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

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- Lecture 5 - Idealized Sampling, Reconstruction
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- Lecture 8 - Desired requirements for discrete system
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- 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 itâ€™s impulse response
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- Lecture 17 - Characterisation of LSI systems, Convolution-properties
- Lecture 18 - Response of LSI Systems to Complex Sinusoids
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- Lecture 28 - Discrete time fourier transform
- Lecture 29 - DTFT in LSI System and Convolution Theorem.
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Lecture 59 - Introduction to Filter Design. Analog IIR Filter, FIR discrete-time filter, IIR discrete-time filter

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Lecture 62 - Steps for IIR filter design

Lecture 63 - Analog filter design using Butterworth Approximation

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Lecture 82 - Comparison of FIR And IIR Filter

Lecture 83 - Comparison of FIR And IIR Filter

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

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Lecture 87 - Cascade Parallel Structure

Lecture 88 - Lattice Structure

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

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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

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

Lecture 24 - Linear System Quadratic Cost Problem

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

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

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**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
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- 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 \(Continued.\)](#)

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Lecture 2 - Embedded Hardware

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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

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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

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- Lecture 11 - Capacitance of Transmission Lines
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- Lecture 16 - Compensation of Transmission Lines
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- Lecture 18 - Underground Cables
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- Lecture 20 - Insulators for Overhead Lines
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- Lecture 29 - Newton Raphson (NR), Load Flow Method
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- Lecture 4 - Solution of Switching Equation
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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

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Lecture 14 - Midband Analysis of FET Amplifiers

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

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

Lecture 18 - Low Frequency Response of Small Signal Amplifiers

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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

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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

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**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



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

[Lecture 34 - Unity Gain Bandwidth](#)

[Lecture 35 - Power Amplification](#)

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

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

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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 \(STTC\)](#)

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

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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

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

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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

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

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

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- 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 Commutation Overlap
- Lecture 12 - Commutation 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

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

Lecture 3 - Magnetic Circuit - II

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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

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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

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

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

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Lecture 30 - 3 Phase Induction Machine: Equivalent Circuit

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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...)

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

Lecture 14 - Analysis of Asymmetrical Machine

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

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Lecture 20 - Variable Reluctance (VR) Motors

Lecture 21 - Switched Reluctance Motor (Continued...)

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- Lecture 2 - Basic Understanding of Converter (Half Bridge and Full Bridge Circuit Operation)
- Lecture 3 - Basic Understanding of Converter (Sinusoidal Pulse width Modulation and Three Phase Circuit)
- Lecture 4 - Basic Understanding of Converter (Harmonics in Sinusoidal PWM)
- Lecture 5 - Third harmonic addition in Sine PWM
- Lecture 6 - Introduction to Space Vectors
- Lecture 7 - Space Vector PWM - Timing Calculation
- Lecture 8 - Space Vector PWM - Switching Sequence
- Lecture 9 - Space Vector PWM - Using Carriers
- Lecture 10 - Basic Introduction to Power Devices
- Lecture 11 - Introduction to Multilevel Converters
- Lecture 12 - Cascaded H-bridge Multilevel Converters
- Lecture 13 - Output Voltage Waveform Synthesis in CHB Converter and Basic of Asymmetrical CHB Converters
- Lecture 14 - Cascaded H-Bridge Converters: Phase-Shifted PWM
- Lecture 15 - Cascaded H-Bridge Converters: Level-Shifted PWM
- Lecture 16 - Fault Tolerant Operation of Cascaded H-Bridge Converter - Part I
- Lecture 17 - Fault Tolerant Operation of Cascaded H-Bridge Converter - Part II
- Lecture 18 - Modular Multilevel Converter - Topology and Operation
- Lecture 19 - Modular Multilevel Converter - Arm and Cell Voltage Ratings
- Lecture 20 - Modular Multilevel Converter - Arm Currents
- Lecture 21 - Modular Multilevel Converter - Arm Energy Balancing
- Lecture 22 - Modular Multilevel Converter - Different Circuit Topologies
- Lecture 23 - Modular Multilevel Converter - PWM Technique and Capacitor Voltage Balancing
- Lecture 24 - Modular Multilevel Converter - Fault Tolerant Operation and Commercial Production
- Lecture 25 - Design of Components in MMC
- Lecture 26 - Neutral Point Clamped Converter - Circuit Topology - Part I
- Lecture 27 - Neutral Point Clamped Converter - Circuit Topology - Part II
- Lecture 28 - Neutral Point Clamped Converter - Space Vector Diagram
- Lecture 29 - Neutral Point Clamped Converter - Space Vector PWM
- Lecture 30 - NPC - Sinusoidal PWM and Space Vector PWM using Single Carrier Strategy
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[Lecture 41 - Condition Monitoring of Converters](#)

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Lecture 2 - Introduction continued with Project demos

Lecture 3 - Modular Approach to ESD

Lecture 4 - Modular Approach to ESD (Continued...)

Lecture 5 - Salient Features of Modern Microcontrollers

Lecture 6 - Salient Features of Modern Microcontrollers (Continued...)

Lecture 7 - Elements of Microcontroller Ecosystem

Lecture 8 - Elements of Microcontroller Ecosystem (Continued...)

Lecture 9 - Power Supply for Embedded Systems

Lecture 10 - Power Supply for Embedded Systems (Continued...)

Lecture 11 - Introduction to MSP430

Lecture 12 - MSP430 Architecture

Lecture 13 - MSP430 Architecture- (Continued...) And Introduction to Lunchbox

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Lecture 16 - Physical Interfacing - 2

Lecture 17 - Physical Interfacing - 3

Lecture 18 - Physical Interfacing - 4

Lecture 19 - Physical Interfacing - 5

Lecture 20 - Physical Interfacing - 6

Lecture 21 - GIT, CCS Installation and Embedded C

Lecture 22 - MSP430 Digital I/O

Lecture 23 - MSP430 Digital I/O: Switch Interfacing

Lecture 24 - MSP430 Clock System and Reset

Lecture 25 - Interrupts in MSP430

Lecture 26 - Interrupts in MSP430 (Continued...)

Lecture 27 - Interfacing Seven Segment Displays with MSP430; Low Power Modes in MSP430

Lecture 28 - Interfacing Liquid Crystal Displays (LCD)

Lecture 29 - MSP430 Timer Module: Introduction and Timer Capture

Lecture 30 - Pulse Width Modulation, PWM using Timer Capture

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[Lecture 39 - Single Purpose Computers \(Continued...\)](#)

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- Lecture 2 - Power Quality Standards and Monitoring
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- Lecture 4 - Passive Shunt and Series Compensations
- Lecture 5 - Passive Shunt and Series Compensations (Continued...)
- Lecture 6 - Passive Shunt and Series Compensations (Continued...)
- Lecture 7 - Active Shunt Compensation
- Lecture 8 - Active Shunt Compensation (Continued...)
- Lecture 9 - Active Shunt Compensation (Continued...)
- Lecture 10 - Active Series Compensation
- Lecture 11 - Active Series Compensation (Continued...)
- Lecture 12 - Unified Power Quality Compensators
- Lecture 13 - Unified Power Quality Compensators (Continued...)
- Lecture 14 - Unified Power Quality Compensators (Continued...)
- Lecture 15 - Loads Which Cause Power Quality Problems
- Lecture 16 - Loads Which Cause Power Quality Problems (Continued...)
- Lecture 17 - Passive Power Filters
- Lecture 18 - Passive Power Filters (Continued...)
- Lecture 19 - Passive Power Filters (Continued...)
- Lecture 20 - Shunt Active Power Filters
- Lecture 21 - Shunt Active Power Filters (Continued...)
- Lecture 22 - Shunt Active Power Filters (Continued...)
- Lecture 23 - Active Series Power Filters
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- Lecture 25 - Active Series Power Filters (Continued...)
- Lecture 26 - Hybrid Power Filters
- Lecture 27 - Hybrid Power Filters (Continued...)
- Lecture 28 - Hybrid Power Filters (Continued...)
- Lecture 29 - AC-DC Converters That Cause Power Quality
- Lecture 30 - Improved Power Quality Converters - AC-DC Boost Converters
- Lecture 31 - Improved Power Quality Converters - AC-DC Boost Converters (Continued...)

[Lecture 32 - Improved Power Quality Converters - AC-DC Buck Converters](#)

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[Lecture 34 - Improved Power Quality Converters - AC-DC Buck-Boost Converters \(Continued...\)](#)

[Lecture 35 - Improved Power Quality Converters - AC-DC Buck-Boost Converters \(Continued...\)](#)

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[Lecture 43 - Power Quality Improvement in Diesel Generator Set Based Power Supply System](#)

[Lecture 44 - Power Quality Improvement in Diesel Generator Set Based Power Supply System \(Continued...\)](#)

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Lecture 2 - Control structures and performance measures

Lecture 3 - Time and frequency domain performance measures

Lecture 4 - Design of controller

Lecture 5 - Design of controller for SISO system

Lecture 6 - Controller design for TITO processes

Lecture 7 - Limitations of PID controllers

Lecture 8 - PI-PD controller for SISO system

Lecture 9 - PID-P controller for Two Input Two Output system

Lecture 10 - Effects of measurement noise and load

Lecture 11 - Identification of dynamic models of plants

Lecture 12 - Relay control system for identification

Lecture 13 - Off-line identification of process dynamics

Lecture 14 - On-line identification of plant dynamics

Lecture 15 - State space based identification

Lecture 16 - State space analysis of systems

Lecture 17 - State space based identification of systems - 1

Lecture 18 - State space based identification of systems - 2

Lecture 19 - Identification of simple systems

Lecture 20 - Identification of FOPDT model

Lecture 21 - Identification of second order plus dead time model

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Lecture 23 - Steady state gain from asymmetrical relay test

Lecture 24 - Identification of SOPDT model with pole multiplicity

Lecture 25 - Existence of limit cycle for unstable system

Lecture 26 - Identification procedures

Lecture 27 - Identification of underdamped systems

Lecture 28 - Off-line identification of TITO systems

Lecture 29 - On-line identification of TITO systems

Lecture 30 - Review of time domain based identification

Lecture 31 - DF based analytical expressions for on-line identification

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[Lecture 40 - Tuning of reconfigurable PID controllers](#)

- Lecture 1 - Introduction to Digital VLSI Design Flow
- Lecture 2 - High-level Synthesis (HLS) flow with an example
- Lecture 3 - Automation of High-level Synthesis Steps
- Lecture 4 - Impact of Coding Style on HLS Results
- Lecture 5 - Impact of Compiler Optimizations on HLS Results
- Lecture 6 - RTL Optimizations for Timing
- Lecture 7 - Retiming
- Lecture 8 - RTL Optimizations for Area
- Lecture 9 - RTL Optimizations for Power
- Lecture 10 - High Level Synthesis: Introduction to Logic Synthesis
- Lecture 11 - Overview of FPGA Technology Mapping
- Lecture 12 - Introduction to Physical Synthesis
- Lecture 13 - Introduction to Digital VLSI Testing - I
- Lecture 14 - Introduction to Digital VLSI Testing - II
- Lecture 15 - Optimization Techniques for ATPG - Part I
- Lecture 16 - Optimization Techniques for ATPG - Part II
- Lecture 17 - Optimization Techniques for Design for Testability
- Lecture 18 - High-level fault modeling and RTL level Testing
- Lecture 19 - LTL/CTL based Verification
- Lecture 20 - Verification of Large Scale Systems
- Lecture 21 - BDD based verification
- Lecture 22 - Verification: ADD based verification, HDD based verification
- Lecture 23 - Verification: Symbolic Model Checking
- Lecture 24 - Verification: Bounded Model Checking

Lecture 1 - Probability Basics

Lecture 2 - Random Variable - I

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Lecture 4 - Random Vectors and Random Processes

Lecture 5 - Infinite Sequence of Events - I

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Lecture 7 - Convergence of Sequence of Random Variables

