FACULTY OF ENGINEERING

Scheme of Instruction & Examination
(AICTE Model Curriculum)
and
Syllabi

B.E. V and VI Semesters
of
Four Year Degree Programme
in

ELECTRONICS & COMMUNICATION ENGINEERING
(w.e.f.: 2022 - 2023)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2022

Chairperson, BoS   **Dean, FoE OU**

SCHEME OF INSTRUCTION &EXAMINATION
B.E. V- Semester

ELECTRONICS AND COMMUNICATIONENGINEERING

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	Credits
Theory Course										
1	PC408EC	Digital Signal Processing	3	-	-	3	30	70	3	3
2	PC409EC	Microprocessor and Microcontroller	3	-	-	3	30	70	3	3
3	PC410EC	Analog Communication	3	-	-	3	30	70	3	3
4	PC411EC	Automatic Control Systems	3	-	-	3	30	70	3	3
5	PC412EC	Antennas and wave Propagation	3	-	-	3	30	70	3	3
6	HS104ME	Industrial Administration and Financial Management	3	-	-	3	30	70	3	3
Practical/Laboratory Course										
7	PC455EC	Microprocessor and Microcontroller Lab	-	-	2	2	25	50	3	1
8	PC456EC	Systems and Signal Processing Lab	-	-	2	2	25	50	3	1
9	PW701EC	Mini Project	-	-	2	2	50	-	-	2
Total			18	-	6	24	280	520	24	22

PC: Professional Core **HS:** Humanities and Social Sciences   **PW**: Project Work
L: *Lecture*   **T:** *Tutorial*   **P:** *Practical*   **D:** *Drawing*
CIE: Continuous Internal Evaluation   **SEE:** Semester End Examination (Univ. Exam)
EC: Electronics and Communication Engineering   **ME:** Mechanical Engineering

NOTE:
    1. Each contact hour is a Clock Hour.
    2. The duration of the practical class is two clock hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

DIGITAL SIGNAL PROCESSING

PC408EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Signals and Systems (EC305EC)

Course Objectives:

1. To describe the necessity and efficiency of digital signal processing.
2. To discuss various design methods of FIR & IIR filters.
3. To describe the concepts of multirate signal processing and identify important features of TMS320C67XX DSP processors.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. apply the knowledge of FFT Algorithms for computation of DFT.
2. design of FIR filters using various methods.
3. design of IIR filters using various methods.
4. apply decimation and interpolation concepts for the design of sampling rate converters
5. understand TMS320C67XX DSP processors for the design of digital filters.

UNIT – I

Discrete Fourier Transform and Fast Fourier Transform: Discrete Fourier Transform (DFT), Computation of DFT- Linear and Circular Convolution, FFT algorithms: Radix-2 case, Decimation in Time and Decimation in Frequency algorithms, in place computation, bit Reversal.

UNIT – II

Finite Impulse-Response Filters (FIR): Linear phase filters, Windowing techniques for design of Linear phase FIR filters-Rectangular, triangular, Bartlett, Hamming, Hanning, Kaiser windows, Realization of filters, Finite word length effects.

UNIT – III

Infinite Impulse-Response Filters (IIR): Introduction to filters, comparison between practical and theoretical filters, Butterworth and Chebyshev approximation, IIR digital filter design Techniques, Impulse Invariant technique, Bilinear transformation technique, DigitalButterworth & Chebyshev filters, Implementation, Digital filters structures, Comparison between FIR and IIR.

UNIT – IV

Multirate Digital Signal Processing: Introduction, Decimation by factor D and interpolation by a factor I, Sampling Rate conversion by a Rational factor I/D.

Implementation of Sampling Rate Conversion: Multistage implementation of sampling rate conversion, Sampling conversion by an arbitrary factor, Application of Multirate Signal Processing.

UNIT – V

Introduction to DSP Processors: Difference between DSP and other microprocessors architectures Importance of DSP Processors- General purpose DSP processorsTMS320C67XX processor, architecture, registers, pipelining, addressing modes and introduction to instruction set.

Suggested Reading:

1 Alan V. Oppenheim & Ronald W. Schafer, "Digital Signal Processing," PHI, 2nd edition, 2014.

2 John G. Proakis & Dimtris G. Manolakis, "Digital Signal Processing Principles, Algorithms and Application," PHI, 4th edition, 2012.

3 Ashok Ambardar, "Digital Signal Processing: A Modern Introduction," Cengage Learning, 2009.

4 Li Tan, "Digital Signal Processing: Fundamentals and Applications," Elsevier, 2012.

5 B.Venkataramani & M. Bhaskar, "Digital Signal Processor Architecture, Programming and Application," TMH, 2e 2013.

MICROPROCESSOR AND MICROCONTROLLER

PC409EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Computer Organization and Architecture (PC404EC)

Course Objectives:
1. To understand architecture and programming of 8086 microprocessor and 8051 microcontroller.
2. To describe interfacing of memory, 8255 PPI, and 8251 USART to 8086 processor and differentiation of 8086 and 8051 in terms of internal architecture, memory, and programming.
3. To describe interfacing and programming of I/O ports, Timers and UART using 8051 controller and develop interfacing of real time devices like ADC, DAC and stepper motor with 8051.

Course Outcomes: On successful completion of the course, the students will be able to
1. explain the architecture of 8086 microprocessor and recognize different types ofaddressing modes.
2. write assembly language programming using 8086 microprocessor instruction set.
3. interface different peripherals to 8086 microprocessor.
4. explain the architecture of 8051 microcontroller and write assembly/C languageprogramming using 8051 microcontroller.
5. interface different peripheral modules to 8051 microcontroller.

UNIT – I

8086 Microprocessor:

Intel 8086/8088 architecture, Segmented memory, Minimum and Maximum modes of operation, Timing diagram, addressing modes, Instruction set, assembly language programming using data transfer, arithmetic, logical and branching instructions.

UNIT – II

8086 Programming and Interfacing:

Assembler directives, macros, procedures, assembly language programming using string manipulation instructions, 8086 Interrupt structure, I/O and memory interfacing concepts using 8086, IC Chip Peripherals-8255 PPI, 8251 USART and their interfacing with 8086.

UNIT – III

8051 Microcontroller: Internal architecture and pin configuration, 8051 addressing modes, instruction set, bit addressable features. I/O port structures, assembly language programming using data transfer, arithmetic, logical and branch instructions.

UNIT – IV

8051 Timers, Serial Port and Interrupts:

8051 Timers/Counters and its programming, Serial data communication, Serial port and its programming, 8051 interrupts, Interrupt vector table, Interrupts programming.

UNIT – V

8051 Interfacing: Interfacing of 8051 with LCD, ADC, DAC, external memory, stepper motor interfacing.

Suggested Reading:

1. Ray A.K and Bhurchandi K.M, "Advanced Microprocessors and Peripherals", 3/e, Tata McGraw Hill Education Pvt Ltd, 2013.

2. Mazidi M.A, Mazidi J.G and Rolin D. Mckinlay, "The 8051 Microcontroller & Embedded Systems Using Assembly and C", 2/e, Pearson Education, 2008.

3. Douglas V. Hall, "Microprocessors and Interfacing Programming and Hardware", 2nd Edition, Tata McGraw- Hill publishing company Limited, New Delhi, 2008.

4. Ayala K.J, "The 8051 Microcontroller Architecture, programming & Applications",Penram International, 2007.

5. Scott Mackenzie and Raphael C. W. Phan. "The 8051 Microcontroller", 4th Edition, Pearson education, 2008.

ANALOG COMMUNICATION

PC410EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Signals & Systems (ES305EC)
Probability Theory and Stochastic Processes (ES304EC)

Course Objectives:
1. To understand the concept of modulation.
2. To describe the generation and detection of various analog and pulse modulation techniques.
3. To describe the structures of AM, FM transmitters and Receivers and analyze the noise performance of analog modulation techniques.

Course Outcomes: On successful completion of the course, the students will be able to
1. understand the need for modulation, transmitter and receiver structures.
2. understand the generation, detection of Amplitude and Angle modulation schemes.
3. compute and compare power and bandwidth requirements of AM, DSB-SC, SSB and FM techniques.
4. understand and compare pulse analog and digital modulation techniques.
5. identify the sources of noise and evaluate the performance of analog communication systems over a noisy channel.

UNIT – I
Introduction: Introduction to communication system, Communication channels, Need for modulation.
Amplitude Modulation: Definition, Time and Frequency domain description – AM, DSB-SC, Single tone modulation, Power relations in AM, Generation of AM signal– Square-law, Switching modulators, AM demodulation- envelop Detector, Generation of DSB-SC Signal – Balanced, Ring modulators,   DSB-SC demodulation – Coherent Detector, COSTAS loop.

SSB Modulation: Definition, Time and Frequency domain description, Generation of SSB Signal – Frequency discrimination and phase discrimination methods, Demodulation of SSB – Coherent Detection, Frequency Division Multiplexing, Vestigial Sideband Modulation – Time and Frequency domain description, Generation of VSB signal, Envelop detection of VSB plus carrier, Comparison of all AM techniques, Applications of different AM systems, AM Transmitter, AM super heterodyne receiver, Receiver characteristics.

UNIT – II
Angle Modulation: Definition, basic concepts, Frequency modulation: Single tone FM, Spectrum analysis of sinusoidal FM wave, Narrow band FM, Wide band FM. Constant average power, Transmission bandwidth of FM wave. Generation of FM - Direct and Indirect (Armstrong's) methods. Detection of FM - Balanced frequency discriminator, Phase Locked Loop. Comparison of FM and AM. FM Transmitter, FM Super heterodyne receiver.

UNIT-III
Pulse Analog Modulation schemes: Review of sampling theorem, types of sampling.
Types of Pulse Analog and Digital Modulation Schemes, Generation and demodulation of Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM). Time Division Multiplexing.

UNIT – IV
Pulse Digital Modulation Schemes: Quantization, Analog to Digital Conversion, PCM, Companding in PCM – mu law, A law. DPCM, DM and ADM. Comparison of PCM, DPCM, DM and ADM. SNR_Q of PCM and DM.

UNIT – V
Noise: Definition, Sources of noise, Atmospheric noise, thermal noise, shot noise, Noise in two-port network: noise figure, equivalent noise temperature of Single and cascade stages, noise equivalent bandwidth. Narrow band noise representation
Noise in Analog Communication Systems: Signal to Noise Ratio (SNR) and Figure of merit calculations in AM, DSB-SC, SSB and FM systems, Pre-Emphasis and De-Emphasis.

Suggested Reading:
1. Simon Haykin, "Communication Systems," 2nd edition, Wiley India, 2011.
2. H. Taub, D.L. Schilling, "Principles of communication systems", Tata McGraw Hill, 2001.
3. B.P. Lathi, Zhi Ding, "Modern Digital and Analog Communication Systems", 4th edition, Oxford University Press, 2016.
4. Leon W Couch II., "Digital and Analog Communication Systems", 6th edition, Pearson Education Inc., 2001.
5. P. Ramakrishna Rao, "Analog Communication," 1st edition, TMH, 2011.

AUTOMATIC CONTROL SYSTEMS

PC411EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Signals & Systems (EC305EC)

Course Objectives:

1. To analyze the stability and performance of dynamic systems in both time and frequency domain.
2. To understand the impact of various compensators and controllers on system performance.
3. To provide the knowledge of state variable models and digital control systems.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. develop the mathematical model of the physical systems and find the transfer function using different approaches.
2. analyze system stability using time domain techniques.
3. analyze system stability using frequency domain techniques.
4. verify the stability of digital control systems.
5. illustrate the control systems via state space models.

UNIT – I
Control System Fundamentals: Classification of control systems including Open and Closed loop systems, Effect of feedback on Control systems, Mathematical modeling of Mechanical systems and their conversion into electrical systems, Transfer function representation, Block diagram representation, Block diagram algebra and reduction and Signal flow graphs and Mason's gain formula.

UNIT – II
Time Response Analysis: Transfer function and types of input. Transient response of first and second order system for step input. Time domain specifications, Characteristic equation of Feedback control systems, Static error coefficients, Error series,

Stability: Concept of Stability, Routh-Hurwitz criterion for stability,

Root locus technique and its construction

UNIT – III

Frequency Response Analysis: Introduction to Frequency response of the system. Frequency domain Specifications, Bode plots, Stability analysis, Nyquist plot and Nyquist criterion for stability

Compensation Techniques: Types of Compensation. Phase Lag, Lead and Lag-Lead compensators. Types of controllers proportional (P), integral (I), derivative (D), PID controller

UNIT – IV

Digital Control Systems: Digital control, advantages and disadvantages, Digital control system architecture. Sample and Hold Circuit. Transfer function of sample data systems. Stability analysis by Jury's test.

UNIT – V

State Space Representation: Concept of state and state variables. State models of linear time invariant systems, Derivation of Transfer Function from State Model, State transition matrix, Solution of state equations. Controllability and Observability.

Suggested Reading:

1. Nagrath, I.J, and Gopal, M., "Control System Engineering", 5th edition, New Age Publishers, 2009

2. NagoorKani, "Control systems Engineering", Oxford & IBH Publishing Company Private Limited, 2021.

3. Ogata, K., "Modern Control Engineering", 5th edition, Pearson India Education Services Pvt. Limited, 2015

4. Alan V Oppenheim, A. S. Wlisky, "Signals and Systems", Prentice-Hall of India Private Limited, 2008.

5. A.K.Jairath , "Problems and Solutions of Control Systems" , CBS Publishers, 2022.

ANTENNAS AND WAVE PROPAGATION

PC412EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Electromagnetic Theory & Transmission Lines (PC405EC)

Course Objectives:

1. To describe the basic principles of antennas and introduce the antenna terminologies.
2. To discuss the working principles of wire antennas, non-resonant antennas, antenna arrays and techniques for measurement of antennas characteristics.
3. To explain the various modes of radio wave propagation.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. Illustrate the basic principles of antennas and learn the antenna terminology.
2. apply the design considerations of different types of wire antennas and make proficient in analytical skills for understanding practical antennas
3. Analyse the non-resonant antennas for various ranges of frequencies and get updated with latest developments in the smart antennas.
4. Apply the principles and design considerations of antennas as well as antenna arrays, measure standard antenna parameters and obtain awareness about radiation hazards.
5. Understand and compare various modes of radio wave propagation used for different applications.

