

Lecture 1 - Introduction

Lecture 2 - The Haar Wavelet

Lecture 3 - The Haar Multiresolution Analysis

Lecture 4 - Wavelets And Multirate Digital Signal Processing

Lecture 5 - Equivalence - Functions And Sequences

Lecture 6 - The Haar Filter Bank

Lecture 7 - Haar Filter Bank Analysis And Synthesis

Lecture 8 - Relating  $\psi$ ,  $\phi$  and the Filters

Lecture 9 - Iterating the filter bank from  $\Psi$ ,  $\Phi$

Lecture 10 - Z-Domain Analysis Of Multirate Filter Bank

Lecture 11 - Two Channel Filter Bank

Lecture 12 - Perfect Reconstruction - Conjugate Quadrature

Lecture 13 - Conjugate Quadrature Filters - Daubechies Family of MRA

Lecture 14 - Daubechies' Filter Banks - Conjugate Quadrature Filters

Lecture 15 - Time And Frequency Joint Perspective

Lecture 16 - Ideal Time Frequency Behaviour

Lecture 17 - The Uncertainty Principle

Lecture 18 - Time Bandwidth Product Uncertainty

Lecture 19 - Evaluating and Bounding  $\sqrt{t} \cdot \sqrt{\omega}$

Lecture 20 - The Time Frequency Plane & its Tilings

Lecture 21 - Short time Fourier Transform & Wavelet Transform in General

Lecture 22 - Reconstruction & Admissibility

Lecture 23 - Admissibility in Detail Discretization of Scale

Lecture 24 - Logarithmic Scale Discretization, Dyadic Discretization

Lecture 25 - The Theorem of (DYADIC) Multiresolution Analysis

Lecture 26 - Proof of the Theorem of (DYADIC) Multiresolution Analysis

Lecture 27 - Introducing Variants of The Multiresolution Analysis Concept

Lecture 28 - JPEG 2000 5/3 FilterBank & Spline MRA

Lecture 29 - Orthogonal Multiresolution Analysis with Splines

Lecture 30 - Building Piecewise Linear Scaling Function, Wavelet

Lecture 31 - The Wave Packet Transform

- Lecture 32 - Nobel Identities & The Haar Wave Packet Transform
- Lecture 33 - The Lattice Structure for Orthogonal Filter Banks
- Lecture 34 - Constructing the Lattice & its Variants
- Lecture 35 - The Lifting Structure & Polyphase Matrices
- Lecture 36 - The Polyphase Approach - The Modulation Approach
- Lecture 37 - Modulation Analysis and The 3-Band Filter Bank, Applications
- Lecture 38 - The Applications \*Data Mining, \*Face Recognition
- Lecture 39 - Proof that a non-zero function can not be both time and band-limited
- Lecture 40 - M-Band Filter Banks and Looking Ahead
- Lecture 41 - Tutorial -Session 1
- Lecture 42 - Student's Presentation
- Lecture 43 - Tutorial on Uncertainty Product
- Lecture 44 - Tutorial on Two band Filter Bank
- Lecture 45 - Tutorial -Frequency Domain Analysis of Two band Filter Bank
- Lecture 46 - Zoom in and Zoom out using Wavelet Transform
- Lecture 47 - More Thoughts on Wavelets : Zooming In
- Lecture 48 - Towards selecting Wavelets through vanishing moments
- Lecture 49 - In Search of Scaling Coefficients
- Lecture 50 - Wavelet Applications

Lecture 1 - Introduction

Lecture 2 - Basics of Light

Lecture 3 - Ray Model - I

Lecture 4 - Ray Model - II

Lecture 5 - Wave Model - I

Lecture 6 - Wave Model - II

Lecture 7 - Wave Model - III

Lecture 8 - Signal Distortion - I

Lecture 9 - Signal Distortion - II

Lecture 10 - Signal Distortion - III

Lecture 11 - Practical issues in Implementation of Fiber link

Lecture 12 - Optical Sources

Lecture 13 - Light Emitting Diodes - I

Lecture 14 - Light Emitting Diodes - II

Lecture 15 - Laser - I

Lecture 16 - Laser - II

Lecture 17 - Laser - III

Lecture 18 - Laser - IV

Lecture 19 - Laser - V + Photon Detector

Lecture 20 - Photo Diodes and Detector Noise

Lecture 21 - Photo Detector

Lecture 22 - Optical Receivers - I

Lecture 23 - Optical Receivers - II

Lecture 24 - Receiver Sensitivity Degradation

Lecture 25 - Fiber Optic Link Design

Lecture 26 - Wavelength Division Multiplexed Systems

Lecture 27 - EDFA

Lecture 28 - Integrated Optics - I

Lecture 29 - Integrated Optics - II

Lecture 30 - Tutorials - I

Lecture 31 - Tutorials - II

[Lecture 32 - Introduction to Non-Linear Fiber Optics](#)

[Lecture 33 - Non-linear Schrodinger Equation](#)

[Lecture 34 - Group Velocity Dispersion \(GVD\)](#)

[Lecture 35 - Self Phase Modulation \(SPM\)](#)

[Lecture 36 - Solitonic Communication](#)

[Lecture 37 - Raman Amplifier](#)

[Lecture 38 - Cross Phase Modulation and four wave mixing](#)

[Lecture 39 - Laboratory Experiments - I](#)

[Lecture 40 - Laboratory Experiments - II](#)

[Lecture 41 - Laboratory Experiments - III](#)

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

**NPTEL : Advanced VLSI Design (Electronics and Communication Engineering)**

**Co-ordinators : Prof. A.N. Chandorkar, Prof. D.K. Sharma, Prof. Sachin Patkar, Prof. Virendra Singh**

Lecture 1 - Historical Perspective and Future Trends in CMOS VLSI Circuit and System Design - Part I

Lecture 2 - Historical Perspective and Future Trends in CMOS VLSI Circuit and System Design - Part II

Lecture 3 - Logical Effort - A way of Designing Fast CMOS Circuits - Part I

Lecture 4 - Logical Effort - A way of Designing Fast CMOS Circuits - Part II

Lecture 5 - Logical Effort - A way of Designing Fast CMOS Circuits - Part III

Lecture 6 - Power Estimation and Control in CMOS VLSI circuits - Part I

Lecture 7 - Power Estimation and Control in CMOS VLSI circuits - Part II

Lecture 8 - Low Power Design Techniques - Part I

Lecture 9 - Low Power Design Techniques - Part II

Lecture 10 - Arithmetic Implementation Strategies for VLSI - Part I

Lecture 11 - Arithmetic Implementation Strategies for VLSI - Part II

Lecture 12 - Arithmetic Implementation Strategies for VLSI - Part III

Lecture 13 - Arithmetic Implementation Strategies for VLSI - Part IV

Lecture 14 - Interconnect aware design: Impact of scaling, buffer insertion and inductive peaking

Lecture 15 - Interconnect aware design: Low swing and Current mode signaling

Lecture 16 - Interconnect aware design: capacitively coupled interconnects

Lecture 17 - Introduction to Hardware Description Languages

Lecture 18 - Managing concurrency and time in Hardware Description Languages

Lecture 19 - Introduction to VHDL

Lecture 20 - Basic Components in VHDL

Lecture 21 - Structural Description in VHDL

Lecture 22 - Behavioral Description in VHDL

Lecture 23 - Introduction to Verilog

Lecture 24 - FSM + datapath (GCD example)

Lecture 25 - FSM + datapath (Continued...)

Lecture 26 - Single Cycle MMIPS

Lecture 27 - Multicycle MMIPS

Lecture 28 - Multicycle MMIPS – FSM

Lecture 29 - Brief Overview of Basic VLSI Design Automation Concepts

Lecture 30 - Netlist and System Partitioning

Lecture 31 - Timing Analysis in the context of Physical Design Automation

[Lecture 32 - Placement algorithm](#)

[Lecture 33 - Introduction to VLSI Testing](#)

[Lecture 34 - VLSI Test Basics - I](#)

[Lecture 35 - VLSI Test Basics - II](#)

[Lecture 36 - VLSI Testing: Automatic Test Pattern Generation](#)

[Lecture 37 - VLSI Testing: Design for Test \(DFT\)](#)

[Lecture 38 - VLSI Testing: Built-In Self-Test \(BIST\)](#)

[Lecture 39 - VLSI Design Verification: An Introduction](#)

[Lecture 40 - VLSI Design Verification: An Introduction](#)

[Lecture 41 - VLSI Design Verification: Equivalence/Model Checking](#)

[Lecture 42 - VLSI Design Verification: Model Checking](#)

- Lecture 1 - Introduction to Broadband Networks
- Lecture 2 - Qos in Packet Switching and ATM
- Lecture 3 - ATM Networks
- Lecture 4 - Effective Bandwidth - I
- Lecture 5 - Effective Bandwidth - II
- Lecture 6 - Traffic Descriptor in ATM
- Lecture 7 - Calculus for QOS - I
- Lecture 8 - Calculus For Qos - II
- Lecture 9 - Packet Scheduling Algorithm Introduction
- Lecture 10 - Fluid Fair Queueing and Weighted Fair Queueing
- Lecture 11 - Virtual Time In Scheduling
- Lecture 12 - Fairness of WFO and SCFO Scheduling Algorithms
- Lecture 13 - Rate Proportional Servers
- Lecture 14 - Latency Rate Servers - I
- Lecture 15 - Latency Rate Servers - II And Delay Bounds
- Lecture 16 - QOS In Best Effort Internet
- Lecture 17 - TCP Congestion Control
- Lecture 18 - Analysis of TCP
- Lecture 19 - TCP Throughput
- Lecture 20 - Buffer Management
- Lecture 21 - IP Addressing Scheme
- Lecture 22 - IP Addressing Lookup And Packet Classification
- Lecture 23 - IP Over ATM
- Lecture 24 - Multiple Label Switching (MPLS)
- Lecture 25 - MPLS and Traffic Engineering
- Lecture 26 - Optical Network and MPLS
- Lecture 27 - Integrated Service Internet (IntServ) and RSVP
- Lecture 28 - Differentiated Services Internet
- Lecture 29 - Voice over IP
- Lecture 30 - RTP
- Lecture 31 - Metro Ethernet Access Networks



Lecture 1 - Introduction to Digital Communication

Lecture 2 - Sampling

Lecture 3 - Quantization, PCM and Delta Modulation

Lecture 4 - Probability and Random Processes (Part-1)

Lecture 5 - Probability and Random Processes (Part-2)

Lecture 6 - Channels and their Models (Part-1)

Lecture 7 - Channels and their Models (Part-2)

Lecture 8 - Information Theory (Part-1)

Lecture 9 - Information Theory (Part-2)

Lecture 10 - Bandpass Signal Representation (Part-1)

Lecture 11 - Bandpass Signal Representation (Part-2)

Lecture 12 - Digital Modulation Techniques (Part-1)

Lecture 13 - Digital Modulation Techniques (Part-2)

Lecture 14 - Digital Modulation Techniques (Part-3)

Lecture 15 - Digital Modulation Techniques (Part-4)

Lecture 16 - Digital Modulation Techniques (Part-5)

Lecture 17 - Digital Modulation Techniques (Part-6)

Lecture 18 - Digital Modulation Techniques (Part-7)

Lecture 19 - Digital Modulation Techniques (Part-8)

Lecture 20 - Digital Modulation Techniques (Part-9)

Lecture 21 - Digital Modulation Techniques (Part-10)

Lecture 22 - Probability of Error Calculation

Lecture 23 - Calculation of Probability of Error

Lecture 24 - Calculation of Probability of Error

Lecture 25 - Equalizers

Lecture 26 - Source Coding (Part-1)

Lecture 27 - Source Coding (Part-2)

Lecture 28 - Source Coding (Part-3)

Lecture 29 - Source Coding (Part-4)

Lecture 30 - Channel Coding

Lecture 31 - Fundamentals of OFDM



Lecture 1 - Introduction to Information Theory and Coding

Lecture 2 - Definition of Information Measure and Entropy

Lecture 3 - Extension of An Information Source and Markov Source

Lecture 4 - Adjoint of An Information Source, Joint and Conditional Information Measure

Lecture 5 - Properties of Joint and Conditional Information Measures and A Markov Source

Lecture 6 - Asymptotic Properties of Entropy and Problem Solving in Entropy

Lecture 7 - Block Code and its Properties

Lecture 8 - Instantaneous Code and Its Properties

Lecture 9 - Kraft-McMillan Equality and Compact Codes

Lecture 10 - Shannon's First Theorem

Lecture 11 - Coding Strategies and Introduction to Huffman Coding

Lecture 12 - Huffman Coding and Proof of Its Optimality

Lecture 13 - Competitive Optimality of The Shannon Code

Lecture 14 - Non-Binary Huffman Code and Other Codes

Lecture 15 - Adaptive Huffman Coding - Part-I

Lecture 16 - Adaptive Huffman Coding - Part-II

Lecture 17 - Shannon-Fano-Elias Coding and Introduction to Arithmetic Coding

Lecture 18 - Arithmetic Coding - Part-I

Lecture 19 - Arithmetic Coding - Part-II

Lecture 20 - Introduction to Information Channels

Lecture 21 - Equivocation and Mutual Information

Lecture 22 - Properties of Different Information Channels

Lecture 23 - Reduction of Information Channels

Lecture 24 - Properties of Mutual Information and Introduction to Channel Capacity

Lecture 25 - Calculation of Channel Capacity for Different Information Channels

Lecture 26 - Shannon's Second Theorem

Lecture 27 - Discussion On Error Free Communication Over Noisy Channel

Lecture 28 - Error Free Communication Over A Binary Symmetric Channel and Introduction to Continuous Sources and Channels

Lecture 29 - Differential Entropy and Evaluation of Mutual Information for Continuous Sources and Channels

Lecture 30 - Channel Capacity of A BandLimited Continuous Channel

Lecture 31 - Introduction to Rate-Distortion Theory

[Lecture 32 - Definition and Properties of Rate-Distortion Functions](#)

[Lecture 33 - Calculation of Rate-Distortion Functions](#)

[Lecture 34 - Computational Approach for Calculation of Rate-Distortion Functions](#)

[Lecture 35 - Introduction to Quantization](#)

[Lecture 36 - Lloyd-Max Quantizer](#)

[Lecture 37 - Companded Quantization](#)

[Lecture 38 - Variable Length Coding and Problem Solving in Quantizer Design](#)

[Lecture 39 - Vector Quantization](#)

[Lecture 40 - Transform Coding - Part-I](#)

[Lecture 41 - Transform Coding - Part-II](#)

- Lecture 1 - Introduction to EM waves and various techniques of communication
- Lecture 2 - Equations of Voltage and Current on TX line
- Lecture 3 - Propagation constant, Characteristic impedance and reflection coefficient
- Lecture 4 - Impedance Transformation
- Lecture 5 - Loss-less and Low loss Transmission line and VSWR
- Lecture 6 - Power transfer on TX line
- Lecture 7 - Smith Chart
- Lecture 8 - Admittance Smith Chart
- Lecture 9 - Experimental setup for transmission line measurements
- Lecture 10 - Applications of transmission lines
- Lecture 11 - Applications of transmission lines-II
- Lecture 12 - Impedance Matching
- Lecture 13 - Lossy Transmission Line
- Lecture 14 - Problems on Transmission line
- Lecture 15 - Types of transmission line
- Lecture 16 - Basics of Vectors
- Lecture 17 - Vector calculus
- Lecture 18 - Basic laws of Electromagnetics
- Lecture 19 - Maxwell's Equations
- Lecture 20 - Boundary conditions at Media Interface
- Lecture 21 - Uniform plane wave
- Lecture 22 - Propagation of wave
- Lecture 23 - Wave polarization
- Lecture 24 - Pioncere's Sphere
- Lecture 25 - Wave propagation in conducting medium
- Lecture 26 - Wave propagation and phase velocity
- Lecture 27 - Power flow and Poynting vector
- Lecture 28 - Surface current and power loss in a conductor
- Lecture 29 - Plane wave in arbitrary direction
- Lecture 30 - Plane wave at dielectric interface
- Lecture 31 - Reflection and refraction at media interface

- Lecture 32 - Total internal reflection
- Lecture 33 - Polarization at media interface
- Lecture 34 - Reflection from a conducting boundary
- Lecture 35 - Parallel plane waveguide
- Lecture 36 - Wave propagation in parallel plane waveguide
- Lecture 37 - Analysis of waveguide general approach
- Lecture 38 - Rectangular waveguide
- Lecture 39 - Modal propagation in rectangular waveguide
- Lecture 40 - Surface currents on the waveguide walls
- Lecture 41 - Field visualization and Attenuation in waveguide
- Lecture 42 - Attenuation in waveguide continued
- Lecture 43 - Radiation (Antenna)
- Lecture 44 - Solution for potential function
- Lecture 45 - Radiation form the Hertz dipole
- Lecture 46 - Power radiated by hertz dipole
- Lecture 47 - Thin linear antenna
- Lecture 48 - Radiation Parameters of antenna
- Lecture 49 - Receiving antenna
- Lecture 50 - Monopole and Dipole antenna
- Lecture 51 - Fourier transform relation between current and radiation pattern
- Lecture 52 - Antenna arrays
- Lecture 53 - Uniform Linear array
- Lecture 54 - Uniform Linear array continued
- Lecture 55 - Synthesis of array
- Lecture 56 - Binomial array and general array synthesis
- Lecture 57 - Problems on uniform plane wave
- Lecture 58 - Problems on uniform plane wave in a meduim
- Lecture 59 - Problems on waveguides
- Lecture 60 - Problems on Antennas and radiation

- Lecture 1 - Introduction to CMOS Analog VLSI Design
- Lecture 2 - Introduction to CMOS Analog VLSI Design (Continued...)
- Lecture 3 - MOS Fundamentals
- Lecture 4 - MOS Fundamentals (Continued...)
- Lecture 5 - Basic of MOS Amplifier (Part-1)
- Lecture 6 - Basic of MOS Amplifier (Part-2)
- Lecture 7 - Basic of MOS Amplifier (Part-3)
- Lecture 8 - Cascode Amplifier
- Lecture 9 - Types of MOSFET Amplifier
- Lecture 10 - Types of MOSFET Amplifier
- Lecture 11 - Differential Amplifier
- Lecture 12 - Differential Amplifier
- Lecture 13 - Current Sources
- Lecture 14 - Current Sources
- Lecture 15 - Current Sources
- Lecture 16 - Frequency Response of Amplifier
- Lecture 17 - Basic of CMOS OPAMP
- Lecture 18 - OPAMP Design Issues
- Lecture 19 - OPAMP Design
- Lecture 20 - OPAMP Design
- Lecture 21 - Operational Transconductance Amplifier
- Lecture 22 - OTA Operation Transconductance Amplifier and Application
- Lecture 23 - Fully Differential Amplifier and Noise
- Lecture 24 - Noise
- Lecture 25 - Noise (Continued...)
- Lecture 26 - Layout of Analog Circuit
- Lecture 27 - Oscillators
- Lecture 28 - Oscillators (Continued...)
- Lecture 29 - Oscillators (Continued...)

Lecture 1 - Introduction to Analog Circuits - An Overview

Lecture 2 - Two Parts of Review of Analog Filter Approximation

Lecture 3 - BJT Small Signal Model

Lecture 4 - BJT Small Signal Model [Continuation from Lecture 3]

Lecture 5 - MOS Circuit Model

Lecture 6 - Biasing of Circuits

Lecture 7 - Amplifiers

Lecture 8 - MOS Amplifiers

Lecture 9 - Cascode Amplifier

Lecture 10 - Frequency Response of Amplifier

Lecture 11 - Frequency Response of Amplifier

Lecture 12 - Frequency Response of Amplifier

Lecture 13 - Frequency Response of Amplifier

Lecture 14 - Differential Amplifier

Lecture 15 - Differential Amplifier

Lecture 16 - Differential Amplifier

Lecture 17 - Feedback Theory

Lecture 18 - Feedback Theory

Lecture 19 - OPAMP Circuits

Lecture 20 - OPAMP Circuits

Lecture 21 - Active RC Filters

Lecture 22 - Active Filters

Lecture 23 - Oscillators

Lecture 24 - Oscillators

Lecture 25 - DAC/ADC

Lecture 1 - Introduction

Lecture 2 - Reflection Coefficient, VSWR, Smith Chart

Lecture 3 - Reflection Coefficient, VSWR

Lecture 4 - Smith Chart

Lecture 5 - Application of the Smith Chart

Lecture 6 - Microwave Components

Lecture 7 - Broadband Impedance Matching

Lecture 8 - Multi-section transformer

Lecture 9 - Maximally flat (binomial) transformer, Chebyshev transformer

Lecture 10 - Non-uniform transmission line (Tapers)

Lecture 11 - Scattering Parameters

Lecture 12 - Properties of Scattering Parameters

Lecture 13 - Properties of Scattering Parameters (Continued...)

Lecture 14 - Signal flow graph, ABCD parameters

Lecture 15 - 1 and 2 Port passive Components

Lecture 16 - 3 Port Microwave Components

Lecture 17 - Couplers

Lecture 18 - Coupled Line Couplers

Lecture 19 - Resonators and narrow band filters

Lecture 20 - Narrow-band filters

Lecture 21 - Filter design: Image parameter method, Insertion loss method

Lecture 22 - Filter synthesis, Kuroda's Identity

Lecture 23 - Impedance Matching Circuits for Amplifiers

Lecture 24 - Microstrip Matching (Continued...), Masons Rule, Power Gain Equations

Lecture 25 - Amplifier Gain Stability

Lecture 26 - Amplifier Gain Stability (Continued...)

Lecture 27 - Gain Circles

Lecture 28 - Gain Circles (Continued...)

Lecture 29 - Noise

Lecture 30 - Noise Figure Circles (Continued...)

Lecture 31 - DC Bias

[Lecture 32 - Amplifier Classes, Frequency Compensation](#)

[Lecture 33 - Linearity](#)

[Lecture 34 - Oscillator Design](#)

Lecture 1 - Introduction

Lecture 2 - Origin of wavelets

Lecture 3 - Haar wavelet

Lecture 4 - Dyadic wavelet

Lecture 5 - Dilates and translates of Haar wavelet

Lecture 6 - L2 norm of a function

Lecture 7 - Piecewise constant representation of a function

Lecture 8 - Ladder of subspaces

Lecture 9 - Scaling function of Haar wavelet

Lecture 10 - Demonstration: Piecewise constant approximation of functions

Lecture 11 - Vector representation of sequences

Lecture 12 - Properties of norm

Lecture 13 - Parsevals theorem

Lecture 14 - Equivalence of functions and sequences

Lecture 15 - Angle between Functions and their Decomposition

Lecture 16 - Additional Information on Direct-Sum

Lecture 17 - Introduction to filter banks

Lecture 18 - Haar Analysis filter bank in Z-domain

Lecture 19 - Haar Synthesis filter bank in Z-domain

Lecture 20 - Moving from Z-domain to frequency domain

Lecture 21 - Frequency Response of Haar Analysis Low pass Filter bank

Lecture 22 - Frequency Response of Haar Analysis High pass Filter bank

Lecture 23 - Ideal Two-band Filter bank

Lecture 24 - Disqualification of Ideal Filter bank

Lecture 25 - Realizable Two-band Filter bank

Lecture 26 - Demonstration: DWT of images

Lecture 27 - Relating Fourier transform of scaling function to filter bank

Lecture 28 - Fourier transform of scaling function

Lecture 29 - Construction of scaling and wavelet functions from filter bank

Lecture 30 - Demonstration: Constructing scaling and wavelet functions.

Lecture 31 - Conclusive Remarks and Future Prospects



- Lecture 1 - RF system basic architectures
- Lecture 2 - Transmission media reflection
- Lecture 3 - Maximum power transfer
- Lecture 4 - Parallel RLC tank
- Lecture 5 - Matching
- Lecture 6 - Other matching networks
- Lecture 7 - Resistors capacitors
- Lecture 8 - Inductors
- Lecture 9 - Inductors and wires
- Lecture 10 - Wires
- Lecture 11 - Transmission lines
- Lecture 12 - Device review
- Lecture 13 - MOS capacitances
- Lecture 14 - Bandwidth estimation constants
- Lecture 15 - Bandwidth estimation constants (Continued.)
- Lecture 16 - Bandwidth estimation using short circuit
- Lecture 17 - Bandwidth groupdelay and peaking
- Lecture 18 - Shunt series amplifier
- Lecture 19 - Shunt series amplifier (Continued.)
- Lecture 20 - Various noise sources
- Lecture 21 - Noise in a mosfet
- Lecture 22 - Motivation first cut design
- Lecture 23 - Motivation first cut design (Continued.)
- Lecture 24 - Noise other possible topologies
- Lecture 25 - Multiplier Fundamentals
- Lecture 26 - Mixer non idealties
- Lecture 27 - Mixer non idealties (Continued.)
- Lecture 28 - A tank based oscillators
- Lecture 29 - Phase noise in oscillators
- Lecture 30 - Other oscillators topologies
- Lecture 31 - Phase locked loop basics

[Lecture 32 - Charge pump](#)

[Lecture 33 - PLL dynamics integer](#)

[Lecture 34 - Spurious frequencies fractional and synthesis](#)

[Lecture 35 - Fractional spurs](#)

[Lecture 36 - Delta and sigma modulation](#)

[Lecture 37 - Class abc power amplifiers](#)

[Lecture 38 - Class bcd power amplifiers](#)

[Lecture 39 - Class cd pwm amplifiers](#)

[Lecture 40 - Course summary and conclusion](#)

Lecture 1 - Introduction to Communication Engineering

Lecture 2 - Communication channel

Lecture 3 - Brief Review of Signal and Systems

Lecture 4 - The Hilbert Transform

Lecture 5 - Analytic Representation of band pass Signals

Lecture 6 - Fundamentals of Analog Signal Transmission

Lecture 7 - Analog Modulation of Carriers

Lecture 8 - Amplitude Modulation

Lecture 9 - Amplitude Modulation

Lecture 10 - Single Sideband Modulation

Lecture 11 - Suppressed Sideband Modulation

Lecture 12 - VSB Modulation - Superhet Receiver

Lecture 13 - Superhet Receiver etc

Lecture 14 - Practical Mixers-Effects of Tonal

Lecture 15 - Angle Modulation

Lecture 16 - Angle Modulation

Lecture 17 - Generation of FM Signals

Lecture 18 - FM Generation and Detection

Lecture 19 - Demodulation of Angle Modulated Signals

Lecture 20 - Demodulation of Angle Modulated Signals

Lecture 21 - Demodulation of Angle Modulated Signals

Lecture 22 - Feedback Demodulators - phase locked loop

Lecture 23 - The Phase Locked Loop

Lecture 24 - Frequency Compressive Feedback Demodulator

Lecture 25 - FM Receivers

Lecture 26 - TV Transmission

Lecture 27 - Review of Probability Theory and Random Process

Lecture 28 - Review of Probability Theory and Random Variables

Lecture 29 - Random Processes

Lecture 30 - Random Processes

Lecture 31 - Random Processes

[Lecture 32 - Gaussian Random Processes](#)

[Lecture 33 - Behaviour of Communication System](#)

[Lecture 34 - Performance of AM Systems in Noise](#)

[Lecture 35 - Noise in AM and Angle Modulation Systems](#)

[Lecture 36 - Noise in Phase and Frequency Modulation systems](#)

[Lecture 37 - Noise in Angle Modulation](#)

[Lecture 38 - Pre emphasis - De emphasis](#)

[Lecture 39 - Pulse Modulation Schemes - PWM and PPM](#)

[Lecture 40 - Data Modulation](#)

[Lecture 41 - Pulse Code Modulation](#)

Lecture 1 - Digital Signal Processing Introduction

Lecture 2 - Digital Signal Processing Introduction (Continued.)

Lecture 3 - Digital Systems

Lecture 4 - Characterization Description, Testing of Digital Systems

Lecture 5 - LTI Systems Step & Impulse Responses, Convolution

Lecture 6 - Inverse Systems, Stability, FIR & IIR

Lecture 7 - FIR & IIR; Recursive & Non Recursive

Lecture 8 - Discrete Time Fourier Transform

Lecture 9 - Discrete Fourier Transform (DFT)

Lecture 10 - DFT (Continued.)

Lecture 11 - DFT (Continued.) Introduction to Z Transform

Lecture 12 - Z Transform

Lecture 13 - Z Transform (Continued.)

Lecture 14 - Discrete Time Systems in the Frequency Domain

Lecture 15 - Simple Digital Filters

Lecture 16 - All Pass Filters, Com.Filters

Lecture 17 - Linear Phase filters, Complementary Transfer Fn

Lecture 18 - Compensatory Transfer Functions, (Continued.)

Lecture 19 - Test for Stability using All Pass Functions

Lecture 20 - Digital Processing of Continuous Time Signals

Lecture 21 - Problem Solving Session: FT, DFT, & Z Transforms

Lecture 22 - Problem Solving Session: FT, DFT, & Z Transforms

Lecture 23 - Analog Filter Design

Lecture 24 - Analog Chebyshev LPF Design

Lecture 25 - Analog Filter Design (Continued.): Transformations

Lecture 26 - Analog frequency Transformation

Lecture 27 - Problem Solving Session on Discrete Time System

Lecture 28 - Digital Filter Structures

Lecture 29 - IIR Realizations

Lecture 30 - All Pass Realizations

Lecture 31 - Lattice Synthesis (Continued.)

[Lecture 32 - FIR Lattice Synthesis](#)

[Lecture 33 - FIR Lattice \(Continued.\) and Digital Filter Design](#)

[Lecture 34 - IIR Filter Design](#)

[Lecture 35 - IIR Design by Bilinear Transformation](#)

[Lecture 36 - IIR Design Examples](#)

[Lecture 37 - Digital to Digital Frequency Transformation](#)

[Lecture 38 - FIR Design](#)

[Lecture 39 - FIR Digital Filter Design by Windowing](#)

[Lecture 40 - FIR Design by Windowing & Frequency Sampling](#)

[Lecture 41 - Solving Problems on DSP Structures](#)

[Lecture 42 - FIR Design by Frequency Sampling](#)

[Lecture 43 - FIR Design by Frequency Sampling \(Continued.\)](#)

- Lecture 1 - Motivation and Introduction
- Lecture 2 - Types of Wireless communication
- Lecture 3 - The modern wireless Communication Systems
- Lecture 4 - The cellular concept - System Design issues
- Lecture 5 - Cell capacity and reuse
- Lecture 6 - Interference and System capacity
- Lecture 7 - Improving coverage and system capacity
- Lecture 8 - Mobile Radio Propagation
- Lecture 9 - Mobile Radio Propagation (Continued.)
- Lecture 10 - Mobile Radio Propagation (Continued.)
- Lecture 11 - Mobile Radio Propagation (Continued.)
- Lecture 12 - Mobile Radio Propagation (Continued.)
- Lecture 13 - Mobile Radio Propagation (Continued.)
- Lecture 14 - Mobile Radio Propagation II
- Lecture 15 - Mobile Radio Propagation II (Continued.)
- Lecture 16 - Mobile Radio Propagation II (Continued.)
- Lecture 17 - Mobile Radio Propagation II (Continued.)
- Lecture 18 - Mobile Radio Propagation II (Continued.)
- Lecture 19 - Mobile Radio Propagation II (Continued.)
- Lecture 20 - Mobile Radio Propagation II (Continued.)
- Lecture 21 - Modulation Techniques for Mobile Communication
- Lecture 22 - Modulation Techniques (Continued.)
- Lecture 23 - Modulation Techniques (Continued.)
- Lecture 24 - Modulation Techniques (Continued.)
- Lecture 25 - Modulation Techniques (Continued.)
- Lecture 26 - Modulation Techniques (Continued.)
- Lecture 27 - Modulation Techniques (Continued.)
- Lecture 28 - Equalization and Diversity Techniques
- Lecture 29 - Equalization and Diversity Techniques (Continued.)
- Lecture 30 - Equalization and Diversity Techniques (Continued.)
- Lecture 31 - Equalization and Diversity Techniques (Continued.)

