Electronics Engineering Department

B. Tech. Electronics and Communication Engineering

Scheme

SEMESTER – V

Sr. No.	Subject	Code	Scheme	Credit	Examination Scheme				
					Theory Marks	Tutorial Marks	Term work Marks	Practical Marks	Total Marks
1.	Core-9 – Transmission Lines and Electromagnetic Waves	EC 301	3-1-2	05	100	25	25	25	175
2.	Core-10 – Digital Communication	EC 303	3-1-2	05	100	25	25	25	175
3.	Core-11 – Digital Signal Processing	EC 305	3-1-2	05	100	25	25	25	175
4.	Seminar	EC 307	0-0-2	01	-	-	25	25	50
5.	Institute Elective-1 - Sensors and Transducers - Neural Networks - Multimedia Communication	EC 361 EC 363 EC 365	3-0-0	03	100	-	-	-	100
6.	Core Elective- I - Computer Architecture and Organization - Data Structures and Algorithms - VLSI Technology - Digital Image Processing	EC 321 EC 323 EC 325 EC 327	3-0-0	03	100	-	-	-	100
		Total	**15-3-8=26**	**22**	**500**	**75**	**100**	**100**	**775**

SEMESTER – VI

Sr. No.	Subject	Code	Scheme	Credit	Examination Scheme				
					Theory Marks	Tutorial Marks	Term work Marks	Practical Marks	Total Marks
1.	Professional Ethics, Economics and Business Management*	HU 304	3-1-0	04	100	25	-	-	125
2.	Core-12 – Wireless and Mobile Communication	EC 302	3-1-2	05	100	25	25	25	175
3.	Core-13 – Digital Integrated Circuits	EC 304	3-1-2	05	100	25	25	25	175
4.	Core Elective Lab # - Optical Fiber Commmunication lab - Electronic Instrumentation lab - Machine Learning lab - Communication Networks lab	EC 306 EC 308 EC 312 EC 314	0-0-2	01	-	-	25	25	50
5.	Institute Elective-2 - High Performance Computing - Computer Vision - Micro - Electromechanical ystems	EC 362 EC 364 EC 366	3-0-0	03	100	-	-	-	100
6.	Core Elective- II - Optical Fiber Communication - Electronic Instrumentation - Machine Learning - Communication Networks	EC 322 EC 324 EC 326 EC 328	3-0-0	03	100	-	-	-	100
		Total	**15-3-6=24**	**21**	**500**	**75**	**75**	**75**	**725**

*Syllabus is prepared jointly by ASHD and concerned department and one hour on Ethics will be taught by the concerned department

The Core elective Labs are offered with reference to subjects offered under the pool of Core Elective-II and students have to elect the same Lab based on the their choice of subject as Core Elective -II

TRANSMISSION LINES AND ELECTROMAGNETIC WAVES

L	T	P	Credit
3	1	2	05

EC 301 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Describe** the basic concepts and theorems of electromagnetic theory and its applications.
CO2	**Explain** the wave propagation and radiation phenomenon in different environments.
CO3	**Apply** the principles of electromagnetic theory and wave propagation to model transmission line and radiating systems.
CO4	**Analyze** the theoretical concepts based on Maxwell's equation, transmission line theory and antennas.
CO5	**Evaluate** the wave propagation behavior between two mediums.
CO6	**Formulate** the aspects of electromagnetic theory for different application.

2. **Syllabus:**

- **TRANSMISSION LINE ANALYSIS (11 Hours)**
  Transmission Line Equations, Voltage and Current Waves, Solutions for Different Terminations, Transmission-line Loading, Impedance Transformation and Matching, Smith Chart, Quarter-wave and Half-wave Transformers, The Multiple Reflection Viewpoint, Binomial and Tchebeyshev Transformers, Single and Double Stub Matching, Introduction to Microstrip lines, Slot lines and Coplanar lines.

- **ELECTROMAGNETIC THEOREM and MAXWELL'S EQUATIONS (08 Hours)**
  Divergence and Stoke's Theorem, Coulomb's law, Gauss's law and Applications, Electric Potential, Poisson's and Laplace Equations, Biot-Savart's law, Faraday's law and Ampere's Work law in the Differential Vector form , Flux rule for Motional EMF, Magnetic Vector Potential, Introduction to The Equation of Continuity For Time Varying Fields, Inconsistency of Ampere's Law, Maxwell's Equation, Condition at a Boundary Surface, Poynting Theorem.

- **ELECTROMAGNETIC WAVES (06 Hours)**
  Solution for Free Space Conditions, Uniform Plane Waves and Propagation, The Wave Equations for a Conducting Medium, Sinusoidal Time Variations, Conductors and Dielectrics, Polarization, Reflection by a Perfect Conductor: Normal Incidence and Oblique Incidence, Reflection by a Perfect Dielectric: Normal Incidence and Oblique Incidence, Reflection at the Surface of a Conductive Medium.

- **RADIATION (11 Hours)**
  Potential functions and the Electromagnetic field, Oscillating Electric Dipole derivations for E and H field components in spherical coordinate systems, Power Radiated by a Current Element, Application to Antennas, Radiation from Quarter wave Monopole and Half wave Dipoles, Derivation for Radiation Resistance, Application of Reciprocity Theorem to Antennas, Equality of Directional Patterns and Effective Lengths of Transmitting and Receiving Antennas, Directional Properties of Dipole Antennas, Antenna Feeding Methods, Antenna Parameters and Definitions, Radiation from Wire Antenna.

- **GROUNDWAVE PROPAGATION** **(03 Hours)**
  Plane Earth Reflection, Spherical Earth Propagation, Tropospheric Waves.

- **IONOSPHERIC PROPAGATION** **(03 Hours)**
  The Ionosphere, Reflection and Refraction Waves by the Ionosphere, Regular and Irregular Variations of the Ionosphere.

- **TUTORIALS** **(14 Hours)**

(Total Contact Hours: 56)

3. Practicals:

1. To obtain Radiation Pattern of Dipole Antenna in two planes.
2. To observe Current Distribution on Dipole Antenna.
3. To obtain radiation Pattern of Yagi-Uda Antenna in two planes.
4. Measurement of Dielectric Constant using Solid Dielectric Cell
5. To determine the Standing Wave-Ratio and Reflection Coefficient for different loads
6. To measure an unknown impedance of the given load using Smith chart
7. Phase shift measurement of the given DUT
8. To do gain measurement of different antennas.
9. To realize impedance matching using single and double stub
10. Return loss measurement of given DUT
11. Insertion loss measurement of given DUT
12. To simulate Dipole antenna / Microstip Patch Antena in HFSS
13. To simulate waveguide based components in HFSS.

4. Books Recommended:

1. E.C. Jordan & G. Balmain, "Electromagnetic Waves and Radiating Systems", 2nd Ed., PHI, Reprint 2011.
2. R. K. Shevgaonkar, "Electromagnetic Waves", 1st Ed., Tata McGraw Hill, 2006.
3. M.N.O. Sadiku, "Principles of Electromagnetics", 4th Ed., Oxford University Press, 2011.
4. W.H. Hayt, "Engineering Electromagnetics", 7th Ed., McGraw Hill, 2006.
5. Roger F. Harrington, "Time-Harmonic Electromagnetic Fields", Wiley-IEEE Press, 2001.

DIGITAL COMMUNICATION

L	T	P	Credit
3	1	2	05

EC 303 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Describe** the basic knowledge of Digital communication including source coding, channel coding, modulation, line coding and equalization techniques as per the channel capacity requirements over various channels and also the point to point link for data communication.
CO2	**Explain** about signal processing aspects involved in digital communication with time and frequency domain fundamentals.
CO3	**Solve** the problems of digital communication techniques for optimizing the performance.
CO4	**Compare** performance analysis of various digital modulation and coding techniques for a link, case study and problem solving as per given parameters.
CO5	**Evaluate** various stages of digital communication link and system performance parameters by experimentation using modern tools/simulators and hardware.
CO6	**Design** the digital/data communication link with optimum parameter selection criteria satisfying given requirements.

2. Syllabus:

- **INTRODUCTION TO INFORMATION THEORY AND CODING (10 Hours)**

  Measurement of Information and Entropy, Mutual Information, Joint Entropy, Source Encoding fundamentals, Kraft Inequality, Shanon-Fano and Huffman Coding, Error-Free Communication over Channel, Channel Capacity, Shannon's Capacity Equation, Introduction to Vector Space, Introduction to Channel Coding fundamentals and Error Correcting Codes. Linear Block codes, Convolution codes

- **PRINCIPLES OF DIGITAL DATA TRANSMISSION AND RECEPTION (10 Hours)**

  Digital Communication System, Line Coding, Pulse Shaping For Optimum Transmission, ISI and ISI-Free transmission, Band-limiting of Rectangular Pulses, Raised Cosine Filtering, Duo binary Signaling, Scrambling, Regenerative Repeaters, Matched Filter And Equalizers, Timing Extraction, Eye Diagrams, M-ary Baseband Signaling For Higher Data Rate.

- **BANDPASS SIGNAL TRANSMISSION-DIGITAL CARRIER SYSTEM (10 Hours)**

  Representation Of Digital Modulated Signal, ASK, PSK, FSK, QAM (MODEMs) with Mathematics and Constellation Diagram, Spectral Characteristics of Digitally Modulated Signals. M-Ary Digital Carrier Modulation. Advance Modulation technique OFDM, Mathematical aspects of OFDM, OFDM transceiver.

- **BANDPASS SIGNAL RECEPTION (06 Hours)**
  Synchronization, Decision Theory, Bandpass Receiving Filter, Error Performance of Bandpass Systems, Performance Evaluation of Communication Systems, BER.

- **DIGITAL DATA COMMUNICATION FUNDAMENTALS (06 Hours)**
  Asynchronous And Synchronous Transmission over point to point link, Concept of Frames, Packets and Segments, Frame Error handling, Error Detection, Error Correction, Line Configurations, Serial Interface.