UNIT – I

Antenna Fundamentals: Introduction, principle of radiation, isotropic radiator, basic antenna parameters: radiation pattern, beam area, radiation intensity, beam efficiency, directivity, gain, resolution,

antenna apertures, effective length and effective area, Friis transmission equation, fields from oscillating dipole, antenna field zones, antenna polarization, front–to-back ratio, antenna theorems, antenna impedance and antenna temperature. Retarded potential: Lorentz and Coulomb gauge conditions.

UNIT – II

Thin Linear Wire Antennas: Introduction, current distributions, radiation from infinitesimal/short dipole or an alternating current element, half-wave dipole and quarter wave monopole, loop antennas-small loop, comparison of far fields of small loop and short dipole, far field pattern of circular loop with uniform current, radiation resistance of loops, slot antennas, helical antennas- helical geometry, helix modes: transmission and radiation, practical design considerations for monofilar helical antenna in axial modes, wideband characteristics of monofilar helical antenna radiating in axial mode, radiation efficiency.

UNIT – III

Non-Resonant Antennas: Comparison between resonant and non-resonant antennas, Long-wire antennas: V-antenna and Rhombic Antenna, Yagi-Uda Antenna, Folded dipole antennas, Broadband and frequency-independent concept, Log-periodic Antenna, Aperture Antennas- Huygen's principle, Babinets principle, Radiation from Horns and design considerations, Parabolic Reflector and Cassegrain Antennas, Lens Antennas, Micro Strip Antennas- Basic characteristics, feeding Methods, Design of Rectangular Patch Antennas, Smart Antennas- Fixed weight and Adaptive Beam forming.

UNIT – IV

Antenna Arrays: Array of point sources, two element array with equal and unequal amplitudes, different phases, linear n-element array with uniform distribution, Broadside and End fire arrays, Principle of Pattern Multiplication, Effect of inter element phase shift on beam scanning, Binomial array. EFA with Increased Directivity, Derivation of their characteristics and comparison; Effects of Uniform and Non-uniform Amplitude Distributions.

Antenna Measurements: Introduction, Basic Concepts-Reciprocity, Near and Far fields, Source of Errors, Antenna Test Site. Measurement setup and distance criterion for directional patterns, gain (absolute and comparison methods) and impedance, Radiation Hazards.

UNIT – V
Wave Propagation: Ground, Space and Surface waves, Troposphere refraction and reflection, Duct propagation, Sky wave propagation, Regular and irregular variations in ionosphere Line of sight propagation.

Suggested Reading:

1. J. D. Kraus, R. J. Marhefka, and Ahmad S. Khan, "Antennas and Wave Propagation", McGraw-Hill, 4th Edition, 2010.
2. Constantine A. Balanis, "Antenna Theory: Analysis and Design", 3rd Edition, John Wiley, 2005.
3. Edward C. Jordan and Keith G. Balmain, "Electromagnetic Waves and Radiating Systems", 2nd Edition, PHI, 1968.
4. Robert E. Collin, "Antennas and Radiowave Propagation", McGraw-Hill, 1985.
5. A.R.Harish and M. Sachidananda, "Antennas and Wave Propagation", Oxford University Press, 2007.

INDUSTRIAL ADMINISTRATION AND FINANCIAL MANAGEMENT

HS104ME

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Finance and Accounting (HS103CM)

Course Objectives
1. To understand various types of organizational structures, manufacturing processes and importance of plant layout and the role of scheduling function in optimizing the utilization of resources.
2. To understand the importance of quality, inventory control and concepts like MRP I and MRPII.
3. To understand the nature of financial management and concepts like breakeven analysis,

Course Outcomes: *On successful completion of the course, the students will be able to*
1. Understand the different phases of product life cycle, types of manufacturing systems, plant layout optimization problems and role of scheduling function in better utilization of resources.

2. Understand the principles of work study, time stud and evaluation of jobs.
3. Understand the Fundamental concepts of quality control, process control, material control and appreciate the importance of MRP-I and MRP—H.
4. Understand the concepts of material management, Project management.
5. Know the different terminology used in financial management and understand the different techniques of capital budgeting and various types of costs involved in running an industrial organization.

UNIT-I

Industrial Organization: Types of various business organizations, organization structure sand their relative merits and demerits. Functions of management. Plant Location and Layouts: Factors affecting the location of plant and layout. Types of layouts and their merits and demerits.

UNIT-II

Work Study: Definitions, objectives of method study and time study. Steps in conducting method study. Symbols and charts used in method study. Principles of motion economy. Calculation of standard time by time study and work sampling. Performance rating factor. Types of ratings. Jobs evaluation and performance appraisal. Wages, incentives, bonus, wage payment plans.

UNIT-III

Inspection and Quality Control: Types and objectives of inspection S.Q.C., its principles. Quality control by chain sampling plans. Quality circles, introduction to ISO.

UNIT-IV

Optimization: Introduction to linear programming and its graphical solutions. Assignment problems. Project Management: Introduction to CPM and PERT. Determination of critical path. Material Management: Classification of materials, Materials planning. Duties of purchase manager. Determination of economic ordering quantities. Types of materials purchase.

UNIT-V

Cost Accounting: Elements of cost (Various costs) types of overheads, Breakeven analysis and its applications. Depreciation. Methods of calculating depreciation fund. Nature of financial management. Time value of money. Techniques of capital budgeting and methods. Cost of Capital, Financial leverage.

Suggested Reading:

1. Pandey I M, "Elements of Financial Management", Vikas Publications House New Delhi 1994
2. Khanna O P, "Industrial Engineering and Management", Dhanpat Rai &Sons.
3. Marshall/Bansal, "Financial Engineering", PHI.
4. Keown,"Financial Management", 9th edition, PHI.
5. Chandra Bose, "Principles of Management &Administration", PHI.

MICROPROCESSOR AND
MICROCONTROLLER LAB

PC 455 EC

Instruction	: 2 periods per week
Duration of SEE	: 3 hours
CIE	: 25 marks
SEE	: 50 marks
Credits	: 1

Course Objectives:
1. Apply assembly language programs on 8086 trainer kit in standalone/serial mode.
2. Classify interface modules into input /output and memory interfaces with 8086.
3. Develop and execute the assembly language programming concepts of 8051 microcontroller and for various interface modules.

Course Outcomes: *On successful completion of the course, the students will be able to*
1. apply different addressing modes and model programs using 8086 Instruction set.
2. explain the usage of string instructions of 8086 for string manipulation, and comparison.
3. develop interfacing applications using 8086 processor.
4. develop different programs using C cross compilers for 8051 microcontroller.
5. develop interfacing applications using 8051 microcontroller.

List of Experiments

PART- A

1. Use of 8086 trainer kit and execution of programs. (Instruction set for simple Programs using 4 to 5 lines of instruction code under different addressing modes for data transfer, manipulation, and arithmetic operations).
2. Branching operations and logical operations in a given data.

      i)   Transfer byte and word data from source to destination memory.

      ii)   Count even and odd numbers from given array of ten bytes.

      iii)   Find Largest and Smallest number from given array of words.

      iv)   Sort the given array in ascending order, descending order.

3. Multiplication and Division

      i)   Use MUL and IMUL for Unsigned and signed multiplication on 8 bit and 16 bit sets.

      ii)   Use DIV and IDIV for Unsigned and signed division on 8 bit and 16 bit data sets.

      iii)   Obtain given decimal number to unpacked BCD ex: 123410 as 01,02,03,04 and store in memory using DIV.

      iv)   Find Factorial of a given number using multiplication instructions.

4. Single byte, multi byte Binary and BCD addition and subtraction.

5. Code conversions.

      i)   BCD Unpacked to Packed BCD code.

      ii)   ASCII code to BCD code.

      iii)   BCD to ASCII code.

6. String Searching and Sorting. (Using string instructions)

      i)   Find number of repetitions of a character in a string.

      ii)   Find and replace a character in the given string.

      iii)   Convert Case of a given string.

      iv)   Find whether given string is palindrome or not.

PART B

[Experiments for 8051 using any C- Cross Compiler & appropriate hardware]

1. Familiarity and use of 8051/8031 microcontroller trainer, and execution ofprograms.
2. Instruction set for simple programs (using 4 to 5 lines of instruction code).
3. Timer and counter operations & programming using 8051.

4. Serial communications using UART.
5. Programming using interrupts.
6. Interfacing 8051 with DAC to generate waveforms.

7. Interfacing traffic signal control using 8051.
8. Program to control stepper motor using 8051.
9. ADC interfacing with 8051.
10. Serial RTC interfacing with 8051.
11. LCD interfacing with 8051.

Note:
1. At least 10 experiments to be conducted in the semester.
2. Minimum of 5 from Part A and 5 from Part B is compulsory.
3. In Part-B, perform the experiments using assembler simulators like edsim51/Keil software.

SYSTEMS AND SIGNAL PROCESSING LAB

PC456EC

Instruction	: 2 periods per week
Duration of SEE	: 3 hours
CIE	: 25 marks
SEE	: 50 marks
Credits	: 1

Course Objectives:
1. To develop C & MATLAB programs for operation of sequences.
2. To implement the algorithms of DFT, IDFT, FFT and IFFT on discrete time signals
3. To design and obtain the frequency response of various digital filters.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. develop MATLAB files for the verification of system response.
2. design and analyze the digital filters using MATLAB
3. verify the functionality of FFT algorithms.
4. experiment with multirate techniques using MATLAB & CCS
5. design and implement the digital filters on DSP processor

PART-A

List of Signal Processing Experiments

Perform the following programs using MATLAB Simulator

1. Introduction to MATLAB and signal generation.
2. Perform Linear Convolution.
3. Perform Circular Convolutions.
4. Perform DFT and FFT algorithm
5. Perform FIR filters design using different window functions.
6. Perform IIR filters design: Butterworth and Chebyshev, LPF, HPF, BPF & BSF filter.
7. Perform Interpolation and Decimation.
8. Implementation of multi-rate systems.

PART-B

List of DSP Processor Experiments

Implement the following experiments using DSK (TMS320C67XX)

1. Introduction to DSP processors and Study of procedure to work in real-time.
2. Implement Solution of difference equations
3. Implement Impulse Response.
4. Implement Linear Convolution.
5. Implement Circular Convolution.
6. Implement Fast Fourier Transform Algorithms.
7. Design of FIR (LP/HP) USING windows: (a) Rectangular (b) Triangular(c)Hamming windows.
8. Design of IIR (HP/LP) filters.

Note:
1. At least ten experiments to be conducted in the semester.
2. Minimum of 5 from Part A and Part B is compulsory.
3. For Section -A' MATLAB with different toolboxes like signal processing.
4. Block set and SIMULINK / MATHEMATICA / any popular software can be used.

MINI PROJECT

PW701EC

Instruction	: 2 periods per week
Duration of SEE	: NA
CIE	: 50 marks
SEE	: NA
Credits	: 2

Course Objectives:

1. To conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.
2. To provide training in soft skills and also train them in presenting seminars and technical report writing.
3. To design, implement and test the prototype/algorithm in order to solve the conceived problem.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. get practical experience of software design and development, and coding practices within Industrial/R&D Environments.
2. gain working practices within Industrial/R&D Environments
3. prepare reports and deliver effective presentation.
4. demonstrate effective written and oral communication skills
5. innovate in various engineering disciplines and nurture their entrepreneurial ideas.

Guidelines for Mini Project

1. The mini-project is a team activity having maximum of 3 students in a team. This is electronic product design work with a focus on electronic circuit design.
2. The mini project may be a complete hardware or a combination of hardware and software. The software part in mini project should be less than 50% of the total work.
3. Mini Project should cater to a small system required in laboratory or real life.
4. It should encompass components, devices, analog or digital ICs, micro controller with which functional familiarity is introduced.
5. After interactions with course coordinator and based on

comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini-project.

6. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.

7. The student is expected to exert on design, development and testing of the proposed work as per the schedule.

8. Art work and Layout should be made using CAD based PCB simulation software. Due considerations should be given for power requirement of the system, mechanical aspects for enclosure and control panel design.

9. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

10. The tutorial sessions should be used for discussion on standard practices used for electronic circuits/product design, converting the circuit design into a complete electronic product, PCB design using suitable simulation software, estimation of power budget analysis of the product, front panel design and mechanical aspects of the product, and guidelines for documentation /report writing.

SCHEME OF INSTRUCTION & EXAMINATION
B.E. VI - Semester
(ELECTRONICS AND COMMUNICATIONENGINEERING)

S. No.	CourseCode	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Examination		Durationin Hrs	Credits
			L	T	P/D		CIE	SEE		
Theory Course										
1	PC413EC	Digital Communication	3	-	-	3	30	70	3	3
2	PC414EC	VLSI Design	3	-	-	3	30	70	3	3
3	PC415EC	Data Communication and Computer Networks	3	-	-	3	30	70	3	3
4	PE5XXEC	Professional Elective-I	3	-	-	3	30	70	3	3
5	PE5XXEC	Professional Elective-II	3	-	-	3	30	70	3	3
6	OE6XXYY	Open Elective-I	3	-	-	3	30	70	3	3
Practical/Laboratory Course										
7	PC458EC	Communication Systems Lab	-	-	2	2	25	50	3	1
8	PC459EC	Digital Integrated Circuits Lab	-	-	2	2	25	50	3	1
9	PC460EC	Data Communication and Computer Networks Lab	-	-	2	2	25	50	3	1
*10	*PW701EC	*Summer Internship	-	-	-	-	*50		-	*2
Total			18	-	6	24	255	570	27	21

PC: Professional Core   **HS:** Humanities and Social Sciences   **W:** Project Work
L: *Lecture*   **T:** *Tutorial*   **P:** *Practical*   **D:** *Drawing*
CIE: Continuous Internal Evaluation   **SEE:** Semester End Examination (Univ. Exam)
EC: Electronics and Communication Engineering
ME: Mechanical Engineering
NOTE:
     1.   Each contact hour is a Clock Hour.
     2.   The duration of the practical class is two clock hours, however it can be extended wherever necessary, to enable the student to complete the experiment.

