Courses of Study

(Detailed Course Contents)

Post-graduate Programmes

Shri Mata Vaishno Devi University

Kakryal, Katra 182320 Jammu & Kashmir

VISION

Establishment of a Scientific & Technical University of Excellence to nurture young and talented human resources for the service of Indian Society & world at large and preserving the integrity and sanctity of human values.

MISSION

The mission of the University is the pursuit of Education, Scholarship and Research at the highest International level of excellence.

OBJECTIVES

- Provide education and training of excellent quality, both at undergraduate and postgraduate level.
- Ensure that the University achieves and maintains an international standing in both teaching and research
- Promote study and research in new and emerging areas and encourage academic interaction of the faculty and the students at national and international levels.
- Encourage close collaboration with industry and facilitate the application of research for commercial use and for the benefit of society.

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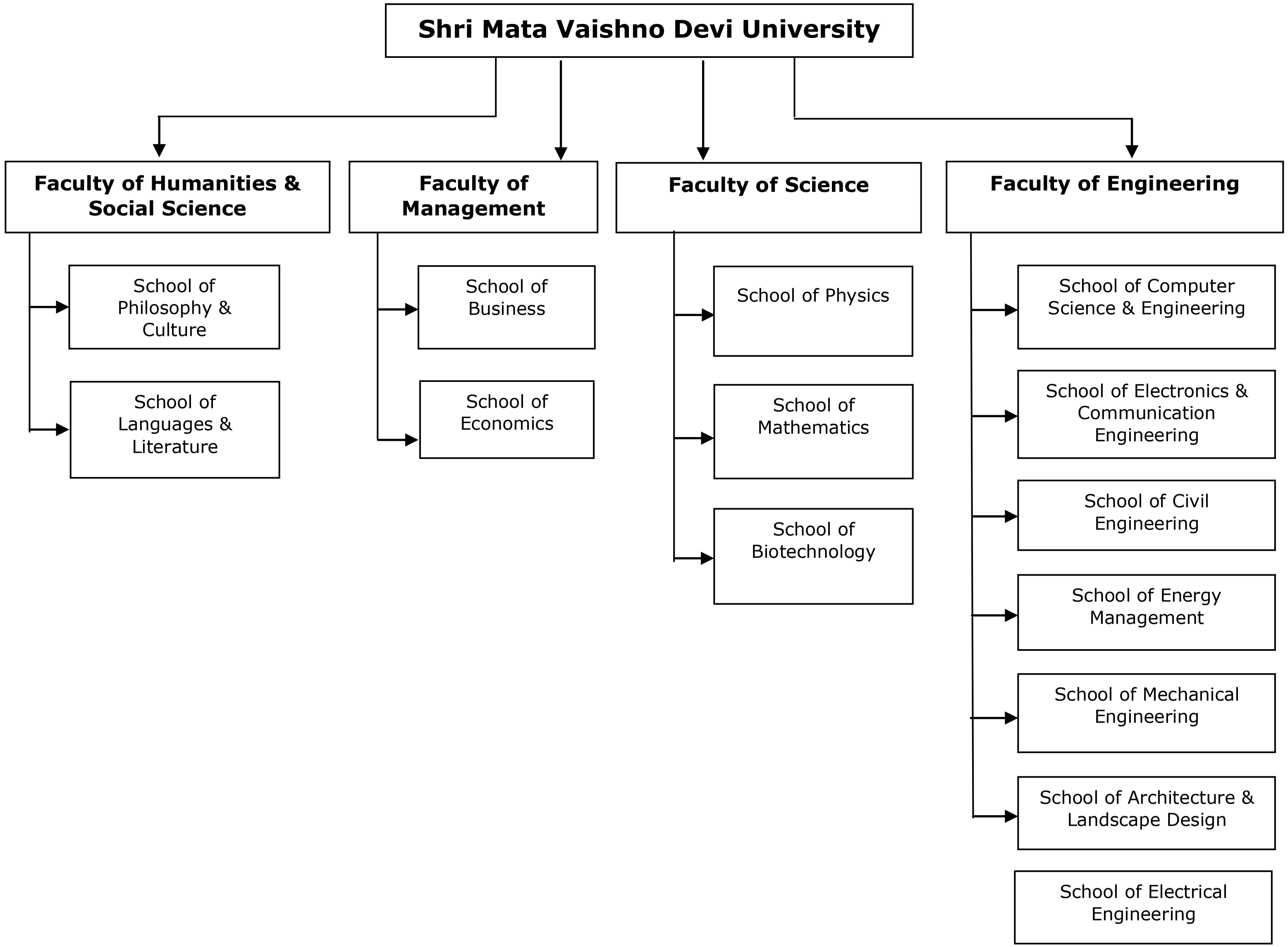
Academic Structure of the University



Details of

Programme of Study

&

Syllabus of Courses

Offered by

School of Electronics & Communication Engineering

Introduction
The field of electronics is the fastest growing and the most rapidly changing area of technology in the current times. Electronics has become the all-pervasive technology, which finds application in all spheres of engineering including computers, communication, defense, mechatronics, instrumentation, automation, robotics, artificial intelligence, computer networks, satellites, education etc. The use of electronics has brought about a drastic change in the way human civilization exists today.

The School currently offers a 4 Year (8 Semester) B.Tech(Electronics & Communication Engineering) program, M.Tech(Electronics & Communication Engineering) program and PhD.The field of communication has benefited significantly because of the growth of electronics technology. Currently it is possible to communicate using computers and mobile phones across cities, deserts, and oceans via satellites orbiting in space but there is more to come. Latest technologies in the communication field are entirely dependent on the field of electronics.

