JALPAIGURI GOVERNMENT ENGINEERING COLLEGEJALPAIGURI-735102

(An Autonomous Government College)

COURSE STRUCTURE AND SYLLABUSFOR FIRST SEMESTER TO EIGHTH SEMESTER B.TECH. DEGREE

IN

ELECTRONICS & COMMUNICATION ENGINEERING

(Implemented for the new entry batch from the Academic Year 2021-22)

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Structure and syllabus of B.Tech. in **Electronics & Communication Engineering** to be implemented from the entry batch of 2021-22

CC: Course Code, SC: Subject Code. Cr.: Credit, L-T-P-T: Lecture-Tutorial-Practical-Total

1st Year

CC	SC	Subject Name	Contact Hrs./Week		CC	SC	Subject name	Contact Hrs./Week	
			L–T- P-TO	Cr.				L–T-P-TO	Cr.
BSC	BS-CH101	Chemistry	3-1-0-4	4	BSC	BS-PH201	Physics	3-1-0-4	4
BSC	BS-M101B	Mathematics-IB	3-1-0-4	4	BSC	BS-M201B	Mathematics-IIB	3-1-0-4	4
ESC	ES-ES101	Basic Electrical Engineering	3-1-0-4	4	HUM	HM-HU201	English	2-0-0-2	2
BSC	BS-CH191	Chemistry Laboratory	0-0-3-3	1.5	ESC	ES-CS201	Programming for Problem Solving	3-0-0-3	3
ESC	ES-EE191	Basic Electrical Engineering Laboratory	0-0-2-2	1	ESC	ES-ME292	Workshop/Manufacturing Practice	1-0-4-5	3
ESC	ES-ME191	Engineering Graphics & Design	1-0-4-5	3	ESC	ES-CS291	Programming for Problem Solving Laboratory	0-0-4-4	2
Mandatory Induction Program- 3 weeks duration. It is tobe done before initiation of classes (theoretical, laboratory & sessional) as per syllabus following guidelines of AICTE and MAKAUT			10-3-9-22	17.5	BSC	BS-PH291	Physics Laboratory	0-0-3-3	1.5
					HUM	HM-HU291	Language Laboratory	0-0-2-2	1
					Total			12-2-13-30	20.5

2nd Year

CC	SC	Subject Name	Contact Hrs./Week		CC	SC	Subject Name	Contact Hrs./Week	
			L –T-P-TO	Cr.				L–T-P-TO	Cr.
HUM	HM-HU(EC)301	Value & Ethics in Profession	2-0-0-2	2	BSC	BS-M(EC)401	Mathematics – III	3-1-0-4	4
ESC	ES-EC301	Basic Electronics	3-1-0-4	4	BSC	BS-CH(EC)401	Biology	2-0-0-2	2
ESC	ES-CS (EC)301	Data Structure	3-0-0-3	3	ESC	ES-CS(EC)401	Design and Analysis of Algorithm	3-0-0-3	3
PCC	PC-EC301	Network Theory	3-0-0-3	3	PCC	PC-EC401	Analog Electronics	3-0-0-3	3
PCC	PC-EC302	Signal & System	3-0-0-3	3	PCC	PC-EC402	Digital Electronics	3-0-0-3	3
PCC	PC-EC303	Solid State and Opto-Electronic Devices	3-0-0-3	3	PCC	PC-EC403	EM Theory & Antenna	3-0-0-3	3
PCC	PC-EC391	Laboratories on Basic Electronics, Circuit Theory & Network and Data Structure	0-0-6-6	3	PCC	PC-EC491	Laboratories on Analog Electronics, Digital Electronics and EM Theory	0-0-6-6	3
MC	MC-EC301	Essence of Traditional Knowledge	3-0-0-3	0	MC	MC-EC401	Environmental Science	3-0-0-3	0
Total			20-1-6-27	21	Total			20-1-6-27	21