[Lecture 32 - Coding Techniques for Mobile Communications](#)

[Lecture 33 - Coding Techniques for Mobile Communications \(Continued.\)](#)

[Lecture 34 - Coding Techniques for Mobile Communications \(Continued.\)](#)

[Lecture 35 - Coding Techniques for Mobile Communications \(Continued.\)](#)

[Lecture 36 - Wireless Networks](#)

[Lecture 37 - GSM and CDMA](#)

[Lecture 38 - GSM and CDMA \(Continued.\)](#)

- Lecture 1 - Semiconductor materials
- Lecture 2 - PN Junction Diodes
- Lecture 3 - Diode Equivalent Circuits
- Lecture 4 - Diode Rectifier Circuits
- Lecture 5 - Zener Diode and Applications
- Lecture 6 - Clipping and Clamping Circuits
- Lecture 7 - Transistor Operation - Part-1
- Lecture 8 - Transistor Operation - Part-2
- Lecture 9 - Biasing the BJT - Part-1
- Lecture 10 - Biasing the BJT - Part-2
- Lecture 11 - BJT Small Signal Analysis
- Lecture 12 - BJT Amplifier - Part-1
- Lecture 13 - BJT Amplifier - Part-2
- Lecture 14 - Frequency Response of BJT Analysis - Part-1
- Lecture 15 - Bipolar Junction Transistors
- Lecture 16 - Transistor as a Switch
- Lecture 17 - MOSFET - Part-1
- Lecture 18 - MOSFET - Part-2
- Lecture 19 - MOSFET under dc operation
- Lecture 20 - Mosfet as an Amplifier
- Lecture 21 - Small signal model of MOSFET - Part-1
- Lecture 22 - Small signal model of MOSFET - Part-2
- Lecture 23 - High Frequency model of mosfet
- Lecture 24 - Junction Field Effect Transistor
- Lecture 25 - Operational Amplifier Introduction
- Lecture 26 - Ideal Op-Amp
- Lecture 27 - Op-Amp applications Part-1
- Lecture 28 - Op-Amp Applications Part-2
- Lecture 29 - Op-Amp Applications Part-3
- Lecture 30 - The practical Op-Amp
- Lecture 31 - Positive feedback and oscillation

[Lecture 32 - Comparator](#)

[Lecture 33 - Large Signal Amplifiers](#)

[Lecture 34 - Transformer Couple Power Amplifier](#)

[Lecture 35 - Class AB Operations of Power Amplifier](#)

[Lecture 36 - Power BJTs](#)

[Lecture 37 - Regulated Power Supply](#)

[Lecture 38 - Four Layered Diode](#)

[Lecture 39 - Silicon Control Rectifier](#)

[Lecture 40 - SCR Applications](#)

[Lecture 1 - Introduction - Part 1](#)

[Lecture 2 - Introduction - Part 2](#)

[Lecture 3 - Overview of VLSI Design Flow](#)

[Lecture 4 - High Level Synthesis Overview - Part 1](#)

[Lecture 5 - High Level Synthesis Overview - Part 2](#)

[Lecture 6 - Scheduling in HLS - Part 1](#)

[Lecture 7 - Scheduling in HLS - Part 2](#)

[Lecture 8 - Scheduling in HLS - Part 3](#)

[Lecture 9 - Scheduling in HLS - Part 4](#)

[Lecture 10 - Scheduling in HLS - Part 5](#)

[Lecture 11 - Scheduling in HLS - Part 6](#)

[Lecture 12 - Scheduling in HLS - Part 7](#)

[Lecture 13 - Resource Sharing and Binding in HLS - Part 1](#)

[Lecture 14 - Resource Sharing and Binding in HLS - Part 2](#)

[Lecture 15 - Resource Sharing and Binding in HLS - Part 3](#)

[Lecture 16 - Resource Sharing and Binding in HLS - Part 4](#)

[Lecture 17 - Resource Sharing and Binding in HLS - Part 5](#)

[Lecture 18 - Resource Sharing and Binding in HLS - Part 6](#)

[Lecture 19 - Resource Sharing and Binding in HLS - Part 7](#)

[Lecture 20 - Logic Synthesis - Part 1](#)

[Lecture 21 - Logic Synthesis - Part 2](#)

[Lecture 22 - Logic Synthesis - Part 3](#)

[Lecture 23 - Physical Design - Part 1](#)

[Lecture 24 - Physical Design - Part 2](#)

[Lecture 25 - Physical Design - Part 3](#)

[Lecture 26 - Introduction to formal methods for design verification](#)

[Lecture 27 - Temporal Logic: Introduction and Basic Operations on Temporal Logic](#)

[Lecture 28 - Syntax and Semantics of CLT](#)

[Lecture 29 - Syntax and semantics of CTL \(Continued...\)](#)

[Lecture 30 - Equivalences between CTL Formulas](#)

[Lecture 31 - Introduction to Model Checking](#)

[Lecture 32 - Model checking Algorithms](#)

[Lecture 33 - Model checking Algorithms \(Continued...\)](#)

[Lecture 34 - Model Checking with Fairness](#)

[Lecture 35 - Binary Decision Diagram: Introduction and Construction](#)

[Lecture 36 - Ordered Binary Decision Diagram \(OBDD\)](#)

[Lecture 37 - Operation On OBDD](#)

[Lecture 38 - OBDD for State Transition Systems E](#)

[Lecture 39 - Symbolic Model Checking](#)

[Lecture 40 - Introduction to Digital VLSI Testing](#)

[Lecture 41 - Functional and Structural Testing](#)

[Lecture 42 - Fault Equivalence](#)

[Lecture 43 - Fault Simulation - I](#)

[Lecture 44 - Fault Simulation - II](#)

[Lecture 45 - Fault Simulation - III](#)

[Lecture 46 - Testability Measures \(SCOAP\)](#)

[Lecture 47 - Introduction to Automatic Test Pattern Generation \(ATPG\) and ATPG Algebras](#)

[Lecture 48 - D-Algorithm - I](#)

[Lecture 49 - D-Algorithm - II](#)

[Lecture 50 - ATPG for Synchronous Sequential Circuits](#)

[Lecture 51 - Scan Chain based Sequential Circuit Testing - I](#)

[Lecture 52 - Scan Chain based Sequential Circuit Testing - II](#)

[Lecture 53 - BIST - I](#)

[Lecture 54 - BIST - II](#)

Lecture 1 - Introduction

Lecture 2 - Analysis of Buck Converter

Lecture 3 - Choosing L and C

Lecture 4 - Design Example of Buck Converter

Lecture 5 - Analysis of H Bridge

Lecture 6 - Bipolar PWM

Lecture 7 - Unipolar PWM

Lecture 8 - Bipolar vs Unipolar PWM

Lecture 9 - Different types of power diode

Lecture 10 - Diode characteristics

Lecture 11 - Diode Datasheets

Lecture 12 - Diode Datasheet Examples

Lecture 13 - MOSFET

Lecture 14 - Switching characteristics of MOSFET

Lecture 15 - MOSFET Datasheets - I

Lecture 16 - MOSFET Datasheets - II

Lecture 17 - MOSFET Datasheet example

Lecture 18 - IGBT

Lecture 19 - IGBT Datasheets - I

Lecture 20 - IGBT Datasheets - II

Lecture 21 - IGBT Datasheet Example

Lecture 22 - Introduction to Gate Drivers

Lecture 23 - Gate Driver Requirements

Lecture 24 - Optocouplers based Gate Drivers - I

Lecture 25 - Optocouplers based Gate Drivers - II

Lecture 26 - Desat Protection

Lecture 27 - Bootstrapping

Lecture 28 - Pulse Transformer based Gate Drivers

Lecture 29 - Gate Drivers - Few Other Requirements

Lecture 30 - Introduction to Snubbers

Lecture 31 - RC Snubber Analysis - I

[Lecture 32 - RC Snubber Analysis - II : Underdamped Case](#)

[Lecture 33 - RC Snubber Analysis - III : Overdamped and Critically Damped Case](#)

[Lecture 34 - RC Snubber Design - I](#)

[Lecture 35 - RC Snubber Design - II](#)

[Lecture 36 - RCD Snubbers - I](#)

[Lecture 37 - RCD Snubbers - II](#)

[Lecture 38 - Power Loss - I](#)

[Lecture 39 - Power Loss - II](#)

[Lecture 40 - Thermal Modelling - I](#)

[Lecture 41 - Thermal Modelling - II](#)

[Lecture 42 - Thermal Modelling - III](#)

[Lecture 43 - Choosing Heat Sinks](#)

[Lecture 44 - Fundamentals](#)

[Lecture 45 - Magnetic Losses](#)

[Lecture 46 - Conductors](#)

[Lecture 47 - Magnetic Materials](#)

[Lecture 48 - Magnetic Core](#)

[Lecture 49 - Inductor Design - I](#)

[Lecture 50 - Inductor Design - II](#)

[Lecture 51 - Transformer Design](#)

[Lecture 52 - Inductor Design Example](#)

[Lecture 53 - Example of Transformer Design](#)

[Lecture 54 - Introduction to EMI](#)

[Lecture 55 - EMI Measurements](#)

[Lecture 56 - EMI in Power Electronics](#)

[Lecture 57 - CM and DM noise](#)

[Lecture 58 - Design Solutions of EMI](#)

[Lecture 59 - EMI Filter - I](#)

[Lecture 60 - EMI Filter - II](#)

[Lecture 61 - Sections of Power Converters](#)

[Lecture 62 - Capacitors](#)

[Lecture 63 - Familiarity with Components - I](#)

[Lecture 64 - Familiarity with Components - II](#)

[Lecture 65 - PCB - I](#)

[Lecture 66 - PCB - II](#)

[Lecture 67 - PCB - III](#)

[Lecture 68 - Grounds](#)

[Lecture 69 - Lab Demo of Hardware Design](#)

[Lecture 70 - Tutorial: PCB Designing](#)

- Lecture 1 - Power systems: Overview and historical developments
- Lecture 2 - Introduction to power delivery systems
- Lecture 3 - Introduction to electrical loads
- Lecture 4 - Load diversity
- Lecture 5 - Different load indices
- Lecture 6 - Loss factor
- Lecture 7 - Load management
- Lecture 8 - Brief overview of power distribution substation
- Lecture 9 - Substation bus schemes and primary distribution network topology
- Lecture 10 - Voltage drop and power loss computations for typical radial distribution feeders
- Lecture 11 - Generalized expression for voltage drop for radial distribution feeder
- Lecture 12 - Derivation of K-constant for voltage drop computation
- Lecture 13 - Different reliability indices used in distribution networks
- Lecture 14 - Different reliability indices with numerical examples
- Lecture 15 - Mathematical concept of reliability
- Lecture 16 - Reliability evaluation of multiple units connected to series and/or parallel
- Lecture 17 - Numerical problems on reliability evaluation
- Lecture 18 - Power quality problems in distribution systems
- Lecture 19 - Forward backward load flow approach for power distribution systems
- Lecture 20 - Forward backward load flow approach for power distribution systems
- Lecture 21 - Reactive power compensation: Basic idea
- Lecture 22 - Reactive power compensation: Numerical examples
- Lecture 23 - Capacitor placement at distribution feeder: Analytical approach
- Lecture 24 - Power distribution system planning: Economic aspects
- Lecture 25 - Power distribution system planning: Different models and solution strategies
- Lecture 26 - Mono-objective power distribution system planning approach
- Lecture 27 - Multi-objective power distribution system planning approach
- Lecture 28 - Multi-objective planning incorporating sectionalizing switches and tie-lines
- Lecture 29 - Reconfiguration of power distribution networks
- Lecture 30 - Distribution networks with the integration of Distributed Generation
- Lecture 31 - Concept of microgrids

[Lecture 32 - Wind and solar energy conversion systems](#)

[Lecture 33 - Energy storage systems](#)

[Lecture 34 - Distribution system automation and smart grid - Part I](#)

[Lecture 35 - Distribution system automation and smart grid - Part II](#)

Lecture 1 - Introduction to Nanophotonics and Plasmonics

Lecture 2 - Introduction to Metamaterials and Metasurfaces

Lecture 3 - Overview and current status

Lecture 4 - Electromagnetic theory of light

Lecture 5 - Electromagnetic properties of material

Lecture 6 - Electromagnetic waves in dielectric media

Lecture 7 - Polarization of light

Lecture 8 - Reflection and refraction: Fresnel equations

Lecture 9 - Absorption, dispersion and scattering of light

Lecture 10 - Matrix theory of dielectric layered media

Lecture 11 - 1D Photonic crystals

Lecture 12 - Dispersion relation and photonic band structure

Lecture 13 - Real and reciprocal lattices

Lecture 14 - 2D and 3D Photonic crystals

Lecture 15 - Emerging Applications of Photonic Crystals

Lecture 16 - Optical properties of metals

Lecture 17 - Surface Plasmon Polaritons (SPP): Fundamentals

Lecture 18 - Applications of SPPs

Lecture 19 - Localized surface plasmon resonance (LSPR)

Lecture 20 - Plasmonic nanoparticles: Antenna and Waveguides

Lecture 21 - Applications of LSPR

Lecture 22 - Fundamentals of metamaterials

Lecture 23 - Effective medium theories

Lecture 24 - Single and Double-Negative Metamaterials

Lecture 25 - Metamaterial Perfect absorbers

Lecture 26 - Super lens, Hyperbolic Metamaterials and Hyper lens

Lecture 27 - Tunable photonic metamaterial based devices

Lecture 28 - Metasurfaces and Frequency selective surfaces

Lecture 29 - Guided mode resonances (GMR)

Lecture 30 - Applications of metasurfaces and GMR devices

Lecture 31 - Transformation Optics (TO) and Invisibility Cloaks

[Lecture 32 - Carpet cloaking and TO metamaterials](#)

[Lecture 33 - Introduction to alternative materials](#)

[Lecture 34 - Nanofabrication: Physical and Chemical methods](#)

[Lecture 35 - Lithography and Pattern transfer](#)

[Lecture 36 - Nanophotonic characterization methods](#)

Lecture 1 - Basic Concepts of active and reactive power

Lecture 2 - Basic Concepts of reactive power compensation

Lecture 3 - Basic mathematical modelling of power transmission systems

Lecture 4 - Derivation of the relation of sending and receiving end voltages and currents - Part A

Lecture 5 - Derivation of the relation of sending and receiving end voltages and currents - Part B

Lecture 6 - Derivations of power flow expressions

Lecture 7 - Numerical example showing determination of power flow

Lecture 8 - Generalized expression for active and reactive power at any point of a long line

Lecture 9 - Mid-point voltage and current for long, lossless transmission lines

Lecture 10 - Plot of mid-point voltage vs line loading

Lecture 11 - Numerical example of mid-point compensation - Part A

Lecture 12 - Numerical example of mid-point compensation - Part B

Lecture 13 - Effect of Mid-point compensation on power flow of transmission lines

Lecture 14 - Thyristor controlled reactor (TCR)

Lecture 15 - Harmonics in TCR and Three-phase TCR configuration

Lecture 16 - Operating Characteristics of TCR

Lecture 17 - Categorization of different types of SVC and Fixed capacitor TCR (FC-TCR)

Lecture 18 - Mechanically Switched Capacitor TCR (MSC-TCR) and Thyristor Switch Capacitor (TSC)

Lecture 19 - Thyristor Switch Capacitor (TSC)

Lecture 20 - Design of TSC-TCR: Numerical Example

Lecture 21 - SVC in enhancement of steady-state power transmission capacity

Lecture 22 - SVC in enhancement of transient stability of power systems

Lecture 23 - SVC in enhancement of synchronizing power coefficient

Lecture 24 - SVC in and power system oscillation damping

Lecture 25 - SVC in voltage control of power systems: Modelling

Lecture 26 - SVC in voltage control of power systems: Control characteristics

Lecture 27 - SVC in voltage control of power systems: Numerical example

Lecture 28 - Basic operating principle of TCSC

Lecture 29 - Basic mathematical modelling of TCSC - Part 1

Lecture 30 - Basic mathematical modelling of TCSC - Part 2

Lecture 31 - TCSC reactance and harmonics analysis

[Lecture 32 - Applications of TCSC in power systems](#)

[Lecture 33 - Basic mathematical modelling of STATCOM](#)

[Lecture 34 - Applications of STATCOM in power systems](#)

[Lecture 35 - Basic mathematical modelling of SSSC](#)

[Lecture 36 - Applications of SSSC in power systems](#)

Lecture 1 - Introduction to Microwave and Optical Metamaterials - I

Lecture 2 - Introduction to Microwave and Optical Metamaterials - II

Lecture 3 - Applications of Optical Metamaterials and Classifications of Metamaterials

Lecture 4 - Classifications of Metamaterials - II

Lecture 5 - Overview of Metamaterials Technology

Lecture 6 - Basic Electromagnetic Theory - I

Lecture 7 - Basic Electromagnetic Theory - II

Lecture 8 - Electromagnetic Properties of Materials

Lecture 9 - Electromagnetic Waves in Materials

Lecture 10 - Electromagnetic Waves in Periodic Medium

Lecture 11 - Polarization of Electromagnetic Waves

Lecture 12 - Fresnel Equations

Lecture 13 - Absorption and Dispersion of Electromagnetic Waves

Lecture 14 - Scattering of Electromagnetic Waves

Lecture 15 - Concept Behind Metamaterials

Lecture 16 - Optical Properties of Metals - I

Lecture 17 - Optical Properties of Metal and Dielectrics

Lecture 18 - Optical Properties of Dielectrics

Lecture 19 - Mixing Rules and Effective Medium Theories

Lecture 20 - Effective Medium Theory - II

Lecture 21 - Overview of Electric Metamaterials

Lecture 22 - Periodic Array of Metallic Wires - I

Lecture 23 - Periodic Array of Metallic Wires - II

Lecture 24 - Inhomogeneous and Chiral Metamaterials

Lecture 25 - Types of Engineered Metamaterials and Applications

Lecture 26 - Split Ring Resonators

Lecture 27 - Optical Magnetic Elements

Lecture 28 - Analytical model of magnetic nanostrips

Lecture 29 - High-Permittivity Route to Artificial Magnetism

Lecture 30 - Modelling of Microwave devices using metamaterials

Lecture 31 - 2D Model of Microwave Antenna with One Layer Metamaterial

[Lecture 32 - Miniaturized Design of Microwave Antenna](#)

[Lecture 33 - Far-field Focusing for Microwave Antennas](#)

[Lecture 34 - Metamaterial-Inspired Antennas - I](#)

[Lecture 35 - Metamaterial-Inspired Antennas - II](#)

[Lecture 36 - Brief Overview of Negative Index Metamaterials](#)

[Lecture 37 - Negative Index Metamaterials - I](#)

[Lecture 38 - Negative Index Metamaterials - II](#)

[Lecture 39 - Super Resolution with Meta-Lenses](#)

[Lecture 40 - Applications of Composite Near-Field Superlens](#)

[Lecture 41 - Fundamentals of Hyperbolic Metamaterials](#)

[Lecture 42 - Hyperbolic Metamaterials for Super-resolution Hyperlens Imaging](#)

[Lecture 43 - Hyperbolic metamaterials for nanoscale optical cavities](#)

[Lecture 44 - Metamaterials Based Nanoscale Optical Cavities and Active Hyperbolic Metamaterials](#)

[Lecture 45 - Applications of Active Hyperbolic Metamaterials](#)

[Lecture 46 - Active Hyperbolic Metamaterials for Various Spectral Band](#)

[Lecture 47 - Principles of Transformational Electromagnetics](#)

[Lecture 48 - Examples and Applications of Transformational Electromagnetics](#)

[Lecture 49 - Invisibility Cloaks](#)

[Lecture 50 - Carpet Cloaking](#)

[Lecture 51 - Realizing Electromagnetic Cloaking using Metamaterials](#)

[Lecture 52 - Transformation Electromagnetics for Antenna Applications and Stealth Technology](#)

[Lecture 53 - Tunable metamaterials and Magnetically tunable metamaterials](#)

[Lecture 54 - Electrically Tunable Metamaterials](#)

[Lecture 55 - Thermally Tunable Metamaterials](#)

[Lecture 56 - Tunable Metamaterials-based Sensors](#)

[Lecture 57 - Metamaterial Fabrication Techniques](#)

[Lecture 58 - Microwave Metamaterial Patterning Methods](#)

[Lecture 59 - Optical Metamaterial Patterning Methods](#)

[Lecture 60 - Metamaterial Fabrication Technique: Pattern Transfer](#)

[Lecture 61 - Characterization Methods of Metamaterials](#)

Lecture 1 - Introduction to Time-Domain Signal Processing

Lecture 2 - Correlation and Convolution

Lecture 3 - Zero-crossing Detection

Lecture 4 - Peak Detection

Lecture 5 - Envelope Detection and Smoothing

Lecture 6 - Pattern Matching

Lecture 7 - Introduction to Frequency-Domain Signal Processing

Lecture 8 - Fourier Analysis

Lecture 9 - Fast Fourier Transforms

Lecture 10 - Applications of FFT

Lecture 11 - Z-transform

Lecture 12 - Coherence Analysis

Lecture 13 - Introduction to Time-Frequency Analysis

Lecture 14 - Multirate Signal Processing - I

Lecture 15 - Multirate Signal Processing - II

Lecture 16 - Short-Time Fourier Transform (STFT)

Lecture 17 - Wavelet Transform - I

Lecture 18 - Wavelet Transform - II

Lecture 19 - Introduction to Signal Processing Architectures

Lecture 20 - Signal Processor Components

Lecture 21 - Interfacing, Pipelining and Parallelism

Lecture 22 - Filter Structures - I

Lecture 23 - Filter Structures - II

Lecture 24 - Filter Design

Lecture 1 - Introduction of Sensor and its Classification

Lecture 2 - Sensor's Classification, Application and Fabrication Process - I

Lecture 3 - Fabrication Process - II

Lecture 4 - Fabrication Process - III

Lecture 5 - Fabrication Process - IV

Lecture 6 - Sensor Characteristics - I

Lecture 7 - Sensor Characteristics - II

Lecture 8 - Sensor Characteristics - III

Lecture 9 - Sensor Characteristics - IV

Lecture 10 - Sensor Characteristics - V

Lecture 11 - Principle of Sensing - Capacitance

Lecture 12 - Principle of Sensing - Inductor

Lecture 13 - Principle of Sensing - Resistance

Lecture 14 - Principle of Sensing - Piezoelectric

Lecture 15 - Principle of Sensing - Pyroelectric

Lecture 16 - Interface Circuit - I

Lecture 17 - Interface Circuit - II

Lecture 18 - Interface Circuit - III

Lecture 19 - Interface Circuit - IV

Lecture 20 - Interface Circuit - V

Lecture 21 - Humidity Sensors - I

Lecture 22 - Humidity Sensors - II

Lecture 23 - Humidity Sensors - III and Gas Sensor - I

Lecture 24 - Gas Sensor - II

Lecture 25 - Gas Sensor - III

Lecture 26 - Temperature Sensors - RTD

Lecture 27 - Temperature Sensors - Thermistors - I

Lecture 28 - Temperature Sensors - Thermistors - II

Lecture 29 - Temperature Sensors - Thermocouple

Lecture 30 - Temperature Sensors - PN Junction, IC and IR

Lecture 31 - Force Sensors - Strain Gauge

[Lecture 32 - Force Sensors - Capacitive](#)

[Lecture 33 - Force Sensors - Piezoresistive](#)

[Lecture 34 - Force Sensors - Piezomagnetic and Electroactive](#)

[Lecture 35 - Force Sensors - Optical](#)

[Lecture 36 - Tactile Sensors - I](#)

[Lecture 37 - Tactile Sensors - II](#)

[Lecture 38 - Pressure Sensors - I](#)

[Lecture 39 - Pressure Sensors - II](#)

[Lecture 40 - Pressure Sensors - III](#)

[Lecture 41 - Occupancy and Motion Sensors - Ultrasonic and Microwave - I](#)

[Lecture 42 - Occupancy and Motion Sensors - Microwave - II and Capacitive](#)

[Lecture 43 - Occupancy and Motion Sensors - Triboelectric and Optoelectronic - I](#)

[Lecture 44 - Occupancy and Motion Sensors - Optoelectronic - II, Visible, IR and Heat Transfer - I](#)

[Lecture 45 - Occupancy and Motion Sensors - Heat Transfer - II and PIR](#)

[Lecture 46 - Position and Displacement Sensors - I](#)

[Lecture 47 - Displacement Sensors - II](#)

[Lecture 48 - Optical Displacement Sensors and Accelerometers - I](#)

[Lecture 49 - Accelerometers - II](#)

[Lecture 50 - Accelerometers - III](#)

[Lecture 51 - Smart Building Sensors - I](#)

[Lecture 52 - Smart Building Sensors - II](#)

[Lecture 53 - Smart Building Sensors - III](#)

[Lecture 54 - Smart Building Sensors - IV](#)

[Lecture 55 - Smart Building Sensors - V](#)

[Lecture 56 - Sensors for Healthcare - I](#)

[Lecture 57 - Sensors for Healthcare - II](#)

[Lecture 58 - Sensors for Healthcare - III](#)

[Lecture 59 - Sensors for Healthcare - IV](#)

[Lecture 60 - Sensors for Healthcare - V](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

[Lecture 41](#)

[Lecture 42](#)

[Lecture 43](#)

[Lecture 44](#)

[Lecture 45](#)

Lecture 1 - Introduction to 3G/4G Standards

Lecture 2 - Wireless Channel and Fading

Lecture 3 - Rayleigh Fading and BER of Wired Communication

Lecture 4 - BER for Wireless Communication

Lecture 5 - Introduction to Diversity

Lecture 6 - Multi-antenna Maximal Ratio Combiner

Lecture 7 - BER with Diversity

Lecture 8 - Spatial Diversity and Diversity Order

Lecture 9 - Wireless Channel and Delay Spread

Lecture 10 - Coherence Bandwidth of the Wireless Channel

Lecture 11 - ISI and Doppler in Wireless Communications

Lecture 12 - Doppler Spectrum and Jakes Model

Lecture 13 - Introduction to CDMA, Spread Spectrum and LFSR

Lecture 14 - Generation and Properties of PN Sequences

Lecture 15 - Correlation of PN Sequences and Jammer Margin

Lecture 16 - CDMA Advantages and RAKE Receiver

Lecture 17 - Multi-User CDMA Downlink Part I

Lecture 18 - Multi-User CDMA Downlink Part II

Lecture 19 - Multi-User CDMA Uplink and Asynchronous CDMA

Lecture 20 - CDMA Near-Far Problem and Introduction to MIMO

Lecture 21 - MIMO System Model and Zero-Forcing Receiver

Lecture 22 - MIMO MMSE Receiver and Introduction to SVD

Lecture 23 - SVD Based Optimal MIMO Transmission and Capacity

Lecture 24 - SVD Based Optimal MIMO Transmission and Capacity

Lecture 25 - OSTBCs and Introduction to V-BLAST Receiver

Lecture 26 - V-BLAST (Continued) and MIMO Beamforming

Lecture 27 - Introduction to OFDM and Multi-Carrier Modulation

Lecture 28 - IFFT Sampling for OFDM

Lecture 29 - OFDM Schematic and Cyclic Prefix

Lecture 30 - OFDM Based Parallelization and OFDM Example

Lecture 31 - OFDM Example (Continued) and Introduction to MIMO-OFDM

[Lecture 32 - MIMO-OFDM \(Continued\)](#)

[Lecture 33 - Impact of Carrier Frequency Offset \(CFO\) in OFDM](#)

[Lecture 34 - PAPR in OFDM Systems and Introduction to SC-FDMA](#)

[Lecture 35 - SC-FDMA \(Continued\) and Introduction of Wireless Propagation Models](#)

[Lecture 36 - Ground Reflection and Okumura Models](#)

[Lecture 37 - Hata Model and Log Normal Shadowing](#)

[Lecture 38 - Link Budget Analysis](#)

[Lecture 39 - Introduction to Teletraffic Theory](#)

[Lecture 40 - Cellular Traffic Modeling and Blocking Probability](#)

[Lecture 1 - Digital Switching](#)

[Lecture 2 - Digital Switching](#)

[Lecture 3 - Digital Switching](#)

[Lecture 4 - Digital Switching](#)

[Lecture 5 - Digital Switching](#)

[Lecture 6 - Digital Switching](#)

[Lecture 7 - Digital Switching](#)

[Lecture 8 - Digital Switching](#)

[Lecture 9 - Digital Switching](#)

[Lecture 10 - Digital Switching](#)

[Lecture 11 - Digital Switching](#)

[Lecture 12 - Digital Switching](#)

[Lecture 13 - Digital Switching](#)

[Lecture 14 - Digital Switching](#)

[Lecture 15 - Digital Switching](#)

[Lecture 16 - Digital Switching](#)

[Lecture 17 - Digital Switching](#)

[Lecture 18 - Digital Switching](#)

[Lecture 19 - Digital Switching](#)

[Lecture 20 - Digital Switching](#)

[Lecture 21 - Digital Switching](#)

[Lecture 22 - Digital Switching](#)

[Lecture 23 - Digital Switching](#)

[Lecture 24 - Digital Switching](#)

[Lecture 25 - Digital Switching](#)

[Lecture 26 - Digital Switching](#)

[Lecture 27 - Digital Switching](#)

[Lecture 28 - Digital Switching](#)

[Lecture 29 - Digital Switching](#)

[Lecture 30 - Digital Switching](#)

[Lecture 31 - Digital Switching](#)

[Lecture 32 - Digital Switching](#)

[Lecture 33 - Digital Switching](#)

[Lecture 34 - Digital Switching](#)

[Lecture 35 - Digital Switching](#)

[Lecture 36 - Digital Switching](#)

[Lecture 37 - Digital Switching](#)

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

**NPTEL : NOC:Principles of Modern CDMA-MIMO-OFDM Wireless Communications (Electronics and Communication Engineering)**

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

- Lecture 1 - Evolution of Wireless Communication Technologies
- Lecture 2 - Modeling Wireless Channel
- Lecture 3 - Wireless Fading Channel Model
- Lecture 4 - Fading Channel Distribution
- Lecture 5 - Rayleigh Fading Channel
- Lecture 6 - Bit Error Rate (BER) Performance
- Lecture 7 - Bit Error Rate (BER) of AWGN Channels
- Lecture 8 - Bit Error Rate of Rayleigh Fading Wireless Channel
- Lecture 9 - Exact BER Expression for Rayleigh Fading Wireless Channel
- Lecture 10 - Deep Fade Analysis of Wireless Communication
- Lecture 11 - Principle of Diversity
- Lecture 12 - Multiple Antenna Diversity
- Lecture 13 - Maximal-Ratio Combining
- Lecture 14 - BER of Multiple Antenna Wireless Systems
- Lecture 15 - Approximate BER for Multiple Antenna Wireless System
- Lecture 16 - Examples for BER of Wireless Communication
- Lecture 17 - Deep Fade in Multi Antenna Systems
- Lecture 18 - Intuition for Deep Fade in Multi-Antenna System
- Lecture 19 - Definition of Diversity Order
- Lecture 20 - Max Delay Spread
- Lecture 21 - RMS Delay Spread
- Lecture 22 - Delay Spread and Inter Symbol Interference
- Lecture 23 - Coherence Bandwidth of Wireless Channel
- Lecture 24 - Mobility and Doppler Effect in Wireless Channels
- Lecture 25 - Impact of Doppler Effect on Wireless Channel
- Lecture 26 - Introduction to Code Division Multiple Access (CDMA)
- Lecture 27 - Chip Time and Bandwidth Expansion in CDMA
- Lecture 28 - Code Generation for CDMA
- Lecture 29 - CDMA Codes: Properties of PN Sequences
- Lecture 30 - BER of CDMA Systems

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

- Lecture 31 - Analysis of Multi-user CDMA
- Lecture 32 - Multipath Diversity in CDMA Systems
- Lecture 33 - Near-Far Problem in CDMA
- Lecture 34 - Multiple Input Multiple Output (MIMO) Systems
- Lecture 35 - Examples of MIMO Systems
- Lecture 36 - MIMO Receivers
- Lecture 37 - BER Performance of ZF Receiver
- Lecture 38 - Transmit Beamforming in MISO Systems
- Lecture 39 - Alamouti Code and Space-Time Block Codes
- Lecture 40 - BER of Alamouti Coded System
- Lecture 41 - Singular Value Decomposition (SVD)
- Lecture 42 - SVD in MIMO
- Lecture 43 - Capacity of MIMO Wireless Systems
- Lecture 44 - SVD based MIMO Transmission
- Lecture 45 - Orthogonal Frequency Division Multiplexing (OFDM)
- Lecture 46 - Transmission in Multicarrier Systems
- Lecture 47 - FFT/IFFT Processing in OFDM
- Lecture 48 - Cyclic Prefix in OFDM Systems
- Lecture 49 - Schematic Representation of OFDM Transmitter and Receiver
- Lecture 50 - BER Performance of OFDM Systems

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

**NPTEL : NOC:Probability and Random Variables, Processes for Wireless Communications (Electronics and Communication Engineering)**

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

Lecture 1 - Basics - Sample Space and Events

Lecture 2 - Axioms of Probability

Lecture 3 - Conditional Probability - Mary-PAM Example

Lecture 4 - Independent Events - Mary-PAM Example

Lecture 5 - Independent Events - Block Transmission Example

Lecture 6 - Independent Events - Multiantenna Fading Example

Lecture 7 - Bayes Theorem and Aposteriori Probabilities

Lecture 8 - Maximum Aposteriori Probability (MAP) Receiver

Lecture 9 - Random Variables, Probability Density Function (PDF)

Lecture 10 - Application: Power of Fading Wireless Channel

Lecture 11 - Mean, Variance of Random Variables

Lecture 12 - Application: Average Delay and RMS Delay Spread of Wireless Channel

Lecture 13 - Transformation of Random Variables and Rayleigh Fading Wireless Channel

Lecture 14 - Gaussian Random Variable and Linear Transformation

Lecture 15 - Special Case: IID Gaussian Random Variables

Lecture 16 - Application: Array Processing and Array Gain with Uniform Linear Arrays

Lecture 17 - Random Processes and Wide Sense Stationarity (WSS)

Lecture 18 - WSS Example Narrowband Wireless Signal with Random Phase

Lecture 19 - Power Spectral Density (PSD) for WSS Random Process

Lecture 20 - PSD Application in Wireless Bandwidth Required for Signal Transmission

Lecture 21 - Transmission of WSS Random Process Through LTI System

Lecture 22 - Special Random Processes Gaussian Process and White Noise AWGN Communication Channel

Lecture 23 - Gaussian Process Through LTI System Example: WGN Through RC Low Pass Filter Not Started

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

**NPTEL : NOC:Estimation for Wireless Communications, MIMO, OFDM Cellular and Sensor Networks (Electronics and Communication Engineering)**