Professional Elective-I		
S. No.	Course Code	Course Title
1	PE501EC	Digital Image and Video Processing
2	PE502EC	Advanced Microcontrollers
3	PE503EC	Python Programming and Applications
4	PE504EC	Neural Networks

Professional Elective-II		
S.No.	Course Code	Course Title
1	PE505EC	FPGA Architectures
2	PE506EC	Advanced Digital Signal Processing
3	PE507EC	CMOS Analog IC Design
4	PE508EC	IoT system Design and Applications

Open Elective 1		
Sl. No	Code	Name of Subject
1	OE601EE	Electrical Energy Conservation and Safety (Not for EEE & EIE Students)
2	OE602EE	Reliability Engineering (Not for EEE & EIE Students)
3	OE611AE	Basics of Automobile Engineering (Not for Mech./Prod./Automobile Engg. students)
4	OE611ME	Industrial Robotics (Not for Mech./Prod./Automobile Engg. students)
5	OE601EG	Soft Skills & Interpersonal Skills
6	OE602MB	Human Resource Development and Organizational Behaviour
7	OE601LW	Cyber Law and Ethics
8	OE601CS	OOP using Java (Not for CSE, IT, AD, AM, DS and CB Students)
9	OE602CS	Data Structures & Algorithms (Not for CSE, IT, AD, AM, DS and CB Students)
10	OE601IT	Operating Systems (Not for CSE, IT, AD, AM, DS and CB Students)
11	OE601AD	Principles of Artificial Intelligence (Not for CSE, IT, AD, AM, DS and CB Students)
12	OE601AM	Principles of Machine Learning (Not for CSE, IT, AD, AM, DS and CB Students)
13	OE601DS	Data Science (Not for CSE, IT, AD, AM, DS and CB Students)
14	OE601CB	Principles of IOT (Not for CSE, IT, AD, AM, DS and CB Students)
15	OE601CE	Disaster Mitigation (Not for Civil Engg. Students)
16	OE601EC	Principles of Electronic Communication (Not for ECE students)
17	OE602EC	Digital system design using verilog HDL (Not for ECE students)

AD- Artificial Intelligence & Data Science
AE- Automobile Engineering

AM-Artificial Intelligence & Machine Learning
CB- IoT, Cyber Security & Block Chain

CE-Civil Engineering

CS-Computer Science

DS- Data Science

EC-Electronics and Communication Engg.
EE- Electrical Engineering

EG-English

IT-Information Technology
LW-Law

MB-Business Management
ME-Mechanical Engineering

DIGITAL COMMUNICATION

PC413EC

Instruction   : 3 periods per week
Duration of SEE   : 3 hours
CIE   : 30 marks
SEE   : 70 marks
Credits   : 3
Prerequisites: Probability Theory and Stochastic Processes (ES304ES)
                       Analog Communication (PC410EC)

Course Objectives:
1. To introduce the concepts of optimum receiver, baseband digital data transmission and analyze the error performance of different digital carrier modulation schemes like ASK, FSK, PSK etc.
2. To familiarize the students with the concepts of information theory, basic source coding and channel coding techniques.
3. To familiarize the students with the concepts of spread spectrum communication with emphasis on DSSS and FHSS.

Course Outcomes: *On successful completion of the course, the students will be able to*
1. understand the design of optimum receiver and analyze the Performance of Baseband and Band pass Modulation schemes based on Probability of error.
2. apply concepts of Information theory and assess information capacity of various channels.
3. encode the source alphabet using Shannon Fano and Huffman encoding methods.
4. distinguish different types of Error control codes along with their encoding/decoding algorithms.
5. understand generation of PN sequence and analyze the performance of Spread Spectrum communication systems.

UNIT – I

Introduction to Digital Communication: Elements of Digital Communication System**,** Comparison of Digital and Analog Communication Systems.

Detection and Estimation: Receiver structure, Detection of signals in the presence of noise **-**Gaussian error probability, optimum receiver – matched filter, Gram-Schmidt orthogonalization procedure, correlation receiver, Maximum Likelihood decoding.

Base band digital data transmission – Block diagram, Inter Symbol Interference, Nyquist criterion for Zero ISI, Eye pattern.

UNIT – II

Digital Carrier Modulation Schemes — Description and generation of ASK, FSK, PSK. Signal Constellation, Coherent detection of Binary ASK, FSK, PSK. DPSK. Comparison of digital carrier modulation schemes.

M-ary signaling schemes: Introduction, QPSK- generation and detection, Signal Constellation, Synchronization methods.

UNIT – III

Information Theory and Source Coding: Uncertainty, Information, entropy, information rate.. Discrete memory less channel – Probability relations in a channel, priori & posteriori entropies, Joint entropy, conditional entropy, mutual information, Channel capacity - Binary Symmetric Channel, Binary Erasure Channel, cascaded channels, Shannon-Hartley Theorem – Shannon Bound.

Source coding: Shannon – Fano and Huffman coding.

UNIT – IV

Channel Coding: Introduction to error correcting codes, types of transmission errors, need for error control coding.

Linear Block Codes (LBC): Matrix description of LBC, generation, Syndrome calculation and error detection, Minimum distance of Linear block code, error detection and error correction capabilities, Hamming codes.

Binary cyclic codes (BCC): Polynomials, Algebraic description of cyclic codes, systematic encoding using generator polynomial and parity check polynomial, syndrome calculation, decoding and error correction using shift registers.

Convolution codes: Encoding, Decoding using code tree, state diagram.

UNIT – V

Spread Spectrum Communication: Advantages of Spread Spectrum, generation and characteristics of PN sequences. Direct sequence spread spectrum and Frequency hopping spread spectrum systems. CDMA, ranging using DSSS. Acquisition and Tracking of DSSS and FHSS signals.

Suggested Reading:

1. Simon Haykin, "Digital Communication", 4th edition, Wiley India 2011.
2. Sam Shanmugam K, "Digital and Analog Communication systems", Wiley 1979.
3. B.P.Lathi, "Modern digital and analog communication systems", 3rd edition, Oxford University Press. 1998.
4. *Leon W.Couch II., "Digital and Analog Communication Systems", 6th edition, Pearson Education inc., New Delhi, 2001.*
5. *H. Taub, D.L. Schilling, "Principles of communication systems", Tata McGraw Hill, 2001.*

VLSI DESIGN

PC414EC

Instruction	: 3 periods per week
Duration of SEE	: 3hours
CIE	: 30 marks
SEE	: 70 Marks
Credits	: 3

Prerequisites: Digital Electronics (ES215EC)

Course Objectives:
1. To explain electrical properties of MOS devices to analyze the behavior of inverters designed with various loads.
2. To give exposure to the design rules to be followed to draw the layout of any logic circuit and Provide concept to design different types of Combinational and sequential circuits
3. To describe verilog HDL and develop digital circuits using various modeling styles.

Course Outcomes: *On successful completion of the course, the students will be able to*
1. analyze modes of operation of MOS transistor and its basic electrical properties.
2. draw stick diagrams and layouts for any MOS transistors and calculate the parasitic R&C
3. familiarize with the constructs and conventions of the verilog HDL programming in gate level and data flow modeling.
4. generalize combinational and sequential logic circuits in behavioral modeling and concepts of switch level modelling.
5. analyse the operation of various arithmetic and sequential logic circuits using CMOS transistors

UNIT I
Introduction: Introduction to IC Technology – MOS, PMOS, NMOS, CMOS Fabrication Process.

Basic Electrical Properties: Basic Electrical Properties of MOS: Ids-Vds relationships, MOS transistor threshold Voltage, gm, gds, figure of merit; Pass transistor, NMOS Inverter, Various pull ups, CMOS Inverter analysis and design.

UNIT –II
VLSI Circuit Design Processes: VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, and Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates.
Basic circuit concepts, Sheet Resistance R_S and its concept to MOS, Area Capacitance Units, Calculations – RC Delays.

UNIT- III
Introduction to HDLs: Basic Concepts of Verilog, Data types, system tasks and compiler directives.
Gate level modeling: Gate types and gate delays, dataflow modeling: Continuous assignments and Delays. Design of stimulus blocks. Design of Arithmetic Circuits using Gate level/ Data flow modeling –Adders, Subtractors, 4- bit Binary and BCD adders and 8-bit Comparators.

UNIT – IV
Behavioral modeling: Structured Procedures, Procedural Assignments, Timing Control, Conditional Statements, Sequential and parallel blocks, generate Blocks, Switch level modeling. Behavioral modeling of sequential logic modules: Latches, Flip Flops, counters and shift registers applications
Tasks, Functions, Procedural Continuous Assignments, Design of Mealy and Moore FSM models for sequence detector using Verilog. Logic Synthesis, Synthesis Design Flow, Gate level netlist

UNIT –V
Subsystem Design: Shifters, Carry skip adder, carry select adder , Booth Multiplier, Memory Elements: 6T SRAM cell, 1T DRAM cell.
Sequential Logic Design: Behavior of Bi-stable elements, CMOS D latch and Edge triggered Flip flops.

Suggested Reading:

1. Kamran Eshraghian Dougles and A. Pucknell, 'Essentials of VLSI circuits and systems', PHI, 2005Edition
2. Weste and Eshraghian 'Principles of CMOS VLSI Design', Pearson Education, 2nd edition, 1999.
3. John .P. Uyemura, 'Introduction to VLSI Circuits and Systems', JohnWiley, 2003
4. John M. Rabaey, 'Digital Integrated Circuits', PHI, EEE, 1997. Wayne Wolf, 'Modern VLSI Design', Pearson Education, 3rd edition, 1997

DATA COMMUNICATION AND COMPUTER NETWORKS

PC415EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Digital Electronics (ES215EC),
Analog Communication (PC410EC)

Course Objectives:

1. To understand concepts of switched communication networks and functions of each layer of OSI model for layered architecture and introduce TCP/IP suite of protocols.
2. To understand performance of data link layer protocol for flow and error control.
3. To understand different routing protocols, and various networked applications such as DNS, FTP, www architecture and network security.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. study function of layers in OSI model and understand various network topologies.
2. understand network layer protocols, IP addressing and internetworking.
3. understand transport layer working with TCP, and UDP.
4. understand functionality of application layer and its protocols
5. understand the importance of network security principles.

UNIT-I

Introduction to Data communication: A Communication Model, The Need for Protocol Architecture and Standardization, Network Types: LAN, WAN, MAN. Network Topologies: Bus, Star, Ring, Hybrid, Line configurations. Reference Models: OSI, TCP/IP. Transmission modes, DTE-DCE Interface, Transmission media-

Guided media, Unguided media, Circuit Switching principles and concepts, Virtual circuit and Datagram subnets.

UNIT-II

Data Link Layer: Need for Data Link Control, Design issues, Framing, Error Detection and Correction, Flow control Protocols: Stop and Wait, Sliding Window, ARQ Protocols, HDLC. MAC Sub Layer: Multiple Access Protocols: ALOHA, CSMA, LAN- IEEE 802.2, 802.3, Wireless LAN- 802.11, 802.15, 802.16 standards. Bridges and Routers.

UNIT-III

Network Layer: Network layer Services, Routing algorithms: Shortest Path Routing, Flooding, Hierarchical routing, Broadcast, Multicast, Distance Vector Routing, and Congestion Control Algorithms. Internet Working: The Network Layer in Internet: IPV4, IPV6, Comparison of IPV4 and IPV6, IP Addressing.

UNIT-IV

Transport Layer: Transport Services, Elements of Transport Layer, Connection management, TCP and UDP protocols, ATM AAL Layer Protocol.

UNIT-V

Application Layer: Domain Name System, SNMP, Electronic Mail, World Wide Web.

Network Security: Cryptography Symmetric Key and Public Key algorithms, Digital Signatures, Authentication Protocols.

Suggested Reading:

1. Behrouz A. Forouzan, "Data Communication and Networking,"3/e, TMH, 2008.
2. William Stallings, "Data and Computer Communications," 8/e, PHI, 2004.
3. Andrew S Tanenbaum, "Computer Networks," 5/e, Pearson Education, 2011.
4. Douglas E Comer, "Computer Networks and Internet", 5/e, Pearson Education Asia, 2009.
5. Prakash C. Gupta, "Data Communications and Computer Networks", 2/e, PHI learning, 2013.

PROFESSIONAL ELECTIVE-I

DIGITAL IMAGE AND VIDEO PROROCESSING

PE501EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Digital Signal Processing(PC408EC)

Course Objectives:
1. To provide an introduction to the basic concepts and methodologies for Digital Image and Video processing.
2. To acquaint with spatial and transform domain techniques used in Image Enhancement and to gain knowledge about various Image compression and segmentation methods.
3. To study applications of motion estimation in video processing.

Course Outcomes: *On successful completion of the course, the students will be able to*
1. develop a foundation that can be used as the basis for higher study and research in the Image and Video processing areas.
2. design various filters for processing of images without destroying fine details like edges and lines.
3. apply image processing techniques for processing and analysis of remotely sensed, Microscope, Radar and Medical images
4. understand the requirement for various image and video compression algorithms.
5. understand and analyze the performance of block matching algorithms in video coding standards.

