTs - Part II

Lecture 3 - Introduction to IOTs - Examples

Lecture 4 - IOT applications - I

Lecture 5 - IOT applications - II

Lecture 6 - Power management in IOT device

Lecture 7 - Introduction to LDO

Lecture 8 - Design with an LDO

Lecture 9 - Introduction to switching regulators

Lecture 10 - Designing with LDO's, switching regulators and case studies - Part I

Lecture 11 - Designing with LDO's, switching regulators and case studies - Part II

Lecture 12 - Designing with LDO's, switching regulators and case studies - Part II

Lecture 13 - Designing with LDO's, switching regulators and case studies - Part IV

Lecture 14 - Power Conditioning with Energy Harvesters - I

Lecture 15 - Power Conditioning with Energy Harvesters - II

Lecture 16 - Power Conditioning with Energy Harvesters - III

Lecture 17 - Battery less power supply and battery life calculation for embedded devices - I

Lecture 18 - Battery less power supply and battery life calculation for embedded devices - II

Lecture 19 - Battery less power supply and battery life calculation for embedded devices - III

Lecture 20 - Introduction to MQTT

Lecture 21 - Quality of Service in MQTT

Lecture 22 - Standards and Security in MQTT

Lecture 23 - Introduction and Implementation of AMQP

Lecture 24 - Implementation of CoAP and MDNS

Lecture 25 - Basics of RFID

Lecture 26 - RFID protocol and applications

Lecture 27 - BLE Security

Lecture 28 - LPWAN technologies

Lecture 29 - Choice of Microcontrollers

Lecture 30 - Case Study 1 - Joule Jotter

Lecture 31 - Case Study 2 - Cloud Based Systems



Lecture 1 - Advantages of HVAC/DC Transmission, Introduction to Grid Management

Lecture 2 - Transmission system development, Important components of transmission system

Lecture 3 - Insulation coordination, over voltage in power systems

Lecture 4 - Design/selection of insulators, Importance of grading/cc rings

Lecture 5 - Non ceramic insulators performance-service experience

Lecture 6 - Failure of apparatus in the field, importance of reliability and testing

Lecture 7 - Pollution flashover phenomena, modeling etc

Lecture 8 - Planning of High Voltage laboratories

Lecture 9 - Importance of High Voltage testing and techniques employed

Lecture 10 - Basic philosophy of HV testing, tests for various HV apparatus

Lecture 11 - HV testing techniques for various apparatus

Lecture 12 - HV testing on Composite Insulators

Lecture 13 - Surface degradation studies on composite insulators

Lecture 14 - Surface morphological techniques for composite insulators

Lecture 15 - Conductors used for EHV/UHV transmission

Lecture 16 - Corona and interference on transmission lines

Lecture 17 - Introduction of HTLS conductors and their advantages

Lecture 18 - Mechanical considerations for HV conductors

Lecture 19 - Introduction to Towers and importance of foundations

Lecture 20 - Selection/Design of clearances for HV towers

Lecture 21 - Design Optimization for UHV towers

Lecture 22 - Introduction to 1100kV HVDC

Lecture 23 - Introduction to HV Substations

Lecture 24 - Types of Substations, comparison

Lecture 25 - Insulation coordination, Components in a typical substation

Lecture 26 - Preventive maintenance of Substation

Lecture 27 - Electric and magnetic fields, mitigations techniques

Lecture 28 - Importance of Grounding, reducing Earthing resistance

Lecture 29 - Introduction to the use of Fiber optic cables, OPGW

Lecture 30 - Introduction to communication and SCADA

Lecture 31 - Precautions and safety measures in substation

[Lecture 32 - Electrical hazards, minimum clearances in substation](#)

[Lecture 33 - Importance of Generation of HVDC in the laboratory](#)

[Lecture 34 - Importance of Generation of HVAC, Impulse Voltage and Currents in the laboratory](#)

[Lecture 35 - Measurements of High Voltages](#)

[Lecture 36 - Measurements of High Voltages \(Continued...\)](#)

[Lecture 37 - Introduction to digital recorders, measurement](#)

[Lecture 38 - Upgradation/uprating of transmission lines- advantages](#)

[Lecture 39 - Upgradation/uprating of transmission lines- advantages \(Continued...\)](#)

[Lecture 40 - Summary of the course](#)