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

Lecture 1 - Basics - Sensor Network and Noisy Observation Model

Lecture 2 - Likelihood Function and Maximum Likelihood (ML) Estimate

Lecture 3 - Properties of Maximum Likelihood (ML) Estimate  $\hat{A}$ – Mean and Unbiasedness

Lecture 4 - Properties of Maximum Likelihood (ML) Estimate  $\hat{A}$ – Variance and Spread Around Mean

Lecture 5 - Reliability of the Maximum Likelihood (ML) Estimate  $\hat{A}$ – Number of Samples Required

Lecture 6 - Estimation of Complex Parameters  $\hat{A}$ – Symmetric Zero Mean Complex Gaussian Noise

Lecture 7 - Wireless Fading Channel Estimation  $\hat{A}$ – Pilot Symbols and Likelihood Function

Lecture 8 - Wireless Fading Channel Estimation  $\hat{A}$ – Pilot Training based Maximum Likelihood ML Estimate

Lecture 9 - Wireless Fading Channel Estimation  $\hat{A}$ – Mean and Variance of Pilot Training Based Maximum Likelihood

Lecture 10 - Example  $\hat{A}$ – Wireless Fading Channel Estimation for Downlink Mobile Communication

Lecture 11 - Cramer Rao Bound (CRB) for Parameter Estimation

Lecture 12 - Cramer Rao Bound CRB Example  $\hat{A}$ – Wireless Sensor Network

Lecture 13 - Vector Parameter Estimation  $\hat{A}$ – System Model for Multi Antenna Downlink Channel Estimation

Lecture 14 - Likelihood Function and Least Squares Cost Function for Vector Parameter Estimation

Lecture 15 - Least Squares Cost Function for Vector Parameter Estimation Vector Derivative Gradient

Lecture 16 - Least Squares Solution Maximum Likelihood ML Estimate Pseudo Inverse

Lecture 17 - Properties of Least Squares Estimate  $\hat{A}$ – Mean Covariance and Distribution

Lecture 18 - Least Squares Multi Antenna Downlink Maximum Likelihood Channel Estimation

Lecture 19 - Multiple Input Multiple Output MIMO Channel Estimation  $\hat{A}$ – Least Squares Maximum Likelihood ML

Lecture 20 - Example  $\hat{A}$ – Least Squares Multiple Input Multiple Output MIMO Channel Estimation

Lecture 21 - Channel Equalization and Inter Symbol Interference ISI Model

Lecture 22 - Least Squares based Zero Forcing Channel Equalizer

Lecture 23 - Example of ISI Channel and Least Squares based Zero Forcing

Lecture 24 - Equalization and Approximation Error for Zero Forcing Channel Equalizer

Lecture 25 - Example Equalization and Approximation Error for Zero Forcing Channel Equalizer

Lecture 26 - Introduction to Orthogonal Frequency Division Multiplexing OFDM  $\hat{A}$ – Cyclic Prefix CP and Circular Convolution

Lecture 27 - Introduction to Orthogonal Frequency Division Multiplexing OFDM  $\hat{A}$ – FFT at Receiver and Flat Fading

Lecture 28 - Channel Estimation Across Each Subcarrier in Orthogonal Frequency Division Multiplexing OFDM

Lecture 29 - Example Orthogonal Frequency Division Multiplexing OFDM  $\hat{A}$ – Transmission of Samples with Cyclic Prefix

Lecture 30 - Example Orthogonal Frequency Division Multiplexing OFDM  $\hat{A}$ – FFT at Receiver and Channel Estimation

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

[Lecture 31 - Comb Type Pilot CTP Based Orthogonal Frequency Division Multiplexing OFDM Channel Estimation](#)

[Lecture 32 - Comb Type Pilot CTP Based Orthogonal Frequency Division Multiplexing OFDM Channel Estimation](#)

[Lecture 33 - Example Comb Type Pilot CTP Based Orthogonal Frequency Division Multiplexing OFDM Channel](#)

[Lecture 34 - Frequency Domain Equalization FDE for Inter Symbol Interference ISI Removal in Wireless System](#)

[Lecture 35 - Example Frequency Domain Equalization FDE for Inter Symbol Interference ISI Removal in Wireless Channels](#)

[Lecture 36 - Example Frequency Domain Equalization FDE for Inter Symbol Interference ISI Removal in Wireless Channels](#)

[Lecture 37 - Introduction to Sequential Estimation  \$\hat{A}\$ – Application in Wireless Channel Estimation](#)

[Lecture 38 - Sequential Estimation of Wireless Channel Coefficient  \$\hat{A}\$ – Estimate and Variance Update Equation](#)

[Lecture 39 - Example Sequential Estimation of Wireless Channel Coefficient](#)

Lecture 1 - Introduction to Error Coding - I

Lecture 2 - Introduction to Error Coding - II

Lecture 3 - Introduction to Error Control Coding - III

Lecture 4 - Introduction to Convolutional Codes - I: Encoding

Lecture 5 - Introduction to Convolutional Codes - II: State Diagram, Trellis Diagram

Lecture 6 - Convolutional Codes: Classification, Realization

Lecture 7 - Convolutional Codes:Distance Properties

Lecture 8 - Decoding of Convolutional Codes - I: Viterbi Algorithm

Lecture 9 - Decoding of Convolutional Codes - II: BCJR Algorithm

Lecture 10 - Problem Solving Session - I

Lecture 11 - Problem Solving Session - II

Lecture 12 - Performance Bounds for Convolutional Codes

Lecture 13 - Turbo Codes

Lecture 14 - Turbo Decoding

Lecture 15 - Convergence of Turbo Codes

Lecture 16 - Applications of Convolutional Codes

Lecture 17 - Problem Solving Sessions - III

Lecture 1 - Introduction to Error Control Coding - I

Lecture 2 - Introduction to Error Control Coding - II

Lecture 3 - Introduction to Error Control Coding - III

Lecture 4 - Introduction to Linear Block Codes, Generator Matrix and Parity Check Matrix

Lecture 5 - Syndrome, Error Correction and Error Detection

Lecture 6 - Problem Solving Session - I

Lecture 7 - Decoding of Linear Block Codes

Lecture 8 - Distance Properties of Linear Block Codes - I

Lecture 9 - Distance Properties of Linear Block Codes - II

Lecture 10 - Problem Solving Session - II

Lecture 11 - Some Simple Linear Block Codes - I

Lecture 12 - Some Simple Linear Block Codes - II: Reed Muller Codes

Lecture 13 - Bounds on the Size of a Code

Lecture 14 - Problem Solving Session - III

Lecture 15 - Low Density Parity Check Codes

Lecture 16 - Decoding of Low Density Parity Check Codes - I

Lecture 17 - Decoding of Low Density Parity Check Codes - II: Belief Propagation Algorithm

Lecture 18 - Applications of Linear Block Codes

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

**NPTEL : NOC:Bayesian, MMSE Estimation for Wireless Communications MIMO, OFDM Cellular and Sensor Networks  
(Electronics and Communication Engineering)**

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

Lecture 1 - Basics  $\hat{A}$ – Introduction to Bayesian Minimum Mean Squared Error

Lecture 2 - Optimal Bayesian Minimum Mean Squared Error (MMSE) Estimate

Lecture 3 - Derivation of Minimum Mean Squared Error MMSE Estimate for Gaussian Parameter  $\hat{A}$ – Part I

Lecture 4 - Derivation of Minimum Mean Squared Error MMSE Estimate for Gaussian Parameter  $\hat{A}$ – Part II

Lecture 5 - Derivation of Minimum Mean Squared Error (MMSE) Estimate for Gaussian Parameter  $\hat{A}$ – Non-Zero Mean and Vector Parameter / Observation

Lecture 6 - Minimum Mean Squared Error MMSE Estimation Application  $\hat{A}$ – Wireless Sensor Network

Lecture 7 - Simplification and Example of Minimum Mean Squared Error MMSE Estimate for Wireless Sensor Networks

Lecture 8 - Minimum Mean Squared Error MMSE Estimation Application  $\hat{A}$ – Wireless Fading Channel Estimation

Lecture 9 - Simplification and Example of Minimum Mean Squared Error MMSE Estimate for Wireless Fading Channel

Lecture 10 - Minimum Mean Squared Error MMSE for Wireless Sensor Network WSN  $\hat{A}$ – Derivation and Example

Lecture 11 - Reliability of Minimum Mean Squared Error MMSE Estimate  $\hat{A}$ – Part I

Lecture 12 - Reliability of Minimum Mean Squared Error MMSE Estimate  $\hat{A}$ – Part II

Lecture 13 - Minimum Mean Squared Error MMSE for Wireless Fading Channel Estimation  $\hat{A}$ – Derivation

Lecture 14 - Minimum Mean Squared Error (MMSE) for Wireless Fading Channel Estimation  $\hat{A}$ – Example and Properties of Complex Channel Coefficient Estimate

Lecture 15 - Linear Minimum Mean Squared Error LMMSE Estimate Derivation  $\hat{A}$ – Part I

Lecture 16 - Linear Minimum Mean Squared Error LMMSE Estimate Derivation  $\hat{A}$ – Part II

Lecture 17 - Vector Parameter Estimation  $\hat{A}$ – System Model for Multi-Antenna Downlink Channel Estimation

Lecture 18 - Linear Minimum Mean Squared Error LMMSE Estimate for Multi Antenna Downlink Wireless Channel - Part I

Lecture 19 - Linear Minimum Mean Squared Error LMMSE Estimate for Multi Antenna Downlink Wireless Channel - Part II

Lecture 20 - Example of Linear Minimum Mean Squared Error LMMSE Estimation for Multi Antenna Downlink Wireless Channel

Lecture 21 - Derivation and Example of Error Covariance of Multi Antenna LMMSE Channel Estimation

Lecture 22 - System Model for Multiple Input Multiple Output MIMO Downlink Wireless Channel Estimation

Lecture 23 - Channel/ Noise Statistics for Multiple-Input Multiple-Output (MIMO) Downlink Wireless Channel Estimation

Lecture 24 - LMMSE/ MMSE Estimation for Multiple-Input Multiple-Output(MIMO) Downlink Wireless Channel Estimation

Lecture 25 - Example of LMMSE/ MMSE Estimation for Multiple-Input Multiple-Output (MIMO) Downlink Wireless Channel Estimation

Lecture 26 - Introduction and system model for equalization

Lecture 27 - Linear Minimum Mean Square Error (LMMSE) Channel Equalization

Lecture 28 - Error for LMMSE Channel Equalizer and Example of LMMSE Channel Equalization

Lecture 29 - Example of Linear Minimum Mean Square Error (LMMSE) Channel Equalization

[Lecture 30 - Introduction and system model for OFDM](#)

[Lecture 31 - System model for OFDM, IFFT/ FFT Operations](#)

[Lecture 32 - LMMSE Estimation for OFDM](#)

[Lecture 33 - Estimate and Error variance of LMMSE Estimate](#)

[Lecture 34 - Example of OFDM](#)

[Lecture 35 - Example of LMMSE estimate and Error variance for OFDM](#)

Lecture 1 - Overview of Fiber-optic communications

Lecture 2 - Optical Transmitter - I

Lecture 3 - Optical Transmitter - I (Continued...)

Lecture 4 - Optical Transmitter - II

Lecture 5 - Optical Transmitter - II (Continued...)

Lecture 6 - Intensity modulation

Lecture 7 - Review of Signals and Representations - I

Lecture 8 - Review of Signals and Representations - II

Lecture 9 - Digital Modulation - I

Lecture 10 - Review of Signals and Representations - III

Lecture 11 - Review of Signals and Representations - IV

Lecture 12 - Digital Modulation - II

Lecture 13 - Digital Modulation - II (Continued...)

Lecture 14 - Digital Modulation - III

Lecture 15 - Optical receivers - I

Lecture 16 - Optical receivers - II

Lecture 17 - Optical Modulator : Physical Structure

Lecture 18 - Propagation of Electromagnetic wave

Lecture 19 - Review of EM Theory

Lecture 20 - Reflection of Waves

Lecture 21 - Optical fiber - I

Lecture 22 - Optical fiber - II

Lecture 23 - Modes in Optical fiber - I

Lecture 24 - Modes in Optical fiber - I (Continued...)

Lecture 25 - Modes in Optical fiber - II

Lecture 26 - Dispersion in Fibers

Lecture 27 - Dispersion in Fibers (Continued...)

Lecture 28 - Wrapping up fiber parameters

Lecture 29 - System Design - I

Lecture 30 - Passive WDM components - I

Lecture 31 - Passive WDM components - II

- [Lecture 32 - Detection of light](#)
- [Lecture 33 - Detection of light \(Continued...\)](#)
- [Lecture 34 - Response time and Noise in Detectors](#)
- [Lecture 35 - Noise in photodiodes - I Edit Lesson](#)
- [Lecture 36 - Noise in photodiodes - II](#)
- [Lecture 37 - Light sources - I](#)
- [Lecture 38 - Light sources - II Edit Lesson](#)
- [Lecture 39 - Semiconductor laser diodes](#)
- [Lecture 40 - Optical communication:Pulse shape and BW](#)
- [Lecture 41 - Power spectral density](#)
- [Lecture 42 - Power spectral density \(Continued...\)](#)
- [Lecture 43 - Advantage of coherent receiver](#)
- [Lecture 44 - Dispersion induced limitations](#)
- [Lecture 45 - Optical amplifiers - I](#)
- [Lecture 46 - Optical amplifiers - II](#)
- [Lecture 47 - Noise in optical amplifiers](#)
- [Lecture 48 - Noise in optical amplifiers \(Continued...\)](#)
- [Lecture 49 - ASE induced limitations](#)
- [Lecture 50 - Determining BER in OOK system](#)
- [Lecture 51 - BER determination](#)
- [Lecture 52 - Eye diagram and Higher modulation techniques Edit Lesson](#)
- [Lecture 53 - Higher modulation techniques \(Continued...\)](#)
- [Lecture 54 - Optical OFDM](#)

Lecture 1 - Introduction to Telephony and Networks

Lecture 2 - Strowger Automatic Exchange

Lecture 3 - Crossbar Switching

Lecture 4 - Logic Circuit for Crosspoint Operation

Lecture 5 - Introduction to Multistage Interconnection Networks

Lecture 6 - Blocking probability of crossbar switches

Lecture 7 - Call congestion and time congestio

Lecture 8 - Clos network

Lecture 9 - Lee's approximation

Lecture 10 - Karnaugh's approximation

Lecture 11 - Time switch

Lecture 12 - Time switch and Clos network

Lecture 13 - TST switch, Strictly Non-blocking network, Rearrangeably non-blocking network

Lecture 14 - Paull's Matrix

Lecture 15 - f-way multicasting

Lecture 16 - Strictly sense non blocking multicasting switch

Lecture 17 - Rearrangeably non blocking networks

Lecture 18 - Slepian Duguid theorem, Paull's theorem

Lecture 19 - Paull's matrix for rearrangeably non blocking networks

Lecture 20 - Recursive construction; Crosspoint complexity for rearrangeably and strictly non-blocking networks

Lecture 21 - Cantor network

Lecture 22 - Wide-sense non blocking network

Lecture 23 - Example of wide -sense non-blocking switch

Lecture 24 - Packet Switching

Lecture 25 - Buffering strategies

Lecture 26 - Output Queued Switch

Lecture 27 - Input Queued Switch

Lecture 28 - Banyan Network, Delta Network

Lecture 29 - Shufflenet as Delta network

Lecture 30 - Performance analysis of crossbar and delta network

Lecture 31 - Properties of Delta Network

[Lecture 32 - Buffered and Unbuffered Delta network](#)

[Lecture 33 - Analysis of Buffered Delta Network - 1 of 3](#)

[Lecture 34 - Analysis of Buffered Delta Network - 2 of 3](#)

[Lecture 35 - Analysis of Buffered Delta Network - 3 of 3](#)

Lecture 1 - Introduction

Lecture 2 - Measure of Information

Lecture 3 - Information Inequalities

Lecture 4 - Problem solving session - I

Lecture 5 - Block to Variable Length Coding - I : Prefix-free code

Lecture 6 - Block to Variable Length Coding - II : Bounds on Optimal Code Length

Lecture 7 - Block to Variable Length Coding - III : Huffman Coding

Lecture 8 - Variable to block length coding

Lecture 9 - The asymptotic equipartition property

Lecture 10 - Block to block coding of DMS

Lecture 11 - Problem solving session - II

Lecture 12 - Universal Source Coding - I : Lempel-Ziv Algorithm-LZ77

Lecture 13 - Universal source coding - II : Lempel-Ziv Welch Algorithm (LZW)

Lecture 14 - Coding of sources with memory

Lecture 15 - Channel Capacity

Lecture 16 - Joint typical sequences

Lecture 17 - Noisy channel coding theorem

Lecture 18 - Differential entropy

Lecture 19 - Gaussian channel

Lecture 20 - Parallel Gaussian channel

Lecture 21 - Problem solving session - III

Lecture 22 - Rate distortion theory

Lecture 23 - Blahut-Arimoto Algorithm

Lecture 24 - Problem solving session - IV

Lecture 1 - Course Introduction

Lecture 2 - Key 5G Technologies - Adaptive Modulation and Coding (AMC)

Lecture 3 - Key 5G Technologies - Hybrid automatic repeat request (HARQ)

Lecture 4 - Key 5G Technologies - Orthogonal frequency division multiplexing (OFDM)

Lecture 5 - 5G Numerology

Lecture 6 - 5G frame structure

Lecture 7 - 5G physical downlink shared channel (PDSCH) transmit chain- CRC generation

Lecture 8 - 5G PDSCH transmit chain - code block segmentation â€œ Part I

Lecture 9 - 5G PDSCH transmit chain - LDPC coding

Lecture 10 - 5G PDSCH transmit chain - code block segmentation â€œ Part II

Lecture 11 - 5G PDSCH transmit chain - rate matching â€œ Part I

Lecture 12 - 5G PDSCH transmit chain - rate matching â€œ Part II

Lecture 13 - 5G PDSCH transmit chain - interleaving and concatenation

Lecture 14 - 5G PDSCH transmit chain - scrambling and modulation

Lecture 15 - 5G PDSCH transmit chain - recap

Lecture 16 - 5G PDSCH receive chain - Part I

Lecture 17 - 5G PDSCH receive chain - Part II

Lecture 18 - 5G PDSCH - map receiver design - Part I

Lecture 19 - 5G PDSCH - map receiver design - Part II

Lecture 20 - 5G baseband - RF conversion

Lecture 21 - Indigenous 5G network architecture

Lecture 22 - 5G physical downlink control channel (PDCCH) transmit chain - introduction

Lecture 23 - 5G PDCCH transmit chain - CRC and segmentation

Lecture 24 - 5G PDCCH transmit chain - Polar encoding

Lecture 25 - 5G PDCCH transmit chain - CRC interleaver

Lecture 26 - 5G PDCCH transmit chain - sub-block interleaver

Lecture 27 - 5G PDCCH transmit chain - rate matching

Lecture 28 - 5G PDCCH transmit chain - control resource set (CORESET) design â€œ Part I

Lecture 29 - 5G PDCCH transmit chain - CORESET design â€œ Part II

Lecture 30 - 5G PDCCH transmit chain - CORESET design â€œ Part III

Lecture 31 - 5G PDCCH transmit chain - CORESET design â€œ Part IV

- Lecture 32 - 5G physical uplink control channel (PUCCH) - Part I
- Lecture 33 - 5G physical uplink control channel (PUCCH) - Part II
- Lecture 34 - Multiple input multiple output (MIMO) transceiver chain - Part I
- Lecture 35 - MIMO transceiver chain - Part II
- Lecture 36 - MIMO transceiver chain - Part III
- Lecture 37 - MIMO transceiver chain - Part IV
- Lecture 38 - MIMO transceiver chain - Part V
- Lecture 39 - MIMO transceiver chain - Part VI
- Lecture 40 - MIMO transceiver chain - Part VII
- Lecture 41 - 5G demodulation reference signal (DM-RS) design - Part I
- Lecture 42 - 5G DM-RS design - Part II
- Lecture 43 - 5G DM-RS design - Part III
- Lecture 44 - 5G DM-RS design - Part IV
- Lecture 45 - 5G sounding reference signal (SRS) design - Part I
- Lecture 46 - 5G SRS design - Part II
- Lecture 47 - 5G SRS design - Part III
- Lecture 48 - 5G SRS design - Part IV
- Lecture 49 - 5G SRS design - Part V
- Lecture 50 - 5G channel state estimation reference signal (CSI-RS) - Part I
- Lecture 51 - 5G CSI-RS - Part II
- Lecture 52 - 5G MIMO transceiver chain - Part I
- Lecture 53 - 5G MIMO transceiver chain - Part II
- Lecture 54 - 5G MIMO codebook design - Part I
- Lecture 55 - 5G MIMO codebook design - Part II
- Lecture 56
- Lecture 57
- Lecture 58
- Lecture 59
- Lecture 60

- Lecture 1 - Introduction
- Lecture 2 - Refresher dB and Fourier series
- Lecture 3 - Linear system frequency properties
- Lecture 4 - Frequency Translation and Transmission
- Lecture 5 - Introduction to Receivers
- Lecture 6 - Receiver Architecture (Continued...)
- Lecture 7 - Introduction to Transmission Lines
- Lecture 8 - Transmission Line Analysis
- Lecture 9 - Introduction to S parameters
- Lecture 10 - S11 and S21 (Continued...)
- Lecture 11 - Single Transistor Matching Techniques
- Lecture 12 - Example Architecture For Matching
- Lecture 13 - Biasing CG Stage Intro To  $f_T$
- Lecture 14 - Maximising  $f_T$  of a Transistor
- Lecture 15 - Introduction to Thermal Noise
- Lecture 16 - Relating Noise to Port Impedances
- Lecture 17 - Input Referred Noise Model
- Lecture 18 - Input Referred Noise - Noise Figure
- Lecture 19 - Gate Noise-Noise Figure Reduction Example
- Lecture 20 - Sensitivity NF with matching
- Lecture 21 - Noise Analysis in Source Degenerated LNA
- Lecture 22 - Use\_of\_cascode\_transistor\_in\_LNA
- Lecture 23 - Intuition\_of\_cascode\_noise\_and\_Introduction\_to\_IIP2\_IIP3
- Lecture 24 - Spurious Free Dynamic Range\_P1dB\_B1dB
- Lecture 25 - Noise and distortion in cascaded systems
- Lecture 26 - Distortion Mitigation Techniques in LNAs
- Lecture 27 - Inductor Design
- Lecture 28 - On chip design of Capacitors and Resistors
- Lecture 29 - Impedance Transformation Using LC
- Lecture 30 - Losses In Matching Network
- Lecture 31 - Multi Stage Matching

[Lecture 32 - Mixers](#)

[Lecture 33 - Image Reject Mixers](#)

[Lecture 34 - Passive mixers sizing noise](#)

[Lecture 35 - Intro to Transmitters Upconversion Mixers](#)

[Lecture 36 - ClassA ClassB PA](#)

[Lecture 37 - Modulation Schemes Issue with PA](#)

[Lecture 38 - FLO Generation](#)

- Lecture 1 - Introduction to Adaptive Filters
- Lecture 2 - Introduction to Stochastic Processes
- Lecture 3 - Stochastic Processes
- Lecture 4 - Correlation Structure
- Lecture 5 - FIR Wiener Filter (Real)
- Lecture 6 - Steepest Descent Technique
- Lecture 7 - LMS Algorithm
- Lecture 8 - Convergence Analysis
- Lecture 9 - Convergence Analysis (Mean Square)
- Lecture 10 - Convergence Analysis (Mean Square)
- Lecture 11 - Misadjustment and Excess MSE
- Lecture 12 - Misadjustment and Excess MSE
- Lecture 13 - Sign LMS Algorithm
- Lecture 14 - Block LMS Algorithm
- Lecture 15 - Fast Implementation of Block LMS Algorithm
- Lecture 16 - Fast Implementation of Block LMS Algorithm
- Lecture 17 - Vector Space Treatment to Random Variables
- Lecture 18 - Vector Space Treatment to Random Variables
- Lecture 19 - Orthogonalization and Orthogonal Projection
- Lecture 20 - Orthogonal Decomposition of Signal Subspaces
- Lecture 21 - Introduction to Linear Prediction
- Lecture 22 - Lattice Filter
- Lecture 23 - Lattice Recursions
- Lecture 24 - Lattice as Optimal Filter
- Lecture 25 - Linear Prediction and Autoregressive Modeling
- Lecture 26 - Gradient Adaptive Lattice
- Lecture 27 - Gradient Adaptive Lattice
- Lecture 28 - Introduction to Recursive Least Squares
- Lecture 29 - RLS Approach to Adaptive Filters
- Lecture 30 - RLS Adaptive Lattice
- Lecture 31 - RLS Lattice Recursions

[Lecture 32 - RLS Lattice Recursions](#)

[Lecture 33 - RLS Lattice Algorithm](#)

[Lecture 34 - RLS Using QR Decomposition](#)

[Lecture 35 - Givens Rotation](#)

[Lecture 36 - Givens Rotation and QR Decomposition](#)

[Lecture 37 - Systolic Implementation](#)

[Lecture 38 - Systolic Implementation](#)

[Lecture 39 - Singular Value Decomposition](#)

[Lecture 40 - Singular Value Decomposition](#)

[Lecture 41 - Singular Value Decomposition](#)

Lecture 1 - Introduction to Digital Computer Organization

Lecture 2 - CPU Design - I

Lecture 3 - CPU Design - II

Lecture 4 - CPU Design Timing and Control

Lecture 5 - Micro programmed Control - I

Lecture 6 - Micro programmed Control - II

Lecture 7 - Pipeline Concept - I

Lecture 8 - Pipeline Concept - II

Lecture 9 - Pipeline Concept - III

Lecture 10 - Pipeline CPU - I

Lecture 11 - Pipeline CPU - II

Lecture 12 - Pipeline CPU - III

Lecture 13 - Memory Organization - I

Lecture 14 - Memory Organization - II

Lecture 15 - Memory Organization - III

Lecture 16 - Memory Organization - IV

Lecture 17 - Memory Organization - V

Lecture 18 - Cache Memory Architecture

Lecture 19 - Cache Memory Architecture RAM Architecture

Lecture 20 - RAM Architecture

Lecture 21 - DAM Architecture-1

Lecture 22 - DAM Architecture Buffer Cache

Lecture 23 - Buffer Cache

Lecture 24 - Secondary Storage Organization - I

Lecture 25 - Secondary Storage Organization - II

Lecture 26 - Secondary Storage Organization - III

Lecture 27 - I/O Subsystem Organization

Lecture 28 - Error Detection and Correction

Lecture 1 - Introduction

Lecture 2 - Image Digitization - I

Lecture 3 - Image Digitization - II

Lecture 4 - Pixels Relationships - I

Lecture 5 - Pixels Relationships - II

Lecture 6 - Basic Transformations

Lecture 7 - Camera Model and Imaging Geometry

Lecture 8 - Camera Calibration and Stereo Imaging

Lecture 9 - Interpolation and Resampling

Lecture 10 - Image Interpolation - II

Lecture 11 - Image Interpolation - I

Lecture 12 - Image Transformation - II

Lecture 13 - Fourier Transformation - I

Lecture 14 - Fourier Transformation - II

Lecture 15 - Discrete Cosine Transform

Lecture 16 - K-L Transform

Lecture 17 - Image Enhancement

Lecture 18 - Image Enhancement

Lecture 19 - Image Enhancement

Lecture 20 - Image Enhancement

Lecture 21 - Image Enhancement Frequency

Lecture 22 - Image Restoration - I

Lecture 23 - Image Restoration - II

Lecture 24 - Image Restoration - III

Lecture 25 - Image Registration

Lecture 26 - Colour Image Processing - I

Lecture 27 - Colour Image Processing - II

Lecture 28 - Colour Image Processing - III

Lecture 29 - Image Segmentation - I

Lecture 30 - Image Segmentation - II

Lecture 31 - Image Segmentation - III

[Lecture 32 - Image Segmentation - IV](#)

[Lecture 33 - Mathematical Morphology - I](#)

[Lecture 34 - Mathematical Morphology - II](#)

[Lecture 35 - Mathematical Morphology - III](#)

[Lecture 36 - Mathematical Morphology - IV](#)

[Lecture 37 - Object Representation and Description - I](#)

[Lecture 38 - Object Representation and Description - II](#)

[Lecture 39 - Object Representation and Description - III](#)

[Lecture 40 - Object Recognition](#)

Lecture 1 - Introduction to Digital Systems Design

Lecture 2 - Introduction

Lecture 3 - Digital Logic - I

Lecture 4 - Digital Logic - II

Lecture 5 - Digital Logic - III

Lecture 6 - Boolean Algebra

Lecture 7 - Boolean Algebra

Lecture 8 - Boolean Function Minimization

Lecture 9 - Boolean Function Minimization

Lecture 10 - Boolean Function Minimization

Lecture 11 - Hazzard Covers by K - Map

Lecture 12 - Combinational Circuit Design

Lecture 13 - Design of ADDER Circuits

Lecture 14 - Design of Subtractor Circuits

Lecture 15 - Digital of Common Digital Elements

Lecture 16 - Design of Complex Combinational Circuits

Lecture 17 - Design of Combinational Circuits

Lecture 18 - Combinational Logic Problem Design

Lecture 19 - Combinational Logic Design

Lecture 20 - Logic Design with PLA

Lecture 21 - Synchronous Sequential Circuit Design

Lecture 22 - Design of Sequential Modules

Lecture 23 - Design of Registers and Counter

Lecture 24 - Finite State Machine Design

Lecture 25 - Finite State Machine Design and Optimization

Lecture 26 - Programmable Logic Devices

Lecture 27 - Programmable Logic Devices

Lecture 28 - Programmable Logic Devices

Lecture 29 - Design of Arithmetic Circuits

Lecture 30 - Design of Arithmetic Circuits

Lecture 31 - Design of Memory Circuits

[Lecture 32 - Algorithmic State Machines Chart](#)

[Lecture 33 - Design of Computer Instruction Set and the CPU](#)

[Lecture 34 - Design of Computer Instruction Set and the CPU](#)

[Lecture 35 - Design of Computer Instruction Set and the CPU](#)

[Lecture 36 - Design of Computer Instruction Set and the CPU](#)

[Lecture 37 - Design of Computer Instruction Set and the CPU](#)

[Lecture 38 - Design of Computer Instruction Set and the CPU](#)

[Lecture 39 - Design of a Micro Programmed CPU](#)

[Lecture 40 - Digital System Design Current State of the Art](#)

Lecture 1 - Introduction

Lecture 2 - Speech Production Model

Lecture 3 - Speech Coding : Objectives and Requirements

Lecture 4 - Quantizers for Speech Signal

Lecture 5 - mew - Law and Optimum Quantizer

Lecture 6 - Adaptive Quantizer

Lecture 7 - Differential Quantization

Lecture 8 - LDM and ADM

Lecture 9 - Differential PCM and Adaptive Prediction

Lecture 10 - Linear Prediction of Speech

Lecture 11 - Computational Aspects of LPC parameters

Lecture 12 - Cholesky Decomposition

Lecture 13 - Lattice Formulation of LPC Coefficient

Lecture 14 - Linear Predictive Synthesizer

Lecture 15 - LPC Vocoder

Lecture 16 - Introduction to Image and Video Coding

Lecture 17 - Lossy Image Compression : DCT

Lecture 18 - DCT Quantization and Limitations

Lecture 19 - Theory of Wavelets

Lecture 20 - Discrete Wavelet Transforms

Lecture 21 - DWT on the Images and its Encoding

Lecture 22 - Embedded Zero Tree Wavelet Encoding

Lecture 23 - Video Coding : Basic Building Blocks

Lecture 24 - Motion Estimate Techniques

Lecture 25 - Fast Motion Estimation Techniques

Lecture 26 - Video Coding Standards

Lecture 27 - Advanced Coding Aspects

Lecture 28 - Audio Coding: Basic Concepts

Lecture 29 - Audio Coding AC - 3

Lecture 30 - AC -3 Decoder

Lecture 31 - MPEG - 1 Audio Coding

[Lecture 32 - Introduction to VoIP](#)

[Lecture 33 - VoIP Signaling : H.323 Protocol](#)

[Lecture 34 - H.323 Call Controls and Enhancements](#)

[Lecture 35 - Interworking with PSTN Limitations and Solution](#)

[Lecture 36 - Multiplexing Schemes](#)

[Lecture 37 - H.323:Multiplexing:Header Compression and BW](#)

[Lecture 38 - ISDN Video Conferencing](#)

[Lecture 39 - Video Conferencing : SIP Protocol](#)

[Lecture 40 - 4G Multimedia Conferencing](#)

