DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Syllabus for M.Tech. (ECE) Programme

Choice Based Credit System

RAJIV GANDHI UNIVERSITY, RONO HILLS, DOIMUKH

Course Structure for Master of Technology in Electronics and Communication Engineering w.e.f. September 2020

M. Tech Sem-I

Paper Code	Paper Title	Scheme of Studies Per Week			Credits
		L	T	P	
ECEC 411	Advanced Digital Signal Processing	3	1	0	4
ECEC 412	Wireless and Mobile Communications.	3	1	0	4
ECEE 413X	Elective – I	3	0	0	3
ECEE 414X	Elective – II	3	1	0	4
ECEM 415	XXXX (MOOC Course)	-	-	-	XX
ECEL 416	Laboratory 1 (Advanced Digital Signal Processing)	0	0	2	2
ECEL 417	Laboratory 2 (Based on Elective I)	0	0	2	2

Total Credits: 19+XX

M. Tech Sem-II

Paper Code	Paper Title	Scheme of Studies Per Week			Credits
		L	T	P	
ECEC 421	Information Theory and Coding	3	1	0	4
ECEC 422	MEMS and Microsystems	3	1	0	4
ECEE 423X	Elective – III	3	0	0	3
ECEE 424X	Elective – IV	3	1	0	4
ECEM 425	XXXX (MOOC Course)	-	-	-	XX
ECEL 426	Laboratory 3 (MEMS and Microsystems)	0	0	2	2
ECEL 427	Laboratory 4 (Based on Elective III)	0	0	2	2

Total Credits: 19+XX

M. Tech Sem-III

Paper Code	Paper Title	Scheme of Studies Per Week			Credits
		L	T	P	
ECEM 531	XXXX (MOOC Course)	-	-	-	XX
ECE0 512X	Open Elective	4	0	0	4
ECEP 514	Dissertation-I	0	0	10	10

Total Credits: 14+XX

M. Tech Sem-IV

Paper Code	Paper Title	Scheme of Studies Per Week			Credits
		L	T	P	
ECEP 521	Dissertation-I I	0	0	20	20

Total Credits: 20

Total Course Credit: 19+19+14+20+XX+XX+XX=72+XX+XX+XX.

XX: Information provided by the MOOC Co-ordinator.

NOTE:

1. **A candidate must earn minimum 80 Credit to award the M.Tech. Degree.**
2. **Minimum 3 credit course should be opted, in case if 3 credit course is not available, then 2 credit course may be opted.**
3. **MOOC course should be approved by the Department.**
4. **If relevant MOOC course is not available, then the department may run elective course against the MOOC course as under:**
   i. **One more Elective II may run against the ECEM 415.**
   ii. **One more Elective IV may run against the ECEM 425.**
   iii. **One more Elective IV may run against the ECEM 531.**

Marks Distribution of each Paper

M. Tech Sem-I

Paper Code	Paper Title	Marks Distribution			Total
		End Semester	Sessional/ Internal	Practical/ External	
ECEC 411	Advanced Digital Signal Processing	80	20		100
ECEC 412	Wireless and Mobile Communications	80	20		100
ECEE 413X	Elective – I	80	20		100
ECEE 414X	Elective – II	80	20		100
ECEM 415	XXXX (MOOC Course)	XX	XX		XX
ECEL 416	Laboratory 1 (Advanced Digital Signal Processing)		50	50	100
ECEL 417	Laboratory 2 (Based on Elective I)		50	50	100

M. Tech Sem-II

Paper Code	Paper Title	Marks Distribution			Total
		End Semester	Sessional/ Internal	Practical/ External	
ECEC 421	Information Theory and Coding	80	20		100
ECEC 422	MEMS and Microsystems	80	20		100
ECEE 423X	Elective – III	80	20		100
ECEE 424X	Elective – IV	80	20		100
ECEM 425	XXXX (MOOC Course)	XX	XX		XX
ECEL 426	Laboratory 3 (MEMS and Microsystems)		50	50	100
ECEL 427	Laboratory 4 (Based on Elective III)		50	50	100

M. Tech Sem-III

Paper Code	Paper Title	Marks Distribution			Total
		End Semester	Sessional/ Internal	Practical/ External	
ECEM 531	XXXX (MOOC Course)	XX	XX	XX	XX
ECE0 512X	Open Elective	80	20		100
ECEP 514	Dissertation-I		120	80	200

M. Tech Sem-IV

Paper Code	Paper Title	Marks Distribution			Total
		End Semester	Sessional/ Internal	Practical/ External	
ECEP 521	Dissertation-II		240	160	400

Program Outcomes of ECE (M. Tech.) program:

The main outcomes of the ECE (M. Tech.) program are given here. At the end of the program a student is expected to have:

1. An understanding of the theoretical foundations and the limits of Electronics and Communications Engineering.
2. An ability to adapt existing models, techniques, algorithms, devices, etc. for efficiently solving problems.
3. An ability to design, develop and evaluate new electronics based systems for novel applications which meet the desired needs of industry and society.
4. Understanding and ability to use advanced signal processing techniques and tools.
5. An ability to undertake original research at the cutting edge of Electronics and Communications & its related areas.
6. An ability to function effectively individually or as a part of a team to accomplish a stated goal.
7. An understanding of professional and ethical responsibility.
8. An ability to communicate effectively with a wide range of audience.
9. An ability to learn independently and engage in life-long learning.
10. An understanding of the impact of IT related solutions in an economic, social and environment context.
11. An ability to work in competitive environment like industry, cooperate.
12. An ability to do research work in cutting edge technology.

Elective – I

ECEE-4131: Advanced Digital System Design
ECEE-4132: Advanced Communication Networks
ECEE-4133: Programming language for Embedded Software
ECEE-4134: Microprocessors and Microcontrollers
ECEE-4135: Embedded Systems

Elective – II

ECEE-4141: MOS-VLSI Circuit Design
ECEE-4142: DC Analysis for MOS transistor
ECEE-4143: Remote Sensing
ECEE-4144: Physics of Semiconductor Devices
ECEE-4145: Computer Vision

Elective – III

ECEE-5231: Wireless Sensors and Networks
ECEE 4232: Biomedical Signal Processing
ECEE 4233: CMOS Analog IC design
ECEE 4234: RTL Simulation and Synthesis with PLD
ECEE 4235: FPGA Design

Elective – IV

ECEE-4241: Artificial Intelligence
ECEE-4242: Advanced Computer Architecture
ECEE-4243: Cognitive Radio
ECEE-4244: VLSI Testing and Testability
ECEE-4245: Low Power VLSI Design

Open Elective

ECE0 5120- Fundamentals of Electronics and Communications

MOOC Course

ECEM 415

ECEM 425

ECEM 531

ECEC-411: Advanced Digital Signal Processing

Course Outcomes:

At the end of this course, students will be able to

- Learn different techniques for filter design.
- Understanding of sampling techniques.
- Understanding of linear filters.
- Understand the techniques for various adaptive filtering.
- Study techniques for DSP in one dimensional signal analysis.

Syllabus Contents:

Unit-1

Overview of DSP, Characterization in time and frequency, FFT, Realization of Discrete Time System: Structure of Realization of IIR and FIR systems, linear phase realizations, design and analysis of IIR and FIR filters, approximation of derivative and impulse invariant transformation of the IIR filters, and frequency response of linear phase FIR filters.

Unit-2

Multi-rate DSP, Sampling, Down sampling, Up sampling, Sampling rate conversion, multistage decimator & interpolator, poly phase decomposition, digital filter design for FIR and IIR interpolators and decimators.