- **TUTORIAL (14 Hours)**

(Total Lecture Hours : 56)

3. Practicals:

1. Simulation of ASK, FSK, PSK, QAM with Performance Analysis under Channel Effects and BER.
2. Simulation of Line Coding Techniques.
3. Simulation and Implement the Effect of Raised Cosine Filter.
4. Simulation of Eye Diagram, Constellation Diagram, Etc.
5. Source Coding Techniques
6. Error Control Coding Techniques.
7. Data communication serial link analysis
8. OFDM modulator and demodulator by simulation

4. Books Recommended:

1. John G. Proakis and Masoud Salehi, “Digital Communications”, 5th Ed., McGraw-Hill, 2014.
2. Bhattacharya Amitabh, "Digital Communication", 1st Ed., Tata McGraw-Hill, 2006.
3. Lathi B.P. and Ding Zhu, "Modern Digital And Analog Communication Systems", 4th Ed., Oxford University Press, 2010.
4. Sklar Bernard, "Digital Communications — Fundamentals and Applications", 2nd Ed., Pearson Education-LPE, 2009.
5. Leon W. Couch, II “Digital and Analog Communication Systems”, 8th Ed., Pearson Education-LPE, 2013.

5. Reference Book:

1. R.N.Mutagi, “Digital communication- Theory, Techniques and Applications”, 1st Ed., Oxford Publications, 2012.

DIGITAL SIGNAL PROCESSING

L	T	P	Credit
3	1	2	05

EC305 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Describe** Discrete Time Signal, System and Discrete Fourier Transform.
CO2	**Implement** FIR and IIR Filters
CO3	**Analyze** Finite word length effect in Digital System
CO4	**Evaluate** various Realizations of filter structure
CO5	**Design** Multirate Signal Processing Systems.

2. **Syllabus:**

- **REVIEW OF DISCRETE TIME SIGNAL AND SYSTEMS (06 Hours)**

  Discrete - Time Signals, Signal classification, Discrete-time system & analysis of Discrete-time linear time invariant systems, Correlation of Discrete-time signals, Analysis of Linear Time invariant System in Z Domain, One sided Z-transform.

- **COMPUTATION OF THE DISCRETE FOURIER TRANSFORM (06 Hours)**

  Introduction, Direct evaluation of DFT, DFT symmetry relation, Fast Fourier Transform, Goertzel algorithm, Decimation-in-Time algorithm, Decimation-in-Frequency algorithm, Approaches to design radix-m algorithm. Implementation of DFT using convolution algorithm, The Discrete Time Cosine Transform, The Haar transform.

- **FIR FILTER DESIGN (07 Hours)**

  Causality and its implications, Linear Phase FIR filters, Frequency response of linear Phase FIR filters, Location of zeros of linear phase FIR filters, The Fourier Series method of designing FIR Filters, Design of FIR filter using different Windowing techniques, Digital differentiator, Hilbert transform, Frequency sampling method for designing FIR Filters, Various approach to design Optimum linear phase FIR filters.

- **IIR FILTER DESIGN (08 Hours)**

  Introduction, Frequency selective filter, Design of Digital Filter from Analog Filter, Analog low pass filter design, Analog low pass Butterworth filter, Analog low pass Chebyshev filter, Comparison between Butterworth filter and Chebyshev filter, Frequency transformation in analog domain, Design of high pass filter, bandpass and bandstop filters, Design of IIR filters From analog filters, Approximation of derivatives transformation method, Design of IIR filter using Impulse invariance technique, Design of IIR filter using Bilinear transformation, frequency transformation in digital Domain.

- **REALIZATION OF FILTER STRUCTURE (06 Hours)**

  Realization of FIR filters, Transversal structure, Linear phase realization, Lattice structure of FIR filter, Polyphase realization of FIR filter, Realization of Digital filter, Direct Form-I realization, Direct Form-II realization, Signal Flow Graph, Transposition theorem &Transposed structure, Cascade form, Parallel form structure, Lattice structure of IIR system, Comb Filter design, All-pass filter, Minimum phase, Maximum phase & Non-minimum phase systems. Tunable IIR digital filter

- **FINITE WORD LENGTH EFFECT IN DIGITAL SYSTEM (04 Hours)**

  Floating point numbers representation, Block floating point numbers representation, Quantization noise, Input Quantization error, Product Quantization error, Coefficient Quantization error, Quantization In floating point realization of IIR digital filters, Finite word length effect in FIR digital filters, Signal to Noise ratio in low-order IIR filter, Limit cycle in IIR digital filter, Round-off error in FFT Algorithm.

- **MULTIRATE SIGNAL PROCESSING (05 Hours)**

  Introduction, Down Sampling, Spectrum of down sampled signal, Up Sampling Spectrum of Up-sampled signal, Anti-Imaging filter, Cascading sample rate converters, Efficient transversal structure for decimator, Efficient transversal structure for interpolator, Polyphase structure of decimator, Polyphase decimation using Z-transform, Polyphase structure of interpolator, Polyphase interpolation using Z-transform, Multistage implementation of sampling rate conversion.

- **TUTORIAL (14 Hours)**

(Total Lecture Hours : 56)

3. Practicals:

1. Implementation of DFT & FFT algorithms
2. Finding the DFT and FFT for real-time signal.
3. Finding liner convolution and circular convolution for given signal.
4. Design FIR Filter for given specifications.
5. Design IIR Filter for given specification
6. Implementation of digital system and analysis finite word length effect for system.
7. Implementation of interpolation and decimation for given rate-conversion.
8. Speech and Musical sound processing.
9. Study of DSP Processor &Implement FIR Filter.
10. Linear prediction and optimum linear filter design using simulation & hardware.
11. Power spectrum analysis using the simulation.

4. Books Recommended:

1. Proakis J. G. and Manolakis D. G., "Digital Signal Processing: Principles, Algorithms And Applications", 4th Ed., Pearson Education, 2014.
2. Babu Ramesh P., "Digital Signal Processing", 4th Ed., SciTech Publication, 2008.
3. MitraSanjit K., "Digital Signal Processing: A Computer Based Approach", 4th Ed., Tata McGraw-Hill, 2011.
4. Oppenhein A. V. and Shafer R. W., "Discrete-Time Signal Processing", 3rd Ed., PHI, 2014.
5. Shaliwahan S., Vallavaraj A. and Gnanapriya C., "Digital Signal Processing", 2nd Ed., Tata McGraw-Hill, 2012.

5. Reference Books:

1. Padmanabhan K.,"A Practical Approach to Digital Signal Processing", 1st Ed., New Age International, 2001.
2. SudhankarRadhakrishna, “Application of Digital Signal Processing through practical Approaches”, 1st Ed., Intech Open, http:://dx.doi.org/10.5772/59529. 2015.
3. Fredric Cohen Tenoudji, “Analog and Digital Signal Analysis: From Basic to Applications”, Modern Acoustic and signal Processing. Ecllipse-Edition marketing, Paris-2012.

COMPUTER ARCHITECTURE AND ORGANIZATION

L	T	P	Credit
3	0	0	03

EC 321 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Identify** the functional architecture of computing systems.
CO2	**Estimate** the performance of various classes of machines, memories, pipelined architectures etc.
CO3	**Compare** CPU implementations, I/O methods etc.
CO4	**Analyze** fast methods of ALU and FP unit implementations.
CO5	**Design** an instruction encoding scheme for an ISA and Build large memories using small memories for better performance.

2. Syllabus:

- **DESIGN OF INSTRUCTION SET ARCHITECTURE (ISA)** **(12 Hours)**

  Various Addressing Modes and Designing of an Instruction Set, Concepts of Subroutine and Subroutine call and return, Introduction to CPU design, Instruction Interpretation and Execution, the instruction set of a modern RISC processor, including how constructs in high-level languages are realized;

- **PROCESSING UNIT** **(10 Hours)**

  The representation of both fixed- and floating-point numbers, together with hardware algorithms for fixed-point arithmetic operations; Basic processor organization, Data path in a CPU, Instruction cycle, Organization of a control unit - Operations of a control unit, Hardwired control unit, Micro programmed control unit.

- **MEMORY SUBSYSTEMS** **(10 Hours)**

  Memory Hierarchy; Cache memory design, Virtual Memory, A Real-World Example of Memory Management, DMA Controller, Overview of SRAM and DRAM Design; Memory bus between CPU and DDR3/DDR4 based SDRAM, Memory controller for DDR3/DDR4.

- **BUSES AND PROTOCOLS** **(10 hours)**

  Introduction to Input/output Processing, Programmed Controlled I/O transfer, Interrupt Controlled I/O transfer, Introduction to serial and parallel Bus systems, Popular bus architecture standard such as IDE, SCSI, ATA, SATA, USB and IEEE 1394, Network component and protocols such as Ethernet and CAN.

(Total Contact Hours: 42)

3. Books Recommended:

1. David. A. Patterson and John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", 5th Ed., Morgan-Kaufmann Publishers Inc. 2014
2. Linda Null and Julia Lobur, "The Essentials of Computer Organization and Architecture", 4th Ed., Jones & Bartlett Learning, 2014
3. Alan Clements, "Principles of Computer Hardware", 4th Ed., Oxford University Press, 2006
4. Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", McGraw-Hill, 2003
5. M. Morris Mano, "Digital Design", 3rd Ed., Prentice Hall, Upper-Saddle River, New Jersey, 2002

DATA STRUCTURES AND ALGORITHMS

L	T	P	Credit
3	0	0	03

EC 323 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Describe** the concept of dynamic memory management, data types, algorithms, Big-O notation, arrays, linked lists, stacks and queues.
CO2	**Apply** the hash function and concepts of collision and its resolution methods.
CO3	**Analyze** problems involving graphs, trees and heaps.
CO4	**Evaluate** algorithms for solving problems like sorting, searching, insertion and deletion of data.
CO5	**Design** a data structure to real-life problem.

2. **Syllabus:**

- **INTRODUCTION** **(04 Hours)**

  Algorithms as opposed to programs, Four Fundamental Data Structure, Complexity of Algorithms, Big Oh Notation, Complexity of Mergesort, Role of constant. Big Omega and Big Theta Notions, Time versus space complexity, Worst versus average complexity, Concrete measures for performance, Big-O notation for complexity class, Formal definition of complexity classes.