UNIT – I
Fundamentals of Image Processing: Basic steps in Image Processing, Sampling and Quantization of an image, Relationship between pixels.
Image Transforms: 2D- Discrete Fourier Transform, Discrete Cosine Transform, Haar Transform and Hoteling Transform.

UNIT – II

Image Processing Techniques: Histogram processing, Fundamentals of Spatial filtering, Smoothing spatial filters, Sharpening spatial filters.
Frequency domain methods: Basics of filtering in frequency domain, Image smoothing, Image sharpening, Selective filtering.

UNIT – III

Image Compression: Functional Block diagram of a general image compression system, Various types of redundancies, Huffman coding, Arithmetic coding.
Segmentation: Segmentation concepts, Point, Line and Edge Detection, Thresholding, Region based segmentation.

UNIT – IV

Basic concepts of Video Processing: Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image formation, sampling of video signals, filtering operations.

UNIT – V

2-D Motion Estimation: Optical flow, Pixel Based Motion Estimation, Block Matching Algorithm, Mesh based Motion Estimation, Global Motion Estimation, Region based Motion Estimation, multi resolution motion estimation. Application of motion estimation in Video coding.

Suggested Reading:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing', Pearson Education, 2009, 3rd edition.

2. Yao Wang, Joern Ostermann, Ya-quin Zhang, 'Video processing and Communication', 1st edition, Prentice Hall International.

3. Vipul Singh, 'Digital Image Processing with MATLAB and Lab view', Elsevier 2013.

4. Anil K Jain, 'Fundamentals of Digital Image Processing', Prentice-Hall of India Private Limited, New Delhi, 1995.

5. M. Tekalp,'Digital Video Processing', Prentice Hall International,1995.

ADVANCED MICROCONTROLLERS

PE502EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Microprocessor & Microcontroller (PC409EC)

Course Objectives:

1. To describe industry standard ARM microcontroller architecture.
2. To explain ability of programming ARM using Assembly language and Embedded C.
3. To discuss the Bus Architecture of ARM microcontroller.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. illustrate the basic architecture of ARM.
2. analyse the instruction set of ARM and thumb instructions.
3. understand basic Embedded C concepts and multitasking.
4. program and interface the ARM with peripheral devices using Assembly Language and C.
5. understand the advance microprocessor bus architecture (AMBA).

UNIT – I
Introduction:

Introduction to advanced microcontrollers, Difference between RISC and CISC architectures, Endianness (Little and Big), Design philosophy of RISC and ARM architectures. History of ARM microprocessor, ARM processor family, Development of ARM architecture.

The ARM Architecture and Programmers' Model:

The Acorn RISC Machine, ARM core data flow model, architectural inheritance, The ARM7 TDMI programmer's model: General purpose registers, CPSR, SPSR, ARM memory map, data format, load and store architecture, Core extensions, Architecture revisions, ARM development tools.

UNIT – II

ARM Instruction Set: Data processing instructions, Arithmetic and logical instructions, Rotate and barrel shifter, Branch instructions, Load and store instructions, Software interrupt instructions, Program status register instructions, Conditional execution, Multiple register load and store instructions, Stack instructions, Thumb instruction set, advantage of thumb instructions, Assembler rules and directives.

UNIT – III

Basics of Embedded C : Overview of C compiler and optimization, Basic data types, Looping and branching, Register allocations, function calls, pointer aliasing, structure arrangement, bit fields, unaligned data, Division, floating point, Inline functions and inline assembly, Portability issues, Multitasking.

UNIT – IV

Assembly and C Programming for ARM: Assembly language programs for shifting of data, factorial calculation, swapping register contents, moving values between integer and floating point registers.
C programs for General purpose I/O, general purpose timer, PWM Modulator, UART, I2C Interface, SPI Interface, ADC, DAC.

UNIT – V

Advanced Microprocessor Bus Architecture (AMBA): Advanced Microprocessor Bus Architecture (AMBA), AMBA Bus System, User peripherals, Exception handling in ARM, and ARM optimization techniques.

Suggested Reading:

1. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM Systems Developer's Guide: Designing & Optimizing System Software", Elsevier, 2004.
2. Muhammad Ali Mazidi, "ARM Assembly Language Programming & Architecture", Kindle Edition, 2013.
3. William Hohl, Christopher Hinds, "Arm Assembly Language: Fundamentals and Techniques", 2nd Edition, CRC Press, 2014.
4. Michael J. Pont, "Embedded C", Pearson Education India, 1st Edition, 2007.
5. Dr. Yifeng Zhu, "Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C", E-Man Press LLC, 3rd Edition, 2017.

PYTHON PROGRAMMING AND APPLICATIONS

PE503EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Network Theory (PC402C), Signals and Systems (PC405EC)

Course Objectives:

1. To acquire programming skills by learning Syntax, Semantics and Regular expressions in core Python.
2. To analyse electronic circuits and examine the various signal transformation techniques using Python
3. To build IoT solutions using MicroPython running on small, dedicated microcontroller boards

Course Outcomes: *On successful completion of the course, the students will be able to*

1. build basic programs using fundamental programming constructs like variables, conditional logic, looping, and functions

2. examine Python syntax and semantics and be fluent in the use of Python flow control and functions.

3. create, run and manipulate Python Programs using core data structures like Lists, dictionaries and use Regular Expressions

4. develop programs in Python for implementation of non-linear circuits and analyze filters.

5. program their own IoT solutions in Python using MicroPython on small microcontroller boards.

UNIT-I

Introduction to Python: History of Python, Need of Python programming, Features of python, Python basics: Tokens, working with data types and variables, working with numeric data, working with string data, Python functions, Boolean expressions, selection structure, iteration structure.

Functions: default values of arguments, named arguments, local and global variables,

Modules: creating, documenting and Importing modules, Use of standard modules.

UNIT-II

Lists: basic lists, creating and processing list of lists, Tuples, Dictionaries

Data structures: Implementation of stacks and sets, binary search trees, Graph searching, working on sequences- reversing, permuting, sorting, Data Visualization: Different types of charts and graphs, selection of correct data visualization elements, software and tools available for data visualization.

Unit-III

Python Installation and Packages: Introduction to PIP, installing and uninstalling packages via PIP, Using python Packages: Numpy, Matplotlib, Scipy.

Circuit analysis: Operations on vectors and matrices, Circuit representation, processing of components, Data structures of components, Introduction to Nodes, Branches and Loops, Loop and Nodal analysis.

Case study: Model circuits and perform nodal analysis and loop analysis using **Lcapy** (open-source) Python package for solving linear circuits using matrix operations.

Unit- IV

Signal Analysis: Representation Continuous time signals, Discrete time signals, Python Implementation of sampling, Fourier Transform, Laplace transform, Z-transform, Discrete Fourier Transform, Fast Fourier transform, Design of LTI filters, FIR filters and IIR filters using Python

Case study: Cleaning Up Data Noise with Fourier Transform using Python

Unit-V

MicroPython : Introduction, Installing and running MicroPython, **Pyboard**- Architectural overview and Networking, hardware features of BBCmicro:bit, Overview of MicroPython libraries

Case study: Traffic light simulation using MicroPython

Suggested Reading:

1. Michael Urban and Joel Murach, "Python Programming", Mike Murach & Associates, Incorporated, 2016.
2. Kalilur Rahman, "Python Data Visualization Essentials Guide", BPB publications,2021.
3. Shivkumar V. Iyer , " Simulating Nonlinear Circuits with Python Power Electronics-An Open-Source Simulator, Based on Python, Springer International Publishing, 2018.
4. Thomas Haslwanter, "Hands-on Signal Analysis with Python: An Introduction", Springer International Publishing, 2021.
5. Charles Bell, "MicroPython for the Internet of Things A Beginner's Guide to Programming with Python on Microcontrollers", Apress, 2017

NEURAL NETWORKS

PE501EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Probability Theory and Stochastic Processes (ES304ES)

Course Objectives:

1. To understand the functioning of biological neuron and its electronic implementation using different neuron models
2. To acquire knowledge on learning algorithms, architecture of deep learning, CNN and transfer learning.
3. To implement simple neural network using python programming.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. differentiate between biological neuron & artificial neuron and different neuron models
2. apply learning algorithms and different feed forward neural networks
3. understand deep learning concepts and its architectures.
4. learn concepts of CNN and transfer learning techniques.
5. develop programs in Python for implementation of neural networks models

UNIT – I

Introduction to Neural Networks: Description of Biological Neuron, Mathematical model of Artificial Neural Network, Classification of Neural Networks, Different Neuron models: McCulloch-Pitts Neuron model, Perceptron Neuron model and ADALINE Neuron model, Basic learning laws.

UNIT – II

Neural Networks Algorithms: Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Neural Networks Multilayer Perceptron, Back-propagation algorithm and its variants Stochastic gradient decent, Curse of Dimensionality.

UNIT – III

Introduction to Deep Learning & Architectures: Machine Learning Vs. Deep Learning, Representation Learning, Width Vs. Depth of Neural Networks, Activation Functions: Sigmoid, RELU, LRELU, ERELU, Tanh. Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Autoencoders.

UNIT – IV

Convolution Neural Networks: Architectural Overview – Motivation - Layers – Filters – Parameter sharing – Regularization, Popular CNN Architectures: ResNet, AlexNet . Transfer learning Techniques, Variants of CNN: DenseNet, PixelNet.

UNIT – V

Python programming: Python basics, Arrays and array operations, Functions and Files, Simple implementation of Artificial Neural Network, Classification with Multilayer Perceptron using Scikit-learn (MNIST Dataset).

Suggested Reading:

1.   B. Yeganaranarana, "Artificial Neural Networks", Eleventh Edition Prentice Hall, New Delhi, 2007.
2.   Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, 2017.
3.   Subir Varma and Sanjiv Das," Deep Learning" , 1st Edition, Published by Bookdown , 2018.
4.   Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.
5.   Ahmed Gad and Fatima Jarmouni, "Introduction to Deep Learning and Neural Networks with Python," A Practical Guide by Elsevier 1st Edition, 2020.

PROFESSIONAL ELECTIVE-II

FPGA Architectures

PE505EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Digital Electronics (ES303EC)

Course Objectives:

1. To discuss about Application Specific IC (ASIC) fundamentals and FPGA
2. To describe the power consumption in IC design
3. To discuss about the interconnection, placement and routing, verification and testing schemes.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. understand the design flow of ASICs and identify the implementation tools required for simulationand synthesis of FPGA Design.
2. demonstrate the architecture of FPGAs.
3. explain the physical design of FPGAs and CAD tools for low level design entry.
4. Identify the placement & routing algorithms.
5. validate the digital design and analyse the general design issues.

UNIT – I

Introduction to ASICs: Types of ASICs, ASIC design flow, Economies of ASIC's, Programmable ASICs: CPLD and FPGA. Commercially available CPLDs and FPGAs: XILINX, ALTERA, ACTEL. FPGA Design cycle, Implementation tools: Simulation and synthesis, Programming technologies. Applications of FPGAs.

UNIT – II

FPGA logic cell for XILINX, ALTERA and ACTEL ACT, Technology trends, Programmable I/O blocks, FPGA interconnect: Routing resources, Elmore's constant, RC delay and parasitic capacitance, FPGA design flow, Dedicated specialized components of FPGAs.

UNIT – III

FPGA physical design, CAD tools, Power dissipation, FPGA Partitioning, Partitioning methods. Floor planning: I/O, Power and clock planning, Low-level design entry.

UNIT – IV

Placement and Routing: Placement algorithms: Min-cut based placement, Iterative Improvement and simulated annealing.

Routing: introduction, Global routing: Global routing methods, Back-annotation. Detailed Routing: Channel density, Segmented channel routing, Maze routing, Clock and power routing, Circuit extraction and DRC.

UNIT – V

Verification and Testing: Verification: Logic simulation, Design validation, Timing verification. Testing concepts: Failures, mechanism and faults, and fault coverage. Design Applications: General Design issues, Counter Examples, Case study of adders and accumulator architectures with Xilinx Vivado tool.

Suggested Reading:

1. Michael John Sebastian Smith, "Application Specific Integrated Circuits", PearsonEducation Asia, 3rd edition, 2001.

2. Pak and Chan, Samiha Mourad, "Digital Design using Field Programmable Gate Arrays",Pearson Education, 1st edition, 2009

3. S. Trimberger, Edr, "Field Programmable Gate Array Technology", Kluwer AcademicPublications, 1994.

4. John V. Oldfield, Richard C Dore, "Field Programmable Gate Arrays", Wiley Publications.

5. Clive Maxfield, "The Design Warrior's Guide to FPGAs", Elsevier, 2004.

ADVANCED DIGITAL SIGNAL PROCESSING

PE506EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: Digital Signal Processing (PC408EC)

Course Objectives:
1. To comprehend characteristics of discrete time signals and systems
2. To analyze signals using various transform techniques
3. To identify various factors involved in design of digital filters

Course Outcomes: *On successful completion of the course, the students will be able to*
1. design FIR and IIR filters structure for different applications
2. design FIR and IIR type digital filters with error analysis
3. interpret various DSP algorithms for arithmetic operations
4. identify filter structures and evaluate the coefficient quantization effects
5. estimate power spectrum of signals using different methods

UNIT – I
Digital Filter Structures: FIR filters - Direct form, Cascade form, Frequency sampling, Lattice IIR filter - Direct form I, Direct form II, Cascade form, Parallel form Lattice & Lattice loader, Quantization of filter coefficients - Sensitivity to Quantization of filter coefficients, Quantization of coefficients in FIR filters, Round off effects in digital filters - Limit cycle, scaling to prevent overflow.

UNIT – II
Digital Filter Design: Linear phase FIR filter, characteristic response, location of zeros, Design of FIR filter - Windowing, Frequency sampling, Design of IIR filters from Analog filters - Impulse invariance, Bilinear transformation, Matched z-transform. Spectral transformations of IIR filters – FIR filter design –based on Windowed Fourier series – design of FIR digital filters with least – mean square-error – constrained Least –square design of FIR digital filters.