Unit-3

Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, Wiener Filters: principle of orthogonality, minimum mean-square error, Wiener Hopf equations.

Unit-4

Adaptive Filters, Applications, Minimum mean square criterion, Least-Mean-Square (LMS): signal flow graph, optimally considerations, applications, and Normalized least-mean-square algorithm.

Unit-5

Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum- Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation.

Text Book and References:

- J.G. Proakis and D.G. Manolakis "Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.
- N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks – Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999.
- Bruce W. Suter, "Multirate and Wavelet Signal Processing",1st Edition, Academic Press, 1997.
- M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & Sons Inc., 2002.
- S.Haykin, "Adaptive Filter Theory", 4th Edition, Prentice Hall, 2001.

- D.G.Manolakis, V.K. Ingle and S.M.Kogon, “Statistical and Adaptive Signal Processing”, McGraw Hill, 2000.

ECEC-412: Wireless and Mobile Communications

Course Outcomes:

At the end of this course, students will be able to

- Design appropriate mobile communication systems.
- Apply frequency-reuse concept in mobile communications, and to analyze its effects on interference, system capacity, handoff techniques
- Distinguish various multiple-access techniques for mobile communications e.g. FDMA, TDMA, CDMA, and their advantages and disadvantages.
- Analyze path loss and interference for wireless telephony and their influences on a mobile-communication system’s performance.
- Analyze and design CDMA system functioning with knowledge of forward and reverse channel details, Understanding upcoming technologies like 3G, 4G etc.

Syllabus Contents:

Unit-1

Cellular Communication Fundamentals: Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment’s, 5G architecture and interfaces.

Unit-2

Spectral efficiency analysis based on calculations for Multiple access technologies: TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas.

Unit-3

Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor and Indoor Propagation Models. Small Scale Fading and Multipath Propagation.

Unit-4

Equalization, Diversity: Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving.

Unit-5

Code Division Multiple Access: Introduction to CDMA technology, IS 95 system Architecture, Higher Generation Cellular Standards:3G Standards, introduction to 4G and 5G.

Text Book and References:

- V.K. Garg, J.E. Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008.
- V.K. Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4 th edition, 2009.
- T.S. Rappaport, "Wireless Communications Principles and Practice", 2 nd edition, PHI,2002.
- William C.Y.Lee, "Mobile Cellular Telecommunications Analog and Digital Systems", 2nd edition, TMH, 1995.
- Asha Mehrotra, "A GSM system Engineering" Artech House Publishers Bosten, London,1997.

ELECTIVE -I

ECEE-4131: Advanced Digital System Design

Course Outcomes:

At the end of this course, students will be able to

- Understand the combinational and sequential circuit logic.
- Learn the different technique to realize the sequential circuit from the Boolean equation.
- Understanding of design procedure of logic circuits.
- Learn the realization of state machine using mealy and moore machine.
- Study the basics of verilog HDL for both combinational and sequential circuits.

Syllabus Contents:

Unit-1

Introductory concepts of Basic logic gates, Decoders, Encoders, Multiplexers, Implementing functions using Multiplexers, Demultiplexers, half adder, full adder, half subtractor, full subtractor, Parity Generators and Checkers, Signed Binary Arithmetic, ripple carry adders , BCD adders, carry look ahead adder.

Unit-2

Introduction to sequential circuits, latch, flip-flop, Synchronous and Asynchronous Digital Counters and shift registers, Mealy machine, Moore machine, State diagrams, State table minimization, realization of Mealy and Moore machine.

Unit-3

State transition table- state assignment for FPGAs, Algorithmic State Machine Charts, Derivation of ASM Charts, Realization of ASM charts, linked state machines, Implementation of Binary Multiplier, dice game controller.

Unit-4

Basic concepts, Programming technologies, Programmable Logic Element (PLE), Programmable Logic Array(PLA), Programmable Array Logic (PAL), Structure of standard PLDs, complex PLDs (CPLD). Design of combinational and sequential circuits using PLD's, Introduction to Field Programmable Gate Arrays-types of FPGA- XILINX XC 3000 series and 4000 series.

Unit-5

Basic Concepts: Design Methodology, Data Objects, Data Types, Operators, Concurrent and Sequential Assignment Statements, Gate level modelling, Data flow modelling, Behavioral level modelling.

Text Book and References:

- Digital Design – Morris Mano, M.D.Ciletti, 4th Edition, PHI.
- Verilog HDL – Guide to Digital Design and Synthesis- Samir Palnitkar, Pearson Education, 3rd Edition, 2003.
- Fundamentals of Logic Design – Charles H. Roth, 5^{th} Ed., Cengage Learning.
- Logic Design Theory – N. N. Biswas, PHI
- Switching and Finite Automata Theory – Z. Kohavi , 2nd Ed., 2001, TMH
- Digital Circuits and Logic Design – Samuel C. Lee , PHI
- William Fletcher: An Engineering Approach to Digital Design, Prentice-Hall India,1980.
- William J Dally and John W Poulton, Digital Systems Engineering, Cambridge University Press, 1998.
- Jayaram Bhaskar A, VHDL Primer, Prentice-Hall India,1999.

ECEE-4132: Advanced Communication Networks

Course Outcomes:

At the end of this course, students will be able to

- Understand advanced concepts in Communication Networking.
- Design and develop protocols for Communication Networks.
- Understand the mechanisms in Quality of Service in networking.
- Optimise the Network Design.
- Understand engineering issues in MPLS

Syllabus Contents :

Unit-1

Overview of Internet-Concepts, challenges and history. Overview of -ATM. TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control, TCP for high bandwidth delay networks, Fairness issues in TCP.

Unit-2

Real Time Communications over Internet, Adaptive applications, Latency and throughput issues, Integrated Services Model (intServ), Resource reservation in Internet, RSVP, Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP), Leaky bucket algorithm and its properties.

Unit-3
Packet Scheduling, Algorithms-requirements and choices, Scheduling guaranteed service connections, GPS, WFQ and Rate proportional algorithms, High speed scheduler design, Theory of Latency Rate servers and delay bounds in packet switched networks for LBAP traffic, Active Queue Management – RED, WRED and Virtual clock, Control theoretic analysis of active queue management.

Unit-4
IP address lookup-challenges, Packet classification algorithms and Flow Identification-Grid of Tries, cross product and controlled prefix expansion algorithms, Admission control in Internet, Concept of Effective bandwidth, Measurement based admission control, Differentiated Services in Internet (DiffServ), DiffServ architecture and framework.

Unit-5
IPV4, IPV6, IP tunnelling, IP switching and MPLS, Overview of IP over ATM and its evolution to IP switching, MPLS architecture and framework. MPLS Protocols, Traffic engineering issues in MPLS.

Text Book and References:

- Jean Wairand and Pravin Varaiya, "High Performance Communications Networks", 2nd edition, 2000.
- Jean Le Boudec and Patrick Thiran, "Network Calculus A Theory of Deterministic Queuing Systems for the Internet", Springer Veriag, 2001.
- Zhang Wang, "Internet QoS", Morgan Kaufman, 2001.
- Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking: An Analytical Approach" , Morgan Kaufman Publishers, 2004.
- George Kesidis, "ATM Network Performance", Kluwer Academic, Research Papers, 2005

ECEE-4133: Programming Languages for Embedded System

Course Outcomes:
At the end of this course, students will be able to

- Write an embedded C application of moderate complexity.
- Develop and analyze algorithms in C++.
- Differentiate interpreted languages from compiled languages.
- Brief knowledge of overloading.
- Brief knowledge of template and exceptional handling.