3rd Year

CC	SC	Subject Name	Contact Hrs./Week		CC	SC	Subject Name	Contact Hrs./Week	
			L –T-P-TO	Cr.				L –T-P-TO	Cr.
PCC	PC-EC501	Microprocessors & Microcontrollers	3-0-0-3	3	HUM	HM-HU(EC)601	Principles of Management	2-0-0-2	2
PCC	PC-EC502	Analog Communication	3-0-0-3	3	PCC	PC-EC601	Digital Communication	3-1-0-4	4
PCC	PC-EC503	Control system	3-0-0-3	3	**PCC**	**PC-EC602**	DSP	3-0-0-3	3
PEC	PE-EC501	Professional Elective-I a) Electronic Measurement and Instrumentation b) Biomedical Instrumentation c) RF Components and CircuitDesign d) MEMS and Applications	3-0-0-3	3	**PCC**	**PC-EC603**	VLSI	3-0-0-3	3
PEC	PE-EC502	Professional Elective-II a) Power Electronics b) Nano Electronics c) Computer Architecture & Organization d) Telecommunication Switching and Computer Networking	3-0-0-3	3	PEC	PE-EC601	Professional Elective-IV a) VLSI Technology b) Embedded System c) FPGA & Reconfigurable Computing d) Mobile communication and Network	3-0-0-3	3

PEC	PE-EC503	Professional Elective-III a) Upper Atmospheric Propagation b) Fiber Optic Communication c) Information Theory &Coding d) Remote Sensing & GIS	3-0-0-3	3	OEC	OE-CS(EC)601	Open Elective-1 a) Object Oriented Programming b) Data Base Management c) Internet of Things (IoT) d) Numerical Methods in Engineering	3-0-0-3	3
PCC	PC-EC591	Laboratory on Microcontroller, Control System, Analog Communication	0-0-6-6	3	PCC	PC-EC691	Laboratory on Digital Communication, DSP and VLSI	0-0-6-6	2
Total			18-0-6-24	21	Proj	PR-EC681	Design	0-0-2-2	1
					Total			17-1-6-24	21

4th Year

CC	SC	Subject Name	Contact Hrs./Week		CC	SC	Subject Name	Contact Hrs./Week	
			L –T-P-TO	Cr.				L–T-P-TO	Cr.
PCC	PC-EC701	Microwave & Radar	3-0-0-3	3	HUM	HM-HU(EC)801	Financial Management and Accounts	3-0-0-3	3
PEC	PE-EC702	Professional Elective-V a) Mixed signal VLSI design b) Electronics Design andAutomation c) Satellite Communication d)Architectural Design of ICs	3-0-0-3	3	PEC	PE-EC801	Professional Elective-VI a) Wireless Communication b) Semiconductor Device Modelling c) Speech and Audio Processing d) Electronic Device and Material Characterization	3-0-0-3	3
OEC	OE-CS(EC)701	Open Elective-II a) Artificial Intelligence b) Software Engineering c) Cryptography and CyberSecurity d) Consumer Electronics	3-0-0-3	3	OEC	OE-CS(EC)801	Open Elective-V a) Machine Learning b) Hardware Security C) FOUNDATIONS OF EDUCATIONAL TECHNOLOGY d) Deep Learning	3-0-0-3	3
OEC	OE-EC(EC)702	Open Elective-III e) Digital Image Processing f) Robotics g) Adhoc Networks h) Operating Systems	3-0-0-3	3	**Proj**	PR-EC881	Project-II	0-0-12-12	6
OEC	OE-EC(EC)703	Open Elective-IV a) Biomedical SignalProcessing b) SYSTEMS BIOLOGY: MODELING AND CONTROL c) Internet Technology d) Renewable Energy	3-0-0-3	3	Proj	PR-EC882	Viva	0-0-0-0	2
PCC	PC-EC791	Laboratories on Microwave and Antenna Lab.	0-0-4-4	2	**Proj**	**PR-EC883**	Internship Evaluation	0-0-0-0	0
Proj	PR-EC781	Project-I	0-0-8-8	4				9-0-12-21	17
Total Credit			15-0-12-27	21					

