Department of Electronics Engineering
B. Tech. Electronics and Communication Engineering

SEMESTER – V

Sr. No.	Subject	Code	Credit	Teaching Scheme		
				L	T	P
1.	Professional Ethics, Economics, and Business Management	HU 301	03	3	0	0
2.	Digital Signal Processing	EC 301	04	3	0	2
3.	Digital Communication	EC 305	04	3	0	2
4.	Data Communication Networks	EC 307	04	3	0	2
5.	Department Elective - I	EC 3XX	04	3	0	2
6.	Institute Elective -1	EC 3XX	03	3	0	0
	Total		**22**	**18**	**0**	**8**

List of Subjects for Department Elective I (3 - 0 - 2)

Sr. No.	Subject	Code
1.	Electronic Instrumentation	EC 321
2.	VLSI Technology	EC 323
3.	Digital Image Processing	EC 325
4.	Antenna Theory	EC 327
5.	Object Oriented Programming (To be offered by DoCSE)	CS 321

List of Subjects for Institute Elective 1 (3 - 0 - 0)

Sr. No.	Subject	Code
1.	Sensors and Transducers	EC 361
2.	Neural Networks	EC 363
3.	Multimedia Communication	EC 365
4.	Solar Photovoltaic Technology	EC 367

SEMESTER – VI

Sr. No.	Subject	Code	Credit	Teaching Scheme		
				L	T	P
1.	VLSI Design	EC 302	04	3	0	2
2.	Wireless and Mobile Communication	EC 304	04	3	0	2
3.	Machine Learning	EC 306	04	3	0	2
4.	Seminar	EC 308	01	0	0	2
5.	Department Elective - II	EC 3XX	04	3	0	2
6.	Department Elective - III	EC 3XX	03	3	0	0
7.	Institute Elective-2	EC 3XX	03	3	0	0
	Total		**23**	**18**	**0**	**10**

List of Subjects for Department Elective II (3 - 0 - 2)

Sr. No.	Subject	Code
1.	Speech Processing and Human-Machine Communication	EC 322
2.	Embedded Systems	EC 324
3.	Optical Fiber Communication	EC 326
4.	Internet of Things	EC 328

List of Subjects for Department Elective III (3 - 0 - 0)

Sr. No.	Subject	Code
1.	Global Navigation Satellite System	EC 332
2.	Adaptive Signal Processing	EC 334
3.	Advanced Electronic Circuits	EC 336
4.	Innovation, Incubation and Entrepreneurship (To be offered by DoAMH)	HU 322

List of Subjects for Institute Elective 2 (3 - 0 - 0)

Sr. No.	Subject	Code
1.	High-Performance Computing	EC 362
2.	Computer Vision	EC 364
3.	MEMS	EC 366

PROFESSIONAL ETHICS, ECONOMICS AND BUSINESS MANAGEMENT

L	T	P	Credit
3	0	0	03

HU 301 **Scheme**

1. Course Outcomes (COs):

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

CO1	Develop knowledge regarding Professional ethics
CO2	Develop knowledge of Economics in engineering
CO3	Develop managerial skills to become future engineering managers
CO4	Develop skills related to various functional areas of management (Marketing Management, Financial Management, Operations Management, Personnel Management etc.)
CO5	Build knowledge about modern management concepts
CO6	Develop experiential learning through Assignments, Management games, Case study discussion, Group discussion, Group presentations etc.

2. Syllabus:

- **PROFESSIONAL ETHICS** **(06 Hours)**
  Introduction, Meaning of Ethics, Approaches to 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

- **ECONOMICS** **(08 Hours)**
  Introduction To Economics, Applications & Scopes Of Economics, Micro & Macro Economics, Demand Analysis, Demand Forecasting, Factors Of Production, Types Of Cost, Market Structures, Break Even Analysis

- **MANAGEMENT** **(14 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, Theories of 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; 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** **(02 Hours)**
  Introduction To ERP, e – CRM, SCM, RE – Engineering, WTO, IPR Etc.

(Total Contact Hours: 42)

3. Books Recommended:

1. Balachandran V. and Chandrasekaran, Corporate Governance, Ethics and Social Responsibility, PHI, 2nd Edition, 2011
2. Prasad L.M., Principles & Practice Of Management, Sultan Chand & Sons, 8th Edition,2015
3. Banga T. R. & Shrama S.C., Industrial Organisation & Engineering Economics, Khanna Publishers, 25th Edition, 2015
4. Everett E. Adam, Ronald J. Ebert, Production and Operations Management , Prentice Hall of India, 5th edition, 2012
5. Kotler P., Keller K. L, Koshi A.& Jha M., Marketing Management – A South Asian Perspective, Pearson, 14th Edition, 2014
6. Tripathi P.C., Personnel Management & Industrial Relations, Sultan Chand & sons, 21st Edition, 2013
7. Chandra P., Financial Management, Tata McGraw Hill, 9th Edition, 2015

4. Additional Reading:

1. Crane A. & Matten D., Business Ethics: Managing Corporate Citizenship and Sustainability in the Age of Globalisation, Oxford University, 2010
2. Fritzsche D. J., Business Ethics: a Global and Managerial Perspectives, McGraw Hill Irwin, Singapore, 2004
3. Mandal S. K., Ethics in Business and Corporate Governance, Tata McGraw Hill, 2011

DIGITAL SIGNAL PROCESSING

L	T	P	Credit
3	0	2	04

EC 301 **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.

(Total Contact Hours: 42)

3. List of 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.

DIGITAL COMMUNICATION

L	T	P	Credit
3	0	2	04

EC 305 **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:

- **SOURCE CODING AND CHANNEL CODING (14 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 for AWGN Channel, Asynchronous And Synchronous Transmission over point to point link, Concept of Frames, Packets and Segments. Introduction to Channel Coding and Forward Error Correcting Codes (FEC)-- Linear Block codes, Convolution codes. Linear block code based checksum generation for frames, Frame Error Handling.

- **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 (12 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. Direct Sequence Spread spectrum modulation and demodulation.