Lecture 8 - Weak Convergence - I

Lecture 9 - Weak Convergence - II

Lecture 10 - Laws of Large Numbers

Lecture 11 - Central Limit Theorem

Lecture 12 - Large Deviation Theory

Lecture 13 - Crammer's Theorem for Large Deviation

Lecture 14 - Introduction to Markov Processes

Lecture 15 - Discrete Time Markov Chain - 1

Lecture 16 - Discrete Time Markov Chain - 2

Lecture 17 - Discrete Time Markov Chain - 3

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Lecture 20 - Continuous Time Markov Chain - 1

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Lecture 2 - Introduction to Transmission Line Theory

Lecture 3 - Lossy Transmission Line

Lecture 4 - Smith Chart

Lecture 5 - Introduction to Waveguides and Rectangular Waveguide

Lecture 6 - Circular Waveguide

Lecture 7 - Attenuation Waveguide

Lecture 8 - N-port microwave networks and equivalent voltages and currents

Lecture 9 - Scattering Matrix (S-Parameters) Part-1

Lecture 10 - Scattering Matrix (S-parameters) Part-2 and Transmission Matrix (ABCD-Parameters)

Lecture 11 - Impedance Matching Using L-Section and Series Stub Networks

Lecture 12 - Impedance Matching Using Shunt Stub, Double Stub and Quarter wave Transformer

Lecture 13 - Multisection Matching Networks and Tapered Lines

Lecture 14 - Series and Parallel RLC Resonators

Lecture 15 - Transmission Line Resonators

Lecture 16 - Waveguide Resonators

Lecture 17 - Introduction to power dividers

Lecture 18 - Directional couplers

Lecture 19 - Microwave Filters - Part 1

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Lecture 21 - Characteristics of Microwave BJT and FET

Lecture 22 - PIN Diodes and Control Circuits

Lecture 23 - Schottky Diodes and Detectors and Tunnel Diodes

Lecture 24 - Gunn Diodes, IMPATT Diodes and Varactor Diodes

Lecture 25 - Two-Port Power Gain and Stability

Lecture 26 - Design of single stage transistor amplifier (for maximum gain, specified gain, low noise)

Lecture 27 - RF oscillator

Lecture 28 - Limitations of Conventional Tubes at Microwave Ranges

Lecture 29 - Introduction to Klystron

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Lecture 31 - Ferrite Devices

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[Lecture 33 - Lumped elements for MIC](#)

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Lecture 1 - Microprocessor Operations

Lecture 2 - 8086 Flags

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Lecture 4 - 8086 Common and Minimum Mode Signals

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Lecture 6 - 8086 Data Transfer Instructions

Lecture 7 - 8086 Arithmetic Instructions - I

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Lecture 9 - 8086 Logical Instructions

Lecture 10 - 8086 Branch and String Instructions

Lecture 11 - 8086 Interrupt and Machine Control Instructions

Lecture 12 - Sum of Products, Multi-byte addition

Lecture 13 - Largest number, 2's complement Programs

Lecture 14 - Programs on Subroutines

Lecture 15 - ROM, RAM

Lecture 16 - Example I

Lecture 17 - Example II

Lecture 18 - Architecture, Interfacing to Simple I/O

Lecture 19 - Keyboard Interface

Lecture 20 - 7-segment Display Interface

Lecture 21 - Multiplexed 7-segment Display Interface

Lecture 22 - Stepper motor, Liquid level control

Lecture 23 - Traffic light control, A/D converter

Lecture 24 - D/A converter

Lecture 25 - Electronic weighing machine

Lecture 26 - Programmable Interval Timer (8254)

Lecture 27 - Modes of 8254

Lecture 28 - Architecture of 8259

Lecture 29 - Initialization command words of 8259

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Lecture 31 - 8237 Architecture, interfacing and Programming

[Lecture 32 - Basic Concepts of serial I/O](#)

[Lecture 33 - Basic Concepts of serial I/O \(Continued...\)](#)

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- Lecture 1 - Overview of Statistical Signal Processing
- Lecture 2 - Probability and Random Variables
- Lecture 3 - Linear Algebra of Random Variables
- Lecture 4 - Random Processes
- Lecture 5 - Linear Shift Invariant Systems with Random Inputs
- Lecture 6 - White Noise and Spectral Factorization Theorem
- Lecture 7 - Linear Models of Random Signals
- Lecture 8 - Estimation Theory - 1
- Lecture 9 - Estimation Theory - 2: MVUE and Cramer Rao Lower Bound
- Lecture 10 - Cramer Rao Lower Bound 2
- Lecture 11 - MVUE through Sufficient Statistic - 1
- Lecture 12 - MVUE through Sufficient Statistic - 2
- Lecture 13 - Method of Moments and Maximum Likelihood Estimators
- Lecture 14 - Properties of Maximum Likelihood Estimator (MLE)
- Lecture 15 - Bayesian Estimators - 1
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- Lecture 17 - Optimal linear filters: Wiener Filter
- Lecture 18 - FIR Wiener filter
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- Lecture 20 - Causal IIR Wiener Filter
- Lecture 21 - Linear Prediction of Signals - 1
- Lecture 22 - Linear Prediction of Signals - 2
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- Lecture 24 - Review Assignment - 1
- Lecture 25 - Adaptive Filters - 1
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Lecture 1 - Introduction to Digital Image Processing

Lecture 2 - Introduction to Computer Vision

Lecture 3 - Introduction to Computer Vision and Basic Concepts of Image Formation

Lecture 4 - Shape From Shading

Lecture 5 - Image Formation: Geometric Camera Models - I

Lecture 6 - Image Formation: Geometric Camera Models - II

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Lecture 8 - Image Formation in a Stereo Vision Setup

Lecture 9 - Image Reconstruction from a Series of Projections

Lecture 10 - Image Reconstruction from a Series of Projections

Lecture 11 - Image Transforms - I

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Lecture 21 - Image Features and Edge Detection

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Lecture 4 - Half adder, full adder and ripple carry adder

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Lecture 21 - Combinational circuit examples

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Lecture 24 - Static RAM and Braun Multiplier

Lecture 25 - FIR filter implementation

Lecture 26 - Baugh-Wooley signed multiplier architecture

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Lecture 2 - Usability - Historical Foundations

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**NPTEL : Advanced Electric Drives (Electrical Engineering)**

**Co-ordinators : Dr. S.P. Das**

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- Lecture 46 - Approaching Lower Bound on Average code length and Block Coding
- Lecture 47 - Huffman Code, Algorithm, Example and Average Code Length
- Lecture 48 - Introduction to channel coding, Rate of Code, Repetition Code and Hamming Distance
- Lecture 49 - Introduction to Convolutional Codes, Binary Field Arithmetic and Linear Codes
- Lecture 50 - Example of Convolutional Code Output and Convolution Operation for Code generation
- Lecture 51 - Matrix Representation of Convolutional Codes, Generator Matrix, Transform Domain Representation and Shift Register Architecture
- Lecture 52 - State Diagram Representation of Convolutional Code, State transitions and Example of Code Generation using State transitions
- Lecture 53 - Trellis Representation of Convolutional Code and Valid Code Words
- Lecture 54 - Decoding of the Convolutional Code, Minimum Hamming distance and Maximum Likelihood Codeword Estimate
- Lecture 55 - Principle of Decoding of Convolutional code
- Lecture 56 - Viterbi Decoder for Maximum Likelihood Decoding of Convolutional Code Using Trellis Representation, Branch Metric Calculation, State Metric Calculation and Example



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

[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](#)

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**NPTEL : NOC:Applied Optimization for Wireless, Machine Learning, Big Data (Electrical Engineering)**

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

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

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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](#)

[Lecture 79 - Matrix Completion Problem in Big Data: Netflix-II](#)

- Lecture 1 - Overview of fiber-optic communication systems
- Lecture 2 - Review of Maxwell's equations
- Lecture 3 - Uniform plane waves (UWPs) in free-space
- Lecture 4 - Properties of UWPs (propagation constant, polarization, and Poynting vector)
- Lecture 5 - Boundary conditions and reflection from a PEC
- Lecture 6 - Obliquely incident waves-I (TE and TM waves, Snell's laws)
- Lecture 7 - Obliquely incident waves-II (Reflection and transmission coefficients, Brewster angle)
- Lecture 8 - Total internal reflection
- Lecture 9 - Ray theory of dielectric slab waveguides
- Lecture 10 - Transverse resonance condition for slab waveguides
- Lecture 11 - Introduction to optical fibers
- Lecture 12 - Ray theory of light propagation in optical fibers
- Lecture 13 - Concept of waveguide modes
- Lecture 14 - Systematic procedure to obtain modes of a waveguide
- Lecture 15 - Systematic analysis of parallel plate metallic waveguide
- Lecture 16 - Systematic analysis of dielectric slab waveguides
- Lecture 17 - Further discussion on slab waveguides
- Lecture 18 - Modal analysis of step index optical fiber
- Lecture 19 - Properties of modes of step-index optical fiber - I
- Lecture 20 - Properties of modes of step-index optical fiber - II
- Lecture 21 - Linearly polarized modes
- Lecture 22 - Attenuation and power loss in fibers
- Lecture 23 - Introduction to dispersion in fibers
- Lecture 24 - Mathematical modelling of dispersion: Transfer function approach
- Lecture 25 - Pulse propagation equation and its solution
- Lecture 26 - Pre-chirped pulses and Inter and Intra-modal dispersion in optical fibers
- Lecture 27 - Beam Propagation Method
- Lecture 28 - Polarization Effects on Pulse Propagation
- Lecture 29 - Modes in Optical Fibres and Pulse Propagation in Optical Fibres
- Lecture 30 - Graded Index Fibers
- Lecture 31 - Light Sources, Detectors and Amplifiers

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

Lecture 1 - Introduction and Types of Transmission Lines

Lecture 2 - Distributed Circuit Model of Uniform Transmission Line

Lecture 3 - Voltage and Current Equation of the Transmission line

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

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

Lecture 6 - Power Calculations and Introduction to Smith Chart

Lecture 7 - Smith Chart

Lecture 8 - Additional Applications of Smith Chart

Lecture 9 - Time domain Analysis of Transmission Line - I

Lecture 10 - Time domain Analysis of Transmission Line - II

Lecture 11 - Usage of Lattice Diagrams

Lecture 12 - TDR analysis of Transmission Lines

Lecture 13 - Introduction to Propagation of Electromagnetic Waves

Lecture 14 - Uniform Plane Waves - I

Lecture 15 - Uniform Plane Waves - II

Lecture 16 - Poynting Vector, Average Power, Polarization

Lecture 17 - Uniform Plane Waves in Lossy Medium

Lecture 18 - Normal Incidence of Plane Waves

Lecture 19 - Oblique Incidence of Plane Waves - I

Lecture 20 - Oblique Incidence of Plane Waves - II

Lecture 21 - Total Internal Reflection

Lecture 22 - Slab Waveguides

Lecture 23 - Optical Fibers

Lecture 24 - Parallel Plate Waveguides

Lecture 25 - Rectangular Waveguides

Lecture 26 - Modes of Rectangular Waveguides

Lecture 27 - Waveguides summary and Introduction to Radiation

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

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

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

Lecture 31 - Linear antenna - I

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

[Lecture 33 - Friis Transmission Formula](#)

[Lecture 34 - Antenna Array](#)

[Lecture 35 - Wireless Channel](#)

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

[Lecture 37 - Diffraction - I](#)

[Lecture 38 - Diffraction - II](#)

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

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

[Lecture 41 - Summary](#)

Lecture 1 - Basic Concepts

Lecture 2 - Sinusoids and Phasors

Lecture 3 - Circuit Elements - Part 1

Lecture 4 - Circuit Elements - Part 2

Lecture 5 - AC Power Analysis

Lecture 6 - RMS Voltage and Current

Lecture 7 - Topology

Lecture 8 - Star-Delta Transformation and Mesh Analysis

Lecture 9 - Mesh Analysis.