UNIT – III

DSP Algorithm Implementation: Computation of the discrete Fourier transform, Number representation, arithmetic operations, handling of overflow, tunable digital filters, function approximation.

UNIT – IV

Analysis of Finite Word Length Effects: The Quantization process and errors, Quantization of fixed–point and floating–point Numbers, Analysis of coefficient Quantization effects, Analysis of Arithmetic Round-off errors, Dynamic range scaling, signal-to-noise in Low-order IIR filters, Low-Sensitivity Digital filter, Reduction of Product round-off errors feedback, Limit cycles in IIR digital filter, Round-off errors in FFT Algorithms.

UNIT – V

Power Spectrum Estimation: Estimation of spectra from finite duration observation signals, the Periodogram, Use DFT in power Spectral Estimation, Bartlett, Welch and Blackman, Tukey methods, Comparison of performance of Non-Parametric Power Spectrum Estimation Methods. Parametric Method of Power Spectrum Estimation, Relationship between Auto-Correlation and Model Parameters, AR (Auto-Regressive) Process and Linear Prediction, Yule-Walker, Burg and Unconstrained Least Squares Methods, Sequential Estimation, Moving Average (MA) and ARMA Models.

Suggested Reading:

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing-Principles, Algorithms and Applications", PHI, 3rd edition, 2002.

2. Alan V. Oppenheim and Ronald W.Schafer , "Discrete Time Signal Processing"
   3rd Edition, PHI Publications.

3. Glenn Zelniker, Fred J. Taylor, "Advanced Digital Signal Processing-Theory and Applications", CRC Press.

4. Li Tan, "Digital Signal Processing-Fundamentals and Applications", Academic Press Publications.

5. Emmanuel C. Ifeacher, Barrie. W. Jervis, "DSP – A Practical Approach", 2nd edition, Pearson Education.

CMOS ANALOG IC DESIGN

PE507EC

Instruction	: 3 periods per week
Duration of SEE	: 3hours
CIE	: 30 marks
SEE	: 70 Marks
Credits	: 3

Prerequisites: VLSI Design (PC414EC)

Course Objectives:
1. To develop models of basic CMOS amplifiers and Learn the concepts of advanced current mirrors.
2. To design and analyse differential amplifier and two-stage operational amplifier.
3. To study the Bandgap Reference circuits.

Course Outcomes: *On successful completion of the course, the students will be able to*
1. describe the small signal model of MOSFET and analyse the Single Stage Amplifiers.
2. analyse the differential amplifiers with MOS Loads and Current mirror loads.
3. analyse the frequency response of amplifiers.
4. design a fully compensated opamp and analyse the frequency response of the opamp.
5. analyse the bandgap reference circuits.

UNIT I
Basic MOS device Physics: MOS FET device I/V characteristics, second order effects, MOS device Capacitances, MOS small signal Model, NMOS verses PMOS devices.

Single stage amplifiers: Common source stage with resistive load, diode connected load, triode load, current source load, CS stage with source degeneration, source follower, Common Gate stage, Gain boosting techniques, Cascode, folded cascode, choice of device models.

UNIT –II

Differential amplifiers: Single ended and differential operation, Basic differential pair, Common mode response, Differential amplifier with MOS loads, Gilbert cell.

Passive and Active Current mirrors: Basic Current mirrors, Cascode Current mirrors, Active Current mirrors, Wilson and Widlar current mirrors

UNIT- III

Frequency Response of Amplifiers: General Considerations, Common-Source Stage, Source Followers, Common–Gate Stage, Cascode Stage, Differential Pair.

UNIT – IV

Operational Amplifiers: General Considerations, One stage Op-amp, 2-stage OP amp, Gain Boosting, Common mode feedback, Phase Margin, Frequency compensation.

UNIT –V

Band Gap References: General considerations, Supply independent biasing, temperature-independent references, negative-TC voltage, positive TC voltage, Bandgap reference, PTAT current generation.

Suggested Reading:

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, Tata McGraw Hill. 2002
2. Jacob Baker.R.et.al., CMOS Circuit Design, IEEE Press, Prentice Hall, India, 2000
3. David Johns, Ken Martin, Analog Integrated Circuit Design, John Wiley & sons. 2004
4. Philip E. Allen and Douglas R. Holberg, CMOS Analog Circuit Design, Oxford University Press, International Second Edition/Indian Edition, 2010.
5. Paul.R. Gray & Robert G. Major, Analysis and Design of Analog Integrated Circuits, John Wiley & sons. 2004

IoT SYSTEM DESIGN AND APPLICATIONS

PE508EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Prerequisites: MicroProcessor and MicroController (PC409EC)

Course Objectives:
1. To discuss fundamentals of IoT and its applications and requisite infrastructure.
2. To describe Internet principles and architecture and applications relevant to IoT.
3. To discuss private and security aspects of IoT system.

Course Outcomes: *On successful completion of the course, the students will be able to*
1. understand IoT technology and research directions.
2. comprehend various protocols and architecture of IoT
3. design simple IoT systems with IoT reference model
4. understand the various applications of IoT
5. comprehend the different privacy and security approaches at IoT.

UNIT – I
IoT & Web Technology The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

UNIT – II
M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview–

Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNIT – III
IoT Architecture -State of the Art – Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture-Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

UNIT – IV
IoT Applications: Introduction, IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi - Controlling LED and LDR using Pi, Opinions on IoT Application and Value for Industry, Home Management, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and eHealth.

UNIT – V
Internet of Things Privacy: Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

Suggested Reading:

1. Vijay Madisetti and Arshdeep Bahga, 'Internet of Things (A Hands-on-Approach)', 1st edition, VPT, 2014.
2. Francis daCosta, 'Rethinking the Internet of Things: A Scalable Approach to Connecting Everything', 1st edition, Apress Publications, 2013.
3. Cuno Pfister, 'Getting Started with the Internet of Things', O"Reilly Media, 2011.
4. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", Wiley India Publishers, 2014.
5. Vermesan, Ovidiu and Peter Friess, eds. Internet of things: converging technologies for smart environments and integrated ecosystems. River publishers, 2013.

OPEN ELECTIVE-1

ELECTRICAL ENERGY CONSERVATION AND SAFETY

OE601EE

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:
1. To understand the concepts of basic energy and various forms of energy.
2. To understand the energy management and need of energy audit.
3. To understand the energy efficiency technologies.

Course Outcomes: *On successful completion of the course, the students will be able to*
1. Explain the current energy scenario and importance of energy conservation.
2. Describe the concepts of energy management and its importance.
3. Recognize the methods of improving energy efficiency in different electrical systems.
4. Discuss the concepts of different energy efficient devices.
5. Explain the basic concepts related to electrical safety codes and standards.

UNIT – I
Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy ,long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

UNIT – II
Basics of Energy and its various forms: Electricity tariff, load management and maximum demand control, power factor improvement ,selection & location of capacitors, Thermal Basics-fuels ,thermal energy contents of fuel, temperature & pressure ,heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

UNIT – III

Energy Efficiency in Electrical Systems: Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, perform ace assessment of PF capacitors, distribution and transformer losses. Electricmotors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

UNIT – IV

Energy Efficient Technologies in Electrical Systems: Maximum demand controllers ,automatic power factor controllers, energy efficient motors ,soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

UNIT – V

Electrical Safety: Physiological effects of Electricity, Important Susceptibility parameters, Distribution of Electric Power, Macro shock hazards, Micro Shock hazards, Electrical - Safety codes and Standards, Basic Approaches to protection against shock, Protection: Power distribution, Protection: Equipment Design, Electrical Safety Analyzers, Testing the Electrical System. Test of Electric Appliances.

Suggested Reading:

1. Guide books for National Certification Examination for Energy Manager/Energy Auditors Book-1, General Aspects (available online).
2. S. C. Tripathy, Utilization of Electrical Energy and Conservation, McGraw Hill,1991.
3. Success stories of Energy Conservation by BEE, New Delhi(www.bee-india.org)

RELIABILITY ENGINEERING

OE602EE

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:

1. Description of the design aspects of different types spillways.
2. Knowledge regarding the design of energy dissipation arrangements.
3. Awareness about urban storm drainage and concepts of dam safety.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. Understand the meaning of discrete and continuous random variables and their significance, causes of failures of a system.
2. Acquire the knowledge of different distribution functions and their applications.
3. Able to develop reliability block diagrams and evaluation of reliability of different systems.
4. Understand the concept of STM , Reliability and Availability models of different systems.
5. Calculate the Capacity outage probability Table of Generating units

UNIT-I
Discrete and continuous random variables. Probability density function and Cumulative distribution function. Mean and variance. Binomial, Poisson, Exponential and WeibulI distributions.

UNIT-II
Failure and causes of failure. Failure rate and failure density. Reliability function and MTTF. Bathtub curve for different systems. Parametric methods for above distributions. Non-Parametric methods from field data.

UNIT-III
Reliability block diagram. Series and parallel systems. Network reduction technique, Examples. Evaluation of failure rate, MTTF and reliability, Active and Standby Redundancy, routofn configuration. Non-series–parallel systems. Path based and cutest methods.

UNIT - IV

Availability, MTTR and MTBF, Mark ov models and State transition matrices. Reliability models for single component. Two components, Load sharing and standby systems. Reliability and availability models of two-unit parallel systems with repair and standby systems with repair.

UNIT – V

Repairable Systems. maintainability. Preventive maintenance, Evaluation of reliability and J1TTF. Overhauling and replacement. Optimum maintenance policy. Markov model of a power plant with identical units and non- identical units. Capacity outage probability table. Frequency of failures and Cumulative frequency.

Suggested Reading:

1. CharlesE. Ebeling, Reliability and Maintainability Engineering, McGraw Hill International Edition, 1997.

2. Balaguruswamy, Reliability Engineering, Tata McGraw Hill Publishing Company Ltd, 1984.

3. R.N. Allan, Reliability Evaluation of Engineering Systems, Pitman Publishing, 1996.

4. Endrenyi, Reliability Modeling in Electric Power Systems, John Wiley & Sons, 1978.

BASICS OF AUTOMOBILE ENGINEERING
OE611AE

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:
1. Understand the Working of Fuel, Ignition, and cooling Systems
2. Understand the Working of Lubrication and Electrical Systems.
3. Understand the Working of transmission, Suspension, Steering and Braking Systems
4. To provide broad introduction to Alternative Energy Sources, Euro norms and Bharat   Norms

Course Outcomes: *On successful completion of the course, the students will be able to*
1. Generalize the different types of automobiles and engine components
2. Differentiate the Fuel system and electrical system
3. Describe and differentiate the Transmission Systems
4. To identify different components and working of Steering, Brakes and Suspension systems
5. Adapt techniques, skills and modern engineering tools necessary to control the pollution

UNIT – I
Vehicle Structure and Engines: Types of Automobiles, Vehicle Construction, Chassis, Frame and Body , Components of Engine , Cooling and Lubrication systems in Engine, Turbo Chargers, Engine Emission Control by 3 Way Catalytic Controller, Electronic Engine Management System.

UNIT – II
Engine Auxiliary Systems: Carburettor working principle, Electronic fuel injection system, single-point and Multi-Point Injection Systems, Electrical systems, Battery, generator, Starting Motor and Lighting and Ignition.

UNIT – III
Transmission Systems-Clutch: Types and Construction, Gear Boxes-Manual and Automatic, , Over Drives, Transfer Box Fluid flywheel Torque convertors, Propeller shaft – Slip Joint – Universal Joints, Differential and Rear Axle, Hotchkiss Drive and Torque Tube Drive.

UNIT – IV
Steering, Brakes and Suspension: Wheels and Tires – Wheel Alignment Parameters, Steering Geometry and Types of steering gear box, Power Steering, Types of Front Axle – Suspension systems. Braking Systems, Types and Construction, Antilock Braking System.

UNIT – V
Alternative Energy Sources: Use of Natural Gas, LPG, Biodiesel, Gasohol and Hydrogen in Automobiles, Electric and Hybrid Vehicles, Fuel Cells. Euro and Bharat Norms. Recent trends.

Suggested Reading:

1. Crouse & Anglin, 'Automotive Mechanics' Tata McGraw Hill, Publishing Co., Ltd., New Delhi, Tenth edition - 2004.
2. Kirpal Singh, "Automobile Engineering", Vol I & II Standard Publishers, Delhi.
3. Joseph Heitner, 'Automotive Mechanics', Affiliated East West Pvt., Ltd
4. C.P. Nakra, "Basic Automobile Engineering", Dhanpat Rai Publishing Co.(P) Ltd., New Delhi, 2003

INDUSTRIAL ROBOTICS

OE611ME

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:

1. To familiarize the student with the anatomy of robot and their applications.
2. To provide knowledge about various kinds of end effectors usage.
3. To equip the students with information about various sensors used in industrial robots.
4. To make the student understand the importance of spatial transformation of robots using forward and inverse kinematics.
5. To specify and provide the knowledge of techniques involved in robot vision in industry.
6. To equip students with latest robot languages implemented in industrial manipulators.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. Demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics and have an understanding of the functionality and limitations of robot actuators and sensors.
2. Demonstrate an ability to apply spatial transformation to obtain forward/Inverse kinematics equation of robot manipulators using analytical/numerical/simulation tools.
3. Select the best & economically suitable sensors/end effectors required for specific applications.
4. Understand the importance of robot vision and apply the learnt techniques to get the required information from input images.
5. Design and develop a industrial robot for a given purpose economically.
6. Appreciate the current state and potential for robotics in new application areas.

UNIT – I

Introduction to Robotics: Basic structure of Robots. Degree of freedom of Robots, Work envelope, Classification of Robots based on Drive Technology, Work-Envelope and motion control methods. Application of Robots in Industry, Repeatability, Precision and Accuracy as applied to Robots, Specifications of robots used for various applications. End effectors, Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers, Two fingered and three fingered grippers, internal grippers and external grippers, Selection and design considerations.