Syllabus Contents:

Unit-1

Embedded 'C' Programming: Bitwise operations, Dynamic memory allocation, OS services, Linked stack and queue, Sparse matrices, Binary tree, Interrupt handling in C, Code optimization issues, Writing LCD drives, Drivers for serial port communication, Embedded Software Development Cycle and Methods (Waterfall, Agile).

Unit-2

Object Oriented Programming: Introduction to procedural, modular, object-oriented and generic programming techniques, Limitations of procedural programming, objects, classes, data members, methods, data encapsulation, data abstraction and information hiding, inheritance, polymorphism.

Unit-3

CPP Programming: 'cin', 'cout', formatting and I/O manipulators, new and delete operators, Defining a class, data members and methods, 'this' pointer, constructors, destructors, friend function, dynamic memory allocation.

Unit-4

Overloading and Inheritance: Need of operator overloading, overloading the assignment, overloading using friends, type conversions, single inheritance, base and derived classes, friend classes, types of inheritance, hybrid inheritance, multiple inheritance, virtual base class, polymorphism, virtual functions.

Unit-5

Templates: Function template and class template, member function templates and template arguments, Exception Handling: syntax for exception handling code: try-catch- throw, Multiple Exceptions.

Text Book and References:

- Michael J. Pont , "Embedded C", Pearson Education, 2nd Edition, 2008
- Randal L. Schwartz, "Learning Perl", O'Reilly Publications, 6th Edition 2011
- A. Michael Berman, "Data structures via C++", Oxford University Press, 2002
- Robert Sedgewick, "Algorithms in C++", Addison Wesley Publishing Company, 1999
- Abraham Silberschatz, Peter B, Greg Gagne, "Operating System Concepts", John Willey & Sons, 2005

ECEE-4134: Microprocessors and Microcontrollers

Course Outcomes:

At the end of this course, students will be able to

- Write an Assembly Language Programming for 8086 and 80386.

- Understand the interfacing of different peripheral.
- Understand the different memory organization.
- Understand the difference between Microprocessor and Microcontroller.
- Design a system based on microcontroller

Syllabus Contents:

Unit-1
History of Microprocessor, Pin diagram, Block Diagram, Minimum and Maximum Mode and Bus Timings, Ready and Wait states and 8086 based micro-computing system, Machine language instruction formats, Addressing modes, Instruction set, Assembler directives.

Unit-2
ALP, programming with an assembler, stack structure, Interrupts, Service subroutines and Interrupt programming and Macros.

Unit-3
Memory Interfacing (DRAM), PPI- Modes of operation of 8255, interfacing to ADC & DAC Programmable timer- 8253, PIC 8259A, USART and their interfacing.

Unit-4
Architectural and features of 80386, additional instructions of 80386, Data types of 80386, thread, multithreading, Pipeline, Architectural and features of 80486, Difference between 80386 and 80486.

Unit-5
Introduction to Intel 8-bit and 16-bit Micro controllers, 8051-Architecture, memory organization, Addressing modes. Instruction formats, Instruction sets, Interrupt structure and interrupt priorities, Port structures and Different modes of operation and programming Examples.

Text Book and References:

- “The Intel Microprocessors”, Architecture, Programming and interfacing by Barry B. Brey
- 8086 Micro Processors by Kenrith J Ayala, Thomson Publishers.
- Microcontrollers by K.J.Ayala - Thomson Publishers.
- Micro Processors and Interfacing Programming and Hardware by Douglas V. Hall.
- The 8088 and 8086 Microprocessor- W.A. Triebel & Avtar Singh- PHI, 4th Edn, 2002.

ECEE-4135: Embedded System

Course Outcomes:

At the end of this course, students will be able to

- Understand the interfacing circuits for controlling.
- Understand the internal processor design.

- Write program for embedded C.
- Interface many peripheral.
- Built minor project base on microcontroller.

Syllabus Contents:

Unit-1

Operational Amplifier and Analog Signal Processing Circuits: Introduction, Voltage Follower Circuit, Inverting Amplifier, Sign Changer, Phase Shifter, Inverting Summing Amplifier, Non-inverting Amplifier, Non-inverting Summing Amplifier, Difference Amplifier, Current to Voltage (I-V) Converter, Integrator, Differentiator, Comparators and Schmitt Triggers.

Unit-2

Embedded Processors: ISA Architecture Models, Internal Processor Design, Processor Performance, Reading a Processor's Datasheet. Board Memory: Read-Only Memory (ROM), Random-Access Memory (RAM), Auxiliary Memory, Memory Management of External Memory, Board Memory and Performance.

Unit-3

Board I/O (Input/Output): Managing Data: Serial vs. Parallel I/O, Interfacing the I/O Components, I/O and Performance. Board Buses: Bus Arbitration and Timing, Integrating the Bus with Other Board Components, Bus Performance.

Unit-4

Embedded C: C Statements, Structures, Operations, Data Type, Bit Operation, Control Statement, Looping, Data modifier.

Unit-5

Design Concept: Embedded Microcontroller Based DC Motor Control, Embedded Microcontroller Based Switched Mode Power Supply, Embedded Microcontroller Based Magnetic Levitation.

Text Book and References:

- Embedded Systems Architecture, programming and design by Raj Kamal, McGraw Hill Education Private Limited.
- Embedded Microprocessor Systems Real World Design by Stuart R. BaII, Third Edition, Newnes.
- Introduction to Embedded systems by Shibu K V, McGraw Hill Education Private Limited.
- Readings in Hardware/Software Co-Design by G. De Micheli, Rolf Ernst, and Wayne Wolf, eds. Morgan Kaufmann, Systems-on-Silicon Series
- Embedded System Design: A Unified Hardware/Software Introduction by Frank Vahid and Tony D. Givargis, Addison Wesley.
- Programming Embedded Systems in C and C++ by Michael Barr, O'Reilly.
- An Embedded Software Primer by David E. Simon, Addison Wesley.
- The Art of Designing Embedded Systems by Jack Ganssle, Newnes

ELECTIVE-II

ECEE-4141: MOS-VLSI Circuit Design

Course Outcomes:

At the end of this course, students will be able to

- Understand realization of digital logic using CMOS.
- Understand the physics of MOSFET.
- Learn the analysis of static and dynamic power dissipation of circuits.
- Learn the concept of digital switches
- Design the VLSI circuit.

Syllabus Contents:

Unit-1

Classification of CMOS digital circuits and Circuit design, Overview of VLSI design methodologies, VLSI design flow, Design hierarchy and concepts, VLSI design styles, Design quality, Packing technology, CAD technology, Fabrication process flow, CMOS n-well process, layout design rules.

Unit-2

MOS structure, MOS system under external bias, structure and operation of MOS transistor, MOSFET current/voltage characteristics, MOSFET scaling and small-geometry effects, MOSFET capacitances.

Unit-3

Introduction, Resistive-Load Inverter, Inverter with n-type MOSFET load, CMOS Inverter, Delay-Time Definitions, Calculation of Delay Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters.

Unit-4

Introduction, MOS logic circuits with depletion nMOS loads, CMOS logic Circuits, Complex logic circuits, CMOS transmission gates (Pass gates), Behavior of bistable elements, SR latch circuit, clocked latch and flip-flop circuits, CMOS D-latch and Edge-triggered flip-flop.