- **TYPE OF LIST** **(02 Hours)**

  Implementation of Lists, Array Implementation, loops and Iteration Pointer Implementation, Double Linked List Implementation, Stack, Queues, Circular array Implementation, Double linked list, Buddy System Memory Allocation

  SEARCHING ALGORITHMS

  Requirements for searching, Specification of the search problem, A simple algorithm: Linear Search, A more efficient algorithm: Binary Search.

- **DICTIONARIES& HASH TABLES** **(06 Hours)**

  Various Sets of Dictionary, Implantation of Dictionaries, Hash Tables, Closing of Hashing, Analysis of Closed Hashing, Skip Lists, Analysis og Skip Lists.

- **BINARY TREES** **(05 Hours)**

  Definition, Quad trees, Preorder, Inorder, Postorder, Data structures for tree representation, Binary Trees, Binary Trees for Huffman Code construction, Binary Search Tree, Splay Trees, Search, Insert, Delete in Bottom-up Splay, Amortized Algorithm Analysis.

- **BALANCED TREES** **(04 Hours)**

  AVL Trees, Maximum Height of an AVL Tree, Insertions and Deletions, Red-Black Trees, 2-3 Trees, B-Trees, Variants of B-Trees

- **PRIORITY QUEUES AND HEAP TREES** **(04 Hours)**

  Binary Heaps, Creating heap, Implementation of Binary heap, Binomial Queues, Binomial Queue Operations, Binomial Amortized Analysis, Lazy Binomial Queues, Fibonacci heaps, heap time complexity comparision.

- **DIRECTED GRAPHS** **(07 Hours)**

  Data Structures for Graph Representation, Shortest path Problem, Single shortest paths problmes, Dynamic programing Algorithms, Warshall's Algorithms, Depth First Search and breadth search, Directed Acyclic Graphs.

- **UNDIRECTED GRAPHS** **(04 Hours)**

  Some Definitions, Breadth-first search of undirected graphs, Minimum-Cost Spanning, MST Property, Prim's Algorithm, Kruskal's Algorithm, Traveling Salesman Problem using greedy algorithm.

- **SORTING METHODS** **(06 Hours)**

  Bubble Sort, Insertion Sort, Selection Sort, Shellsort, Heap Sort, Quick Sort, Algorithm for Partitioning, Average Case Analysis, Order Statistics, Lower Bound on Complexity for Sorting Methods, Lower Bound on Worst Case Complexity, Lower Bound on Average Case Complexity, Radix Sorting, Merge Sort, Heap Sort and Quicksort, Mergesort.

(Total Lecture Hours:42)

3. Books Recommended:

1. Mark A. Weiss, "Data Structures and Algorithm Analysis in C++", 4th Ed., Published by Pearson (June 13th 2013).
2. Gilles Brassard, "Fundamentals of Algorithms", Pearson Education 2015.
3. E. Horowitz, S. Sahni and S. Rajasekaran, "Computer Algorithms/C++", Second Edition, University Press, 2007.
4. A. V. Aho, J. E. Hopcroft, and J. D. Ullman. Data Structures and Algorithms. Addison-Wesley, Reading, Massachusetts, 1983.
5. Anany Levitin "Introduction to the Design and Analysis of Algorithms" Pearson Education, 2015.

4. Book Recommended:

1. Richard F. Gilberg, Behrouz A. Forouzan, "Data Structures – A Pseudocode Approach with C++", Thomson Brooks / COLE, 1998.

VLSI TECHNOLOGY

L	T	P	Credit
3	0	0	03

EC 325 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Explain** various aspects of VLSI chip fabrication and techniques used for realizing metals, semiconductors and insulators on a wafer.
CO2	**Illustrate** micro-fabrication processes along with their flow diagrams for various geometrical shapes.
CO3	**Analyze** micro-fabrication practices and their variants.
CO4	**Evaluate** the suitability of processes depending on the structures to be fabricated.
CO5	**Develop** process flow for various devices.

2. **Syllabus:**

- **SILICON WAFERS** **(08 Hours)**
  Clean Room and Safety Requirements, Crystals and Growth, Wafer Cleaning, Wet Chemical Etching Techniques, Plasma Enhanced and RIE Etching, Oxidation and Oxide Kinetics.

- **IMPURITY INCORPORATION** **(06 Hours)**
  Concept of Doping, Diffusion Modeling and Technology, Ion Implantation Modeling and Technology, Damage Annealing, Characterization of Impurity Profiles, RTP Techniques for Annealing.

- **PATTERNING** **(06 Hours)**
  Photolithography, E-Beam Lithography, Newer Lithography Techniques for VLSI / ULSI, Mask Generation, Limits of Lithography.

- **DEPOSITION** **(06 Hours)**
  CVD Techniques for Deposition of Polysilicon, Silicon Dioxide, Silicon Nitride, High K And Low K Dielectrics For ULSI, Epitaxial Growth of Silicon, Plasma Enhanced CVD.

- **METALLIZATION** **(04 Hours)**
  Evaporation and Sputtering Techniques, Failure Mechanisms in Metal Interconnects, Multi-level Metallization Schemes.

- **CMOS PROCESS** **(12 Hours)**
  Basic n–well CMOS Process, Gate Surround Process, Layout Design Rules and Back-end Design, Latch-up: Origin, Triggering, Prevention Techniques, Interconnects, Bonding and Packaging, Process Integration, SOI Technology, 3D Integration Techniques.

(Total Lecture Hours:42)

3. Books Recommended:

1. Sze S. M., “Semiconductor Devices, Physics and Technology”, 2nd Ed., John Wiley and Son’s, 2002.
2. Plummer, Deal, Griffin, “Silicon VLSI Technology Fundamentals Practice and Modeling”, Pearson Education Limited, 2014.
3. Baker R. Jacob, “CMOS Circuit Design, Layout and Simulation”, 4th Ed., Wiley-IEEE Press, 2019.
4. Ghandhi S. K., "VLSI Fabrication Principles", 2nd Ed., John Wiley Inc., New York, 1994.
5. Kang, Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, 4th Ed., Mc Graw Hill India, 2016.

4. Reference Books:

1. Rabaey Jan, Chandrakasan Anantha and Borivoje Nikolic,"Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Ed., Second Impression, 2008.
2. J. Knechtel, O. Sinanoglu, I. M. Elfadel, J. Lienig, C. C. N. Sze, "Large-Scale 3D Chips: Challenges and Solutions for Design Automation, Testing, and Trustworthy Integration", IPSJ Transactions on System LSI Design Methodology, vol. 10, pp. 45–62, Aug. 2017.
3. International Technology Roadmap for Semiconductors 2011 Edition.
4. Garrou, Philip (6 August 2008). "Introduction to 3D Integration" (PDF). Handbook of 3D Integration: Technology and Applications of 3D Integrated Circuits. Wiley-VCH.

DIGITAL IMAGE PROCESSING

L	T	P	Credit
3	0	0	03

EC 327 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Discuss** Fourier transform for image processing in frequency domain and Compare the image compression techniques in spatial and frequency domains.
CO2	**Apply** techniques for image enhancement both in spatial and frequency domains.
CO3	**Analyze** causes for image degradation and apply restoration techniques.
CO4	**Evaluate** different image segmentation techniques.
CO5	**Develop** solutions using morphological concepts.

2. **Syllabus:**

- **INTRODUCTION** **(02 Hours)**
  Digital Image, Image Processing origins; Imaging in X-Rays, Ultraviolet, Visible Infrared, Visible, Microwave and Radio Bands; Fundamentals of Image Processing; Components of Image Processing Systems.

- **DIGITAL IMAGE FUNDAMENTALS** **(06 Hours)**
  Visual Perception — Human Eye, Brightness Adaptation and Discrimination, Electromagnetic Spectrum; Image Sensing and Acquisition — Single, Strip and Array Sensors, Image Formation Models; Image Sampling and Quantization — Basic Concepts, Representation of Image, Special and Gray Level Resolution, Aliasing, Zooming and Shrinking; Relationships Between Pixels-Nearest Neighbor, Adjacency, Connectivity, Regions, and Boundaries; Distance Measures; Image Operations on a Pixel Basis; Linear and Nonlinear Operations.

- **IMAGE ENHANCEMENT** **(08 Hours)**
  Gray Level Transformations-Image Negatives, Log, Power-Law and Piecewise Linear Transformation Functions; Histogram Processing -Equalization, Matching; Enhancement Operations - Arithmetic, Logic, Subtraction and Averaging; Spatial Filtering -Linear and Order-Statistics for Smoothing, First and Second Derivatives/Gradients for Sharpening, 2-D Fourier Transform, Its Inverse and Properties; Discrete and Fast Fourier Transform; Convolution and Correlation Theorems; Filtering in Frequency Domain - Low Pass Smoothing, High Pass Sharpening, Homomorphic Filtering.

- **IMAGE RESTORATION** **(08 Hours)**
  Image Degradation and Restoration Processes; Noise 'Models - Spatial Properties, Noise Probability Density Functions, Periodic Noise, Estimation Of Noise Parameters; Restoration in the Presence Of Noise and Mean Filters, Order-Statistics Filters, Adaptive Filters; Linear Position-Invariant Degradations and Estimation; Geometric Transformations - Spatial Transformation, Gray-Level Interpolation.

- **IMAGE COMPRESSION** **(04 Hours)**
  Fundamentals of Compression, Image Compression Model, and Error free Compression, Lossy Predictive Coding, and Transform Coding.

- **MORPHOLOGICAL IMAGE PROCESSING** **(04 Hours)**
  Preliminaries-Set Theory and Logic Operations in Binary Images; Basic Morphological Operations - Opening, Closing Operators, Dilation and Erosion, Morphological Algorithms - Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons; Extension of Morphological Operations to Gray-Scale Images.

- **IMAGE SEGMENTATION** **(06 Hours)**
  Detection of Discontinuities - Point, Line and Edges; Edge Linking and Boundary Detection-Local Processing, Global Processing Using Hough Transform; Thresholding - Local, Global and Adaptive; Region-Based Segmentation - Region Growing, Region Splitting and Merging; Motion Detection.