UNIT – II

Requirements of a Sensor: Principles and Applications of the following types of sensors- Position of sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors), Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters), Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors), Touch sensors (Binary sensors, Analog sensors), Wrist Sensors, Compliance Sensors, Slip Sensors.

UNIT – III

Kinematic Analysis of Robots: Rotation matrix. Homogeneous transformation matrix, Denavit & Hartenberg representation, Euler and RPY angles representation. Representation of absolute position and orientation in terms of joint parameters, Direct Kinematics of manipulators, Inverse kinematics of Robot arm for position and orientation. Redundancy in Robots, Static force analysis

UNIT – IV

Introduction to Techniques used in Robot Vision: Image acquisition, illumination techniques, imaging geometry, basic relationship pixels, preprocessing, segmentation & description of 3- dimensional structures, their recognition and interpretation. Types of Camera, frame grabbing, sensing and digitizing image data, Signal conversion, Image Storage, Lighting techniques, Image processing and analysis, Data reduction, Segmentation, Feature extraction, Object recognition, and various algorithms, Applications, Inspection, identification, visual serving and navigation.

UNIT – V

Robot Programming Languages: Characteristics of robot level languages, task level languages. Teach pendant programming, Lead through programming, Robot programming languages, VAL programming, Motion commands, Sensor commands. End effecter commands, Simple programs. RGV, AGV, Implementation of robots in industries, various steps, Safety considerations for robot operations. Economic analysis of robots, Pay back method, EUAC method and Rate of return method.

Suggested Reading:

1. Groover M P, "*Industrial Robotics*", McGraw Hill Publications, 1999.
2. Fu. K.S., Gon Zalez R.C., Lee C.S.G. "*Robotics, Control-sensing vision and Intelligence*", McGraw Hill, Int. Ed., 1987.
3. Spong and Vidyasagar, "*Robot Dynamics & Control*", John Wiley and Sons, Ed.,1990.
4. Mittal and Nagrath, "*Industrial Robotics*", Tata McGraw Hill Publications, 2004.
5. Saha & Subirkumar saha, '*Robotics*', TMH, India.

SOFT SKILLS AND INTERPERSONAL SKILLS
OE601EG

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:
1. Learn conversational skills
2. Learn reading strategies
3. Learn time management
4. Learn stress management
5. Learn career planning

Course Outcomes: *On successful completion of the course, the students will be able to*
1. Express conversational skills
2. Specify reading strategies
3. Perform time management
4. Perform stress management
5. Explore career planning

UNIT – I
Conversation skills, Listening dialogues from TV/radio/Ted talk/Podcast Group discussion Interview skills, Making presentation, Listening to Lectures and News Programmes, Listening to Talk show Watching videos on interesting events on Youtube,

UNIT – II
Reading different genres of tests ranging from newspapers to philosophical treatises Reading strategies – graphic organizers, Reading strategies – summarizing Reading strategies – interpretation, Reports Cover letter, Resume,

UNIT – III
Writingfor publications, Letters, Memos, Emails and blogs Civil Service (Language related), Verbal ability Motivation, Self-image Goal setting, Managing changes

UNIT – IV

Time management, Stress management Leadership traits Team work Career and life planning.

UNIT – V

Multiple intelligences Emotional intelligence Spiritual quotient (ethics) Intercultural communication Creative and critical thinking Learning styles and strategies

Suggested Reading:

1. Business English Certificate Materials, Cambridge University Press.
2. Business English Certificate Materials, Cambridge University Press.
3. Graded Examinations in Spoken English and Spoken English for Work downloadable   materials from Trinity College, London.
4. International English Language Testing System Practice Tests, Cambridge University Press.
5. Interactive Multimedia Programs on Managing Time and Stress.
6. Personality Development (CD-ROM), Times Multimedia, Mumbai.
7. Robert M Sherfield and et al. "Developing Soft Skills" 4th edition, New Delhi: Pearson Education, 2009.

Web Sources:

1. http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
2. http://www.washington.edu/doit/TeamN/present_tips.html
3. http://www.oxforddictionaries.com/words/writing-job-applications
4. http://www.kent.ac.uk/careers/cv/coveringletters.htm
5. http://www.mindtools.com/pages/article/newCDV_34.htm

HUMAN RESOURCE DEVELOPMENT AND ORGANIZATIONAL BEHAVIOR

OE602MB

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:

1. Understand management process and functions
2. Comprehend decision making and negotiations
3. Learn psychological contract
4. Study the models of organization behaviour
5. Managing stress and counseling

Course Outcomes: *On successful completion of the course, the students will be able to*

1. Explain various facets of management
2. Elaborate on ways of making decision
3. Elucidate different motivation content theories
4. Describe approaches to leadership
5. Suggest methods for stress management and counseling

UNIT – I

Management Process and Functions, Scientific and Modern Management, 3D Model of Managerial Behavior - MBO - MBWA - Line and Staff - The Peter's Principle - Parkinson's Law - Approaches to Organization Structure-Management - Classical, Human Relations, Systems and Contingency Approaches, Hawthorne's Experiments - Human Engineering.

UNIT – II

Decision Making and Negotiations: Approaches to Decision making - Rational, Behavioral, Practical, and Personal Approaches - Open and Closed Models of Decision Making, Types and steps in planning, Authority, Responsibility, Centralization, Decentralization and Recentralization, Bureaucracy.

UNIT – III

Psychological contract - Personality Traits, Big 5 personality traits, MBTI inventory, the Process of Perception - Perceptual distortions and errors, Kelly's personal construct Theory, Motivation-Content Theories: Maslow, Alderfer, Herzberg, McCleland. Process Theories: Vroom, Potter and Lawler, Equity Theory - Goal Theory - Attribution Theory.

UNIT – IV

Models of Organization Behavior - Autocratic, Custodial, Supportive, Collegial and System Models, Transactional Analysis, Johari Window. Group Dynamics: Typology of Groups - Conflicts in groups - The nature, of conflict - Reactions to conflict - A model of conflict. Trait and Behavioral Approaches to Leadership, Managerial Grid, Path-Goal Theory, Vroom's Decision Tree Approach to Leadership - Hersey and Blanchard Model.

UNIT – V

Organization Design, Organization culture and organization climate, Stress Management and Counseling, Management of change and organization development. Communication - Emerging aspects of OB.

Suggested Reading:

1. Harold Koontz and Heinz Weihrich, Essentials of Management, 9th Edition, McGraw Hill Education, 2015.

2. Curtis W. Cook and Phillip L. Hunsaker, Management and Organizational Behavior, 3rd Edition, McGraw-Hill,2010.

CYBER LAW AND ETHICS
OE601LW

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:
1. To familiarize various Cyber laws and IT Acts
2. To give cyber security regulations and forensics
3. To study the risk managements and code of ethics

Course Outcomes: *On successful completion of the course, the students will be able to*
1. Describe the various Cyber laws and IT Acts
2. Explain the cyber security regulations and forensics
3. Analyse the risks and assessment of implications and code of ethics

UNIT – I
Cyber laws and rights in today's digital age: IT Act, Intellectual Property Issues connected with use and management of Digital Data The similar Acts of other countries
Information Warfare: Nature of information warfare, including computer crime and information terrorism; Threats to information resources, including military and economic espionage, communications eavesdropping, computer break-ins, denial-of-service, destruction and modification of data, distortion and fabrication of information, forgery, control and disruption of information How, electronic bombs, and sops and perception management.
UNIT – II
Cyberspace and the Law & Cyber Forensics: Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing

UNIT – III

Legal, Ethical, and Professional Issues in Information Security Ethical Component in Information System, Codes of Ethics, Certification Security Analysis: Risk Management, Identifying and assessing risk, and Controlling Risk.

UNIT – IV

Cyber Security: Organizational Implications: Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing.

UNIT – V

Security risks and perils for organizations, social computing and the associated challenges for organizations. Cybercrime and Cyber terrorism: Introduction, intellectual property in the cyberspace, the ethical dimension of cybercrimes the psychology, mindset and skills of hackers and other cyber criminals.

Suggested Reading:

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley 2017
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, 2018.

OOP USING JAVA

OE601CS

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:

To understand fundamentals of object-oriented programming in Java which includes defining classes, invoking methods, difference between applet and application programs, using class libraries

Course Outcomes: *On successful completion of the course, the students will be able to*

1. Define, understand, differentiate the Object Oriented concepts and Java Programmingconcepts
2. Use Exception handling and multithreading mechanisms to create efficient softwareapplications.
3. Utilize modern tools and collection framework to create Java applications to solve real worldproblems.
4. Design and develop GUI based applications using awt for system based applications.
5. Apply object oriented concepts on real time scenarios.

UNIT – I

Object Oriented System Development: understanding object oriented development, understanding object oriented concepts, benefits of object oriented development.

Java Programming Fundamentals: Introduction, overview of Java, data types, variables and arrays, operators, control statements.

UNIT – II
Exceptions Handling, Multithreaded Programming, I/O basics, Reading Console input and output, Reading and Writing Files, Print Writer Class, String Handling.

UNIT – III
Exploring Java Language, Collections Overview, Collections Interfaces, Collections Classes, Iterators, Random Access Interface, Maps, Comparators, Arrays, Legacy classes and interfaces, Sting tokenizer, BitSet, Date, Calendar, Timer.

UNIT – IV
Introducing AWT working With Graphics: AWT Classes, Working with Graphics.

Event Handling: Two Event Handling Mechanisms, The Delegation Event Model, Event Classes,Source of Events, Event Listener Interfaces. and AWT Controls

UNIT – V
Java I/O Classes and Interfaces, Files, Stream and Byte Classes, Character Streams, Serialization.

Suggested Reading:
1. Herbert Schildt, The Complete Reference JAVA, Tata McGraw Hill, 7thEdition,2005

2. James M Slack, Programming and Problem Solving with JAVA, Thomson learning, 2002

3. C.Thomas Wu, An Introduction to Object-Oriented Programming with Java, Tata McGraw Hill, 5thEdition,2005**.**

DATA STRUCTURES AND ALGORITHMS
OE602CS

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:

1. To develop proficiency in the specification, representation, and implementation of abstract data types and data structures.
2. To discuss the linear and non-linear data structures and their applications.
3. To introduce the creation, insertion and deletion operations on binary search trees and balanced binary search trees.
4. To introduce various internal sorting, searching techniques and their time complexities

Course Outcomes: *On successful completion of the course, the students will be able to*

1. Understand the importance of abstract data type and implementing the concepts ofdata structure using abstract data type.
2. Evaluate an algorithm by using algorithmic performance and measures.
3. Distinguish between linear and non-linear data structures and their representations in the memory using array and linked list.
4. Apply the suitable data structure for a real world problem and think critically for improvement in solutions.
5. Determine the suitability of the standard algorithms: Searching, Sorting and Traversals

UNIT – I
Algorithms: Introduction, Algorithm Specifications, Recursive Algorithms, Performance Analysis of an algorithm- Time and Space Complexity, Asymptotic Notations.

Arrays: Arrays - ADT, Polynomials, Sparse matrices, Strings-ADT, Pattern Matching.
UNIT – II
Stacks and Queues: Stacks, Stacks using Arrays, Stacks using dynamic arrays, Evaluation of Expressions – Evaluating Postfix Expression, Infix to Postfix.
Queues: Queues ADT, operations, Circular Queues, Applications
UNIT – III
Linked Lists: Singly Linked Lists and Chains, Linked Stacks and Queues, Polynomials, Operations for Circularly linked lists, Equivalence Classes, Sparse matrices, Doubly Linked Lists.
Hashing: Static Hashing, Hash Tables, Hash Functions, Overflow Handling, Theoretical Evaluation of Overflow Techniques
UNIT – IV
Trees: Introduction, Binary Trees, Binary Tree Traversals, Heaps, **Binary Search trees (BST) :** Definition, Searching an element, Insertion into a BST, Deletion from a BST.
Efficient Binary Search Trees: AVL Trees: Definition, Searching an element, Insertion into a AVL
UNIT – V
Graphs: Graph Abstract Data Type, Elementary Graph operations (DFS and BFS), Minimum Cost Spanning Trees (Prim's and Kruskal's Algorithms).
Sorting and Searching: Insertion sort, Quick sort, Best computing time for Sorting, Merge sort, Heap sort, shell sort, Sorting on Several Keys, List and Table Sorts, Summary of Internal Sorting, Linear and Binary Search algorithms.
Suggested Reading:
1. Horowitz E, Sahni S and Susan Anderson-Freed, Fundamentals of Data structures in C, 2ndEdition (2008), Universities Press
2. Mark A Weiss, Data Structures and Algorithm Analysis In C, Second Edition (2002),Pearson
3. Kushwaha D. S and Misra A.K, Data structures A Programming Approach with C, Second Edition (2014), PHl.
4. Gilberg R. F and Forouzan B. A, Data structures: A Pseudocode Approach with C,Second Edition (2007), Cengage Leaming
5. Tanenbaum A. M , Langsam Y. Augenstein M. J, Data Structures using C, Second Edition (2008), Pearson.
6. Thomas H. Cormen, Charles E. Leiserson, Ronald L Rivest, Clifford Stein,Introduction to Algorithms, Third Edition (2009), MIT Press
7. Yedidyah Langsam , Moshe J. Augenstein ,Aaron M. Tenenbaum, Data Structures Using C and C++ , Second Edition (2009), PHI

OPERATING SYSTEMS

OE601IT

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:
1. To understand the working of computer system and the basic concepts of operating system and the services provided by it.
2. To understand the functions and management of different resources of the operating system (Processor, I/O and Memory etc.)
3. To understand process management concepts including scheduling, synchronization
4. To learn the mechanisms involved in memory management and I/O sub systems of an operating system.
5. To learn protection domain, access matrix and program threats.