- Lecture 1 - Introduction to MEMS & Microsystems
- Lecture 2 - Introduction to Microsensors
- Lecture 3 - Evaluation of MEMS, Microsensors, Market Survey
- Lecture 4 - Application of MEMS
- Lecture 5 - MEMS Materials
- Lecture 6 - MEMS Materials Properties
- Lecture 7 - MEMS Materials Properties (Continued...)
- Lecture 8 - Microelectronic Technology for MEMS - II
- Lecture 9 - Microelectronic Technology for MEMS - III
- Lecture 10 - Micromachining Technology for MEMS
- Lecture 11 - Micromachining Process
- Lecture 12 - Etch Stop Techniques and Microstructure
- Lecture 13 - Surface and Quartz Micromachining
- Lecture 14 - Fabrication of Micromachined Microstructure
- Lecture 15 - Microstereolithography
- Lecture 16 - MEMS Microsensors Thermal
- Lecture 17 - Micromachined Microsensors Mechanical
- Lecture 18 - MEMS Pressure and Flow Sensor
- Lecture 19 - Micromachined Flow Sensors
- Lecture 20 - MEMS Inertial Sensors
- Lecture 21 - Micromachined Microaccelerometers for MEMS
- Lecture 22 - MEMS Accelerometers for Avionics
- Lecture 23 - Temperature Drift and Damping Analysis
- Lecture 24 - Piezoresistive Accelerometer Technology
- Lecture 25 - MEMS Capacitive Accelerometer
- Lecture 26 - MEMS Capacitive Accelerometer Process
- Lecture 27 - MEMS Gyro Sensor
- Lecture 28 - MEMS for Space Application
- Lecture 29 - Polymer MEMS & Carbon Nano Tubes CNT
- Lecture 30 - Wafer Bonding & Packaging of MEMS
- Lecture 31 - Interface Electronics for MEMS

[Lecture 32 - MEMS for Biomedical Applications \(Bio-MEMS\)](#)

- Lecture 1 - Introduction to Artificial Neural Networks
- Lecture 2 - Artificial Neuron Model and Linear Regression
- Lecture 3 - Gradient Descent Algorithm
- Lecture 4 - Nonlinear Activation Units and Learning Mechanisms
- Lecture 5 - Learning Mechanisms-Hebbian, Competitive, Boltzmann
- Lecture 6 - Associative memory
- Lecture 7 - Associative Memory Model
- Lecture 8 - Condition for Perfect Recall in Associative Memory
- Lecture 9 - Statistical Aspects of Learning
- Lecture 10 - V.C. Dimensions: Typical Examples
- Lecture 11 - Importance of V.C. Dimensions Structural Risk Minimization
- Lecture 12 - Single-Layer Perceptions
- Lecture 13 - Unconstrained Optimization: Gauss-Newton's Method
- Lecture 14 - Linear Least Squares Filters
- Lecture 15 - Least Mean Squares Algorithm
- Lecture 16 - Perceptron Convergence Theorem
- Lecture 17 - Bayes Classifier & Perceptron: An Analogy
- Lecture 18 - Bayes Classifier for Gaussian Distribution
- Lecture 19 - Back Propagation Algorithm
- Lecture 20 - Practical Consideration in Back Propagation Algorithm
- Lecture 21 - Solution of Non-Linearly Separable Problems Using MLP
- Lecture 22 - Heuristics For Back-Propagation
- Lecture 23 - Multi-Class Classification Using Multi-layered Perceptrons
- Lecture 24 - Radial Basis Function Networks: Cover's Theorem
- Lecture 25 - Radial Basis Function Networks: Separability & Interpolation
- Lecture 26 - Posed Surface Reconstruction
- Lecture 27 - Solution of Regularization Equation: Greens Function
- Lecture 28 - Use of Greens Function in Regularization Networks
- Lecture 29 - Regularization Networks and Generalized RBF
- Lecture 30 - Comparison Between MLP and RBF
- Lecture 31 - Learning Mechanisms in RBF

[Lecture 32 - Introduction to Principal Components and Analysis](#)

[Lecture 33 - Dimensionality reduction Using PCA](#)

[Lecture 34 - Hebbian-Based Principal Component Analysis](#)

[Lecture 35 - Introduction to Self Organizing Maps](#)

[Lecture 36 - Cooperative and Adaptive Processes in SOM](#)

[Lecture 37 - Vector-Quantization Using SOM](#)

- Lecture 1 - Introduction to the Theory of Probability
- Lecture 2 - Axioms of Probability
- Lecture 3 - Axioms of Probability (Continued.)
- Lecture 4 - Introduction to Random Variables
- Lecture 5 - Probability Distributions and Density Functions
- Lecture 6 - Conditional Distribution and Density Functions
- Lecture 7 - Function of a Random Variable
- Lecture 8 - Function of a Random Variable (Continued.)
- Lecture 9 - Mean and Variance of a Random Variable
- Lecture 10 - Moments
- Lecture 11 - Characteristic Function
- Lecture 12 - Two Random Variables
- Lecture 13 - Function of Two Random Variables
- Lecture 14 - Function of Two Random Variables (Continued.)
- Lecture 15 - Correlation Covariance and Related Inner
- Lecture 16 - Vector Space of Random Variables
- Lecture 17 - Joint Moments
- Lecture 18 - Joint Characteristic Functions
- Lecture 19 - Joint Conditional Densities
- Lecture 20 - Joint Conditional Densities (Continued.)
- Lecture 21 - Sequences of Random Variables
- Lecture 22 - Sequences of Random Variables (Continued.)
- Lecture 23 - Correlation Matrices and their Properties
- Lecture 24 - Correlation Matrices and their Properties
- Lecture 25 - Conditional Densities of Random Vectors
- Lecture 26 - Characteristic Functions and Normality
- Lecture 27 - Tchebycheff Inequality and Estimation of an Unknown Parameter
- Lecture 28 - Central Limit Theorem
- Lecture 29 - Introduction to Stochastic Process
- Lecture 30 - Stationary Processes
- Lecture 31 - Cyclostationary Processes

[Lecture 32 - System with Random Process at Input](#)

[Lecture 33 - Ergodic Processes](#)

[Lecture 34 - Introduction to Spectral Analysis](#)

[Lecture 35 - Spectral Analysis \(Continued.\)](#)

[Lecture 36 - Spectrum Estimation - Non Parametric Methods](#)

[Lecture 37 - Spectrum Estimation - Parametric Methods](#)

[Lecture 38 - Autoregressive Modeling and Linear Prediction](#)

[Lecture 39 - Linear Mean Square Estimation - Wiener \(FIR\)](#)

[Lecture 40 - Adaptive Filtering - LMS Algorithm](#)

Lecture 1 - Introduction

Lecture 2 - Feature Extraction - I

Lecture 3 - Feature Extraction - II

Lecture 4 - Feature Extraction - III

Lecture 5 - Bayes Decision Theory

Lecture 6 - Bayes Decision Theory (Continued.)

Lecture 7 - Normal Density and Discriminant Function

Lecture 8 - Normal Density and Discriminant Function (Continued.)

Lecture 9 - Bayes Decision Theory - Binary Features

Lecture 10 - Maximum Likelihood Estimation

Lecture 11 - Probability Density Estimation

Lecture 12 - Probability Density Estimation (Continued.)

Lecture 13 - Probability Density Estimation (Continued.)

Lecture 14 - Probability Density Estimation (Continued.)

Lecture 15 - Probability Density Estimation (Continued.)

Lecture 16 - Dimensionality Problem

Lecture 17 - Multiple Discriminant Analysis

Lecture 18 - Multiple Discriminant Analysis (Tutorial)

Lecture 19 - Multiple Discriminant Analysis (Tutorial)

Lecture 20 - Perceptron Criterion

Lecture 21 - Perceptron Criterion (Continued.)

Lecture 22 - MSE Criterion

Lecture 23 - Linear Discriminator (Tutorial)

Lecture 24 - Neural Networks for Pattern Recognition

Lecture 25 - Neural Networks for Pattern Recognition (Continued.)

Lecture 26 - Neural Networks for Pattern Recognition (Continued.)

Lecture 27 - RBF Neural Network

Lecture 28 - RBF Neural Network (Continued.)

Lecture 29 - Support Vector Machine

Lecture 30 - Hyperbox Classifier

Lecture 31 - Hyperbox Classifier (Continued.)

[Lecture 32 - Fuzzy Min Max Neural Network for Pattern Recognition](#)

[Lecture 33 - Reflex Fuzzy Min Max Neural Network](#)

[Lecture 34 - Unsupervised Learning - Clustering](#)

[Lecture 35 - Clustering \(Continued.\)](#)

[Lecture 36 - Clustering using minimal spanning tree](#)

[Lecture 37 - Temporal Pattern recognition](#)

[Lecture 38 - Hidden Markov Model](#)

[Lecture 39 - Hidden Markov Model \(Continued.\)](#)

[Lecture 40 - Hidden Markov Model \(Continued.\)](#)

Lecture 1 - Challenges of Microwave Design

Lecture 2 - Introduction to the 1st tool : Smith Chart

Lecture 3 - Measurement of Unknown Impedance

Lecture 4 - Application of Smith Chart for finding unknown impedance in laboratory

Lecture 5 - Problem Solving using Smith Chart

Lecture 6 - Need of Impedance Matching at Microwave Frequency

Lecture 7 - Lumped Element Based Impedance Matching Network Design by Smith Chart

Lecture 8 - Distributed Impedance Matching Design by Smith Chart

Lecture 9 - Broadband Impedance Matching Network Design

Lecture 10 - Tutorial 2: Impedance Matching Network Design by Smith Chart

Lecture 11 - Voltage and Current at Microwave Frequency

Lecture 12 - Scattering Parameter : the Second Tool

Lecture 13 - Properties of Scattering Parameter

Lecture 14 - Network Analyser

Lecture 15 - Tutorial 3: Problem Solving on Equivalent Voltage and Current in Waveguide and on scattering parameters

Lecture 16 - Radiation between S-Parameters and Transmission Parameters

Lecture 17 - Scattering Parameters of Coupler and Magic Tee

Lecture 18 - Signal Flow Graph

Lecture 19 - Understanding Network Analyser Calibration with the help of Signal Flow Graph

Lecture 20 - Tutorial 4: Problem Solving Related to S-Parameters and Signal Flow Graph

Lecture 1 - Concept of Mode

Lecture 2 - Mathematical Model of Modes

Lecture 3 - Mathematical Model of TEM Mode

Lecture 4 - Mathematical Model of TE and TM Mode and Impedance Concept

Lecture 5 - Losses Associated with Microwave Transmission

Lecture 6 - Coaxial Line

Lecture 7 - Rectangular Waveguide

Lecture 8 - Circular Waveguide

Lecture 9 - Planar Transmission Line

Lecture 10 - Coaxial Connectors

Lecture 11 - 3 Port Microwave Power Divider/Combiner - Part I

Lecture 12 - 3 Port Microwave Power Divider/Combiner - Part II

Lecture 13 - 4 Port Microwave Power Divider/Combiner

Lecture 14 - Microwave Resonator

Lecture 15 - Microwave Attenuators

Lecture 16 - Microwave Detector and Switching Diodes

Lecture 17 - Microwave Tubes : Part I Edit Lesson

Lecture 18 - Microwave Tubes : Part II and Amplifiers

Lecture 19 - Microwave Solid State Diode Oscillator and Amplifier

Lecture 20 - Microwave Transistors

Lecture 1 - Introduction

Lecture 2 - Orbit - 1

Lecture 3 - Orbit - 2

Lecture 4 - Orbit - 3

Lecture 5 - Orbit - 4

Lecture 6 - Space Segment - 1

Lecture 7 - Space Segment - 2

Lecture 8 - Space Segment - 3

Lecture 9 - Space Segment - 4

Lecture 10 - Space Segment - 5

Lecture 11 - Link Budget - 1

Lecture 12 - Link Budget - 2

Lecture 13 - Link Budget - 3

Lecture 14 - Link Budget - 4

Lecture 15 - Link Budget - 5

Lecture 16 - Link Budget - 6

Lecture 17 - Link Budget - 7

Lecture 18 - Link Budget - 8

Lecture 19 - Propagation - 1

Lecture 20 - Propagation - 2

Lecture 21 - Propagation - 3

Lecture 22 - Ground Segment - 1

Lecture 23 - Ground Segment - 2

Lecture 24 - Ground Segment - 3

Lecture 25 - Ground Segment - 4

Lecture 26 - Multiple Access - 1

Lecture 27 - Multiple Access - 2

Lecture 28 - Multiple Access - 3

Lecture 29 - Multiple Access - 4

Lecture 30 - Multiple Access - 5

Lecture 31 - Nonlinearity - I

[Lecture 32 - Nonlinearity - II](#)

[Lecture 33 - Nonlinearity - III](#)

[Lecture 34 - Synchronisation - I](#)

[Lecture 35 - Synchronisation - II](#)

[Lecture 36 - Effect on Higher Layer - I](#)

[Lecture 37 - Effect on Higher Layer - II](#)

[Lecture 38 - Effect on Higher Layer - III](#)

[Lecture 39 - Satellite Navigation - I](#)

[Lecture 40 - Satellite Navigation - II](#)

- Lecture 1 - Evolution of Wireless Communication Systems 1G - 5G
- Lecture 2 - Elements of Wireless Communication System
- Lecture 3 - Overview of MIMO Communication Systems
- Lecture 4 - Layered View of Transmitter and Receiver : Introduction to the Channel
- Lecture 5 - Wireless Channel Models - I
- Lecture 6 - Large Scale Propagation Models Path Loss
- Lecture 7 - Large Scale Propagation Models Path Loss and Shadowing
- Lecture 8 - Small Scale Propagation Multipath Model
- Lecture 9 - Small Scale Propagation Frequency Flat Fading
- Lecture 10 - Small Scale Propagation Envelope Distribution
- Lecture 11 - Small Scale Propagation Received Signal Correlation
- Lecture 12 - Small Scale Propagation Received Signal Correlation (Continued...)
- Lecture 13 - Coherence Time
- Lecture 14 - Doppler Spectrum
- Lecture 15 - Frequency Selective Fading
- Lecture 16 - Frequency Selective Fading - II
- Lecture 17 - FSF-Coherence Bandwidth, Delay Doppler Characteristics
- Lecture 18 - Spatial Channel Characteristics - I
- Lecture 19 - Expression of MIMO Channel
- Lecture 20 - MIMO Channel Characteristics
- Lecture 21 - Statistical Properties of H
- Lecture 22 - Important Results from Linear Algebra
- Lecture 23 - Spatial Diversity
- Lecture 24 - Selection Combining
- Lecture 25 - Maximal Ratio Combining
- Lecture 26 - Problem of Error in MRC
- Lecture 27 - Diversity Gain and Transmit MRC
- Lecture 28 - Transmit Diversity without Channel known at Tx
- Lecture 29 - MIMO Transmit Diversity - 1
- Lecture 30 - MIMO Diversity - 2
- Lecture 31 - Fundamentals of Information Theory - I

[Lecture 32 - Fundamentals of Information Theory - II](#)

[Lecture 33 - Fundamentals of Information Theory - III](#)

[Lecture 34 - Fundamentals of Information Theory - IV](#)

[Lecture 35 - Capacity of Deterministic MIMO Channels](#)

[Lecture 36 - Capacity of Channel Unknown at Transmitter](#)

[Lecture 37 - Capacity of Channel Known of Transmitter](#)

[Lecture 38 - More on MIMO Channel Capacity](#)

[Lecture 39 - Capacity of Random Channel](#)

[Lecture 40 - MIMO in Practice](#)

[Lecture 1 - Introduction](#)

[Lecture 2 - Fundamentals of Linear Vibrations Edit Lesson](#)

[Lecture 3 - Damped Oscillation and Forced Oscillation](#)

[Lecture 4 - Equivalent Electrical Circuits for Oscillation](#)

[Lecture 5 - Tutorial I](#)

[Lecture 6 - Acoustic Wave Equation](#)

[Lecture 7 - Acoustic Wave Equation \(Continued...\)](#)

[Lecture 8 - Acoustic Wave Equation \(Continued...\)](#)

[Lecture 9 - Spherical Waves Propagation](#)

[Lecture 10 - Perception at Sound](#)

[Lecture 11 - Sound Transmission](#)

[Lecture 12 - Sound Transmission \(Continued...\)](#)

[Lecture 13 - The Acoustic Environment](#)

[Lecture 14 - Room Acoustics - I](#)

[Lecture 15 - Room Acoustics - II](#)

[Lecture 16 - Large Room Acoustics and Small Room Acoustics](#)

[Lecture 17 - Large Room Acoustics and Small Room Acoustics \(Continued...\)](#)

[Lecture 18 - Auditorium Acoustics](#)

[Lecture 19 - Transduction - I](#)

[Lecture 20 - Transduction - II](#)

[Lecture 21 - Transduction - III](#)

[Lecture 22 - Microphone - I](#)

[Lecture 23 - Microphone Sensitivity](#)

[Lecture 24 - Loudspeaker](#)

Lecture 1 - Introduction

Lecture 2 - Discrete Time Signals and Systems

Lecture 3 - Linear, Shift Invariant Systems

Lecture 4 - Properties of Discrete Convolution Causal and Stable Systems

Lecture 5 - Graphical Evaluation of Discrete Convolutions

Lecture 6 - Discrete Time Fourier Transform

Lecture 7 - Properties of DTFT

Lecture 8 - Dirac Comb and Sampling Analog Signals

Lecture 9 - Relation between DTFT and Analog Fourier Transform

Lecture 10 - Nyquist Interpolation Formula

Lecture 11 - Rational Systems

Lecture 12 - Properties of Rational Systems

Lecture 13 - Introduction to Z-transform

Lecture 14 - Properties of Z-transform

Lecture 15 - Properties of z-transform

Lecture 16 - Inverse z-transform

Lecture 17 - Introduction to DFT

Lecture 18 - Properties of DFT

Lecture 19 - Introduction to Interpretation of Circular Convolution

Lecture 20 - Graphically Interpretation of Circular Convolution

Lecture 21 - Zero Padding and Linear convolution Via DFT

Lecture 22 - Decimation and DFT of Decimated Sequences

Lecture 23 - Expansion and Interpolation of Sequences

Lecture 24 - Factor-of-M Polyphase Decomposition of Sequences

Lecture 25 - Noble Identifies

Lecture 26 - Efficient Decimator and Interpolator Structure

Lecture 27 - Linear Phase Filters

Lecture 28 - Properties of Linear Phase Filters

Lecture 29 - Structures for IIR Filters

Lecture 30 - Structures for FIR Filters

Lecture 31 - Analog LTI Systems, Fourier and Laplace Transforms

[Lecture 32 - Pole, Zero and Stability of Analog Filters](#)

[Lecture 33 - Analog Filter Design Example Butterworth Lowpass Filter](#)

[Lecture 34 - IIR Filter Design by Impulse Invariance Method](#)

[Lecture 35 - Design Filter Design from Analog Prototype Filters by s-z Transformations](#)

[Lecture 36 - Bilinear Transformation](#)

[Lecture 37 - FIR Filter Design by Window](#)

[Lecture 38 - FFT: Decimation in Time](#)

[Lecture 39 - Complexity Analysis of FFT](#)

[Lecture 40 - Bit Reversal and FFT](#)

- Lecture 1 - Introduction to Digital Image Processing
- Lecture 2 - Application of Digital Image Processing
- Lecture 3 - Image Digitalization, Sampling Quantization and Display
- Lecture 4 - Signal Reconstruction from Samples: Convolution Concept
- Lecture 5 - Signal Reconstruction from Image
- Lecture 6 - Quantizer Design
- Lecture 7 - Relationship between Pixels
- Lecture 8 - Relationship of Adjacency and Connected Components Labeling
- Lecture 9 - Application of Distance Measures
- Lecture 10 - Basic Transform
- Lecture 11 - Image Formation - I
- Lecture 12 - Image Formation - II
- Lecture 13 - Image Geometry - I
- Lecture 14 - Image Geometry - II
- Lecture 15 - Stereo Imaging Model - II
- Lecture 16 - Interpolation and Resampling
- Lecture 17 - Interpolation Techniques
- Lecture 18 - Interpolation with examples - I
- Lecture 19 - Interpolation with Examples - II
- Lecture 20 - Image Transformation - I Edit Lesson
- Lecture 21 - Image Transformation - 2
- Lecture 22 - Separable Transformation
- Lecture 23 - Basis Images
- Lecture 24 - Fourier Transformation
- Lecture 25 - Properties of FT
- Lecture 26 - FT Result Display - 2
- Lecture 27 - Rotation Invariance Property
- Lecture 28 - DCT and Walsh Transform
- Lecture 29 - Handmard Transformation
- Lecture 30 - Histogram Equalization and Specifications - I
- Lecture 31 - KL-transform-2

- Lecture 32 - Image Enhancement: Point Processing Techniques
- Lecture 33 - Contrast Stretching Operation
- Lecture 34 - Histogram Equalization and Specification - I
- Lecture 35 - Histogram Equalization and Specification - II
- Lecture 36 - Histogram Implementation - I
- Lecture 37 - Histogram Implementation - II
- Lecture 38 - Image Enhancement : Mask Processing Techniques - I
- Lecture 39 - Image Enhancement : Mask Processing Techniques - II
- Lecture 40 - Image Enhancement : Mask Processing Techniques - III
- Lecture 41 - Frequency Domain Processing Techniques
- Lecture 42 - Image Restoration Techniques - I
- Lecture 43 - Image Restoration Techniques - II
- Lecture 44 - Estimation of Degradation Model and Restoration Techniques - I
- Lecture 45 - Estimation of Degradation Model and Restoration Techniques - II
- Lecture 46 - Other Restoration Techniques - I
- Lecture 47 - Other Restoration Techniques - II
- Lecture 48 - Image Registration - I
- Lecture 49 - Image Registration - II
- Lecture 50 - Colour Image Processing : Colour Fundamentals
- Lecture 51 - Colour Model
- Lecture 52 - Conversion of one color model to another - I
- Lecture 53 - Conversion of one color model to another - II
- Lecture 54 - Pseudo color image processing
- Lecture 55 - Full color image processing
- Lecture 56 - Different Approaches for Image Segmentation
- Lecture 57 - Image Segmentation : Global Processing (Hough Transform)
- Lecture 58 - Region based Segmentation Operation. Thresholding Techniques
- Lecture 59 - Region Splitting and Merging Technique Edit Lesson

- Lecture 1 - Introduction to Spread Spectrum Communication
- Lecture 2 - Direct Sequence Spread Spectrum System
- Lecture 3 - Performance Analysis of DSSS
- Lecture 4 - Concept of Jamming Margin
- Lecture 5 - Frequency Hopping Spread Spectrum System
- Lecture 6 - Tutorial-1
- Lecture 7 - Slow and Fast Frequency Hopping
- Lecture 8 - Hybrid Spread Spectrum System and Time Hopped SSS
- Lecture 9 - Spread Sequences and Waveforms
- Lecture 10 - Generation Mechanism of ML Sequence
- Lecture 11 - Properties of Spread Spectrum Sequences
- Lecture 12 - Tutorial-2
- Lecture 13 - Power Spectral Density of ML Sequence
- Lecture 14 - Walsh Hadamard Code and Properties
- Lecture 15 - Generation Mechanism and Properties of OVSF and Barker Codes
- Lecture 16 - Generation Mechanism and Properties of Gold and Kasami Codes
- Lecture 17 - Performance Analysis of DSSS in Presence of Tone Jamming
- Lecture 18 - Performance Analysis During Generation Tone Jamming
- Lecture 19 - Performance Analysis in Presence of Gaussian Interference
- Lecture 20 - Performance Analysis of a Quaternary System
- Lecture 21 - Despreading with Matched Filter
- Lecture 22 - Noncoherent Systems
- Lecture 23 - Tutorial - III
- Lecture 24 - Galois Field Mathematics
- Lecture 25 - Galois Field Mathematics (Continued...)
- Lecture 26 - Galois Field Mathematics (Continued...)
- Lecture 27 - Polynomials over Binary Field
- Lecture 28 - Long Nonlinear Sequence Generation
- Lecture 29 - Rejection of Narrowband Interference
- Lecture 30 - Narrow Band Interference Cancellation by Transform Domain Processing
- Lecture 31 - PN Code Acquisition Fundamentals

Lecture 32 - Performance Analysis of PN Code Acquisition System - Part I

Lecture 33 - Performance Analysis of PN Code Acquisition System - Part II

Lecture 34 - Tutorial - IV

Lecture 35 - Rapid Acquisition Using Matched Filter - Part I

Lecture 36 - Rapid Acquisition Using Matched Filter - Part II

Lecture 37 - Active Search Acquisition for FFH/MFSK Signals

Lecture 38 - Active Search Code Acquisition for FFH/MFSK Analysis

Lecture 39 - Detection Probability Analysis of Code Acquisition for FFH / MFSK

Lecture 40 - Tutorial - V

Lecture 41 - DSSS Tracking

Lecture 42 - FHSS Synchronization Method - I

Lecture 43 - FHSS Synchronization Method - II

Lecture 44 - FHSS Synchronization Method - III

Lecture 45 - FHSS Tracking

Lecture 46 - Tutorial - VI

Lecture 47 - Concept of Fading for Wireless Communications

Lecture 48 - Diversity for Fading Channels

Lecture 49 - Rake Receiver

Lecture 50 - Performance Analysis of Rake Receiver

Lecture 51 - Spread Spectrum Multiple Access

Lecture 52 - Tutorial - VII

Lecture 53 - Introduction to CDMA

Lecture 54 - Interference Handling Mechanism in CDMA Networks

Lecture 55 - Interference Handling by Soft Handover

Lecture 56 - Interference Handling by Smart Antenna

Lecture 57 - Multiuser Detection and Interference Cancellation

Lecture 58 - Tutorial - VIII

Lecture 59 - Multiuser Detection - Part I

Lecture 60 - Multiuser Detection - Part II

Lecture 61 - MUD - Probability of Error

Lecture 62 - IS95 and CDMA - Part I

Lecture 63 - IS95 and CDMA - Part II

Lecture 64 - Tutorial - IX

[Lecture 65 - WCDMA and UMTS - Part I](#)

[Lecture 66 - WCDMA and UMTS - Part II](#)

[Lecture 67 - LPI Communications](#)

[Lecture 68 - Radiometer](#)

[Lecture 69 - Interceptor Detectors](#)

[Lecture 1 - Introduction](#)

[Lecture 2 - Introduction \(Continued...\)](#)

[Lecture 3 - Introduction \(Continued...\)](#)

[Lecture 4 - Introduction \(Continued...\)](#)

[Lecture 5 - DFT](#)

[Lecture 6 - DFT \(Continued...\)](#)

[Lecture 7 - DFT \(Continued...\)](#)

[Lecture 8 - DFT \(Continued...\)](#)

[Lecture 9 - DFT \(Continued...\)](#)

[Lecture 10 - DFT \(Continued...\)](#)

[Lecture 11 - Logic and Fault Simulation](#)

[Lecture 12 - Logic and Fault Simulation \(Continued...\)](#)

[Lecture 13 - Logic and Fault Simulation \(Continued...\)](#)

[Lecture 14 - Logic and Fault Simulation \(Continued...\)](#)

[Lecture 15 - Logic and Fault Simulation \(Continued...\)](#)

[Lecture 16 - Logic and Fault Simulation \(Continued...\)](#)

[Lecture 17 - Test Generation](#)

[Lecture 18 - Test Generation \(Continued...\)](#)

[Lecture 19 - Test Generation \(Continued...\)](#)

[Lecture 20 - Test Generation \(Continued...\)](#)

[Lecture 21 - Test Generation \(Continued...\)](#)

[Lecture 22 - Test Generation \(Continued...\)](#)

[Lecture 23 - Test Generation \(Continued...\)](#)

[Lecture 24 - Logic BIST](#)

[Lecture 25 - Logic BIST \(Continued...\)](#)

[Lecture 26 - Logic BIST \(Continued...\)](#)

[Lecture 27 - Logic BIST \(Continued...\)](#)

[Lecture 28 - Test Compression](#)

[Lecture 29 - Test Compression \(Continued...\)](#)

[Lecture 30 - Test Compression \(Continued...\)](#)

[Lecture 31 - Test Compression \(Continued...\)](#)

[Lecture 32 - Low Power Testing](#)

[Lecture 33 - Low Power Testing \(Continued...\)](#)

[Lecture 34 - Low Power Testing \(Continued...\)](#)

[Lecture 35 - Low Power Testing \(Continued...\)](#)

[Lecture 36 - Low Power Testing \(Continued...\)](#)

[Lecture 37 - Thermal Aware Testing](#)

[Lecture 38 - Thermal Aware Testing \(Continued...\)](#)

[Lecture 39 - Thermal Aware Testing \(Continued...\)](#)

[Lecture 40 - Boundary Scan](#)

[Lecture 41 - Boundary Scan \(Continued...\)](#)

[Lecture 42 - Boundary Scan \(Continued...\)](#)

[Lecture 43 - Boundary Scan \(Continued...\)](#)

[Lecture 44 - Boundary Scan \(Continued...\)](#)

[Lecture 45 - System/Network - On - Chip Test](#)

[Lecture 46 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 47 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 48 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 49 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 50 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 51 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 52 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 53 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 54 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 55 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 56 - System/Network - On - Chip Test \(Continued...\)](#)

[Lecture 57 - Memory Testing](#)

[Lecture 58 - Memory Testing \(Continued...\)](#)

[Lecture 59 - Memory Testing \(Continued...\)](#)

[Lecture 60 - Memory Testing \(Continued...\)](#)

Lecture 1 - Image Impedance based RF filter design

Lecture 2 - Concept of Image impedance and Propagation Constant

Lecture 3 - Symmetrical lossless network description for filter design

Lecture 4 - Constant k prototype filter design

Lecture 5 - m-derived prototype filter design

Lecture 6 - Introduction to Insertion loss based Microwave Filter Design

Lecture 7 - Prototype low pass filter design

Lecture 8 - Filter transformation

Lecture 9 - Microwave Filter implementation

Lecture 10 - Tutorial an Insertion Loss based Microwave Filter design

Lecture 11 - Gain Definitions of Microwave Amplifiers

Lecture 12 - Stability Analysis of Microwave Amplifiers

Lecture 13 - Conditional stability enforcement for Microwave Amplifier

Lecture 14 - Amplifier design of maximising transducer gain

Lecture 15 - Amplifier design for specified gain

Lecture 16 - Amplifier design for specified noise performance

Lecture 17 - Broadband Amplifier Design

Lecture 18 - Quantitative Characterisation of Nonlinearity for Large Signal Amplifier

Lecture 19 - Quantitative Characterisation of Nonlinearity for Large Signal Amplifier (Continued...)

Lecture 20 - Measurement of Nonlinearity

[Lecture 1 - Introduction to Millimeter-Wave Technology](#)

[Lecture 2 - Introduction to Millimeter-Wave Technology \(Continued...\)](#)

[Lecture 3 - Introduction to Millimeter-Wave Technology \(Continued...\)](#)

[Lecture 4 - Introduction to Millimeter-Wave Technology \(Continued...\)](#)

[Lecture 5 - Introduction to Millimeter-Wave Technology \(Continued...\)](#)

[Lecture 6 - Guiding Structures](#)

[Lecture 7 - Guiding Structures \(Continued...\)](#)

[Lecture 8 - Guiding Structures \(Continued...\)](#)

[Lecture 9 - Guiding Structures \(Continued...\)](#)

[Lecture 10 - Guiding Structures \(Continued...\)](#)

[Lecture 11 - Guiding Structures \(Continued...\)](#)

[Lecture 12 - Guiding Structures \(Continued...\)](#)

[Lecture 13 - Guiding Structures \(Continued...\)](#)

[Lecture 14 - Guiding Structures \(Continued...\)](#)

[Lecture 15 - Guiding Structures \(Continued...\)](#)

[Lecture 16 - Antennas at MM-Wave Frequencies](#)

[Lecture 17 - Antennas at MM-Wave Frequencies \(Continued...\)](#)

[Lecture 18 - Antennas at MM-Wave Frequencies \(Continued...\)](#)

[Lecture 19 - Antennas at MM-Wave Frequencies \(Continued...\)](#)

[Lecture 20 - Antennas at MM-WaveFrequencies \(Continued...\)](#)

[Lecture 21 - Passive Components](#)

[Lecture 22 - Passive Components \(Continued...\)](#)

[Lecture 23 - Passive Components \(Continued...\)](#)

[Lecture 24 - Passive Components \(Continued...\)](#)

[Lecture 25 - Passive Components \(Continued...\)](#)

[Lecture 26 - Active Devices](#)

[Lecture 27 - Active Devices \(Continued...\)](#)

[Lecture 28 - Active Devices \(Continued...\)](#)

[Lecture 29 - Active Devices \(Continued...\)](#)

[Lecture 30 - Active Devices \(Continued...\)](#)

[Lecture 31 - Noise and Link Budget](#)

[Lecture 32 - Noise and Link Budget \(Continued...\)](#)

[Lecture 33 - Noise and Link Budget \(Continued...\)](#)

[Lecture 34 - Noise and Link Budget \(Continued...\)](#)

[Lecture 35 - Noise and Link Budget \(Continued...\)](#)

[Lecture 36 - Millimeter-Wave Systems](#)

[Lecture 37 - Millimeter-Wave Systems \(Continued...\)](#)

[Lecture 38 - Millimeter-Wave Systems \(Continued...\)](#)

[Lecture 39 - Millimeter-Wave Systems \(Continued...\)](#)

[Lecture 40 - Millimeter-Wave Systems \(Continued...\)](#)

- Lecture 1 - Structure of Power Systems and Few other Aspects - I
- Lecture 2 - Structure of Power Systems and Few other Aspects - II
- Lecture 3 - Structure of Power Systems and Few other Aspects - III
- Lecture 4 - Resistance and Inductance
- Lecture 5 - Resistance and Inductance (Continued...)
- Lecture 6 - Resistance and Inductance (Continued...)
- Lecture 7 - Resistance and Inductance (Continued...)
- Lecture 8 - Resistance and Inductance (Continued...)
- Lecture 9 - Resistance and Inductance (Continued...)
- Lecture 10 - Resistance and Inductance (Continued...)
- Lecture 11 - Capacitance of Transmisson Lines
- Lecture 12 - Capacitance of Transmisson Lines (Continued...)
- Lecture 13 - Capacitance of Transmisson Lines (Continued...)
- Lecture 14 - Capacitance of Transmisson Lines (Continued...)
- Lecture 15 - Power System Components and per-unit system
- Lecture 16 - Power System Components and per-unit system (Continued...)
- Lecture 17 - Power System Components and per-unit system (Continued...)
- Lecture 18 - Power System Components and per-unit system (Continued...)
- Lecture 19 - Power System Components and per-unit system (Continued...)
- Lecture 20 - Power System Components and per-unit system (Continued...)
- Lecture 21 - Characteristic and performance of transmission lines
- Lecture 22 - Characteristic and performance of transmission lines (Continued...)
- Lecture 23 - Characteristic and performance of transmission lines (Continued...)
- Lecture 24 - Characteristic and performance of transmission lines (Continued...)
- Lecture 25 - Characteristic and performance of transmission lines (Continued...)
- Lecture 26 - Load flow studies
- Lecture 27 - Load flow studies (Continued...)
- Lecture 28 - Load flow studies (Continued...)
- Lecture 29 - Load flow studies (Continued...)
- Lecture 30 - Load flow studies (Continued...)
- Lecture 31

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36 - Load flow studies \(Continued...\)](#)

[Lecture 37 - Optimal system operation](#)

[Lecture 38 - Optimal system operation \(Continued...\)](#)

[Lecture 39 - Optimal system operation \(Continued...\)](#)

[Lecture 40 - Optimal system operation \(Continued...\)](#)

[Lecture 41 - Optimal system operation \(Continued...\)](#)

[Lecture 42 - Optimal system operation \(Continued...\)](#)

[Lecture 43 - Optimal system operation \(Continued...\)](#)

[Lecture 44 - Optimal system operation \(Continued...\)](#)

[Lecture 45 - Three phase fault studies](#)

[Lecture 46 - Three phase fault studies \(Continued...\)](#)

[Lecture 47 - Three phase fault studies \(Continued...\)](#)

[Lecture 48 - Three phase fault studies \(Continued...\)](#)

[Lecture 49 - Symmetrical components](#)

[Lecture 50 - Symmetrical components \(Continued...\)](#)

[Lecture 51 - Symmetrical components \(Continued...\)](#)

[Lecture 52 - Symmetrical components \(Continued...\)](#)

[Lecture 53 - Symmetrical components \(Continued...\)](#)

[Lecture 54 - Symmetrical components \(Continued...\)](#)

[Lecture 55 - Power system stability>](#)

[Lecture 56 - Power system stability \(Continued...\)](#)

[Lecture 57 - Power system stability \(Continued...\)](#)

[Lecture 58 - Power system stability \(Continued...\)](#)

[Lecture 59 - Power system stability \(Continued...\)](#)

[Lecture 60 - Power system stability \(Continued...\)](#)

Lecture 1 - Fourier Series

Lecture 2 - Fourier Series (Continued...)

