Program Structure of the
M. Tech (Electronics & Communication Engineering)Programme

Semester I **First Year**

Course Code	**Course Title**	**L-T-P**	**Credits**
ECL 6150	Advanced Digital Communications	3-1-0	4
ECL 6182	Signal Processing Techniques & Applications	3-1-2	5
ECL 6221	Integrated Circuit Design	3-0-2	4
ECL 6110	Wireless Networks & Protocols	3-1-2	5
BUL 8223	Research Methodology	4-0-0	4
Total Credits		**18-0-6**	**22**

Semester II **First Year**

Course Code	**Course Title**	**L-T-P**	**Credits**
ECL 6051	Microwave Circuit Design	3-0-2	4
ECL 6170	Optical Switching & Networks	3-0-2	4
ECL 6071	CMOS Digital Design	3-0-0	3
ECE XXXX	School Elective-I	3-0-0	3
ECE XXXX	School Elective-II	3-0-0	3
PCL 1067	Discourse on Human Virtues (Non-Credit/Audit)	3-0-0	0
Total Credits		**16-1-4**	**17**

Semester III **Second Year**

Course Code	**Course Title**	**L-T-P**	**Credits**
	Open Elective-I		3
ECE XXXX	School Elective-III	3-0-0	3
ECL 7084	Embedded System Design	3-0-2	4
ECC 7981	Seminar	-	3
ECD 7990	Project-Synopsis (Phase-I)	-	8
Total Credits		**3-0-0**	**21**

Semester IV **Second Year**

Course Code	**Course Title**	**L-T-P**	**Credits**
ECD 7991	Project-Dissertation (Phase-II)		20
Total Credits			**20**

Total = 80 Credits

List of Electives

Elective –I	**Elective –II & III**
ECE 6193 Audio & Video Processing	EECE 201P Artificial Materials
ECE 6110 Wireless Sensor Networks & Applications.	ECE 6082Real Time Embedded Systems
ECE 6150 Advanced Wireless Communications	ECE 6121 Wireless Networks & Security Issues
ECE 6195 Pattern Recognition	ECE 6065 Advanced Digital Signal Processors & its Applications
ECE 6194 Audio Engineering	ECE 6052 Microwave Antenna Design
ECE 6112 Advanced Computer Networks	EECE 6142 NEMS Design
ECE 6211 ASIC Design & FPGA	ECE 6160 Terahertz Electronics
ECE 6010 Semiconductor Device Modeling	ECE 6222 Digital integrated Circuits
ECE 6141MEMS Design	ECE 6161 RFIC Design
ECE 6063 Advanced Computer Architecture	ECE 7170 Photonics Networks & switching
EECE 105P Detection & Estimation	ECE 7111 Advanced Wireless Sensor Networks
ECE 6106 Information Theory & Coding	ECE 6210P Mixed Signal Testing
ECE 6070 Synthesis & Optimization of Digital Circuits	ECE 6230 Advanced CMOS VLSI Design
ECE XXXX Social Networks	ECE 6111 Internet of Things
ECE 6231 Modelling of Nanodevices	

Advance Digital Communication

ECL 6150 **4 - 0 - 0 = 4**

Course Outcomes

CO1	use mathematical models for describing advanced communication channels and systems such as communication systems with dispersion, interference, multiple users, multipath propagation, multiple carriers and multiple antennas
CO2	use mathematical models for characterising properties for advanced communication channels and systems and identify properties that limit the communication
CO3	summarise advantages and disadvantages with different advanced communication technologies and be able to discuss their optimality and complexity
CO4	choose and optimise design parameters (e.g., power distribution, modulation, redundancy, speed) in advanced communication technologies to adapt them to a given channel model and given requirements
CO5	for a given combination of channel model and communication technique use mathematical models for analysing the expected performance (e.g., error probabilities, speed) and compare the performance for different solutions.

Unit I:Introduction

Digital communication system (description of different modules of the block diagram), Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure. M-ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms.

Unit II: Modulation

Pulse amplitude modulation (binary and M-ary, QAM), Pulse position modulation (binary and M-ary), Carrier modulation (M-array ASK, PSK, FSK, DPSK), Continuous phase modulation (QPSK and variants, MSK, GMSK).

Unit III: Receiver in additive white Gaussian noise channels

Coherent and non-coherent demodulation: Matched filter, Correlator demodulator, square-law, and envelope detection; Detector: Optimum rule for ML and MAP detection Performance: Bit-error-rate, symbol error rate for coherent and non-coherent schemes.

Unit IV: Band-limited channels

Pulse shape design for channels with ISI: Nyquist pulse, Partial response signaling (duobinary and modified duobinary pulses), demodulation; Channel with distortion: Design of transmitting and receiving filters for a known channel and for time varying channel (equalization); Performance: Symbol by symbol detection and BER, symbol and sequence detection, Viterbi algorithm.

Unit V: Synchronization

Different synchronization techniques (Early-Late Gate, MMSE, ML and spectral line methods)

Unit VI:Communication over fading channels

Characteristics of fading channels, Rayleigh and Rician channels, receiver performance-average SNR, outage probability, amount of fading and average bit/symbol error rate.

Signal Processing Techniques & Applications

ECL 6182 **4 - 0 - 0 = 4**

Course Outcomes

CO1	To apply DFT for the analysis of digital signals & systems
CO2	To design FIR filters
CO3	To design IIR filters
CO4	To characterize finite Word length effect on filters
CO5	To design the Multirate Filters

Continuous-Time and Discrete-Time Signals and Systems:

Continuous and discrete time signals: Some Elementary Continuous-time and Discrete-Time signals. Classification of Signals ,Periodic and a periodic even , odd ,energy and power signals ,Deterministic and random signals ,Causal and non-causal signals complex exponential and sinusoidal signals ,Simple Manipulations of Continuous and discrete time signals.

Continuous-Time Systems: Mathematical equation governing LTI Continuous-Time systems, Block diagram and signal flow graph representation, response of LTI Continuous-Time system in time domain, classification of Continuous-Time systems, convolution of Continuous-Time signals.

Discrete-Time Systems: Input-Output Description, Block Diagram Representation, Classification, Interconnection;

Analysis of Discrete-Time LTI Systems: Techniques, Response of LTI Systems, Properties of Convolution, Causal LTI Systems, Stability of LTI Systems; Discrete-Time Systems Described by Difference Equations; Implementation of Discrete-Time Systems;

Correlation of Discrete-Time Signals: Cross correlation and Autocorrelation Sequences, Properties. Understanding of SISO, SIMO, MISO and MIMO

Deterministic Discrete signal analysis:

Discrete Fourier transforms (DFT), Periodic and aperiodic signal analysis, limitations of DFT, Fast Fourier Transforms, Transform equivalence: Z, DTFT, CTFT, FS, DFT. DFT for long sequences, STFT. Practical aspects of DFT. Application of DFT: Filter banks. Stability analysis, Response of a stable system, marginal and asymptotic stability.

Random Discrete signal and systems:

Mathematical description of random signals, pseudorandom signals, stochastic processes. Brief review of probability. Spectral representation and analysis of nonstationary signals, random signals. Linear systems to random input. Parametric representation of Stochastic processes. Basic concept of processing random signals

Image Representation and compression:

Gray scale and colour Images, image sampling and quantization. Two dimensional orthogonal transforms: DFT, WHT, Haar transform, KLT, DCT. Fundamental Concepts of Image Compression: Compression models - Information theoretic perspective -Fundamental coding theorem - Lossless Compression: Huffman Coding- Arithmetic coding - Bit plane coding – Run length coding - Lossy compression: Transform coding - Image compression standards.

Video Processing:

Representation of Digital Video, Spatio-temporal sampling; Motion Estimation; Video Filtering; Video Compression, Video coding standards.

Recommended Books:

1. J. G. Proakis and D. G. Manolakis, Digital Signal Processing – Principles, Algorithms and Applications, Pearson.
2. Alan V. oppenheim and Alan S. Willsky ,Signals and Systems---, PHI
3. A. K. Jain, Fundamentals of digital image processing, Prentice Hall of India,
4. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson Education.

Integrated Circuit Design

ECL6221 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Able to carry out research and development in the area of analog and mixed signal IC design.
CO2	To be well versed with the MOS fundamentals, small signal models and analysis of MOSFET based circuits.
CO3	Able to analyze and design analog circuits such as Differential Amplifier, OP-AMP, Current mirrors, Biasing circuits.
CO4	Able to analyze and design mixed mode circuits such as Comparator, ADCs, DACs, PLL.
CO5	Solve practical and state of the art analog IC design problems to serve VLSI industries.

Unit I:

IC components - their characterization and design. Analysis and design of basic logic circuits. Linear ICs. Large Scale Integration.

Unit II:

Basics of MOSFET ,Introduction to digital IC design, MOS inverter-Resistive load ,Depletion load,CMOS inverter,Switching Characteristics of MOS inverter, design of combinational logic gates in CMOS- static and dynamic CMOS -design, CMOS Transmission gates, Power consumption in CMOS gates,Low power CMOS logic ckts ,MOS memory circuits, Bi-CMOS Logic ckts, Design of sequential logic circuits, Set up time,Hold time requirements.

Unit III:

Low power design:

Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. Physics of power dissipation in CMOS devices.

Device & Technology Impact on Low Power Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation.

Power estimation, Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems.

Recommended Books:

1. R.S. Muller and T.I. Kamins, "*Device Electronics for Integrated Circuits*", Wiley,
2. DA. And Eshrachian K, "*Basic VLSI design systems & circuits*", PHI,
3. Geigar BR, Allen PE &Strader ME, " *VLSI design techniques for analog & digital circuit*",McGraw Hill,
4. Carver Mead and Lynn Conway, "*Introduction to VLSI Systems*", BS Publications, Indian Reprint
5. Neil H. E. Weste& Kamran Eshraghian, "*Principles of CMOS VLSI Design*", Pearson education asia,

6. Gary K. Yeap, “Practical Low Power Digital VLSI Design”, KAP,
7. Rabaey, Pedram, “Low power design methodologies” Kluwer Academic,
8. Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI Circuit Design” Wiley,
9. Rabaey J.M, Chandrakasan A, Nikolic B , “Digital Integrated Circuits- A Design Perspective”, Prentice Hall.
10. S M Kang and Y Lebici,”CMOS Digital Integrated Circuits-analysis and design”, McGraw Hill.

Wireless Networks & Protocols

ECL 6110 **4 - 0 - 0 = 4**

Course Outcomes

CO1	Understand fundamentals of wireless communications.
CO2	Analyze security, energy efficiency, mobility, scalability, and their unique characteristics in wireless networks.
CO3	Demonstrate basic skills for cellular networks design.
CO4	Apply knowledge of TCP/IP extensions for mobile and wireless networking.

Unit 1
Introduction to Fundamentals of Wireless Communication, Channel Diversity & Fading, Multiple Access Techniques, Wireless LANs: IEEE 802.11 WLANs - protocol architecture, physical layer, MAC layer, analysis, deployment of 802.11 infrastructure

Unit 2
WPANs: IEEE 802.15.4, Bluetooth, ZigBee, UWB. protocol architecture, physical layer, MAC layer, analysis, deployment of 802.15.4 infrastructure

Unit 3
Mobile Ad-Hoc Networks (MANETS): Introduction; MAC Protocols - classification, comparative analysis; Routing - reactive and proactive routing, power-aware routing, performance comparison; Quality of Service

Unit 4
Wireless Sensor Networks (WSNs): Overview/Architectures; Data Dissemination/Data Gathering; MAC Protocols; Routing Protocol, Security, Power control; Cross layer design; Localization

Lab Work: Simulation of Various Wireless Networks using Qualnet Simulation Software

Recommended Books:

1. Rappaport, “Wireless Communications – Principles& Practices”, PHI, Latest Edition
2. C. Siva Ram Murthy and B. S. Manoj, “Ad Hoc Wireless Networks: Architectures and Protocols”, Pearson Education, Inc.,
3. Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons,
4. Charles E Perkins, “Ad Hoc Networking”, Addison Wesley,
5. Jochen Schiller, “Mobile Communications”, Addison Wesley,
6. Ramjee Prasad and Luis Munoz, “WLANs and WPANs towards 4G wireless”, Artech House,
7. Selected papers from IEEE & ACM to be provided by Faculty

Microwave Circuit Design

ECL6051 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Understanding the design concept of various RF/Microwave devices.
CO2	Knowledge of Microwave Circuit Analysis and Impedance matching.
CO3	Understanding the behavior of non-linear RF/Microwave Devises.
CO4	Ability to design discrete RF/ Microwave Devices

Unit -1
Introduction
Importance of RF Design, RF Behavior of Passive Components: High Frequency Resistors, High-Frequency Capacitors, High-Frequency Inductors. Chip Components and Circuit Board Considerations: Chip Resistors, Chip Capacitors, Surface-Mounted Inductors.