Unit-5

Basic principles of pass transistor circuits, voltage bootstrapping, synchronous dynamic circuit techniques, Dynamic CMOS circuit techniques, High performance dynamic CMOS circuits.

Text Book and References:

- Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits” TMH 2003

- Neil H. E. Weste and David. Harris Ayan Banerjee “CMOS VLSI Design” - Pearson Education, 1999.
- Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits” Pearson Education, 2003
- Wayne Wolf, “Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.
- Kamran Ehraghian, Dauglas A. Pucknell and Sholeh Eshraghiam, “Essentials of VLSI Circuits and Systems” – PHI, EEE, 2005 Edition.

ECEE-4142: DC Analysis for MOS Transistor

Course Outcomes:

At the end of this course, students will be able to

- Understand working principle of MOS transistor.
- Learn the Modeling of MOS transistor.
- Learn the short channel effect in MOS transistor.
- Learn the concept of field inversion.
- Learn the problems in MOS modelling.

Syllabus Contents:

Unit-1
Introduction, semiconductors, equilibrium in absence of electric field, equilibrium in presence of electric field, Non-equilibrium : Quasi Fermi Level, Poisson's equation, the P-N Junction, Overview of MOS Transistor

Unit-2
Introduction, Flat-band voltage, potential balance and charge balance, effect of Gate body voltage on surface condition, Accumulation, Depletion and Inversion, Small Signal Capacitance

Unit-3
Introduction, Contacting the inversion layer, the Body effect, Regions of inversion: Strong, weak and moderate inversion, A “Vcb control” point of view: fundamental, Pinch- off voltage , Uses of three terminal MOS structure

Unit-4
Introduction, transistor regions of operation, complete all region models, simplified all regions model, model based on quasi-fermi potentials, regions of inversion in terms of terminal voltages, Strong inversion: Complete Strong inversion model, body referenced strong inversion model, source referenced simplified strong inversion model, weak inversion: special conditions in weak inversion, body and source referenced models, moderate inversion and Single piece model.

Unit-5
Introduction, Carrier velocity saturation, channel length modulation, charge sharing, DIBL, Punch through, combining small dimension effects into one model, Hot carrier effects, impact ionization, Velocity overshoot and Ballistic operation, quantum mechanical effects.

Text Book and References:

- Yannis T., Colin M., "Operation and modeling of the NOS Transistor". 3rd Edition, Oxford University Press (2010).
- Arora, Narain D., "MOSFET model for VLSI circuit simulation: Theory and Practice". Springer (1993).
- Trond Y., Yuhua C., "Device Modeling for analog and RF CMOS circuit design ". Wiley online library (2003).

ECEE-4143: Remote Sensing

Course Outcomes:

At the end of this course, students shall be able to

- Understand basic concepts, principles and applications of remote sensing on the geometric.
- Understand basic concepts, principles and applications of remote sensing on radiometric principles.
- Provide examples of applications of principles to a variety of topics in remote sensing, particularly related to data collection, radiation, resolution, and sampling.
- Understand the various sensing remote sensing techniques.
- Understand the various scattering system systems.

Syllabus Contents:

Unit 1
Physics Of Remote Sensing: Electro Magnetic Spectrum, Physics of Remote Sensing-Effects of Atmosphere Scattering, Different types, Absorption, Atmospheric window, Energy interaction with surface features, Spectral reflectance of vegetation, soil and water atmospheric influence on spectral response patterns-multi concept in Remote sensing.

Unit 2
Data Acquisition: Types of Platforms–different types of aircrafts-Manned and Unmanned space crafts, sun synchronous and geo synchronous satellites, Types and characteristics of different platforms ,LANDSAT, SPOT, IRS, INSAT, IKONOS, QUICKBIRD etc.

Unit 3

Photographic products, B/W, color, color IR film and their characteristics, resolving power of lens and film, Optomechanical electro optical sensors, across track and along track scanners multispectral scanners and thermal scanners–geometric characteristics of scanner imagery calibration of thermal scanners.

Unit 4
Scattering System: Microwave scatterometry, types of RADAR, SLAR resolution range and azimuth real aperture and synthetic aperture RADAR. Characteristics of Microwave image stopographic effect-different types of Remote Sensing platforms airborne and space borne sensors ERS, JERS, RADARSAT, RISAT, Scatterometer, Altimeter, LiDAR remote sensing, principles, applications.

Unit 5
Thermal And Hyper Spectral Remote Sensing: Sensors characteristics-principle of spectroscopy imaging, spectroscopy field conditions, compound spectral curve, Spectral

library, radiative models, processing procedures, derivative spectrometry, thermal remote sensing ,thermal sensors, principles, thermal data processing, applications.

Text Book and References:

- Lillesand.T.M. and Kiefer.R.W,“Remote Sensing and Image interpretation”, 6thEdition, John Wiley & Sons, 2000.
- John R. Jensen, “Introductory Digital Image Processing: A Remote Sensing Perspective”, 2nd Edition, Prentice Hall,1995.
- Richards, John A., Jia, Xiuping, “Remote Sensing Digital Image Analysis”,5th Edition, Springer-Verlag Berlin Heidelberg, 2013.
- Paul Curran P.J. Principles of Remote Sensing, 1st Edition, Longman Publishing Group, 1984.
- Charles Elachi, Jakob J. van Zyl, “Introduction to The Physicsand Techniques of Remote Sensing”, 2nd Edition, Wiley Serie, 2006.
- Sabins, F.F.Jr, “Remote Sensing Principles and Image Interpretation”, 3rd Edition, W.H.Freeman& Co, 1978

ECEE-4144: Physics of Semiconductor Devices

Course Outcomes:

At the end of this course, students will be able to

- Understand the basic of Quantum Mechanics.
- Understand the Quantum Theory of Solids.
- Understand the Energy equilibrium for semiconductors.
- Understand the characteristic of Semiconductor Junction
- Understand the Physic of MOS.

Syllabus Contents:

Unit-1

Introduction to Quantum Mechanics: Principles of Quantum Mechanics, Schrodinger's Wave Equation, Applications of Schrodinger's Wave Equation, Extensions of the Wave Theory to Atoms.

Unit-2

Introduction to the Quantum Theory of Solids: Allowed and Forbidden Energy Bands, Electrical Conduction in Solids, Extension to Three Dimensions, Density of States Function, Statistical Mechanics.

Unit-3

The Semiconductor in Equilibrium: Charge Carriers in Semiconductors, Dopant Atoms and Energy Levels, The Extrinsic Semiconductor, Statistics of Donors and Acceptors, Charge Neutrality, Position of Fermi Energy Level, Carrier Drift, Carrier Diffusion, Graded Impurity Distribution.

Unit-4

The pn Junction: Basic Structure of the pn Junction, Zero Applied Bias, Reverse Applied Bias, Non-uniformly Doped Junctions, pn Junction Current, Small-Signal Model of the pn Junction, Generation-Recombination Currents, Junction Breakdown, Charge Storage and Diode Transients

Unit-5

MOSFET Characteristics: Threshold Voltage, Current-Voltage Characteristics, p-Channel MOSFETs, MOSFET Capacitances, Junction Leakage Currents, Parasitic Resistances, Scaling Theory, Short-Channel Effects, Narrow-Width Threshold Voltage, Hot Electrons.