Lecture 3 - Fourier Series (Continued...)

Lecture 4 - Fourier Series (Continued...)

Lecture 5 - Fourier Series (Continued...)

Lecture 6 - Fourier Series (Continued...)

Lecture 7 - Fourier Series (Continued...)

Lecture 8 - Fourier Transform

Lecture 9 - Fourier Transform (Continued...)

Lecture 10 - Fourier Transform (Continued...)

Lecture 11 - Fourier Transform (Continued...)

Lecture 12 - Energy Spectral Density

Lecture 13 - Power Spectral Density

Lecture 14 - PSD of Random Signal

Lecture 15 - Amplitude Modulation

Lecture 16 - Amplitude Modulation (Continued...)

Lecture 17 - Amplitude Modulation (Continued...)

Lecture 18 - Amplitude Modulation (Continued...)

Lecture 19 - SSB - SC

Lecture 20 - SSB - SC (Continued...)

Lecture 21 - VSB-SC

Lecture 22 - VSB-SC (Continued...)

Lecture 23 - Effect of Carrier Synchronization

Lecture 24 - Comparison of Different Modulation Technique

Lecture 25 - PLL

Lecture 26 - PLL (Continued...)

Lecture 27 - PLL (Continued...)

Lecture 28 - PLL (Continued...) and LTI

Lecture 29 - Dispersion

Lecture 30 - Channel Nonlinearities and Multipath Effects

Lecture 31 - Probability Theory

[Lecture 32 - Probability Theory \(Continued...\)](#)

[Lecture 33 - Probability Theory \(Continued...\)](#)

[Lecture 34 - Probability Theory \(Continued...\)](#)

[Lecture 35 - Probability Theory \(Continued...\)](#)

[Lecture 36 - Probability Theory \(Continued...\)](#)

[Lecture 37 - Probability Theory \(Continued...\)](#)

[Lecture 38 - Random Process](#)

[Lecture 39 - Random Process \(Continued...\)](#)

[Lecture 40 - Random Process \(Continued...\)](#)

[Lecture 41 - Random Process \(Continued...\)](#)

[Lecture 42 - Random Process \(Continued...\)](#)

[Lecture 43 - Random Process \(Continued...\)](#)

[Lecture 44 - Noise Analysis - DSB-SC](#)

[Lecture 45 - Noise Analysis - AM](#)

[Lecture 46 - Noise Analysis - SSB-SC](#)

[Lecture 47 - Frequency Modulation](#)

[Lecture 48 - Frequency Modulation \(Continued...\)](#)

[Lecture 49 - Frequency Modulation \(Continued...\)](#)

[Lecture 50 - Frequency Modulation \(Continued...\)](#)

[Lecture 51 - Frequency Modulation \(Continued...\)](#)

[Lecture 52 - Frequency Modulation \(Continued...\)](#)

[Lecture 53 - FM Noise Analysis](#)

[Lecture 54 - FM Noise Analysis \(Continued...\)](#)

[Lecture 55 - FM Noise Analysis \(Continued...\)>](#)

[Lecture 56 - Sampling Theorem](#)

[Lecture 57 - Sampling Theorem \(Continued...\)](#)

[Lecture 58 - FDM Vs TDM](#)

[Lecture 59 - Flat Top Vs Natural Sampling](#)

[Lecture 60 - Pulse Coded Modulation](#)

[Lecture 1 - Introduction of Digital Communication System](#)

[Lecture 2 - Introduction of Digital Communication System \(Continued...\)](#)

[Lecture 3 - Introduction of Digital Communication System \(Continued...\)](#)

[Lecture 4 - Introduction of Digital Communication System \(Continued...\)](#)

[Lecture 5 - Introduction of Digital Communication System \(Continued...\)](#)

[Lecture 6 - Source Coding](#)

[Lecture 7 - Source Coding \(Continued...\)](#)

[Lecture 8 - Source Coding \(Continued...\)](#)

[Lecture 9 - Source Coding \(Continued...\)](#)

[Lecture 10 - Source Coding \(Continued...\)](#)

[Lecture 11 - Source Coding \(Continued...\)](#)

[Lecture 12 - Source Coding \(Continued...\)](#)

[Lecture 13 - Source Coding \(Continued...\)](#)

[Lecture 14 - Source Coding \(Continued...\)](#)

[Lecture 15 - Analog to Digital Conversion](#)

[Lecture 16 - Analog to Digital Conversion \(Continued...\)](#)

[Lecture 17 - Characterization of Signals and Systems](#)

[Lecture 18 - Characterization of Signals and Systems \(Continued...\)](#)

[Lecture 19 - Characterization of Signals and Systems \(Continued...\)](#)

[Lecture 20 - Characterization of Signals and Systems \(Continued...\)](#)

[Lecture 21 - Characterization of Signals and Systems \(Continued...\)](#)

[Lecture 22 - Characterization of Signals and Systems \(Continued...\)](#)

[Lecture 23 - Characterization of Signals and Systems \(Continued...\)](#)

[Lecture 24 - Memoryless Modulation](#)

[Lecture 25 - Memoryless Modulation \(Continued...\)](#)

[Lecture 26 - Memoryless Modulation \(Continued...\)](#)

[Lecture 27 - Memoryless Modulation \(Continued...\)](#)

[Lecture 28 - Memoryless Modulation \(Continued...\)](#)

[Lecture 29 - Memoryless Modulation \(Continued...\)](#)

[Lecture 30 - Memoryless Modulation \(Continued...\)](#)

[Lecture 31 - Memoryless Modulation \(Continued...\)](#)

- [Lecture 32 - Memoryless Modulation \(Continued...\)](#)
- [Lecture 33 - With Memory Modulation](#)
- [Lecture 34 - With Memory Modulation \(Continued...\)](#)
- [Lecture 35 - With Memory Modulation \(Continued...\)](#)
- [Lecture 36 - With Memory Modulation \(Continued...\)](#)
- [Lecture 37 - With Memory Modulation \(Continued...\)](#)
- [Lecture 38 - With Memory Modulation \(Continued...\)](#)
- [Lecture 39 - With Memory Modulation \(Continued...\)](#)
- [Lecture 40 - Optimum Receivers for AWGN](#)
- [Lecture 41 - Optimum Receivers for AWGN \(Continued...\)](#)
- [Lecture 42 - Optimum Receivers for AWGN \(Continued...\)](#)
- [Lecture 43 - Optimum Receivers for AWGN \(Continued...\)](#)
- [Lecture 44 - Optimum Receivers for AWGN \(Continued...\)](#)
- [Lecture 45 - Optimum Receivers for AWGN \(Continued...\)](#)
- [Lecture 46 - Performance of Digital Modulation Techniques](#)
- [Lecture 47 - Performance of Digital Modulation Techniques \(Continued...\)](#)
- [Lecture 48 - Performance of Digital Modulation Techniques \(Continued...\)](#)
- [Lecture 49 - Performance of Digital Modulation Techniques \(Continued...\)](#)
- [Lecture 50 - Performance of Digital Modulation Techniques \(Continued...\)](#)
- [Lecture 51 - Performance of Digital Modulation Techniques \(Continued...\)](#)
- [Lecture 52 - Performance of Digital Modulation Techniques \(Continued...\)](#)
- [Lecture 53 - Channel Estimation and Equalization](#)
- [Lecture 54 - Channel Estimation and Equalization \(Continued...\)](#)
- [Lecture 55 - Channel Estimation and Equalization \(Continued...\)>](#)
- [Lecture 56 - Channel Estimation and Equalization \(Continued...\)](#)
- [Lecture 57 - Synchronization Techniques](#)
- [Lecture 58 - Synchronization Techniques \(Continued...\)](#)
- [Lecture 59 - Synchronization Techniques \(Continued...\)](#)
- [Lecture 60 - Synchronization Techniques \(Continued...\)](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16 - Human Auditory System](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19 - Time Domain Methods in Speech Processing](#)

[Lecture 20](#)

[Lecture 21 - Introduction to Liner Prediction](#)

[Lecture 22 - Autocorrelation Method of LPC analysis](#)

[Lecture 23 - Autocorrelation Method of LPC analysis \(Continued...\)](#)

[Lecture 24 - Lattice Formulations of Linear Prediction](#)

[Lecture 25 - Lattice Formulations of Linear Prediction \(Continued...\)](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31 - Segmental and Supra-segmental features of speech signal](#)

[Lecture 32 - Cepstral Transform Coefficients \(CC\) Parameters extraction](#)

[Lecture 33 - Mel Frequency Cepstral Coefficients](#)

[Lecture 34 - MFCC features vector](#)

[Lecture 35 - Fundamental Frequency \(F0\) Detection of speech signal](#)

[Lecture 36 - Frequency Domain Fundamental Frequency Detection Algorithms](#)

[Lecture 37 - Text to Speech Synthesis](#)

[Lecture 38 - Text to Speech Synthesis \(Continued...\)](#)

[Lecture 39 - Automatic Speech Recognition](#)

[Lecture 40 - Statistical Modeling of Automatic Speech Recognition](#)

[Lecture 41 - Speech based Technology Development for e-learning](#)

[Lecture 42 - Prosody Modeling](#)

[Lecture 43 - Fundamental frequency contour modeling](#)

[Lecture 44 - Fundamental frequency contour modeling \(Continued...\)](#)

[Lecture 1 - Basic Analog Design Part I](#)

[Lecture 2 - Basic Analog Design Part I \(Continued...\)](#)

[Lecture 3 - Basic Analog Design Part II](#)

[Lecture 4 - Basic Analog Design Part II \(Continued...\)](#)

[Lecture 5 - Basic Analog Design Part III](#)

[Lecture 6 - Basic Analog Design Part III \(Continued...\)](#)

[Lecture 7 - Basic Analog Design Part III \(Continued...\)](#)

[Lecture 8 - Basic Analog Design Part III \(Continued...\)](#)

[Lecture 9 - Basic Analog Design Part III \(Continued...\)](#)

[Lecture 10 - Basic Analog Design Part III \(Continued...\)](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

- [Lecture 32](#)
- [Lecture 33](#)
- [Lecture 34](#)
- [Lecture 35](#)
- [Lecture 36](#)
- [Lecture 37](#)
- [Lecture 38](#)
- [Lecture 39](#)
- [Lecture 40](#)
- [Lecture 41](#)
- [Lecture 42](#)
- [Lecture 43](#)
- [Lecture 44](#)
- [Lecture 45](#)
- [Lecture 46](#)
- [Lecture 47](#)
- [Lecture 48](#)
- [Lecture 49](#)
- [Lecture 50](#)
- [Lecture 51](#)
- [Lecture 52](#)
- [Lecture 53](#)
- [Lecture 54](#)
- [Lecture 55](#)
- [Lecture 56](#)
- [Lecture 57](#)
- [Lecture 58](#)

[Lecture 1 - Introduction to Communication Networks](#)

[Lecture 2 - Introduction to Communication Networks \(Continued...\)](#)

[Lecture 3 - Introduction to Communication Networks \(Continued...\)](#)

[Lecture 4 - Circuit Switch Networks](#)

[Lecture 5 - Space switch Architecture](#)

[Lecture 6 - Space switch Architecture \(Continued...\)](#)

[Lecture 7 - Space Switch Architecture \(Continued...\)](#)

[Lecture 8 - Space Switch Architecture \(Continued...\)](#)

[Lecture 9 - Space Switch Architecture \(Continued...\)](#)

[Lecture 10 - Time Switch](#)

[Lecture 11 - Space Time Switch](#)

[Lecture 12 - Space Time Switch \(Continued...\)](#)

[Lecture 13 - Synchronisation](#)

[Lecture 14 - Synchronisation \(Continued...\)](#)

[Lecture 15 - Introduction to Queuing Theory](#)

[Lecture 16 - Arrival and Service Process](#)

[Lecture 17 - Poisson Process](#)

[Lecture 18 - poisson process \(Continued...\)](#)

[Lecture 19 - Memorylessness](#)

[Lecture 20 - Little's Theorem](#)

[Lecture 21 - Little's Theorem \(Continued...\)](#)

[Lecture 22 - D T M C](#)

[Lecture 23 - D T M C \(Continued...\)](#)

[Lecture 24 - D T M C To C T M C](#)

[Lecture 25 - C T M C](#)

[Lecture 26 - M/M/1 Queue](#)

[Lecture 27 - M/M/m And M/M/m/m System](#)

[Lecture 28 - Introduction to Data Networks](#)

[Lecture 29 - Introduction to Data Networks \(Continued...\)](#)

[Lecture 30 - Introduction to Data Networks \(Continued...\)](#)

[Lecture 31 - Layered Architecture](#)

- [Lecture 32 - Layered Architecture \(Continued...\)](#)
- [Lecture 33 - Broadband Access - Dail Up/ADSL](#)
- [Lecture 34 - Broadband Access - DSL, Aloha](#)
- [Lecture 35 - Aloha/Slotted Aloha](#)
- [Lecture 36 - Slotted Aloha](#)
- [Lecture 37 - Slotted Aloha \(Continued...\)](#)
- [Lecture 38 - Slotted Aloha- Stability Analysis](#)
- [Lecture 39 - Slotted Aloha- Stability Analysis \(Continued...\)](#)
- [Lecture 40 - Stabilized Slotted Aloha-bayesian Estimation](#)
- [Lecture 41 - Binary Back- off Algorithm](#)
- [Lecture 42 - Effect of Physical Media](#)
- [Lecture 43 - PON and Ethernet MAC](#)
- [Lecture 44 - PON and Ethernet MAC \(Continued...\)](#)
- [Lecture 45 - CSMA/CD](#)
- [Lecture 46 - CSMA/CA](#)
- [Lecture 47 - CSMA/CA \(Continued...\)](#)
- [Lecture 48 - CSMA/CA \(Continued...\)](#)
- [Lecture 49 - CSMA/CA \(Continued...\)](#)
- [Lecture 50 - Learning Bridges](#)
- [Lecture 51 - Learning Bridges \(Continued...\)](#)
- [Lecture 52 - Distributed Spanning Tree](#)
- [Lecture 53 - Distributed Spanning Tree \(Continued...\)](#)
- [Lecture 54 - Internet Protocol](#)
- [Lecture 55 - Internet Protocol \(Continued...\)](#)
- [Lecture 56 - Subnet and ARP](#)
- [Lecture 57 - ARP and DHCP](#)
- [Lecture 58 - DHCP and Routing](#)

Lecture 1 - Introduction

Lecture 2 - Signal and its Types

Lecture 3 - Characteristics of a Signal

Lecture 4 - Digitization of Signal

Lecture 5 - Digitization of Signal (Continued...)

Lecture 6 - Concept of Frequency in Continuous-time and Discrete-time Signal

Lecture 7 - Tutorial 1

Lecture 8 - Discrete Time Signal

Lecture 9 - Discrete Time System

Lecture 10 - D.T.S (L.T.I System)

Lecture 11 - Linear Time-Invariant Systems (Continued...)

Lecture 12 - Correlation

Lecture 13 - Tutorial 02

Lecture 14 - Z-Transform

Lecture 15 - Z-Transform Properties

Lecture 16 - Pole and Zero in Z-Transform

Lecture 17 - Inverse Z-Transform

Lecture 18 - Frequency-Domain Representation of Discrete Signals and L.T.I Systems

Lecture 19 - Discrete Fourier Transform (DFT)

Lecture 20 - Discrete Fourier Transform Linear Transform View

Lecture 21 - Discrete Fourier Transform Linear Transform View (Continued...)

Lecture 22 - Properties of Discrete Fourier Transform

Lecture 23 - Properties of Discrete Fourier Transform (Continued...)

Lecture 24 - Properties of Discrete Fourier Transform (Continued...)

Lecture 25 - Properties of Discrete Fourier Transform (Continued...)

Lecture 26 - Linear Filtering

Lecture 27 - Tutorial 5

Lecture 28 - Two Dimensional Discrete Fourier Transform

Lecture 29 - Discrete Cosine Transform

Lecture 30 - Frequency analysis of long signal using DFT

Lecture 31 - Short-Time Fourier Transform (STFT)

- Lecture 32 - STFT Synthesis
- Lecture 33 - Fast Fourier Transform (FFT) Algorithms
- Lecture 34 - Fast Fourier Transform (FFT) Algorithms (Continued...)
- Lecture 35 - Radix-2 FFT Algorithms
- Lecture 36 - Radix-2 FFT Algorithms (Continued...)
- Lecture 37 - Spectrum and spectrogram
- Lecture 38 - Digital Filter
- Lecture 39 - FIR Filter
- Lecture 40 - Linear Symmetric and Anti-symmetric filter
- Lecture 41 - FIR Filter Design
- Lecture 42 - Frequency Sampling Method
- Lecture 43 - Design Optimum equiripple Linear-Phase FIR Filters (optimization methods)
- Lecture 44 - Infinite Impulse Response (IIR) Filters
- Lecture 45 - Traditional Analog Filter Design
- Lecture 46 - Chebyshev filter Design Method
- Lecture 47 - Analogue filter to digital filter transformation
- Lecture 48 - Linear Prediction and Optimum Linear Filters
- Lecture 49 - Autocorrelation Method for Linear Prediction
- Lecture 50 - Covariance Method for Linear Prediction
- Lecture 51 - Lattice Formulations of Linear Prediction
- Lecture 52 - Lattice Formulations of Linear Prediction (Continued....)
- Lecture 53 - Introduction to Multirate Signal Processing
- Lecture 54 - Analysis of Decimation and Interpolation
- Lecture 55 - Fractional Rate Conversion
- Lecture 56 - Implementations of Decimator and Interpolator
- Lecture 57 - Sample Rate Conversion by Stages
- Lecture 58 - Power Spectrum Estimation
- Lecture 59 - Power Spectrum Estimation (Continued...)
- Lecture 60 - Tutorial 6: Tutorial for Final Examination

- Lecture 1 - Course introduction; Negative feedback control
- Lecture 2 - Negative feedback amplifier
- Lecture 3 - Step response, sinusoidal steady state response
- Lecture 4 - Loop gain and unity loop gain frequency; Opamp
- Lecture 5 - Opamp realization using controlled sources; Delay in the loop
- Lecture 6 - Negative feedback amplifier with ideal delay-small delays
- Lecture 7 - Negative feedback amplifier with ideal delay-large delays
- Lecture 8 - Negative feedback amplifier with parasitic poles and zeros
- Lecture 9 - Negative feedback amplifier with parasitic poles and zeros; Nyquist criterion
- Lecture 10 - Nyquist criterion; Phase margin
- Lecture 11 - Phase margin
- Lecture 12 - Single stage opamp realization
- Lecture 13 - Two stage miller compensated opamp
- Lecture 14 - Two stage miller compensated opamp
- Lecture 15 - Two and three stage miller compensated opamps; Feedforward compensated opamp
- Lecture 16 - Feedforward compensated opamp
- Lecture 17 - Feedforward compensated opamp
- Lecture 18 - Feedforward compensated opamp; typical opamp data sheet
- Lecture 19 - Opamp offset and CMRR; Transimpedance amplifier using an opamp
- Lecture 20 - Components available in a CMOS process
- Lecture 21 - MOS transistors-basics
- Lecture 22 - MOS transistors-parasitics, mismatch
- Lecture 23 - MOS transistors-mismatch, speed
- Lecture 24 - Noise in resistors
- Lecture 25 - Noise in MOS transistors; Input and output referred noise
- Lecture 26 - Noise scaling; Basic amplifier stages-Common source, common gate
- Lecture 27 - Basic amplifier stages-Common drain; Frequency response of amplifiers
- Lecture 28 - Common source amplifier frequency response; Differential amplifier
- Lecture 29 - Differential and common mode half circuits; Differential pair with active load
- Lecture 30 - Differential pair with current mirror load
- Lecture 31 - Single stage opamp characteristics

- Lecture 32 - Opamp with single and dual supplies; Single stage opamp tradeoffs
- Lecture 33 - Telescopic cascode opamp
- Lecture 34 - Telescopic cascode opamp; Folded cascode opamp
- Lecture 35 - Folded cascode opamp
- Lecture 36 - Two stage opamp
- Lecture 37 - Two stage opamp; Three stage and triple cascode opamps
- Lecture 38 - Common mode rejection ratio; Example
- Lecture 39 - Fully differential circuits
- Lecture 40 - Fully differential single stage opamp
- Lecture 41 - Common mode feedback
- Lecture 42 - Fully differential single stage opamp
- Lecture 43 - Fully differential two stage opamp; Fully differential versus pseudo-differential
- Lecture 44 - Circuit simulators and analyses
- Lecture 45 - Phase locked loop as frequency multiplier
- Lecture 46 - Phase domain model
- Lecture 47 - Type I PLL transfer function and reference feedthrough
- Lecture 48 - Type II PLL
- Lecture 49 - Type II PLL transfer functions; Implementation
- Lecture 50 - Type II PLL-extra poles; Random noise in a PLL
- Lecture 51 - Oscillator phase noise
- Lecture 52 - PLL phase noise; LC and ring Oscillators
- Lecture 53 - Generating PTAT and constant MOS gm bias currents
- Lecture 54 - Reducing supply sensitivity; Bandgap voltage reference
- Lecture 55 - Fractional bandgap reference; Low dropout regulator
- Lecture 56 - Low dropout regulators; Continuous-time active filters
- Lecture 57 - Continuous-time active filters
- Lecture 58 - Continuous-time active filters
- Lecture 59 - Discrete-time active filters
- Lecture 60 - Transistor sizing in practice; Course summary

Lecture 1 - Introduction to Linear Block Codes

Lecture 2 - Properties of Linear Block Codes

Lecture 3 - Dual of Linear Block Codes

Lecture 4 - Minimum Distance of Codes

Lecture 5 - Operations on Codes

Lecture 6 - Bounds on Code Parameters

Lecture 7 - Optimal Decoders

Lecture 8 - Syndrome Decoder, Basics of Finite Fields

Lecture 9 - Constructions of Finite Fields

Lecture 10 - Computations in Finite Fields

Lecture 11 - Codes over Finite Fields, Minimal Polynomials

Lecture 12 - BCH Codes

Lecture 13 - BCH and RS Codes I

Lecture 14 - BCH and RS Codes II

Lecture 15 - Decoding BCH Codes

Lecture 16 - Decoding RS Codes

Lecture 17 - Coded Modulation and Soft Decision Decoding

Lecture 18 - Optimal Decoders for BPSK and AWGN

Lecture 19 - Bitwise Map Decoder for BPSK over AWGN

Lecture 20 - Bitwise Map Decoder from the Dual Code

Lecture 21 - Simulating Coded Modulation

Lecture 22 - Union Bound, Introduction to LDPC Codes

Lecture 23 - LDPC Codes

Lecture 24 - Message Passing, Density Evolution Analysis

Lecture 25 - Thresholds of LDPC Codes

Lecture 26 - Irregular LDPC Codes

Lecture 27 - Optimized Irregular LDPC Codes, Soft Message Passing Decoders

Lecture 28 - Density Evolution for Soft Message Passing Decoding of LDPC Codes

Lecture 29 - LDPC Codes in Practice

Lecture 30 - Introduction to Convolutional Codes

Lecture 31 - Viterbi Decoding of Convolutional Codes

[Lecture 32 - Union Bound, Recursive Convolutional Encoders](#)

[Lecture 33 - Convolutional Codes in Practice](#)

[Lecture 34 - BCJR Decoder](#)

[Lecture 35 - BCJR & Max-Log-MAP Decoder, Introduction to Turbo Codes](#)

[Lecture 36 - Turbo Decoder](#)

[Lecture 37 - Turbo Codes in Practice](#)

[Lecture 38 - Modern Codes](#)

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

[Lecture 41](#)

[Lecture 42](#)

[Lecture 43](#)

[Lecture 44](#)

[Lecture 45](#)

[Lecture 46](#)

[Lecture 47](#)

[Lecture 48](#)

[Lecture 49](#)

[Lecture 50](#)

[Lecture 51](#)

[Lecture 52](#)

[Lecture 53](#)

[Lecture 54](#)

[Lecture 55](#)

[Lecture 56](#)

[Lecture 57](#)

Lecture 1 - Introduction to Data Conversion

Lecture 2 - Sampling-1

Lecture 3 - Sampling-2

Lecture 4 - Nonidealities in Samples

Lecture 5 - Noise due to Sampling

Lecture 6 - Distortion in a Sampling Switch

Lecture 7 - Gate Boosted Switches-1

Lecture 8 - Gate Boosted Switches-2

Lecture 9 - Charge Injection

Lecture 10 - S/H Characterization-1

Lecture 11 - S/H Characterization-2

Lecture 12 - FFTs and Leakage

Lecture 13 - Spectral Windows-1

Lecture 14 - Spectral Windows-2

Lecture 15 - ADC/DAC Definition

Lecture 16 - Quantization Noise-1

Lecture 17 - Quantization Noise-2

Lecture 18 - Over Sampling and Noise Shaping

Lecture 19 - Delta-Sigma Modulation-1

Lecture 20 - Delta-Sigma Modulation-2

Lecture 21 - Linearized Analysis

Lecture 22 - Stability of Delta Sigma Modulators

Lecture 23 - High Order DSMs

Lecture 24 - NTF Design and Tradeoffs

Lecture 25 - Single bit Modulators

Lecture 26 - Loop Filter Architectures

Lecture 27 - Continuous-time Delta Sigma Modulation

Lecture 28 - Implicit Antialiasing

Lecture 29 - Modulators with NRZ and Impulsive DACs

Lecture 30 - High Order CTDSMs

Lecture 31 - CTDM Design

[Lecture 32 - Excess Loop Delay \(ELD\)](#)

[Lecture 33 - ELD Compensation](#)

[Lecture 34 - Effect of Clock Jitter on CTDSMs-1](#)

[Lecture 35 - Effect of Clock Jitter on CTDSMs-2](#)

[Lecture 36 - Dynamic Range Scaling](#)

[Lecture 37 - Simulation of CTDSMs](#)

[Lecture 38 - Integrator Design-1](#)

[Lecture 39 - Integrator Design-2](#)

[Lecture 40 - Flash ADC Design](#)

[Lecture 41 - Latches and Metastability](#)

[Lecture 42 - Offset in a Latch-1](#)

[Lecture 43 - Offset in a Latch-2 Auto Zeroing](#)

[Lecture 44 - Auto Zeroing-2](#)

[Lecture 45 - Auto Zeroing-3](#)

[Lecture 46 - Auto Zeroing in flash ADCs](#)

[Lecture 47 - Flash ADCs Case Study](#)

[Lecture 48 - Flash ADC Case Study](#)

[Lecture 49 - Flash ADC in a Delta Sigma Loop](#)

[Lecture 50 - DAC Basics](#)

[Lecture 51 - Binary and Thermometer DACs](#)

[Lecture 52 - Segmented DACs](#)

[Lecture 53 - Optimal DAC Segmentation](#)

[Lecture 54 - DAC Nonlinearities](#)

[Lecture 55 - Current Steering DACs-1](#)

[Lecture 56 - Current Steering DACs-2](#)

[Lecture 57 - DAC Mismatches in DSMs](#)

[Lecture 58 - Calibration and Randomization](#)

[Lecture 59 - Dynamic Element Matching-1](#)

[Lecture 60 - Dynamic Element Matching-2](#)

Lecture 1 - Introduction To Digital Circuits

Lecture 2 - Introduction To Digital Circuits

Lecture 3 - Combinational Logic Basics

Lecture 4 - Combinational Circuits

Lecture 5 - Logic Simplification

Lecture 6 - Karnaugh Maps And Implicants

Lecture 7 - Logic Minimization Using Karnaugh Maps

Lecture 8 - Karnaugh Map Minimization Using Maxterms

Lecture 9 - Code Converters

Lecture 10 - Parity Generators And Display Decoder

Lecture 11 - Arithmetic Circuits

Lecture 12 - Carry Look Ahead Adders

Lecture 13 - Subtractors

Lecture 14 - 2's Complement Subtractor and BCD Adder

Lecture 15 - Array Multiplier

Lecture 16 - Introduction to Sequential Circuits

Lecture 17 - S-R, J-K and D Flip Flops

Lecture 18 - J-K and T Flip Flops

Lecture 19 - Triggering Mechanisms of Flip Flops and Counters

Lecture 20 - Up/Down Counters

Lecture 21 - Shift Registers

Lecture 22 - Application of shift Registers

Lecture 23 - State Machines

Lecture 24 - Design of Synchronous Sequential Circuits

Lecture 25 - Design using J-K Flip Flop

Lecture 26 - Mealy and Moore Circuits

Lecture 27 - Pattern Detector

Lecture 28 - MSI and LSI Based Design

Lecture 29 - Multiplexer Based Design

Lecture 30 - Encoders and Decoders

Lecture 31 - Programmable Logic Devices

[Lecture 32 - Design using Programmable Logic Devices](#)

[Lecture 33 - Design using Programmable Logic Devices \(Continued\)](#)

[Lecture 34 - MSI and LSI based Implementation of Sequential Circuits](#)

[Lecture 35 - MSI and LSI based Implementation of Sequential Circuits \(Continued\)](#)

[Lecture 36 - Design of circuits using MSI sequential blocks](#)

[Lecture 37 - System Design Example](#)

[Lecture 38 - System Design Example \(Continued\)](#)

[Lecture 39 - System Design using the concept of controllers](#)

[Lecture 40 - System Design using the concept of controllers \(Continued\)](#)

Lecture 1 - Introduction

Lecture 2 - Diode

Lecture 3 - Diode characteristics

Lecture 4 - Rectifier

Lecture 5 - Voltage Multiplier

Lecture 6 - Full Wave Rectifier and Peak Detector

Lecture 7 - Diode as a GATE

Lecture 8 - Analog GATE

Lecture 9 - Small Signal Analysis of Diode Circuit

Lecture 10 - Zener Regulator and Voltage Regulator

Lecture 11 - Varactor Diode

Lecture 12 - Amplifiers

Lecture 13 - Cascading of Amplifiers

Lecture 14 - Cascading of Amplifiers

Lecture 15 - h and g Parameters

Lecture 16 - Two Port Analysis

Lecture 17 - Amplifier Applications

Lecture 18 - Frequency Limitations Of An Amplifier

Lecture 19 - Distortion In Amplifiers

Lecture 20 - Bipolar Junction Transistor

Lecture 21 - Transistor (BJT) Inverter

Lecture 22 - Transistor Biasing

Lecture 23 - Stable Way of Biasing

Lecture 24 - Common Emitter Amplifiers

Lecture 25 - Transistor Biasing Using Single Supply

Lecture 26 - Metal Oxide Semiconductor

Lecture 27 - Construction of a MOSFET

Lecture 28 - Varieties of MOSFETS and JFETS

Lecture 29 - Characteristics of MOSFET

Lecture 30 - Cascading Amplifiers

Lecture 31 - Cascading (Direct Coupling)