Objectives
The school of Electronics & Communication engineering has been set up to impart training of the highest standards to the students, in the field of electronics, thus preparing them to meet the exacting demands of the highly competitive global industrial market. The objectives of the B.Tech Programme are:

- The progressively impart training starting from the basic fundamentals of electronics and covering the entire spectrum of current technologies being used in the field of communication, digital design, chip design and industry in general.
- To instill in the students a sense of curiosity about the field of electronics and make them confident to explore and innovate.

To ensure that the students develop strong work ethics, organizational skills, team work and understand the importance of being a thorough professional.

<u>POs & PEOs of Programs</u>

Programme Outcomes:

1. Apply Knowledge of mathematics, science and engineering fundamentals in the domain of Electronics and Communication
2. Identify, formulate, and analyze complex engineering problems to achieve appropriate solutions.
3. Design systems and processes that meet the requirements of public safely and offer solutions for societal and environmental issues.
4. Apply research knowledge to formulate, and analyze complex engineering problems by synthesizing mathematical principles and engineering fundamentals for valid conclusions.
5. Construct, select, and apply the appropriate techniques and modern engineering tools for the system design and analysis.
6. Apply the contextual knowledge to assess the contemporary issues and the impact of engineering solutions on the society.
7. Examine the impact of engineering solutions in environmental context and utilize the knowledge for sustainable development.
8. Develop consciousness and commitment towards professional ethics, responsibilities and norms of engineering practices so as to become good citizens
9. Ability to perform effectively, individually and in a team
10. Proficiency in communication, both verbal and written forms, to be able to compete globally, and communicate effectively on complex engineering activities.
11. Demonstrate the knowledge gained in lifelong learning, and hence participate and succeed in competitive examinations, higher studies, and broader context of technological change.
12. Willingness and ability to take up administrative responsibilities involving both project and financial management confidently.

Programme Educational Objectives (PEOs)

1. To progressively impart training starting from the fundamentals of electronics and covering the entire spectrum of current technologies being used in the field Electronics and Communication Engineering
2. To inculcate a sense of curiosity in the students, about the field of E&C and make them confident to explore and innovate
3. To ensure that the students develop strong work ethics, organizational skills, team work and understand the importance of being a thorough professional

4. To develop integrality, human and Ethical values

Training Methodology

The emphasis of the program is on practical, hands-on learning. Significant part of the curriculum is dedicated to ensuring that the students get to work with latest equipment and explore the implementation of the knowledge learnt through the class-work. Besides regular class-work, skills of the students are honed by their participation in group discussions, presentations, group assignments and project work which is mandatory 5th semester onwards. The students face continuous evaluation based on these activities. The students are also required to undergo summer training in an industrial environment to learn industrial standards of project management, teamwork, quality considerations and documentation.

Infrastructure

State-of-the-art laboratories, containing the latest equipment have been set up to ensure that the students get complete facilities to thoroughly understand and explore the concepts of electronics as learnt in the class-room. Specifically keeping in mind, the fact that the University is located in a region where day-to-day industrial interaction is not feasible, the latest equipment is provided in the laboratories itself to ensure that the students are kept abreast of the newer technologies being used in the industry. The school has established laboratories in collaboration with Multi-national companies like Xilinx Inc., USA & Freescale Semiconductors Ltd., USA. The School has also established the **"Center for Embedded Instrumentation & Networked Controls"** with funding from UGC. The following laboratories have been established to provide the students with the best possible facilities for enhancing the value of the learning process:

1. Analog Electronics Lab
- Basic Electronics &Electrical Engg.Lab
- Linear Integrated circuits Lab
- Electronics Circuits Lab

2. SMVDU Xilinx Lab - Established with support from M/s Xilinx Inc., USA
- Digital Electronics Lab
- VHDL & FPGA Lab
- Electronic Measurement & Instrumentation Lab
- Control Systems Engineering Lab

3. SMVDU Freescale Systems Lab - Setup in collaboration with Freescale Semiconductors Inc.(Erstwhile Motorola Semiconductor)
- Microprocessor Lab
- Microcontrollers Lab
- Embedded Systems Lab

4. Communication Engineering Lab
- Analog Communication Lab
- Digital Communication Lab
- Microwave Lab
- Optical Fiber Communication Lab
- Switching Networks Lab

5. Electrical Machines Lab
- Power Electronics Lab
- Electrical Machines Lab

6. PCB Fabrication & Project Lab

7. Center for Embedded Instrumentation & Networked Controls (Research Lab)
- Embedded Systems Lab
- Image processing
- Wireless Networks Lab
- Signal Processing Lab

8. Microelectronics Lab (Research Lab)
- VLSI Lab
- MEMS Lab

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 7	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 6070	Synthesis & Optimization of Digital Circuits	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 6230 Advanced CMOS VLSI Design

Advance Digital Communication

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

Course Outcomes

CO1	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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**

<u>Course Outcomes</u>

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**

<u>Course Outcomes</u>

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	
CO2	
CO3	

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**

<u>Course Outcomes</u>

CO1	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	

CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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.

<u>Advanced Computer Networks</u>

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	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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	

CO2	
CO3	

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**

Course Outcomes

CO1	
CO2	
CO3	

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**

Course Outcomes

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	
CO2	
CO3	

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

Microwave Antenna Design

ECE 6052 **3 – 0 – 0 = 3**

Course Outcomes

CO1	
CO2	
CO3	

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**

Course Outcomes

CO1	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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	
CO2	
CO3	

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.

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

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