Lecture 10 - Nodal Analysis

Lecture 11 - Linearity Property and Superposition Theorem

Lecture 12 - Source Transformation

Lecture 13 - Duality

Lecture 14 - Thevenin's Theorem - 1

Lecture 15 - Thevenin's Theorem - 2

Lecture 16 - Norton's Theorem - 1

Lecture 17 - Norton's Theorem - 2

Lecture 18 - Maximum Power Transfer Theorem - 1

Lecture 19 - Maximum Power Transfer Theorem - 2

Lecture 20 - Reciprocity and Compensation Theorem

Lecture 21 - First Order RC Circuits

Lecture 22 - First Order RL Circuits

Lecture 23 - Singularity Functions

Lecture 24 - Step Response of RC and RL Circuits

Lecture 25 - Second Order Response

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

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

Lecture 28 - Definition of the Laplace Transform

Lecture 29 - Properties of the Laplace Transform

Lecture 30 - Inverse Laplace Transform

Lecture 31 - Laplace Transform of Circuit Elements

[Lecture 32 - Transfer Function](#)

[Lecture 33 - Convolution Integral](#)

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

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

[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

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[Lecture 51 - Mamdani Fuzzy Model - I](#)

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[Lecture 54 - Example on Mamdani Fuzzy Model for Single Antecedent with Three Rules](#)

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[Lecture 56 - Larsen Fuzzy Model - I](#)

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[Lecture 59 - Tsukamoto Fuzzy Model](#)

[Lecture 60 - TSK Fuzzy Model](#)

Lecture 1 - Introduction to Peer to Peer Networks

Lecture 2 - Peer to Peer Network in Telephony:Voice over Internet Telephony (VoIP) and Distributed Hash Table (DHT)

Lecture 3 - Building DHT Networks

Lecture 4 - Logarithmic Partitioning of Node ID Space and Index Entry Authenticity

Lecture 5 - Implementation of Voice over Internet Telephony in P2P Way

Lecture 6 - Leaf Nodes, Core Nodes and Type of Messages in DHT Networks

Lecture 7 - Static and Dynamic Partitioning of Node ID Space: Fixed and Floating Partitioning

Lecture 8 - PASTRY Protocol: The Efficient Use of Internet Infrastructure

Lecture 9 - Understanding the PASTRY Protocol through Example

Lecture 10 - Kademia: A DHT Routing Protocol

Lecture 11 - Tapestry: An Evolution of Kademia

Lecture 12 - Understanding the Tapestry Protocol through Example

Lecture 13 - Multi-dimensional Distributed Hash Table: Mapping of Peers into Multidimensional Space

Lecture 14 - Multi-Layer DHT: A Design for Multiple Services

Lecture 15 - Keeping Pairs at Correct Root Nodes

Lecture 16 - Abrupt and Graceful Exit of Root Node: Maintaining Pairs Alive

Lecture 17 - Resilience of Pairs

Lecture 18 - A P2P Distributed File System

Lecture 19 - Storage Space Problem and Incentives to Share Storage

Lecture 20 - P2P Nodes Communications Challenges in Heterogeneous Network Environments

Lecture 21 - P2P Overlaid Multicast: Basic Design

Lecture 22 - P2P Overlaid Multicast: Alternate Design

Lecture 23 - A Design of P2P Email System

Lecture 24 - P2P Mailing List Services: A Basic Design

Lecture 25 - P2P Mailing List Services: An Alternate Design

Lecture 26 - P2P Web: A Basic Design

Lecture 27 - P2P Web Search Engine: A Basic Design

Lecture 28 - P2P Internet: On Being Anonymous

Lecture 29 - P2P in Blockchain

Lecture 30 - P2P Anonymous Communication

Lecture 31 - The Anonymous Communication on the Internet through TOR Network

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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
- Lecture 13 - Linear Transformation of Gaussian Random Vectors
- Lecture 14 - Machine Learning Application: Gaussian Classification
- Lecture 15 - Eigenvalue: Definition, Characteristic Equation, Eigenvalue Decomposition
- Lecture 16 - Special Matrices: Rotation and Unitary Matrices, Application: Alamouti Code
- Lecture 17 - Positive Semi-definite (PSD) Matrices: Definition, Properties, Eigenvalue Decomposition
- Lecture 18 - Positive Semidefinite Matrix: Example and Illustration of Eigenvalue Decomposition
- Lecture 19 - Machine Learning Application: Principle Component Analysis (PCA)
- Lecture 20 - Computer Vision Application: Face Recognition, Eigenfaces
- Lecture 21 - Least Squares (LS) Solution, Pseudo-Inverse Concept
- Lecture 22 - Least Squares (LS) via Principle of Orthogonality, Projection Matrix, Properties
- Lecture 23 - Application: Pseudo-Inverse and MIMO Zero Forcing (ZF) Receiver
- Lecture 24 - Wireless Application: Multi-Antenna Channel Estimation
- Lecture 25 - Machine Learning Application: Linear Regression
- Lecture 26 - Computation Mathematics Application: Polynomial Fitting
- Lecture 27 - Least Norm Solution
- Lecture 28 - Wireless Application: Multi-user Beamforming
- Lecture 29 - Singular Value Decomposition (SVD): Definition, Properties, Example
- Lecture 30 - SVD Application in MIMO Wireless Technology: Spatial-Multiplexing and High Data Rates
- Lecture 31 - SVD for MIMO wireless optimization, water-filling algorithm, optimal power allocation

Lecture 32 - SVD application for Machine Learning: Principal component analysis (PCA)

Lecture 33 - Multiple signal classification (MUSIC) algorithm: system model

Lecture 34 - MUSIC algorithm for Direction of Arrival (DoA) estimation

Lecture 35 - Linear minimum mean square error (LMMSE) principle

Lecture 36 - LMMSE estimate and error covariance matrix

Lecture 37 - LMMSE estimation in linear systems

Lecture 38 - LMMSE application: Wireless channel estimation and example

Lecture 39 - Time-series prediction via auto-regressive (AR) model

Lecture 40 - Recommender system: design and rating prediction

Lecture 41 - Recommender system: Illustration via movie rating prediction example

Lecture 42 - Fast Fourier transform (FFT) and Inverse fast Fourier transform (IFFT)

Lecture 43 - IFFT/ FFT application in Orthogonal Frequency Division Multiplexing (OFDM) wireless technology

Lecture 44 - OFDM system: Circulant matrices and properties

Lecture 45 - OFDM system model: Transmitter and receiver processing

Lecture 46 - Single-carrier frequency division for multiple access (SC-FDMA) technology

Lecture 47 - Linear dynamical systems: definition and solution via matrix exponential

Lecture 48 - Linear dynamical systems: matrix exponential via SVD

Lecture 49 - Machine Learning application: Support Vector Machines (SVM)

Lecture 50 - Support Vector Machines (SVM): Problem formulation via maximum hyperplane separation

Lecture 51 - Sparse regression: problem formulation and relation to Compressive Sensing (CS)

Lecture 52 - Sparse regression: solution via the Orthogonal Matching Pursuit (OMP) algorithm

Lecture 53 - OMP Example for Sparse Regression

Lecture 54 - Machine Learning Application: Clustering

Lecture 55 - K-Means Clustering algorithm

Lecture 56 - Introduction to Stochastic Processes and Markov Chains

Lecture 57 - Discrete Time Markov Chains and Transition Probability Matrix

Lecture 58 - Discrete Time Markov Chain Examples

Lecture 59 - m-STEP Transition Probabilities for Discrete Time Markov Chains

Lecture 60 - Limiting Behavior of Discrete Time Markov Chains

Lecture 61 - Least Squares Revisited: Rank Deficient Matrix

Lecture 62 - Least Squares using SVD

Lecture 63 - Weighted Least Squares

Lecture 64 - Weighted Least Squares Example

[Lecture 65 - Woodbury Matrix Identity - Matrix Inversion Lemma](#)

[Lecture 66 - Woodbury Matrix Identity - Proof](#)

[Lecture 67 - Conditional Gaussian Density - Mean](#)

[Lecture 68 - Conditional Gaussian Density - Covariance](#)

[Lecture 69 - Scalar Linear Model for Gaussian Estimation](#)

[Lecture 70 - MMSE Estimate and Covariance for the Scalar Linear Model](#)



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Lecture 1 - Introduction

Lecture 2 - Operating Principles and Construction of Single Phase Transformers

Lecture 3 - Modeling of Single Phase Transformers

Lecture 4 - Equivalent Circuits of Single Phase Transformers

Lecture 5 - Testing of Single Phase Transformers

Lecture 6 - Efficiency of Single Phase Transformers

Lecture 7 - Voltage Regulation of Single Phase Transformers

Lecture 8 - Parallel Operation of Single Phase Transformers

Lecture 9 - Harmonics and Switching Transients in Single Phase Transformers

Lecture 10 - Introduction to Three Phase Transformer

Lecture 11 - Construction of Three Phase Transformers

Lecture 12 - Three Phase Transformer Connections

Lecture 13 - Three Phase Transformer Phase Groups Part - I

Lecture 14 - Three Phase Transformer Phase Groups Part - II

Lecture 15 - Analysis and Testing of Three Phase Transformers

Lecture 16 - Operation of Three Phase Transformers

Lecture 17 - Auto Transformers

Lecture 18 - Three Winding Transformers

Lecture 19 - Scott Connected Transformers

Lecture 20 - Potential and Current Transformers

Lecture 21 - Operating Principles of DC Machines

Lecture 22 - Constructional Features of DC Machines

Lecture 23 - Generated EMF and Torque in DC Machines

Lecture 24 - Armature Reaction

Lecture 25 - Commutation in DC Machines

Lecture 26 - Separately Excited DC Generators

Lecture 27 - DC Shunt Generators

Lecture 28 - Compound DC Generators

Lecture 29 - Interconnected DC Generators

Lecture 30 - Characteristics of DC Shunt Motors

Lecture 31 - Starting of DC Shunt Motors



[Lecture 32 - Speed Control of DC Shunt Motors](#)

[Lecture 33 - Braking of DC Shunt Motors](#)

[Lecture 34 - Electronic Control of DC Shunt Motors](#)

[Lecture 35 - Testing of DC Shunt Motors](#)

[Lecture 36 - Characteristics of DC Series Motors](#)

[Lecture 37 - Starting and Braking of DC Series Motors](#)

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[Lecture 39 - Testing of DC Series Motors](#)

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**NPTEL : Optimal Control (Electrical Engineering)**

**Co-ordinators : Prof. G.D. Ray**

- Lecture 1 - Introduction to Optimization Problem: Some Examples
- Lecture 2 - Introduction to Optimization Problem: Some Examples (Continued.)
- Lecture 3 - Optimality Conditions for Function of Several Variables
- Lecture 4 - Optimality Conditions for Function of Several Variables (Continued.)
- Lecture 5 - Unconstrained Optimization Problem (Numerical Techniques)
- Lecture 6 - Solution of Unconstrained Optimization Problem Using Conjugate Gradient Method and Networks Methods
- Lecture 7 - Solution of Unconstrained Optimization Problem Using Conjugate Gradient Method and Networks Methods (Continued.)
- Lecture 8 - Solution of Constraint Optimization Problem-Karush-Kuhn Tucker (KKT) Conditions
- Lecture 9 - Solution of Constraint Optimization Problem-Karush-Kuhn Tucker (KKT) Conditions (Continued.)
- Lecture 10 - Problem and Solution Session
- Lecture 11 - Post Optimality Analysis, Convex Function and its Properties
- Lecture 12 - Post Optimality Analysis, Convex Function and its Properties (Continued.)
- Lecture 13 - Quadratic Optimization Problem Using Linear Programming
- Lecture 14 - Matrix form of the Simplex Method
- Lecture 15 - Matrix form of the Simplex Method (Continued.)
- Lecture 16 - Solution of Linear Programming Using Simplex Method:- Algebraic Approach
- Lecture 17 - Solution of Linear Programming Using Simplex Method:- Algebraic Approach (Continued.)
- Lecture 18 - Solution of LP Problems with Two Phase Method
- Lecture 19 - Solution of LP Problems with Two Phase Method (Continued.)
- Lecture 20 - Standard Primal and Dual Problems
- Lecture 21 - Relationship Between Primal and Dual Variables
- Lecture 22 - Solution of Quadratic Programming Problem Using Simplex Method
- Lecture 23 - Interior Point Method for Solving Optimization Problems
- Lecture 24 - Interior Point Method for Solving Optimization Problems (Continued.)
- Lecture 25 - Solution of Nonlinear Programming Problem Using Exterior Penalty Function Method
- Lecture 26 - Solution of Nonlinear Programming Problem Using Exterior Penalty Function Method (Continued.)
- Lecture 27 - Solution of Nonlinear Programming Problem Using Interior Penalty Function Method
- Lecture 28 - Solution of Nonlinear Programming Problem Using Interior Penalty Function Method (Continued.)
- Lecture 29 - Multiobjective Optimization Problem
- Lecture 30 - Dynamic Optimization Problem: Basic Concepts and Necessary and Sufficient Condition
- Lecture 31 - Dynamic Optimization Problem: Basic Concepts and Necessary and Sufficient Condition (Continued...I)