Unit -2
An Overview of RF Filter Design I

Basic Resonator and Filter Configurations: Filter Type and Parameters, Low-Pass Filter, High Pass Filter, Bandpass and Bandstop Filters, Insertion Loss, Special Filter Realizations: Butterworth –Type, Chebyshev and De-normalization of Standard Low-Pass Design.

Unit -3

An Overview of RF Filter Design II

Filter Implementations: Unit Elements, Kuroda's Identities and Examples of Microstrip Filter Design. Coupled Filter: Odd and Even Mode Excitation, Bandpass Filter Section,Cascading Bandpass Filter Elements, Design Examples.

Unit -4

Matching and Biasing Network

Impedance Matching using Discrete Components: Two Component Matching Networks, Forbidden regions, Frequency Response and Quality Factor, Microstrip Line Matching Networks: From Discrete Components to Microstrip Lines, Single-Stub Matching Networks, Double-Stub Matching Networks, Amplifier Classes of Operation and Biasing Network: Classes of Operation and Efficiency of Amplifiers, Bipolar Transistor Biasing Networks, Field Effect Transistor Biasing Networks.

Unit -5

RF Transistor Amplifier Design I

Characteristics of Amplifiers, Amplifier Power Relations: RF source, Transducer Power Gain, Additional Power Relations, Stability Considerations: Satbility Circles, Unconditional Stability, Stabilization Methods.

Unit -6

RF Transistor Amplifier Design II

Constant Gain: Unilateral Design, Unilateral Figure of Merit, Bilateral Design, Operating and Available Power Gain Circles. Noise Figure Circles, Constant VSWR Circles. Broadband, High Power and Multistage Amplifiers.

Unit -7

RF Oscillators and Mixers:

Basic Oscillator Model: Negative Resistance Oscillator, Feedback Oscillator Design, Design Steps, Quartz Oscillators. High Frequency Oscillator Configuration: Fixed Frequency Oscillators, Dielectric Resonator Oscillators, YIG-Tuned Oscillators, Voltage Controlled Oscillators, Gunn Element Oscillator. Basic Characteristics of Mixers: Basic Concepts, Frequency Domain Considerations, Single-Balanced Mixer Double-Balanced Mixer.

Text Book :

1. RF Circuit Design Theory and Application, Reinhold Ludwig and Pavel Bretchko, Ed. 2004, Pearson Education

Reference Book:

1. Radio Frequency & Microwave Electronics Illustrated, Radmanesh, Pearson,

Optical Switching & Networks

ECL 6170 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Recognize and classify the structures of Optical fiber and types.
CO2	Discuss the channel impairments like losses and dispersion (Absorption, Scattering, Material loss, Wave guide loss, Chromatic loss, Coupling Loss, PMD loss, MFD loss, Bending loss etc.)
CO3	Students learn about the various optical sources (LED, LASERS), detectors (PIN, APD) and fiber types and their suitability for any application
CO4	Familiar with Design considerations of fiber optic systems like WDM, PON, SONET/SDH etc.
CO5	To perform characteristics of optical fiber, sources and detectors, design as well as conduct experiments in software (OptiSystem) and hardware, analyze the results to provide valid conclusions.
CO6	Display a wide breadth of knowledge regarding current developments at the forefront of optical technologies (160Gbps backhaul support network, SDON, Next Generation Backhaul network)
CO7	Use practically, configure optimally and deploy several complex optical measurement and systems, be able to interpret systematically measurement results and evaluate errors.

Unit I: Optical Networking Introduction and Challenges

Advantages of optical network, telecom network overview and architecture, WDM optical networks, WDM network evolution, WDM network construction, broadcast and select optical WDM network, wavelength routed optical WDM network, Challenges of optical WDM network.

Unit II: Optical Networking Components/Building Blocks

Optical transmitters, semiconductor laser diode, tunable and fixed laser, laser characteristics, photo-detectors, tunable and fixed optical filters, channel equalizers, optical amplifiers and its characteristics, semiconductor laser amplifier, Raman amplifier, doped fiber amplifier, various switching elements, OADM, OXC, CLOS architecture, MEMS, wavelength convertors.

Unit III: Single and Multi-hop Networks

Introduction to single and multi-hop networks, Characteristics of single and multi-hop networks, experimental single hop networks: LAMBDANET, STARNET, SONATA, Rainbow, experimental multi-hop networks: Shufflenet, De Bruijn Graph, And Hypercube.

Unit IV: Optical switching

Optical packet switching basics, slotted and un-slotted networks, header and packet format, contention resolution in OPS networks, self routing, examples on OPS node architecture, optical burst switching, signaling and routing protocols for OBS networks, contention resolution in OPS networks, multicasting, implementation and application. MEMs based switching, switching with SOAs.

Unit V: Optical Access Network

Introduction to access network, PON, EPON and WDN EPON: overview, principal of operation, architecture; dynamic wavelength allocation, STARGATE: overview, need, architecture, operation and application, gigabit Ethernet, radio over fiber network.

Unit VI: Optical Multicasting and traffic grooming

Introduction to multicasting, Multicastcapable switch architecture, unicast,broadcast and multicast traffic, multicast tree protection, traffic grooming overview, static and dynamic traffic grooming.

Synthesis & Optimization Of Digital Circuits

ECL6070 **3 - 0 - 0 = 3**

Course Outcomes

CO1	To give theoretical background and practical skills in the area of synthesis and design of modern digital systems from high-level architectural synthesis to physical (chip) design stage.
CO2	Analyze the functional and nonfunctional performance of the system early in the design process to support design decisions.
CO3	Analyze hardware/software tradeoffs, algorithms, and architectures to optimize the system based on requirements and implementation constraints.
CO4	Describe architectures for control-dominated and data-dominated systems and real-time systems.
CO5	Understand synthesis process of EDA tools, Case studies include the architectural synthesis in DSP applications from specification to logic implementation.

Unit-I

Introductions: Models for systems, characteristics of a signal processing system.

Unit-II

Design Space Exploration: Introduction to the fundamental architectural synthesis problems: scheduling, allocation, binding, estimation, and control-unit synthesis

Unit-III

Optimization: Introduction to graph theory and combinatorial optimization, optimization of digital signal processing systems, graph representation and annotation, mapping techniques, Optimizing timing/area.

Unit-IV

Scheduling: Various scheduling techniques, scheduling algorithms, as-soon-as-possible and as-late-as-possible, list scheduling, integer linear programming.

Unit-V

Binding and resource allocation: Resource sharing algorithms, interval graphs, graph colouring, integer linear program models, register sharing, Retiming, function approximation.

Unit-VI

Technology Mapping and logic optimization: Technology mapping, technology libraries, cost models, graph covers, Two-level, multilevel factorization, CAD tools.

Recommended Books:

1. Synthesis and Optimization of Digital Circuits – Giovanni De Micheli, McGraw Hill International edition,
2. Logic synthesis and verification, S. Hassoun and T. Sasao, Kluwer Academic Publishers,
3. Logic Synthsis, Srinivas Devadas et al, McGraw Hill,

Embedded System Design

ECL7084 **2 - 0 - 0 = 2**

Course Outcomes

CO1	Acquire a basic knowledge about fundamentals of microcontrollers
CO2	Acquire knowledge about devices and buses used in embedded networking
CO3	Develop skills in embedded systems for various applications
CO4	Acquire knowledge about Life cycle of embedded design and its testing.

Unit I: Introduction of Embedded Systems: Hardware/software systems and codesign, Hardware Software synthesis, Hardware Software Interface

Unit II: Modeling: Models of computation for embedded systems, Behavioral design, Requirement Specifications, System Architecture

Unit II: Architectural Aspects: Architecture selection, Hardware software partitioning, scheduling, and communication, resource allocation and binding. Optimization techniques.

Unit IV: Design: Implementation, Simulation, synthesis, and verification, Hardware/software implementation. System level low power and high performance techniques.
Unit V: Methodologies: Design methodologies and tools, Performance analysis and optimization.
Unit VI: Examples: Design examples and case studies

ecommended Books:

1. Embedded System Design by Peter Marwedel, Springer,
2. *Computers as Components* by Wayne Wolf, Morgan Kaufman
3. Readings in Hardware/Software Co-Design by G. De Micheli, Rolf Ernst, and Wayne Wolf, eds. Morgan Kaufmann, **Systems-on-Silicon Series**
4. Embedded System Design: A Unified Hardware/Software Introduction by Frank Vahid and Tony D. Givargis, Addison Wesley
5. Programming Embedded Systems in C and C++ by Michael Barr, O'Reilly,
6. An Embedded Software Primer by David E. Simon, Addison Wesley
7. The Art of Designing Embedded Systems by Jack Ganssle, Newnes

Lab Courses

Wireless Networks Lab

ECP 6110 **0 - 0 - 2 = 1**

Introduction to Simulation Tool & its features
Simulation & Analysis of IEEE 802.11 based network scenarios
Simulation & Analysis of IEEE 802.15.4 based Network scenarios
Design & Simulation of Simple Routing Algorithm (Modified AODV etc.)
Introduction to Programming of Motes to form simple WSN

Signal Processing Lab

ECP 6182 **0 - 0 -2 = 1**

- Basic Sampling Rate Alteration Devices
- Decimator and Interpolator Design and Implementation
- *Design of Digital Filter and Implementation*
- *IIR Filter Design*
- *FIR Filter Design*
- Simulation of IIR Digital Filters
- Simulation of FIR Digital Filters
- Design of Tunable Digital Filters
- Function Approximation

VLSI Lab

ECP 6130 **0 - 0 - 2 = 1**

Description of Analog & Digital Design flow. Circuit level simulation, pre-layout simulation, Layout , Design Rule Check, parasitic extraction, post layout simulation , generation of GDS-II format.
Digital Design implementation on EDA Tools.
Project covering detailed flows both and analog and digital need to submitted by students for evaluation

Embedded Systems Lab

ECP 7084 **0 - 0 - 2 = 1**

Introduction to Kiel IDE & its features
Introduction to Open Source Tools for Embedded system Design
Embedded Programs for utilizing on-board resources of ARM Processors
Interface of UART based Devices, SPI

Optical Networks Lab

ECP 6170 **0 - 0 - 2 = 1**

Practical Work pertaining to:

- Digital/optical link communication
- Propagation loss
- Intensity modulation
- NA/LED/LASER Performance analysis
- Computer to computer serial Port Communication
- Design an Optical Network in Optiwave
- Analyze the network on the basis of BER, SNR etc.
- Receiver response analysis
- Performance analysis of Different Amplifier

Microwave Circuits Lab

ECP 6051 **0 - 0 - 2 = 1**

Introduction to CAD Tool & its features
Simulation of Microwave Passive Components – Filters, Antennas, Couplers, Power dividers
Introduction to Measurement Techniques: Measurement of Passive Components using VNA & Spectrum Analyzer

List of Electives

Audio & Video Processing

ECE 6193 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Interpret and analyze 2D signals in frequency domain through image transforms.
CO2	Understand theory and models in Image and Video Processing.
CO3	Apply quantitative models of image and video processing for various engineering applications.
CO4	Develop innovative design for practical applications in various fields.
CO5	Understand different methods, models for video processing and motion estimation.

UNIT-I

Speech processing: Physiology of speech generation: characteristic of speech sounds; glottal excitation; speech production models: discrete time speech production model; discrete time filter model for speech production; source excitation model.

Linear prediction analysis: All-pole models; least-squares estimation; spectral matching; spectral envelopes; applications of LP analysis.

Speech coding: Coder's attributes; waveform coding; vocoders; analysis-by-synthesis coding; code-excited linear predictive vocoder; regular pulse-excited LPC.

UNIT-II

Image processing: Fundamentals of digital image: Digital image representation and visual perception, image sampling and quantization.

Image enhancement: Histogram processing; Median filtering; Low-pass filtering; High-pass filtering; Spatial filtering; Linear interpolation, Zooming.

Image coding and compression techniques: Scalar and vector quantizations; Codeword assignment; Entropy coding; Transform image coding; Wavelet coding; Codec examples

Image analysis and segmentation: Feature extraction; Histogram; Edge detection; Thresholding.

Image representation and description: Boundary descriptor; Chaincode; Fourier descriptor; Skeletonizing; Texture descriptor; Moments.

UNIT-III

Audio processing: Fundamentals of digital audio: Sampling; Dithering; Quantization; psychoacoustic model. Basic digital audio processing techniques: Anti-aliasing filtering; Oversampling; Analog-to-digital conversion; Dithering; Noise shaping; Digital-to-analog Conversion; Equalisation.

Digital Audio compression: Critical bands; threshold of hearing; Amplitude masking; Temporal masking; Waveform coding; Perceptual coding; Coding techniques: Subband coding and Transform coding; Codec examples.