[Lecture 32 - The Differential Amplifiers](#)

[Lecture 33 - BJT Differential Amplifiers](#)

[Lecture 34 - MOSFET Differential Amplifiers](#)

[Lecture 35 - Cascading Differential Amplifiers](#)

[Lecture 36 - Current Source and Current Sink](#)

[Lecture 37 - NMOS Inverters and CMOS Inverters](#)

[Lecture 38 - Active Components used in Electronics](#)

- Lecture 1 - Feedback Theory
- Lecture 2 - Negative Feedback
- Lecture 3 - Negative Feedback
- Lecture 4 - Y-Feedback
- Lecture 5 - h and g Negative Feedback
- Lecture 6 - g Feedback with Mosfet
- Lecture 7 - Operational Amplifier in Negative Feedback
- Lecture 8 - Operational Amplifier in Negative Feedback
- Lecture 9 - Positive Feedback (Regenerative)
- Lecture 10 - Experimental Demonstration
- Lecture 11 - Instrumentation Amplifiers
- Lecture 12 - Active Filters
- Lecture 13 - Simulation of Harmonic Oscillators
- Lecture 14 - Oscillators
- Lecture 15 - Oscillators
- Lecture 16 - Frequency Compensation in Negative Feedback
- Lecture 17 - Frequency Compensation
- Lecture 18 - Wideband (video) Amplifiers
- Lecture 19 - Wideband Amplifiers
- Lecture 20 - ICs For Video And Tuned Amplifier Applications
- Lecture 21 - Power Amplifier
- Lecture 22 - Power Amplifier
- Lecture 23 - Class B and C Power Amplifiers
- Lecture 24 - Class-B Power Amplifier Load and Drive
- Lecture 25 - Control Circuits
- Lecture 26 - Voltage Regulators
- Lecture 27 - Voltage Regulators
- Lecture 28 - Voltage Regulators
- Lecture 29 - Convertors
- Lecture 30 - Analog Multipliers (Modems & Mixers)
- Lecture 31 - Log-Antilog Multipliers

[Lecture 32 - Multipliers](#)

[Lecture 33 - Multipliers](#)

[Lecture 34 - AGC/AVC](#)

[Lecture 35 - AGC/AVC](#)

[Lecture 36 - Experimental Demonstration](#)

[Lecture 37 - PLL \(Phase Locked Loop\)](#)

[Lecture 38 - PLL \(Phase Locked Loop\)](#)

[Lecture 39 - Lock Range Capture Range and FSK and FM](#)

- Lecture 1 - Introduction to Basic concepts
- Lecture 2 - Requirements for high speed circuits, devices and materials
- Lecture 3 - Classification and properties of semiconductor devices
- Lecture 4 - Ternary compound semiconductors and their applications
- Lecture 5 - Ternary compound semiconductors and their applications (Continued.)
- Lecture 6 - Crystal structures in GaAs
- Lecture 7 - Dopants and impurities in GaAs and InP
- Lecture 8 - Brief Overview of GaAs Technology for High Speed Devices
- Lecture 9 - Epitaxial Techniques for GaAs and high speed devices
- Lecture 10 - MBE and LPE for GaAs Epitaxy
- Lecture 11 - GaAs and InP devices for Microelectronics
- Lecture 12 - Metal Semiconductor contacts for MESFET
- Lecture 13 - Metal Semiconductor contacts for MESFET (Continued.)
- Lecture 14 - Metal Semiconductor contacts for MESFET (Continued.)
- Lecture 15 - Ohmic contacts on semiconductors
- Lecture 16 - Fermi level pinning, I V characteristics of Schottky Barrier Diodes
- Lecture 17 - Schottky Barrier Diodes I V characteristics of Non idealities -1
- Lecture 18 - Schottky Barrier Diodes I V characteristics of Non idealities -1
- Lecture 19 - Causes of Non idealities in the Schottky Barrier Diodes (I V characteristics)
- Lecture 20 - MESFET operations and I V characteristics
- Lecture 21 - MESFET I V characteristics Shockley's Model
- Lecture 22 - MESFET Shockley's Model and velocity saturation effect
- Lecture 23 - MESFET velocity saturation effect on drain current saturation
- Lecture 24 - MESFET : Drain current saturation  $I_{ds}$  due to velocity saturation
- Lecture 25 - MESFET : Effects of channel length and gate length on  $I_{DS}$  and  $g_m$
- Lecture 26 - MESFET : Effects of velocity saturation and velocity field characteristics
- Lecture 27 - MESFET : Effects of velocity field characteristics - Overshoot effects
- Lecture 28 - MESFET : Velocity overshoot effect and self aligned MESFET SAINT
- Lecture 29 - Self Aligned MESFET SAINT Threshold Voltage and Sub Threshold current
- Lecture 30 - Hetero junctions
- Lecture 31 - Hetero junctions and high electron Mobility Transistor (HEMT)

[Lecture 32 - Hetero junctions and high electron Mobility Transistor \(HEMT\) \(Continued.\)](#)

[Lecture 33 - High Electron Mobility Transistor](#)

[Lecture 34 - HEMT off voltage, I-V characteristics and trans conductance](#)

[Lecture 35 - I-V characteristics and trans conductance and optimization](#)

[Lecture 36 - Indium phosphide based HEMT](#)

[Lecture 37 - Pseudomorphic HEMT and Hetrojunction Bipolar Transistors](#)

[Lecture 38 - Hetero junction Bipolar Transistors \(HBT\)](#)

[Lecture 39 - Hetero junction Bipolar Transistors \(HBT\) \(Continued.\)](#)

[Lecture 40 - Hetero junction Bipolar Transistors \(HBT\) \(Continued.\)](#)

[Lecture 41 - Hetero junction Bipolar Transistors \(HBT\) \(Continued.\)](#)

Lecture 1 - Introduction on Solid State Devices

Lecture 2 - Evolution and Uniqueness of Semiconductor

Lecture 3 - Equilibrium Carrier Concentration

Lecture 4 - Equilibrium Carrier Concentration

Lecture 5 - Equilibrium Carrier Concentration

Lecture 6 - Equilibrium Carrier Concentration

Lecture 7 - Equilibrium Carrier Concentration

Lecture 8 - Equilibrium Carrier Concentration

Lecture 9 - Equilibrium Carrier Concentration

Lecture 10 - Equilibrium Carrier Concentration

Lecture 11 - Equilibrium Carrier Concentration

Lecture 12 - Carrier Transport

Lecture 13 - Carrier Transport (Continued.)

Lecture 14 - Carrier Transport (Continued.)

Lecture 15 - Excess Carriers

Lecture 16 - Excess Carriers (Continued.)

Lecture 17 - Procedure for Device Analysis

Lecture 18 - Procedure for Device Analysis (Continued.)

Lecture 19 - PN Junction

Lecture 20 - PN Junction (Continued.)

Lecture 21 - PN Junction (Continued.)

Lecture 22 - PN Junction (Continued.)

Lecture 23 - PN Junction (Continued.)

Lecture 24 - PN Junction (Continued.)

Lecture 25 - PN Junction (Continued.)

Lecture 26 - Bipolar Junction Transistor

Lecture 27 - Bipolar Junction Transistor (Continued.)

Lecture 28 - Bipolar Junction Transistor (Continued.)

Lecture 29 - Bipolar Junction Transistor (Continued.)

Lecture 30 - Bipolar Junction Transistor (Continued.)

Lecture 31 - Bipolar Junction Transistor (Continued.)

- [Lecture 32 - Bipolar Junction Transistor \(Continued.\)](#)
- [Lecture 33 - Metal-Oxide-Semiconductor \(MOS\) Junction](#)
- [Lecture 34 - Metal-Oxide-Semiconductor \(MOS\) Junction \(Continued.\)](#)
- [Lecture 35 - Metal-Oxide-Semiconductor \(MOS\) Junction \(Continued.\)](#)
- [Lecture 36 - Metal-Oxide-Semiconductor \(MOS\) Junction \(Continued.\)](#)
- [Lecture 37 - Metal-Oxide-Semiconductor \(MOS\) Junction \(Continued.\)](#)
- [Lecture 38 - MOS Field Effect Transistor](#)
- [Lecture 39 - MOS Field Effect Transistor \(Continued.\)](#)
- [Lecture 40 - MOS Field Effect Transistor \(Continued.\)](#)
- [Lecture 41 - MOS Field Effect Transistor \(Continued.\)](#)
- [Lecture 42 - The Final Lecture - Conclusion](#)

Lecture 1 - Introduction to VLSI Design

Lecture 2 - Combinational Circuit Design

Lecture 3 - Programmable Logic Devices

Lecture 4 - Programmable Array Logic

Lecture 5 - Review of Flip-Flops

Lecture 6 - Sequential Circuits

Lecture 7 - Sequential Circuit Design

Lecture 8 - MSI Implementation of Sequential Circuits

Lecture 9 - Design of Sequential Circuits using One Hot Controller

Lecture 10 - Verilog Modeling of Combinational Circuits

Lecture 11 - Modeling of Verilog Sequential Circuits - Core Statements

Lecture 12 - Modeling of Verilog Sequential Circuits - Core Statements(Continued.)

Lecture 13 - RTL Coding Guidelines

Lecture 14 - Coding Organization - Complete Realization

Lecture 15 - Coding Organization - Complete Realization (Continued.)

Lecture 16 - Writing a Test Bench

Lecture 17 - System Design using ASM Chart

Lecture 18 - Example of System Design using ASM Chart

Lecture 19 - Examples of System Design using Sequential Circuits

Lecture 20 - Examples of System Design using Sequential Circuits (Continued.)

Lecture 21 - Microprogrammed Design

Lecture 22 - Microprogrammed Design (Continued.)

Lecture 23 - Design Flow of VLSI Circuits

Lecture 24 - Simulation of Combinational Circuits

Lecture 25 - Simulation of Combinational and Sequential Circuits

Lecture 26 - Analysis of Waveforms using Modelsim

Lecture 27 - Analysis of Waveforms using Modelsim (Continued.)

Lecture 28 - ModelSim Simulation Tool

Lecture 29 - Synthesis Tool

Lecture 30 - Synthesis Tool (Continued.)

Lecture 31 - Synplify Tool - Schematic Circuit Diagram View

- Lecture 32 - Technology View using Synplify Tool
- Lecture 33 - Synopsys Full and Parallel Cases
- Lecture 34 - Xilinx Place & Route Tool
- Lecture 35 - Xilinx Place & Route Tool (Continued.)
- Lecture 36 - PCI Arbiter Design using ASM Chart
- Lecture 37 - Design of Memories - ROM
- Lecture 38 - Design of Memories- RAM
- Lecture 39 - Design of External RAM
- Lecture 40 - Design of Arithmetic Circuits
- Lecture 41 - Design of Arithmetic Circuits (Continued.)
- Lecture 42 - Design of Arithmetic Circuits (Continued.)
- Lecture 43 - System Design Examples
- Lecture 44 - System Design Examples (Continued.)
- Lecture 45 - System Design Examples (Continued.)
- Lecture 46 - System Design Examples (Continued.)
- Lecture 47 - System Design Examples (Continued.)
- Lecture 48 - System Design Examples using FPGA Board
- Lecture 49 - System Design Examples using FPGA Board (Continued.)
- Lecture 50 - Advanced Features of Xilinx Project Navigator
- Lecture 51 - System Design Examples using FPGA Board (Continued.)
- Lecture 52 - System Design Examples using FPGA Board (Continued.)
- Lecture 53 - System Design Examples using FPGA Board (Continued.)
- Lecture 54 - System Design Examples using FPGA Board (Continued.)
- Lecture 55 - Project Design Suggested for FPGA/ASIC Implementations

- Lecture 1 - Introduction on VLSI Design
- Lecture 2 - Bipolar Junction Transistor Fabrication
- Lecture 3 - MOSFET Fabrication for IC
- Lecture 4 - Crystal Structure of Si
- Lecture 5 - Crystal Structure (Continued.)
- Lecture 6 - Defects in Crystal + Crystal growth
- Lecture 7 - Crystal growth Contd + Epitaxy I
- Lecture 8 - Epitaxy II - Vapour phase Epitaxy
- Lecture 9 - Epitaxy III - Doping during Epitaxy
- Lecture 10 - Molecular beam Epitaxy
- Lecture 11 - Oxidation I - Kinetics of Oxidation
- Lecture 12 - Oxidation II - Oxidation rate constants
- Lecture 13 - Oxidation III - Dopant Redistribution
- Lecture 14 - Oxidation IV - Oxide Charges
- Lecture 15 - Diffusion I - Theory of Diffusion
- Lecture 16 - Diffusion II - Infinite Source
- Lecture 17 - Diffusion III - Actual Doping Profiles
- Lecture 18 - Diffusion IV - Diffusion Systems
- Lecture 19 - Ion - Implantation Process
- Lecture 20 - Ion - Implantation Process
- Lecture 21 - Annealing of Damages
- Lecture 22 - Masking during Implantation
- Lecture 23 - Lithography - I
- Lecture 24 - Lithography - II
- Lecture 25 - Wet Chemical Etching
- Lecture 26 - Dry Etching
- Lecture 27 - Plasma Etching Systems
- Lecture 28 - Etching of Si, SiO<sub>2</sub>, SiN and other materials
- Lecture 29 - Plasma Deposition Process
- Lecture 30 - Metallization - I
- Lecture 31 - Problems in Aluminium Metal contacts

[Lecture 32 - IC BJT - From junction isolation to LOCOS](#)

[Lecture 33 - Problems in LOCOS + Trench isolation](#)

[Lecture 34 - More about BJT Fabrication and Realization](#)

[Lecture 35 - Circuits + Transistors in ECL Circuits](#)

[Lecture 36 - MOSFET I - Metal gate vs. Self-aligned Poly-gate](#)

[Lecture 37 - MOSFET II Tailoring of Device Parameters](#)

[Lecture 38 - CMOS Technology](#)

[Lecture 39 - Latch - up in CMOS](#)

[Lecture 40 - BICMOS Technology](#)

Lecture 1 - Introduction to the course; Current and Voltage; Kirchhoff's Current and Voltage laws

Lecture 2 - Electrical circuit elements: Voltage and current sources; R, C, L; Voltage sources in series; Example of superposition

Lecture 3 - Elements in series and parallel; Superposition in linear circuits

Lecture 4 - Controlled sources; Determining the characteristics of a two terminal element; Realizing a resistor using a VCCS or a CCVS

Lecture 5 - Nodal analysis of a network with conductances and current sources; Setting up the equations; Conductance matrix; Superposition

Lecture 6 - Circuit analysis; Number of KCL and KVL equations in a circuit; Nodal analysis of a network with conductances and current sources; Setting up the equations; Conductance matrix;

Lecture 7 - Nodal analysis with voltage sources and controlled sources; Brief introduction to modified nodal analysis; Use of supernode to solve circuits with voltage sources; Superposition theorem

Lecture 8 - Mesh analysis of a circuit with resistors and voltage sources; Comparison with nodal analysis; Mesh analysis of circuits with current sources-supermesh

Lecture 9 - Choice of nodal versus mesh analysis; Circuit theorems: Pushing a voltage source through a node, splitting a current source, substitution theorem, superposition

Lecture 10 - Thevenin and Norton (theorem and) equivalent circuits; Power conservation in a circuit

Lecture 11 - Tellegen's theorem; Reciprocity theorem

Lecture 12 - Compensation Theorem; Two ports

Lecture 13 - Two port parameters-y parameters

Lecture 14 - Two port parameters(z, h, and g); Reciprocal two ports

Lecture 15 - Opamp, ideal opamp circuits, non-inverting and inverting amplifiers; Ensuring that the opamp has negative feedback

Lecture 16 - RC circuit natural response; First order differential equation

Lecture 17 - RC (first-order) circuit, complete response with step inputs; Transient(natural) and steady state(forced) responses; Zero-state and zero-input responses

Lecture 18 - Step response of RC circuit with loops of voltage sources and capacitors; RL circuits; RLC circuits

Lecture 19 - Second order(RLC circuit) natural response; Series and parallel RLC circuits; Differential equation-characteristic equation and solutions; Forced response of a second order circuit

Lecture 20 - General formulation of second order(RLC circuit) natural response; Natural frequency and damping/quality factor; Series/parallel RLC circuits; R, L, C in sinusoidal steady state

Lecture 21 - Sinusoidal steady state response of RC and RLC circuits

Lecture 1 - Preliminaries

Lecture 2 - Current

Lecture 3 - Voltage

Lecture 4 - Electrical elements and circuits

Lecture 5 - Kirchhoff's current law (KCL)

Lecture 6 - Kirchhoff's Voltage law (KVL)

Lecture 7 - Voltage Source

Lecture 8 - Current Source

Lecture 9 - Resistor

Lecture 10 - Capacitor

Lecture 11 - Inductor

Lecture 12 - Mutual Inductor

Lecture 13 - Linearity of Elements

Lecture 14 - Solutions to the assignment on units 1 and 2

Lecture 15 - Series connection-Voltage sources in series

Lecture 16 - Series connection of R, L, C, current source

Lecture 17 - Elements in parallel

Lecture 18 - Current source in series with an element; Voltage source in parallel with an element

Lecture 19 - Extreme cases: Open and short circuits

Lecture 20 - Summary

Lecture 21 - Voltage controlled voltage source (VCVS)

Lecture 22 - Voltage controlled current source (VCCS)

Lecture 23 - Current controlled voltage source (CCVS)

Lecture 24 - Current controlled current source (CCCS)

Lecture 25 - Realizing a resistance using a VCCS or CCCS

Lecture 26 - Scaling an element's value using controlled sources

Lecture 27 - Example calculation

Lecture 28 - Solution to the assignment on units 3 and 4

Lecture 29 - Power and energy absorbed by electrical elements

Lecture 30 - Power and energy in a resistor

Lecture 31 - Power and energy in a capacitor

- Lecture 32 - Power and energy in an inductor
- Lecture 33 - Power and energy in a voltage source
- Lecture 34 - Power and energy in a current source
- Lecture 35 - Goals of circuit analysis
- Lecture 36 - Number of independent KCL equations
- Lecture 37 - Number of independent KVL equations and branch relationships
- Lecture 38 - Analysis of circuits with a single independent source
- Lecture 39 - Analysis of circuits with multiple independent sources using superposition
- Lecture 40 - Superposition: Example
- Lecture 41 - Solution to the assignment on units 5 and 6
- Lecture 42 - What is nodal analysis
- Lecture 43 - Setting up nodal analysis equations
- Lecture 44 - Structure of the conductance matrix
- Lecture 45 - How elements appear in the nodal analysis formulation
- Lecture 46 - Completely solving the circuit starting from nodal analysis
- Lecture 47 - Nodal analysis example
- Lecture 48 - Matrix inversion basics
- Lecture 49 - Nodal analysis with independent voltage sources
- Lecture 50 - Supernode for nodal analysis with independent voltage sources
- Lecture 51 - Nodal analysis with VCCS
- Lecture 52 - Nodal analysis with VCVS
- Lecture 53 - Nodal analysis with CCVS
- Lecture 54 - Nodal analysis with CCCS
- Lecture 55 - Nodal analysis summary
- Lecture 56 - Solution to the assignment on units 7 and 8
- Lecture 57 - Planar circuits
- Lecture 58 - Mesh currents and their relationship to branch currents
- Lecture 59 - Mesh analysis
- Lecture 60 - Mesh analysis with independent current sources-Supermesh
- Lecture 61 - Mesh analysis with current controlled voltage sources
- Lecture 62 - Mesh analysis with current controlled current sources
- Lecture 63 - Mesh analysis using voltage controlled sources
- Lecture 64 - Nodal analysis versus Mesh analysis

Lecture 65 - Superposition theorem

Lecture 66 - Pushing a voltage source through a node

Lecture 67 - Splitting a current source

Lecture 68 - Substitution theorem: Current source

Lecture 69 - Substitution theorem: Voltage source

Lecture 70 - Substituting a voltage or current source with a resistor

Lecture 71 - Solutions

Lecture 72 - Extensions to Superposition and Substitution theorem

Lecture 73 - Thevenin's theorem

Lecture 74 - Worked out example: Thevenin's theorem

Lecture 75 - Norton's theorem

Lecture 76 - Worked out example: Norton's theorem

Lecture 77 - Maximum power transfer theorem

Lecture 78 - Preliminaries.

Lecture 79 - Two port parameters

Lecture 80 - y parameters

Lecture 81 - y parameters: Examples

Lecture 82 - Solutions.

Lecture 83 - z parameters

Lecture 84 - z parameters: Examples

Lecture 85 - h parameters

Lecture 86 - h parameters: Examples

Lecture 87 - g parameters

Lecture 88 - g parameters: Examples

Lecture 89 - Calculations with a two-port element

Lecture 90 - Calculations with a two-port element.

Lecture 91 - Degenerate cases

Lecture 92 - Relationships between different two-port parameters

Lecture 93 - Equivalent circuit representation for two ports

Lecture 94 - Reciprocity

Lecture 95 - Proof of reciprocity of resistive two-ports

Lecture 96 - Proof for 4-terminal two-ports

Lecture 97 - Reciprocity in terms of different two-port parameters

- Lecture 98 - Reciprocity in circuits containing controlled sources
- Lecture 99 - Examples
- Lecture 100 - Solutions..
- Lecture 101 - Feedback amplifier using an opamp
- Lecture 102 - Ideal opamp
- Lecture 103 - Negative feedback around the opamp
- Lecture 104 - Finding opamp signs for negative feedback
- Lecture 105 - Example: Determining opamp sign for negative feedback
- Lecture 106 - Analysis of circuits with opamps
- Lecture 107 - Inverting amplifier
- Lecture 108 - Summing amplifier
- Lecture 109 - Instrumentation amplifier
- Lecture 110 - Negative resistance and Miller effect
- Lecture 111 - Finding opamp signs for negative feedback-circuits with multiple opamps
- Lecture 112 - Opamp supply voltages and saturation
- Lecture 113 - KCL with an opamp and supply currents
- Lecture 114 - Solutions...
- Lecture 115 - Circuits with storage elements (capacitors and inductors)
- Lecture 116 - First order circuit with zero input-natural response
- Lecture 117 - First order RC circuit with zero input-Example
- Lecture 118 - First order circuit with a constant input
- Lecture 119 - General form of the first order circuit response
- Lecture 120 - First order RC circuit with a constant input-Example
- Lecture 121 - First order circuit with piecewise constant input
- Lecture 122 - First order circuit with piecewise constant input-Example
- Lecture 123 - First order circuit-Response of arbitrary circuit variables
- Lecture 124 - Summary: Computing first order circuit response
- Lecture 125 - Does a capacitor block DC?
- Lecture 126 - Finding the order of a circuit
- Lecture 127 - First order RC circuits with discontinuous capacitor voltages
- Lecture 128 - Summary: Computing first order circuit response with discontinuities
- Lecture 129 - First order RL circuits
- Lecture 130 - First order RL circuit with discontinuous inductor current-Example

- [Lecture 131 - First order RC circuit with an exponential input](#)
- [Lecture 132 - First order RC response to its own natural response](#)
- [Lecture 133 - First order RC response to a sinusoidal input](#)
- [Lecture 134 - First order RC response to a sinusoidal input-via the complex exponential](#)
- [Lecture 135 - Summary: Linear circuit response to sinusoidal input via the complex exponential](#)
- [Lecture 136 - Three methods of calculating the sinusoidal steady state response](#)
- [Lecture 137 - Calculating the total response including initial conditions](#)
- [Lecture 138 - Why are sinusoids used in measurement?](#)
- [Lecture 139 - Second order system natural response](#)
- [Lecture 140 - Second order system as a cascade of two first order systems](#)
- [Lecture 141 - Second order system natural response-critically damped and underdamped](#)
- [Lecture 142 - Generalized form of a second order system](#)
- [Lecture 143 - Numerical example](#)
- [Lecture 144 - Series and parallel RLC circuits](#)
- [Lecture 145 - Forced response of a second order system](#)
- [Lecture 146 - Steady state response calculation and Phasors](#)
- [Lecture 147 - Phasors \(Continued...\)](#)
- [Lecture 148 - Magnitude and Phase plots](#)
- [Lecture 149 - Magnitude and phase plots of a second order system](#)
- [Lecture 150 - Maximum power transfer and Conjugate matching](#)

Lecture 1 - MOS Transistor

Lecture 2 - MOS Transistor - Detailed Study

Lecture 3 - Combinational Circuits and layout

Lecture 4 - Delay

Lecture 5 - Sequential Circuits

Lecture 6 - Logical Effort

Lecture 7 - Circuit Families

Lecture 8 - Lab-01

Lecture 9 - Lab-02

Lecture 10 - Lab-03

Lecture 11 - Lab-04

Lecture 12 - Introduction to Synthesis

Lecture 13 - Libraries

Lecture 14 - RTL Coding for Synthesis

Lecture 15 - Reading Design in DC

Lecture 16 - Design Environment

Lecture 17 - Design Constraints

Lecture 18 - Compile Flow and strategies

Lecture 19 - Analysis and Reporting

Lecture 20 - Lab-05

Lecture 21 - Advanced Synthesis Techniques

Lecture 22 - Datapath Extraction Guidelines

Lecture 23 - Power - Methodology and Analysis

Lecture 24 - Lab-06

Lecture 25 - Lab-07

Lecture 26 - Lab-08

Lecture 27 - Lab-09

Lecture 28 - Static Timing Analysis - Concepts and Flow

Lecture 29 - Interconnects and Delay calculation

Lecture 30 - Clock and Exceptions

Lecture 31 - On Chip Variation

[Lecture 32 - Introduction to Crosstalk](#)

[Lecture 33 - Gaussian / Normal Distribution](#)

[Lecture 34 - Equivalence Checking / Formal Verification](#)

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

## NPTEL : ARM Based Development (Electronics and Communication Engineering)

**Co-ordinators : Mr. S. Chandramouleeswaran**

Lecture 1 - Types of computer Architectures, ISA's and ARM History

Lecture 2 - Embedded System Software and Hardware, stack implementation in ARM, Endianness, condition codes

Lecture 3 - Processor core VS CPU core, ARM7TDMI Interface signals, Memory Interface, Bus Cycle types, Register set, Operational Modes

Lecture 4 - Instruction Format, ARM Core Data Flow Model, ARM 3 stage Pipeline, ARM family attribute comparison

Lecture 5 - ARM 5 stage Pipeline, Pipeline Hazards, Data forwarding - a hardware solution

Lecture 6 - ARM ISA and Processor Variants, Different Types of Instructions, ARM Instruction set, data processing instructions

Lecture 7 - Shift Operations, shift Operations using RS lower byte, Immediate value encoding

Lecture 8 - Dataprocessing Instructions

Lecture 9 - Addressing Mode-1, Addressing Mode-2

Lecture 10 - Addressing Mode-2, LDR/STR, Addressing mode-3 with examples

Lecture 11 - Instruction Timing, Addressing Mode-4 with Examples

Lecture 12 - Swap Instructions, Swap Register related Instructions, Loading Constants

Lecture 13 - Program Control Flow, Control Flow Instructions, B & BL instructions, BX instruction

Lecture 14 - Interrupts and Exceptions, Exception Handlers, Reset Handling

Lecture 15 - Aborts, software Interrupt Instruction, undefined instruction exception

Lecture 16 - Interrupt Latency, Multiply Instructions, Instruction set examples

Lecture 17 - Thumb state, Thumb Programmers model, Thumb Implementation, Thumb Applications

Lecture 18 - Thumb Instructions, Interrupt processing

Lecture 19 - Interrupt Handelling schemes, Examples of Interrupt Handlers

Lecture 20 - Coprocessors

Lecture 21 - Coprocessor Instructions, data Processing Instruction, data transfers, register transfers

Lecture 22 - Number representations, floating point representation

Lecture 23 - Flynn's Taxonomy, SIMD and Vector Processors, Vector Floating Point Processor (VFP), VFP and ARM interactions, An example vector operation

Lecture 24 - Memory Technologies, Need for memory Hierarchy, Hierarchical Memory Organization, Virtual Memory

Lecture 25 - Cache Memory, Mapping Functions

Lecture 26 - Cache Design, Unified or split cache, multiple level of caches, ARM cache features, coprocessor 15 for system control

Lecture 27 - Processes, Memory Map, Protected Systems, ARM systems with MPU, memory Protection Unit (MPU)

Lecture 28 - Physical Vs Virtual Memory, Paging, Segmentation

Lecture 29 - MMU Advantage, virtual memory translation, Multitasking with MMU, MMU organization, Tightly coupled Memory (TCM)

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

Lecture 30 - ARM Development Environment, Arm Procedure Call Standard (APCS),

Lecture 31 - Example C program

Lecture 32 - Embedded software Development, Image structure, linker inputs and outputs, memory map, application startup

Lecture 33 - AMBA Overview, Typical AMAB Based Microcontroller, AHB bus features, AHB Bus transfers, APB bus transfers, APB bridge

Lecture 34 - DMA, Peripherals, Programming Peripherals in ARM

Lecture 35 - DMA:Direct Memory Access

Lecture 36 - Protocols (I2c, SPI), UART, GPIO

Lecture 37 - ARM ISAs, ARMv5, ARMv6, ARM v7, big.little technology, ARMv8

Lecture 1 - Embedded Systems Basics Session 1

Lecture 2 - Embedded Systems Basics Session 1 (Continued...)

Lecture 3 - Prerequisites for Embedded Systems Testing

Lecture 4 - Test Case Design and procedures

Lecture 5 - Test Standards

Lecture 6 - Depicting Levels of Testing

Lecture 7 - Depicting Levels of Testing (Continued...)

Lecture 8 - Software Life Cycle

Lecture 9 - Embedded V-Model Life Cycle

Lecture 10 - Embedded V-Model Life Cycle (Continued...)

Lecture 11 - Master Test Planning

Lecture 12 - Dynamic Testing

Lecture 13 - Black Box Testing

Lecture 14 - Black Box Testing (Continued...)

Lecture 15 - Black Box Testing (Continued...)

Lecture 16 - Black Box Testing (Continued...)

Lecture 17 - Model based Design Introduction

Lecture 18 - Dynamic Testing

Lecture 19 - Dynamic Testing (Continued...)

Lecture 20 - White Box Testing

Lecture 21 - White Box Testing (Continued...)

Lecture 22 - Grey-box testing

Lecture 23 - Static Testing

Lecture 24 - Static Analysis

Lecture 25 - Static Analysis (Continued...)

Lecture 26 - Static Analysis (Continued...)