- Lecture 32 - Dynamic Optimization Problem: Basic Concepts and Necessary and Sufficient Condition (Continued...2)
- Lecture 33 - Numerical Example and Solution of Optimal Control Problem using Calculus of Variation principle
- Lecture 34 - Numerical Example and Solution of Optimal Control Problem using Calculus of Variation principle (Continued.)
- Lecture 35 - Hamiltonian Formulation for solution of optimal Control problem and numerical example
- Lecture 36 - Hamiltonian Formulation for solution of optimal Control problem and numerical example (Continued.)
- Lecture 37 - Performance Indices and Linear Quadratic Regulator Problem
- Lecture 38 - Performance Indices and Linear Quadratic Regulator Problem (Continued.)
- Lecture 39 - Solution and Stability Analysis of Finite - time LQR Problem: Numerical Example
- Lecture 40 - Solution and Infinite - time LQR Problem and Stability Analysis
- Lecture 41 - Numerical Example and Methods for Solution of A.R.E.
- Lecture 42 - Numerical Example and Methods for Solution of A.R.E. (Continued.)
- Lecture 43 - Frequency Domain Interpretation of LQR Controlled System
- Lecture 44 - Gain and Phase Margin of LQR Controlled System
- Lecture 45 - The Linear Quadratic Gaussian Problem
- Lecture 46 - Loop-Transfer Recovery
- Lecture 47 - Dynamic Programming for Discrete Time Systems
- Lecture 48 - Minimum  $\|u\|$  Time Control of a Linear Time Invariant System
- Lecture 49 - Solution of Minimum  $\|u\|$  Time Control Problem with an Example
- Lecture 50 - Constraint in Control Inputs and State Variables
- Lecture 51 - Constraint in Control Inputs and State Variables (Continued...)
- Lecture 52 - Norms for Vectors, Matrices, Signals and Linear Systems
- Lecture 53 - Signal and System Norms
- Lecture 54 - Internal Stability, Sensitivity and Complementary Sensitivity Functions
- Lecture 55 - Internal Stability, Sensitivity and Complementary Sensitivity Functions (Continued...)
- Lecture 56 - Plant Uncertainty and Standard form for Robust Stability Analysis
- Lecture 57 - Plant Uncertainty and Standard form for Robust Stability Analysis (Continued...)
- Lecture 58 - Frequency Response of Linear System and Singular Value Decomposition of System
- Lecture 59 - Control Problem Statement in H-  $\alpha$  Framework
- Lecture 60 - Control Problem Statement in H -  $\alpha$  Framework (Continued...)

- Lecture 1 - Representations of Dynamical Systems
- Lecture 2 - Vector Fields of Nonlinear Systems
- Lecture 3 - Limit Cycles
- Lecture 4 - The Lorenz Equation - I
- Lecture 5 - The Lorenz Equation - II
- Lecture 6 - The Rossler Equation and Forced Pendulum
- Lecture 7 - The Chua's Circuit
- Lecture 8 - Discrete Time Dynamical Systems
- Lecture 9 - The Logistic Map and Period doubling
- Lecture 10 - Flip and Tangent Bifurcations
- Lecture 11 - Intermittency Transcritical and pitchfork
- Lecture 12 - Two Dimensional Maps
- Lecture 13 - Bifurcations in Two Dimensional Maps
- Lecture 14 - Introduction to Fractals
- Lecture 15 - Mandelbrot Sets and Julia Sets
- Lecture 16 - The Space Where Fractals Live
- Lecture 17 - Interactive Function Systems
- Lecture 18 - IFS Algorithms
- Lecture 19 - Fractal Image Compression
- Lecture 20 - Stable and Unstable Manifolds
- Lecture 21 - Boundary Crisis and Interior Crisis
- Lecture 22 - Statistics of Chaotic Attractors
- Lecture 23 - Matrix Times Circle : Ellipse
- Lecture 24 - Lyapunov Exponent
- Lecture 25 - Frequency Spectra of Orbits
- Lecture 26 - Dynamics on a Torus
- Lecture 27 - Dynamics on a Torus
- Lecture 28 - Analysis of Chaotic Time Series
- Lecture 29 - Analysis of Chaotic Time Series
- Lecture 30 - Lyapunou Function and Centre Manifold Theory
- Lecture 31 - Non-Smooth Bifurcations

[Lecture 32 - Non-Smooth Bifurcations](#)

[Lecture 33 - Normal form for Piecewise Smooth 2D Maps](#)

[Lecture 34 - Bifurcations in Piecewise Linear 2D Maps](#)

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[Lecture 36 - Multiple Attractor Bifurcation and Dangerous](#)

[Lecture 37 - Dynamics of Discontinuous Maps](#)

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[Lecture 40 - Control of Chaos](#)

Lecture 1 - Discrete Time Signal and System

Lecture 2 - Discrete Time Signal and System (Continued...)

Lecture 3 - Discrete Time Signal and System (Continued...)

Lecture 4 - Frequency Domain Representation of Discrete Signals

Lecture 5 - Z-Transform

Lecture 6 - Z-Transform (Continued...)

Lecture 7 - Solution of Difference Equation

Lecture 8 - Tutorial on Discrete Time Signals & Their Transforms

Lecture 9 - Relation Between Discrete Time and Continuous Signals

Lecture 10 - Discrete Fourier Transform (DFT)

Lecture 11 - Discrete Fourier Transform (DFT) (Continued...)

Lecture 12 - Discrete Fourier Transform (DFT) (Continued...)

Lecture 13 - State Space Representation

Lecture 14 - Filters Introduction

Lecture 15 - FIR Filters

Lecture 16 - FIR Filters (Continued...) Introduction to IIR Filters

Lecture 17 - IIR Filters (Continued...)

Lecture 18 - IIR Filters (Continued...)

Lecture 19 - IIR Filters (Continued...)

Lecture 20 - Tutorial & Introduction to Computer Aided Design of Filters

Lecture 21 - Computer Aided Design of Filters

Lecture 22 - FFT and Computer Aided Design of Filters

Lecture 23 - Introduction to Lattice Filter

Lecture 24 - Lattice Filter (Continued...)

Lecture 25 - Effects of Quantization

Lecture 26 - Effects of Quantization (Continued...)

Lecture 27 - Effects of Quantization (Continued...)

Lecture 28 - Effects of Quantization (Continued...)

Lecture 29 - Random Signals

Lecture 30 - Relationship Between Real and Imaginary Parts of DTFT

Lecture 31 - Relationship Between Real and Imaginary Parts of DTFT

[Lecture 32 - Relationship Between Real and Imaginary Parts of DTFT](#)

[Lecture 33 - Multi rate Signal Processing](#)

[Lecture 34 - Multi rate Signal Processing \(Continued...\)](#)

[Lecture 35 - Polyphase Decomposition](#)

Lecture 1 - Introduction to System Elements

Lecture 2 - Newton's Method and Constraints

Lecture 3 - Derivation of the Lagrangian Equation

Lecture 4 - Using the lagrangian Equation to Obtain Differential Equations (Part-I)

Lecture 5 - Using the lagrangian Equation to Obtain Differential Equations (Part-II)

Lecture 6 - Using the lagrangian Equation to Obtain Differential Equations (Part-III)

Lecture 7 - Using the lagrangian Equation to Obtain Differential Equations (Part-IV)

Lecture 8 - Obtaining First Order Equations

Lecture 9 - Application of the Hamiltonian Method

Lecture 10 - Obtaining Differential Equations Using Kirchoff's Laws

Lecture 11 - The Graph Theory Approach for Electrical Circuits (Part-I)

Lecture 12 - The Graph Theory Approach for Electrical Circuits (Part-II)

Lecture 13 - The Bond Graph Approach - I

Lecture 14 - The Bond Graph Approach - II

Lecture 15 - The Bond Graph Approach - III

Lecture 16 - The Bond Graph Approach - IV

Lecture 17 - The Bond Graph Approach - V

Lecture 18 - The Bond Graph Approach - VI

Lecture 19 - The Bond Graph Approach - VII

Lecture 20 - Numerical Solution of Differential Equations

Lecture 21 - Dynamics in the State Space

Lecture 22 - Vector Field Around Equilibrium Points - I

Lecture 23 - Vector Field Around Equilibrium Points - II

Lecture 24 - Vector Field Around Equilibrium Points - III

Lecture 25 - Vector Field Around Equilibrium Points - IV

Lecture 26 - High Dimensional Linear Systems

Lecture 27 - Linear Systems with External Input - I

Lecture 28 - Linear Systems with External Input - II

Lecture 29 - Linear Systems with External Input - III

Lecture 30 - Dynamics of Nonlinear Systems - I

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[Lecture 32 - Dynamics of Nonlinear Systems - III](#)

[Lecture 33 - Discrete-Time Dynamical Systems - I](#)

[Lecture 34 - Discrete-Time Dynamical Systems - II](#)

Lecture 1 - Thermodynamics: Fundamentals Of Energy - Energy Resources & Technology

Lecture 2 - Quality of Energy

Lecture 3 - Complete Cycle Analysis of Fossil Fuels

Lecture 4 - Energy in Transportation

Lecture 5 - Other Fossil Fuels

Lecture 6 - Energy Economics : Input-Output Analysis

Lecture 7 - Energy Economics : Input-Output Analysis

Lecture 8 - Thermal Power Plants

Lecture 9 - Thermal Power Plants

Lecture 10 - Hydroelectric Power

Lecture 11 - Hydroelectric Power

Lecture 12 - Nuclear Power Generation

Lecture 13 - Nuclear Fusion Reactors

Lecture 14 - Environmental Effects of Conventional Power

Lecture 15 - Solar Thermal Energy Conversion

Lecture 16 - Solar Concentrating Collectors

Lecture 17 - Photovoltaic Power Generation

Lecture 18 - Photovoltaic Power Generation (Continued.)

Lecture 19 - Photovoltaic Power Generation (Continued.)

Lecture 20 - Photovoltaic Power Generation (Continued.)