UNIT-IV

Video processing: Fundamentals of digital video: Basics of digital video; Digital video formats. Basic digital video processing techniques: Motion estimation; Interframe filtering; Motion-compensated filtering; Error concealment.

UNIT-V

Video coding techniques: Temporal redundancy; Spatial redundancy; Block-based motion estimation and compensation; Coding techniques: Model-based coding, Motion-compensated waveform coding; Codec examples.

Recommended Books:

1. Alistair Mo_at and Andrew Turpin, Compression and Coding Algorithms, Kluwer Academic Publishers, Boston,
2. K.R. Rao & J.J. Hwang, Techniques & Standards for Image, Video & Audio Coding, Prentice Hall,

Wireless Sensor Networks & Applications

ECE 6110 **3-0-0 = 3**

Course Outcomes

CO1	explain the basic concepts of wireless sensor networks, sensing, computing and communication tasks
CO2	describe and explain radio standards and communication protocols adopted in wireless sensor networks
CO3	describe and explain the hardware, software and communication for wireless sensor network nodes
CO4	explain the architectures, features, and performance for wireless sensor network systems and platforms
CO5	describe and analyze the specific requirements of applications in wireless sensor networks for

	energy efficiency, computing, storage and transmission

Unit 1: Introduction to Pervasive Computing, Characteristics & features of Pervasive Computing Systems, Potential applications of Pervasive computing systems, Context, Context aware applications, Relationship between sensors and context, Personal Area Network as defined by IEEE 802.15.4, Introduction to Sensors, Need for Wireless Sensor Networks, Scope & Limitations of Wireless sensor Networks, Adhoc Networks v/s Sensor Networks,
Unit 2: Routing Algorithms: Need for routing mechanism, requirements & characteristics of routing algorithms, Traditional routing algorithms AODV, DSR, LMR. Concept of Network Lifetime, Categorisation of Routing algorithms – Flat, Hierarchical, Cluster based, Single-hop, Multi-hop & Energy Aware.
Unit 3: MAC Layer in Sensor Networks: Importance of Media Access Control (MAC) Protocols in Sensor Networks, Issues in designing MAC protocols , Classifications of MAC protocols, Popular MAC protocols
Unit 4: Localization: Need for localization, requirements,- hardware & software, Localization techniques based on Distance, Angle Measurements. Different localization algorithms – Triangulation, MDS, Probabilistic localization. Tracking of moving objects
Unit 5: Applications of Wireless Sensor Networks: Potential Application Areas of Wireless Sensor Networks, Data Acquisition Systems using WSN, Target Tracking, HVAC Applications using WSN, Intrusion Detection using WSN
Lab Work: Programming of Crossbow Motes, Creation of Wireless Sensor Network Testbed, Data Acquisition using WSN, Localization techniques using test bed
Recommended Books:

1. Adelstein, Sandeep Gupta "Fundamentals of Mobile & Pervasive Computing", Tata McGraw Hill
2. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Pearson Education, Inc.,
3. Selected papers from IEEE & ACM to be provided by Faculty

Advanced Wireless Communication

ECE 6150 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Derive expressions for error performance and capacity for various transmission schemes covered in the lectures, such as space-time coding, MRC, OFDM, CDMA.
CO2	Explain the operation of example algorithms covered in lectures, and discuss the effects of varying parameter values within these (water-filling, channel inversion, MMSE, ZF);
CO3	Apply the principles and technique to communication systems design or undertake further research (case study based on allocated power, spectrum and users, QoS)

Unit I: Wireless Communications and Diversity
Fast Fading Wireless Channel Modeling, Rayleigh/Ricean Fading Channels, BER Performance in Fading Channels, Diversity modeling for Wireless Communications, BER Performance Improvement with diversity, Types of Diversity – Frequency, Time, Space.
Unit II: Broadband Wireless Channel Modeling
WSSUS Channel Modeling, RMS Delay Spread, Doppler Fading, Jakes Model, Autocorrelation, Jakes Spectrum, Impact of Doppler Fading
Unit III: Cellular Communications
Introduction to Cellular Communications, Frequency reuse, Multiple Access Technologies, Cellular Processes - Call Setup, Handover etc, Teletraffic Theory.
Unit IV: CDMA, OFDMA, MIMO
Introduction to CDMA, Walsh codes, Variable tree OVSF, Multipath diversity, RAKE Receiver, CDMA Receiver Synchronization, Introduction to OFDM, Multicarrier Modulation and Cyclic Prefix, Channel model and SNR performance, OFDM Issues – PAPR, Frequency and Timing Offset Issues, Introduction to MIMO, MIMO Channel Capacity, SVD and Eigenmodes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST, MIMO Diversity – Alamouti, OSTBC, MRT, MIMO - OFDM
Unit V: Ultrawide Band
UWB Definition and Features, UWB Wireless Channels, UWB Data Modulation, Uniform Pulse Train, Bit-Error Rate Performance of UWB
Unit VI: 3G and 4G Wireless Standards
GSM, GPRS, WCDMA, LTE, WiMAX

Pattern Recognition

ECE 6195 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Explain and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques.
CO2	Summarize, analyze, and relate research in the pattern recognition area verbally and in writing.
CO3	Apply performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature.
CO4	Apply pattern recognition techniques to real-world problems such as document analysis and

	recognition.
CO5	Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

Basics of pattern recognition;
Bayesian decision theory: Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, Discrete features;
Parameter estimation methods: Maximum-Likelihood estimation, Gaussianmixture models, Expectation-maximization method, Bayesian estimation; Hidden Markov models for sequential pattern classification;
Dimension reduction methods: Fisher discriminant analysis, Principal component analysis; Non-parametric techniques for density estimation;
Linear discriminant function based classifiers: Perceptron Support vector machines; Non-metric methods for pattern classification;
Unsupervised learning and clustering: Algorithms for clustering: K-means, Hierarchical and other methods

Recommended Books:

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley,
2. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press,
3. C.M.Bishop, Pattern Recognition and Machine Learning, Springer,

Detection & Estimation

EECE 105P **3 - 0 - 0 = 3**

Course Outcomes

CO1	Implement the estimation techniques in Communication and Signal Processing problems and acquire expertise in Classical and Bayesian estimation techniques for parameters and signals, and Detection of signals in the presence of white Gaussian noise
CO2	Conduct in-depth analysis of estimation problems and apply suitable estimation and detection techniques that meet the constraints of the problem such as performance, bandwidth and power overheads and computational complexity
CO3	Judge the scenarios under which signal or parameter estimation techniques are preferred and develop estimation techniques that are suitable for the context from a wider perspective
CO4	Design and implement the solutions to problems that are critical to humanity

Review of random process, problem formulation and objective of signal detection and signal parameter estimation; Hypothesis testing: Neyman-Pearson, minimax, and Bayesian detection criteria; Randomized decision; Compound hypothesis testing; Locally and universally most powerful tests, generalized likelihood-ratio test; Chernoff bound, asymptotic relative efficiency; Sequential detection; Nonparametric detection, sign test, rank test. Parameter estimation: sufficient statistics, minimum statistics, complete statistics; Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, Bhattacharya bound; Linear models; Best linear unbiased estimation; Maximum likelihood estimation, invariance principle; Estimation efficiency; Least squares, weighted least squares; Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation.

Recommended Books:

H. V. Poor, An Introduction to Signal Detection and Estimation, Springer,
S. M. Kay, Fundamentals of Statistical Signal Processing: Detection Theory, Prentice Hall PTR,
S. M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall PTR,
H. L. Van Trees, Detection, Estimation and Modulation Theory, Part I, John Wiley
D. L. Melsa and J. L. Cohn, Detection and Estimation Theory, McGraw Hill,
L. L. Scharf, Statistical Signal Processing: Detection, Estimation, and Time Series Analysis, Addison-Wesley,
V. K. Rohatgi and A. K. M. E. Saleh, An Introduction to Probability and Statistics, Wiley,

Audio Engineering

ECE 6194 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Demonstrate the initial steps to set up a control room mixing board for a multitrack to two-track mixdown.
CO2	Effectively utilize VGA signal processing equipment during a recording session and during mixdown.
CO3	Plan a complete recording session by preparing pre-session tracking sheets and organizational documents.
CO4	Recognize by ear, the 10 audio spectrum octaves and discern specific frequency ranges.
CO5	Demonstrate effective use of equalization, imaging, subgrouping, balancing, and fader moves as used during a mixdown.

Sound and Hearing

The Basics of Sound, Waveform Characteristics, Loudness Levels, the Ear, Auditory Perception, Perception of Direction, Perception of Space, Doubling

Studio Acoustics and Design
Studio Types, Primary Factors Governing Studio and Control Room Acoustics, Frequency Balance, Reverberation, Acoustic Echo Chambers, Power- and Ground-Related Issues
Microphones: Design and Application
The Microphone: An Introduction, Microphone Design, Microphone Characteristics, Microphone Preamps, Microphone Techniques, Pickup Characteristics as a Function of Working Distance, Stereo Miking Techniques, Surround Miking Techniques, Recording Direct, Microphone Placement Techniques for different instruments like Brass, Strings, Keyboard, Percussion, Wood instruments, Voice etc. Microphone Selection
Multimedia Audio:
Data acquisition, Sampling and Quantization, Human Speech production mechanism, Digital model of speech production, Analysis and synthesis, Psycho-acoustics, Data structures used in audio files, Characteristics of sound waves, psycho, digital audio, MIDI and MIDI File format, CD and DVD formats.
Audio file formats: WAV, VOC, AVI, MPEG Audio,mp3,mp4 etc
Audio compression: Compression in audio, PCM, DM, DPCM study of different audio file formats and compression techniques Programming considerations for audio compression.

Advanced Computer Networks

ECE 6112 **3 - 0 - 0 = 3**

Course Outcomes

CO1	Define what is a computer network and what are computer protocols
CO2	Discuss and explain the need of abstract layer protocol model, OSI model and TCP/IP model
CO3	Discuss and Explain the issues prevalent in LANs, WANs, and packet switched networks
CO4	Describe, analyse and compare a number of data-link, network, and transport layer protocol
CO5	Design and analyse subnets for IP based LANs

Chapter 1: Networks and need of Internetworking, PAN, LAN, WAN, MAN
Chapter 2: Physical Layer: Baseband Communication, Ethernet, Frame Relay: Electrical features, frame structure and principle of operation
Chapter 3: Network Layer: Routing and Routed Protocols, Best Effort Service, Distance Vector and Bellman Ford Algorithms, Routing Loops, OSPF, RIP and IP: Packet Structure, Fragmentation and Routing Tables
Chapter 4: Transport Layer: Connectionless and Connection oriented transports, Reliable and Unreliable Transports, Error Control, Flow Control, Congestion Control, Sliding Window and Handshaking, UDP & TCP and their implementations
Chapter 5: Other Protocols: ICMP, SNMP, IGMP, Multicasting and Broadcasting, DoS

ASIC Design and FPGA

ECE 6211 **3-0-0 = 3**

Course Outcomes

CO1	To study the design flow of different types of ASIC.
CO2	To familiarize the different types of programming technologies and logic devices.
CO3	To analyse the synthesis, Simulation and testing of systems and Apply the techniques to improve the timing analysis of digital circuits
CO4	Model the digital designs including FSMs to Processor architectures using the knowledge of HDL Language
CO5	Apply the knowledge of Reconfigurable architectures like FPGAs in designing and implementing digital ICs

Introduction To ASICS, CMOS Logic And ASIC Library Design
Types of ASICs - Design flow - CMOS transistors CMOS Design rules - Combinational Logic Cell – Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance-Logical effort -Library cell design - Library architecture.
Review of VHDL/Verilog: Entities and architectures
Programmable Asics, Programmable ASIC Logic Cells And Programmable ASIC I/O Cells, Anti fuse -static RAM - EPROM and EEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA - Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks.
Programmable ASIC Interconnect, Programmable ASIC Design Software And Low Level Design Entry Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 – Altera FLEX - Design systems - Logic Synthesis - Half gate ASIC -Schematic entry - Low level design language - PLA tools - EDIF- CFI design representation.
ASIC Construction, Floor Planning, Placement And Routing, System partition - FPGA partitioning - partitioning methods - floor planning - placement - physical design flow - global routing – detailed routing - special routing - circuit extraction - DRC. Design using Xilinx family FPGA
Recommended Books:

- M.J.S .Smith, - " Application - Specific Integrated Circuits " - Addison –Wesley Longman Inc.,

- Skahill, Kevin,” VHDL for Programmable Logic”, Addison-Wesley,
- John F. Wakherly, “ Digital Design: Principles and Practices”, Prentice Hall International
- Charles W. Mckay, “Digital Circuits a proportion for microprocessors”, Prentice Hall