- Lecture 1 - Introduction to signal processing
- Lecture 2 - Basics of signals and systems
- Lecture 3 - Linear time-invariant systems
- Lecture 4 - Modes in a linear system
- Lecture 5 - Introduction to state space representation
- Lecture 6 - State space representation
- Lecture 7 - Non-uniqueness of state space representation
- Lecture 8 - Introduction to vector space
- Lecture 9 - Linear independence and spanning set
- Lecture 10 - Unique representation theorem
- Lecture 11 - Basis and cardinality of basis
- Lecture 12 - Norms and inner product spaces
- Lecture 13 - Inner products and induced norm
- Lecture 14 - Cauchy Schwartz inequality
- Lecture 15 - Orthonormality
- Lecture 16 - Problem on sum of subspaces
- Lecture 17 - Linear independence of orthogonal vectors
- Lecture 18 - Hilbert space and linear transformation
- Lecture 19 - Gram Schmidt orthonormalization
- Lecture 20 - Linear approximation of signal space
- Lecture 21 - Gram Schmidt orthogonalization of signals
- Lecture 22 - Problem on orthogonal complement
- Lecture 23 - Problem on signal geometry (4-QAM)
- Lecture 24 - Basics of probability and random variables
- Lecture 25 - Mean and variance of a random variable
- Lecture 26 - Introduction to random process
- Lecture 27 - Statistical specification of random processes
- Lecture 28 - Stationarity of random processes
- Lecture 29 - Problem on mean and variance
- Lecture 30 - Problem on MAP Detection
- Lecture 31 - Fourier transform of dirac comb sequence

Lecture 32 - Sampling theorem

Lecture 33 - Basics of multirate systems

Lecture 34 - Frequency representation of expanders and decimators

Lecture 35 - Decimation and interpolation filters

Lecture 36 - Fractional sampling rate alterations

Lecture 37 - Digital filter banks

Lecture 38 - DFT as filter bank

Lecture 39 - Noble Identities

Lecture 40 - Polyphase representation

Lecture 41 - Efficient architectures for interpolation and decimation filters

Lecture 42 - Problems on simplifying multirate systems using noble identities

Lecture 43 - Problem on designing synthesis bank filters

Lecture 44 - Efficient architecture for fractional decimator

Lecture 45 - Multistage filter design

Lecture 46 - Two-channel filter banks

Lecture 47 - Amplitude and phase distortion in signals

Lecture 48 - Polyphase representation of 2-channel filter banks, signal flow graphs and perfect reconstruction

Lecture 49 - M-channel filter banks

Lecture 50 - Polyphase representation of M-channel filter bank

Lecture 51 - Perfect reconstruction of signals

Lecture 52 - Nyquist and half band filters

Lecture 53 - Special filter banks for perfect reconstruction

Lecture 54 - Introduction to wavelets

Lecture 55 - Multiresolution analysis and properties

Lecture 56 - The Haar wavelet

Lecture 57 - Structure of subspaces in MRA

Lecture 58 - Haar decomposition - 1

Lecture 59 - Haar decomposition - 2

Lecture 60 - Wavelet Reconstruction

Lecture 61 - Haar wavelet and link to filter banks

Lecture 62 - Demo on wavelet decomposition

Lecture 63 - Problem on circular convolution

Lecture 64 - Time frequency localization

[Lecture 65 - Basic analysis: Pointwise and uniform continuity of functions](#)

[Lecture 66 - Basic Analysis : Convergence of sequence of functions](#)

[Lecture 67 - Fourier series and notions of convergence](#)

[Lecture 68 - Convergence of Fourier series at a point of continuity](#)

[Lecture 69 - Convergence of Fourier series for piecewise differentiable periodic functions](#)

[Lecture 70 - Uniform convergence of Fourier series of piecewise smooth periodic function](#)

[Lecture 71 - Convergence in norm of Fourier series](#)

[Lecture 72 - Convergence of Fourier series for all square integrable periodic functions](#)

[Lecture 73 - Problem on limits of integration of periodic functions](#)

[Lecture 74 - Matrix Calculus](#)

[Lecture 75 - KL transform](#)

[Lecture 76 - Applications of KL transform](#)

[Lecture 77 - Demo on KL Transform](#)

[Lecture 78 - Live Session](#)

[Lecture 79 - Live Session 2](#)