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

(Total Contact Hours: 42)

3. List of 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 Books:

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

DATA COMMUNICATION NETWORKS

L	T	P	Credit
3	0	2	04

EC 307 **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. List of Practicals:

1. Study of basic TCP/IP network commands: ipconfig, hostname, ping <ip_address>, tracert <ip_address>, netstat<ip_address> etc..
2. Write a C program to do Bit stuffing and De-Stuffing for all the type.
3. Write a C program to generate Cyclic Redundancy Check (CRC) and Hamming code for Error Correction and Detection.
4. Write a C program to find the shortest path between the Node among the given networks.
5. Write a C Program to implement Cipher text using Classical-Symmetric Key Ciphering and Deciphering and also implement RSA Algorithm for Modern cipher method.
6. Introduction to Network Simulator (NS3).
7. Elementary Network Model design using NS3.
8. Various data communication and result trace understanding in NS3.
9. Dynamic Network Model design for Optimum Routing using NS3.
10. Local Area Network Architecture and its Performance Analysis using NS3.
11. Wireless Network Implementation using NS3.

4. 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.

ELECTRONIC INSTRUMENTATION

L	T	P	Credit
3	0	2	04

EC 321 **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	Analyze 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. List of Practicals:

1. Design and implement voltage to voltage converter using non-inverting and inverting configurations.
2. Design and implement voltage to current converter (V to I)
   (a) using Howland Current Converter
   (b) with Floating Load
   for given specifications.
3. Design and implement signal conditioning circuit using wheat-stone resistive bridge and instrumentation amplifier.
4. To design the circuit for measurement of the phase difference using Ex-OR gate.
5. To design and implement two position controller using D flip-flop and comparator.
6. Design and implementation of bridge linearity technique using single op-amp and two-op amps.
7. To design and implement relaxation oscillator using op-amp.
8. To design and implement R to V converter.
9. To study phase difference measurement technique using S-R latch.
10. To study the characteristic of strain gauge sensor using instrumentation trainer kit.
11. To study characteristics of thermistor and thermocouple with the help of instrumentation trainer kit.

4. 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.

VLSI TECHNOLOGY

L	T	P	Credit
3	0	2	04

EC 323 **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 Contact Hours: 42)

3. List of Practicals:

1. Simulation of microfabrication processes like oxidation, deposition, patterning, etc. using TCAD tool.
2. Demonstration of processing steps involved in the cleaning of Silicon wafers.
3. Demonstration of microfabrication processes like oxidation, deposition, patterning, etc.

4. Electrical properties estimation of the thin film materials using Four Probe Hall Effect measurement setup.
5. Demonstration of Spin Coating and Hydrothermal Process for the material growth.
6. Current-Voltage characteristics measurement using semiconductor parameter analyzer for different semiconductor devices.
7. Demonstration of UV-Visible absorption measurement.
8. Back end design of various CMOS logic circuits and their functional verification.

4. 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.

5. 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	2	04

EC 325 **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. List of Practicals:

1. To study data types and conversion from (i) Index image to gray image and vice-versa (ii) RGB image to grayscale image, and gray image to RGB image. (iii) RGB image to index image and vice-versa. Open grayscale image cameraman.tif image and view it.
2. Write a program that demonstrates spatial resolution and intensity resolution effect on the given image.
3. (i)Read an image and observe the brightness modification as well as contrast manipulation.
   (ii) Perform thresholding on the given image.
   (iii) Find the negative image of the given image.
   (iv) For non-linear gray level transform apply the “Long transformation” and “Power law transformation” to the given image. Also, write comments on the output result for both non-linear gray level transformations.
4. Experiment on Bit-Plane Slicing.
5. Read the image and equalized the histogram.
6. Convolve image mask 3x3 and show that it performs avg. an operation that results in blurring of the image. Also, analyze the impact of increasing the size of the mask to 5x5.
7. Read an image and apply salt and pepper noise. Apply box filter (3x3), (5x5) & nonlinear median filter. Comment on results obtained.
8. Read an image and then corrupt by adding salt & pepper noise, Gaussian noise, and apply average filter (3x3), (5x5) to this corrupted image. Comment on the result.
9. Read an image and then apply un-sharp masking, average filter, (3x3), Gaussian kernel, high boost filter, Laplacian mask with center co-efficient positive & negative. Comment on the result.
10. Write a program to demonstrate the rotation property of DFT. Also, write a program on generating synthetic images and take FT of these images, and comment on the results.
11. You are given two images: Image A and Image B, First, take FT of both images. Determine the magnitude and phase component. During reconstruction using Inverse FT, interchange the phase of two images and reconstruct the image and observe the difference.
12. Read an image and then apply the ideal low pass filter, Butterworth LPF & Gaussian LPF. Comment on the result.
13. Write a program for Different types of High-pass filters. Comment on results.
14. Inverse filter and Pseudo inverse filter.

15. Deblurring using wiener filter.
16. Corrupt input image by appropriate periodic noise and write program to remove periodic noise.
17. Read an image and then apply the Sobel operator, Robert operator, Prewitt operator. Comment on the result.

4. Books Recommended:

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

ANTENNA THEORY

L	T	P	Credit
3	0	2	04

EC 327 **Scheme**

1. Course Outcomes (COs):

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

CO1	Describe the working principle of different antennas.
CO2	Compare the various antennas in terms of their design, functionality, use etc.
CO3	Apply the developed theories to model different radiating systems.
CO4	Evaluate the radiation and impedance characteristics of aperture, broadband, microstrip antennas and arrays.
CO5	Design suitable antennas and validate their performance for antenna arrays and smart antennas, mathematically analyze the types of antenna arrays.

2. Syllabus:

- **FUNDAMENTAL CONCEPTS** **(06 Hours)**
  Physical concept of radiation, Radiation pattern, Near- and Far-field regions, Reciprocity, Directivity and Gain, Effective Aperture, Polarization, Input Impedance, Efficiency, Friis transmission equation, Radiation integrals and Auxiliary Potential Functions.

- **RADIATION FROM WIRES AND LOOPS** **(06 Hours)**
  Infinitesimal dipole, Finite-length Dipole, Linear Elements near Conductors, Dipoles for Mobile Communication, Small Circular Loop Folded Dipole.

- **APERTURE AND HORN ANTENNAS** **(06 Hours)**
  Huygens' Principle, Radiation from Rectangular and Circular Apertures, Design Considerations, Babinet's Principle, Radiation from Sectoral and Pyramidal Horns, Design Concepts.

- **REFLECTOR ANTENNAS** **(05 Hours)**
  Parabolic Reflector, Paraboloidal Reflector, Aperture Pattern of Large Circular Apertures with Uniform Illumination, Off axis operation of Paraboloidal Reflectors, Cassegrain feed system.

- **BROADBAND ANTENNAS** **(04 Hours)**
  Broadband concept, Log-periodic antennas, Frequency independent antennas.