Semiconductors Devices & Modelling

ECE 6010 **3-0-0 = 3**

Course Outcomes

CO1	knowledge of semiconductor bonding and energy band models
CO2	ability to apply standard device models to explain/calculate critical internal parameters and standard characteristics of the pn-junction diode
CO3	ability to apply standard device models to explain/calculate critical internal parameters and standard characteristics of the Metal-Oxide- Semiconductor Field Effect Transistor
CO4	ability to apply standard device models to explain/calculate critical internal parameters and standard characteristics of the Bipolar Junction Transistor

1. BASIC SEMICONDUCTOR PHYSICS
Introduction, Solis-state Structure, Band Structure, Electrons and Hole: SemiconductorStatistics, Intrinsic; Extrinsic and Compensated Semiconductors, Electron and HoleMobilities and Drift Velocities, Hall Effect and Magnetoresistance.
2. P-N JUNCTIONS, SCHOTTKY BARRIER JUNCTIONS, HETEROJUNCTIONSAND OHMIC CONTACTS
Introduction, p-n Junction Under Zero Bias Condition, Current Voltage Characteristics ofan Ideal p-n Junction (The Diode Equation), Tunneling and Tunnel Diodes, JunctionBreakdown – Breakdown Mechanisms; Impact Ionization and Avalanche Breakdown,Schottky Barriers, Current Voltage Characteristics of Schottky Diodes – Thermionic
Emission Model; Current Voltage Characteristics : Thermionic Field Emission & FieldEmission; Small-Signal Circuit of a Schottky Diode
3. BIPOLAR JUNCTION TRANSISTORS
Principle of Operation, Minority Carrier Profiles in a Bipolar Junction Transistor, CurrentComponents and Current Gain, Base Spreading Resistance and Emitter Current Crowdingin Bipolar Junction Transistor, Effects of Non-Uniform Doping in the Base Region:Graded Base Transistors, Output Characteristics of Bipolar Junction Transistors and Earlyeffect, Ebers-Moll Model, Bipolar Junction Transistor as a Small Signal Amplifier: CutoffFrequencies, Bipolar Junction Transistor as a Switch, Bipolar Junction Transistors inIntegrated Circuits.
4. FIELD EFFECT TRANSISTORS
Introduction, Surface Charge in Metal Oxide Semiconductor Capacitor, Capacitance-Voltage Characteristics of an MIS Structure, Metal Oxide Semiconductor Field-EffectTransistors (MOSFETs), Velocity Saturation Effects in MOSFETs, Short Channel andNonideal Effects in MOSFETs, Subthreshold Current in MOSFETs, MOSFETCapacitances and Equivalent Circuit, Enhancemment-and Depletion-Mode MOSFETsComplementary MOSFETs (CMOS) and Silicon on Sapphire, Metal Semi-conductorField-Effect Transistors.
Recommended Books:
1. R.S. Muller and T.I. Kamins, “*Device Electronics for Integrated Circuits*”, Wiley,
2. R. F. Pierret, Addison, “*Semiconductor Device Fundamentals*”, Wesley,
3. S M Sze, “*Physics of Semiconductor Devices*”, Wiley,
4. S M sze,G S May, “*Fundamentals of semiconductor fabrication*”, Wiley
5. S. Wolf, “*The Submicron MOSFET, volume 3 of Silicon Processing for the VLSI Era*”,Lattice Press,

MEMS Design

ECE 6141 **3-0-0 = 3**

Course Outcomes

CO1	To learn important concepts and terminology pertaining to MEMS.
CO2	To learn the basic MEMS fabrication process and comparison with microelectronics fabrication.
CO3	To learn operating principle of variousMEMS sensors and actuators, and their applications.
CO4	To learn the design principle of MEMS sensors and actuators.
CO5	To learn advanced concepts like Microstereolithography (MSL) and its application.

Module 01: Historical Background: Silicon Pressure sensors, Micromachining, MicroElectro Mechanical Systems. Micro fabrication and Micromachining: Integrated Circuit Processes. Potential of MEMS in industry.
Module 02: Bulk Micromachining: Isotropic Etching and Anisotropic Etching, WaferBonding, High Aspect-Ratio Processes (LIGA)
Module 03: Physical Micro sensors: Classification of physical sensors, Integrated,Intelligent, or Smart sensors, Sensor Principles and Examples: Thermalsensors, Electrical Sensors, Mechanical Sensors, Chemical and Biosensors.

Microactuators: Electromagnetic and Thermal microactuation, Mechanicaldesign of microactuators, Microactuator examples, microvalves,micropumps, micromotorsMicroactuator systems: Success Stories, Ink-Jetprinter heads, Micro-mirror TV Projector.

Module 04: Microstereolithography (MSL) for 3D fabrication, Two photon MSL,Dynamic mask MSL, scanning systems, Optomechatronics system forMSL. Ceramic and Metal Microstereolithography.

Module 05: Ceramic and Metal Microstereolithography. Scattering of light by smallparticles. Effect of particle properties on accuracy and resolution ofcomponent in Ceramic and Metal MSL. Monte carlo ray tracing method.Nanolithography.

Module06: Surface Micromaching: One or two sacrificial layer processes, Surfacemicromachining requirements, Polysilicon surface micromachining, Othercompatible materials, Silicon Dioxide, Silicon, Micromotors, Gear trains,Mechanisms. Characterisation of MEMS devices.

Recommended Books:

1. MEMS, Vijay Vardan, *Wiley Publication*
2. MEMS and Microsytems Design and Manufacture, Tai- Ran Hsu, *Tata McGraw Hill*
3. MEMS, NitaigourMahalik, *Tata McGraw Hill*
4. MEMS and MOEMS Technology and Applications, Rai Chaoudhary, PHI Learning
5. Stephen D. Senturia, Microsystem Design, *Kluwer Academic Publishers,*
6. Marc Madou, Fundamentals of Microfabrication, *CRC Press*
7. Kovacs, Micromachined Transducers Sourcebook, WCB *McGraw-Hill, Boston*
8.M-H. Bao, Elsevier, Micromechanical Transducers: Pressure sensors, accelerometers, andgyroscopes, New York,

Advanced Computer System Architecture

ECE 6063 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Demonstrate concepts of parallelism in hardware/software.
CO2	Discuss memory organization and mapping techniques.
CO3	Describe architectural features of advanced processors.
CO4	Interpret performance of different pipelined processors.
CO5	Development of software to solve computationally intensive problems.

Chapter 1

History of Calculation and Computer Architecture, Influence of Technology and Software on Instruction Sets: Up to the dawn of IBM 360, Complex Instruction Set Evolution in the Sixties: Stack and GPR Architectures, Microprogramming, Simple Instruction Pipelining, Pipeline Hazards

Chapter 2

Multilevel Memories – Technology, Cache (Memory) Performance Optimization, Virtual Memory Basics, Virtual Memory

Chapter 3

Complex Pipelining, Out of Order Execution and Register Renaming, Branch Prediction and Speculative Execution, Advanced Superscalar Architectures, Microprocessor Evolution

Chapter 4

Synchronization and Sequential Consistency, Cache Coherence, Cache Coherence (Implementation), Snoopy Protocols, Relaxed Memory Models

Chapter 5

VLIW/EPIC: Statically Scheduled, Vector Computers, Multithreaded Processors, Reliable Architectures, Virtual Machines

Artificial Material

EECE 201P **3 – 0 – 0 = 3**

Course Outcomes

CO1	Describe a metasurface; explain the types of metasurfaces; and identify their limitations and properties.
CO2	Develop analytic models to characterize canonical metasurfaces and periodic structures.
CO3	Choose the appropriate type of metasurface for a particular application.
CO4	Design basic metasurface structures with commercial software.
CO5	Develop an advanced microwave circuit or antenna that makes use of metasurfaces.

Unit I Introduction

Definition of Metamaterials (MTMs) and Left-Handed (LH) MTMs, Theoretical Speculation by Viktor Veselago, Experimental Demonstration of Left-Handedness, Further Numerical and Experimental Confirmations, Backward Waves and Novelty of LH MTMs, Terminology, Transmission Line (TL) Approach, Composite Right/Left-Handed (CRLH) MTMs, MTMs and Photonic Band-Gap (PBG) Structures

Unit II Fundamentals of LH MTMs

Left-Handedness from Maxwell's Equations, Entropy Conditions in Dispersive Media, Boundary Conditions, Reversal of Doppler Effect, Reversal of Vavilov- Cerenkov Radiation, Reversal of Snell's Law: Negative

Refraction, Focusing by a Flat LH Lens, Fresnel Coefficients, Reversal of Goos-Hanchen Effect, Reversal of Convergence and Divergence in Convex and Concave Lenses, Sub-wavelength diffraction.

Unit IIITL Theory of MTMs

Ideal Homogeneous CRLH TLs, LC Network Implementation, Real Distributed 1D CRLH Structures, Experimental Transmission Characteristics, Conversion from Transmission Line to Constitutive Parameters.

Unit IVTwo-Dimensional MTMs

Eigenvalue Problem, Transmission Line Matrix (TLM) Modeling Method, Negative Refractive Index (NRI) Effects, Distributed 2D Structures.

Unit V Application

Guided wave application: Power divider, couplers, Resonators, Filters, Radiated wave Application: Fundamental Aspects of Leaky-Wave Structures, Leaky wave antenna, meta interfaces.

Recommended Books:

- Christophe Caloz and Tatsuo Itoh, **"**Electromagnetic metamaterials: Transmission line theory and microwave applications," Wiley Interscience.
- Nader Engheta and R. W. Ziolkowski, "Metamaterials Physics and Engineering Explorations" John Wiley and Sons.
- T. J. Kui, D. R. Smith, and R. Liu, "Metamaterials theory, design, and applications" Springer.
- M. A. Noginov and V. A. Podolskiy, "Tutorials in Metamaterials," CRC Press.

Real Time Embedded Systems

ECE 6082 **3 – 0 – 0 = 3**

<u>Course Outcomes</u>

CO1	To present the mathematical model of the system.
CO2	To develop real-time algorithm for task scheduling.
CO3	To understand the working of real-time operating systems and real-time database.
CO5	To work on design and development of protocols related to real-time communication.

Chapter 1

Real-Time Scenarios, Computer as Real-Time Component, Embedded Processors in Real-Time Systems, Role of RISC technology, ARM and MIPS: Architecture, Versions, Instruction Sets

Chapter 2

Simultaneous Multitasking, Real-Time Constraints, Task Scheduling Policies (Rate Monotonic, Earliest Deadline First etc.), Preemption, Context Switching

Chapter 3

Real Time Operating Systems, flavors and the design approach, Linux as Real-Time OS, OS for Sensor Networks

Chapter 4

Simulation of Real Time Systems using TIME tool, Build Tools for Real-Time Embedded Systems, IDEs, Compilers, Debugger

Wireless Networks & Security Issues

ECE 6121 **3 – 0 – 0 = 3**

<u>Course Outcomes</u>

CO1	The aim of this course is to introduce the student to the areas of cryptography and cryptanalysis.
CO2	This course develops a basic understanding of the algorithms used to protect users online and to understand some of the design choices behind these algorithms.
CO3	To develop a workable knowledge of the mathematics used in cryptology in this course.
CO4	The course emphasizes to give a basic understanding of previous attacks on cryptosystems with the aim of preventing future attacks.

Introduction: Basic objectives of cryptography, secret-key and public-key cryptography, one-way and trapdoor one-way functions, cryptanalysis, attack models, classical cryptography.

Block ciphers: Modes of operation, DES and its variants, RCS, IDEA, SAFER, FEAL, BlowFish, AES, linear and differential cryptanalysis.

Stream ciphers: Stream ciphers based on linear feedback shift registers, SEAL, unconditional security.

Message digest: Properties of hash functions, MD2, MD5 and SHA-1, keyed hash functions, attacks on hash functions.

Public-key parameters: Modular arithmetic, gcd,primality testing, Chinese remainder theorem, modular square roots, finite fields.

Intractable problems: Integer factorization problem, RSA problem, modular square root problem, discrete logarithm problem, Diffie-Hellman problem, known algorithms for solving the intractable problems.

Public-key encryption: RSA, Rabin and EIGamal schemes, side channel attacks.

Key exchange: Diffie-Hellman and MQV.
Digital signatures: RSA, DSA and NR signature schemes, blind and undeniable signatures.
Entity authentication: Passwords, challenge-response algorithms, zero-knowledge protocols.
Standards: IEEE, RSA and ISO standards.
Network security: Certification, public-key infra-structure (PKI), secure socket layer (SSL), Kerberos.
Advanced topics: Elliptic and hyper-elliptic curve cryptography, number field sieve, lattices and their applications in cryptography, hidden monomial cryptosystems, cryptographically secure random number generators.