Lecture 1 - Electronic Equipment Thermal issues

Lecture 2 - Practical Examples - 1

Lecture 3 - Practical Examples - 2

Lecture 4 - CEDT worked examples - 1

Lecture 5 - CEDT worked examples - 2

Lecture 6 - Text book theory

Lecture 7 - Sample heat sinks

Lecture 8 - Published correlations - 1

Lecture 9 - Published correlations - 2

Lecture 10 - Parallel combined effects

Lecture 11 - Mounting of packages

Lecture 12 - Combined Rth of devices

Lecture 13 - Schonholzer moduls

Lecture 14 - 1972 model paper

Lecture 15 - Jensen model

Lecture 16 - Thermal management - 1

Lecture 17 - Thermal management - 2

Lecture 18 - Round up of full model

Lecture 19 - Fan cooling

Lecture 20 - Thermo-electric cooling

Lecture 21 - On-the-net DIY work

Lecture 22 - Practical video

Lecture 23

Lecture 24

Lecture 25

Lecture 26

Lecture 27 - Real packages

Lecture 28 - Prior art

Lecture 29 - OTS standard profiles

Lecture 30 - CAD detailed design of profiles

Lecture 31 - Round up

[Lecture 32 - 4X Peltier Cooler](#)

[Lecture 33 - Manufacturing Video](#)

[Lecture 34 - Peltier heat sink](#)

- Lecture 1 - Introduction to Integrated Circuits (IC) Technology
- Lecture 2 - Introduction to fabrication of IC: Substrates
- Lecture 3 - Introduction to IC fabrication
- Lecture 4 - Introduction to IC fabrication (Continued...)
- Lecture 5 - Introduction to the fabrication of sensors
- Lecture 6 - Introduction to fabrication technology
- Lecture 7 - Introduction to fabrication technology (Continued...)
- Lecture 8 - Introduction to fabrication technology (Continued...)
- Lecture 9 - Introduction to fabrication technology (Continued...)
- Lecture 10 - Introduction to fabrication technology (Continued...)
- Lecture 11 - Process flow for Fabrication of MOSFETs
- Lecture 12 - Operation of Enhancement type MOSFET
- Lecture 13 - Operation of Depletion type MOSFET
- Lecture 14 - MOSFETs Characteristics and Applications (Current Mirrors)
- Lecture 15 - Introduction to Operational Amplifiers
- Lecture 16 - Operational Amplifier Characteristics
- Lecture 17 - Operational Amplifier Characteristics (Continued...)
- Lecture 18 - Characteristics of an op-amp (Continued...)
- Lecture 19 - Operational Amplifier Configurations
- Lecture 20 - Operational Amplifier Configurations (Continued...)
- Lecture 21 - Applications of Operational Amplifier: Differential Amplifier
- Lecture 22 - Applications of Operational Amplifier: Integrator
- Lecture 23 - Applications of Operational Amplifier: Differentiator
- Lecture 24 - Introduction to Passive and Active Filters and op-amp as Low Pass Filter
- Lecture 25 - Operational Amplifier as a High Pass Filter
- Lecture 26 - Operational Amplifier as a Band Pass and Band Reject Filter
- Lecture 27 - Introduction to Oscillator
- Lecture 28 - RC Phase Shift Oscillator using Op-amp
- Lecture 29 - Wein Bridge Oscillator using Op-amp
- Lecture 30 - Hartley and Colpitts Oscillator using Op-amp
- Lecture 31 - Working of Crystal Oscillators

- Lecture 32 - Construction and Operation of UJT Relaxation Oscillators
- Lecture 33 - Introduction to Noise and its Types
- Lecture 34 - Analysis of Data Sheets of an Op-Amp
- Lecture 35 - Analysis of Data Sheets of an Op-Amp (Continued...)
- Lecture 36 - Analysis of Data Sheets of an Op-Amp (Continued...)
- Lecture 37 - Experiment - Introduction to Laboratory Equipment
- Lecture 38 - Experiment - Measurement of Active and Passive elements using Multimeter
- Lecture 39 - Experiment - Working with Laboratory Equipment: Power Supply
- Lecture 40 - Experiment - Working with Laboratory Equipment: Function Generator, Oscilloscope
- Lecture 41 - Experiment - Op-Amp Characteristics: Input Bias Current
- Lecture 42 - Experiment - Op-Amp Characteristics: Input Offset Current
- Lecture 43 - Experiment - Op-Amp Characteristics: Input Offset Voltage
- Lecture 44 - Experiment - Op-Amp as Inverting Amplifier
- Lecture 45 - Experiment - Op-Amp as Non-Inverting Amplifier
- Lecture 46 - Experiment - To study input and output voltage range of an Op-Amp
- Lecture 47 - Experiment - Differential amplifier using op-amp
- Lecture 48 - Experiment - To study the gain of instrumentation amplifier
- Lecture 49 - Experiment - Summing amplifier using op-amp
- Lecture 50 - Experiment - To study op-amp based comparator
- Lecture 51 - Experiment - To study op-amp based integrator and differentiator
- Lecture 52 - Experiment - Study of passive low pass filter
- Lecture 53 - Experiment - Op-amp based active low pass filter
- Lecture 54 - Experiment - Passive and active high pass filter
- Lecture 55 - Experiment - Introduction to experimental set-up of band pass filter
- Lecture 56 - Experiment - Passive and active band pass filter
- Lecture 57 - Experiment - Introduction to experimental set-up for band reject filter
- Lecture 58 - Experiment - Active band reject filter
- Lecture 59 - Experiment - Peak detector circuit using Op-Amp

