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NPTEL : Advanced VLSI Design (Electronics and Communication Engineering)

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

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

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Lecture 24 - SVD Based Optimal MIMO Transmission and Capacity

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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

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

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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

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

Co-ordinators : Prof. Aditya K. Jagannatham

Lecture 1 - Basics - Sensor Network and Noisy Observation Model

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

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

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

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

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

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

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

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

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

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

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

Lecture 13 - Vector Parameter Estimation $\hat{\theta}$ - 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 $\hat{\theta}$ - Mean Covariance and Distribution

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

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

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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 $\hat{\theta}$ - Cyclic Prefix CP and Circular Convolution

Lecture 27 - Introduction to Orthogonal Frequency Division Multiplexing OFDM $\hat{\theta}$ - 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 $\hat{\theta}$ - Transmission of Samples with Cyclic Prefix

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

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

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Lecture 4 - Introduction to Convolutional Codes - I: Encoding

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

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Lecture 7 - Convolutional Codes:Distance Properties

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Lecture 12 - Performance Bounds for Convolutional Codes

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Lecture 16 - Applications of Convolutional Codes

Lecture 17 - Problem Solving Sessions - III

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- Lecture 2 - Introduction to Error Control Coding - II
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- Lecture 4 - Introduction to Linear Block Codes, Generator Matrix and Parity Check Matrix
- Lecture 5 - Syndrome, Error Correction and Error Detection
- 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
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- Lecture 18 - Applications of Linear Block Codes

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

Co-ordinators : Prof. Aditya K. Jagannatham

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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

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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

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[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.)

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[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 \(Continued.\)](#)

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[Lecture 38 - MOS Field Effect Transistor](#)

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[Lecture 40 - MOS Field Effect Transistor \(Continued.\)](#)

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[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, SiO₂, 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 - Kirchoff's current law (KCL)

Lecture 6 - Kirchoff'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](#)

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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)

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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 - Prerequistics for Embedded Systems Testing

Lecture 4 - Test Case Designa 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 - Understanding 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](#)

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

NPTEL : NOC:Design and Simulation of DC-DC converters using Open Source Tools (Electronics and Communication Engineering)

Co-ordinators : Prof. L. Umanand

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- 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
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- 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
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- Lecture 17 - Inductor Design
- Lecture 18 - Flyback Converter Topology
- Lecture 19 - Pushpull Converter
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- Lecture 21 - Close Loop Operation of Converters
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- Lecture 24 - Concluding Remarks

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Lecture 4 - Design as applied to small electronics products and projects

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Lecture 6 - Sketching as a tool with example and exercise

Lecture 7 - Sketching Part 2

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Lecture 10 - Enclosures with detailing: Examples

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Lecture 13 - Layouts and Materials of small equipment

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