2nd Year (3rd semester)

CC: Course Code, SC: Subject Code. Cr.: Credit, L-T-P-T: Lecture-Tutorial-Practical-Total

CC	SC	Subject Name	Contact Hrs./Week	
			L –T-P-TO	Cr.
HUM	HM-HU(EC)301	Value & Ethics in Profession	2-0-0-2	2
ESC	ES-EC301	Basic Electronics	3-1-0-4	4
ESC	ES-CS (EC)301	Data Structure	3-0-0-3	3
PCC	PC-EC301	Network Theory	3-0-0-3	3
PCC	PC-EC302	Signal & System	3-0-0-3	3
PCC	PC-EC303	Solid State and Opto-Electronic Devices	3-0-0-3	3
PCC	PC-EC391	Laboratories on Basic Electronics, Circuit Theory and Network and Data Structure	0-0-6-6	3
MC	MC-EC301	Essence of Traditional Knowledge	3-0-0-3	0
Total			20-1-6-27	21

Course Prerequisites: No pre-requisite required, open to all.

SC	Subject Name	Contact Hrs/Week	Credits
HM-HU(EC)301	Value & Ethics in Profession	2L:0T:0P	2 credits

Unit	Topic	No. of Lectures
Unit I	Science, Technology and Engineering as knowledge and as Social and Professional Activities Effects of Technological Growth. Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth : sustainable development	06
Unit II	Energy Crisis: Renewable Energy Resources, Environmental degradation and pollution. Eco-friendly Technologies, Environmental Regulations, Environmental Ethics, Appropriate Technology Movement of Schumacher, later developments Technology and developing nations Problems of Technology assessment impact analysis. Human Operator in Engineering projects and industries. Problems of man, machine, interaction, impact of assembly line and automation. Human centred Technology.	07
Unit III	Ethic of Profession: Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologies. Codes of professional ethics, Whistle blowing and beyond, Case studies. Profession and Human Values, Values Crisis in contemporary society Nature of Values Spectrum of a good life	07
Unit IV	Psychological values : Integrated personality; mental health Special values: The modern search for a good society, justice, democracy, secularism, rule of law values in Indian Constitution. Aesthetic Values : Perception and enjoyment of beauty, simplicity, clarity	06
Unit V	Moral and ethical values: Nature of moral judgments: canons of ethics of virtue; ethics duty, ethics of responsibility.	04

Suggested Books:

1. Stephen H Unger, Controlling Technology : Ethics and the Responsible Engineers, John Wiley Sons, New York 1994 (2nd Ed)
2. Deborah Johnson, Ethical issues in Engineering, Prentice Hall, Englewood Cliffs, New Jercy 1991.
3. A.N. Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996

Course Outcomes:

1. Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field
2. Identify the multiple ethical interests at stake in a real-world situation or practice
3. Articulate what makes a particular course of action ethically defensible
4. Assess their own ethical values and the social context of problems
5. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
6. Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research

Course Prerequisites: Knowledge of class XII level Physics and Mathematics

SC	Subject Name	Contact Hrs/Week	Credits
ES-EC301	Basic Electronics	3L:1T:0P	4 credits