Lecture 1 - Quantum Mechanics: Concept of Wave Particle, Schrodingers Equation

Lecture 2 - Quantum Mechanics: Particle in a Box

Lecture 3 - Quantum Mechanics: Particle in a Box (Continued...), Harmonic Oscillator

Lecture 4 - Solids: Formation of Bands, Kronig-Penny Model

Lecture 5 - Solids: Kronig-Penny Model (Continued...)

Lecture 6 - Solids: Electrons and Holes

Lecture 7 - Solids: Electrons and Holes (Continued...)

Lecture 8 - Solids: Crystals

Lecture 9 - Density of States

Lecture 10 - Density of States (Continued...), Fermi Function

Lecture 11 - Fermi Function - Carrier Concentration

Lecture 12 - Doping

Lecture 13 - Doping (Continued...)

Lecture 14 - Recombination and Generation

Lecture 15 - Recombination and Generation (Continued...)

Lecture 16 - Recombination and Generation (Continued...), Charge Transport

Lecture 17 - Charge Transport (Continued...)

Lecture 18 - Continuity Equation

Lecture 19 - Junctions

Lecture 20 - Metal Semiconductor Junctions

Lecture 21 - Schottky Contact: Electrostatics

Lecture 22 - Schottky Contact: Current-Voltage (IV) Characteristics

Lecture 23 - Schottky Contact: IV Characteristics (Continued...)

Lecture 24 - Schottky Contact: Small Signal Impedance

Lecture 25 - PN Junctions: Electrostatics

Lecture 26 - PN Junctions: IV Characteristics

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- Lecture 43 - Design of Induction Machine- Rotor Design - 4 (Skewing of Rotor)
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- Lecture 45 - Carter's Coefficient of Electrical Machines
- Lecture 46 - Effective Length Equations of the Machine Core with Different Stator and Rotor Lengths
- Lecture 47 - Stator MMF and Magnetizing Current Equations of Induction Machine
- Lecture 48 - Magnetizing Inductance of Induction Machine
- Lecture 49 - Stator and Rotor Leakage Inductances of Induction Machine
- Lecture 50 - Equivalent Circuit Parameters of Induction Machine
- Lecture 51 - Loss Calculation of Induction Machine - 1
- Lecture 52 - Loss Calculation of Induction Machine - 2 and Performance Parameters of Induction Motor
- Lecture 53 - Switched Reluctance Machine Sizing Equations-Output Power and Volume (D2L) Product Equation
- Lecture 54 - The Figure of Merits for SRM and Example Problem on Output Power Equation i t f D2L Product
- Lecture 55 - Design of Switched Reluctance Machine: Stator Design - 1
- Lecture 56 - Design of Switched Reluctance Machine: Stator Design - 2 and Rotor Design
- Lecture 57 - Procedure for Calculation of SRM Inductance: Aligned Inductance - 1
- Lecture 58 - Calculation of SRM Inductance: Aligned Inductance - 2
- Lecture 59 - Efficiency and Loss Calculation of SRM
- Lecture 60 - Importance of Thermal Design and Thermal Limits for Electrical Machines
- Lecture 61 - Electric and Thermal Circuits Interface
- Lecture 62 - Heat Transfer Methods and Basic Equations for Thermal Resistance
- Lecture 63 - Heat Flow in Electrical Machines
- Lecture 64 - Cooling Methods and Standards for Electrical Machines

[Lecture 65 - Basics of Thermal Equivalent Circuits](#)

[Lecture 66 - Thermal Equivalent Circuit - 1](#)

[Lecture 67 - Thermal Equivalent Circuit - 2](#)