- **MICROSTRIP ANTENNAS** **(06 Hours)**
  Basic characteristics of microstrip antennas, Feeding methods, Methods of Analysis, Design of Rectangular and Circular Patch Antennas.

- **ANTENNA ARRAYS** **(05 Hours)**
  Analysis of Uniformly Spaced Arrays with Uniform and Non-uniform Excitation amplitudes, Extension to planar arrays.

- **ANTENNA MEASUREMENTS** **(04 Hours)**
  Introduction, Antenna ranges, Radiation Pattern, Gain Measurements, Directivity Measurements, Radiation Efficiency, Impedance and Polarization Measurements.

(Total Contact Hours: 42)

3. List of Experiments:

1. To study various antennas, its application and tentative radiation pattern. (study experiment)
2. To study and observe the radiation pattern of a dipole antenna.
3. To study and compare the radiation pattern of folded dipole with straight dipole antenna and comment on the radiation resistance.
4. To study and compare the radiation pattern of 3-element and 5-element Yagi and comment on effect of addition of parasitic elements to the given antenna.
5. To study the variation of radiated field with distance from transmitting antenna.
6. To measure the gain of the given antenna (DUT) using two identical antennas.
7. To study and observe the radiation pattern of the horn antenna.
8. Introduction to HFSS and CST.
9. To design and simulate a Microstrip patch antenna using HFSS.
10. Study of Antenna Measurement setup in anechoic chamber.

4. Books Recommended:

1. C. A. Balanis, “Antenna Theory and Design”, 4th Ed., John Wiley & Sons., 2016.
2. J.D. Krauss, “Antennas for all Applications”, 3rd Ed., Tata McGraw-Hill, 2008.
3. W. L. Stutzman, and G. A. Thiele, “Antenna Theory and Design”, 2nd Ed., John Wiley & Sons, 1998.
4. R. S. Elliot, “Antenna Theory and Design”, Revised edition, Wiley-IEEE Press., 2003.
5. R. E. Collin, “Antennas and Radio Wave Propagation”, McGraw-Hill., 1985.

OBJECT ORIENTED PROGRAMMING

L	T	P	Credit
3	0	2	04

CS 321 **Scheme**

1. Course Outcomes (COs):

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

CO1	Interpret the basic principles of object oriented programming.
CO2	Design and develop computer programs to solve real world problems based on object oriented principles.
CO3	Implement multi-threaded applications, algorithms and complex problems.
CO4	Define data types but also deals with operations applied for data structures

2. Syllabus:

- **INTRODUCTION** **(06 Hours)**
  Introduction: Object oriented programming, Introduction, Application, characteristics, difference between object oriented and procedure programming, Comparison of C and C++, Cout, Cin, Data Type, identifiers.

- **OBJECT AND CLASSES** **(10 Hours)**
  Implementation of class and object in C++, access modifiers, object as data type, constructor, destructor, Object as function arguments, default copy constructor, parameterized constructor, returning object from function, Structures and classes, Classes objects and memory, static class data, Arrays of object, Arrays as class Member Data, the standard C++ String class, Run time and Compile time polymorphism.

- **OPERATOR OVERLOADING AND INHERITANCE** **(08 Hours)**
  Overloading unary operators, overloading binary operators, data conversion, pitfalls of operators overloading, Concept of inheritance, Derived class and base class, access modifiers, types of inheritance, Derived class constructors, member function, public and private inheritance.

- **POINTER AND VIRTUAL FUNCTION** **(10 Hours)**
  Addresses and pointers, the address-of operator & pointer and arrays, Pointer and Function pointer, Memory management: New and Delete, pointers to objects, debugging pointers, Virtual Function, friend function, Static function, friend class, Assignment and copy initialization, this pointer, dynamic type information.

- **STREAMS AND FILES** **(08 Hours)**
  fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exceptions subclasses).

(Total Contact Hours: 42)

3. List of Experiments:

1. Write a program to find out the largest number using function.
2. Write a program to find the area of circle, rectangle and triangle using function overloading.
3. Write a program to implement complex numbers using operator overloading and type

conversion.

4. Write a program using class and object to print bio-data of the students.
5. Write a program which defines a class with constructor and destructor which will count number of object created and destroyed.
6. Write a program to implement single and multiple inheritances taking student as the sample base class.
7. Write a program to add two private data members using friend function.
8. Write a program using dynamic memory allocation to perform 2x2 matrix addition and subtraction.
9. Write a program to create a stack using virtual function.
10. Write a program that store five student records in a file.
11. Write a program to get IP address of the system.
12. Write a program to shut down the system on windows operating system.

4. Books Recommended:

1. E. Balaguruswami," Object Oriented Programming in C++", TMH.
2. Robert Lafore, "Object Oriented Programming in C++", Pearson.
3. M.T. Somashekare, D.S. Guru, "Object-Oriented Programming with C++", PHI.
4. Herbert Shildt, "The Complete Reference C++", Tata McGraw Hill publication.

SENSORS AND TRANSDUCERS

L	T	P	Credit
3	0	0	03

EC 361 **Scheme**

1. Course Outcomes (COs):

At the end of the course the 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 Contact Hours: 42)

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

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.

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 Contact 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.

SOLAR PHOTOVOLTAICS TECHNOLOGY

L	T	P	Credit
3	0	0	03

EC 367 **Scheme**

1. Course Outcomes (COs):

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

CO1	Explain Solar Resource and Basics of Photovoltaic Systems.
CO2	Describe requirements for the efficient Photovoltaic Device Design and Processing.
CO3	Demonstrate different solar cell fabrication and characterization techniques.
CO4	Explain and analyze the concepts of PV Module.
CO5	Design the Solar Photovoltaic Devices and PV Modules

2. Syllabus:

- **INTRODUCTION TO SOLAR PHOTOVOLTAICS (03 Hours)**
  Solar Resource, Solar Energy Conversion Technologies, Need of Solar PV, Prospects of PV technology.

- **FUNDAMENTALS OF SOLAR CELLS (12 Hours)**
  Light Absorption, Charge Excitation, Charge Drift/Diffusion, Charge Separation, Charge Collection, PN junction diodes: Dark IV, illuminated IV, Device Performance parameters, Series/ Shunt Resistance, Factors affecting the performance parameters, Detailed Balanced Limit.