Lecture 21 - Wind Energy - I

Lecture 22 - Wind Energy - II

Lecture 23 - Wind Energy - III

Lecture 24 - Wind Energy - IV

Lecture 25 - Wind Energy - V

Lecture 26 - Wind Energy - VI

Lecture 27 - Wind Electrical Conversion - I

Lecture 28 - Wind Electrical Conversion - II

Lecture 29 - Wind Electrical Conversion - III

Lecture 30 - Tidal Energy

Lecture 31 - Tidal Energy

[Lecture 32 - Tidal Energy](#)

[Lecture 33 - Ocean Thermal Energy Conversion](#)

[Lecture 34 - Solar Pond and Wave Power](#)

[Lecture 35 - Geothermal Energy](#)

[Lecture 36 - Solar Distillation and Biomass Energy](#)

[Lecture 37 - Energy Storage](#)

[Lecture 38 - Magneto hydrodynamic Power Generation](#)

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Lecture 2 - Probability Theory

Lecture 3 - Random Variables

Lecture 4 - Function of Random Variable Joint Density

Lecture 5 - Mean and Variance

Lecture 6 - Random Vectors Random Processes

Lecture 7 - Random Processes and Linear Systems

Lecture 8 - Some Numerical Problems

Lecture 9 - Miscellaneous Topics on Random Process

Lecture 10 - Linear Signal Models

Lecture 11 - Linear Mean Sq.Error Estimation

Lecture 12 - Auto Correlation and Power Spectrum Estimation

Lecture 13 - Z-Transform Revisited Eigen Vectors/Values

Lecture 14 - The Concept of Innovation

Lecture 15 - Last Squares Estimation Optimal IIR Filters

Lecture 16 - Introduction to Adaptive Filters

Lecture 17 - State Estimation

Lecture 18 - Kalman Filter-Model and Derivation

Lecture 19 - Kalman Filter-Derivation (Continued...)

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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 18 - Optical Waveguides: Theory and Design: Orthogonality of Guided Modes
- Lecture 19 - Optical Waveguides: Theory and Design: Coupled Mode Theory of Guided Modes
- Lecture 20 - Optical Waveguides: Theory and Design: Coupled Mode Theory (Continued...)
- Lecture 21 - Optical Waveguides: Theory and Design: Coupled Mode Theory (Continued...)
- Lecture 22 - Integrated Optical Components: Y-Junction Power Splitter/Combiner and Mach-Zehnder Interferometer
- Lecture 23 - Integrated Optical Components: Directional Coupler: Coupled Waveguides
- Lecture 24 - Integrated Optical Components: Directional Coupler: Coupled Waveguides (Continued...)
- Lecture 25 - Integrated Optical Components: Directional Coupler: Design and Modelling
- Lecture 26 - Integrated Optical Components: DC based MZI and Microring Resonator (MRR)
- Lecture 27 - Integrated Optical Components: Microring Resonator (MRR): Passive Characteristics
- Lecture 28 - Integrated Optical Components: Distributed Bragg Reflector (DBR)
- Lecture 29 - Integrated Optical Components: Distributed Bragg Reflector (DBR): Device Design - Part 1
- Lecture 30 - Integrated Optical Components: Distributed Bragg Reflector (DBR): Device Design - Part 2
- Lecture 31 - Tunable Devices and Reconfigurable Circuits: Phase Error Interference

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[Lecture 33 - Tunable Devices and Reconfigurable Circuits: Thermo-Optic Switching and Tuning](#)

[Lecture 34 - Tunable Devices and Reconfigurable Circuits: Programmable Silicon Photonics](#)

[Lecture 35 - Electro-Optic Modulators for Integrated Photonics: Basic Design and Working Principle](#)

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[Lecture 38 - Light Sources and Photodetectors for Integrated Photonics: Integrated Photonic light Sources - Part 1](#)

[Lecture 39 - Light Sources and Photodetectors for Integrated Photonics: Integrated Photonic light Sources - Part 2](#)

[Lecture 40 - Light Sources and Photodetectors for Integrated Photonics: Photodetectors for Silicon Photonics](#)

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- Lecture 2 - Classical Vs Quantum Mechanics
- Lecture 3 - Electrons in infinite and finite 1D potential well
- Lecture 4 - 3D potential well model of atom and Bohr's model
- Lecture 5 - Covalent bonds and inter-atomic interactions in Silicon
- Lecture 6 - Energy band formation
- Lecture 7 - Electron hole pair generation
- Lecture 8 - Direct and Indirect bandgap semiconductors
- Lecture 9 - Energy levels in infinite and finite potential wells (short demo)
- Lecture 10 - Effective mass in Semiconductors
- Lecture 11 - Intrinsic carrier density
- Lecture 12 - Doping and extrinsic semiconductors
- Lecture 13 - Fermi level in extrinsic semiconductors
- Lecture 14 - Temperature dependence of Fermi level
- Lecture 15 - Temperature dependence of Fermi level
- Lecture 16 - Charge neutrality relationship
- Lecture 17 - Drift current and energy band representation of kinetic energy of carriers
- Lecture 18 - Semiconductor bands in a electric field
- Lecture 19 - Diffusion current
- Lecture 20 - Non-uniform doping
- Lecture 21 - Equilibrium Vs Nonequilibrium carrier response
- Lecture 22 - Minority carrier diffusion equation (MCDE) - Example problems
- Lecture 23 - Quasi Fermi level in nonequilibrium conditions
- Lecture 24 - Quasi Fermi level and minority carrier diffusion length
- Lecture 25 - Semiconductor device fabrication
- Lecture 26 - PN Junctions - An introduction
- Lecture 27 - PN Junction electrostatics
- Lecture 28 - Energy band diagram of PN junction
- Lecture 29 - Depletion width and peak electric field
- Lecture 30 - PN junction electrostatics - examples
- Lecture 31 - Demo of PN Junction Lab on Nanohub

- Lecture 32 - Forward and reverse biased PN junctions
- Lecture 33 - Minority carrier injection in PN junctions
- Lecture 34 - Current in forward biased PN junction
- Lecture 35 - Current in reverse biased PN junction
- Lecture 36 - Depletion capacitance in PN junction
- Lecture 37 - Non-idealities in PN junction diode
- Lecture 38 - Nanohub Demo - PN Junction with applied bias
- Lecture 39 - Schottky barrier in metal-semiconductor junction
- Lecture 40 - Current flow across a Schottky barrier
- Lecture 41 - Ohmic vs rectifying contacts
- Lecture 42 - An Ideal MOS Capacitor
- Lecture 43 - Operating regimes of a MOSCAP
- Lecture 44 - Simplified band diagrams of accumulation and depletion in MOSCAP
- Lecture 45 - Inversion in a MOSCAP
- Lecture 46 - NMOSCAP in accumulation mode
- Lecture 47 - NMOSCAP in depletion mode
- Lecture 48 - NMOSCAP in inversion mode
- Lecture 49 - Exact solution vs delta-depletion approximation
- Lecture 50 - Threshold voltage in a MOSCAP
- Lecture 51 - Nanohub Demo - MOSCAP tool
- Lecture 52 - Non-ideal MOS Capacitor
- Lecture 53 - MOSCAP Capacitance-Voltage (CV) Characteristics
- Lecture 54 - Example problems with MOSCAPs
- Lecture 55 - Impact of doping, oxide thickness and temperature on CV
- Lecture 56 - Nanohub Demo - MOS CV
- Lecture 57 - Introduction to MOSFET
- Lecture 58 - Operating modes of a MOSFET
- Lecture 59 - IV Characteristics of a long channel MOSFET
- Lecture 60 - Example problems with MOSFETs
- Lecture 61 - MOSFET device metrics
- Lecture 62 - CMOS Technology
- Lecture 63 - MOSFET Scaling and technology nodes
- Lecture 64 - Limits of scaling

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[Lecture 74 - Radiative absorption and emission processes](#)

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[Lecture 76 - Operation of a light emitting diode \(LED\)](#)

[Lecture 77 - LED emission spectrum](#)

[Lecture 78 - Stimulated emission and lasing](#)

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

**NPTEL : NOC:Electric Vehicles and Renewable Energy (Electrical Engineering)**

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

Lecture 1 - Electric Vehicle Introduction

Lecture 2 - The drive Torque, Power, Speed and Energy

Lecture 3 - Energy Source

Lecture 4 - Vehicle Auxillary, Petrol pumps and Charging stations

Lecture 5 - Introduction to Electric Vehicles in India

Lecture 6 - Can India Drive its EV program Innovatively and Differently and scale

Lecture 7 - Battery Cost reduction strategy

Lecture 8 - A bit about Batteries, Charging and Swapping Infrastructure

Lecture 9 - Where will we get Lithium for batteries and EV Subsystems

Lecture 10 - Forces acting when a vehicle move

Lecture 11 - Aerodynamic drag, Rolling Resistance and Uphill Resistance

Lecture 12 - Power and torque to accelerate

Lecture 13 - Putting it all together - 1

Lecture 14 - Putting it all together - 2

Lecture 15 - Concept of drive cycle - 1

Lecture 16 - Concept of drive cycle - 2

Lecture 17 - Drive Cycles and Energy used per km - Part 1

Lecture 18 - Drive Cycles and Energy used per km - Part 2

Lecture 19 - EV Subsystem: Design of EV Drive Train - Part 1

Lecture 20 - EV Subsystem: Design of EV Drive Train - Part 2

Lecture 21 - Introduction to Battery Parameters - Part 1

Lecture 22 - Introduction to Battery Parameters - Part 2

Lecture 23 - Why Lithium Ion Battery? - Part 1

Lecture 24 - Why Lithium Ion Battery? - Part 2

Lecture 25 - Batteries in Future

Lecture 26 - Li-Ion Battery Cells

Lecture 27 - SoH and SoC estimation and Self Discharge - Part 1

Lecture 28 - SoH and SoC estimation and Self Discharge - Part 2

Lecture 29 - Battery Pack Development - Part 1

Lecture 30 - Battery Pack Development - Part 2

Lecture 31 - Computation of Effective cost of battery - Part 1



- [Lecture 32 - Computation of Effective cost of battery - Part 2](#)
- [Lecture 33 - Charging Batteries](#)
- [Lecture 34 - Fundamentals of Battery Pack Design](#)
- [Lecture 35 - Electrical Design of Battery Pack - Part 1](#)
- [Lecture 36 - Electrical Design of Battery Pack - Part 2](#)
- [Lecture 37 - Electrical Design of Battery Pack - Part 3](#)
- [Lecture 38 - Mechanical Design of Battery Pack - Part 1](#)
- [Lecture 39 - Mechanical Design of Battery Pack - Part 2](#)
- [Lecture 40 - Mechanical Design of Battery Pack - Part 3](#)
- [Lecture 41 - Mechanical Design of Battery Pack - Part 4](#)
- [Lecture 42 - Thermal Design of Battery Pack - Part 1](#)
- [Lecture 43 - Thermal Design of Battery Pack - Part 2](#)
- [Lecture 44 - Thermal Design of Battery Pack - Part 3](#)
- [Lecture 45 - Thermal Design of Battery Pack - Part 4](#)
- [Lecture 46 - BMS Design and Embedded System - Part 1](#)
- [Lecture 47 - BMS Design and Embedded System - Part 2](#)
- [Lecture 48 - BMS Design and Embedded System - Part 3](#)
- [Lecture 49 - BMS Design and Embedded System - Part 4](#)
- [Lecture 50 - BMS Design and Embedded System - Part 5](#)
- [Lecture 51 - Cell Testing and Characterization - Part 1](#)
- [Lecture 52 - Cell Testing and Characterization - Part 2](#)
- [Lecture 53 - EV Motors and Controllers - Vehicle Dynamics - Part 1](#)
- [Lecture 54 - EV Motors and Controllers - Vehicle Dynamics - Part 2](#)
- [Lecture 55 - EV Motors and Controllers - Understanding Flow - Part 1](#)
- [Lecture 56 - EV Motors and Controllers - Understanding Flow - Part 2](#)
- [Lecture 57 - Power and Efficiency](#)
- [Lecture 58 - Torque Production - Part 1](#)
- [Lecture 59 - Torque Production - Part 2](#)
- [Lecture 60 - Torque Production - Part 3](#)
- [Lecture 61 - Speed and Back EMF](#)
- [Lecture 62 - The d-q Equivalent circuit - Part 1](#)
- [Lecture 63 - The d-q Equivalent circuit - Part 2](#)
- [Lecture 64 - Field-oriented Control](#)