Course Outcomes: *On successful completion of the course, the students will be able to*
1. Explain the components and functions of operating systems
2. Understand process scheduling in a multi-programming environment and implementing process scheduling algorithms.
3. Write application and system calls related programs for managing processes, memory, I/O and inter-process Communication related system calls.
4. Understand memory management, disk management techniques, including virtual memory and file system structure.
5. Understand the different types of protection principles and system security.

UNIT-I
Introduction: Computer System organization & Architecture, Operating System Structure & Operations, Process, Memory and Storage Managements, Protection and Security, Distributed and Special-Purpose Systems, Computing Environments.

System Structures: Operating-System Services, User Operating System Interface, System calls, Types of System Calls, System Programs, Operating-System Structure, Virtual Machines, Operating– System Generation, System Boot.

Process Concept: Overview, Process Scheduling, Operations on Processes, Inter process communication, Examples of IPC Systems, Communication in Client/ Server Systems.

UNIT-II

Process Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multi-Processor Scheduling, Thread Scheduling: Pthreads, Operating System Examples, Algorithm Evaluation Process

Coordination and Synchronization: Background, The Critical-Section Problem, Peterson's Solution, Synchronization, Monitors, Synchronization Examples.

UNIT-III

Memory-Management Strategies: Background, Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation, Example: The Intel Pentium.

Virtual Memory Management: Background, Demand paging, Copy-on-write, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files, Allocating Kernel Memory, Other Considerations.

UNIT-IV

Implementing File Systems: File System-Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance, Recovery, Log-Structured File Systems, NFS.

Secondary –Storage Structure: Overview of Mass-Storage Structure, Disk Structure, Disk Attachment, RAID Structure, Stable-Storage Implementation, Tertiary-Storage Structure.

UNIT-V

Protection and Security: Goals of Protection, Principles of Protection, Domain of protection, Access Matrix, Implementation of Access Matrix, Access control, Revocation of access rights, Capability-based Systems, Language-based protection.

System Security: The security problem, program Threats, System and System

Suggested Reading:

1. Abraham Silber schatz, Peter B Galvin, Operating System Concepts, Addison Wesley,2006
2. William Stallings, Operating Systems-Internals and Design Principles, 5th edition, PHI, 2005
3. Andrew S Tanenbaum, Modern Operating Systems, 4th edition, Pearson, 2016.
4. IdaM.Flynn, Understanding Operating Systems, Sixth Edition, Cengage, 2011

PRINCIPLES OF ARTIFICIAL INTELLIGENCE

OE601AD

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:
1. To learn the difference between optimal reasoning and human like reasoning.
2. To understand the concept of state space representation.
3. To understand heuristic and exhaustive search.
4. To introduce the concept of Machine Learning

Course Outcomes: *On successful completion of the course, the students will be able to*
1. Understand the basics of AI and knowledge representation using appropriate technique.
2. Apply AI techniques for problem solving using various search and game Playing algorithms.
3. Interpret architectures of different intelligent agents and Expert Systems.
4. Interpret probabilistic and logical reasoning and analyze different Machine Learning approaches.
5. Recognize basics of Artificial Neural Networks and Natural Language Processing.

UNIT – I
Introduction: History, Foundations of AI, Sub areas of AI, Objectives and Applications of AI.

Intelligent Agent: Agents and Environments and the Structure of Agents.

Solving Problem by Searching: Introduction, General Problem Solving.

Uninformed Search Strategies: Breadth First Search and Depth First Search.

Informed (Heuristic) Search Strategies: Heuristic Function, A* Algorithm and Hill Climbing.
UNIT – II

Game Playing: Optimal Decisions in Games, the Mini max Algorithm, Alpha-Beta Pruning, Constraint Satisfaction Algorithm.

Logic Concepts: Introduction, Propositional Logic, Predicate Logic, Unification Algorithm, Natural Deduction System, Semantic Tableau System in Propositional Logic, Resolution Refutation in Propositional Logic.
UNIT – III

Knowledge Representation: Introduction, Approaches to Knowledge Representation, Knowledge Representation using Semantic Networks and Extended Semantic Networks, Knowledge Representation using Frames.
Expert System and Applications: Introduction, Phases in Building Expert Systems, Expert System Architecture, Expert Systems Vs Traditional Systems, Application of Expert Systems, List of Shells and Tools.
UNIT – IV

Uncertainty Measure – **Probability Theory:** Introduction, Probability Theory, Bayesian Belief Networks, Dempster - Shafer Theory.
Machine Learning: Introduction. Machine Learning Systems. Supervised, Unsupervised Learning and Reinforcement Learning, Learning Decision Trees, Clustering, Support Vector Machines.
UNIT – V

Artificial Neural Networks: Introduction, Artificial Neural Networks, Single- Layer Feed Forward Networks, Multi-Layer Feed-Forward Networks, Recurrent Networks, Design Issues of Artificial Neural Networks.

Advanced   Knowledge Representation Techniques: Case Grammars, Semantic Web.
Natural Language Processing: Introduction, Sentence Analysis Phases, Grammars and Parsers, Types of Parsers.

Suggested Reading:

1. Russell and Norvig, Artificial intelligence, A Modern Approach, Pearson Education, 3rd Edition. 2014.
2. Rich, Knight and Nair, Artificial intelligence, Tata McGraw Hill, 3rd Edition 2009.
3. Deepak Khemani, A First Course in Artificial Intelligence, McGraw-Hill Education,2013
4. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 2011D, Samanta, Classic Data Structures, 2nd Edition, PHI.

PRINCIPLES OF MACHINE LEARNING
OE601AM

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:

1. To introduce students to the basic concepts of Data Science and techniques of Machine Learning.
2. To develop skills of using recent machine learning software for solving practical problems.
3. To gain experience of doing independent study and research.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. Design and implement machine learning solutions of classification, regression problems.
2. Evaluate and interpret the results of the machine learning algorithms.
3. Evaluate exploratory data analysis and Data preparation and preprocessing on different datasets.
4. Calculate Statistical measurements of the given data.
5. Analyze and identify the best algorithm matches for a given dataset.

UNIT – I
Introduction: What is Machine Learning, Use Machine Learning, and Types of Machine Learning Systems: supervised, unsupervised, semi-supervised, Reinforcement Learning, Batch and Online Learning, Main Challenges of Machine Learning.

UNIT – II

Descriptive Statistics: Data representation, types of data- nominal, ordinal, interval and continuous, central tendency- calculating mean mode median, mean vs median, variability, variance, standard deviation, Mean Absolute Deviation using sample dataset, finding the percentile,

interquartile range, Box Plot, Outlier, whisker, calculating correlation, covariance, causation.

Exploratory data analysis, Data preparation and preprocessing, Data visualization.

UNIT – III

Regression: Introduction to Regression analysis, measure of linear relationship, Regression with stats models, Determining coefficient, meaning and significance of coefficients, coefficient calculation with least square method, Types of regression, Simple Linear Regression, Using Multiple features, Polynomial Regression, Metrics for Regression: MSE, RMSE, MAE.

UNIT – IV

Classification: Classification problem, Probability based approach, Logistic Regression- log-odd, sigmoid transformation, Metrics: Confusion Matrix, Accuracy, Error Rate, Precision, Recall, ROC curve, F1 score, and introduction to gradient descent.

UNIT – V

Non Parametric & SVM classification: About Non parametric classification, Decision Trees: Entropy, Gain ratio, Information Gain, Splitting criteria,

Ensemble Method: Introduction to Random Forest, Accuracy measure & performance

Instance based learning- Introduction, KNN algorithm, Distance measures, model building, locally weighted regression, radial basis functions, SVM classifier, hyper-plane, slack variables, geometric transformation kerneltrick, kernel transformation.

Suggested Reading:
1. Booz, Allen, Hamilton, The Field Guide to Data Science
2. AurélienGéron, Hands-On Machine Learning with Scikit-Learn and Tensor Flow, O'Reilly Media, 2017-03- 10
3. Peter Harrington, Machine Learning in Action, Manning Publications
4. Python For Data Analysis by wes McKinny 2nd edition, O'REILLY publications.
5. Jason Brownlee data analysis for machine learning.

DATA SCIENCE

OE601DS

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:

1. To identify the scope and essentiality of Data warehousing and Data Mining.
2. To develop research interest towards advances in data mining.
3. To analyze the data, data science lifecycle, data collection and cleaning, exploratory data analysis and visualization, statistical inference and prediction, and decision-making algorithms for respective applications.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. Understand the basic concepts in data science.
2. Understand i real world applications in Data Science
3. Understand fundamentals of data and Data Mining Principles.
4. To Understand importance of qualitative data, terminologies related to Data Science.
5. Understand and Extract knowledge using data pre processing concepts in data science.

UNIT – I
Introduction to Data Science: Data Science Definition - The Data Science Venn Diagram Terminology Types of Data: - Flavors of Data-Structured and Unstructured Data-Quantitative versus qualitative Data, Four Levels of Data- Case study

UNIT – II
Evolutionary of (Five Steps) of Data Science: - Overview of Evolutionary (Five Steps)- Explore the Data Dataset 1 - Dataset2 – Titanic Communication Data: Communication matter- Identifying

effective and ineffective visualizations- graphs and statistics Be- Verbal Communication

UNIT – III

Basics of Data Mining : importance of Data Mining, Moving toward the Information Age Data Mining as the Evolution of Information Technology, What Is Data Mining, What Kinds of Data Can Be Mined, Database Data, Data Warehouses, Transactional Data, Other Kinds of Data, OLTP & Online Analytical Processing(OLAP), Graphs Database.

UNIT – IV

Identification of data: Data Objects and Attribute Types, Basic Statistical Descriptions of Data, Data Visualization, Measuring Data Similarity and Dissimilarity: Euclidean, Jaccard's Index & Cosine Similarity

UNIT – V

Data Pre-processing: Data Cleaning, Data Integration, Data Reduction, Data Transformation and Data Discretization (ETL Operations)

Suggested Reading:

1. Principles of Data Science , Sinon Ozdemir, Packt Publishing Ltd,2016 (Unit 1& 2)
2. Han, Jiawei, MichelineKamber, and Jian Pei. "Data mining concepts and techniques third edition."The Morgan Kaufmann Series in Data Management Systems 5.4 (2011). (Unit 3 &4)
3. SinanOzdemir Principles of Data Science: Mathematical techniques and theory to succeed in datadriven industries, Packt Publishing Limited (13 December 2016)
4. Cielen, Davy, Arno DB Meysman, and Mohamed Ali. Introducing data science: big data, machine learning, and more, using Python tools. Manning Publications Co., 2016
5. Jason Brownlee data analysis for machine learning.

PRINCIPLES OF IOT

OE601CB

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:

1. To apprise students with basic knowledge of IoT that paves a platform to understand physical, logical design and business models
2. To teach a student how to analyze requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
3. To explain the students how to code for an IoT application and deploy for real-time scenario

Course Outcomes: *On successful completion of the course, the students will be able to*

1. Describe various layers of IoT protocol stack and describe protocol functionalities.

2. Evaluate efficiency trade-offs among alternative communication models for an efficient IoT application design.

3. Understand working principles of various sensor for different IoT platforms.

4. Compare various application business models of different domains.

5. Solve real-time problems and demonstrate IoT applications in various domains using prototype models.

UNIT – I

Introduction to Internet of Things: Definition & Characteristics of IoT - Challenges and Issues- Physical Design of IoT, Logical Design of IoT - IoT Functional Blocks, Security.

Components in Internet of Things: Control Units Communication modules Bluetooth, ZigBee, Wi-Fi GPS- IOT Protocols (IPv6,

6LoWPAN, RPL, CoAP etc), MQTT, Wired Communication, Power Sources.

UNIT – II

Technologies Behind IoT: Four pillars of IOT paradigm, - RFID, Wireless Sensor Networks, SCADA (Supervisory Control and Data Acquisition), M2M - IOT Enabling Technologies - BigData Analytics, Cloud Computing, Embedded Systems.

UNIT – III

Programming The Microcontroller for IoT: Working principles of sensors IOT deployment for Raspberry Pi /Arduino /Equivalent platform Reading from Sensors, Communication: Connecting microcontroller with mobile devices, communication through Bluetooth, Wi-Fi and USB - Contiki OS- Cooja Simulator.

Resource Management in IoT: Clustering, clustering for Scalability,Clustering Protocols for IOT

UNIT – IV

From The Internet of Things to The Web of Things: The Future Web of Things Set up cloud environment Cloud access from sensors Data Analytics for IOT- Case studies- Open Source e-Health sensor platform, Be Close Elderly Monitoring, Other recent projects.

UNIT – V

IoT Applications & Recent Trends: Business models for the internet of things, Smart city, smart mobility and transport, smart buildings and infrastructure, smart health, environment monitoring and surveillance.

Suggested Reading:

1. Architecting the Internet of Things ,Dieter Uckelmann et.al, , Springer, 2011
2. Internet of Things A Hand-on Approach ,Arshdeep Bahga and Vijay Madisetti, Universities press, 2015
3. Building Internet of Things with the Arduino, Charalampos Doukas , Create space, April 2002
4. Internet of Things: From research and innovation to market deployment, Dr. Ovidiu Vermesan and Dr. Peter Friess, River Publishers 2014.

DISASTER MANAGEMENT
OE601CE

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:
1. To impart knowledge of the basic principles of disaster management.
2. To give knowledge of the various types of disasters.
3. To understand the disaster management cycle and framework.
4. To become aware of the disaster management systems in India.
5. To become aware of the applications of the latest technologies in disaster management

Course Outcomes: *On successful completion of the course, the students will be able to*
1. Define and explain the terms and concepts related to disaster management.
2. Describe the various categories of disasters and their specific characteristics.
3. Explain the pre-disaster, during disaster and post-disaster measures and framework
4. Describe the disaster management acts and frameworks specific to India
5. List and explain the various technological applications to aid disaster management.