- **FABRICATION AND CHARACTERIZATION OF SOLAR CELLS (12 Hours)**
  Solar Cell Fabrication:
  Vacuum Based Deposition Techniques: Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD): Sputtering, Electron Beam Evaporation, Pulsed Laser Deposition, Atomic Layer Deposition. Solution Based Deposition Techniques: Electrodeposition, Spin Coating, Layer-by Layer Deposition.
  Solar Cell Characterization:
  Solar Simulator, Quantum Efficiency Measurement, XPS/UPS, FESEM, Energy Dispersive X-Ray Spectroscopy, Photo-Luminescence

- **CUTTING-EDGE THEMES AND PV MODULES (09 Hours)**
  Light manipulation in PV Devices: Plasmonic Integration, Surface Texturing, Spectrum Splitting Techniques.
  Module Design, Interconnection effects, Temperature effects, Lifetime of PV modules, Module measurement.

- **PV DEVICE MODELING (06 Hours)**
  Basics of Solar Cell Device Modeling, Thin-Film Solar Cell Device Modeling: Hands-on with an Open Source Tool, Modeling of PV Modules.

(Total Contact Hours: 42)

3. Books Recommended:

1. Martin A. Green, “Solar Cells: Operating Principles, Technology and System Applications”,, Prentice-Hall, 1986.
2. Jenny Nelson, “The Physics of Solar cells”, World Scientific, 2003.
3. Smets Arno et al., “Solar Energy Fundamentals, Technology, and Systems”, UIT Cambridge. 2013
4. D. K. Schroder, “Semiconductor Material and Device Characterization”, Wiley Interscience, 2006
5. Konrad Mertens, “Photovoltaics Fundamentals, Technology, and Practice”, Wiley, 2018,
6. J. Poortmans and V. Arkhipov, “Thin Film Solar Cells: Fabrication, Characterization and Applications”, Willey, 2006.

4. Additional Resources:

1. Antonio Luque, Steven Hegedus, “Handbook of Photovoltaic Science and Engineering”, Wiley, 2011
2. Relevant Journal and Conference publications.

VLSI DESIGN

L	T	P	Credit
3	0	2	04

EC 302 **Scheme**

1. Course Outcomes (COs):

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

CO1	Describe VLSI Design flow and circuit characterization for performance estimation.
CO2	Demonstrate dynamic Logic circuits.
CO3	Compare different semiconductor memories.
CO4	Evaluate the circuit performance using Logical efforts.
CO5	Design arithmetic building blocks (data-path) from the system's perspective along with the design of FSM (Control-path).

2. Syllabus:

- **INTRODUCTION OF VLSI DESIGN** **(06 Hours)**
  Historical Perspective, Design Hierarchy, Concepts of Regularity, Modularity and Locality, VLSI Design Styles, VLSI Design Flow, Semi-Custom- Full Custom IC Design Flow, Data Path, Control Path Programmable Logic Array, CMOS and Bipolar Transistor Gate Arrays and Their Limitations, Standard Cells, FPGA/CPLD Architecture.

- **DYNAMIC LOGIC CIRCUITS** **(06 Hours)**
  Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic and High Performance Dynamic CMOS Circuit, Dynamic Latches and Registers.

- **CIRCUIT CHARACTERIZATION FOR PERFORMANCE ESTIMATION** **(07 Hours)**
  Interconnect, Estimation of Interconnect Parasites, Delay Estimation, Logical Efforts and Transistor Sizing, Power Dissipation, Design Margin, Reliability.

- **SEMICONDUCTOR MEMORIES** **(08 Hours)**
  Type of Memories, design and analysis of ROM Cells, Static and Dynamic Read - Write Memories, Memory Peripheral Circuits, Power Dissipation in Memory, Flash Memory.

- **DESIGN OF ARITHMETIC BUILDING BLOCKS** **(10 Hours)**
  Data Path Operations: Adders, Shifter, Multiplier, Power and Speed Trade-off in Data-path Structures, Control Path and FSM.

- **INPUT-OUTPUT CIRCUITS** **(05 Hours)**
  ESD Protection, Input Circuits, Output Circuits, Pad Drivers and Protection Circuit, On-Chip Clock Generation/Distribution, Latch-up and its Prevention.

(Total Contact Hours: 42)

3. List of Practicals:

1. Introduction to Verilog HDL and FPGA.
2. Implementation and Simulation of Logic Gate using Verilog HDL on FPGA
3. Design and Implementation of Half adder and Full Adder using Verilog HDL on FPGA.
4. Design and Implementation of Half subtractor and Full Subtractor using Verilog HDL on FPGA.

5. Design and Implementation of Ripple Carry Adder using Verilog HDL on FPGA.
6. Design and Implementation of Multiplexer using Verilog HDL on FPGA.
7. Design and Implementation of Flip-Flops using Verilog HDL on FPGA.
8. Design and Implementation of Registers using Verilog HDL on FPGA.
9. Design and Implementation of Four Bit Up-Down Counter using Verilog HDL on FPGA.
10. Design and Implementation of Array Building Blocks.

4. Books Recommended:

1. Sung-Mo Kang and Leblebici Y., “CMOS Digital Integrated Circuits: Analysis and Design”, 3rd Ed., Tata McGraw-Hill, 2003.
2. Rabaey Jan, Chandrakasan Anantha and Borivoje Nikolic, “Digital Integrated Circuits”: A Design Perspective, Pearson Education, 2nd Ed., Second Impression, 2008.
3. Weste Neil H.E, Harris D. and Banerjee A., “CMOS VLSI Design: A Circuits and Systems Perspective”, 3rd Ed., Pearson Education, 2002.
4. Samir Palnitkar, “Verilog Hdl”– 2nd Ed., Pearson, 2003.
5. Bhasker J., “A Verilog Hdl Primer”, 3rd Ed., BS Publication, 2008.

5. Reference Book:

1. Pucknell D.A. and Eshraghian K., “Basic VLSI Design, 3rd Ed., Prentice Hall of India”, 2003.

WIRELESS AND MOBILE COMMUNICATION

L	T	P	Credit
3	0	2	04

EC 304 **Scheme**

1. Course Outcomes (COs):

At the end of the course 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

(Total Contact Hours: 42)

3. List of Practicals:

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.

MACHINE LEARNING

L	T	P	Credit
3	0	2	04

EC 306 **Scheme**

1. Course Outcomes (COs):

At the end of the course the 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. List of Practicals:

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 Backpropagation 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.

4. 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).