- Lecture 65 - Three phase AC - Part 1
- Lecture 66 - Three phase AC - Part 2
- Lecture 67 - Thermal Design - Part 1
- Lecture 68 - Thermal Design - Part 2
- Lecture 69 - Thermal Design - Part 3
- Lecture 70 - Engineering Considerations - Part 1
- Lecture 71 - Engineering Considerations - Part 2
- Lecture 72 - Engineering Considerations - Part 3 and Future Frontiers
- Lecture 73 - EV Charger Introduction
- Lecture 74 - Charger Parameters and Types
- Lecture 75 - Slow Fast chargers and Swapping
- Lecture 76 - Swapping
- Lecture 77 - Standardization and on board chargers
- Lecture 78 - Public chargers
- Lecture 79 - Public charger economics in Indian Context
- Lecture 80 - Bulk Chargers, Swapping stations and data analytics
- Lecture 81 - Introduction to Energy Scenario in India - Part 1
- Lecture 82 - Introduction to Energy Scenario in India - Part 2
- Lecture 83 - A novel Approach towards 100% RE in India - Part 1
- Lecture 84 - A novel Approach towards 100% RE in India - Part 2
- Lecture 85 - Going Beyond solar, wind, Li Ion and chilled water storage
- Lecture 86 - Solar Photovoltaic
- Lecture 87 - Solar Cell and its Characteristics
- Lecture 88 - Solar Cells to Modules
- Lecture 89 - Wind Energy
- Lecture 90 - The War of Currents
- Lecture 91 - The Birth of Solar - DC
- Lecture 92 - Storage Options for Energy - Part 1
- Lecture 93 - Storage Options for Energy - Part 2
- Lecture 94 - Storage Options for Energy - Part 3
- Lecture 95 - Storage Options for Energy - Part 4
- Lecture 96 - The EV Ecosystem - Part 1
- Lecture 97 - The EV Ecosystem - Part 2



**NPTEL : Phase-locked loops (Electrical Engineering)**

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

Lecture 1 - Course Introduction and Motivation - Part I

Lecture 2 - Course Introduction and Motivation - Part II

Lecture 3 - Basic Operation of a Phase Locked Loop

Lecture 4 - Simple Implementation of a Phase Locked Loop

Lecture 5 - Input Output Characteristics of Basic PLL Blocks

Lecture 6 - Time Domain Analysis of a Simple PLL

Lecture 7 - Time Domain Versus Small Signal Analysis of a Simple PLL

Lecture 8 - Type and Order of PLL

Lecture 9 - Small Signal Analysis of Type-I/II/III PLLs for Phase Step, Frequency Step and Frequency Ramp

Lecture 10 - Frequency Acquisition Range for PLLs

Lecture 11 - Frequency Acquisition in Type-I PLLs

Lecture 12 - Frequency Acquisition Limits in Type-I PLLs

Lecture 13 - Frequency Acquisition in Type II PLLs

Lecture 14 - Frequency Acquisition Ranges in Type II PLLs with Ideal and Non Ideal Integrator

Lecture 15 - Frequency Domain Insight in Frequency Acquisition for Type II PLLs

Lecture 16 - Introduction to Clock Multipliers

Lecture 17 - Analog Phase Error Detectors - Part I

Lecture 18 - Analog Phase Error Detectors - Part II

Lecture 19 - Digital Phase Error Detectors - Part I

Lecture 20 - Digital Phase Error Detectors - Part II

Lecture 21 - Range Extension for Phase Error Detectors

Lecture 22 - Phase Frequency Detector

Lecture 23 - Digital Frequency Detector

Lecture 24 - Charge Pump PLL

Lecture 25 - Small Signal and Stability Analysis of Type II Order 2 Charge Pump PLL

Lecture 26 - Problems in Charge Pump PLL - Dead Zone in PFD

Lecture 27 - Problems in Charge Pump PLL - Reference Spur

Lecture 28 - Design Procedure for Type-II Order 3 Charge Pump PLL

Lecture 29 - Design Procedure for Charge Pump Clock Multiplier

Lecture 30 - Sources of Non-Linearities in CP-PLL - Part I

Lecture 31 - Sources of Non-Linearities in CP-PLL - Part II

- Lecture 32 - Noise Analysis in CP-PLL - Part I
- Lecture 33 - Noise Analysis in CP PLL - Part II
- Lecture 34 - Noise Analysis in CP-PLL - Part III
- Lecture 35 - Noise Simulations for CP-PLL Blocks
- Lecture 36 - Introduction to Oscillators
- Lecture 37 - Low Swing Ring Oscillator - Part I
- Lecture 38 - Low-Swing Ring Oscillator - Part II
- Lecture 39 - Large-Swing Ring Oscillator - Part I
- Lecture 40 - Large-Swing Ring Oscillator - Part II
- Lecture 41 - Large-Swing Ring Oscillator - Part III
- Lecture 42 - Large-Swing Ring Oscillator - Part IV
- Lecture 43 - Large-Swing Ring Oscillator - Part V
- Lecture 44 - Supply Regulated VCO - Part I
- Lecture 45 - Supply Regulated VCO - Part II
- Lecture 46 - Supply Regulated VCO - Part III
- Lecture 47 - Phase Noise in Ring Oscillators
- Lecture 48 - Circuit level Design of PFD - Part I
- Lecture 49 - Circuit level Design of PFD - Part II
- Lecture 50 - Circuit level Design of PFD - Part III
- Lecture 51 - Circuit level Design of Charge Pump - Part I
- Lecture 52 - Circuit-level Design of Charge Pump - Part II
- Lecture 53 - Circuit-level Design of Charge Pump - Part III
- Lecture 54 - Circuit-level Design of Charge Pump - Part IV
- Lecture 55 - Circuit-level Design of Charge Pump - Part V
- Lecture 56 - Circuit-level Design of Charge Pump - Part VI
- Lecture 57 - Circuit-level Design of Clock Frequency Divider
- Lecture 58 - Techniques for Wide Frequency Range Clock Multiplier
- Lecture 59 - Introduction to Digital PLL
- Lecture 60 - Design of Time-to-Digital Converter
- Lecture 61 - Small Signal Analysis of Digital PLL
- Lecture 62 - Noise Analysis in Digital PLL
- Lecture 63 - Analog/Digital Hybrid PLL - Part I
- Lecture 64 - Analog/Digital Hybrid PLL - Part II



Lecture 1 - Review of Maxwell's Equations

Lecture 2 - Wave Equation

Lecture 3 - Dispersion Relation

Lecture 4 - Propagating and Evanescent Waves

Lecture 5 - Diffraction Limit and Spatial Frequencies

Lecture 6 - Plane Waves

Lecture 7 - Optical Response of Materials

Lecture 8 - Lorentz Model

Lecture 9 - Properties of Lorentz Oscillator Model

Lecture 10 - Drude-Lorentz Model for Metals

Lecture 11 - Kramers-Kronig Relation

Lecture 12 - Engineering Optical Response of Materials

Lecture 13 - Low dimensional systems

Lecture 14 - Absorption in Semiconductors

Lecture 15 - Optical gain in semiconductors

Lecture 16 - Absorption in low-dimensional semiconductors

Lecture 17 - Selection rules for optical processes

Lecture 18 - Scattering of EM radiation

Lecture 19 - LSPR: Quasi-static approximation

Lecture 20 - Size dependence of Plasmon Resonance

Lecture 21 - Tuning Plasmonic Resonances

Lecture 22 - Surface Plasmon Polariton(SPP)

Lecture 23 - Understanding SPP Dispersion Diagram

Lecture 24 - Exciting Surface Plasmon Polaritons

Lecture 25 - Analytical Calculation of Scattering Coefficients - IPython code overview

Lecture 26 - EM Waves in Multilayer Stack - T Matrix formulation

Lecture 27 - Photonic Bandgap in 1D

Lecture 28 - EM Waves in 1D Photonic Crystal

Lecture 29 - Diffracton Grating

Lecture 30 - Applications of Photonic Crystals

Lecture 31 - PhC in 1D - T-matrix examples

- Lecture 32 - Introduction to Metamaterials
- Lecture 33 - Metamaterials at GHz and THz frequencies
- Lecture 34 - Negative index materials at optical frequencies
- Lecture 35 - Plasmonic Metasurfaces
- Lecture 36 - Dielectric Metasurfaces
- Lecture 37 - Tunable and Active Metamaterials
- Lecture 38 - Radiative Absorption and Emission
- Lecture 39 - Miniaturization of Integrated Photonic Devices
- Lecture 40 - Recent trends in nanoscale lasers
- Lecture 41 - Non-Hermitian Systems
- Lecture 42 - Resonant light-atom interactions
- Lecture 43 - Experimental observation of Rabi oscillations
- Lecture 44 - Atom-Cavity Interaction - Weak and strong coupling regimes
- Lecture 45 - Experimental observation of weak and strong coupling
- Lecture 46 - Fabrication of nanophotonic structures - 1
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- Lecture 48 - Measuring light quanta
- Lecture 49 - Photon Statistics
- Lecture 50 - Photodetection and shot noise limit
- Lecture 51 - Second order correlation function
- Lecture 52 - Hanbury Brown-Twiss Experiment with Photons
- Lecture 53 - EM Waves as harmonic oscillator
- Lecture 54 - Vacuum fluctuations
- Lecture 55 - Coherent and squeezed states
- Lecture 56 - Squeezed and photon number states
- Lecture 57 - Application of squeezed states
- Lecture 58 - Preliminaries for quantum theory of light
- Lecture 59 - Quantum theory of light
- Lecture 60 - Operator solution of quantum harmonic oscillator
- Lecture 61 - Photon number states
- Lecture 62 - Field quadratures and operators
- Lecture 63 - Uncertainty relations for quantum light
- Lecture 64 - Applications of quantum light - Quantum Key Distribution





- Lecture 1 - Introduction Linear and Nonlinear Network
- Lecture 2 - Small Signal Analysis of Nonlinear Networks
- Lecture 3 - Small Signal Analysis
- Lecture 4 - Incremental Model for Common Two Terminal Element Passive Two Terminal Elements
- Lecture 5 - Linear and Nonlinear Two Ports and the Incremental Y Matrix
- Lecture 6 - Graphical Representation of the Y Matrix
- Lecture 7 - Nonlinear Two Ports With Incremental Gain
- Lecture 8 - IV Characteristic of a Nonlinear 2 port with Incremental Gain
- Lecture 9 - The MOSFET and its Characteristics
- Lecture 10 - Deriving the Common V Source Amplifier - Part 1
- Lecture 11 - The Common Source Amplifier
- Lecture 12 - Large Signal Behaviour of the Common Source Amplifier
- Lecture 13 - The Common Source Amplifier Swing Limits
- Lecture 14 - Introduction to Robust Biasing
- Lecture 15 - Robust Biasing Part 1 Common Source Amplifier with DC Drain Feedback
- Lecture 16 - Robust Biasing with the Current Mirror and Drain Gate Resistor
- Lecture 17 - Robust Biasing With Source Feedback - Part 1
- Lecture 18 - Robust Biasing with Source Feedback - Part 2
- Lecture 19 - Robust Biasing with Source Degeneration
- Lecture 20 - Introduction to Negative Feedback
- Lecture 21 - The Ideal Operational Amplifier
- Lecture 22 - Negative Feedback (Continued...)
- Lecture 23 - Robust Biasing with Drain Measurement and Source Feedback
- Lecture 24 - Robust biasing with source measurement and gate feedback
- Lecture 25 - The Incremental Voltage Controlled Voltage Source The Common drain Amplifier Incremental Picture
- Lecture 26 - Biasing of the Common Drain Amplifier and Signal Swings
- Lecture 27 - The VCVS Continued, the Incremental
- Lecture 28 - Introducing the Current Controlled Voltage Source
- Lecture 29 - The Incremental Current Controlled Voltage Source Transimpedance Amplifier
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- Lecture 31 - The Incremental current controlled current source, the common gate amplifier

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Lecture 33 - Effect of Finite Output Resistance on the Basic Building Blocks - Part 1

Lecture 34 - Effect of Finite Output Resistance on the Basic Building Blocks - Part 2

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Lecture 36 - Finite output Effect in current Mirrors the Cascode Current Mirror

Lecture 37 - Comparison of Current Mirrors The High Swing Cascode

Lecture 38 - Precision High Swing Cascode

Lecture 39 - The PMOS transistor

Lecture 40 - Small Signal Model and Bias Stabilization

Lecture 41 - Basic Building Blocks with PMOS Devices

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Lecture 43 - Limitation of a Resistive Load

Lecture 44 - The Active Load

Lecture 45 - The Active Load (Continued...)