UNIT-I
Introduction: Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, and Capacity – Disaster and Development, and disaster management.
UNIT-II
Disasters: Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological

Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.

UNIT-III
Disaster Management Cycle and Framework: Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness.

During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation.

Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR.

UNIT-IV
Disaster Management in India: Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter Governmental Agencies.

UNIT-V
Applications of Science and Technology for Disaster Management: Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non-Structural Mitigation of Disasters S&T Institutions for Disaster Management in India.

Suggested Reading:

1. Rajib, S and Krishna Murthy, R. R, Disaster Management Global Challenges and Local Solutions" CRC Press, 2009.

2. Navele, P & Raja, C. K, Earth and Atmospheric Disasters Management, Natural and Manmade. B. S. Publications.2009

3. Battacharya, T., Disaster Science and Management. Tata McGraw hill Company, 2017

4. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi

5. An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi

6. Encyclopedia of disaster management, Vol I, II and IIIL Disaster management policy and administration, S L Goyal, Deep & Deep, New Delhi, 2006

7. Disasters in India Studies of grim reality, Anu Kapur& others, 2005, 283 pages, Rawat Publishers, Jaipur

8. Disaster Management Act 2005, Publisher by Govt. of India

9. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management

10. National Disaster Management Policy, 2009, Govt. of India

11. Jagbirsingh, Disaster management–Future challenges and opportunities, I.K. International publishing house, 1st edition, 2007.

12. Coppala P Damon, Introduction to International Disaster management, Butterworth-Heinemann, 2015.

PRINCIPLES OF ELECTRONIC COMMUNICATION

OE601EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:
1. To provide an introduction to fundamental concepts in the understanding of communications systems.
2. To describe the network model and some of the network layers including physical layer, data link layer, network layer and transport layer.
3. To discuss the evolution of wireless systems and current wireless technologies.

Course Outcomes: On successful completion of the course, the students will be able to
1. understand the working of analog and digital communication systems.
2. explain the OSI network model and the working of data transmission.
3. describe the evolution of communication technologies from traditional telephony systems to modern wireless communication systems.
4. differentiate between analog and digital modulation techniques
5. understand the optical fiber communication link, structure, propagation and transmission properties.

UNIT – I

Introduction to Communication systems: Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels.

Signal Transmission Concepts: Baseband transmission and Broadband transmission, Communication Parameters: Transmitted

power, Channel bandwidth and Noise, Need for modulation **Signal Radiation and Propagation:** Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation.

UNIT – II

Analog and Digital Communications: Amplitude modulation and demodulation, FM modulationand demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation.

UNIT – III

Data Communication and Networking: Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP.

UNIT-IV

Telecommunication Systems: Telephones, Telephonesystem, Optical Communications: Optical Principles, Optical Communication Systems, Fiber –OpticCables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

UNIT-V

Wireless Communications: Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks.

Suggested Reading:

1. Louis E. Frenzel, "Principles of Electronic Communication Systems", 3rd edition, McGraw Hill,2008.
2. Behrouz A. Forouzan, "Data Communications and Networking", 5th edition, TMH, 2012.
3. George Kennedy, Bernard Davis, "Electronic Communication systems", 4th edition, McGraw Hill, 1999.
4. Rappaport T.S., "Wireless communications", 2nd edition, Pearson Education, 2010.
5. Wayne Tomasi, "Advanced Electronic Communications Systems", 6th edition, Pearson Education.

DIGITAL SYSTEM DESIGN USING VERILOG HDL

OE602EC

Instruction	: 3 periods per week
Duration of SEE	: 3 hours
CIE	: 30 marks
SEE	: 70 marks
Credits	: 3

Course Objectives:
1. To familiarize with various modeling styles: structural, dataflow and behavioral ofVerilog HDL.
2. To develop combinational and sequential circuits using various modeling styles of Verilog HDL.
3. To review the implementation of Verilog HDL Modeling using real time examples.

Course Outcomes: *On successful completion of the course, the students will be able to*
1. implement and distinguish different Verilog HDL modeling styles
2. construct and analyze Verilog HDL models of combinational and sequential circuits.
3. design and develop Verilog HDL modeling and test bench for digital systems for thegiven specifications.
4. outline FPGA design flow and timing analysis.
5. understand the realworld design examples such as UART, timers, and CPUs.

UNIT-I
Structural modeling: Overview of Digital Design with Verilog HDL, Basic concepts, modulesand ports, gate-level modeling, hazards and design examples.
UNIT-II
Dataflow and Switch level modeling: dataflow modeling, operands and operators. Switch Level Modeling: CMOS switches and bidirectional switches and design examples.

UNIT-III

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules and design examples.

UNIT-IV

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions. Verilog HDL synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

UNIT-V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), CPU design: Data path and control units.

Suggested Reading:

1. Sameer Palnitkar, "Verilog HDL A Guide to Digital Design and Synthesis", 2nd edition, Pearson Education, 2006.
2. Ming-Bo Lin, "Digital System Designs and Practices: Using Verilog HDL and FPGA", Wiley India edition, 2008.
3. J. Bhasker, A Verilog HDL Primer, 2nd edition, BS Publications, 2001.
4. Charles Roth, Lizy.K.John, Byeong Kil Lee,-Digital Systems Design Using Verilog, 1st edition, Cengage Learning, 2015.
5. T.R.Padmanabhan, B.Bala Tripura Sundari, "Design through Verilog HDL" ,Studentedition, Wiley Publishers,2008.

COMMUNICATION SYSTEMS LAB

PC458EC

Instruction	: 2 periods per week
Duration of SEE	: 3 hours
CIE	: 25 marks
SEE	: 50 marks
Credits	: 1

Course Objectives:

1. To demonstrate AM, FM, Mixer, PAM, PWM, PPM and multiplexing techniques.
2. To understand and simulate digital modulation (i.e., ASK, FSK, BPSK, QPSK) generation.
3. To model analog, pulse modulation, PCM, Delta and Digital modulation techniques using CAD tools.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. understand and simulate modulation and demodulation of AM and FM.
2. construct and understand the need for pre-emphasis and de-emphasis at the transmitter and receiver respectively.
3. simulate the PAM, PWM & PPM circuits.
4. understand generation and detection of baseband transmission (i.e., PCM, DM, and ADM) and bandpass transmission (i.e., ASK,FSK,PSK, MSK and QPSK)

5. understand the error control coding.

List of Experiments
PART-A

Analog Communication

1. Amplitude Modulation and Demodulation.
2. Frequency Modulation and Demodulation.
3. Pre-emphasis and De-emphasis and plot the frequency response.
4. Multiplexing Techniques (FDM and TDM).
5. Mixer Characteristics and plot the frequency response.
6. Verification of Sampling Theorem.
7. PWM, PPM generation and detection.

8. Generation and Detection of AM, FM, PAM, PWM, PPM modulation techniques   using MATLAB/Simulink/Lab-view.

PART-B

Digital Communication

1. PCM modulation and demodulation.
2. Channel encoding and decoding.
3. Linear and Adaptive Delta Modulation and Demodulation.
4. ASK generation and Detection.
5. FSK and Minimum Shift Keying generation and Detection.
6. ASK generation and Detection.
7. Generation and Detection of PCM, Delta modulation and Digital modulation schemes (ASK, FSK, BPSK, QPSK) by using MATLAB/ Simulink /Lab-view.

NOTE:
1. At least ten experiments to be conducted in the semester.
2. Minimum of 5 from Part A and 5 from Part B is compulsory.

DIGITAL INTEGRATED CIRCUITS DESIGN LAB
PC459EC

Instruction	: 2 periods per week
Duration of SEE	: 3hours
CIE	: 25 marks
SEE	: 50 Marks
Credits	: 1

Course Objectives:

1. To develop verilog HDL code for digital circuits using gate level, data flow and behavioral, modeling and Verify the design block using stimulus.

2. To study the VLSI CAD tools.

3. To implement transistor level circuits.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. write the Verilog HDL programs in gate level and data flow modeling.
2. implement combinational and sequential circuits using Verilog.
3. analyse digital circuits using VLSI CAD tools like Mentor Graphics / Cadence
4. design CMOS circuits like basic gates, adders at the transistor level
5. implement the layout of simple CMOS circuits like inverter and basic gates.

List of Experiments: Part-A

Write the Code using Verilog and simulate the following:

1. Write structural and dataflow Verilog HDL models for

   a) 4-bit ripple carry adder. b) 4-bit carry Adder – cum Subtractor.
   c) 2-digit BCD adder / subtractor.

   d) 4-bit carry look ahead adder e) 4-bit comparator

2. Write a Verilog HDL program in behavioral model for

   a) 8:1 multiplexer

   b) 3:8 decoder   c) 8:3 encoder

   d) 8 bit parity generator and checker

3. Write a Verilog HDL program in Hierarchical structural model for
   a) 16:1 multiplexer realization using 4:1 multiplexer

   b) 3:8 decoder realization through 2:4 decoder

   c) 8-bit comparator using 4-bit comparators and additional logic

4. Write a Verilog HDL program in behavioral model for D,T and JK
   flip flops, shift registers and counters.

5. Write a Verilog HDL program in structural and behavioral models
   for

   a) 8 bit asynchronous up-down counter
   b) 8 bit synchronous up-down counter

6. Write a Verilog HDL program for 4 bit sequence detector through
   Moore state machines

7. Write a Verilog HDL program for 4 bit sequence detector through
   Mealy state machines

PART-B

Transistor Level implementation of CMOS circuits using VLSI CAD
tool
1. Basic Logic Gates: Inverter, NAND and NOR
2. Half Adder and Full Adder

3. 2:1 Multiplexer and 4:1 Multiplexer using 2:1 Multiplexer
4. one bit comparator and four-bit magnitude comparator using one bit comparator
5. Implement the Layout of CMOS Inverter.
6. Implement the Layout of CMOS NAND.

Note:
1. A total of 10 experiments must be completed in the semester.
2. Minimum of 5 experiments from Part-A and 5 from Part-B is compulsory.

DATA COMMUNICATION AND COMPUTER NETWORKS LAB

PC460EC

Instruction	: 2 periods per week
Duration of SEE	: 3 hours
CIE	: 25 marks
SEE	: 50 marks
Credits	: 1

Course Objectives:

1. To understand a conceptual foundation for the study of data communications using the open Systems interconnect (OSI) model for layered architecture.
2. To understand the performance of data link layer protocol HDLC.
3. To understand network layer routing protocols and algorithms.

Course Outcomes: *On successful completion of the course, the students will be able to*

1. understand the working of various network topologies in circuit and packet switching.
2. implement HDLC protocol and significance of MAC protocols.
3. understand the network routing protocols and the associated algorithms.
4. understand the transport layer working with TCP, and UDP.
5. implement network scenario and obtain its performance evaluation.

List of Experiments:

PART- A

Design and implement the following experiments using C Compiler and packet tracer software

1. Study of network devices in detail.
2. A HDLC frame to perform the following.
   i.   Bit stuffing
   ii. Character stuffing.
3. Distance vector algorithm and find path for transmission.
4. Dijkstra's algorithm to compute the shortest routing path.
5. Simulation of network topologies.
6. Configuration of a network using different routing protocols.

PART B

Simulation using NS2/ NS3/ NCTUNS/ NetSim or any other equivalent tool in Linux OS.

1. Point to point network with four nodes and duplex links between them. Analyse the network performance by setting the queue size and varying the bandwidth.
2. Four node point to point network with links n0-n2, n1-n2 and n2-n3. Apply TCP agent between n0-n3 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP/UDP.
3. Ethernet LAN using n (6-10) nodes. Compare the throughput by changing the error rate and data rate.
4. Implement Ethernet LAN using n nodes and assignment of multiple traffic to obtain congestion window for different sources/ destinations.
5. ESS with transmission nodes in Wireless LAN and study of performance parameters.
6. Implementation of Link state routing algorithm.

Note:
1. At least ten experiments to be conducted in the semester.
2. Minimum of 5 from Part A and 5 from Part B is compulsory.

SUMMER INTERNSHIP

PW702EC

Instruction	: NA
Duration of SEE	: NA
CIE	: 50 marks
SEE	: NA
Credits	: 2

Course Objectives:

1. To enhance practical and professional skills.
2. To provide training in soft skills and also train them in presenting seminars and technical report writing.
3. To expose the students to industry practices and team work

Course Outcomes: *On successful completion of the course, the students will be able to*

1. acquire practical experience of software design and development, and coding practices within Industrial/R&D Environments.
2. understand working practices within Industrial/R&D Environments
3. prepare reports and deliver effective presentation.
4. demonstrate effective written and oral communication skills
5. innovate in various engineering disciplines and nurture their entrepreneurial ideas.

Summer Internship is introduced as part of the curriculum for encouraging students to work on problems of interest to industries. A batch of three students will be attached to a person from the Government or Private Organisations/Computer Industry/Software Companies/R&D Organization for a period of 4 to 6 weeks. This will be during the summer vacation following the completion of the III-year Course. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry co-ordinate (person from industry).

The course schedule will depend on the specific internship/training experience. The typical time per topic will vary depending on the internship

- Overview of company/project
- Safety training

- Discussions with project teams
- Background research, review of documents, white papers, and scientific papers
- Planning, designing, and reviewing the planned work
- Executing the plans
- Documenting progress, experiments, and other technical documentation
- Further team discussions to discuss results
- Final report writing and presentation

After the completion of the project, each student will be required to:
1. Submit a brief technical report on the project executed and
2. Present the work through a seminar talk (to be organized by the Department)

Award of internal marks are to be based on the performance of the students at the workplace and awarded by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will co-ordinate the overall activity of Industry Attachment Program.

Note: Students have to undergo summer internship of 4 to 6 weeks at the end of semester VI and credits will be awarded after evaluation in VII semester.