Text Book and References:

- Semiconductor Physics and Devices by Donald A. Neamen, McGraw-Hill Higher-Education.
- CIRCUIT DESIGN for CMOS VLSI by John P. Uyemura, Springer Science Business Media, LLC
- Semiconductor Device Physics and Design By Umesh K. Mishra And Jasprit Singh, Springer.

ECEE-4145: Computer Vision

Course Outcomes:

At the end of this course, students will be able to

- Study the image formation models for computer vision.
- Study the feature extraction for computer vision.
- Knowledge representation for computer vision.
- Identify the segmentation and motion detection and estimation techniques.
- Develop small applications and detect the objects in various applications.

Syllabus Contents:

Unit-1

Image Formation Models

Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems, Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration. Apparel, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto calibration. Apparel, Stereo vision.

Unit-2

Feature Extraction

Image representations (continuous and discrete), Edge detection, Edge linking, corner detection, texture, binary shape analysis, boundary pattern analysis, circle and ellipse detection, Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.

Unit-3

Shape Representation and Segmentation

Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multi-resolution analysis, Region

Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation.

Unit-4
Motion Detection and Estimation
Regularization theory, Optical computation, Stereo Vision, Motion estimation, Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation, Structure from motion, Motion Tracking in Video.

Unit-5
Object recognition
Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition. Applications of Computer Vision

Text Book and References:

- D. Forsyth and J. Ponce,"Computer Vision - A modern approach", 2nd Edition, Pearson Prentice Hall, 2012
- Szeliski, Richard, "Computer Vision: Algorithms and Applications", 1st Edition, Springer-Verlag London Limited, 2011.
- Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", 2nd Edition, Cambridge University Press, 2004.
- K. Fukunaga,"Introduction to Statistical Pattern Recognition",2ndEdition, Morgan Kaufmann, 1990.
- Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rd Edition,
  Prentice Hall, 2008.
- B. K. P. Horn, "Robot Vision", 1st Edition, McGraw-Hill, 1986.
  E. R. Davies"Computer and Machine Vision: Theory, Algorithms, Practicalities", 4th
  Edition, Elsevier Inc, 2012.

ECEC-421: Information Theory and Coding

Course Outcomes:
At the end of this course, students will be able to:
- Design the channel performance using information theory.
- Comprehend various error control properties.
- Apply linear block codes for error detection and correction.
- Apply convolution codes for performance analysis & cyclic codes for error detection and correction.
- Design BCH & RS codes for channel performance improvement against burst errors.

Syllabus Contents:

Unit-1
Source Coding - Introduction to information theory, uncertainty and information, average mutual information and entropy, source coding theorem, Shannon-fano coding, Huffman

coding, Adaptive Huffman coding, Arithmetic coding, Lempel-Ziv algorithm, run-length encoding and rate distortion function.

Unit-2

Channel capacity and coding - channel models, channel capacity, channel coding, information capacity theorem, random selection of codes. Error control coding: linear block codes and their properties, decoding of linear block code, perfect codes, hamming codes, optimal linear codes and MDS codes.

Unit-3

Cyclic codes - polynomials, division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, burst error correction, fire codes, golay codes, CRC codes, circuit implementation of cyclic codes. BCH codes: minimal polynomials, generator polynomial for BCH codes, decoding of BCH codes, Reed-Solomon codes and nested codes.

Unit-4

Convolutional codes - tree codes and trellis codes, polynomial description of convolutional codes, distance notions for convolutional codes, generation function, matrix description of convolutional codes, viterbi decoding of convolutional codes, distance bounds for convolutional codes, turbo codes and turbo decoding.

Unit-5

Trellis Coded Modulation - concept of coded modulation, mapping by set partitioning, ungerboeck's TCM design rules, TCM decoder, Performance evaluation for Additive White Gaussian Noise (AWGN) channel, TCM for fading channels.

Text Book and References :

- Ranjan Bose, "Information theory, coding and cryptography", Tata McGraw Hill, 2002.
- Viterbi, "Information theory and coding", McGraw Hill, 1982.
- John G. Proakis, "Digital Communications", 2nd Edition, McGraw Hill, 1989.
- G. A. Jones and J. M. Jones, "Information and Coding Theory", Springer, 2000.
- R. W. Hamming, "Coding and Information Theory", Prentice Hall, 1986.
- T. K. Moon, "Error Correction Coding: Mathematical Methods and Algorithms", Wiley, 2006
- S. Lin and D. J. Costello, "Error Control Coding: Fundamentals and Application", 1983

ECEC-422: MEMS and Microsystems

Course Outcomes:

At the end of this course, students will be able to

- Understand the semiconductor based MEMS Devices.

- Understand the working principle of MEMS devices.
- Learn the various types of actuators and sensors.
- Learn the modelling and simulation of MEMS Devices.
- Understand the MEMS interfacing Circuit.

Syllabus Contents:

Unit 1

Introduction to MEMS, Micro-System; Evolution of Micro-System; Integrated Microsystem: Micromechanical Structure; Micro-Sensor, Micro-Actuator, Sensor Characteristic; Physical Principle of Sensing; Application of Smart Material and Microsystem.

Unit 2

MEMS Materials: metal and metal alloys for MEMS, Polymers for MEMS, Composite MEMS materials, MEMS Material Properties: Mechanical properties of materials: Shear stress and strain, Poissson's ratio, Yield and tensile strength, other mechanical properties: creep, fatigue, piezoelectricity and piezo-resistivity, Semiconductor sensor technologies.

Unit 3

Mechanics of beam and diaphragm structures: Stress and Strain; Stress and Strain of Beam Structures; Vibration Frequency by Energy Method; Vibration Modes and the Buckling of a Beam; Damped and forced vibration; Basic Mechanics of Diaphragms.

Unit 4

MEMS Micro-sensors: Thermal MEMS micro sensors, Mechanical micro machined micro sensor, MEMS pressure and Flow sensors, Micro machined flow sensor, MEMS Inertial sensors.

Unit 5

MEMS Accelerometers: Piezo-resistive accelerometer technology, MEMS capacitive accelerometer, MEMS Gyro sensor, MEMS for space application, MEMS for Bio-medical applications.

Text Book and References:

- "Analysis and Design Principles of MEMS Devices", Minhang Bao, ELSEVIER, 2005, ISBN: 0 444 51616
- "Microsystem Design", Stephen D.Senturia, Kluwer Academic publishers, ISBN: 0-7923-7246-8
- "Microsensors, MEMS, and Smart Devices" Julian W. Gardner, Vijay K. , Awadelkarim, John Wiley & Sons, Ltd, ISBN 0-471-86109-X
- "Handbook Of Modern Sensors Physics, Designs, and Applications", Jacob Fraden, Springer, ISBN 0-387-00750-4.