Recommended Books:

1. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press.
2. William Stallings, Cryptography and Network Security: Principles and Practice, Prentice Hall of India.
3. Neal Koblitz, A course in number theory and cryptography, Springer.
4. Johannes A. Buchmann, Introduction to Cryptography, Undergraduate Text in Mathematics, Springer.
5. Doug Stinson, Cryptography Theory and Practice, CRC Press.
6. A. Das and C. E. VeniMadhavan, Public-Key Cryptography: Theory and Practice, Pearson Education Asia.

Advanced Digital Signal Processors & Applications

ECE 6065 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Know the analysis of discrete time signals.
CO2	To study the modern digital signal processing algorithms and applications.
CO3	Have an in-depth knowledge of use of digital systems in real time applications
CO4	Apply the algorithms for wide area of recent applications.

TMS320C6x Architecture: CPU Operation – Pipelined CPU- VelociTI – C6x DSP- Software tools: EVM – DSK Target C6x board – Assembly file – Memory management- Compiler utility- Code initialization – Code composer studio – Interrupt data processing.
Freescale DSP56XXX Architecture and Programming: Introduction, Core Architecture Overview, Data Arithmetic Logic Unit, Address Generation Unit, Program Control Unit, PLL and Clock Generator, Debugging Support, Instruction Cache, External Memory Interface, DMA Controller, Operating Modes and Memory Spaces, Instruction Set, Benchmark Programs.
FFT and Filter Implementation using DSP Processors: Implementation of FFT: Radix- 2 fast Fourier transforms – Block floating point scaling – Optimized radix- 2 DIT FFT, Filtering, Modulation, Audio and Image Processing.
Code optimization: Word – wide optimization – Mixing C and assembly- software pipelining – C64x improvements - Real time filtering – Circular buffering- Adaptive filtering.

Recommended Books:

1. Sen M Kuo, Bob H Lee, Wenshun Tian "Real-Time Digital Signal Processing Implementations and Applications" John Wiley.
2. User manuals of TI TMS320C55X from www.ti.com
3. User manuals of DSP 56371 from www.freescale.com
4. TMS320C55x DSP CPU Reference Guide
5. TMS320C55x DSP Mnemonic Instruction Set Reference Guide
6. Digital Signal Processing Applications With Motorola's DSP56002 Processor by Mohammed El-Sharkawy
7. Motorola Dsp Assembler Reference Manual

CMOS Digital Design

ECE 6071 **3 – 0 – 0 = 3**

Course Outcomes

CO1	To analyse and implement various CMOS static logic circuits.
CO2	To learn the design of various CMOS dynamic logic circuits.
CO3	To learn the design techniques for CMOS Sequential Circuits.
CO4	To learn the different types of memory circuits design and testability.

Unit-I

Designing Combinational Logic Gates in CMOS

Static CMOS Design. Dynamic CMOS Design. How to Choose a Logic Style? Perspective: Gate Design in the Ultra Deep-Submicron Era.

Unit-II

Dynamic Logic circuits. Bootstrap Logic , Domino Logic. Basic Principles of Pass Transistor Circuits, Synchronous Dynamic Circuit Techniques ,High-Performance Dynamic CMOS Circuits

Unit-III

Sequential MOS Logic Circuits: Introduction, SR latch circuits, Clocked latch and Flip-flop circuits, CMOS D-latch and edge -triggered flip-flop. Dynamic MOS Logic Circuit. Timing Metrics for Sequential Circuits. Classification of Memory Elements. Static Latches and Registers. Dynamic Latches and Registers. Pulse Registers. Sense-Amplifier Based Registers. Pipelining: An Approach to Optimize Sequential Circuits. Non-Bistable Sequential Circuits. Perspective: Choosing a Clocking Strategy.

Unit-IV

Semiconductor Memories: Introduction, Dynamic random access memory (DRAM), Static Read-Write Memory (SRAM) Circuits ,Non-volatile memory. Read-Only Memory (ROM) Circuits and Dynamic Read-Write Memory (DRAM) Circuits

Unit -V

Design for testability : Introduction to fault types and Models, Built in Self Test (BIST).

Recommended Books:

1. Rabaey J.M, Chandrakasan A, Nikolic B , "Digital Integrated Circuits- A Design Perspective", Prentice Hall
2. S M Kang and Y Lebici,"CMOS Digital Integrated Circuits-analysis and design", McGraw Hill.
3. Pucknell D A and Eshraghian K, *"Basic VLSI Design"*, Prentice Hall India, New Delhi
4. Glaser L and Dobberpuhl D, *"The Design and Analysis of VLSI Circuits"*, Addison Wesley
5. Weste N and Eshranghian K, *"Principles of CMOS VLSI Design"*, Pearson Education Asia

Microwave Antenna Design

ECE 6052 **3 – 0 – 0 = 3**

Course Outcomes

CO1	Gain proficiency regarding microwave circuit concepts and relation between different parameters.
CO2	Design impedance matching networks and familiarity with passive microwave components
CO3	Design of basic microwave laboratory set up along with measurement of parameters
CO4	Knowledge of VNA will help in the measurement of S parameters of different microwave antennas
CO5	Familiarity with VNA concept can be used for finding gain, phase, reflection and transmission

	coefficient etc.

Unit I
Antenna Fundamentals and Definitions: Radiation mechanism - over view, Electromagnetic Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole, Radiation Patterns, Directivity and Gain, Antenna Impedance, Radiation Efficiency. Antenna Polarization
Unit II
Resonant Antennas: Wires and Patches, Dipole Antennas, wide band antennas, Helix antenna, Lens Antenna, Microstrip Antenna.
Unit III
Arrays: Array factor for linear arrays, uniformly excited, equally spaced Linear arrays, pattern multiplication, directivity of linear arrays, non- uniformly excited -equally spaced linear arrays, Mutual coupling, multidimensional arrays, phased arrays, feeding techniques.
Unit IV
Aperture Antennas: Techniques for evaluating Gain, reflector antennas - Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, offset parabolic reflectors, dual reflector antennas, Gain calculations for reflector antennas, feed antennas for reflectors, field representations, matching the feed to the reflector, general feed model, feed antennas used in practice.
Unit V
Antenna Synthesis: Formulation of the synthesis problem, synthesis principles, line sources shaped beam synthesis, linear array shaped beam synthesis — Fourier Series, Woodward — Lawson sampling method, comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods Dolph Chebyshev linear array, Taylor line source method.
Recommended Books:
1. Stutzman and Thiele, "Antenna Theory and Design", John Wiley and Sons Inc.
2. C. A. Balanis: "Antenna Theory Analysis and Design", John Wiley and Sons Inc.
3. Kraus, "Antennas", McGraw Hill, TMH, .
4. Kraus and R.J. Marhefka:, "Antennas", McGraw Hil.
5. V. F. Fusco, "Foundations of Antenna Theory and Techniques," Pearson Education Limited

NEMS Design

ECE 6142 **3 – 0 – 0 = 3**

<u>Course Outcomes</u>

CO1	Gain a knowledge of basic approaches for various sensor design
CO2	Gain a knowledge of basic approaches for various actuator design
CO3	Develop experience on micro/nano systems for photonics .
CO4	Gain the technical knowledge required for computer-aided design, fabrication, analysis and characterization of nano-structured materials, micro- and nano-scale devices.

UNIT I :
Nanoscale I/V: Quantum wells, Q wires and dots, density of states, electrical transport properties in semiconductor nanostructures, quantization of conductance, coulomb blockade, Kondo effect, ballistic transport, non relativisticdirac fermions (massless electrons) & their conductance, Quantum Hall effect, fractional Q Hall effect
UNIT II :
Nanofluid mechanics; flow of nanofluid, electrophoresis dielectrophoresis: Size selective sepration of dielectric nano particles, nano and micro fluid channels, low reynold number fluid dynamics, optical tweezer.
Unit-III
Nanosensors: Gas sensors, Pollution sensor, Photo sensor, Temperature sensor, IR detector, Biosensor, nanomaterial gas discharge devices, CNT based fluid velocity sensor. Turbo and ultra high vacuum, Clean room technology, class 1000,100,10 clean rooms.
Unit-IV
Nature of carbon bonds, Different allotropes of carbon, structure and properties of C60, Graphene, Carbon nanotubes and its types, Laser vaporization techniques, arc discharge method and chemical vapor deposition techniques for CNT preparation, purification techniques. Properties of Carbon Nanotubes and Graphene: Optical, Electrical and electronic properties, Mechanical, Thermal and vibrational properties. C NT nanoelectronics, FETs, SETs
Unit V:
Fundamentals of carrier transport in quantum structures, temperature effects, Resonant tunneling diodes, single electron transistor, modulation-doped field effect transistor MODFETs, and Heterojunction Bipolar Transistors (HBTs),
Recommended Books:
M. Madou, *Fundamentals of Microfabrication*, CRC Press
Stephen D. Senturia, *Microsystem Design*, Kluwer Academic Publishers
G. Kovacs, *Micromachined Transducers*, McGraw-Hill,
L. Ristic, *Sensor Technology and Devices*, Artech House,

S. M. Sze, *Semiconductor Sensors*, John Wiley and Sons,

Terahertz Electronics

ECE 6160 **3 – 0 – 0 = 3**

Course Outcomes

CO1	overview on the unique specifications of terahertz waves and potential applications as well as the state of the current terahertz systems
CO2	Understand THz Detectors (single-photon detectors, microbolometers, Golay cells, Pyroelectric detectors, diode detectors, and focal-plane arrays), THz Sources (vacuum-electronics-based, semiconductor-based, photoconduction-based and nonlinearity-based),
CO3	Knowledge of THz electronic components (waveguides, Metamaterials, filters and modulators), sensing with THz radiation (THz spectroscopy, imaging and tomography)
CO4	Study THz applications (biology, medicine, space sciences, pharmaceutical industry, security and communications)

Unit I Introduction
Terahertz Terminology, Terahertz Applications and Opportunities, Terahertz components,

Unit II Terahertz Sources
Vacuum electronics, Semiconductor, Direct THz lasers, Photonic sources of THz radiation
Unit III Terahertz and Infrared Quantum Photodetectors
Detector Principles, Terahertz and Infrared Quantum Cascade Detectors, Terahertz Quantum Well Photodetector, Quantum Dots THZ-IR Photodetector, Terahertz and Infrared Photodetector based on Electromagnetically Induced Transparency
Unit IV Terahertz and Infrared Quantum Cascade Lasers
Quantum Cascade Laser Principles, Analysis of Transport Properties of THz QCLs, Dual-Wavelength Generation Based on Monolithic THz-IR QCL
Unit V Terahertz in communication
Broadband communication, Defense systems, High speed digital communication systems.

Recommended Books
- A. Rostami, H. Rasooli, and H. Baghban, "Terahertz Technology fundamentals and applications," Springer.
- D. Mittleman, "Sensing with terahertz radiation," Springer.
- Terry Edwards, "Gigahertz and Terahertz Technologies for Broadband Communications," Artech House.
- Yun-Shik Lee, "Principles of Terahertz Science and Technology," Springer.

Digital Integrated Circuits

ECE 6222 **3 – 0 – 0 = 3**

Course Outcomes

CO1	To learn the basic concepts of integrated circuits and CMOS logic and be able to understand their applications.
CO2	To study to apply different logics to implement Boolean functions.
CO3	To learn the different power dissipation components and possible solutions for reduction.
CO4	To learn the basics of flip-flops and dynamic logics with their applications.

Unit-I
MOS Inverter: Introduction to resistive - load inverter, inverter with n-type MOSFET load, CMOS inverter
Switching Characteristics and Interconnects Effects: Introduction, Delay time definitions, Calculation of delay
times, Inverter design with delay constraints, MOS Inverters: Switching Characteristics & Interconnect Effects. Estimation of interconnect parasitic.
Unit-II
Sequential MOS Logic Circuits: Introduction, SR latch circuits, Clocked latch and Flip-flop circuits, CMOS D-latch and edge -triggered flip-flop. Dynamic MOS Logic Circuit
Unit-III
Semiconductor Memories: Introduction, Dynamic random access memory (DRAM), Static random acces memory(SRAM),Non-volatile memory.
Low Power CMOS Logic Circuits: Introduction, Overview of power consumption, Switching power dissipation o
CMOS inverter, Estimation and optimization of switching activity.

Recommended Books:
1. Rabaey J.M, Chandrakasan A, Nikolic B , "Digital Integrated Circuits- A Design Perspective", Prentice Hall
2. S M Kang and Y Lebici,"CMOS Digital Integrated Circuits-analysis and design", McGraw Hill.

3. Pucknell D A and Eshraghian K, *"Basic VLSI Design"*, Prentice Hall India, New Delhi
4. Glaser L and Dobberpuhl D, *"The Design and Analysis of VLSI Circuits"*, Addison Wesley
5. Weste N and Eshranghian K, *"Principles of CMOS VLSI Design"*, Pearson Education Asia

RFIC Design.