Lecture 46 - The CMOS Inverter

Lecture 47 - The CMOS Inverter (Continued...)

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Lecture 49 - Half - Circuit Analysis

Lecture 50 - The Different Amplifier with Active Load - Part 1

Lecture 51 - The Different Amplifier with Active Load - Part 2

Lecture 52 - Large Signal Behaviour of the Different Pair

Lecture 53 - The two Stage Opamp and Single Supply Operation

Lecture 54 - The two Stage Opamp (Continued...)

Lecture 55 - The Two Stage Opamp (Continued...)

Lecture 56 - Swing Limits of the Two Stage OTA

Lecture 57 - The Two-Stage Opamp

Lecture 58 - The Bandgap Reference Principle

Lecture 59 - The Bandgap Reference - Part 1

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Lecture 61 - Memory Effects in MOS Transistors

Lecture 62 - The Common Source Amplifier with Parasitic Capacitances

Lecture 63 - The Common Source Amplifier with Parasitic Capacitances

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- [Lecture 65 - Frequency Response of the Common Gate Amplifier](#)
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- [Lecture 69 - Dominant Pole Compensation - Part 1](#)
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- [Lecture 71 - Phase Margin](#)
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- [Lecture 80 - Bipolar Junction Transistor Circuits-Device Equations and Small Signal Model](#)
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Lecture 19 - Dropout

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Lecture 21 - Convolutional Neural Networks - 1

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Lecture 25 - Alexnet

Lecture 26 - CNN Architectures - 1

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- Lecture 2 - Basics of Lighting System
- Lecture 3 - Optical Sources (LED)
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- Lecture 9 - Indoor OWC channel modelling (Continued...)
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[Lecture 40 - Concept of Memory and its Designing - II](#)



Lecture 1 - Bipolar Junction Transistor : Physical structure and Modes of Operation

Lecture 2 - Bipolar Junction Transistor : Modes of operation - I

Lecture 3 - Bipolar Junction Transistor : Modes of operation - II

Lecture 4 - BJT Operation in active mode Circuit symbol and conventions - I

Lecture 5 - BJT Operation in active mode Circuit symbol and conventions - II

Lecture 6 - BJT as an amplifier small circuit model - I

Lecture 7 - BJT as an amplifier small circuit model - II

Lecture 8 - BJT Small Signal Circuit Model - I

Lecture 9 - BJT Small Signal Circuit Model - II

Lecture 10 - BJT as a switch and Ebers Moll Model

Lecture 11 - Simple BJT Inverter and second order effects

Lecture 12 - BJT Second order effects - I

Lecture 13 - BJT Second order effects - II

Lecture 14 - MOS Transistor basics - I

Lecture 15 - MOS Transistor basics - II

Lecture 16 - MOS Transistor basics - III

Lecture 17 - MOS Parasitic and SPICE Model

Lecture 18 - CMOS Inverter Basics - I

Lecture 19 - CMOS Inverter Basics - II

Lecture 20 - CMOS Inverter Basics - III

Lecture 21 - Power Analysis - I

Lecture 22 - Logical Efforts - I

Lecture 23 - Fabrication-Process - I

Lecture 24 - Fabrication-Process - II

Lecture 25 - Biasing of Amplifier and its behaviour as an Analog switch - I

Lecture 26 - Biasing of Amplifier and its behaviour as an Analog switch - II

Lecture 27 - Biasing of Amplifier and its behaviour as an Analog switch - III

Lecture 28 - CMOS CS/CG/CD Amplifier Configuration

Lecture 29 - CMOS CG/CD Amplifier Configuration

Lecture 30 - Internal CAP Models and high frequency Modelling - I

Lecture 31 - Internal CAP Models and high frequency Modelling - II

- Lecture 32 - JFET, Structure and Operation
- Lecture 33 - Multistage and Differential Amplifier - I
- Lecture 34 - Multistage and Differential Amplifier - II
- Lecture 35 - MOS Differential Amplifier - I
- Lecture 36 - MOS Differential Amplifier - II
- Lecture 37 - Small signal operation and Differential Amplifiers - I
- Lecture 38 - Small signal operation and Differential Amplifiers - II
- Lecture 39 - Multistage Amplifier with SPICE Simulation
- Lecture 40 - S-Domain Analysis, Transfer Function, Poles and Zeros - I
- Lecture 41 - S-Domain Analysis, Transfer Function, Poles and Zeros - II
- Lecture 42 - High Frequency response of CS and CE Amplifier
- Lecture 43 - High Frequency response of CC and SF Configuration
- Lecture 44 - Frequency response of Differential Amplifier
- Lecture 45 - General Feedback Structure and properties of negative Feedback
- Lecture 46 - Basic Feedback Topologies
- Lecture 47 - Design of feedback amplifier for all configuration
- Lecture 48 - Stability and amplifier poles
- Lecture 49 - Bode plots and Frequency Plot
- Lecture 50 - Ideal Operational Amplifier and its terminal
- Lecture 51 - Op-amp as a Integrator and Differentiator
- Lecture 52 - Large Signal Operation of Op-amp and second order effects
- Lecture 53 - Combinational logic design - I
- Lecture 54 - Combinational logic design - II
- Lecture 55 - Combinational logic design - III
- Lecture 56 - Combinational logic design - IV
- Lecture 57 - Sequential logic design - I
- Lecture 58 - Clocking strategies For Sequential design - I
- Lecture 59 - Clocking strategies For Sequential design - II
- Lecture 60 - Memory Design

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

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

Lecture 1 - Overview of Microgrids

Lecture 2 - Concept of Microgrids

Lecture 3 - Microgrid and distributed generation

Lecture 4 - Microgrid vs Conventional Power System

Lecture 5 - AC and DC Microgrid with Distributed Energy Resources (AC Microgrid Part)

Lecture 6 - AC and DC Microgrid with Distributed Energy Resources (AC Microgrid Part) (Continued...)

Lecture 7 - Power Electronics for Microgrid

Lecture 8 - Power Electronic Converters in Microgrid Applications

Lecture 9 - Power Electronic Converters in Microgrid Applications (Power Electronic for Interfacing )

Lecture 10 - Power Electronic Converters in Microgrid Applications (Converter Modulation Techniques)

Lecture 11 - Modeling of converters in microgrid power system (AC/DC and DC/AC Converters Modeling)

Lecture 12 - Modeling of Power Converters in Microgrid Power System (DC/DC Converter Modeling and Control)

Lecture 13 - Modeling of Renewable Energy Resources (Modeling of Wind Energy System)

Lecture 14 - Modeling of Renewable Energy Resources (Modeling of Photovoltaic System)

Lecture 15 - Modeling of Energy Storage System

Lecture 16 - Microgrid Dynamics and Modeling

Lecture 17 - Microgrid Dynamics and Modeling (Continued...)

Lecture 18 - Microgrid Operation Modes and Standards - Part I

Lecture 19 - Microgrid Operation Modes and Standards - Part II

Lecture 20 - Microgrid Control Architectures

Lecture 21 - Microgrid Control Architectures (Continued...)

Lecture 22 - Intelligent Microgrid Operation and Control

Lecture 23 - Intelligent Microgrid Operation and Control (Continued...)

Lecture 24 - Intelligent Microgrid Operation and Control (Continued...)

Lecture 25 - Energy Management in Microgrid System (Continued...)

Lecture 26 - DC Microgrid System Architecture and AC Interface

Lecture 27 - DC Microgrid System Architecture and AC Interface (Continued...)

Lecture 28 - DC Microgrid System Architecture and AC Interface (Continued...)

Lecture 29 - DC Microgrid Dynamics and Modeling

Lecture 30 - DC Microgrid Dynamics and Modeling (Continued...)

Lecture 31 - Control of DC Microgrid System

[Lecture 32 - Control of DC Microgrid System \(Continued...\)](#)

[Lecture 33 - Applications of DC Microgrids](#)

[Lecture 34 - Stability in Microgrid](#)

[Lecture 35 - Stability Analysis of DC Microgrid](#)

[Lecture 36 - Stability Analysis of DC Microgrid \(Continued...\)](#)

[Lecture 37 - DC Microgrid stabilization strategies \(Passive damping method\)](#)

[Lecture 38 - DC Microgrid Stabilization Strategies \(Impedance/Admittance stability criteria\)](#)

[Lecture 39 - DC microgrid stabilization using nonlinear Techniques](#)

[Lecture 40 - General Summary of DC Microgrids](#)

- Lecture 1 - Introduction
- Lecture 2 - Overview - I
- Lecture 3 - Overview - II
- Lecture 4 - Overview - III
- Lecture 5 - Source of Poor Power Quality - I
- Lecture 6 - Source of Poor Power Quality - II
- Lecture 7 - AC Power Quality Standard
- Lecture 8 - Improvement of Power Factor by Capacitor
- Lecture 9 - Passive Filter - I
- Lecture 10 - Passive Filter - II
- Lecture 11 - Passive Filter Design - I
- Lecture 12 - Passive Filter Design - II
- Lecture 13 - PWM Rectifier - I
- Lecture 14 - PWM Rectifier - II
- Lecture 15 - PWM Rectifier - III
- Lecture 16 - Three phase converters - I
- Lecture 17 - Three Phase Converters - II and multi pulse Converters
- Lecture 18 - Three Phase Converters - III and multi-pulse Converters
- Lecture 19 - VSI and CSI
- Lecture 20 - Multilevel Inverter - I
- Lecture 21 - Multilevel Inverter - II
- Lecture 22 - Multilevel Inverter - III
- Lecture 23 - PWM for Voltage Source Inverter - I
- Lecture 24 - PWM for Voltage Source Inverter - II
- Lecture 25 - PWM for Voltage Source inverter - III
- Lecture 26 - PWM for Voltage Source Inverter - IV
- Lecture 27 - Operation and Control of Grid-Connected VSC
- Lecture 28 - Grid Connected VSC with inner Current Control
- Lecture 29 - Shunt Active Power Filter - I
- Lecture 30 - Shunt Active Power Filter - II
- Lecture 31 - Shunt Active Power Filter - III

[Lecture 32 - Shunt Active Power Filter - IV](#)

[Lecture 33 - Hybrid Active Power Filter - I](#)

[Lecture 34 - Hybrid Active power Filter - II](#)

[Lecture 35 - Hybrid Shunt Active Power Filter](#)

[Lecture 36 - UPQC Introduction and classification](#)

[Lecture 37 - UPQC Classification](#)

[Lecture 38 - Operation and Control of UPQC](#)

[Lecture 39 - Control of UPQC](#)

[Lecture 40 - Conclusion](#)

- Lecture 1 - Fundamentals of Protective Relaying - I
- Lecture 2 - Fundamentals of Protective Relaying - II
- Lecture 3 - Fundamentals of Protective Relaying - III
- Lecture 4 - Fundamentals of Protective Relaying - IV
- Lecture 5 - Fundamentals of Protective Relaying - V
- Lecture 6 - Current based Relaying Scheme - I
- Lecture 7 - Current based Relaying Scheme - II
- 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](#)

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Lecture 22 - Design of Speed Control of DC Motor: Circuit Explanation

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- Lecture 49 - Process flow for Microcantilever for Mechanical Phenotyping of breast cancer tissues
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- Lecture 51 - Installation and Introduction to Physical Vapour Deposition System
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- Lecture 53 - Flexible MEMS for phenotyping tissue properties - I
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Lecture 4 - Feedback and network architectures