ELECTIVE-III

ECEE-4231: Wireless Sensors Networks
Course Outcomes: At the end of this course, students will be able to • Design wireless sensor network system for different applications under consideration. • Understand the hardware details of different types of sensors. • Understand radio standards and communication protocols. • Use operating systems and programming languages for wireless sensor nodes, performance of wireless sensor networks systems and platforms. • Handle special issues related to sensors like energy conservation and security challenges.
Syllabus Contents: **Unit-1** Applications of Ad Hoc Wireless Networks, Issues in Ad Hoc Wireless Networks: Medium Access Scheme, Routing, Multicasting, Transport Layer Protocols, Quality of Service Provisioning, self-organization, Security Addressing and Service Discovery - Energy management Scalability-Deployment Considerations, Ad Hoc Wireless Internet. **Unit-2** Challenges for WSNs–Difference between sensor networks and Traditional sensor networks, types of applications, Enabling Technologies for Wireless Sensor Networks –Single Node Architectures, Hardware Components, Energy Consumption of Sensor Nodes, Issues in Designing a Multicast Routing Protocol. **Unit-3** Flooding and Gossiping, Data gathering Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design Principles for WSNs Gateway Concepts, Need for gateway. **Unit-4** WSN to Internet Communication, Internet to WSN Communication –WSN Tunnelling ,MAC Protocols for Sensor Networks, Location Discovery, Quality of Sensor Networks, Evolving Standards, Other Issues- Low duty cycle and wake up concepts- The IEEE802.15.4 MAC Protocols- Energy Efficiency. **Unit-5** Mobile nodes - Gossiping and Agent based Unicast Forwarding-Energy Efficient Unicast, Broadcast and Multicast, Geographic Routing.
Text Book and References: • Holger Karl and Andreas Wiilig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons Limited 2008. • I.F .Akyildiz and Weillian, "A Survey on Sensor Networks", IEEE Communication Magazine, August 2007. • Jon S. Wilson, "Sensor Technology hand book", Elsevier publications, 2005.

- Anna Hac, “Wireless Sensor Networks Design” ,John Wiley& Sons Limited Publications 2003
- C. Siva Ram Murthy and B.S. Manoj, “Ad Hoc Wireless Networks”, Pearson Edition 2005

ECEE-4232: Biomedical Signal Processing

Course Outcomes:

At the end of this course, students will be able to

- Understand different types of biomedical signal.
- Understand the data acquisition for various biomedical signal.
- Identify and analyze different biomedical signals.
- Find applications related to biomedical signal processing
- Understand the various signal processing techniques.

Syllabus Contents:

Unit 1

Introduction to biomedical signals, nature and examples of biomedical signals: Action potential, ENG, EMG, ECG, EEG, event related potential, EGG, PCG, CP, speech signal etc. ECG signal acquisition, and difficulties in biomedical signal analysis.

Unit 2

Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes, Practical aspects of using electrodes, computer aided diagnosis system.

Unit 3

Stationary and non-stationary biomedical signal, filtering for removal of artifacts: noise in event related potentials, high frequency noise in the ECG, powerline interference in the ECG signal, time domain filters and frequency domain filters.

Unit 4

Classification of signals and noise, Spectral analysis of deterministic, stationary random Signals and non-stationary signals. Biomedical signal processing by Fourier analysis. Biomedical signal processing by wavelet (time frequency) analysis.

Unit 5

Event Detection: Waves in the ECG, Heart Sound, EEG rhythms waves and transients, Derivative-based methods, Pan-Tompkins algorithm for QRS detection. Correlation analysis of EEG channels: EEG rhythms detection, template matching. Cross-spectral techniques.

Text Book and References:

- Pramod K. Varshney, Manoj K. Arora, “Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data”, Springer, 2013.
- S. Svanberg, “Multi-spectral Imaging– from Astronomy to Microscopy – from Radio waves to Gamma rays”, Springer Verlag, 2009

ECEE-4233: CMOS Analog IC Design

Course Outcomes:

At the end of this course, students will be able to

- Analyze, design, optimize and simulate analog circuits using CMOS constrained by the design metrics.
- Understand the MOS as switch.
- Understand the basic component of Operational Amplifier.
- Connect the individual CMOS to form the building blocks of an IC.
- Use EDA tools like Cadence, Synopsis and other open source software tools.

Syllabus Contents:

Unit – 1

The MOS Transistor, Passive components: resistor and Capacitor, CMOS device modeling, Model Parameters, Large Signal Model, Small signal Model, Sub-threshold MOS Model, Computer Simulation Model.

Unit – 2

MOS Switch, MOS Diode, MOS active resistor, Current sinks and sources Current Mirror with beta Helper, Current and Voltage references.

Unit-3

Switched Capacitor circuits: basic building blocks, Operation and Analysis, Non-ideal effects in switched capacitor circuits, Switched capacitor integrators, first order filters

Unit -4

Inverters, Differential Amplifiers, Cascode Amplifiers, Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Power-Supply Rejection Ratio of Two-Stage Op Amps, Cascode Op Amps, Measurement Techniques of OP Amp.

Unit – 5

Two-Stage, Open-Loop Comparators, Other Open Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators

Text Book and References:

- J P Rabaey, A P Chandrakasan, B Nikolic, “Digital Integrated circuits: A design perspective”, Prentice Hall electronics and VLSI series, 2nd Edition.
- Baker, Li, Boyce, “CMOS Circuit Design, Layout, and Simulation”, Wiley, 2nd Edition.
- BehzadRazavi , “Design of Analog CMOS Integrated Circuits”, TMH, 2007.
- Phillip E. Allen and Douglas R. Holberg, “CMOS Analog Circuit Design”, Oxford, 3rd Edition.
- R J Baker, “CMOS circuit Design, Layout and Simulation”, IEEE Inc., 2008.
- Kang, S. and Leblebici, Y., “CMOS Digital Integrated Circuits, Analysis and Design”, TMH, 3rd Edition.
- Pucknell, D.A. and Eshraghian, K., “Basic VLSI Design”, PHI, 3rd Edition.

ECEE-4234: RTL Simulation and Synthesis with PLD

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

- Familiarity of Finite State Machines, RTL design using reconfigurable logic.
- Write the Hardware Descriptive Language for Logic Devices.

- Learn the concept of power optimization.
- Design and develop IP cores and Prototypes with performance guarantees.
- Use EDA tools like Cadence, Mentor Graphics and Xilinx.

Syllabus Contents:

Unit-1
Top down approach to design, Design of FSMs (Synchronous and asynchronous), Static timing analysis, Meta-stability, Clock issues, Need and design strategies for multi-clock domain designs.

Unit-2
Design entry by Verilog/VHDL/FSM, Verilog AMS.

Unit-3
Programmable Logic Devices, Introduction to ASIC Design Flow, FPGA, SoC, Floor Planning, Placement, Clock tree synthesis, Routing, Physical verification, Power analysis, ESD protection.

Unit-4
Design for performance, Low power VLSI design techniques. Design for testability.

Unit 5
IP and Prototyping: IP in various forms: RTL Source code, Encrypted Source code, Soft IP, Netlist, Physical IP, Use of external hard IP during prototyping

Text Book and References:

- W. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall, 1993.
- Eugene N Bruce, "Biomedical Signal Processing and Signal Modeling", John Wiley & Son's _publication, 2001.
- Myer Kutz, "Biomedical Engineering and Design Handbook, Volume I", McGraw Hill, 2009.
- D C Reddy, "Biomedical Signal Processing", McGraw Hill, 2005.
- Katarzyn J. Blinowska, Jaroslaw Zygierewicz, "Practical Biomedical Signal Analysis Using MATLAB", 1st Edition, CRC Press, 2011.

ECEE-4235: FPGA Design

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

- Understand the different types of Programmable logic devices.
- Learn the working of principle of FPGA devices.
- Learn the implementation of algorithm of FPGA devices.
- Learn the optimization of FPGA.
- Learn the placement and routing of FPGA design.

Syllabus Contents:

Unit –1
Evolution of programmable devices: Introduction to AND-OR structured Programmable Logic Devices PROM, PLA, PAL and MPGAs; Combinational and sequential circuit

realization using PROM based Programmable Logic Element (PLE); Architecture of FPAD, FPLA, FPLS and FPID devices.