Lecture 27 - Test Metrics

Lecture 28 - Software Testing Metrics

Lecture 29 - Integration Test Strategy

Lecture 30 - Integration Tests Environment

Lecture 31 - Use Case Diagram

[Lecture 32 - Depicting Levels of Testing \(Continued...\)](#)

[Lecture 33 - Configure Management Elements](#)

[Lecture 34 - SCM Activities](#)

[Lecture 35 - Test Management Tool](#)

[Lecture 36 - SCM Activities \(Continued...\)](#)

[Lecture 37 - Overview Lecture 1](#)

[Lecture 38 - Unit Testing](#)

[Lecture 39 - Unit Testing \(Continued...\)](#)

[Lecture 40 - Understading C++](#)

[Lecture 41 - Unit Testing \(Continued...\)](#)

[Lecture 42 - Level Testing](#)

[Lecture 43 - Identify Test Cases](#)

[Lecture 44 - Test Link Work Flow](#)

[Lecture 1 - Linux Basics - I](#)

[Lecture 2 - Linux Basics - II](#)

[Lecture 3 - Linux Basics - III](#)

[Lecture 4 - Linux Basics - IV](#)

[Lecture 5 - Linux Networking - I](#)

[Lecture 6 - Linux Networking - II](#)

[Lecture 7 - File Transfer Protocol](#)

[Lecture 8 - Domain Name System](#)

[Lecture 9 - DNS \(Continued...\)](#)

[Lecture 10 - DFS](#)

[Lecture 11 - AFS and NIS](#)

[Lecture 12 - PERL 1](#)

[Lecture 13 - PERL 2](#)

[Lecture 14 - PERL 3](#)

[Lecture 15 - PERL 4](#)

[Lecture 16 - PERL 5](#)

[Lecture 17 - PERL 6](#)

[Lecture 18 - PERL 7](#)

[Lecture 19 - PERL 8](#)

[Lecture 20 - PERL 9](#)

[Lecture 21 - Using sort](#)

[Lecture 22 - PERL 10](#)

[Lecture 23 - Programming Using Tcl/Tk - I](#)

[Lecture 24 - Programming Using Tcl/Tk - II](#)

[Lecture 25 - Programming Using Tcl/Tk - III](#)

[Lecture 26 - More about Procedures](#)

[Lecture 27 - TCP, Ports and Sockets](#)

[Lecture 28 - I/O and Processes](#)

[Lecture 29 - Bindings](#)

[Lecture 30 - Programming Using Tcl/Tk - IV](#)

[Lecture 31 - Furniture Arranger](#)

[Lecture 32 - Bindtags](#)

[Lecture 33 - Tcl in Synopsys Tools](#)

[Lecture 34 - Python Programming](#)

[Lecture 35 - Scope](#)

[Lecture 36 - Iteration](#)

[Lecture 37 - More about Regexprs](#)

[Lecture 38 - Advanced Functions](#)

[Lecture 39 - Exception Handling](#)

[Lecture 40 - Examples of file Parsing](#)

[Lecture 41 - Program on If Statement](#)

[Lecture 42 - Program on Lists](#)

[Lecture 43 - Makefiles](#)

Lecture 1 - Introduction

Lecture 2 - Basic Boolean Logic

Lecture 3 - Boolean Theorems

Lecture 4 - Definitions, SoP and Pos

Lecture 5 - Algebraic Minimization Examples

Lecture 6 - Introduction to Verilog

Lecture 7 - Universality, Rearranging Truth Tables

Lecture 8 - Karnaugh Maps

Lecture 9 - K-Map Minimization

Lecture 10 - K-Map with Don't cares

Lecture 11 - Multiple Output Functions

Lecture 12 - Number Systems

Lecture 13 - Encoders and Decoders

Lecture 14 - Multiplexers

Lecture 15 - Multiplexer based Circuit Design

Lecture 16 - Verilog

Lecture 17 - Compiling and Running Verilog - A Demonstration

Lecture 18 - Sequential Elements

Lecture 19 - Gated Latches

Lecture 20 - Flipflops

Lecture 21 - Verilog - Assign Statement and Instantiation

Lecture 22 - Sequential Circuits

Lecture 23 - CMOS+Electrical Properties

Lecture 24 - Delays

Lecture 25 - Sequential Element Delays

Lecture 26 - More Sequential Circuits

Lecture 27 - Introduction to State Machines

Lecture 28 - Always Statement in Verilog

Lecture 29 - Sequential Logic Synthesis

Lecture 30 - FSM Design Problems

Lecture 31 - State Minimization

[Lecture 32 - State Assignment](#)

[Lecture 33 - Timing Sequential Circuits](#)

[Lecture 34 - Verilog Styles + Sequential Elements](#)

[Lecture 35 - GCD Algorithm](#)

[Lecture 36 - GCD Machines Datapath](#)

[Lecture 37 - GCD State Machine](#)

[Lecture 38 - GCD Top Level Module](#)

[Lecture 39 - Datapath in Verilog](#)

[Lecture 40 - Datapath Elements in Verilog](#)

[Lecture 41 - FSM in Verilog](#)

[Lecture 42 - Putting it all together](#)

[Lecture 43 - Pipelining](#)

[Lecture 44 - K-stage Pipeline](#)

[Lecture 45 - Interleaving and Parallelism](#)

[Lecture 46 - Blocking and Non-blocking Statements](#)

[Lecture 47 - Modeling Circuits with Pipelining](#)

[Lecture 48 - Signed Number Representation](#)

[Lecture 49 - Signed Number Addition](#)

[Lecture 50 - Adder/Subtractor](#)

[Lecture 51 - Fast Adders](#)

[Lecture 52 - Multiplication](#)

[Lecture 53 - Closing](#)

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

**NPTEL : NOC:Networks and Systems (Electronics and Communication Engineering)**

**Co-ordinators : Prof. V.G.K. Murti, Mr. C. S. Ramalingam, Dr. Andrew Thangaraj**

Lecture 1 - Functions in circuits - constant and sinusoidal functions

Lecture 2 - Functions in circuits - Exponential function

Lecture 3 - Complex numbers and other topics

Lecture 4 - Systems, Signals, Networks

Lecture 5 - Representation and Classification of Systems

Lecture 6 - Linear systems

Lecture 7 - Time-invariance and causality

Lecture 8 - Signals, Elementary continuous signals

Lecture 9 - Complex frequencies of signals

Lecture 10 - Discontinuous signals - step, ramp

Lecture 11 - Unit impulse or delta function

Lecture 12 - Basic discrete-time signals

Lecture 13 - Examples of Signals

Lecture 14 - Introduction to Systems, Complementary Functions, Initial Conditions

Lecture 15 - Special initial conditions

Lecture 16 - Characterization of a linear system

Lecture 17 - Impulse Response

Lecture 18 - Evaluating the Convolution Integral

Lecture 19 - Worked-out Problems

Lecture 20 - Introduction and Motivation

Lecture 21 - Evaluating Fourier series coefficients

Lecture 22 - Symmetry conditions

Lecture 23 - Symmetry Condition Examples

Lecture 24 - Application to Network Analysis

Lecture 25 - Exponential Fourier Series

Lecture 26 - Frequency Spectrum

Lecture 27 - Examples

Lecture 28 - Signal Power and Related Ideas

Lecture 29 - Convergence of Fourier Series

Lecture 30 - Week 1 Solutions

Lecture 31 - Hints for Assignment 2

[Lecture 32 - Hints for Assignment 3](#)

[Lecture 33 - Additional Properties of Fourier Series](#)

[Lecture 34 - Exercises on Fourier Series](#)

[Lecture 35 - Lab Demo](#)

[Lecture 36 - From Fourier Series to Fourier Transform](#)

[Lecture 37 - Continuous Time Fourier Transform](#)

[Lecture 38 - Fourier Transform Examples](#)

[Lecture 39 - Examples and Some Properties of Fourier Transform](#)

[Lecture 40 - Properties of Fourier Transform \(contd.\)](#)

[Lecture 41 - More Fourier Transform Properties](#)

[Lecture 42 - Energy Considerations](#)

[Lecture 43 - Energy Considerations II](#)

[Lecture 44 - Helpful Relationships for Inverse Fourier Transform](#)

[Lecture 45 - Fourier transform of signals that are not absolutely integrable](#)

[Lecture 46 - Fourier Transform of Periodic Signals, Unit Step and Signum Function](#)

[Lecture 47 - Truncated Sine wave and Convolution properties](#)

[Lecture 48 - Integration in Time domain](#)

[Lecture 49 - Application of continuous-time Fourier transform to system analysis](#)

[Lecture 50 - Comments about transient analysis](#)

[Lecture 51 - Sampling Theorem and Exercises on Fourier Transforms](#)

[Lecture 52 - Introduction to Laplace Transform](#)

[Lecture 53 - Laplace transforms of important functions](#)

[Lecture 54 - Recap, Poles / Zeros and Laplace Transform Notation](#)

[Lecture 55 - Properties: Linearity, differentiation in the time domain](#)

[Lecture 56 - Application and properties of Laplace transform](#)

[Lecture 57 - More properties of Laplace transform: Shift in frequency domain](#)

[Lecture 58 - More properties of Laplace transform](#)

[Lecture 59 - Properties: Division by  \$t\$ , Initial value theorem, Final value theorem](#)

[Lecture 60 - Properties: Convolution in time domain](#)

[Lecture 61 - Complex convolution and periodic functions](#)

[Lecture 62 - Examples of Laplace transform](#)

[Lecture 63 - Laplace transform examples](#)

[Lecture 64 - Inverse Laplace transform](#)

[Lecture 65 - Partial fractions: general case](#)

[Lecture 66 - Inverse Laplace Transform and Contour Integration](#)

[Lecture 67 - Relating Fourier and Laplace Transform](#)

[Lecture 68 - Exercises](#)

[Lecture 69 - Applications of Laplace transform to network transients](#)

[Lecture 70 - Laplace transform for resistor and system analysis](#)

[Lecture 71 - Laplace transform method for mutual inductance](#)

[Lecture 72 - Mutual Inductance Continued](#)

[Lecture 73 - Examples and Advantages of L-transform](#)

[Lecture 74 - General LTI systems and more about H\(s\)](#)

[Lecture 75 - Many facets of the system function \(contd\)](#)

[Lecture 76 - Frequency response and stability](#)

[Lecture 77 - Full circuit example](#)

[Lecture 78 - Exercises](#)

Lecture 1 - Course Introduction and Motivation

Lecture 2 - Kirchoff's Current and Voltage Laws, and the Incidence Matrix

Lecture 3 - Power Conservation and Tellegen's Theorem

Lecture 4 - Intuition behind Tellegen's Theorem

Lecture 5 - Tellegen's Theorem and reciprocity in linear resistive networks

Lecture 6 - Why is reciprocity useful in practice?

Lecture 7 - Inter-reciprocity in linear time-invariant networks

Lecture 8 - Inter-reciprocity in linear time-invariant networks (Continued...)

Lecture 9 - Inter-reciprocity in networks with ideal operational amplifiers

Lecture 10 - Review of Modified Nodal Analysis (MNA) of linear networks

Lecture 11 - MNA stamps of controlled sources - the VCCS and VCVS

Lecture 12 - MNA stamps of controlled sources - the CCCS and CCVS

Lecture 13 - Inter-reciprocity in linear networks - using the MNA stamp approach

Lecture 14 - The Adjoint Network

Lecture 15 - MNA stamp of an ideal opamp

Lecture 16 - Properties of circuits with multiple ideal opamps

Lecture 17 - Introduction to Analog Active Filters

Lecture 18 - Magnitude approximation principles

Lecture 19 - The maximally flat (Butterworth) approximation

Lecture 20 - The Butterworth Approximation (Continued...)

Lecture 21 - Connection between magnitude response and pole locations in an all-pole filter

Lecture 22 - Cascade-of-biquads, realization of stray-insensitive first-order section

Lecture 23 - Opamp-RC biquadratic sections

Lecture 24 - Active-RC biquads and Impedance scaling

Lecture 25 - Opamp-RC biquadratic sections (Continued...)

Lecture 26 - High-order filters using cascade of biquads, Dynamic range scaling in opamp-RC filters

Lecture 27 - The finite gain-bandwidth model of nonideal opamps

Lecture 28 - Effect of finite opamp bandwidth on an active-RC integrator

Lecture 29 - Effect of finite opamp bandwidth on an active-RC biquad

Lecture 30 - Visualization and mitigation of the effect of Q-enhancement

Lecture 31 - Transconductance-Capacitance integrators

- Lecture 32 - Introduction to noise in electrical networks
- Lecture 33 - Noise processed by a linear time-invariant system
- Lecture 34 -  $kT/C$  noise in a sample-and-hold circuit
- Lecture 35 - Noise in RLC networks
- Lecture 36 - Total integrated noise in RLC Networks
- Lecture 37 - Bode's Noise Theorem - Frequency domain
- Lecture 38 - Input referred noise in electrical networks - Part 1
- Lecture 39 - Input referred noise in electrical networks - Part 2
- Lecture 40 - Input referred noise and the noise factor
- Lecture 41 - Noise Factor Examples
- Lecture 42 - Introduction to distributed networks, the ideal transmission line
- Lecture 43 - Solving the wave equation in an ideal transmission line
- Lecture 44 - Transmission line circuit analysis : The short circuited and open circuited line
- Lecture 45 - Transmission line circuit analysis, the reflection coefficient, open and short-circuited lines
- Lecture 46 - Transmission line driven by a source, power in a transmission line
- Lecture 47 - The Smith chart
- Lecture 48 - The need for scattering parameters
- Lecture 49 - Scattering Parameters: Introduction
- Lecture 50 - Example scattering matrix calculations
- Lecture 51 - Scattering matrices properties
- Lecture 52 - Measuring the S-parameters of a one-port
- Lecture 53 - The one-port vector network analyzer
- Lecture 54 - The two-port vector network analyzer
- Lecture 55 - Weak nonlinearity in electronic circuits, second-order harmonic distortion, HD2 and IM2
- Lecture 56 - Weak nonlinearity in electronic circuits, second-order intermodulation distortion
- Lecture 57 - Gain compression and third-order harmonic distortion
- Lecture 58 - Third-order intermodulation distortion
- Lecture 59 - Weak nonlinearities in circuits: Intuition behind the method of current injection
- Lecture 60 - Weak nonlinearities in circuits: Calculating nonlinear components
- Lecture 61 - Current-injection analysis of distortion in a negative feedback system
- Lecture 62 - Current-injection analysis of distortion in a negative feedback system (Continued...)
- Lecture 63 - Course summary and recap

Lecture 1 - Understanding Silicon

Lecture 2 - Introduction to NMOS

Lecture 3 - NMOS Transistor Working

Lecture 4 - PMOS Transistor

Lecture 5 - MOS Capacitances

Lecture 6 - Non Ideal MOS model

Lecture 7 - Short channel current model

Lecture 8 - Short channel current model analysis

Lecture 9 - Channel Length modulation index

Lecture 10 - DC characteristics of Inverter

Lecture 11 - Transfer characteristics of Inverter

Lecture 12 - Skewed Inverter

Lecture 13 - Skewed Inverter and threshold voltage

Lecture 14 - Equivalent of transistors in series

Lecture 15 - Transmission Gate

Lecture 16 - Bad CMOS Buffer - Part 1

Lecture 17 - Bad CMOS Buffer - Part 2

Lecture 18 - Noise margin characteristics of inverter

Lecture 19 - Noise margin parameters

Lecture 20 - Introduction to Delay in CMOS

Lecture 21 - Transient analysis of CMOS Inverter

Lecture 22 - RC approximated delay

Lecture 23 - Switching Resistance

Lecture 24 - CMOS Inverter approximated to RC Circuit

Lecture 25 - Elmore delay

Lecture 26 - Delay of FO4 inverter

Lecture 27 - Extracting capacitances of 3-Nand gate for delay estimation

Lecture 28 - Characterizing Delay of NOR gate

Lecture 29 - Linear Delay model

Lecture 30 - Logical effort and Parasitic delay

Lecture 31 - Logical effort and Parasitic delay for different gates

- Lecture 32 - Logical effort for short-channel current model
- Lecture 33 - Ring Oscillator design
- Lecture 34 - Optimizing Gate Size
- Lecture 35 - Optimizing Gate Sizes Example
- Lecture 36 - Optimizing the Stages for an inverter path
- Lecture 37 - Optimizing the Stages for a General Circuit
- Lecture 38 - Decoder Design
- Lecture 39 - Introduction to Combinational Circuit and assymmetric gates
- Lecture 40 - Assymmetric Gates analysis
- Lecture 41 - Assymmetric Gates analysis using short-channel current model
- Lecture 42 - Introduction to Skewed gates
- Lecture 43 - Skewed gates and best P/N ratio
- Lecture 44 - vIntroduction to Pseudo NMOS
- Lecture 45 - Psudeo NMOS gates
- Lecture 46 - Other Logic Family
- Lecture 47 - Dynamic Logic and Domino logic
- Lecture 48 - Domino gates
- Lecture 49 - Introduction to Stick Diagram
- Lecture 50 - Stick Diagram for different gates
- Lecture 51 - Applying Eulers path for stick diagram representations
- Lecture 52 - Multiplexer design and layout
- Lecture 53 - Introduction to Interconnects
- Lecture 54 - Interconnects - RC delay, and Energy
- Lecture 55 - Introduction to crosstalks in interconnects
- Lecture 56 - Transient analysis in Crosstalk
- Lecture 57 - Introduction to Repeaters in Interconnect Engineering
- Lecture 58 - Repeater Design
- Lecture 59 - Energy and delay analysis for interconnectwith repeaters
- Lecture 60
- Lecture 61 - Introduction to Power
- Lecture 62 - Switching Power and Energy Estimation
- Lecture 63 - Activity factor and estimating dynamic power for a combinational circuit design
- Lecture 64 - Analyzing Dynamic Power

[Lecture 65 - Energy estimation through driving factor](#)

[Lecture 66 - Energy expression in terms of delay](#)

[Lecture 67 - Voltage Scaling](#)

[Lecture 68 - DVFS](#)

[Lecture 69 - Introduction to subthreshold leakage current model](#)

[Lecture 70 - Subthreshold leakage current and Gate leakage current](#)

[Lecture 71 - Estimating Static Power](#)

[Lecture 72 - Introduction to CMOS Latch design](#)

[Lecture 73 - CMOS Latch Design](#)

[Lecture 74 - CMOS Latch and flipflop design](#)

[Lecture 75 - Static Timing Analysis](#)

[Lecture 76 - Static Timing Analysis \(Continued...\)](#)

[Lecture 77 - Static Timing Analysis - Part 2](#)

[Lecture 78 - Static Timing Analysis - Part 2.1](#)

[Lecture 79 - Static Timing Analysis - Part 3](#)

[Lecture 80 - TPDQ and TPCQ](#)

[Lecture 81 - Static Timing Analysis - Part 4](#)

[Lecture 82 - Static Timing Analysis - Part 5](#)

[Lecture 83 - Static Timing Analysis - Part 6](#)

[Lecture 84 - SET and CLEAR enabled Latch and Flipflop Design](#)

[Lecture 85 - 1-bit Adder design](#)

[Lecture 86 - Adder-Part2](#)

[Lecture 87 - PG architecture - Part 1](#)

[Lecture 88 - PG architecture - Part 2](#)

[Lecture 89 - Carry Skip Adder](#)

[Lecture 90 - Carry Look Ahead and Carry Increment Adder](#)

[Lecture 91 - Other Adder Subsystems](#)

[Lecture 92 - Approximate Multipliers - Part 1](#)

[Lecture 93 - Approximate Multipliers - Part 2](#)

[Lecture 94 - Approximate Adder](#)

Lecture 1 - Introduction - Part 1

Lecture 2 - Introduction - Part 2

Lecture 3 - Ordinary Differential Equations - Part 1

Lecture 4 - Ordinary Differential Equations - Part 2

Lecture 5 - ODE Solutions via Examples

Lecture 6 - Solutions to ODEs

Lecture 7 - Existence and Uniqueness Theorems

Lecture 8 - Asymptotic Behaviour of Dynamical Systems - Part 1

Lecture 9 - Asymptotic Behaviour of Dynamical Systems - Part 2

Lecture 10 - Asymptotic Behaviour of Dynamical Systems - Part 3

Lecture 11 - Stability Theory: Definitions - Part 1

Lecture 12 - Stability Theory: Definitions - Part 2

Lecture 13 - Stability Theory: Lyapunov Methods - Part 1

Lecture 14 - Stability Theory: Lyapunov Methods - Part 2

Lecture 15 - Lyapunov Function Examples

Lecture 16 - LaSalle's Invariance Theorem

Lecture 17 - Stability Theory: Converse Lyapunov and Instability Theorems

Lecture 18 - Solved Problems - Part 1

Lecture 19 - Solved Problems - Part 2

Lecture 20 - Linear Systems - Part 1

Lecture 21 - Linear Systems - Part 2

Lecture 22 - Linearization of Nonlinear Systems

Lecture 23 - Linear Systems and Linearization: Solved Problems - Part 1

Lecture 24 - Linear Systems and Linearization: Solved Problems - Part 2

Lecture 25 - Nonlinear Analysis: Key Concepts and Results - Part 1

Lecture 26 - Nonlinear Analysis: Key Concepts and Results - Part 2

Lecture 27 - Construction of Lyapunov Functions - Part 1

Lecture 28 - Construction of Lyapunov Functions - Part 2

Lecture 29 - Further Topics - Part 1

Lecture 30 - Further Topics - Part 2

Lecture 31 - Introduction to Robust Stability

- [Lecture 32 - Robust Stability for Structured Uncertainty - Part 1](#)
- [Lecture 33 - Robust Stability for Structured Uncertainty - Part 2](#)
- [Lecture 34 - Robust Stability for Structured Uncertainty - Part 3](#)
- [Lecture 35 - The Absolute Stability \(Lure\) Problem](#)
- [Lecture 36 - Robust Stability: A Solved Problem](#)
- [Lecture 37 - Dissipativity Theory - Part 1](#)
- [Lecture 38 - Dissipativity Theory - Part 2](#)
- [Lecture 39 - Dissipativity: Solved Problems](#)
- [Lecture 40 - Feedback Interconnection of Dissipative Systems - Part 1](#)
- [Lecture 41 - Feedback Interconnection of Dissipative Systems - Part 2](#)
- [Lecture 42 - Stable Adaptive Control - Part 1](#)
- [Lecture 43 - Stable Adaptive Control - Part 2](#)
- [Lecture 44 - Examples and Generalizations - Part 1](#)
- [Lecture 45 - Examples and Generalizations - Part 2](#)
- [Lecture 46 - Optimization - Part 1](#)
- [Lecture 47 - Optimization - Part 2](#)
- [Lecture 48 - Functional Optimization - Part 1](#)
- [Lecture 49 - Functional Optimization - Part 2](#)
- [Lecture 50 - Optimal Control - Part 1](#)
- [Lecture 51 - Optimal Control - Part 2](#)
- [Lecture 52 - Optimal Control - Part 3](#)
- [Lecture 53 - Stability Margins of Feedback Controllers](#)
- [Lecture 54 - Control Lyapunov Functions](#)
- [Lecture 55 - Disturbance Rejection - Part 1](#)
- [Lecture 56 - Disturbance Rejection - Part 2](#)
- [Lecture 57 - Revision through Solved Problems - I](#)
- [Lecture 58 - Revision through Solved Problems - I \(Continued...\)](#)
- [Lecture 59 - Revision through Solved Problems II](#)
- [Lecture 60 - Revision through Solved Problems III - Part 1](#)
- [Lecture 61 - Revision through Solved Problems III - Part 2](#)
- [Lecture 62 - Assorted Topics: Highlights - Part 1](#)
- [Lecture 63 - Assorted Topics: Highlights - Part 2](#)

Lecture 1 - Introduction to Digital Relays - I

Lecture 2 - Introduction to Digital Relays - II

Lecture 3 - Components of Digital Relays

Lecture 4 - Fundamentals of Digital Relays

Lecture 5 - Phasor Estimation Algorithm - I

Lecture 6 - Phasor Estimation Algorithm - II

Lecture 7 - Phasor Estimation Algorithm - III

Lecture 8 - Phasor Estimation Algorithm - IV

Lecture 9 - Phasor Estimation Algorithm - V

Lecture 10 - Frequency Estimation Algorithm

Lecture 11 - Digital Protection of Transformer - I

Lecture 12 - Digital Protection of Transformer - II

Lecture 13 - Digital Protection of Transformer - III

Lecture 14 - Digital Protection of Transformer - IV

Lecture 15 - Digital Protection of Transformer - V

Lecture 16 - Digital Protection of Induction Motors - I

Lecture 17 - Digital Protection of Induction Motors - II

Lecture 18 - Digital Protection of Induction Motors - III

Lecture 19 - Digital Protection of Generators - I

Lecture 20 - Digital Protection OF Generators - II

Lecture 21 - Coordination of Overcurrent Relays for Distribution Network - I

Lecture 22 - Coordination of Overcurrent Relays for Distribution Network - II

Lecture 23 - Coordination of Overcurrent Relays for Distribution Network - III

Lecture 24 - Coordination of Overcurrent Relays for Distribution Network - IV

Lecture 25 - Coordination of Overcurrent Relays for Distribution Network - V

Lecture 26 - Coordination of Overcurrent Relays for Distribution Network - VI

Lecture 27 - Load Shedding and Frequency Relaying - I

Lecture 28 - Load Shedding and Frequency Relaying - II

Lecture 29 - Islanding Detection

Lecture 30 - Digital Distance Relaying Scheme for transmission Line - I

Lecture 31 - Digital Distance Relaying Scheme for transmission Line - II

[Lecture 32 - Introduction to Phasor Measurement Unit - I](#)

[Lecture 33 - Introduction to Phasor Measurement Unit - II](#)

[Lecture 34 - Introduction to Phasor Measurement Unit - III](#)

[Lecture 35 - Introduction to IEC 61850 - I](#)

[Lecture 36 - Introduction to IEC 61850 - II](#)

[Lecture 37 - Application of Big-Data Analytics in Power System Protection](#)

[Lecture 38 - Cyber Security Issues in Power System Network](#)

[Lecture 39 - Protection of Hybride AC/DC Microgrid: Issues and Challenges](#)

[Lecture 40 - Application of AI-Based Techniques in Digital Protection](#)

Lecture 1 - Introduction

Lecture 2 - Introduction and Course Overview

Lecture 3 - Basics of Quantum Mechanics

Lecture 4 - Electron in a Potential Well

Lecture 5 - Electrons in Solids

Lecture 6 - KP Model

Lecture 7 - KP Model, Effective Mass

Lecture 8 - Bands, Effective Mass, DOS

Lecture 9 - Effective Mass, DOS

Lecture 10 - Density of States

Lecture 11 - Density of States

Lecture 12 - Density of States - 3D, 2D

Lecture 13 - Density of States - 2D, 1D, 0D

Lecture 14 - DOS, Fermi Function

Lecture 15 - Fermi- Dirac Distribution

Lecture 16 - Fermi Function, General Model of Transport

Lecture 17 - General Model of Transport - I

Lecture 18 - General Model of Transport - II

Lecture 19 - General Model of Transport - III

Lecture 20 - General Model of Transport, Modes

Lecture 21 - Modes - I

Lecture 22 - Modes - II

Lecture 23 - Modes, Diffusive Transport

Lecture 24 - Diffusive Transport

Lecture 25 - Diffusive Transport, Conductance

Lecture 26 - Conductance, Bulk Transport - I

Lecture 27 - Conductance, Bulk Transport - II

Lecture 28 - Resistance: Ballistic and Diffusive Cases - I

Lecture 29 - Resistance: Ballistic and Diffusive Cases - II

Lecture 30 - Resistance: Ballistic and Diffusive Cases - III

Lecture 31 - Resistance: Diffusive Case

- Lecture 32 - The Idea of Mobility
- Lecture 33 - Voltage Drop in Ballistic Conductor
- Lecture 34 - 1D and 2D Realistic Conductors
- Lecture 35 - Introduction to MOSFET - I
- Lecture 36 - Introduction to MOSFET - II
- Lecture 37 - MOSFET: A Barrier Controlled Device
- Lecture 38 - MOSFET Electrical Characteristics
- Lecture 39 - MOSFET IV Characteristics - I
- Lecture 40 - MOSFET IV Characteristics - II
- Lecture 41 - MOSFET IV Characteristics - III
- Lecture 42 - MOSFET IV Characteristics - Traditional Approach
- Lecture 43 - MOSFET: Transport - I
- Lecture 44 - MOSFET: Transport - II
- Lecture 45 - MOSFET: Landauer Transport
- Lecture 46 - Landauer Transport and Ballistic MOSFET
- Lecture 47 - Ballistic MOSFET
- Lecture 48 - Ballistic Injection Velocity
- Lecture 49 - Velocity Saturation in Ballistic MOSFET and Electrostatics
- Lecture 50 - MOS Electrostatics
- Lecture 51 - MOS Electrostatics
- Lecture 52 - MOSFET: Electrostatics, Threshold Voltage
- Lecture 53 - MOSFET: 2D Electrostatics
- Lecture 54 - MOSFET: 2D Electrostatics and Quantum Confinement
- Lecture 55 - ETSOI MOSFETs, Quantum Confinement, Strain Engineering
- Lecture 56 - Strain Engineering, Thermoelectric Effects
- Lecture 57 - Thermoelectric Effects
- Lecture 58 - Thermoelectric Effects, Quantum Dot Devices
- Lecture 59 - Quantum Dot Devices
- Lecture 60 - Quantum Dot Devices - IV Characteristics, DFT, Course Summary

Lecture 1 - Introduction and Motivation

Lecture 2 - Review of MOSFET operation - I

Lecture 3 - Review of MOSFET operation - II

Lecture 4 - Basic charge model - I

Lecture 5 - Basic charge model - II

Lecture 6 - Basic charge model - III

Lecture 7 - Basic charge model - IV

Lecture 8 - Basic charge model - V

Lecture 9 - Basic charge model - VI

Lecture 10 - Basic charge model - VII

Lecture 11 - Basic charge model - VIII

Lecture 12 - Basic charge model - IX

Lecture 13 - Basic charge model - X

Lecture 14 - Minimum energy point - I

Lecture 15 - Minimum energy point - II

Lecture 16 - Minimum energy point - III

Lecture 17 - Transistor sizing for combinational circuit - I

Lecture 18 - Transistor sizing for combinational circuit - II

Lecture 19 - Transistor sizing for asymmetric combinational circuits

Lecture 20 - Charging and discharging mechanism in NTV combinational gates

Lecture 21 - Effective current for NTV inverter

Lecture 22 - Effective current for NTV combinational gates - I

Lecture 23 - Effective current for NTV combinational gates - II

Lecture 24 - Effective current for NTV combinational gates - III

Lecture 25 - Combinational circuit design considering variations - I

Lecture 26 - Combinational circuit design considering variations - II

Lecture 27 - Buffer design considering INWE

Lecture 28 - Decoder design considering INWE

Lecture 29 - Flip-flop operation

Lecture 30 - Warning flip-flops design and operation

Lecture 31 - Single phase flip-flops design and operation

[Lecture 32 - Consideration of radiation effects in NTV](#)

[Lecture 33 - Radiation-hardened NTV sequential circuit elements](#)

[Lecture 34 - Level shifters for multi-Vdd domains](#)

[Lecture 35 - Introduction to 6T SRAM](#)

[Lecture 36 - Stability and Reliability Issues in 6T SRAM](#)

[Lecture 37 - Read and Write-Assist Circuits in 6T SRAM](#)

[Lecture 38 - Physical Insights into Channel Charge Distribution](#)

[Lecture 39 - FinFET based Standard Cell Design](#)

[Lecture 40 - Example problems](#)

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

**NPTEL : NOC:Cryogenic Electronics for Quantum Computing (Electronics and Communication Engineering)**

**Co-ordinators : Prof. Sudeb Dasgupta**

Lecture 1 - Principles of Quantum Mechanics

Lecture 2 - Principles of Quantum Mechanics - II

Lecture 3 - Schrodinger's Wave Equation

Lecture 4 - Schrodinger's Wave Equation - II

Lecture 5 - Formation of Energy Bands, The Kronig-Penney Model, K Space Diagram

Lecture 6 - Electrical Conduction in Solids-The Energy Band and the Bond Model, Drift Current, Electron Effective Mass

Lecture 7 - Density of States Function, Statistical Mechanics - I

Lecture 8 - DOS - II

Lecture 9 - Basic MOSFET Structure, symbol, and working as a Switch

Lecture 10 - MOSFET Operation- Depletion, Accumulation, and Inversion

Lecture 11 - MOSFET I/V Characteristics - Threshold voltage, I/V Characteristics, Transconductance

Lecture 12 - MOSFET I/V and Threshold Voltage - II

Lecture 13 - Second-Order Effects - I

Lecture 14 - Second Order Effects - II

Lecture 15 - Introduction to Cryogenics in Electronics

Lecture 16 - Cryogenic Coolant/Fluids used

Lecture 17 - Transition in Properties of materials with variation in Temperature

Lecture 18 - Transition in Properties of materials with variation in Temperature - II

Lecture 19 - Semiconductor devices at Room Temperature @ 300 K

Lecture 20 - Semiconductor devices at Low Temperature @ below 150 K and 77K

Lecture 21 - Change in Bandgap at Low Temperature - I

Lecture 22 - Change in Bandgap at Low Temperature - II

Lecture 23 - Change in Intrinsic Carrier concentration

Lecture 24 - Lowering in the level of Fermi Energy

Lecture 25 - Effect of Freeze-out on dopant atom concentration

Lecture 26 - Effect of Freeze-out on Dopant Atom Concentration - II and Complete Effect of Overall Phenomenon

Lecture 27 - Introduction to Modelling of Cryo-MOS Device

Lecture 28 - Device Performance Modelling at Cryogenic Temperatures

Lecture 29 - Semiconductor Device Equations at Low Temperature

Lecture 30 - Incomplete Ionization Models

Lecture 31 - Mobility Models: Scattering effect

- Lecture 32 - Change in Threshold Voltage
- Lecture 33 - Change in Threshold Voltage - II
- Lecture 34 - Effect on Mobility
- Lecture 35 - Effect on leakage and saturation current
- Lecture 36 - Kink-observed at higher VDS due to Impact Ionization
- Lecture 37 - Subthreshold Swing and Transconductance - I
- Lecture 38 - Subthreshold Swing and Transconductance - II
- Lecture 39 - Introduction to MOS Capacitance
- Lecture 40 - Traps and Defects at Cryogenic Temperatures
- Lecture 41 - C-V Characteristics: High-Frequency and Low-Frequency Capacitance
- Lecture 42 - Characterization Techniques and Cryogenic MOS Capacitance Modeling
- Lecture 43 - Noise Performance and Flicker Noise
- Lecture 44 - Cryo-Analog to Digital Converter
- Lecture 45 - Cryo-Low Noise Amplifiers
- Lecture 46 - Multiplexers and Circulators
- Lecture 47 - Cryo-Oscillators
- Lecture 48 - Cryo-Power Management Circuits and Sensors and Sensors Interfaces
- Lecture 49 - Introduction to Qubits
- Lecture 50 - Properties of Qubits
- Lecture 51 - Interfacing Quantum Processor with Classical Controllers
- Lecture 52 - Quantum Entanglement and Quantum Communication
- Lecture 53 - Single Qubit System
- Lecture 54 - Extension to Two-Qubit systems and Multiplexing DC and I/O signal for 4 qubits
- Lecture 55 - Multiplexing DC and I/O signal for 4 qubits
- Lecture 56 - Multiplexing techniques based on FDMA, TDMA, SDMA
- Lecture 57 - Introduction to Quantum Metrology and Quantum Sensing
- Lecture 58 - SPADS and Challenges to Quantum Technology
- Lecture 59 - Qubit readout front-end circuits for (a) Spin qubit (b)Transmon qubit
- Lecture 60 - Sensing the Qubits- Microwave Technique
- Lecture 61 - Characterization and Modelling of 22 nm FDSOI Cryogenic RF CMOS
- Lecture 62 - Modelling of 22 nm FDSOI Cryogenic RF CMOS - Part II
- Lecture 63 - Modelling of 22 nm FDSOI Cryogenic RF CMOS - Part III
- Lecture 64 - Parasitic Capacitance in Nanosheet FETs

[Lecture 65 - Performance Perspective of Gate All Around Double Nanosheet](#)