SPEECH PROCESSING AND HUMAN-MACHINE COMMUNICATION

L	T	P	Credit
3	0	2	04

EC 322 **Scheme**

1. Course Outcomes (COs):

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

CO1	Define the fundamentals of speech processing.
CO2	Describe the different parameters of speech signal.
CO3	Apply different algorithms to extract different speech parameters.
CO4	Analyze different speech processing algorithms.
CO5	Design a speech based system for different applications.

2. Syllabus:

- **INTRODUCTION** **(04 Hours)**
  Application of speech processing; Speech signal representation and measurement; Stationary and non-stationary analysis of speech

- **SPEECH PRODUCTION AND PERCEPTION** **(06 Hours)**
  Speech production mechanism; Speech production model; Speech perception; Classification of speech sounds: voiced, unvoiced, silence, vowel, semi-vowel, consonants, diphthongs, nasal, fricative, affricative, stops etc.

- **ANALYSIS OF SPEECH SIGNAL** **(10 Hours)**
  Short-term processing, Time domain analysis: short-time energy, short-time autocorrelation, short-time zero crossing; Frequency domain analysis; Short-term Fourier transform (STFT); Filter-bank analysis; Spectrogram analysis; Cepstrum analysis; Pitch estimation: autocorrelation based, cepstrum based and LP analysis based; Formant estimation

- **LINEAR PREDICTION ANALYSIS** **(10 Hours)**
  All pole model; Pole zero model; Autocorrelation and covariance method; Levinson-Durbin algorithm; Inverse filtering; LP residual; Pitch frequency and formant frequency analysis using LP analysis, Comparison of LP model with non-linear speech production models

- **TEXT-TO-SPEECH SYNTHESIS** **(06 Hours)**
  Components of TTS, Speech synthesis methods: Concatenative and waveform based; Intelligibility and naturalness of synthesized speech; Applications and present status; WORLD vocoder

- **AUTOMATIC SPEECH RECOGNITION** **(06 Hours)**
  Statistical and machine learning Approaches; Acoustic models; Language models

(Total Contact Hours: 42)

3. List of Practicals:

1. Understating the non-stationary and stationary behavior of speech signal.
2. Calculation of short-term energy, short-term zero crossing rate and short-term autocorrelation.
3. Detection of different speech regions, such as voiced, unvoiced and silence regions.

4. Estimation of Pitch frequency using autocorrelation function.
5. Short-term frequency domain analysis of speech: Pitch and Formant estimation.
6. Linear prediction (LP) analysis of speech signal.
7. Pitch frequency estimation using linear prediction (LP) model.
8. Formant estimation from speech signal.
9. Cepstrum analysis of speech signal.
10. Calculation of mel-frequency cepstral coefficient (MFCC) from speech signal.

4. Books Recommended:

1. L. R. Rabiner and R. W. Schafer, “Digital Processing of Speech Signals”, 1st Ed., Pearson Education India, 2003.
2. J. Benetsy, M. M. Sondhi and Y. Huang, “Springer Handbook of Speech Processing”, 1st Ed., Springer Verlag, 2008.
3. J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis “Discrete-Time Processing of Speech Signals”, Wiley- IEEE Press, IEEE Edition, NY, USA, 1999.
4. D. O’Shaughnessy, “Speech Communications: Human and Machine”, 2nd Ed., University Press, 2005.
5. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, 1st Ed., Pearson Education, 2004.

EMBEDDED SYSTEMS

L	T	P	Credit
3	0	2	04

EC 324 **Scheme**

1. Course Outcomes (COs):

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

CO1	Describe ARM processor, its modes, exception handling, instruction pipelining and basic programming
CO2	Implement Assembly and C language programming for ARM Cortex-M.
CO3	Analyze 32-bit ARM microcontroller architecture, External Memory, Counters & Timers, Serial Data Input/output and Interrupts. Design for interfacing Keys, LED/LCD Displays, ADC And DAC
CO4	Evaluate concepts of RTOS and its functionalities.
CO5	Design a typical cost-effective real-world embedded system with appropriate hardware components and software algorithms

2. Syllabus:

- **OVERVIEW OF EMBEDDED SYSTEMS** **(06 Hours)**
  Embedded Vs General computing system, Classification of Embedded systems, Major applications, Quality Attributes of Embedded Systems, Typical components, Embedded software development, Embedded OS, RISC Vs CISC Architectures

- **ARM CORTEX M3/M4 ARCHITECTURE** **(10 Hours)**
  Overview of ARM Cortex family, Operation modes and states, Registers, Special Registers, Floating point Registers, Application program status registers, Memory system and MPU, Exception and interrupts, System control block, OS support features

- **PROGRAMMING CORTEX M3/M4IN ASSEMBLY/C** **(12 Hours)**
  Assembly Instructions: Data Processing, SIMD and saturating, Multiply and MAC, Packing and unpacking, Floating point, Data conversion, Bit field processing, Compare and Test, Branching, Sleep mode, Memory barrier and other instructions, Assembly and Embedded C programming examples

- **PERIPHERAL INTERFACING** **(06 Hours)**
  Serial Communication interfacing such as USB, RS485, SPI, I2C, CAN and Ethernet, Motor control with PWM

- **APPLICATION PROGRAMMING OF CORTEX M3/M4** **(08 Hours)**
  Writing optimized ARM assembly/C code, Exception and fault handling routines, Handling floating point operations, Programming for DSP applications (such as Biquad filter, FIR filter, IIR filter, DFT, FFT etc.)

(Total Contact Hours: 42)

3. List of Practicals:

1. Introduction to ARM Cortex M3/M4 evaluation board and Keil ARM – MDK development flow
2. Write an program to flash simple LEDs (D0, D1, ... , D7) connected to Ports in various

patterns

3. Write code to show up/down BCD count on Multiplexed 7-segment LED display updated every second. Use two keys (up & down) to change direction of counting.
4. Write a program to display “Welcome to SVNIT” as welcome message on LCD interface.
5. Interface 4x4 keypad and Display pressed key on LCD
6. Interface stepper motor and rotate it in clockwise and anti-clock wise direction
7. Generate Sine wave/Triangle/Square wave using SPI based DAC and observe on CRO. Increase or Decrease frequency using Keys in decades.
8. Using the internal PWM module of ARM microcontroller, generate PWM and vary its duty cycle to control DC motor
9. Interface accelerometer and read the its output through I2C serial communication
10. Illustrate use of CMSIS-RTOS functions for embedded programming
11. Demonstrate the use of keil RTX real time operating system for toggling LED ON/OFF
12. Demonstrate use of threads and semaphores using keil RTX RTOS

4. Books Recommended:

1. Joseph Yiu, “A definitive guide to the ARM-Cortex M3 and Cortex-M4 Processors”, 3rdEdition, Newnes, 2013
2. CMSIS-Core support for Cortex-M processor-based devices. Available at: https://www.keil.com/pack/doc/CMSIS/Core/html/index.html
3. Y. Zhu, “Embedded Systems with Arm Cortex-M3 Microcontrollers in Assembly Language and C” E-Man Press LLC, 2014.
4. A.N.Sloss, D.Symes and C. Wright, “ARM System Developer’s Guide: Designing and Optimizing System Software”,Elsevier, 2004.
5. ARM Cortex M4 Technical Reference Manual.