ECE 6161 **3-0-0 = 3**

Course Outcomes

CO1	Ability to apply knowledge of mathematics, science and engineering to the solution of complex engineering problems
CO2	Ability to design and conduct experiments, analyse, interpret data and synthesise valid conclusions.
CO3	Ability to design a system, component, or process, and synthesise solutions to achieve desired needs.
CO4	Ability to identify, formulate, research through relevant literature review, and solve engineering problems reaching substantiated conclusions.
CO5	Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal,and environmental constraints.

Unit I:Introduction
Need of RFIC, Introduction to MOS, Models and History of BJT systems. RF systems – basic architectures.
Unit II: Transmission media and reflections Maximum power transfer. Parallel RLC tank, Qfactor, Series RLC networks, matching: Pi match, T match. Interconnects and skin effect Resistors, capacitors.
Unit III:MOS device review, Introduction to MOS, Transmission lines, reflection coefficient, The wave equation, examples, Lossy transmission lines, Smith charts – plotting gamma. Bandwidth estimation using open-circuit time constants. Risetime, delay and bandwidth, Zeros to enhance bandwidth, Shunt-series amplifiers, tuned amplifiers, Cascaded amplifiers.
Unit IV:
Thermal noise, flicker noise review, Noise figure, Noise figure, Intrinsic MOS noise parametes,
Power match versus noise match.
Unit V:
Large signal performance, design examples & Multiplier based mixers. Subsampling mixersClass A, AB, B, C amplifiers, Class D, E, F amplifiers, RF Power amplifier design examples,Resonators, Negative resistance oscillators, Linearized PLL models, Phase detectors, charge pumps, Loop filters, PLL design examples, GSM radio architecturesCDMA, UMTS radio architectures.

Recommended Books:
1. The Design of CMOS Radio-Frequency Integrated Circuits by Thomas H. Lee. Cambridge University Press,
2. RF Microelectronics by BehzadRazavi. Prentice Hall,

Photonic Networks & Switching

ECE 7170 **3-0-0 = 3**

Course Outcomes

CO1	Fundamental principles & techniques of optical fibre systems
CO2	Photonic components in optical communication systems
CO3	Optical analogue and digital modulation and demodulation techniques
CO4	Noise and signal analysis of optical communication systems
CO5	Design & application of various optical communication systems

Unit 1
Introduction: Overview of the architectures and principles of optical systems and networks; Access Network; LAN, WANS & MANS; SONET, SDH, ATM
Unit II
Components of Optical Networks: Fused fiber device such as couplers, WDMs, and WFC; Fabryperot etalons and Bragg grating; Optical Isolators, Integrated optic modulators and switches; Wavelength converters, Dispersion Compensating Techniques.
Unit III
Optical Amplifiers (EDFA and SOAs): Principles of operation; Gain characteristics; Wavelength characteristics; Cross talk and wavelength conversation; Noise characteristics and Noise figure; characteristics of amplifiers cascades; System performance analysis and power budget analysis for BER 10^{-9} for optically amplified links.
Unit IVPhotonics and Switching Networks: Switching Network, Switch, Non-Blocking Switch,Connection States, Switching Cell, Two-State Switches, Interconnection Network, Unique-Routing Network, Nonblocking Network, Alternate-Routing Network, Nonblocking Properties of Alternate-Routing Networks, Strictly Nonblocking, Wide-Sense Nonblocking, Multi-Stage Networks, Banyan Networks,

Baseline Networks, Omega Networks , Divide-and-conquer Networks, Recursive Application, Central Control

Advanced Topics in Wireless Sensor Networks

ECE 7111 **3-0-0 = 3**

Course Outcomes

CO1	explain the constraints of the wireless physical layer that affect the design and performance of ad hoc and sensor networks, protocols, and applications;
CO2	explain the performance of various unicast and multicast routing protocols that have been proposed for ad hoc networks;
CO3	explain the operation of several media access protocols that have been proposed for ad hoc and sensor networks;
CO4	describe the platform architectures that are suitable for mobile computing and communications, e.g. personal digital assistants (PDAs), handsets, etc.;
CO5	Explain the energy issues in sensor networks and how they can be addressed using scheduling, media access control, and special hardware;

Unit 1: Security Issues in Senor Networks: Security requirement, issues and goals. Security threats, types of attacks on sensor networks and countermeasures. Routing attacks and challenges. Security support for In-network processing. Symmetric key, public-key, Hash function algorithms, Key distribution and certification, Key distribution center (KDC), Network wide shared key, Pair-wise key using PKI, Preconfigured pair-wise shared key.

Unit 2: Unit 3: Data Fusion & Aggregation: Need for Data aggregation, Address Centric Model (AC), Data Centric Model (DC), Different types of data aggregation, Comparative analysis between AC & DC, Compression v/s aggregation, Aggregation algorithms. Need for Sensor Data fusion, impact on bandwidth and inter-node communication, impact on network lifetime & power control Assumptions ,

Unit 3: Wireless Sensor & Actuator Networks: Requirement of Actuation Action in Sensor Networks, Characteristics of Actuator Nodes, preferred topologies for WSAN, Model for Inter-Communication between Actuators & Nodes and for Communication between Actuators, Fault Tolerance in WSAN

Unit-IV: Signal Processing in WSN's: Concept of Distributed Digital Signal Processing in Wireless Sensor Networks, Coherent & non- coherent processing. Collaborative signal processing, its need & challenges. Estimation Technqiues in sensor networks – Wiener filter, Kalman filter in WSN Environment

Recommended Books:

1. Holger Karl and Andreas Willig Protocols and Architectures for Wireless Sensor Networks WILEY (ISBN: 0-470-09510-5)
2. Ad Hoc Wireless Networks: Architectures and Protocols by C. Siva Ram Murthy and B. S. Manoj (Prentice Hall, 2004)
3. Wireless Sensor Networks: An Information Processing Approach by Feng Zhao and Leonidas J. Guibas (Morgan Kaufmann,
4. Selected papers from IEEE & ACM to be provided by Faculty

Information Theory & Coding

ECE 6106 **3-0-0 = 3**

Course Outcomes

CO1	Understand the basics of information and coding theories.
CO2	Discuss the various capacity reduction based coding techniques for text, audio and speech type of data.
CO3	Compare various capacity reduction based coding techniques for image and video type of data.
CO4	Illustrate various security oriented coding techniques for Block codes.
CO5	Implement various error control techniques for Convolutional codes

Module-1: Information Theory: Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Average Information content of symbols in Long dependent sequences, Markov Statistical Model of Information Sources, Entropy and Information rate of Markoff Sources

Module-2: Source Coding: Source coding theorem, Prefix Codes, Kraft McMillan Inequality property – KMI Encoding of the Source Output, Shannon's Encoding Algorithm

Shannon Fano Encoding Algorithm, Huffman codes, Extended Huffman coding, Arithmetic Coding, Lempel – Ziv Algorithm

Module-3: Information Channels: Communication Channels. Channel Models, Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, System Entropies, Mutual Information, Channel Capacity, Channel Capacity of: Binary Symmetric Channel.

Module-4: Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error Detection and Error Correction Capabilities of Linear Block Codes, Single Error Correcting hamming Codes.

Recommended Books:

1.FUNDAMENTALS of INFORMATION THEORY and CODING DESIGN Roberto Togneri Christopher J.S. DaSilva CRC Press Company

2.Information theory, coding and cryptography - Ranjan Bose; TMH.

3.Information and Coding - N Abramson; McGraw Hill.

4.Introduction to Information Theory - M Mansurpur; McGraw Hill.

5.Information Theory - R B Ash; Prentice Hall.

6.Error Control Coding - Shu Lin and D J Costello Jr; Prentice Hall.

Mixed Signal Testing

ECE 6210 **3-0-0 = 3**

Course Outcomes

CO1	Understand the concepts of Switched capacitors Circuits
CO2	Able to know the concepts of PLLS
CO3	To study concepts of Data Converter Fundamentals.
CO4	Understand the concepts of Nyquist Rate A/D Converters ,and applications
CO5	Understand concepts of concepts of Continuous-Time Filters, CMOS Trans conductors

Overview of Mixed Signal Testing

Static Performance, Dynamic Performance, Digital Signals ,Digital Test Systems ,Analog Signals , Analog Test Systems ,Mixed Signal Devices ,Converters ,Datacom Devices

Telecom Devices.

Delay fault testing: path delay test, transition faults, delay test methodologies. IDDQ testing: basic concept, faults detected, test generation, limitations, IDDQ design for testability. Functional testing of arithmetic and regular arrays.

Functional testing of microprocessors and microcontrollers. Sequential circuit testing: time frame expansion and simulation-based approaches to ATPG, design of testable FSMs, use of coding theory. Advanced BIST techniques: theory of linear machines, practical BIST architectures.

System-on-chip design and test: SOC testing problem, core-based design and system wrapper, proposed test architectures for SOC, platform-based design and testability issues.

DSP-based analog and mixed-signal test: functional DSP-based testing, static ADC and DAC testing methods, realizing emulated instruments, CODEC testing, future challenges.

Model-based analog and mixed-signal test: analog fault models, levels of abstraction, analog fault simulation, analog ATPG. Analog test bus standard: analog circuit DFT, analog test bus, IEEE 1149.4 standard.

Recommended Books:

1.M. L. Bushnell and V. D. Agrawal, Essentials of Electronic Testing, Kluwer Academic Publishers.

2.A. Osseiran, Analog and mixed-signal boundary scan: a guide to the IEEE 1149.4 test standard, Kluwer Academic Publishers.

3.A. Krstic and K-T. Cheng, Delay fault testing for VLSI circuits, Kluwer Academic Publishers

4.S. Chakravarty and P. J. Thadikaran, Introduction to IDDQ testing, Kluwer Academic Publishers

Advanced CMOS VLSI Design

ECE 6230 **3-0-0 = 3**

Course Outcomes

CO1	Use mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits, including logic components and their interconnects.
CO2	Learn the various fabrication steps of IC and come across basic electrical properties of MOSFET.
CO3	Apply CMOS technology-specific layout rules in the placement and routing of transistorsand interconnect and to verify the functionality, timing, power and parasitic effects.
CO4	The concepts and techniques of modern integrated circuit design and testing (CMOS VLSI).
CO5	Design static CMOS combinational and sequential logic at the transistor level, including mask layout.

Design methodologies: VLSI Design flow, Design Hierarchy, Regularity, Modularity and Locality, VLSI design styles, Design quality, Packaging technology.MOS device design equations , Second order effects, the complementary CMOS Inverter DC characteristics.

Circuit Characterization and Performance Estimation: Parasitic effect in Integrated Circuits ,Resistance estimation, capacitance estimation, Inductance. Switching characteristics, CMOS - Gate transistor sizing, Power dissipation, CMOS Logic Structures, Clocking Strategies.

CMOS Process Enhancement & Layout Considerations: Interconnect, circuit elements, Stick diagram, Layout design rules, Latchup, latchup triggering, latchup prevention, Technology related CAD issues.

Subsystem Design: Structured design of combinational logic-parity generator, Multiplexer, code converters. Clocked sequential circuits-two phase clocking, charge storage, dynamic register element, dynamic shift register. Subsystem design process, Design of ALU subsystem, Adders, Multipliers. Commonly used storage/ memory elements.

Recommended books:

1. D.A. Pucknell, K. Eshraghian, Basic VLSI Design, PHI,.
2. John P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley & Sons.
3. Niel H.E. Weste, K. Eshraghian,, Principles of CMOS VLSI Design, Person,
4. Mead and L. Conway, Introduction to VLSI Systems, Addison-Wesley.

Modelling of Nanodevices

ECE 6231 **3-0-0 = 3**

Course Outcomes

CO1	To study and understand various transport mechanism in Nanodevices.
CO2	To study and understand about band diagrams at nanodevices level.
CO3	To understand modelling of potential in Nanodevices
CO4	To study and understand modelling of devices of contemporary research.

1.Introduction;
Key Concepts, Why Electrons Flow, Conductance Formula,Ballistic (B) Conductance, Diffusive (D) Conductance , Connecting Ballistic (B) to Diffusive (D), Angular Averaging, Drude Formula.
2. Energy Band Model
Introduction, E(p) or E(k) Relation, Counting States, Density of States , Number of Modes Electron Density (n),Conductivity vs. Electron Density (n), Quantum Capacitance, The Nanotransistor.
3. Modelling of Potential in devices
Introduction , A New Boundary Condition, Quasi-Fermi Levels (QFL's), Current from QFL's, Landauer Formulas , What a Probe Measures, Electrostatic Potential, Boltzmann Equation , Spin Voltages.
4. Nanodevices
CNTFETs Modelling, Molecular Quantum-Dot Cellular Automata.