- **IMAGE REPRESENTATION AND DESCRIPTION** **(04 Hours)**
  Representations - Chain Codes, Polygonal Approximations, Signatures, Boundary Segments, Skeletons; Boundary Descriptors - Shape Numbers, Statistical Moments; Regional Descriptors - Topological, Texture and Moments Of 2-D Functions.

(Total Contact Hours : 42)

3. <u>Books Recommended:</u>

1. Gonzalez R. C. and Woods R. E, "Digital Image Processing", 3rd Ed., Pearson Prentice Hall, 2008.
2. Sonka M. Hlavac V., Boyle R., "Image Processing, Analysis and Machine Vision", Cengage Learning, 2nd Ed. Indian Reprint, 2009.
3. Jain R., Kasturi R. and Schunk B., "Machine Vision", 1st Ed., McGraw - Hill, 1995.
4. Jain A. K., "Fundamentals of Digital Image Processing", 1st Ed., PHI, 1989.
5. W Pratt, “Digital Image Processing”, Wiley , 2001

SENSORS AND TRANSDUCERS

L	T	P	Credit
3	0	0	03

EC 361 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Explain** the different types of sensors and transducers with working principle.
CO2	**Apply** the concepts of sensors for various applications.
CO3	**Analyze** different sensors and transducers for various applications.
CO4	**Evaluate** the applications of sensors in instrumentation.
CO5	**Design** the sensors systems for different applications.

2. **Syllabus:**

- **INTRODUCTION TO SENSOR-BASED MEASUREMENT SYSTEMS (04 Hours)**
  General Concepts And Terminology, Definition of Sensor, Transducer And Actuator, Transducer/Sensor Classification, Criteria to Choose a Transducer/Sensor, Static and Dynamic Characteristics of Sensors.

- **RESISTIVE TRANSDUCERS (05 Hours)**
  Potentiometers Type: Forms, Materials, Resolution, Accuracy, Sensitivity, Strain Gauges: Theory, Types, Materials, Design Consideration, Sensitivity, Gauge Factor, Adhesives, Rosettes, Applications Force, Velocity and Torque Measurements, Resistive Temperature Detectors (RTDs), PTD, Thermistors, Light-Dependent Resistors (LDRs), Resistive Hygrometers, Resistive Gas Sensors.

- **CAPACITIVE TRANSDUCERS (05 Hours)**
  Working Principle of Capacitive Transducer, Variable Distance-parallel plate type, Variable Area-parallel plate, Serrated plate/teeth Type and Cylindrical Type, Variable Dielectric constant type: calculation of sensitivities; proximity measurement, displacement, force, pressure measurement, stretched diaphragm type: microphones, response characteristics, applications of capacitive sensors for measurement of different analytes.

- **INDUCTIVE AND MAGNETIC TRANSDUCERS (05 Hours)**
  Inductive Transducers: Self-inductive transducer, Mutual inductive transducers, Linear Variable Differential Transformer-LVDT Accelerometer, Applications of Inductive Transducers such as proximity sensors for position measurement, dynamic motion measurement, Magnetic Sensors: Sensors based on Hall Effect, Performance Characteristics and Applications.

- **ACTIVE TRANSDUCERS (05 Hours)**
  Principle of operation, construction, theory, advantages and disadvantages and applications of following transducers: Thermocouple, Piezo-electric transducer, Pyroelectric transducers, Photo-voltaic transducer and Electrochemical transducer.

- **OPTICAL AND ACOUSTIC TRANSDUCERS** **(05 Hours)**

  Principle of Optical fiber based sensors, Types of optical sensors, Applications of optical sensors and biosensors. Principle Acoustic transducers, SAW and IDT sensors, Applications of Acoustic transducers, Ultrasonic Sensor.

- **FLOW, PRESSURE AND LEVEL TRANSDUCERS** **(06 Hours)**

  Flow Transducers Like Differential Pressure, Variable Area, Positive Displacement, Electromagnetic, Anemometer, Ultrasonic Flow meter, Turbine Flow meter, Vortex Flow meter. Pressure Transducers Like Mercury Pressure Sensor, Bellows, and Membranes And Thin Plates, Piezoresistive, Capacitive Sensors, VRP Sensors, Optoelectronic Sensors, Vacuum Sensors. Level Transducers Like Displacer, Float, Pressure Gages, Balance Method, Level Measurements By Detecting Physical Properties.

- **ADVANCEMENTS IN SENSORS AND TRANSDUCERS** **(07 Hours)**

  Sensors For Robotics, Sensors Used In Smartphone, Sensors Used In Smartcity, MEMS, Nano Sensors, Smart Sensors, Integrated Sensors, IoT Applications, Study of Sensor IC/Module datasheet .

(Total Lecture Hours : 42)

3. Books Recommended:

1. Patranabis D., "Sensors and Transducers", 2nd Ed., Prentice-Hall India, 2004.
2. Ramon Pallas & John G. Webster, "Sensors and Signal Conditioning", 2nd Ed., John Wiley & Sons, 2001.
3. Alok Barua, “Fundamental of Industrial Instrumentation”, 1st Ed., Wiley India, 2011.
4. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs and Applications", 3rd Ed., Springer, 2004.
5. Shawhney A. K., "Electrical and Electronics Measurements and Instrumentation", Dhanpat Rai & Sons, 1994.

NEURAL NETWORKS

L	T	P	Credit
3	0	0	03

EC 363 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Explain** fundamentals and types of neural networks, learning and adaptation capability of neural networks.
CO2	**Implement** neural network models.
CO3	**Analyze** the concept of CNN architectures.
CO4	**Evaluate** the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic.
CO5	**Design** engineering applications that can learn using neural networks.

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2. **Syllabus:**

- **INTRODUCTION** **(12 Hours)**

  Introduction to neural networks: Biological and Artificial neurons, learning in ANNs, Perceptrons–classification and linear separability, XOR problem, Network architectures, Multilayer feedforward networks and recurrent networks, Generalized delta rule.

- **MULTILAYER NETWORKS** **(10 Hours)**

  Back propagation (BP) network, BP training algorithm, Radial basis function (RBF) networks, Applications of BP and RBF networks. Recurrent networks and unsupervised learning, Hopfield network - energy; stability; capacity; Application to optimization problems, Counter back propagation network, Boltzmann machine, Kohonen's self-organizing feature maps, Adaptive resonance theory.

- **ASSOCIATIVE MEMORY** **(08 Hours)**

  Matrix associative memory, Auto associative memories, Hetero associative memories, Bi-directional associative memory, Applications of associative memories

- **CONVOLUTIONAL NEURAL NETWORKS** **(04 Hours)**

  History, Convolution and pooling, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet.

- **FUZZY SYSTEMS AND NEURO FUZZY SYSTEMS** **(04 Hours)**

  Relevance of Integration between fuzzy sets and neural network, Fuzzy neural network, Neuro fuzzy systems, Fuzzy associative memories.

- **APPLICATION OF NEURAL NETWORKS** **(04 Hours)**

  Applications in Pattern recognition,Image Processing and Computer vision,

(Total Contact Hours: 42)

3. Books Recommended:

1. Simon Haykin, "Network N. A comprehensive foundation. Neural Networks", 2nd Ed., PHI, 1998.
2. Simon Haykin, "Neural Networks & Learning Machines", 3rd Ed., Pearson Education India, 2016.
3. R. Rajasekaran and G. A and Vijayalakshmi Pa, Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, 2nd Ed., PHI, 2003.
4. Satish Kumar, Neural Networks, A classroom approach, 2nd Ed., Mc Graw Hill 2018.
5. Kosko, Bart, "Neural networks and fuzzy systems: a dynamical systems approach to machine intelligence", PHI India, 1994.

4. Reference Books:

1. LaureneFausett, "Fundamentals of Neural Networks: Architectures, Algorithms, and Applications", 1st Ed., PHI, 1994.
2. Christopher M. Bishop & Geoffrey Hinton, "Neural Networks for Pattern Recognition", 1st Ed., OXFORD University Press, 2005.

MULTIMEDIA COMMUNICATION

L	T	P	Credit
3	0	0	03

EC 365 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Describe** the basic knowledge of multimedia communication technologies including audio, image, video, text coding and compression, distributed multimedia system, Standard compressed file formats
CO2	**Demonstrate** about signal processing aspects involved in multimedia including signal properties and human properties, networking aspects of DMS.
CO3	**Implement** source coding/data compression techniques in recent applications for data storage and communication of multimedia
CO4	**Compare** various coding/compression techniques.
CO5	**Design** various multimedia application across network.

2. Syllabus:

- **MULTIMEDIA PROCESSING** **(08 Hours)**

  Digital Media--Digital Audio, Digital Image and Digital Video, Input and Output devices, DPI and PPI, Signal Pre and Post Processing Elements, Revision of Fourier Transform, DFT and DCT, Challenges of Multimedia Information Processing, Storage, Retrieval Issues and Communication issues, Signal Processing For Networked Multimedia, Multimedia Processors.

- **DATA COMPRESSION TECHNIQUES** **(16 Hours)**

  Speech properties, VOCODERS, Audio perception parameters, Concept of Audio Threshold of Hearing, Cochlear filter, Critical Bandwidth, Noise masking Tone and Tone masking Noise, Temporal masking, Vector Quantization, Source Coding techniques, Lossless and Lossy Compression Techniques, Perceptual Coding fundamentals, Parametric coders, Transform Coders, Sub-Band Coders, Hybrid Coders

- **DATA COMPRESSION STANDARDS** **(06 Hours)**

  CD quality Audio Coding for Multimedia Applications, Audio, Image and Video Coding Standards--MPEG—MP3 MP4 etc and JPEG standards.

- **AUDIO-VISUAL INTEGRATION** **(04 Hours)**

  Human Speech Generation Model, Synthetic Speech Generation, Media Interaction, Bimodality of Human Speech, Speech Signal Properties and Visual Properties, Lip Reading, Speech -Driven Talking Heads, Lip Synchronization, Lip Tracking, Audio-To-Visual Mapping, Bimodal Person Verification, Joint Audio-Video Coding techniques.