OPTICAL FIBER COMMUNICATION

L	T	P	Credit
3	0	2	04

EC 326 **Scheme**

1. Course Outcomes (COs):

At the end of the course the 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	Designthe 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. List of Practicals:

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.

4. 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.

INTERNET OF THINGS

L	T	P	Credit
3	0	2	04

EC 328 **Scheme**

1. Course Outcomes (COs):

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

CO1	Describe sensor data available on the Internet for analysis and visualization.
CO2	Demonstrate basic measurement tools to determine the real-time performance of packet-based networks.
CO3	Examine how to communicate with other mobile devices using various communication platforms such as Bluetooth and Wi-Fi.
CO4	Evaluate trade-offs in interconnected wireless embedded sensor networks.
CO5	Create end-to-end IoT applications, working as a team.

2. Syllabus:

- **INTRODUCTION TO IOT** **(06 Hours)**
  IOT Architecture, Major components of IoT, IoT enabling technologies, IoT Standards, IoT Entities, IOT Software Development Platforms (Python/C/C++), Sensors, Actuators, Gateways, Cloud, Mobile/Web Applications

- **MACHINE-TO-MACHINE COMMUNICATIONS** **(08 Hours)**
  Wired Communication Protocols, Role of M2M in IoT, Machine-to-Machine Communication: MQTT/MQTT-SN,COAP

- **INTEROPERABILITY IN IOT** **(04 Hours)**
  Linux-based Edge Device—Raspberry Pi, Integration of Sensors and Actuators with Arduino, RaspberriPi, Python programming.

- **NETWORKING IN IOT** **(08 Hours)**
  Real-time networking, Soft and real time, quality of service/information, resource reservation and scheduling, and performance measurements, Introduction to SDN, SDN for IoT

- **COMPUTING IN IOT** **(08 Hours)**
  Data Handling and Analytics,Cloud Computing, Sensor-Cloud, Fog Computing, IoT Security

- **IOT EXAMPLES** **(08 Hours)**
  IoT System in a Laboratory, Industrial IoT as Managed Service,Smart Cities and Smart Homes, Connected Vehicles, Smart Grid

(Total Contact Hours: 42)

3. List of Practicals:

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED and Buzzer with Arduino/Raspberry Pi and write a program to continuously turn ON LED for 1 second and turn it OFF for 2 seconds.
3. To interface Infrared sensor with Arduino/Raspberry Pi and write a program to turn ON LED at the sensor detection.

4. To interface temperature and humidity sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface LCD with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
6. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when 1/0 is received from smartphone using Bluetooth.
8. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to cloud.
9. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from cloud.
10. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
11. Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and Print it.
12. Write a program to create TCP server on Arduino/Raspberry Pi and Respond with humidity data to TCP client when requested.
13. Write a program to create UPD server on Arduino/Raspberry Pi and respond with humidity data to UPD client when requested.

4. Books Recommended:

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", 1st Ed., CRC Press, 2017.
2. ArshdeepBahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", 1st Ed., Universities Press, x 2014.
3. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos and David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Ed., Academic Press, 2014.
4. Rahul Dubey, “An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications”, 1st Ed., 2019.
5. Brian Russell and Drew Van Duren, “Practical Internet of Things Security”, Packt Publishing, 2016.

GLOBAL NAVIGATION SATELLITE SYSTEM

L	T	P	Credit
3	0	0	03

EC 332 **Scheme**

1. Course Outcomes (COs):

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

CO1	Classify global as well regional navigation systems.
CO2	Apply knowledge of different signal structures of diverse navigation systems.
CO3	Analyze position of GNSS receiver using acquisition and tracking.
CO4	Evaluate various GNSS positioning techniques.
CO5	Design societal application using GNSS.

2. Syllabus:

- **GNSS OVERVIEW** **(04 Hours)**
  Introduction to GNSS systems, GNSS Architecture, Augmentation System

- **SATELLITE NAVIGATION SYSTEMS** **(08 Hours)**
  Global Navigation systems: GPS, GLONASS, GALILEO, Beidou Regional Navigation systems : QZSS, IRNSS/NavIC

- **SATELLITE SIGNAL CHARACTERISTICS: GPS/GNSS** **(08 Hours)**
  Common components of any GNSS Signal, Modulation Techniques, Multiple Accessing Techniques , CDMA-Code Division Multiple Access, FDMA-Frequency Division Multiple Access, Signal structure of different GNSS systems

- **SATELLITE SIGNAL ACQUISITION, TRACKING AND DATA DEMODULATION** **(08 Hours)**
  Introduction of Acquisition, Acquisition Methods, Serial Search in time domain, Parallel Search in frequency domain, Tracking, Navigation Data Decoding

- **GNSS POSITIONING TECHNIQUES** **(10 Hours)**
  code based positioning, phase based positioning , Single Point Positioning, Differential positioning, Precise Point Positioning, RTK

- **APPLICATIONS OF GNSS** **(04 Hours)**
  Aviation Ground-based Augmentation, Marine Navigation, Space Navigation, Vehicle Navigation, Precision Agriculture, Military Applications, Geodesy, Surveying and Mapping, Atmospheric and Ionospheric Science

(Total Contact Hours: 42)

3. Books Recommended:

1. Elliott_D._Kaplan, “Christopher_Hegarty Understanding GPS Principles and Applications”, 3rd Ed., Archtech House, Artech House, 2017.
2. Pratap Misra, “Per Enge - Global Positioning System_ Signals, Measurements, and Performance”, 1st Ed., Ganga-Jamuna Press, 2006.
3. Kai Borre,_Dennis M. Akos, Nicolaj Bertelsen, “A Software-Defined GPS and Galileo Receiver: A Single-Frequency Approach”, 1st Ed., Peterson, 2007.