1.S. Datta, Electronic Transport in Mesocopic Systems. Cambridge University Press 1995 . 2.S. Datta, Quantum Transport: Atom to Transistor. Cambridge University Press 2005.
3.P.L. Hagelstein, S.D. Senturia, and T.P. Orlando, Introductory Applied Quantum and Statistical Mechanics. Wiley 2004.
4.P.W. Atkins and R.S. Friedman, Molecular Quantum Mechanics. Oxford University Press, 3rd edition 1997.
5.M. Lundstrom and J. Guo, Nanoscale Transistors: Physics, Modeling, and Simulation, Springer 2006.
6.Y. Tsividis, The MOS Transistor. Oxford University Press, 2nd edition 1999
7.R. Feynman, Lectures on Computation. Editors A.J.G. Hey and R.W. Allen, Addison-Wesley 1996.

Modeling and analysis of nanoscale devices

ECE 6232 **3– 0 – 0 = 3**

Course Outcomes

CO1	Ability to perform simple analysis of nanoelectronic devices.
CO2	Ability to calculate the density of states in nonelectronic devices
CO3	Ability to perform in-depth analysis of nanoelectronic devices
CO4	Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment
CO5	Study of various Nanodevices and their models

Introduction to nanoelectronics – device scaling, how device physics is fundamentally different in mesoscopic and nano devices – voltage drop, heat dissipation etc., Necessity to understand and invoke quantum mechanics in nanoelectronics.

Quantum mechanics, Schrödinger equation, Free electron wavefunction, Particle/electron in a box, electrons in a solid.

Models in nanodevices : Introduction to KP model, Brillouin Zones, KP model – origin of energy bands in solids. Density of states – 0D, 1D, 2D, 3D conductors, Fermi function, The notion of modes in a conductor. Conductance, Bottom-up approach, Landauer's formalism, Ballistic and Diffusive transport – transmission, transition from ballistic to diffusive transport.
Introduction to MOSFET – A barrier-controlled device, MOSFET electrostatics.MOSFET 2D electrostatics, MOSFET Capacitance. High-K dielectric, Strained Si technology, Quantum confinement in MOSFET.

MOSFET model analysis
ETSOI-MOSFET, Transport in MOSFET, Ballistic MOSFET. Ballistic injection velocity in MOSFET, Thermoelectric effects and thermoelectric devices.
Quantum dot devices – quantum capacitance, IV characteristics, self-consistent method.
Introduction to ab initio simulation, NEGF, Summary of the entire course.

Project – Synopsis

ECD 7990 **8 Credits**

The project seminar is required to evaluate the problem statement of the project. Students must have completed their problem definition and are required to submit a synopsis of their work. The students will be called up for an oral examination or viva voce, the stress is placed on an academically sound, stylistically acceptable and error-free piece of work.

Project – Mid Semester Review

The project seminar is required to evaluate the problem statement of the project. Students must have come up with progress report and will be required to discuss the status of the project. The students are required to present and demonstrate their work. The design or model must have been completed for review. The students will be called up for an oral examination or viva voce, the stress is placed on an academically sound, stylistically acceptable and error-free piece of work.

Project-Dissertation

ECD7991 **20 Credits**

A Master's dissertation is an advanced research project of defined scope and length (±120 pp., one and a half spacing, A4 paper). The criteria are: Technical competence, evidence of scholarly research, critical ability, understanding of relevant theoretical issues, lucidity and coherence. A dissertation should have a theme or 'thesis', usually stated in the title, and the success with which MTech candidates sustain that theme, thereby presenting a unified, cumulative argument, is an important consideration.

A dissertation can be an original contribution to knowledge. It is given a mark and the degree can be awarded based on the quality of the thesis/dissertation

Courses offered to other schools

Semester I **First Year**

Course Code	Course Title	L-T-P	Credits
EEL 1006 EE	Fundamental Of Electrical Engineering	3-0-2	4
ECL 1010 EE	Basic Electronics	3-1-2	5
Total Credits			**9**

Semester II **First Year**

Course Code	Course Title	L-T-P	Credits
ECL 1010 CSE	Basic Electronics	3-1-2	5
Total Credits			**5**

Semester III **Second Year**

Course Code	Course Title	L-T-P	Credits
ECL 2070 EE	Digital Electronics	3-0-2	4
ECL 2070 CSE	Digital Electronics	3-0-2	4
Total Credits			**8**

Semester IV **Second Year**

Course Code	Course Title	L-T-P	Credits
EEL 2412 EE	Analog Electronics (EE)	3-0-2	4
ECL 2040 EE	Electromagnetic Field Theory	3-1-0	4
ECL 2060 EE	Microprocessor Systems	3-1-2	5
Total Credits			**13**

Semester V **Third Year**

Course Code	Course Title	L-T-P	Credits

EEL 3511 EE	Control Systems	3-0-0	3
EEL 3541 EE	Power Electronics	3-1-0	4
CSL 2031 EE	Data Structure Using C	3-0-2	4
ECE 4195 EE	Social Networks	3-0-0	3
Total Credits			**14**

Basic Electronics

ECL 1010 **3-1–2=5**

Course Outcomes

CO1	To learn basic concepts of Semiconductor Devices
CO2	Able to understand and use BJT and MOS Devices.
CO3	Learn and able to apply small signal BJT and FET analysis.
CO4	To analyze and design rectifiers and amplifiers.
CO5	Able to understand advanced semiconductor devices and oscillators.

Introduction:- Semiconductor Classification ,Semiconductor bonds, Energy band description ,Semiconductor types, Hall effect.
Diodes:- P-N junction-I/V characteristics, diode equivalent circuits, semiconductor diodes, rectifiers-(efficiency, ripple factor),filters,clipers,clampers.
Transistors:-BJT construction, characteristics (cb,ce,cc), load line. BJT biasing. FET, JFET, MOSFET (Depletion and enhancement), FET biasing.
Transistor Modeling:-BJT small signal model, hybrid equivalent model,FET small signal model.
Amplifiers:- Single stage amplifiers, voltage gain, effect of frequency on Gain, multistage amplifier.
Other Semi-conductor devices- SCR'S , Diacs, triacs, and other thyristors, basic theory of operation, characteristics,Theory and operation of UJT,
Oscillators:-Feedback BH criteria, oscillator types, sinusoidal oscillator, Hartley oscillator,Collpitts Oscillator, Phase shift,Wein bridge oscillator, crystal oscillator.

Recommended Books:
- Basic Electronics: Devices, Circuits & IT Fundamentals, Kal,PHI
- Basic Electronics for Scientists
- Electronic Devices & Circuits: An Introduction, Mottershead,
- Electronic Devices & Circuits, Boylestad, Nashelky, PHI
- Semiconductor Devices , NanditaDass, PHI
- Electronic Devices & Circuits, Milman&Halkias
- Electronic Devices & Circuits, Theodore Bogart, Jr

Digital Electronics

ECL 2070 **4 – 0 – 0 = 4**

Course Outcomes

CO1	To provide the skills to efficiently acquire knowledge on digital electronic circuit analysis and design.
CO2	To acquire Knowledge of various number systems and codes from historic point of view.
CO3	To understand the logic families in digital circuits.
CO4	To obtain the ability to analyze various aspects of sequential circuit design.
CO5	To learn the design procedure for Sequential Circuits and data converters.

Basic concepts of Boolean Algebra: Review of number systems - Binary, Hexadecimal, conversion from one to another, complement arithmatic, Signed and unsigned numbers and their arithmetic operations. BCD, Excess-3, Gray and Alphanumeric codes. Review of Boolean algebra, De-Morgan's Theorems, Standard Forms of Boolean Expressions, Minimization-Techniques: K-MAPS, VEM Technique, Q-M (Tabulation) method.
CMOS Logic family : Logic family features, noise margin, setup time, hold time, delay, fan in, fan out, CMOS based logic gates**.**
Combinational Logic Circuits: Problem formulation and design of Basic Combinational Logic Circuits, Combinational Logic Using Universal Gates. Basic Adders, ALU, Parity-Checkers and Generators, Comparators, Decoders, Encoders, Code Converters, Multiplexer (Data Selector), De-multiplexers
Sequential Circuits: Latches, Flip-flops (SR, JK, T, D, Master/Slave FF,) Edge-Triggered Flip-Flops, Flip-Flop Operating Characteristics, Basic Flip-Flop Applications, Asynchronous Counter Operation, Synchronous Counter Operation, Up/Down Synchronous Counters.

Shift registers & Memories
Shift Register Functions, Serial In - Serial Out Shift Registers, Serial In - Parallel Out Shift Registers, Parallel In - Serial Out Shift Registers, Parallel In - Parallel Out Shift Registers, Bidirectional Shift Registers,Basics of Semiconductor Memories, Random-Access Memories (ROM), Read Only Memories (ROMs), Programmable ROM's (PROMs and EPROM's), PAL, PLA.FPGA introduction, CPLD.

A/D and D/A convertor
Characteristics of ADC, Types of ADC- SAR, Dual Slope, Flash ADC. Characteristics of DAC, R-2R Ladder, Weighted Resistance Type

Recommended Books:

- "Digital Fundamentals" by Thomas L. Floyd, Prentice Hall, Inc
- "Digital Systems - Principles and Applications" by Tocci, R. J. and Widner, Prentice Hall,
- Switching and finite automata theory: Z V Kohavi.–TMH
- Digital Logic Circuit Analysis & Design, by Victor P. Nelson, H. Troy Nagle, Bill D. Carroll and J. David Irwin, Prentice Hall,
- Digital logic and computer design: M Morris Mano –PHI
- Modern digital electronics: R.P. Jain. TMH
- *Digital Design: Principles and Practices, by* Wakerly J F, Prentice-Hall,
- "Digital Experiments Emphasizing Systems and Design," by David Buchla, Prentice Hall, Inc,

Analog Electronics

EEL 2412 **3 – 0 – 2 = 4**

Course Outcomes

CO1	To learn the basic concept and the characteristics of transistors.
CO2	Understand the design of OP-AMP and OP-AMP based circuits.
CO3	A thorough understanding, functioning of OP-AMP.
CO4	Design sinusoidal and non-sinusoidal oscillators.
CO5	Know the principle of converter and PLL

Overview of BJT: Structure and I-V characteristics of a BJT; BJT as a switch, Small signal equivalent circuits, high-frequency equivalent circuits.

MOSFET:MOSFET structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits small signal equivalent circuits - gain, input and output impedances, trans-conductance, high frequency equivalent circuit.

Operational Amplifiers: Direct coupled and RC Coupled multi-stage amplifier; Differential amplifier; Internal structure of an operational amplifier, Ideal op-amp, non-idealities in an op-amp (offset voltage and current, input bias current, slew rate, gain bandwidth product), Frequency response of an operational amplifier, Power amplifier: Class A, B and C.

Linear and Nonlinear applications of op-amp: Inverting and non-inverting amplifier, Instrumentation amplifier, Integrator, Differentiator, Active filter, Voltage regulator. Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators,
Precision rectifier, peak detector, Monoshot.

Feedback Amplifiers: Different feedback amplifiers, Effect of Feedback on Amplifier characteristics, Feedback configuration: Voltage series and shunt, Current series and shunt feedback configurations.

Oscillators: Condition for Oscillations, RC type Oscillators, LC type Oscillators, Generalized analysis of LC Oscillators, Hartley, Colpitts, Wein Bridge and Crystal oscillator.

Converter: Voltage to frequency and frequency to voltage converter, D-A and A-D Converter, Clipper and clamper, ADC/DAC specification. Phase locked loop: Principle, Phase detector/comparator, Voltage controlled oscillator, Application of PLL.

Recommended Books:

- 1. A. S. Sedra and K. C. Smith, "Microelectronic Circuits," New York, Oxford University Press, 1998.
- 2. J. V. Wait, L. P. Huelsman and G. A. Korn, "Introduction to Operational Amplifier theory and
- applications," McGraw Hill U. S., 1992.
- 3. Ramakant A. Gayakwad, "OP-AMP and Linear IC's," Prentice Hall
- 4. D. Roy Choudhury, "Linear Integrated Circuits," New Age International Pvt Ltd.
- 5. P.R. Gray, R.G. Meyer and S. Lewis, "Analysis and Design of Analog Integrated Circuits," John
- Wiley & Sons.

Electromagnetic Field Theory

ECL 2040 **4 – 0 – 0 = 4**

Course Outcomes

CO1	Able to understand vector analysis and coordinate systems.
CO2	Able to learn time varying electromagnetic field.
CO3	To understand solution of wave equations.
CO4	Able to understand radiation & reflection in time varying EM field.
CO5	To understand the basics of transmission line.

Unit I: Introduction

Vector Analysis, Coordinate System, Gradient, Divergence, Curl, Laplaceian in rectilinear, Cyllindrical, Spherical Coordinate System, Line, surface and volume integrals, Divergence Theorem, Stoke's theorem

Unit II: Time varying fields and Maxwell's equations

Introduction, The Equation of Continuity For Time-Varying Fields, Inconsistency Of Ampere's Law, Maxwell's Equation in Integral and differential form, Physical Significance of Maxwell Equation, Boundary conditions.