- **MULTIMEDIA COMMUNICATION ACROSS NETWORKS** **(08 Hours)**

  Network Requirements, Real Time Packet Transfer Concept, Multimedia Requirements and ATM Networks, Packet Audio Video in The Network Environment, Video Transport Across Generic Networks, VOIP Application. Distributed Multimedia System constraints, architecture and protocols

(Total Lecture Hours : 42)

3. Books Recommended:

1. Rao K. R., Bojkovic Zoran S. and Milovanovic Dragorad A. "Multimedia Communication Systems: Techniques, Standard and Networks", 1st Ed., PHI, 2002.
2. Vaseghi Saeed V., "Multimedia Signal Processing Theory and Application in Speech, Music and Communications", 1st Ed., Wiley, 2007.
3. Rao Kamisetty, Bojkovic Zoras and Dragorad, "Introduction to Multimedia Communications", 1st Ed., Wiley, 2006.
4. Ohm and Jens R., "Multimedia Communication Technology", 1st Ed., Springer, 2004.
5. Mihaela Vander Scharr and Chow Philip A., "Multimedia Over 1P and Wireless Networks— Compression, Networking and Systems", 1st Ed., Academic Press, 2007.

WIRELESS AND MOBILE COMMUNICATION

L	T	P	Credit
3	1	2	05

EC 302 **Scheme**

1. Course Outcomes (COs):

At the end of the students will be able to:

CO1	**Describe** the terminology related to mobile cellular system, traffic, diversity, channel and established standards
CO2	**Explain** the wireless channel scenario with latest techniques, Cellular structure applied in the Mobile Technology by illustrating the various methods and open challenges for the improvement of wireless communication link.
CO3	**Experiment** with the traffic calculation formulas to design and optimize the load at the cellular network with the coverage area optimization using various techniques.
CO4	**Classify** the evolution of the various generation of the Mobile standards, channel models and the technological advancement achieved over the years.
CO5	**Evaluate** the major breakthrough in the field of voice and data services by assessing the latest technology standard.
CO6	**Design** the advance schemes to support the technological advancement for the user demand of higher data rate with improved quality of service.

2. Syllabus:

- **INTRODUCTION TO WIRELESS CHANNEL** **(04 Hours)**
  AWGN Channel, Multipath and Fading Effects, maximum delay spread, RMS delay spread, coherence bandwidth, coherence time, Large and Small Scale Fading, Flat and Frequency Selective Fading, Slow and Fast Fading, BER performance of communication systems

- **OUTDOOR AND INDOOR CHANNEL MODELLING** **(08 Hours)**
  Outdoor Channel Models: ground wave propagation model, Terrain Models, City Models, Indoor Models: Rayleigh, Rician and Nakagami Channel Models, BER performance of wireless channel, channel estimation, equalization

- **DIVERSITY TECHNIQUES** **(08 Hours)**
  Introduction to Diversity, Types of Diversity- Space, Time, Frequency

- **CELLULAR MOBILE SYSTEMS** **(08 Hours)**
  Spread spectrum technology, CDMA, WCDMA, A Basic Cellular System, Cellular Communication Infrastructure: Cells, Clusters, Cell Splitting, Frequency Reuse Concept and Reuse Distance Calculation, Cellular System Components, Operations of Cellular Systems, Call Setup, Handoff/Handover, Channel Assignment-Fixed and Dynamic, Cellular Interferences: Co-Channel and Adjacent Channel, Antennas for The Base Stations, Sectorization., Mobile Traffic Calculation - Grade of Service, Erlang B and C Formula, Traffic Calculation Examples

- **MOBILE STANDARDS** **(08 Hours)**
  GSM: Global System for Mobiles Communications, GPRS: General Packet Radio Service, EDGE: Enhanced Data - Rates for Global Evolution, UMTS: Universal Mobile Telecommunication System

- **INTRODUCTION TO LTE AND 5G** **(06 Hours)**
  Long Term Evaluation Architecture and concept, LTE protocol, physical layer aspects of LTE

- **TUTORIALS** **(14 Hours)**

(Total Contact Hours: 56)

3. Practical:

1. Implement and simulate the various modulation schemes and analyze their performance
2. Implement and simulate M-PSK and M- QAM Modulation Techniques with the help of MATLAB software where M= 4, 8, 16, 32, 64.
3. To Simulate M-PSK and M-QAM Modulation Techniques using AWGN channel considering input as an Image with the help of MATLAB software. Plot SNR v/s BER where M= 4, 8, 16, 32, 64 and constellation as well.
4. To Simulate M-PSK and M-QAM Modulation Techniques using Rayleigh Fading channel considering input as an Image with the help of MATLAB software. Plot SNR v/s BER where M= 4, 8, 16, 32, 64 and constellation as well.
5. Implement and simulate Diversity techniques (frequency) and observe the improvement in the results with respect to previous practical.
6. Implement and simulate any one channel estimation and observe the improvement in the results with respect to previous practical.
7. Implement and simulate any one channel equalization and observe the improvement in the results with respect to previous practical.
8. Analyze the performance of various blocks of Mobile Phone Trainer.
9. To Simulate BPSK, QPSK Modulation Techniques with the help of COMMSIM simulator.
10. Develop the android application using 4G trainer kit
11. Study of Direct Sequence Spread Spectrum (DSSS) Modulation and Demodulation Process.
    11.1: Study of Spreading and Dispersing based on Spread Spectrum technique
    11.2: Study of DSSS Modulation/Demodulation Using Analog Signal as an Input.
    11.3: Study of DSSS Modulation/Demodulation Using Digital Signal as an Input
12. To perform various AT commands for mobile communication

4. Books Recommended:

1. Dalal Upena," Wireless and Mobile Communication ", 1st Ed., Oxford University Press, 2016.
2. Lee William C. Y. "Mobile Cellular Telecommunications", 3rd Ed., McGraw-Hill, 2008.
3. Rappaport Theodore, "Wireless Communications - Principles and Practice", 2nd Ed., Pearson Education LPE, 2010.
4. Andreas F. Molisch, “Wireless Communications” 2nd Ed., Wiley, 2010.
5. Andrea Goldsmith, “Wireless Communication”, Cambridge University Press, reprint, 2011.

DIGITAL INTEGRATED CIRCUITS

L	T	P	Credit
3	1	2	05

EC 304 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Recognize** the fundamental concepts of devices and various logic families with their comparative analysis
CO2	**Explain** the operation of MOS transistor and scaling trends in MOSFETs and illustrate various short channel effects.
CO3	**Illustrate** the various processing techniques of NMOS and CMOS technology.
CO4	**Analyze** the design of inverter using CMOS logic and estimate the switching parameters therein. Also analyze the power dissipation and CMOS-TTL interfacing.
CO5	**Evaluate** the performance of different sequential and combinational circuits using CMOS logic.
CO6	**Design** the sequential and combinational circuits using CMOS with layout and stick diagrams.

2. Syllabus:

- **OVERVIEW OF HIGH-SPEED LOGIC FAMILIES** **(06 Hours)**
  BJT Inverter, DC Switching Characteristic, Introduction to TTL, Schottky TTL, and ECL Logic Family, Concept of Noise margin, Fan Out and Propagation Delay, NMOS, PMOS, CMOS, Bi-CMOS Circuits.

- **MOS TRANSISTORS** **(12 Hours)**
  Structure and Operation, MOSFET Structure and Operations, MOSFET Current- Voltage Characteristics, Channel Length Modulation, Substrate Bias Effect, MOSFET Capacitances, MOSFET Model, Modeling of MOS Transistor using Spice, Scaling and Small Geometry Effects, MOSFET capacitances, Fabrication Process Flow, CMOS N-Well Process and Twin Tub Process.

- **NMOS AND CMOS LOGIC DESIGN** **(12 Hours)**
  Various NMOS Inverters, Determination of VTC, Calculation of VTC Critical Points, CMOS Inverter Technology, VTC, Static Characteristics, Dynamic Behavior, Static and Dynamic Power Dissipation, Power-Delay Product, TTL-CMOS Interfacing.

- **CMOS COMBINATIONAL AND SEQUENTIAL LOGIC CIRCUITS** **(12 Hours)**
  CMOS Logic Circuits, Complex Logic Circuits, Pass transistor and Transmission gate, Behavior of MOS Logic Elements.
  The Bistability Principle, SR Latch Circuit, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered Flip-Flop. Layout Design Rules, Full-Custom Mask Layout Design and Stick Diagrams Antenna effect.

- **TUTORIALS** **(14 Hours)**

(Total Contact Hours: 56)

3. Practical:

1. Introduction to SPICE Circuit Simulator.
2. Realization of MOSFET Characteristics Using Circuit Simulator Characteristics and BSIM Models.
3. Realization of NOR Gate Using RTL Logic. Obtain & Plot its Transfer Characteristics And Determine Noise Margins, Fan-Out and Propagation Delay.
4. Realization of NAND Gate Using TTL Logic. Obtain & Plot Its Transfer Characteristic and Determine Noise margins, Fan-out and Propagation Delay.
5. Implementation of NMOS Inverter, Obtain & Plot Its Transfer Characteristics and Determine Noise margins And Measure Propagation Delay.
6. Implementation of CMOS Inverter. Obtain & Plot Its Transfer Characteristics, Determine Noise Margins and Measure Propagation Delay.
7. Realization Of Inverter Gate Using BiCMOS Logic, Obtain & Plot Its Transfer Characteristics, Determine Noise Margins.
8. Design and Implementation of TTL-CMOS & CMOS-TTL Interfacing.
9. Design and Implementation of Pass transistor and Transmission gate based logic circuits.
10. Design And Implement of JK & SR Flip-Flop using CMOS.
11. Layout of CMOS Inverter and Parasitic Extraction and Obtain VTC of Extracted Net List.