4. Scott Madry, “Global Navigation Satellite Systems and Their Applications”, Springer series 10058, 2015.
5. Teunissen, Montenbruck, “Handbook of Global Navigation Satellite Systems”, 1st Ed., Springer-Verlag, 2017.

ADAPTIVE SIGNAL PROCESSIN

L	T	P	Credit
3	0	0	03

EC 334 **Scheme**

1. Course Outcomes (COs):

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

CO1	Define the different theory/concepts required for adaptive algorithm
CO2	Describe the different algorithms used in adaptive filtering problem
CO3	Solve the problem related to different adaptive filtering techniques
CO4	Analyze different adaptive filtering techniques
CO5	Design different filtering techniques in practical scenario

2. Syllabus:

- **INTRODUCTION** **(06 Hours)**
  Introduction to Filters, Filtering Problem, Linear Optimum Filters, Adaptive Filers, Linear Filter Structures, Different Approaches of Linear Adaptive Filters, Applications

- **RANDOM VARIABLES AND RANDOM PROCESS** **(06 Hours)**
  Random Variables, Probability Density Function and Distribution Function, Joint Random Variable, Random Process, Ensemble Averages, Correlation, Covariance, Power Spectral Density, Ergodicity, Time Averages, Biased & Unbiased Estimators, Consistent Estimators

- **WIENER FILTERING** **(06 Hours)**
  Problem Statement of Optimum Filtering, Orthogonality Principles, Minimum Mean-Square Error, Wiener- Hopf equations and Solutions, Wiener smoothing and prediction filters

- **LINEAR PREDICTION** **(08 Hours)**
  Forward Linear Prediction, Backward Linear Prediction, Prediction Error Filters, Lattice Structure, All-pole Lattice Structure, Pole-Zero Lattice Structure, Adaptive Lattice Structure, Autoregressive modelling, Predictive Modeling of Speech

- **LEAST-MEAN-SQUARE ADAPTIVE FILTERING** **(06 Hours)**
  Steepest-Descent Algorithm, Least-Mean-Square-Adaptation Algorithm (LMS), Canonical Model of the LMS Algorithm, Normalized LMS Adaptation Algorithm, Stability Analysis for Normalized LMS Filter

- **METHOD OF LEAST-SQUARES AND RECURSIVE LEAST-SQUARES** **(06 Hours)**
  Linear Least-Squares Estimation Problem, Orthogonality principles, Normal Equations and Least-Squares Filters, Singular Value Decomposition, Matrix Inversion Lemma, Recursive Least-Squares Algorithm

- **KALMAN FILTERING** **(04 Hours)**
  Statement of the Kalman Filtering Problem, The Innovation Process, Estimation of State using the Innovation Process, Kalman Filtering

(Total Contact Hours: 42)

3. Books Recommended:

1. Simon Haykin “Adaptive filter theory”, Pearson Education India, 2003.
2. 2. Bernard Widrow and Samuel Stearns, “Adaptive Signal Processing”, Pearson Education, 1985
3. 3. Ali H. Sayed, “Fundamentals of adaptive filtering” John Wiley & Sons, 2003.
4. 4. Behrouz Farhang-Boroujeny, “Adaptive filters: theory and applications” John Wiley & Sons, 2013.
5. 5. Tülay Adali and Simon Haykin, “Adaptive signal processing: next generation solutions” Vol. 55. John Wiley & Sons, 2010.

ADVANCED ELECTRONIC CIRCUITS

L	T	P	Credit
3	0	0	03

EC 336 **Scheme**

1. Course Outcomes (COs):

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

CO1	Describe the fundamental principles and applications of Linear and Switch Mode Power Supplies
CO2	Discuss the effect of static op-amp limitations and Illustrate its impact on various circuits.
CO3	Implement various waveform generation techniques
CO4	Analyze the concept of Switched capacitor and its applications in various circuit designs.
CO5	Evaluate analog multiplier circuit and its applications.
CO6	Design Linear and switching regulators according to specifications.

2. Syllabus:

- **LINEAR VOLTAGE REGULATOR** **(08 Hours)**
  Voltage References, Characteristics of Voltage Regulators, Line and Load Regulation, Series and Shunt Voltage Regulators, Protection Circuits, Low Dropout (LDO) Voltage Regulators, Adjustable Voltage Regulators, Voltage Regulator IC.

- **SWITCHING REGULATOR** **(10 Hours)**
  Choice of Switching Frequency, Operation and Design of Different types of Switching Regulators, Buck type, Boost type and Buck-Boost Type, Continuous and Discontinuous Mode, Study of PWM IC, Isolated Multi-Winding Switching Regulator, Push-Pull Configuration, Merits and Demerits of Switching Regulator.

- **STATIC OP-AMP LIMITATION** **(08 Hours)**
  Input Bias and Offset Currents, Low-Input-Bias-Current Op Amps, Input Offset Voltage, Low-Input-Offset-Voltage Op Amps, Input Offset Error and Compensation Techniques, Input Voltage Range/Output Voltage Swing, Maximum Ratings, Effect of offset voltage and bias current on various op-amp based circuits, Stability and compensation of Op-Amps.

- **FUNCTION GENERATORS** **(05 Hours)**
  Transfer Curve Synthesizer, Sine Wave Generation using an analog MUX, Waveform generation Techniques, PLL

- **ANALOG MULTIPLIER** **(05 Hours)**
  Simple Multiplier using an Emitter Coupled Transistor Pair, Gilbert Multiplier Set, Complete Four Quadrants Analog Multiplier, IC Multiplier, Application of Analog Multiplier, Logarithmic and Antilog Amplifiers, Design issue with Log Amplifier.

- **SWITCHED CAPACITOR FILTER** **(06 Hours)**
  Switched Capacitor using a MOSFET, SC Integrator, Practical Limitation of SC Integrator, Switch Capacitor Filters, Universal SC Filters, and Gyrator Circuit.

(Total Contact Hours: 42)

3. Books Recommended:

1. Pressman Abraham I., "Switching Power Supply Design", McGraw-Hill, 2nd Ed., 2015.
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", McGraw-Hill, 4th Ed., Published: May 11, 2016.
3. K R Botkar, “Integrated Circuits”, Khanna Publisher, 10th Ed., 1987
4. Flynn Whittington, “Switched Mode Power Supplies” Universities Press; 2nd Ed. 2009.
5. Salivahanan S., "Linear Integrated Circuits", Fourth Reprint, McGraw-Hill, 2010.