Lecture 5 - Knowledge representation

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Lecture 7 - Learning processes

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Lecture 10 - Batch perceptron algorithm

Lecture 11 - Perceptron and Bayes classifier

Lecture 12 - Linear regression - 1

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Lecture 14 - Linear regression - 3

Lecture 15 - Logistic regression

Lecture 16 - Multi-layer perceptron - 1

Lecture 17 - Multi-layer perceptron - 2

Lecture 18 - Back propagation - 1

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Lecture 20 - XOR problem

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Lecture 22 - Complexity Regularization and Cross validation

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Lecture 25 - Multivariate interpolation problem

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

**NPTEL : NOC:Electronics Equipment Integration and Prototype Building (Electrical Engineering)**

**Co-ordinators : Prof. N.V.Chalapathi Rao**

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- Lecture 2 - Examples from real life: Parts to system
- Lecture 3 - Common Simulation of flat prismatic parts
- Lecture 4 - Common flat parts enclosures
- Lecture 5 - Real life parts to scale on a graph
- Lecture 6 - Early First steps
- Lecture 7 - Top down, outside to internals
- Lecture 8 - Using a print and fabrication video
- Lecture 9 - Details of displays and keys
- Lecture 10 - Improvement on marking and skill
- Lecture 11 - Mass production in sheet metal
- Lecture 12 - Prototyping of user interfaces for concepts
- Lecture 13 - Stacking of equipment to make a system
- Lecture 14 - Recapitulating a sub system
- Lecture 15 - Off the shelf enclosures and making a user interface
- Lecture 16 - Looking around for concepts and integration
- Lecture 17 - Representation on paper
- Lecture 18 - Example features of surfaces and solids
- Lecture 19 - Simple and curved surfaces
- Lecture 20 - Describing inclined surfaces
- Lecture 21 - Basics of engineering Drawing
- Lecture 22 - Introduction to sizing and fits
- Lecture 23 - Practical mechanical assemblies
- Lecture 24 - Analogous Mechanical - Electronics detailing
- Lecture 25 - Solid modelling
- Lecture 26 - Importance of dimensioning
- Lecture 27 - Ease of editing redesign
- Lecture 28 - Dimensioning of electronics components
- Lecture 29 - 2D flat representation
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- Lecture 2 - Refractoring the .cir
- Lecture 3 - Sub-circuits
- Lecture 4 - gschem and netlist generation
- Lecture 5 - Setting up for simulation with Octave
- Lecture 6 - Getting started with equation based simulation
- Lecture 7 - Resuming a simulation in Octave
- Lecture 8 - PV cell model - review
- Lecture 9 - PV cell characteristic - review
- Lecture 10 - PV cell - symbol and subcircuit
- Lecture 11 - Rectifier-capacitor filter - operation review
- Lecture 12 - Rectifier-capacitor filter - NgSpice simulation
- Lecture 13 - Rectifier-capacitor filter with non-idealities
- Lecture 14 - 3 phase Rectifier-capacitor filter
- Lecture 15 - Equation based simulation in Octave
- Lecture 16 - Passive power factor improvement - review
- Lecture 17 - Passive power factor circuit in NgSpice
- Lecture 18 - Buck converter - review
- Lecture 19 - Buck converter - NgSpice
- Lecture 20 - Boost converter - review
- Lecture 21 - Boost converter - NgSpice
- Lecture 22 - Buck-boost converter - review
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- Lecture 24 - Equation based simulation of converters
- Lecture 25 - Forward Converter - review
- Lecture 26 - Forward Converter simulation
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- Lecture 2 - Anatomical (Macroscopic) structure of the CNS
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- Lecture 6 - Neocortical Circuits
- Lecture 7 - The resting Membrane Potential
- Lecture 8 - Applications of MEMS Fabrication Technologies
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- Lecture 13 - Axonology, Neuronal Biophysics (1)
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- Lecture 15 - Experimental Setup for EEG Recording
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- Lecture 17 - Electromagnetic Stimulation of the Brain (1)
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- Lecture 25 - Introduction to Silicone Wafer Processing Techniques
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- Lecture 27 - Inverse Problem, EEG source localization (1)
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- Lecture 29 - Introduction to Brain Computer Interfaces
- Lecture 30 - Signal Conditioning Circuit for EEG Bioamplifiers
- Lecture 31 - Basics of BCI Experimentation: Introduction BCI Applications

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- Lecture 46 - Basics of BCI Experimentation: Signal Acquisition using MATLAB (EEGLAB)
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- Lecture 48 - Demonstration: Resting Membrane Potential
- Lecture 49 - Demonstration: Membrane Time Constant ( $\tau_m$ )
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- Lecture 60 - Recent Trends: Epilepsy Classification using EEG data
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Lecture 2 - How to model uncertainty?

Lecture 3 - Basic concepts of probability

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Lecture 25 - Information per coin-toss

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Lecture 11 - Electrical properties of cells and tissues revisited: Examples and Applications

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Lecture 24 - Thermal Properties of a tissue and cells

Lecture 25 - Probability: Random Variables and CDF

Lecture 26 - Basics of Silicon, Silicon Dioxide for Microfabrication Process

Lecture 27 - Mechanical Properties of human brain tissues and modelling

Lecture 28 - Probability: Important measures and generating functions

Lecture 29 - Near Infrared Spectroscopy and Ultrasound Techniques

Lecture 30 - Thermal Properties of Tissues and Modelling

Lecture 31 - Multisim Simulations for Biomedical Signal Conditioning Circuit

[Lecture 32 - Cleanroom Entry Demonstration](#)

[Lecture 33 - Spin Coating Demonstration](#)

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[Lecture 35 - Introduction to signal Conditioning circuits for biomedical devices](#)

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[Lecture 37 - E Beam Evaporation System Demonstration](#)

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[Lecture 41 - Recent Trends in Biomedical Electronic System Design](#)

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Lecture 1 - Why study concentration inequalities?

Lecture 2 - Chernoff bound

Lecture 3 - Examples of Chernoff bound for common distributions

Lecture 4 - Hoeffding and Bernstein inequalities

Lecture 5 - Azuma and McDiarmid inequalities

Lecture 6 - Bounding variance using the Efron-Stein inequality

Lecture 7 - The Gaussian-Poincare inequality

Lecture 8 - Tail bounds using the Efron-Stein inequality

Lecture 9 - Herbst's argument and the entropy method

Lecture 10 - Log-Sobolev inequalities

Lecture 11 - Binary and Gaussian Log-Sobolev inequalities and concentration

Lecture 12 - Variational formulae for Kullback-Leibler and Bregman Divergence

Lecture 13 - A modified log-Sobolev inequality and concentration

Lecture 14 - Introduction to the transportation method for showing concentration bounds

Lecture 15 - Transportation lemma and a proof of McDiarmid's inequality using the transportation method

Lecture 16 - Concentration bounds for functions beyond bounded difference using transportation method

Lecture 17 - Marton's conditional transportation cost inequality

Lecture 18 - Isoperimetry and concentration of measure

Lecture 19 - Isoperimetry and bounded difference

Lecture 20 - Equivalence of Stam's inequality and log Sobolev inequality

Lecture 21 - An information theoretic proof of log Sobolev inequality

Lecture 22 - Hypercontractivity and strong data processing inequality for Rényi divergence

Lecture 23 - An information theoretic characterization of hypercontractivity

Lecture 24 - Equivalence of Gaussian hypercontractivity and Gaussian log Sobolev inequality

Lecture 25 - Uniform deviation bounds for random walks and the law of the iterated logarithm

Lecture 26 - Self normalized concentration inequalities and application to online regression

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Lecture 2 - Basics of Signal Processing

Lecture 3 - Lab - CCS

Lecture 4 - Number System

Lecture 5 - Architecture - 1

Lecture 6 - Architecture - 2

Lecture 7 - Real-time Constraints

Lecture 8 - FIR - Filters

Lecture 9 - Pipelining and Parallel Processing for Low Power Applications - I

Lecture 10 - Pipelining and Parallel Processing for Low Power Applications - II

Lecture 11 - Lab: Sine Generation

Lecture 12 - IIR Filters - 1

Lecture 13 - IIR Filters - 2

Lecture 14 - Lab: Sine Generation, FIR and IIR

Lecture 15 - Lab 3 IIR Filter as Resonator

Lecture 16 - Lab 4 Use of FDA tool box to generate co-efficients

Lecture 17 - Lab: Real-Time Audio Output through Sine Generation

Lecture 18 - IIR Filters 4

Lecture 19 - Lab: FIR Filter in generation of music

Lecture 20 - Lab: Real-Time Audio Output through FIR Filter

Lecture 21 - DFT, DTFT, twiddle factors, properties, circular convolution and examples

Lecture 22 - Complexity of Filtering and the FFT

Lecture 23 - Lab: Filtering Using FFT

Lecture 24 - Lab: FFT in CCS

Lecture 25 - FFT - 1

Lecture 26 - FFT - 2

Lecture 27 - FFT - 3

Lecture 28 - Overlap - Add

Lecture 29 - Overlap Save Method

Lecture 30 - Lab: Overlap Add and Save Method using MATLAB

Lecture 31 - Correlation



Lecture 32 - Lab: Different ways of implementing FFT in CCS

Lecture 33 - Adaptive Filter

Lecture 34 - Lab: LMS Algorithm in MATLAB

Lecture 35 - LMS Algorithm

Lecture 36 - Lab: Error surface and error contour

Lecture 37 - Adaptive Filter Applications

Lecture 38 - Lab: Application of adaptive filter in MATLAB

Lecture 39 - Adaptive Echo Cancellation

Lecture 40 - Lab: Application of adaptive filter in CCS, Echo, scrambling and graphic equalizer in MATLAB

Lecture 41 - Graphic Equalizer

Lecture 42 - Lab: Adaptive filters (MATLAB)

Lecture 43 - Speech Coding - I

Lecture 44 - Speech Coding - II

Lecture 45 - Speech Coding - III

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Lecture 48 - Discrete Cosine Transform - 2

Lecture 49 - Discrete Cosine Transform - 3

Lecture 50 - Discrete Cosine Transform - 4

Lecture 51 - Lab: Adaptive filters (CCS) - 1

Lecture 52 - Lab: Adaptive filters (CCS) - 2

Lecture 53 - Lab: Discrete Cosine Transformation

Lecture 54 - Lab: Echogeneration

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- Lecture 4 - Lab 2 - Cleanroom and Gowning Protocol
- Lecture 5 - Developed Systems at a glance
- Lecture 6 - Silicon and Silicon Dioxide
- Lecture 7 - Piranha Cleaning of Silicon Wafer
- Lecture 8 - Polyimide Coating on Silicon Wafer
- Lecture 9 - Thermal Oxidation of Silicon and Thickness measurement
- Lecture 10 - Fundamental of Physical Vapour Deposition
- Lecture 11 - Lab 3 - Lithography: Demonstration
- Lecture 12 - Sputtering
- Lecture 13 - Basics of Photolithography
- Lecture 14 - Lab 4 - E-Beam Evaporation: Demo
- Lecture 15 - Photolithography - II
- Lecture 16 - Photolithography - III
- Lecture 17 - Lab 5 - E-Beam Evaporation: Demo - II
- Lecture 18 - Lab 6 - Liftoff Demonstration
- Lecture 19 - Lithography Optics - I
- Lecture 20 - Soft Lithography - I
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- Lecture 24 - Thin Film Deposition: CVD - I
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Lecture 6 - Magnetic Materials and Concepts of BH Curves

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Lecture 8 - Example Problems of Magnetic Circuits

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Lecture 23 - Stator Winding Design-Fractional Slot Double Layer Winding

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Lecture 27 - Electric Machine Sizing Equations-Output Power and Volume (D2L) Product Equation

Lecture 28 - Lab Session on Re-winding of Induction Motor (Example: Double Layer Winding)

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