4. Books Recommended:

1. Taub H. and Schilling D., "Digital Integrated Electronics", International Ed., McGraw-Hill, 2008.
2. Sung-Mo Kang and Leblebici Y., "CMOS Digital Integrated Circuits: Analysis and Design", 3rd Ed., Tata McGraw-Hill; 2003.
3. Rabaey Jan, Chandrakasan Anantha Nikolic, "Digital Integrated Circuits: A Design Perspective", 2nd Ed., Pearson Education, 2008.
4. Hodges D. A. and Jackson H. G. "Analysis And Design Of Digital Integrated Circuits", 3rd Ed., McGraw-Hill, 2004.
5. Baker R. J., Li H. W. and Boyce D. E., "CMOS Circuits Design Layout and Simulation", 2nd Ed., PHI 2005.

OPTICAL FIBER COMMUNICATION LAB

L	T	P	Credit
0	0	2	01

EC 306 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Apply** the concepts of light transmission in optical fiber communication link.
CO2	**Analyze** fiber, optical source, detector and components
CO3	**Evaluate** optical fiber communication link parameters
CO4	**Design** the optical fiber communication system

2. Syllabus:

1. To implement and plot the I-V and I-P characteristics of LED.
2. To implement and plot the I-V and I-P characteristics of LASER Diode.
3. To implement and plot the I-V and I-P characteristics of Photo Detector.
4. To implement, study and analyze numerical aperture and losses in optical fiber.
5. To study and analyze modes and power in optical fiber using software.
6. To implement and study FM and PWM through optical link.
7. To implement and study free space optics using LASER module.
8. To implement and find the BER and EYE Pattern.
9. To implement and study power margin and sensitivity of optical system.
10. Design and performance analysis of a single channel link using Optisystem.
11. Design and performance analysis of a WDM link using Optisystem.
12. Link budget and rise time budget analysis of a single channel optical link using Optisystem.

ELECTRONICS INSTRUMENTATION LAB

L	T	P	Credit
0	0	2	01

EC 308 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Illustrate** data acquisition and converter systems
CO2	**Analyz**e data for different types of signal conditioning circuits.
CO3	**Evaluate** different signal converters
CO4	**Design** instrumentation system that meets desired specifications and requirements.

2. **Syllabus:**

1. Design and Implement Simple V to I converter and modified Howland V to I Convertor.
2. Design and Implement V to V Convertor given specifications.
3. Design and Implement R to V convertor.
4. Bridge Linearity technique using Op-AMP.
5. Measurement of Phase Difference Using X-OR and SR Flip-Flop Methods.
6. Instrumentation amplifier using Feedback.
7. Two Position digital controller with dead-Zone.
8. Instrumentation Trainer.
9. RS485 communications.
10. DATA acquisition using DAQ card.

MACHINE LEARNING LAB

L	T	P	Credit
0	0	2	01

EC 312 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Demonstrate** unsupervised and Reinforcement learning.
CO2	**Implement** feature extraction and selection to represent data as features to serve as input to machine learning models build an application that is based on machine learning.
CO3	**Design** given application based on suitable machine learning task.

2. Syllabus:

1. Implement and demonstrate the **FIND-S algorithm** for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.
2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the **Candidate-Elimination algorithm** to output a description of the set of all hypotheses consistent with the training examples.
3. Write a program to demonstrate the working of the decision tree based **ID3 algorithm**. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
4. Build an Artificial Neural Network by implementing the **Back propagation algorithm** and test the same using appropriate data sets.
5. Write a program to implement the **naïve Bayesian classifier** for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.
6. Assuming a set of documents that need to be classified, use the **naïve Bayesian Classifier** model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.
7. Write a program to construct a **Bayesian network** considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.
8. Apply **EM algorithm** to cluster a set of data stored in a .CSV file. Use the same data set for clustering using ***k*-Means algorithm**. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.
9. Write a program to implement ***k*-Nearest Neighbour algorithm** to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem.
10. Implement the non-parametric **Locally Weighted Regression algorithm** in order to fit data points. Select appropriate data set for your experiment and draw graphs.

COMMUNICATION NETWORKS LAB

L	T	P	Credit
0	0	2	01

EC 314 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Apply** the protocols and techniques in developing the standard networks using standard tools or software overcoming the constraints
CO2	**Analyze** the performance of various techniques and protocols in a given network topology, case study and problem solving as per given data.
CO3	**Design** the codes for the given protocols using appropriate tools

2. Syllabus:

1. Introduction to TCP/IP Networking Commands.
2. Cyclic Redundancy Check (CRC) Method for Error Detection.
3. Hamming Code for Error Detection and Correction.
4. Bit Stuffing.
5. Shortest Path Routing Algorithm.
6. Symmetric Key Ciphering and Deciphering using Classical Ciphers.
7. Asymmetric Key Ciphering and Deciphering using Modern Ciphers.
8. Introduction to Network Simulator (NS2)
9. Elementary Network Model design using NS2
10. Dynamic Network Model design for Optimum Routing using NS2
11. Local Area Network Architecture and its Performance Analysis using NS2
12. Wireless Network Implementation using NS2.

OPTICAL FIBER COMMUNICATION

L	T	P	Credit
3	0	0	03

EC 322 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Explain** the different types of fibers and optical components of an optical communication link.
CO2	**Apply** the concepts of light transmission in optical fiber communication link.
CO3	**Analyze** fiber, optical source, detector and components.
CO4	**Evaluate** optical fiber communication link parameters.
CO5	**Design** the optical fiber communication system.

2. **Syllabus:**

- **LIGHTWAVE TRANSMISSION** **(06 Hours)**
  Nature Of Light, Basic Optical Laws, Propagation Of Light In Fiber, Elements Of Fiber Optic Communication, Optical Spectrum, Optical Power, Types of Optical Fiber, Fiber Fabrication, Fiber Cables.

- **SIGNAL DEGRADATION AND MEASURMENTS** **(08 Hours)**
  Degradation Of Signals In Optical Fiber, Attenuation, Absorption Losses, Scattering Losses, Bending Losses, Effect Of Dispersion On Pulse Transmission, Intermodal, Intramodal and Waveguide Dispersion, Total Dispersion And Maximum Transmission Rates, Nonlinear Effects In Fiber, Numerical Aperture Measurements, Attenuation Measurement, Dispersion Measurement, OTDR Field Applications.

- **OPTICAL SOURCES** **(06 Hours)**
  Basic Structure, Principle And Operation and Types of Light Emitting Diode, Laser Diode, Comparison Between LED And LD.

- **PHOTO DETECTORS AND RECEIVER SYSTEM** **(06 Hours)**
  PIN Photodiode, Avalanche Photodiode, Comparison Between PIN Photodiode And APD, Fundamental Receiver Operation, Receiver Sensitivity, System Performance Evaluation Criteria, Eye Diagram, BER, OSNR, And Q-Factor.

- **POWER LAUNCHING, COUPLING AND LINK DESIGN** **(04 Hours)**
  Source To Fiber Power Launching, Lensing Schemes, Fiber To Fiber Joints, Connectors, Splicing, Point To Point Link, System Design Considerations, Power Budget, Rise Time Budget, Power Penalty.

- **OPTICAL AMPLIFIERS** **(04 Hours)**
  Principle of Optical Amplification, Erbium-Doped Fiber Amplifiers, Raman Amplifiers, Semiconductor Optical Amplifiers.

- **WDM CONCEPTS AND COMPONENTS** **(08 Hours)**
  Principles Of WDM, WDM System Configuration, Types of WDM System, WDM Components, Applications of WDM Systems.

(Total Contact Hours: 42)

3. Books Recommended:

1. Gerd Kaiser, "Optical Fiber Communication", 4th Ed., McGraw Hill, 2008.
2. Senior J. M., "Optical Fiber Communication - Principle and Practice", 3rd Ed., PHI, 2010.
3. T. L. Singhal, "Optical Fiber Communications: Principles and Applications", 1st Ed., Cambrige, 2015.
4. Ramaswami Rajiv and Sivarajan K. N., "Optical Networks A Practical Perspective", 3rd Ed., Elsevier, Morgan Kaufmann Publishers, 2009.
5. Agrawal G.P., "Fiber Optic Communication Systems", 4th Ed., John Wiley & Sons, 2010.

ELECTRONIC INSTRUMENTATION

L	T	P	Credit
3	0	0	03

EC 324 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Describe** the fundamentals of Electronic Instrumentation, signal condition, signal converter, isolation techniques for different applications.
CO2	**Illustrate** data acquisition and converter systems
CO3	**Analyz**e data for different types of signal conditioning circuits.
CO4	**Evaluate** different signal converters
CO5	**Design** instrumentation system that meets desired specifications and requirements.

2. **Syllabus:**

- **SIGNAL CONDITIONING FOR RESISTIVE / REACTIVE / SELF-GENERATING SENSORS** **(08 Hours)**

  Signal Conditioning For Resistive Sensors: Amplifiers For Voltage Dividers, Wheatstone Bridge: Balance Measurements, Deflection Measurements, Differential And Instrumentation Amplifiers, Interference, Signal Conditioning For Reactance Variation Sensors: AC Bridges, Carrier Amplifiers And Coherent Detection, Specific Signal Conditioners For Capacitive Sensors, Resolver-To-Digital And Digital-To-Resolver Converters, Signal Conditioning For Self-Generating Sensors: Chopper And Low-Drift Amplifiers, Electrometer And Trans-impedance Amplifiers, Charge Amplifiers, Noise In Amplifiers.

- **SIGNAL CONVERTERS** **(06 Hours)**

  I To P / P To I Converter, Temperature to Voltage Converter, Conversion To Frequency, Period, or Time Duration, Measurement of Phase Difference Using X-OR and SR Flip-Flop Method, Measurement of Active And Reactive Power of Supply Line, Locking Amplifiers, Variable Oscillators, Direct Sensor-Microcontroller Interfacing.

- **ISOLATION TECHNIQUES** **(06 Hours)**

  Transformer Isolation, Optical Isolation, Digital Techniques For Optical Isolation, Hall-Effect Principle and Measurement of Displacement, Current and Power Using Hall Sensors, Amplifications of Low Level Signals, Guarding, Shielding.

- **DATA ACQUISITION AND CONVERSION** **(06 Hours)**

  Analog Signal Processing, Sample And Hold Operation, S/H Circuits Using Op-Amps, Introduction To Data Acquisition System, Various DAS Configurations, Single Channel DAS, Multi-Channel DAS, IC Based DAS, Data Acquisition, Data Acquisition in PLC, SCADA.