[Lecture 66 - Nanosheet: Part - I](#)

[Lecture 67 - Nanosheet: Part - II](#)

[Lecture 68 - Nanosheet: Part - III](#)

Lecture 1 - Transistor Amplifier

Lecture 2 - Transistor Op-amp and Transistor Based Voltage Regulator

Lecture 3 - Some applications of transistor - I

Lecture 4 - Some applications of transistor - II

Lecture 5 - Transformer design & Heat sink design

Lecture 6 - Op-amp Based Linear Voltage Regulator

Lecture 7 - Short circuit protection for linear power supply

Lecture 8 - Temperature indicator design using Op-amp

Lecture 9 - On & off Temperature controller design

Lecture 10 - Proportional Temperature Controller Design

Lecture 11 - PID - Temperature Controller Design

Lecture 12 - Heater Drive for Various Temperature Controllers

Lecture 13 - Short Circuit Protection of Power MOSFET

Lecture 14 - Error budgeting for temperature Indicator

Lecture 15 - PID Temperature Controllers with Error Budgeting

Lecture 16 - Error Budgeting for Constant Current Sources

Lecture 17 - Error Budgeting for Thermo Couple Amplifier

Lecture 18 - Error Budgeting for Op amp Circuits

Lecture 19 - Gain Error Calculation in Op amp Circuits

Lecture 20 - Input Resistance Calculations for Op amp

Lecture 21 - Output Resistance Calculations for Op amp

Lecture 22 - Error Budgeting for Different Circuits

Lecture 23 - 4-20 mA current Transmitter design

Lecture 24 - Error budgeting for 4-20mA Current Transmitters

Lecture 25 - LVDT Based Current Transmitters

Lecture 26 - Constant Current Source Design

Lecture 27 - 4-20 MA Based Temperature Transmitter

Lecture 28 - 3-Wire Current Transmitter

Lecture 29 - Various Resistance Measurement Techniques

Lecture 30 - Ratio Transformer Technique to Measure Resistance and capacitance

Lecture 31 - Capacitive Sensor Circuit Design Examples

[Lecture 32 - Capacitive Sensor Circuit With High Impedance Amplifier](#)

[Lecture 33 - AC- applications of the Op-Amp and Lock in Amplifier Design](#)

[Lecture 34 - Design of lock in Amplifier Circuit with example](#)

[Lecture 35 - Dual Slopes ADC " Design Examples](#)

[Lecture 36 - Dual Slope ADC and Successor approximation ADC](#)

[Lecture 37 - MC based ADC](#)

[Lecture 38 - Digital to analog Converter design and working, Flash ADC](#)

[Lecture 39 - Flash ADC and ADC Converter errors](#)

[Lecture 40 - Sigma delta ADC working Principle](#)

Lecture 1 - Course Contents, Objective

Lecture 2 - Revision of Prerequisite

Lecture 3 - Design of Synchronous Sequential Circuits

Lecture 4 - Analysis of Synchronous Sequential Circuits

Lecture 5 - Top-down Design

Lecture 6 - Controller Design

Lecture 7 - Control algorithm and State diagram

Lecture 8 - Case study 1

Lecture 9 - FSM issues 1

Lecture 10 - FSM Issues 2

Lecture 11 - FSM Issues 3

Lecture 12 - FSM Issues 4

Lecture 13 - FSM Issues 5

Lecture 14 - Synchronization 1

Lecture 15 - Synchronization 2

Lecture 16 - Case study 2

Lecture 17 - Case study on FPGA Board

Lecture 18 - Entity, Architecture and Operators

Lecture 19 - Concurrency, Data flow and Behavioural models

Lecture 20 - Structural Model, Simulation

Lecture 21 - Simulating Concurrency

Lecture 22 - Classes and Data types

Lecture 23 - Concurrent statements and Sequential statements

Lecture 24 - Sequential statements and Loops

Lecture 25 - Modelling flip-flops, Registers

Lecture 26 - Synthesis of Sequential circuits

Lecture 27 - Libraries and Packages

Lecture 28 - Operators, Delay modelling

Lecture 29 - Delay modelling

Lecture 30 - VHDL Examples

Lecture 31 - VHDL coding of FSM

[Lecture 32 - VHDL Test bench](#)

[Lecture 33 - VHDL Examples, FSM Clock](#)

[Lecture 34 - Evolution of PLDs](#)

[Lecture 35 - Simple PLDs](#)

[Lecture 36 - Simple PLDs: Fitting](#)

[Lecture 37 - Complex PLDs](#)

[Lecture 38 - FPGA Introduction](#)

[Lecture 39 - FPGA Interconnection, Design Methodology](#)

[Lecture 40 - Xilinx Virtex FPGA's CLB](#)

[Lecture 41 - Xilinx Virtex Resource Mapping, IO Block](#)

[Lecture 42 - Xilinx Virtex Clock Tree](#)

[Lecture 43 - FPGA Configuration](#)

[Lecture 44 - Altera and Actel FPGAs](#)

Lecture 1 - Course Overview & Basics

Lecture 2 - Example Codes and their Parameters

Lecture 3 - Mathematical Preliminaries: Groups

Lecture 4 - Subgroups and Equivalence Relations

Lecture 5 - Cosets, Rings & Fields

Lecture 6 - Vector Spaces, Linear Independence and Basis

Lecture 7 - Linear Codes, & Linear independence

Lecture 8 - Spanning & Basis

Lecture 9 - The Dual Code

Lecture 10 - Systematic Generator Matrix

Lecture 11 - Minimum Distance of a Linear Code

Lecture 12 - Bounds on the size of a Code

Lecture 13 - Asymptotic Bounds

Lecture 14 - Standard Array Decoding

Lecture 15 - Performance Analysis of the SAD

Lecture 16 - State and Trellis

Lecture 17 - The Viterbi Decoder

Lecture 18 - Catastrophic Error Propagation

Lecture 19 - Path Enumeration

Lecture 20 - Viterbi Decoder over the AWGN Channel

Lecture 21 - Generalized Distributive Law

Lecture 22 - The MPF Problem

Lecture 23 - Further Examples of the MPF Problem

Lecture 24 - Junction Trees

Lecture 25 - Example of Junction Tree Construction

Lecture 26 - Message passing on the Junction tree

Lecture 27 - GDL Approach to Decoding Convolutional Codes

Lecture 28 - ML Code-Symbol Decoding of the Convolutional Code

Lecture 29 - LDPC Codes

Lecture 30 - LDPC Code Terminology

Lecture 31 - Gallager Decoding Algorithm A

[Lecture 32 - BP Decoding of LDPC Codes](#)

[Lecture 33 - BP Decoding \(Continued\)](#)

[Lecture 34 - Density Evolution under BP decoding](#)

[Lecture 35 - Convergence & Concentration Theorem - LDPC Codes](#)

[Lecture 36 - A Construction for Finite Fields](#)

[Lecture 37 - Finite Fields: A Deductive Approach](#)

[Lecture 38 - Deductive Approach to Finite Fields](#)

[Lecture 39 - Subfields of a Finite field](#)

[Lecture 40 - Transform Approach to Cyclic Codes](#)

[Lecture 41 - Estimating the Parameters of a Cyclic Code](#)

[Lecture 42 - Decoding Cyclic Codes](#)

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

**NPTEL : Nanoelectronics: Devices and Materials (Electronics and Communication Engineering)**

**Co-ordinators : Dr. Navakanta Bhat, Prof. K.N. Bhat, Dr. S.A. Shivashankar**

Lecture 1 - Introduction to Nanoelectronics

Lecture 2 - CMOS Scaling Theory

Lecture 3 - Short Channel Effects

Lecture 4 - Subthreshold Conduction

Lecture 5 - Drain Induced Barrier Lowering

Lecture 6 - Channel and Source / Drain Engineering

Lecture 7 - CMOS Process Flow

Lecture 8 - Gate oxide scaling and reliability

Lecture 9 - High-k gate dielectrics

Lecture 10 - Metal gate transistor

Lecture 11 - Industrial CMOS Technology

Lecture 12 - Ideal MOS C-V Characteristics

Lecture 13 - Effect of non idealities on C-V

Lecture 14 - MOS Parameter Extraction from C-V Characteristics

Lecture 15 - MOS Parameter Extraction from I-V Characteristics

Lecture 16 - MOSFET Analysis, sub-threshold swing  $\hat{A}^{\hat{S}\hat{A}}$

Lecture 17 - Interface state density effects on  $\hat{A}^{\hat{S}\hat{A}}$ . Short Channel Effects (SCE) and Drain Induced Barrier Lowering (DIBL)

Lecture 18 - Velocity Saturation, Ballistic transport, and Velocity Overshoot Effects and Injection Velocity

Lecture 19 - SOI Technology and comparisons with Bulk Silicon CMOS technology

Lecture 20 - SOI MOSFET structures, Partially Depleted (PD) and Fully Depleted (FD) SOI MOSFETs

Lecture 21 - FD SOI MOSFET: Operation Modes and Threshold Voltages and Electric Fields

Lecture 22 - Sub-threshold Slope & SCE suppression in FD SOI MOSFET, Volume Inversion and Ultra thin (UTFD) SOI MOSFET and quantization Effect, FINFET

Lecture 23 - Need for MS contact Source/Drain Junction in Nano scale MOSFETs

Lecture 24 - Rectifying and Ohmic contacts and challenges in MS junction source drain MOSFET Technology

Lecture 25 - Effect of Interface states and Fermi level pinning on MS contacts on Si and passivation techniques for MS S/D MOSFETS

Lecture 26 - Germanium as an alternate to silicon for high performance MOSFETs and the challenges in Germanium Technology

Lecture 27 - Germanium MOSFET technology and recent results on surface passivated Ge MOSFETS

Lecture 28 - Compound semiconductors and hetero junction FETs for high performance

Lecture 29 - GaAs MESFETs: Enhancement and depletion types. Velocity Overshoot effects in GaAs MESFETs

Lecture 30 - Hetero-junctions and High Electron Mobility Transistors (HEMT)

[Lecture 31 - Introduction to Nanomaterials](#)

[Lecture 32 - Basic Principles of Quantum Mechanics](#)

[Lecture 33 - Basic Principles of Quantum Mechanics \(Continued...\)](#)

[Lecture 34 - Energy bands in crystalline solids](#)

[Lecture 35 - Quantum structures and devices](#)

[Lecture 36 - Crystal growth and nanocrystals](#)

[Lecture 37 - Nanocrystals and nanostructured thin films](#)

[Lecture 38 - Nanowires and other nanostructures](#)

[Lecture 39 - Carbon Nanostructures and CVD](#)

[Lecture 40 - Atomic layer deposition \(ALD\)](#)

[Lecture 41 - Characterisation of nanomaterials](#)

Lecture 1 - Introduction to Statistical Pattern Recognition

Lecture 2 - Overview of Pattern Classifiers

Lecture 3 - The Bayes Classifier for minimizing Risk

Lecture 4 - Estimating Bayes Error; Minimax and Neymann-Pearson classifiers

Lecture 5 - Implementing Bayes Classifier; Estimation of Class Conditional Densities

Lecture 6 - Maximum Likelihood estimation of different densities

Lecture 7 - Bayesian estimation of parameters of density functions, MAP estimates

Lecture 8 - Bayesian Estimation examples; the exponential family of densities and ML estimates

Lecture 9 - Sufficient Statistics; Recursive formulation of ML and Bayesian estimates

Lecture 10 - Mixture Densities, ML estimation and EM algorithm

Lecture 11 - Convergence of EM algorithm; overview of Nonparametric density estimation

Lecture 12 - Convergence of EM algorithm, Overview of Nonparametric density estimation

Lecture 13 - Nonparametric estimation, Parzen Windows, nearest neighbour methods

Lecture 14 - Linear Discriminant Functions; Perceptron -- Learning Algorithm and convergence proof

Lecture 15 - Linear Least Squares Regression; LMS algorithm

Lecture 16 - AdaLinE and LMS algorithm; General nonlinear least-squares regression

Lecture 17 - Logistic Regression; Statistics of least squares method; Regularized Least Squares

Lecture 18 - Fisher Linear Discriminant

Lecture 19 - Linear Discriminant functions for multi-class case; multi-class logistic regression

Lecture 20 - Learning and Generalization; PAC learning framework

Lecture 21 - Overview of Statistical Learning Theory; Empirical Risk Minimization

Lecture 22 - Consistency of Empirical Risk Minimization

Lecture 23 - Consistency of Empirical Risk Minimization; VC-Dimension

Lecture 24 - Complexity of Learning problems and VC-Dimension

Lecture 25 - VC-Dimension Examples; VC-Dimension of hyperplanes

Lecture 26 - Overview of Artificial Neural Networks

Lecture 27 - Multilayer Feedforward Neural networks with Sigmoidal activation functions;

Lecture 28 - Backpropagation Algorithm; Representational abilities of feedforward networks

Lecture 29 - Feedforward networks for Classification and Regression; Backpropagation in Practice

Lecture 30 - Radial Basis Function Networks; Gaussian RBF networks

Lecture 31 - Learning Weights in RBF networks; K-means clustering algorithm

Lecture 32 - Support Vector Machines -- Introduction, obtaining the optimal hyperplane

Lecture 33 - SVM formulation with slack variables; nonlinear SVM classifiers

Lecture 34 - Kernel Functions for nonlinear SVMs; Mercer and positive definite Kernels

Lecture 35 - Support Vector Regression and  $\epsilon$ -insensitive Loss function, examples of SVM learning

Lecture 36 - Overview of SMO and other algorithms for SVM;  $\nu$ -SVM and  $\nu$ -SVR; SVM as a risk minimizer

Lecture 37 - Positive Definite Kernels; RKHS; Representer Theorem

Lecture 38 - Feature Selection and Dimensionality Reduction; Principal Component Analysis

Lecture 39 - No Free Lunch Theorem; Model selection and model estimation; Bias-variance trade-off

Lecture 40 - Assessing Learnt classifiers; Cross Validation;

Lecture 41 - Bootstrap, Bagging and Boosting; Classifier Ensembles; AdaBoost

Lecture 42 - Risk minimization view of AdaBoost

- Lecture 1 - Introduction to Sensors, Signals and Systems
- Lecture 2 - Role of Analog Signal Processing in Electronic Products - Part I
- Lecture 3 - Role of Analog Signal Processing in Electronic Products - Part II
- Lecture 4 - Analog Signal Processing using One Port Networks
- Lecture 5 - Analog Signal Processing using One Port Networks, Passive Two Ports and Ideal amplifiers
- Lecture 6 - Synthesis of Amplifiers using Nullators and Norators
- Lecture 7 - Passive Electronic Devices for Analog Signal Processing
- Lecture 8 - Active Devices for Analog Signal Processing Systems
- Lecture 9 - Electronic Devices for Analog Circuits - Part I
- Lecture 10 - Electronic Devices for Analog Circuits - Part II
- Lecture 11 - Feedback in Systems
- Lecture 12 - Static Characteristic of Feedback Systems
- Lecture 13 - Dynamic Behaviour of Feedback Systems - Part I
- Lecture 14 - Dynamic Behavior of Feedback Systems - Part II
- Lecture 15 - Design of Feedback Amplifiers - Part I
- Lecture 16 - Design of Feedback Amplifiers - Part II
- Lecture 17 - Design of Feedback Amplifiers and Instrumentation Amplifiers
- Lecture 18 - Instrumentation Amplifiers, Integrators and Differentiators
- Lecture 19 - Non-linear Analog Signal Processing
- Lecture 20 - DC Voltage Regulators
- Lecture 21 - Filters - Approximations to ideal filter functions
- Lecture 22 - Passive Filters - Part I
- Lecture 23 - Passive Filters - Part II
- Lecture 24 - Active Filters - Part I
- Lecture 25 - Active Filters - Part II
- Lecture 26 - Active Filters: Q-enhancement
- Lecture 27 - State Space Filters
- Lecture 28 - Universal Active Filter - Effect of Active Device GB
- Lecture 29 - State-Space Filters (Tuning of Filters)
- Lecture 30 - Automatic Tuning of Filters (PLL) and Review of Filter Design
- Lecture 31 - Waveform Generation

[Lecture 32 - LC Oscillator - Effect of Non-idealities](#)

[Lecture 33 - Transconductor based Oscillator](#)

[Lecture 34 - Regenerative Comparators and Non-Sinusoidal Oscillators](#)

[Lecture 35 - Non-Sinusoidal Oscillators and VCO \(FM & FSK Generators\)](#)

[Lecture 36 - Phase and Frequency Followers](#)

[Lecture 37 - Frequency Locked Loop \(Popularly known as PLL\)](#)

[Lecture 38 - Design of PLL and FLL](#)

[Lecture 39 - Analog System Design](#)

- Lecture 1 - System Overview
- Lecture 2 - Understanding Rectifier with C-filter
- Lecture 3 - Setting up gEDA, ngSpice and Octave
- Lecture 4 - Simulation walk-through : Rectifier C-filter example
- Lecture 5 - Designing the rectifier capacitor filter circuit
- Lecture 6 - Startup surge limiting
- Lecture 7 - DC-DC converter concepts
- Lecture 8 - Buck, Boost and Buck-Boost Converters
- Lecture 9 - Simulation Example of Buck Converter
- Lecture 10 - Understanding Buck Converter
- Lecture 11 - Understanding Boost and Buck-Boost
- Lecture 12 - Forward Converter Topology
- Lecture 13 - Waveforms and Design
- Lecture 14 - Simulation of Forward Converter
- Lecture 15 - Forward Converter with Lossless Core Reset
- Lecture 16 - Transformer Design
- Lecture 17 - Inductor Design
- Lecture 18 - Flyback Converter Topology
- Lecture 19 - Pushpull Converter
- Lecture 20 - Half and Full Bridge Converters
- Lecture 21 - Close Loop Operation of Converters
- Lecture 22 - Simulation examples
- Lecture 23 - Multi-Output Converters
- Lecture 24 - Concluding Remarks

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

**NPTEL : NOC:Enclosure Design of Electronics Equipment (Electronics and Communication Engineering)**

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

Lecture 1 - Enclosure design for Electronics Equipment Introduction

Lecture 2 - Aspects and features that are non electrical and are essential to Electronic Product Realisation

Lecture 3 - Enclosure Design in electronic equipment

Lecture 4 - Design as applied to small electronics products and projects

Lecture 5 - Sketching in design for communication

Lecture 6 - Sketching as a tool with example and exercise

Lecture 7 - Sketching Part 2

Lecture 8 - Enclosures to Product design

Lecture 9 - Examples of product enclosures ID\_PD

Lecture 10 - Enclosures with detailing: Examples

Lecture 11 - Alternate Designs in an everyday item

Lecture 12 - Sheet metal in small equipment (PSU)

Lecture 13 - Layouts and Materials of small equipment

Lecture 14 - Materials used for construction

Lecture 15 - Materials choice

Lecture 16 - Aluminium for common equipment

Lecture 17 - Use of Aluminium extrusions

Lecture 18 - Application of Sheet metal

Lecture 19 - Sheet Metal bending

Lecture 20 - Development of enclosures for bending

Lecture 21 - Video of Fabrication

Lecture 22 - What can be done in the lab Bending

Lecture 23 - Issues in bending and folding

Lecture 24 - Making a quick model

Lecture 25 - Detailing in plastic

Lecture 26 - Fabricating with flat plastic

Lecture 27 - Video in ID Lab

Lecture 28 - Off the shelf enclosures

Lecture 29 - Ready made enclosures

Lecture 30 - Application documentation and Selection

Lecture 31 - Index of protection, Safety

[Lecture 32 - NEMA and related](#)

[Lecture 33 - Testing for IP class](#)

[Lecture 34 - Sealed Enclosures Video](#)

[Lecture 35 - Public utility boxes](#)

[Lecture 36 - EMI Sealing](#)

[Lecture 37 - Sealed Enclosures 2](#)

[Lecture 38 - Gasketing practice](#)

[Lecture 39 - Gasketing Basics](#)

[Lecture 40 - Off the shelf Aluminum enclosures](#)

[Lecture 41 - Understanding](#)

[Lecture 42 - Heat sink enclosures](#)

[Lecture 43 - Detailing of Built in Heat sink boxes](#)

[Lecture 44 - Connector basics](#)

[Lecture 45 - Connectors - Part 2](#)

[Lecture 46 - Common connectors](#)

[Lecture 47 - Connectors \(multi way\) and CoAx](#)

[Lecture 48 - MIL C connectors](#)

[Lecture 49 - CAD in Layout Drawing](#)

[Lecture 50 - Types of CAD](#)

[Lecture 51 - CAD for enclosure Design](#)

[Lecture 52 - Egpt layout with CAD](#)

[Lecture 53 - CAD sample Example](#)

[Lecture 54 - CAD Layout](#)

[Lecture 55 - Detailing with CAD](#)

[Lecture 56 - Integrating Products with CAD](#)

[Lecture 57 - Product Detailing](#)

[Lecture 58 - Components CAD Physical Models](#)

[Lecture 59 - Sheet Metal and Plastic common details](#)

[Lecture 60 - Sample of Simple Organic Shapes](#)

[Lecture 61 - Conclusion](#)

Lecture 1 - A historical perspective

Lecture 2 - PV cell characteristics and equivalent circuit

Lecture 3 - Model of PV cell

Lecture 4 - Short Circuit, Open Circuit and peak power parameters

Lecture 5 - Datasheet study

Lecture 6 - Cell efficiency

Lecture 7 - Effect of temperature

Lecture 8 - Temperature effect calculation example

Lecture 9 - Fill factor

Lecture 10 - PV cell simulation

Lecture 11 - Identical cells in series

Lecture 12 - Load line

Lecture 13 - Non-identical cells in series

Lecture 14 - Protecting cells in series

Lecture 15 - Interconnecting modules in series

Lecture 16 - Simulation of cells in series

Lecture 17 - Identical cells in parallel

Lecture 18 - Non-identical cells in parallel

Lecture 19 - Protecting cells in parallel

Lecture 20 - Interconnecting modules

Lecture 21 - Simulation of cells in parallel

Lecture 22 - Practicals - Measuring i-v characteristics

Lecture 23 - Practicals - PV source emulation

Lecture 24 - Introduction

Lecture 25 - Insolation and irradiance

Lecture 26 - Insolation variation with time of day

Lecture 27 - Earth centric viewpoint and declination

Lecture 28 - Solar geometry

Lecture 29 - Insolation on a horizontal flat plate

Lecture 30 - Energy on a horizontal flat plate

Lecture 31 - Sunrise and sunset hour angles

Lecture 32 - Examples

Lecture 33 - Energy on a tilted flat plate

Lecture 34 - Energy plots in octave

Lecture 35 - Atmospheric effects

Lecture 36 - Airmass

Lecture 37 - Energy with atmospheric effects

Lecture 38 - Clearness index

Lecture 39 - Clearness index and energy scripts in Octave

Lecture 40 - Sizing PV for applications without batteries

Lecture 41 - Sizing PV Examples

Lecture 42 - Batteries - intro

Lecture 43 - Batteries - Capacity

Lecture 44 - Batteries - C-rate

Lecture 45 - Batteries - Efficiency

Lecture 46 - Batteries - Energy and power densities

Lecture 47 - Batteries - Comparison

Lecture 48 - Battery selection

Lecture 49 - Other energy storage methods

Lecture 50 - PV system design - Load profile

Lecture 51 - PV system design - Days of autonomy and recharge

Lecture 52 - PV system design - Battery size

Lecture 53 - PV system design - PV array size

Lecture 54 - Design toolbox in octave

Lecture 55 - MPPT concept>

Lecture 56 - Input impedance of DC-DC converters - Boost converter

Lecture 57 - Input impedance of DC-DC converters - Buck converter

Lecture 58 - Input impedance of DC-DC converters - Buck-Boost converter

Lecture 59 - Input impedance of DC-DC converters - PV module in SPICE

Lecture 60 - Input impedance of DC-DC converters -Simulation - PV and DC-DC interface

Lecture 61 - Impedance control methods

Lecture 62 - Impedance control methods- Reference cell - voltage scaling

Lecture 63 - Impedance control methods- Reference cell - current scaling

Lecture 64 - Impedance control methods- Reference cell - Sampling method

Lecture 65 - Impedance control methods- Reference cell - Power slope method 1

Lecture 66 - Impedance control methods- Reference cell - Power slope method 2

Lecture 67 - Impedance control methods- Reference cell - Hill climbing method

Lecture 68 - Practical points - Housekeeping power supply

Lecture 69 - Practical points - Gate driver

Lecture 70 - Practical points - MPPT for non-resistive loads

Lecture 71 - Simulation - MPPT

Lecture 72 - Direct PV-battery connection

Lecture 73 - Charge controller

Lecture 74 - Battery charger - Understanding current control

Lecture 75 - Battery charger - slope compensation

Lecture 76 - Battery charger - simulation of current control

Lecture 77 - Batteries in series - charge equalisation

Lecture 78 - Batteries in parallel

Lecture 79 - Peltier device - principle

Lecture 80 - Peltier element - datasheet

Lecture 81 - Peltier cooling

Lecture 82 - Thermal aspects

Lecture 83 - Thermal aspects - Conduction

Lecture 84 - Thermal aspects - Convection

Lecture 85 - Thermal aspects - A peltier refrigeration example

Lecture 86 - Thermal aspects - Radiation and mass transport

Lecture 87 - Demo of Peltier cooling

Lecture 88 - Water pumping principle

Lecture 89 - Hydraulic energy and power

Lecture 90 - Total dynamic head

Lecture 91 - Numerical solution - Colebrook formula

Lecture 92 - Octave script for head calculation

Lecture 93 - PV and Water Pumping Examples

Lecture 94 - Octave script for hydraulic power

Lecture 95 - Centrifugal pump

Lecture 96 - Reciprocating pump

Lecture 97 - PV power

- Lecture 98 - Pumped hydro application
- Lecture 99 - Grid connection principle
- Lecture 100 - PV to grid topologies Part-I
- Lecture 101 - PV to grid topologies Part-II
- Lecture 102 - PV to grid topologies Part-III
- Lecture 103 - 3ph d-q controlled grid connection intro
- Lecture 104 - 3ph d-q controlled grid connection dq-axis theory
- Lecture 105 - 3ph d-q controlled grid connection AC to DC transformations
- Lecture 106 - 3ph d-q controlled grid connection DC to AC transformations
- Lecture 107 - 3ph d-q controlled grid connection Complete 3ph grid connection
- Lecture 108 - 1ph d-q controlled grid connection
- Lecture 109 - 3ph PV-Grid interface example
- Lecture 110 - SVPWM - discrete implementation
- Lecture 111 - SVPWM - analog implementation
- Lecture 112 - Application of integrated magnetics
- Lecture 113 - Life cycle Costing Growth models
- Lecture 114 - Life cycle Costing Growth model examples
- Lecture 115 - Life cycle Costing Annual payment and present worth factor
- Lecture 116 - Life cycle Costing LCC with example - 1
- Lecture 117 - Life cycle Costing LCC example - 2
- Lecture 118 - Life cycle Costing LCC example - 3

- Lecture 1 - Introduction to Photonic Integrated Circuits
- Lecture 2 - Optical Waveguide Theory - Symmetric Waveguides
- Lecture 3 - Optical Waveguide Theory - Asymmetric Waveguides
- Lecture 4 - Vector Modes
- Lecture 5 - Channel Waveguide
- Lecture 6 - Directional Coupler and Coupled Mode Theory
- Lecture 7 - Passive Devices and Beam Propagation Method
- Lecture 8 - Dynamic Devices
- Lecture 9 - Integrated optical Systems and Applications
- Lecture 10 - Fabrication and Characterisation
- Lecture 11 - MOEMS
- Lecture 12 - Ring Resonators
- Lecture 13 - Photonic Band Gap Devices
- Lecture 14 - Lecture Summary

- Lecture 1 - Course Outline and Scope
- Lecture 2 - Biological Information Systems
- Lecture 3 - Analogy between Living Systems with Semiconductor Structures
- Lecture 4 - Action Potential - I
- Lecture 5 - Action Potential - II
- Lecture 6 - Synaptic Potential
- Lecture 7 - Threshold and Action Potential Propagation
- Lecture 8 - Anatomy of a Neuron
- Lecture 9 - Neuro Muscular Junction
- Lecture 10 - Spatial and Temporal Summation of neuronal electrical activities
- Lecture 11 - Brain Anatomy Introduction
- Lecture 12 - Architecture of the Nervous System
- Lecture 13 - Architecture of the Nervous System (Continued...)
- Lecture 14 - Analog and Digital Processing in the Neuron - I
- Lecture 15 - Analog and Digital Processing in the Neuron - II
- Lecture 16 - Energy Sources of Neuronal Systems
- Lecture 17 - Skull Demonstration
- Lecture 18 - Brain Anatomy: Skull
- Lecture 19 - Brain Anatomy 3D - I
- Lecture 20 - Brain Anatomy 3D - II
- Lecture 21 - Brain Anatomy 3D - III
- Lecture 22 - Basics of Brain Imaging Techniques
- Lecture 23 - Brain anatomy using MR images - I
- Lecture 24 - Brain anatomy using MR images - II
- Lecture 25 - Spinal Cord Anatomy
- Lecture 26 - Reflexes: Introduction
- Lecture 27 - Monosynaptic Reflexes
- Lecture 28 - Polysynaptic Reflexes
- Lecture 29 - Criteria for electrode material
- Lecture 30 - Introduction to brain stimulation
- Lecture 31 - Brain Stimulation: Device fabrication - Illustration

[Lecture 32 - Brain Stimulation: Electronic Systems \(Current Mirrors\)](#)

[Lecture 33 - Brain regions and associated functions](#)

[Lecture 34 - Human vision system - II](#)

[Lecture 35 - Network analysis during visual processing](#)

[Lecture 36 - Control of eye movements](#)

[Lecture 37 - COMSOL Multiphysics for Medical Devices](#)

[Lecture 38 - COMSOL Brain Electrical Stimulation Demo](#)

[Lecture 39 - Human vision system - III](#)

[Lecture 40 - Human auditory system - I](#)

[Lecture 41 - Human auditory system - II](#)

[Lecture 42 - Human auditory system - III](#)

[Lecture 43 - The human balance system](#)

[Lecture 44 - Movement: Introduction](#)

[Lecture 45 - Movement: Synchronization](#)

[Lecture 46 - Movement: Role of Spinall Cord](#)

[Lecture 47 - Movement: Role of Cerebellum](#)

[Lecture 48 - Memory and Learning - I](#)

[Lecture 49 - Memory and Learning - II](#)

[Lecture 50 - Microengineering devices for Neural Signal Acquisiton](#)

[Lecture 51 - Microfabrication Process for Multi Electrode Array](#)

[Lecture 52 - Introduction and Applications of Event Related Potentials](#)

[Lecture 53 - ERP Extraction Demonstration](#)

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

**NPTEL : NOC:Analog Circuits and Systems (Electronics and Communication Engineering)**

**Co-ordinators : Prof. K Radhakrishna Rao**

Lecture 1 - Introduction to Sensors, Signals and Systems

Lecture 2 - Role of Analog Signal Processing in Electronic Products - Part 1

Lecture 3 - Role of Analog Signal Processing in Electronic Products - Part 2

Lecture 4 - Analog Signal Processing using One Port Networks

Lecture 5 - Analog Signal Processing using One Port Networks, Passive Two Ports and Ideal amplifiers

Lecture 6 - Synthesis of Amplifiers using Nullators and Norators

Lecture 7 - Passive Electronic Devices for Analog Signal Processing

Lecture 8 - Active Devices for Analog Signal Processing Systems

Lecture 9 - Electronic Devices for Analog Circuits

Lecture 10 - Electronic Devices for Analog Circuits

Lecture 11 - Feedback in Systems

Lecture 12 - Static Characteristic of Feedback Systems

Lecture 13 - Dynamic Behavior of Feedback Systems - Part I

Lecture 14 - Dynamic Behavior of Feedback Systems - Part II

Lecture 15 - Design of Feedback Amplifiers

Lecture 16 - Design of Feedback Amplifiers

Lecture 17 - Design of Feedback Amplifiers and Instrumentation Amplifiers

Lecture 18 - Instrumentation Amplifiers, Integrators and Differentiators

Lecture 19 - Non-linear Analog Signal Processing

Lecture 20 - DC Voltage Regulators

Lecture 21 - Filters - Approximations to ideal filter functions

Lecture 22 - Passive Filters - Part 1

Lecture 23 - Passive Filters - Part 2

Lecture 24 - Active Filters - Part 1

Lecture 25 - Active Filters - Part 2

Lecture 26 - Active Filters: Q-enhancement

Lecture 27 - State Space Filters

Lecture 28 - Universal Active Filter - Effect of Active Device GB

Lecture 29 - State-Space Filters (Tuning of Filters)

Lecture 30 - Automatic Tuning of Filters (PLL) and Review of Filter Design

Lecture 31 - Waveform Generation

[Lecture 32 - LC Oscillator - Effect of Non-idealities](#)

[Lecture 33 - Transconductor based Oscillator](#)

[Lecture 34 - Regenerative Comparators and Non-Sinusoidal Oscillators](#)

[Lecture 35 - Non-Sinusoidal Oscillators and VCO \(FM and FSK Generators\)](#)

[Lecture 36 - Phase and Frequency Followers](#)

[Lecture 37 - Frequency Locked Loop \(Popularly known as PLL\)](#)

[Lecture 38 - Design of PLL and FLL](#)

[Lecture 39 - Analog System Design](#)