INNOVATION, INCUBATION AND ENTREPRENEURSHIP

L	T	P	Credit
3	0	0	03

HU 322 **Scheme**

1. Course Outcomes (COs):

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

CO1	Explain the concepts of Entrepreneurship
CO2	Develop skills related to various functional areas of management (Marketing Management, Financial Management, Operations Management, Personnel Management etc.)
CO3	Develop skills related to Project Planning and Business Plan development
CO4	Demonstrate the concept of Innovation, Intellectual Property Rights (IPR) and Technology Business incubation
CO5	Build knowledge about Sources of Information and Support for Entrepreneurship

2. Syllabus:

- **CONCEPTS OF ENTREPRENEURSHIP (08 Hours)**
  Scope of Entrepreneurship, Definitions of Entrepreneurship and Entrepreneur, Entrepreneurial Traits, Characteristics and Skills, Entrepreneurial Development models and Theories, Entrepreneurs Vs Managers, Classification of Entrepreneurs; Major types of Entrepreneurship – Techno Entrepreneurship, Women Entrepreneurship, Social Entrepreneurship, Intrapreneurship (Corporate entrepreneurship), Rural Entrepreneurship, Family Business etc.; Problems for Small Scale Enterprises and Industrial Sickness; Entrepreneurial Environment – Political, Legal, Technological, Natural, Economic, Socio-Cultural etc.

- **FUNCTIONAL MANAGEMENT AREA IN ENTREPRENEURSHIP (14 Hours)**
  Marketing Management: Basic concepts of Marketing, Development of Marketing Strategy and Marketing plan

  Operations Management: Basic concepts of Operations management, Location problem, Development of Operations strategy and plan

  Personnel Management: Main operative functions of a Personnel Manager, Development of H R strategy and plan

  Financial Management: Basics of Financial Management, Ratio Analysis, Investment Decisions, Capital Budgeting and Risk Analysis, Cash Flow Statement, Break Even Analysis

- **PROJECT PLANNING (08 Hours)**
  Search for Business Idea, Product Innovations, New Product Development – Stages in Product Development; Sequential stages of Project Formulation; Feasibility analysis – Technical, Market, Economic, Financial etc.; Project report; Project appraisal; Setting up an Industrial unit – procedure and formalities in setting up an Industrial unit; Business Plan Development

- **PROTECTION OF INNOVATION THROUGH IPR (02 Hours)**
  Introduction to Intellectual Property Rights – IPR, Patents, Trademarks, Copy Rights

- **INNOVATION AND INCUBATION** **(06 Hours)**
  Innovation and Entrepreneurship, Creativity, Green Technology Innovations, Grassroots Innovations, Issues and Challenges in Commercialization of Technology Innovations, Introduction to Technology Business Incubations, Process of Technology Business Incubation.

- **SOURCES OF INFORMATION AND SUPPORT FOR ENTREPRENEURSHIP** **(04 Hours)**
  State level Institutions, Central Level institutions and other agencies

(Total Contact Hours: 42)

3. Books Recommended:

1. Desai Vasant, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, India, 6th Revised Edition, 2020
2. Charantimath P. M., Entrepreneurial Development and Small Business Enterprises, Pearson Education, 3rd Edition, 2018
3. Holt David H., Entrepreneurship: New Venture Creation, Pearson Education, 2016
4. Chandra P., Projects: Planning, Analysis, Selection, Financing, Implementation and Review, Tata McGraw Hill, 9th Edition, 2019
5. Banga T. R. &Shrama S.C., Industrial Organisation & Engineering Economics, Khanna Publishers, 25th Edition, 2015

4. Additional Books:

1. Prasad L.M., Principles & Practice Of Management, Sultan Chand & Sons, 8th Edition,2015
2. Everett E. Adam, Ronald J. Ebert, Production and Operations Management , Prentice Hall of India, 5th edition, 2012
3. Kotler P., Keller K. L, Koshi A.& Jha M., Marketing Management – A South Asian Perspective, Pearson, 14th Edition, 2014
4. Tripathi P.C. , Personnel Management & Industrial Relations, Sultan Chand & sons, 21st Edition, 2013
5. Chandra P., Financial Management, Tata McGraw Hill, 9th Edition, 2015

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	Understand concept of Image Formation.
CO2	Apply different transformations on images for processing.
CO3	Analyze segmentation problem for an image and Apply different segmentation techniques.
CO4	Evaluate different feature extraction and pattern analysis methods and apply them on real world computer vision problems
CO5	Design algorithms for real world computer vision problems.

2. Syllabus:

- **IMAGE FORMATION** **(07 Hours)**
  Pinhole and Perspective Projection, Image Magnification, Vanishing Point, Image Formation using Lenses, Gaussian Lens Law, Focal Length, Two Lens System, Aperture of the Lens, Lens Defocus, Blur Circle, Depth of Field, Lens Related Issues, Radiometry, Light Flux, Radiant Intensity, Surface Irradiance, Surface Radiance, BRDF, Reflectance Models, Photometric Stereo.

- **LOW-LEVEL PROCESSING** **(05 Hours)**
  Transformations: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Deconvolution, Image Enhancement, Restoration, Histogram Processing.

- **SEGMENTATION** **(08 Hours)**
  Binary Segmentation, Segmentation by Humans, Segmentation as Clustering: k-Means Segmentation, Mean-Shift Segmentation, k-Medoid Segmentation, Gaussian Mixture Model (GMM), Expectation Maximization (EM) for GMM.

- **FEATURE EXTRACTION** **(08 Hours)**
  Edges- Canny, LOG, DOG; Line Detectors, Corner Detectors, SIFT, SURF, HOG, GLOH, Principal Component Analysis (PCA).

- **PATTERN ANALYSIS** **(08 Hours)**
  Clustering Algorithms, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised, Bayes classifier, K-Nearest Neighbor (KNN), Linear Classifiers, Logistic Regression, Support Vector Machine.

- **APPLICATION USING PYTHON AND MATLAB** **(06 Hours)**
  Introduction to Python and MATLAB Programming, Libraries Related to Computer Vision, Real Life Computer Vision Applications.

(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
3. Learning 2015.
4. E. Tresso and A. Verri, “Introductory Techniques for 3-D Computer Vision”, Prentice-Hall,
5. 1998.
6. Gerhard X. Ritter Joseph N. Wilson, “Handbook of Computer Vision Algorithms in Image Algebra,” second edition, CRC Press, 2000.
7. Rafael C. Gonzalez, Richard E.Woods, “Digital Image Processing” Fourth Edition, Pearson, 2018.

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.