- **TELEMETRY SYSTEMS** **(10 Hours)**

  Introduction To Telemetry System, Current Telemetry: 4 To 20 mA Loop, Design Of 2/4 Wire Transmitters, Simultaneous Analog And Digital Communication, Intelligent Sensors, Sensor Buses: Fieldbus, RS232, RS485, MODBUS, AS-I, Devicenet, Profibus, Foundation Fieldbus, Industrial Ethernet, Industrial IoT, Industry 4.0.

- **INSTRUMENTATION STANDARDS** **(06 Hours)**

  Static and Dynamic Characteristic Instrument Enclosure type: NEMA and Ingress protection standards, Test and Calibration: Primary and Secondary Standard, Safety Standard

(Total Contact Hours: 42)

3 **Books Recommended**

1. Ramon Pallas and John G. Webster, "Sensors and Signal Conditioning", 2nd Ed., John Wiley & Sons, 2001.
2. Rangan C. S., Sarma G. R. and Mani V. S. V., "Instrumentation Devices and Systems", 2nd Ed., Tata McGraw-Hill, 2004.
3. Helfrick Albert D. and Cooper W. D., "Modern Electronic Instrumentation and Measurement Techniques", 1st Ed., Prentice Hall India, 1990.
4. A. J. Bouvens, "Digital Instrumentation", 1st Ed., McGraw-Hill, 1997.
5. Johnson Curtis D., "Process Control Instrumentation Technology", 7th Ed., Prentice Hall, 2003.

MACHINE LEARNING

L	T	P	Credit
3	0	0	03

EC 326 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Describe** the differences in approaches and applicability of regression, classification, and clustering.
CO2	**Demonstrate** unsupervised and Reinforcement learning.
CO3	**Implement** feature extraction and selection to represent data as features to serve as input to machine learning models build an application that is based on machine learning.
CO4	**Design** given application based on suitable machine learning task.

2. Syllabus:

- **INTRODUCTION** **(10 Hours)**

  Introduction, Machine learning basics, Supervised Learning: Artificial Neural Network, classifying with k-Nearest Neighbour classifier, Support vector machine classifier, Decision Tree classifier, Naive Bayes classifier, Bagging, Boosting, Improving classification with the AdaBoost meta algorithm.

- **FORECASTING AND LEARNING THEORY** **(08 Hours)**

  Regression, Linear Regression, Multivariate Regression, Logistic regression, Principal Component Regression, Tree-based regression. Bias/variance trade-off, Union and Chernoff/Hoeffding bounds, Vapnik–Chervonenkis (VC) dimension.

- **UNSUPERVISED LEARNING** **(08 Hours)**

  Grouping unlabeled items using k-means clustering, Association analysis with the Apriori algorithm, efficiently finding frequent item sets with FP-growth.

- **REINFORCEMENT LEARNING** **(08 Hours)**

  Markov decision process (MDP), Bellman equations, Value iteration and policy iteration, Linear quadratic regulation, Linear Quadratic Gaussian, Q-learning, Value function approximation, Policy search, Reinforce, POMDPs.

- **DIMENSIONALITY REDUCTION** **(08 Hours)**

  Feature extraction - Principal component analysis, Singular value decomposition. Feature selection – feature ranking and subset selection, filter, wrapper and embedded methods. Machine Learning for Big data: Big Data and Map Reduce.

(Total Contact Hours: 42)

3. Books Recommended:

1. E. Alpaydin, “Introduction to Machine Learning”, 2nd Ed., MIT Press, 2009.
2. T. M. Mitchell, “Machine Learning”, McGraw-Hill, 1997.
3. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, 2nd Ed., Springer; 2011.
4. Miroslav Kubat , “An Introduction to Machine Learning”, Springer (2017)
5. GopinathRebala, Ajay Ravi, Sanjay Churiwala, “An Introduction to Machine Learning”, Springer (2019).

COMMUNICATION NETWORKS

L	T	P	Credit
3	0	0	03

EC 328 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Describe** the basic knowledge of data communication methods, centralized/distributed networking architectures, OSI reference model, networking issues, protocols
CO2	**Illustrate** the suitable network protocols at various layers in computer networks along with the constraints
CO3	**Apply** the protocols and techniques in developing the standard networks using standard tools or software overcoming the constraints
CO4	**Analyze** the performance of various techniques and protocols in a given network topology, case study and problem solving as per given data.
CO5	**Design** the codes for the given protocols using appropriate tools

2. Syllabus:

- **DATA COMMUNICATION AND NETWORKING OVERVIEW** **(06 Hours)**
  A Communication Model, Data Communication, Networking Concept, Topology And Transmission Media, Subnet, Concept of Client and Server, An Example Configuration, The Need For Protocol Architecture, Protocol Architecture and peer processes, OSI Reference Model, The TCP/IP Protocol Stack.

- **DATA LINK CONTROL** **(05 Hours)**
  Medium Access Control (MAC) And Logical Link Control (LLC) Sublayer Issues, Flow Control, Error Control, Access Control, Sliding Window Protocol, Polling, High-Level Data Link Control (HDLC), PPP, Performance Issues.

- **LOCAL AREA NETWORKS — OVERVIEW** **(05 Hours)**
  LAN Protocol Architecture, Bridges, Emergence of High Speed LANs, Ethernet, Wireless LAN Technology (Wi-Fi) Protocols.

- **ROUTING AND CONGESTION CONTROL** **(06 Hours)**
  Logical Addresses, Circuit-Switching and Packet Switching Networks, Classful Addressing, Classless Addressing (CIDR), Subnetting, Supernetting, Network Address Translation, Routing In Packet-Switching Networks, Broadcasting, Multicasting, Flooding, Routing Algorithms, Effects Of Congestion, Congestion Control In Packet-Switching Networks. IP address classes, Ad-Hoc network Routing constraints. Mobile IP and its architecture

- **INTERNETWORK PROTOCOLS** **(05 Hours)**
  Basic Protocol Functions, Principles Of Internetworking, Fragmentation Concept, Connectionless Internetworking, Gateway And Routers, The Internet with IPv4 and IPv6 packet formats, ARP, RARP, DHCP, ICMP, IGMP.

- **TRANSPORT PROTOCOLS** **(04 Hours)**
  Port Addresses, Quality Of Service Parameter, TCP, UDP and SCTP Protocols Mobile TCP

- **NETWORK SECURITY** **(04 Hours)**
  Security Requirement And Attacks, Cryptography, Classical Ciphers, Modern Ciphers, Confidentiality With Encryption, Message Authentication And Hash Functions, Public-Key Encryption And Digital Signatures

- **DISTRIBUTED APPLICATIONS** **(07 Hours)**
  Network Virtual Terminal (TELNET), File Transfer Protocol (FTP), Electronic Mail - SMTP And MIME, Hyper Transfer Protocol (HTTP), Network Management - SNMP, Domain Name Server (DNS), URL, WWW.

(Total Contact Hours: 42)

3. Books Recommended:

1. Tanenbaum Andrew S., "Computer Networks", PHI, 5th Ed., 2011.
2. Stalling William, "Data and Computer Communications", PHI, 10th Ed., 2014.
3. Forouzan Behrouz A., "Data Communications and Networking", Tata McGraw-Hill, 5th Ed., 2013.
4. Gallager R. G. And Bertsekas D., "Data Networks", PHI, 2nd Ed., 1992.
5. Garcia Leon and Wadjaja I., "Communication Networks", Tata McGraw-Hill, 2nd Ed., 2004.

HIGH PERFORMANCE COMPUTING

L	T	P	Credit
3	0	0	03

EC 362 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Explain** parallel programs for scientific computations.
CO2	**Demonstrate** tools for performance optimization and debugging.
CO3	**Analyze** code with respect to performance and suggest and implement performance improvements.
CO4	**Appraise** on performance analysis in clear and correct writing.
CO5	**Develop** different HPC solutions to common problems found in Computational Science.

2. Syllabus:

- **PARALLEL PROCESSING CONCEPTS (QUICK OVERVIEW) (04 Hours)**
  Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation etc), Architectures: N-wide superscalar architectures, multi-core, multi-threaded

- **PARALLEL PROGRAMMING WITH CUDA (10 Hours)**
  Processor Architecture, Interconnect, Communication, Memory Organization, and Programming Models in high performance computing architectures: (Examples: IBM CELL BE, Nvidia Tesla GPU, Intel Larrabee Microarchitecture and Intel Nehalem microarchitecture), Memory hierarchy and transaction specific memory design, Thread Organization

- **FUNDAMENTAL DESIGN ISSUES IN PARALLEL COMPUTING (10 Hours)**
  Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms onto Parallel Architectures, Performance Analysis of Parallel Algorithms

- **FUNDAMENTAL LIMITATIONS FACING PARALLEL COMPUTING (06 Hours)**
  Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their limitations

- **POWER-AWARE COMPUTING AND COMMUNICATION (06 Hours)**
  Power-aware Processing Techniques, Power-aware Memory Design, Power-aware Interconnect Design, Software Power Management

- **ADVANCED TOPICS** **(06 Hours)**

  Petascale Computing, Optics in Parallel Computing, Quantum Computers, Recent developments in Nanotechnology and its impact on HPC

(Total Contact Hours: 42)

3. Books Recommended:

1. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, "Introduction to Parallel Computing", 2nd Ed., Addison-Welsey, 2004.
2. William James Dally and Brian Towles, "Principles and Practices on Interconnection Networks", 1st Ed., Morgan Kauffman, 2004.
3. GPU Gems 3 --- by Hubert Nguyen (Chapter 29 to Chapter 41)
4. James H. Laros III, Kevin Pedretti, Suzanne M. Kelly, Wei Shu, Kurt Ferreira, John Van Dyke, and Courtenay Vaughan, "Energy-Efficient High-performance Computing-Measurement and Tuning", 1st Ed., Springer, 2013
5. Oscar Montiel Ross and Roberto Sepúlveda Cruz, "High Performance Programming for Soft Computing", 1st Ed., CRC press, 2014

COMPUTER VISION

L	T	P	Credit
3	0	0	03

EC 364 **Scheme**

1. **Course Outcomes (COs):**

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

CO1	**Describe** shape analysis and Implement boundary tracking techniques.
CO2	**Apply** feature extraction methods for computer processing.
CO3	**Analyze** pattern recognition algorithms for real world problems.
CO4	**Evaluate** motion related techniques.
CO5	**Design** of face detection and recognition algorithms.