ELECTROMAGNETIC WAVES

Solution For Free-Space Conditions, Uniform Plane Waves & Propagation, The Wave Equations For A Conducting Medium, Sinusoidal Time Variations, Conductors And Dielectrics, Polarization, Reflection By A Perfect Conductor Normal Incidence & Oblique Incidence, Reflection By A Perfect Dielectric — Normal Incidence & Oblique Incidence, Reflection At The Surface Of A Conductive Medium.

RADIATION

Potential Functions And Electromagnetic Field, Potential Functions For Sinusoidal Oscillations, Alternating Current Element, Power Radiated By Current Element, Application To Short Antennas, Radiation From A Monopole Or Dipole.

Transmission Line

Circuit theory analysis of Transmission Line, Loss less and Lossy transmission lines, Reflection coefficient, Transmission Coefficient, VSWR, Input Impedance, Matching of Transmission Line, pulse excitation. Group Velocity and Phase velocity.

Recommended Books:

- Fields & Wave Electromagnetics , DK Cheng
- Electromagnetic Waves and Radiating Systems, Jordan &Balmin
- Elements of Electromagnetics, Sadiku
- Engineering Electromagnetics: W H Hayt& J A Buck
- Advanced Engineering Electromagnetics: C A Balanis

Microprocessor Systems

ECL 2060 **3 – 0 – 0 = 3**

Course Outcomes

CO1	The student will be able to analyze, specify, design, write and test assembly language programs of moderate complexity.
CO2	The student will be able to select an appropriate 'architecture' or program design to apply to a particular situation; e.g. an interrupt-driven I/O handler for a responsive real-time machine.
CO3	The student will be able to calculate the worst-case execution time of programs or parts of programs, and to design and build, or to modify, software to maximize its run time memory or execution-time behavior.
CO4	Write programs to run on 8086 microprocessor based systems.
CO5	Design system using memory chips and peripheral chips for 16 bit 8086 microprocessor.

Introduction to 8085 Microprocessor: Functional block diagram – Registers, ALU, Bus systems, Memory & Instruction cycles Timing diagrams, Address Decoding techniques, Addressing modes, Instruction Set, Assembly Language Programming, Interrupts-Types & handling, ISR, Stack architecture

Memory and Peripheral interfacing: Basic interfacing concepts - Memory space partitioning - Buffering of buses – Timing constraints - Memory control signals - Read and write cycles, Interfacing RAM, ROM, 8255PPI, Interfacing applications using 8255. Need for direct memory access - DMA transfer types

Intel 16 bit Microprocessor: Register organization of 8086 – Architecture - Physical Memory organization - I/O addressing capability, Addressing modes of 8086 - Instruction set of 8086 - Assembler directives and operators, Assembly language programming, Interrupt Architecture

Freescale 32 bit ColdFire Processor:-Introduction to ColdFire Core, Comparison with 8085 & 8086 Architecture, Introduction to MCF5223X Microprocessor Architecture & Functional Blocks

Recommended Books:

- Gaonkar R. S, "Microprocessor Architecture: Programming and Applications with the 8085/8086A", New Age International (P) Ltd.,
- K. Ray, K. M. Bhurchandi – Advanced Microprocessors and Peripherals – Architecture, Programming and Interface – Tata McGraw Hill

- "ColdFire Microprocessors & Microcontrollers" – MunirBannoura, Rudan Bettelheim and Richard Soja, AMT Publishing.
- Douglas V. Hall, "Microprocessors and Interfacing Programming and Hardware", Tata McGraw Hill,
- Daniel Tabak, "Advanced Microprocessors", McGraw Hill,
- David A. Patterson, John.L.Hennessey – Computer organization and design-the hardware/software Interface- Elsevier-Morgan Kaufmann Publishers-

Control Systems

ECL 3090 **4-0-0 = 4**

Course Outcomes

CO1	To learn the basics of Control systems.
CO2	Able to perform time domain analysis of control system.
CO3	Able to know about the stabilty of a system.
CO4	Able to perform frequency domain analysis of a control system.
CO5	To learn about basic concepts of digital control systems.

1. Introduction to Feedback Control System
Mathematical models of physical system , Open loop and closed loop systems, regenerative feedback, Transfer function, Block diagrams and reduction techniques including signal flow graphics, deriving transfer function of physical system one mechanical system and field controlled and armature controlled DC servo motors.
2. Time Response Analysis
Standard test signals, time response of second order system, steady state errors and errorconstants, design specifications of second order system.
3. Stability Analysis
Concept of stability, condition of stability, characteristic equation, relative stability, Routh-Hurwitz criterion, special cases for determining relative stability, Nyquist stabilitycriterion, Nyquist plots
4. Root Locus Techniques.
Basic concept, rules of root locus, application of root locus technique for control systems.
5. Frequency Response Analysis
Bode plots, gain margin, phase margin, effect of addition of poles and zeros on bode-plots.
6. Compensators.
Preliminary design considerations, need of compensation, lead compensations, lag-compensation, lag-lead compensation.
7. Analysis of Control Systems in State – Space
Basic concepts of state, state variable and state models, transfer matrix, Controllability, absorbability, obtaining state space equations in canonical form.
8. Discrete control system: Z Transform and its properties, Basic structure of Digital Control systems, Description and analysis of Sampled-Data system, Stability analysis of Discrete-time systems

Recommended Books:
- Control System Engineering -- I.J. Nagrath, M.Gopal (Willey Eastern)
- Feedback Control Systems -- (Schaum's Series book)
- Modern Control System -- Dorf,Bishop (addison – Wesley Publication)
- Modern Control Engg.(II edition) – Katsuhiko Ogata
- Automatic Control Engg.(II edition)-Kuo

Data Structure Using C

CSL 2031 **3-0-2 = 4**

Course Outcomes

CO1	To impart the basic concepts of data structures and algorithms.
CO2	To understand concepts about searching and sorting techniques.
CO3	To Understand basic concepts about stacks, queues, lists, trees and graphs.
CO4	To understanding about writing algorithms and step by step approach in solving problems with the help of fundamental data structures

Unit 1
Introduction to programming methodologies and design of algorithms. Structured programming concepts Study and implementation of basic data structures like: Arrays, multidimensional arrays and their organization, introduction to sparse arrays
Unit 2
Linked list (singly, doubly and circular)

Unit 3
Stacks, Queues
Unit 4
Searching: Sequential and binary searching.
Unit 5
Sorting: Insertion, selection, shell, merge and quick sort
Unit 6
Introduction to trees and graphs and traversal methods.
Unit 7
Introduction to Files
List of Experiments
1. Implementation of Strings (with and without using functions)
2. Implementation of stack and its operations
3. Implementation of Q and its operations
4. Array and dynamic implementation of linked list and its operations

Recommended Books:

- Mark Allen Weiss, —Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 1996
- Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, —Data Structures and Algorithms, Pearson Education, 1983.
- Robert Kruse, C.L.Tondo, Bruce Leung, Shashi Mogalla , — Data Structures and Program Design in C, Second Edition, Pearson Education, 2007
- Jean-Paul Tremblay and Paul G. Sorenson, —An Introduction to Data Structures with Applications, Second Edition, Tata McGraw-Hill, 1991.

Power Electronics

EEL 3541 **3-0-2 = 4**

Course Outcomes

CO1	Understand the differences between signal level and power level devices.
CO2	Analyse controlled rectifier circuits.
CO3	Analyse the operation of DC-DC choppers.
CO4	Analyse the operation of voltage source inverters.
CO5	Analyse the working and operation of cycloconverter

1. Introduction to Feedback Control System
Mathematical models of physical system , Open loop and closed loop systems, regenerative feedback, Transfer function, Block diagrams and reduction techniques including signal flow graphics, deriving transfer

Power switching devices:
Diode, Thyristor, MOSFET, IGBT: I-V Characteristics, Firing circuit for thyristor, Gate drive circuits for MOSFET and IGBT, Working and Characteristics of GTO, Working and Characteristics of DIAC, Working and Characteristics of TRIAC.

AC-DC Converters (Thyristor rectifiers):
Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load, Operation and analysis of Single phase uncontrolled and controlled rectifiers with RLE load, Three-phase full-bridge uncontrolled and controlled rectifiers with R-load and highly inductive load; Estimation of RMS load voltage, RMS load current and input power factor, power factor improvement methods for phase controlled rectifiers, effect of source inductance Input current wave shape.

DC-DC converters:
Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, Principle of step up and step down operation, Time ratio control for Chopper, Single quadrant DC chopper, Two quadrant and four quadrant DC choppers, analysis and waveforms at steady state.

DC-AC Converters (Inverter):
Power circuit of single-phase voltage source inverter, Single phase half-bridge inverter, Single phase full-bridge inverter, switch states and instantaneous output voltage, square wave operation of the inverter,

concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage, Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages.

AC-AC Converters :
AC Voltage regulator, Single phase half wave AC voltage controller with R load, Single phase full wave AC voltage controller with R load, Single phase full wave AC voltage controller with R-L load, Single phase to single phase (circuit step-up and step-down) cycloconverter, Three-phase to single-phase (halfwave) Cycloconverter, Three-phase to three-phase (half-wave) Cycloconverter.

Recommended Books:
- M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
- N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
- R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2007.
- L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
- PS Bhimbra, "Power Electronics", Khanna Publishers, 2019.

Fundamental of Electrical Engineering

EEL 1006 **3-0-2 = 4**

Course Outcomes

CO1	To solve the electrical circuits (DC & AC).
CO2	Solve and analyze the electrical circuits using network theorems and understand the behavior of AC electrical circuits and resonance.
CO3	To understand the three phase electrical systems and apply the concepts of measurements in measuring electrical quantities.
CO4	Solve and analyze the behavior of magnetic circuits and understand the concept of transformers and their applications.
CO5	To study the working principles of basic electrical machines including DC as well as AC machines.

Unit I
Introduction and Electrical Circuit Analysis: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, Source transformation, Kirchhoff's laws, Loop and nodal methods of analysis, Star-delta transformation,
AC fundamentals: Sinusoidal, square and triangular waveforms – Average and effective values, Form and peak factors, Concept of phasors, Phasor representation of sinusoidally varying voltage and current

Unit II
Steady- State Analysis of Single Phase AC Circuits: Analysis of series and parallel RLC Circuits, Concept of Resonance in series & parallel circuits, bandwidth and quality factor; Apparent, active & reactive powers, Power factor, Concept of power factor improvement and its improvement (Simple numerical problems)
Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem (Simple numerical problems).

Unit III
Three Phase AC Circuits: Three phase system-its necessity and advantages, Star and delta connections, Balanced supply and balanced load, Line and phase voltage/current relations, Three-phase power and its measurement (simple numerical problems).
Measuring Instruments: Types of instruments, Construction and working principles of PMMC and moving iron type voltmeters & ammeters, Single phase dynamometer wattmeter, Use of shunts and multipliers (Simple numerical problems on shunts and multipliers).

Unit IV
Magnetic Circuit: Magnetic circuit concepts, analogy between electric & magnetic circuits, B-H curve, Hysteresis and eddy current losses, Magnetic circuit calculations (Series & Parallel).
Single Phase Transformer: Principle of operation, Construction, EMF equation, Equivalent circuit, Power losses, Efficiency (Simple numerical problems), Introduction to auto transformer.

Unit V
DC Machines: Principle & Construction, Types, EMF equation of generator and torque equation of motor, applications of DC motors (simple numerical problems)
Three Phase Induction Motor: Principle & Construction, Types, Slip-torque characteristics, Applications (Numerical problems related to slip only)
Single Phase Induction motor: Principle of operation and introduction to methods of starting, applications.

Three Phase Synchronous Machines: Principle of operation of alternator and synchronous motor and their applications.

Recommended Books:

- D.P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
- L.S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
- E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
- V.D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.
- B Dwivedi and A Tripathi, "Fundamentals of Electrical Engineering", Wiley India.
- Kuldeep Sahay, "Basic Electrical Engineering", New Age International Publishers.
- J. B. Gupta, "Electrical Engineering", Kataria and Sons.
- C L Wadhwa, "Basic Electrical Engineering", New Age International.
- W.H. Hayt and J.E. Kimerly, "Engineering Circuit Analysis", Mc Graw Hill.

Shri Mata Vaishno Devi University

Campus: Kakryal, Katra 182 320
Phone: 01991-285699, 285634 Fax: 01991-285694

Public Relations Office:
Kalika dham, Near railway Station, Jammu-180004
Telefax: 0191-2470067

Website: www.smvdu.ac.in

Published by: Shri Mata Vaishno Devi University, Katra J&K 182 320