Unit – 2
FPGA Technology: FPGA resources - Logic Blocks and Interconnection Resources; Economics and applications of FPGAs; Implementation Process for FPGAs Programming Technologies - Static RAM Programming, Anti Fuse Programming, EPROM and EEPROM Programming Technology; Commercially available FPGAs - Xilinx FPGAs, Altera FPGAs; FPGA Design Flow Example - Initial Design Entry, Translation to XNF Format, Partitioning, Place and Route, Performance Calculation and Design Verification.

Unit – 3
Technology Mapping for FPGAs: Logic Synthesis - Logic Optimization and Technology Mapping; Lookup Table Technology Mapping - Chortle-crf Technology Mapper, Chortle-d Technology Mapper, Lookup Table Technology Mapping in mis-pga, Lookup Table Technology Mapping in Asyl and Hydra Technology Mapper; Multiplexer Technology Mapping - Multiplexer Technology Mapping in mis-pga.

Unit – 4
Routing for FPGAs: Routing Terminology; Strategy for routing in FPGAs; Routing for Row-Logic Block Architecture: Logic Block Functionality versus Area-Efficiency - Logic Block Selection, Experimental Procedure, Logic Block Area and Routing Model and Results.

Unit – 5
Based FPGAs - Segmented channel routing, 1-channel routing algorithm, K – channel routing algorithm and results.

Text Book and References:

- FPGA-Based System Design by Wayne Wolf, Verlag: Prentice Hall
- Modern VLSI Design: System-on-Chip Design (3rd Edition) by Wayne Wolf, Verilog.
- A Verilog HDL primer by Jayaram Bhasker, Star Galaxy Pub.

ELECTIVE-IV

ECEE-4241: Artificial Intelligence

Course Outcomes:

At the end of this course, students will be able to

- Understand the different search technique.
- Understand the concept of Artificial Intelligence, search techniques and knowledge representation issues.
- Understand the statistical problem solving.
- Understanding reasoning and fuzzy logic for artificial intelligence.
- Understanding game playing and natural language processing.

Syllabus Contents:

UNIT 1:
Introduction to AI: Foundation of AI, History of AI, The Key Concept of AI, Classification under AI, Criteria of Success, Knowledge Representation: Representation and Mapping, Approach to Knowledge Representation. Using Predicate Logic: Representation Simple Fact in Logic, Representation Instance and ISA Relationship, Computation Function and Predicate. Frame and Slot.

UNIT 2:
Search Methodology: Problem Solving as Search, Search Tree, Data-Driven or Goal-Driven Search, Generate and Test, Depth-First Search, Breadth-First Search, Properties of Search Methods: Complexity, Completeness, Optimality, Irrevocability; Hill Climbing; Best-First Search; Beam Search; Identifying Optimal Paths: A* Algorithms, Uniform Cost Search, Greedy Search, Genetic Algorithm.

UNIT 3:
Learning Process: Introduction, Error Correction Learning, Memory Base Learning, Hebbian
Learning, Competitive Learning, Credit Assign Learning, Learning with a Teacher, Learning without a Teacher, Learning Task; Memory; Adaptation; Statistical Nature of the Learning Process, Recurrent Network: Hopfield Networks, Bidirectional Associative Memories.

UNIT 4:
Introduction to Perceptron, Multilayer Perceptron (MLP): Back Propagation, Improving the performance of Back Propagation; Issues in Back propagation: Batch versus online Learning, Activation Function, Initialization of weight, Moment and speed of conversance, Stopping Criteria, Local Minima, Weight decay and Generation. Adaptive parameter, The number of Hidden Neurons, Introduction to Convolutional Network (CNN): Working principle of CNN, Architecture of CNN, and Application of CNN.

UNIT 5:
Fuzzy logic: Introduction, Fuzzy set, Set operation, Boolean logic, Basic Concept of Fuzzy set, Representation of Fuzzy Set, Fuzzy set Properties, Operation of Fuzzy set, Algebraic Operations on Fuzzy Sets, Classical Relations, Classical Reasoning, Fundamentals of Fuzzy Relations, Operations on Binary Fuzzy Relations, Types of Fuzzy Relations, Fuzzy Reasoning, Examples.

Text Book and References:

- Elaine Rich and Kevin Knight "Artificial Intelligence", 2nd Edition, Tata Mcgraw-Hill, 2005.
- Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2009
- "Neural Networks A comprehensive foundation", Simon Haykin, Prentice Hall International, Inc., ISBN 0139083855, Second Edition.
- "Artificial Intelligence A modern approach", Stuart J. Russell and Peter Norvig, Prenyice Hall, Inc., ISBN 0131038052, 1995.
- "Artificial Intelligence Illuminated", Ben Coppin, Jones and Batlett Publishers, 2004, ISBN 076373230.
- "Artificial intelligence A system Approach", M.Tim Jones, Infinity Science Press LLC, 2008, ISBN: 978-0-9778582-3-1
- Elaine Rich and Kevin Knight "Artificial Intelligence", 2nd Edition, Tata Mcgraw-Hill, 2005.

ECEE-4242: Advanced Computer Architecture

Course Outcomes:

At the end of this course, students will be able to

- Understand parallelism and pipelining concepts, the design aspects and challenges.
- Understand the application of pipelining and parallelism.
- Evaluate the issues in vector and array processors.
- Understand the Architecture of Microprocessor.
- Study and analyze the high performance scalable multithreaded and multiprocessor systems.

Syllabus Contents:

Unit-1

Parallel Processing and Pipelining Processing- Architectural Classification, Applications of parallel processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture.

Unit-2

Pipeline Architecture-Principles and implementation of Pipelining, Classification of pipelining processors, Design aspect of Arithmetic and Instruction pipelining, Pipelining hazards and resolving techniques, Data buffering techniques, Advanced pipelining techniques, Software pipelining, VLIW (Very Long Instruction Word) processor.

Unit-3

Vector and Array Processor- Issues in Vector Processing, Vector performance modeling, SIMD Computer Organization, Static Vs Dynamic network, Parallel Algorithms for Array Processors: Matrix Multiplication.

Unit-4

Multiprocessor Architecture - Loosely and Tightly coupled multiprocessors, Inter Processor communication network, Time shared bus, Multiport Memory Model, Memory contention and arbitration techniques, Cache coherency and bus snooping, Massively Parallel Processors (MPP).

Unit-5

Multithreaded Architecture- Multithreaded processors, Latency hiding techniques, Principles of multithreading, Issues and solutions, Parallel Programming Techniques: Message passing program development.

Text Book and References:

- Kai Hwang, Faye A. Briggs, “Computer Architecture and Parallel Processing” McGraw Hill Education, 2012.
- Kai Hwang, “Advanced Computer Architecture”, McGraw Hill Education, 1993.
- William Stallings, “Computer Organization and Architecture, Designing for Performance” Prentice Hall, 6th edition, 2006.
- Kai Hwang, “Scalable Parallel Computing”, McGraw Hill Education, 1998.
- Harold S. Stone “High-Performance Computer Architecture”, Addison-Wesley, 1993.

ECEE-4243: Cognitive Radio

Course Outcomes:

At the end of this course, students will be able to

- Understand the fundamental concepts of cognitive radio networks.
- Develop the cognitive radio, as well as techniques for spectrum holes detection that
- Cognitive radio takes advantages in order to exploit it.
- Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
- Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimisation techniques for better spectrum exploitation

Syllabus Contents:

Unit 1

Basic SDR, Software and Hardware Architecture of an SDR, Spectrum Management – Managing unlicensed spectrum, Noise Aggregation.