2. **Syllabus:**

- **CAMERAS** **(06 Hours)**
  Pinhole Cameras, Radiometry – Measuring Light: Light in Space, Light Surfaces, Important Special Cases, Sources, Shadows, And Shading: Qualitative Radiometry, Sources and Their Effects, Local Shading Models, Application: Photometric Stereo, Interreflections: Global Shading Models, Color: The Physics of Color, Human Color Perception, Representing Color, A Model for Image Color, Surface Color from Image Color, Two Views, Stereopsis: Reconstruction, Human Stereposis, Camera-Computer interface.

- **LOW-LEVEL PROCESSING** **(04 Hours)**
  Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

- **SEGMENTATION BY FITTING A MODEL** **(06 Hours)**
  The Hough Transform, Fitting Lines, Fitting Curves, Fitting as a Probabilistic Inference Problem, Robustness, Segmentation and Fitting Using Probabilistic Methods: Missing Data Problems, Fitting, and Segmentation, The EM Algorithm in Practice, Tracking With Linear Dynamic Models: Tracking as an Abstract Inference Problem, Linear Dynamic Models, Kalman Filtering, Data Association, Applications and Examples.

- **FEATURE EXTRACTION** **(08 Hours)**
  Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative , Gabor Filters and DWT.

- **PATTERN AND MOTION ANALYSIS** **(10 Hours)**
  Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN. Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

- **APPLICATION USING OpenCV AND MATLAB** **(08 Hours)**
  Introduction to Robotic Operating System (ROS), Installation and tasting ROS camera drivers, ROS to OpenCV, Introduction to OpenCV image processing library and MATLAB programming, Finger print recognition, Face detection and recognition, Object tracking, medical Diagnosis etc

(Total Contact Hours: 42)

3. Books Recommended:

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer-Verlag London Limited 2011
2. D. A. Forsyth, J. Ponce, “Computer Vision: A Modern Approach”, 2nd Ed., Pearson Learning 2015.
3. K.S.Fu., R.C. Gonzalez CSG. Lee, “Robotics Control sensing vision and Intelligence”, McGraw Hill Education Pvt. Ltd. 2013.
4. E. Tresso and A. Verri, “Introductory Techniques for 3-D Computer Vision”, Prentice-Hall, 1998.
5. Bradsky & Kaehler, “Learning Open CV”, , O’Reilly;

4. Reference Book:

1. E. R. Davies: “Computer and Machine Vision – Theory”, Algorithms and Practicalities, 4th Ed., Elsevier (Academic Press), 2013.

MEMS

L	T	P	Credit
3	0	0	03

EC 366 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Describe** different electrical and mechanical properties of material used for MEMS and then investigate the impact of strain on MEMS technology.
CO2	**Apply** the theory of thermal and electrostatic sensing & actuation.
CO3	**Analyze** the Piezo-electric properties of material for micro sensor design.
CO4	**Evaluate** different micromachining techniques for MEMS process.
CO5	**Investigate** the various opportunities and challenges in the emerging field of MEMS technology.

2. Syllabus:

- **OVERVIEW OF MEMS AND MICRO-FABRICATION (08 Hours)**
  Introduction to MEMS Development, Characteristics of MEMS, Microelectronics Integration, Micro Fabrication Flow and Frequent Processing Steps, Silicon-based MEMS Processes, Overview of Beyond Silicon Material for MEMS

- **ELECTRO-MECHANICAL THEORY OF MEMS MATERIAL (10 Hours)**
  Conductivity of Semiconductors, Crystal Plane and Orientation, Tensile Stress and Strain, Mechanical Properties of Silicon and Thin Films, Flexural Beam Bending Analysis Under Loading Conditions, Torsional Deflection, Intrinsic Stress, Dynamic System, Resonance and Quality Factor.

- **FUNDAMENTAL OF SENSING AND ACTUATION (10 Hours)**
  Electrostatic Sensing and Actuation, Theory and Application of Parallel Plate Capacitor, Overview and Application Thermal Sensing, Piezo-resistive Sensor Materials and Their Stress Analysis, Applications of Piezo-resistive Sensors.

- **BULK AND SURFACE MICROMACHINING TECHNIQUES (08 Hours)**
  Types of Etching Techniques (definition and overview), Wet Etching for Simple Structures of Silicon, Basic Surface Micromachining Process, Structural and Sacrificial Material.

- **ADVANCEMENT IN MEMS TECHNOLOGY (06 Hours)**
  LIGA Process, Wafer Bonding, Polymer MEMS, Micro-fluidics Applications.

(Total Contact Hours: 42)

3. Books Recommended:

1. Chang Liu, “Foundations of MEMS”, 2nd Ed., Pearson International, 2011.
2. Gaberiel M.Rebiz, “RF MEMS Theory, Design and Technology”, John Wiley & Sons, 2003.
3. Charles P. Poole, Frank J.Owens, “Introduction to nanotechnology” John Wiley & sons, 2003.
4. Julian W. Gardner, Vijay K Varadhan, “Microsensors, MEMS and Smart devices”, John Wiley & sons, 2001.
5. Veikko Lindroos, Markku Tilli, Ari Lehto and Teruaki Motooka, “Handbook of Silicon Based MEMS Materials and Technologies”, 1st Ed., William Andrew, 2010.

PROFESSIONAL ETHICS, ECONOMICS AND BUSINESS MANAGEMENT

L	T	P	Credit
3	1	0	04

HU 304 **Scheme**

1. Course Outcomes (COs):

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

CO1	**Identify** application of ethics in society and development of understanding regarding Professional ethical issues related to Electronics engineering
CO2	**Develop** managerial skills to become future engineering managers
CO3	**Develop** skills related to various functional areas of management (Marketing Management, Financial Management, Operations Management, Personnel Management etc.)
CO4	**Build** knowledge about modern management concepts (ERP, SCM, e-CRM, etc.)
CO5	**Develop** experiential learning through Management games, Case study discussion, Group discussion etc.
CO6	**Apply** knowledge of Economics and Business management aspects in Electronics engineering

2. Syllabus:

- **PROFESSIONAL ETHICS** **(12 Hours)**

  Introduction, Approaches to Ethics, Meaning of Ethics, Major attributes of Ethics, Business Ethics, Factors influencing Ethics, Importance of Ethics, Ethics in Management, Organizational Ethics, Ethical aspects in Marketing, Mass communication and Ethics - Television, Whistle blowing, Education – Ethics and New Professional, Intellectual Properties and Ethics, Introduction to Professional Ethics, Engineering Ethics, Ethical issues related to Electronics Engineering.

- **ECONOMICS** **(06 Hours)**

  Introduction To Economics, Micro & Macro Economics, Applications & Scopes Of Economics, Demand Analysis, Demand Forecasting, Factors Of Production, Types Of Cost, Market Structures, Break Even Analysis.

- **MANAGEMENT** **(08 Hours)**

  Introduction to Management, Features Of Management, Nature Of Management, Development of Management Thoughts – Scientific Management By Taylor & Contribution of Henry Fayol, Coordination & Functions Of Management, Centralization & Decentralization, Decision Making; Fundamentals of Planning; Objectives & MBO; Types of Business Organizations: Private Sector, Public Sector & Joint Sector; Organizational Behavior: Theories of Motivation, Individual & Group Behavior, Perception, Value, Attitude, Leadership.

- **FUNCTIONAL MANAGEMENT** **(12 Hours)**

  Marketing Management: Core Concepts Of Marketing, Marketing Mix (4p), Segmentation – Targeting – Positioning, Marketing Research, Marketing Information System, Concept of International Marketing, Difference Between Domestic Marketing & International Marketing; Operations Management: Introduction to Operations Management, Types of Operation Systems, Types of Layouts, Material Handling, Purchasing & Store System, Inventory Management; Personnel Management: Roles & Functions of Personnel Manager, Recruitment, Selection, Training, Industrial Dispute, Collective Bargaining; Financial Management: Goal of Financial Management, Key Activities In Financial Management, Organization of Financial Management, Financial Institutions, Financial Instruments, Sources of Finance.

- **MODERN MANAGEMENT ASPECTS** **(04 Hours)**
  Introduction To ERP, e – CRM, SCM, RE – Engineering, WTO, IPR Etc**.**
- **TUTORIAL** **(14 Hours)**

(Total Contact Hours: 56)

3. Books Recommended:

1. Balachandran V.and Chandrasekaran, Corporate Governance, Ethics and Social Responsibility, 2nd Ed., PHI, 2011.
2. Prasad L.M., Principles & Practice Of Management, 8th Ed., Sultan Chand & Sons, 2015.
3. Banga T. R. & Shrama S.C., Industrial Organisation & Engineering Economics, 25th Ed., Khanna Publishers, 2015.
4. Everett E. Adam, Ronald J. Ebert, Production and Operations Management, 5th Ed., Prentice Hall of India, 2012.
5. Kotler P., Keller K. L, Koshi A. & Jha M., 14th Ed., Marketing Management – A South Asian Perspective, Pearson, 2014.

4. Reference Books:

1. Tripathi P.C.,Personnel Management & Industrial Relations, 21st Ed., Sultan Chand & sons, 2013.
2. Chandra P., Financial Management, 9th Ed., Tata McGraw Hill, 2015.Crane A. & Matten D., Business Ethics: Managing Corporate Citizenship and Sustainability in the Age of Globalisation, Oxford University, 2010.
3. Fritzsche D. J., Business Ethics: a Global and Managerial Perspectives, McGraw Hill Irwin, Singapore, 2004.
4. Mandal S. K., Ethics in Business and Corporate Governance, Tata McGraw Hill, 2011.