Unit 2

Introduction Hardware and Software architecture, SDR development process and Design – Application software, Component development, Waveform development cognitive waveform development.

Unit 3
Radio flexibility and capability, Aware, Adaptive, Comparison of Radio capabilities and properties Available Technologies, IEEE 802 Cognitive Radio related activities, Application.

Unit 4
Design Challenges associated with CR Hardware requirements, Hidden primary user problem detecting spread spectrum primary users sensing duration and frequency security.

Unit 5
Overview and Classification Matched filter , waveform based sensing , cyclostationary based sensing, Energy detector based sensing, Radio Identifier, Cooperative sensing- other sensing methods

Text Book and References:

- Paul Burns "Software Defined Radio for 3G" Artech House, 2002.
- Tony J Rouphael, "RF and DSP for SDR" Elsevier Newnes Press, 2008.
- Jouko Vanakka, "Digital Synthesizers and Transmitter for Software Radio" Springer, 2005
- P Kenington " RF and Baseband Techniques for Software Defined Radio" Artech House.

ECEE-4244: VLSI Testing and Testability

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

- Understand the different types of faults in digital circuits
- Learn the ATPG algebra for both combinational and sequential circuits
- Learn the use of scan chain in digital circuit testing
- Learn the Ad-hoc design for testability.
- Understand the Architecture like BIST, LFSR etc.

Syllabus Contents:

Unit – 1

Physical Faults and their modelling: Stuck at Faults, Bridging Faults, Fault detection, Fault Equivalence, Fault Dominance, Fault Collapsing and Checkpoint Theorem, General fault simulation techniques serial, parallel, concurrent and deductive fault simulation, critical path tracing.

Unit – 2
Introduction to Automatic Test Pattern Generation (ATPG) and ATPG Algebras, ATPG for single stuck-at faults and multiple stuck-at faults.
Standard ATPG Algorithms**:** D-algorithm. Basics of PODEM and FAN.

Unit – 3

ATPG for Single-Clock Synchronous Circuits, Use of Nine-Valued Logic and Time-Frame Expansion Methods, Complexity of Sequential ATPG

Scan Chain based Sequential Circuit Testing**:** Scan Cell Design, Design variations of Scan Chains, Sequential Testing based on Scan Chains, Overheads of Scan Design.

Unit – 4

Ad-hoc design for testability- test points, Controllability and Observability of digital circuits , partial scan and full scan, serial and non-serial scan; boundary scan standard.

Unit-5

Built in Self test, Architecture of BIST, LFSR and Compaction Techniques, Memory Testing:

Memory architecture, types of faults in memory and March Test

Text Book and References:

- Bushnell and V D Agarwal," Essential of Electronics Testing", Kluwer.
- Laung, Cheng and Xiaoqing" VLSI Test principles and architectures"Elsevier.
- Abramovici, M., Breuer, M. A. and Friedman, "A. D. Digital Systems Testing And Testable Design". IEEE press (Indian edition available through Jayco Publishing house), 2001.

ECEE-4245: Low Power VLSI Design

Course Outcomes:

At the end of the course, students will be able to:

- Identify the sources of power dissipation in digital IC systems & understand the impact of power on system performance and reliability.
- Characterize and model power consumption & understand the basic analysis methods.
- Design techniques of low power circuit.
- Understand leakage sources and reduction techniques.
- Design Low power memory.

Syllabus Contents:

Unit-1

Technology & Circuit Design Levels: Sources of power dissipation in digital ICs, degree of freedom, recurring themes in low-power, emerging low power approaches, dynamic dissipation in CMOS, effects of V_{dd} & V_t on speed, constraints on V_t reduction, transistor sizing & optimal gate oxide thickness, impact of technology scaling, technology innovations.

Unit-2

Low Power Circuit Techniques: Power consumption in circuits, flip-flops & latches, high capacitance nodes, energy recovery, reversible pipelines, high performance approaches.

Unit-3

Low Power Clock Distribution: Power dissipation in clock distribution, single driver Versus distributed buffers, buffers & device sizing under process variations, zero skew Vs. Tolerable skew, chip & package co-design of clock network.

Unit-4
Logic Synthesis for Low Power estimation techniques: Power minimization techniques, low power arithmetic components- circuit design styles, adders, multipliers.

Unit-5
Low Power Memory Design: Sources & reduction of power dissipation in memory subsystem, sources of power dissipation in DRAM & SRAM, low power DRAM circuits, low power SRAM circuits.

Text Book and References:

- P. Rashinkar, Paterson and L. Singh, "Low Power Design Methodologies", Kluwer Academic, 2002
- Kaushik Roy, Sharat Prasad, "Low power CMOS VLSI circuit design", John Wiley sons Inc.,2000.
- J.B.Kulo and J.H Lou, "Low voltage CMOS VLSI Circuits", Wiley, 1999.
- A.P .Chandrasekaran and R.W. Broadersen, "Low power digital CMOS design", Kluwer,1995
- Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998.

ECE0-5120:Fundamentals of Electronics and Communications

Course Outcomes:

At the end of this course, students will be able to

- Learn different digital logics and circuit.
- Understand the fundamental of semiconductor devices like diode and BJT and MOS.
- Understand the techniques of analog.
- Understand the techniques of digital communications.
- Study mobile cellular networks.

Syllabus Contents:

Unit-1
Binary Systems: Introduction to Digital Systems, Number systems, binary number system, Decimal to binary & binary to decimal conversion, representation of binary using hexadecimal Boolean Algebra and Logic Gates: Basic definitions, operators of Boolean algebra, basic theorems and properties of Boolean algebra, basic gates -AND, OR, NOT, XOR, NAND, NOR - only truth table & gate representation, Boolean functions, canonical or standard forms

Unit-2
Introduction to Electronic Devices, PN junction diode and characteristics, BJT characteristics, introduction of MOSFET and characteristics, CMOS logic gate.

Unit-3
Introduction to communication, need for modulation, modulation and demodulation techniques AM, FM and PM (Qualitative Analysis only), Block diagram of AM and FM transmitter and Receiver (Qualitative analysis) Sampling theorem, channel capacity, PAM,

PPM, PWM and PCM, Digital modulation technique ASK, PSK, QPSK (Qualitative Analysis only).

Unit-4

Introductory Aspects of Multiplexing and Multiple Accesses**:** FDM, TDM, FDMA, TDMA, CDMA and OFDM. Satellite Communication: Introduction, to Orbit, types of orbits, Block diagram of satellite transponder.

Unit-5

Evolution of Communication: 1^{st} generation, 2^{nd} generation, 3^{rd} generation 4^{th} generation and 5^{th} generation mobile communication, Basics of cellular communication (GSM, CDMA)- Cell architecture, Base stations, relay stations and principles of communication, Introduction to Bluetooth, Wi-Fi, and LTE network.

Text Book and References:

- Floyd T L "Digital Fundamentals", 7th Edition. (Pearson Education Asia), 2002
- M. Morris Mono, Digital Logic and Computer Design, 4 th Edition, Pearson, 2009
- Simon Haykins, An Introduction to Analog and Digital Communication, Wiley Student Edition, 2008.
- B. P. Lathi, Modern digital and analog Communication systems, 3rd Edition 2005 Oxford University press.
- Harold P.E, Stern Samy and A Mahmond, Communication Systems, Pearson Edition, 2004.
- Dennis Roody and John Coolen, Electronic Communication, 4th Edition, 2008.