Unit	Topic	No. of Lectures
Unit I	**Semiconductor:** atomic structure, energy level, type of semiconductor, doping, impurity, brief idea of hall effect, mass action law. **Diode:** P-N junction diode, V-I charac. Diode application, special purpose diode: Zener diode, application of Zener diode, varacter diode.	08
Unit II	**BJT:** Varieties of BJT, Working principle, CB, CE, CC Connection, V-I char transistor as amplifier, switch, oscillator, DC load line, Ebars-Moll model. **Tx biasing:** Q-point, stabilization Q point(stabilizing factor), h-parameter, current gain, voltage gain, i/p-o/p impedance. **FET:** Basic idea, working principle, difference between FET and BJT, FET as an amplifier, basic idea(JFET and MOSFET)	12
Unit III	**Amplifier:** Feedback amplifier, concept of feedback, advance of negative feedback, Barkhausen criteria, difference between positive and negative feedback. **OP-AMP:** Ideal op-amp, characterisation of op-amp, pin diagram of 741 IC, CMRR Application of op-amp: inverting, non-inverting, adder, subtractor, integrator, differentiator, log, antilog, basic comparator, Schmitt trigger	12
Unit IV	**Special semiconducting device:** LED, SCR, photodiode, [UJT, Triac, Diac] in brief	06

Suggested Books:

1. Robert Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory" PHI; 8th Edition.200
2. Thomas L. Floyd, "Electronic Devices" 8th Edition, Pearson Education, Inc., 2007
3. A.S. Sedra and K.C. Smith, "Microelectronic Circuits", 6th Edition, Oxford University Press, 2006
4. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, 2008.

Course Outcomes:

1. To understand the language of electronics, elements and their functionality
2. Basic understanding of analog systems and their applications
3. Basic understanding of digital systems and their applications

Course Prerequisites: Introduction to Computing, C/C++

SC	Subject Name	Contact Hrs/Week	Credits
ES-CS (EC)301	Data Structure	3L:0T:0P	3 credits

Unit	Topic	No. of Lectures
Unit I	**Introduction:** Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. **Searching:** Linear Search and Binary Search Techniques and their complexity analysis.	06
Unit II	**Stacks and Queues**: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation - corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.	08
Unit III	**Linked Lists:** Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis. **Trees:** Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.	08
Unit IV	**Sorting and Hashing:** Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. **Graph:** Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.	08

Suggested Books:

1. Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
2. "How to Solve it by Computer", 2nd Impression by R.G. Dromey, Pearson Education.
3. Expert Data Structures with C, R. B. Patel, Khanna Publishing House, New Delhi
4. Data Structures & Algorithms using C, R.S. Salaria, Khanna Publishing House, New "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.

Course Outcomes:

1. For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.
2. For a given Search problem (Linear Search and Binary Search) student will able to implement it.
3. For a given problem of Stacks, Queues and linked list student will able to implement it and analyze the same to

determine the time and computation complexity.

4. Student will able to write an algorithm Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort and compare their performance in term of Space and Time complexity.
5. Student will able to implement Graph search and traversal algorithms and determine the time and computation complexity.

Course Prerequisites: Knowledge of matrices, differentiation, integration

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC301	Network Theory	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit I	Node and Mesh Analysis, matrix approach of network containing voltage and current sources, and reactance, source transformation and duality. Network theorems: Superposition, reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tallegen's theorem as applied to AC. circuits.	06
Unit II	Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalanced circuit and power calculation.	07
Unit III	Laplace transforms and properties: Partial fractions, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions.	07
Unit IV	Transient behaviour, concept of complex frequency, Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal response from pole-zero locations, convolution theorem and Two four port network and interconnections, Behaviours of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.	12

Suggested Books:

1. Ashfaq Husain, Networks & Systems, Khanna Publishing House, New Delhi, 2018.
2. Van, Valkenburg.; "Network analysis"; Prentice hall of India, 2000
3. Sudhakar, A., Shyammohan, S. P.; "Circuits and Network"; Tata McGraw-Hill New Delhi, 1994
4. A William Hayt, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill Education

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand basics electrical circuits with nodal and mesh analysis.
2. Appreciate electrical network theorems.
3. Apply Laplace Transform for steady state and transient analysis.
4. Determine different network functions.
5. Appreciate the frequency domain techniques.

Course Prerequisites: Physics of Class-XII, elementary mathematics

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC302	Signal & System	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit I	Signals and systems as seen in everyday life, and in various branches of engineering and science. Energy and power signals, continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.	06
Unit II	Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs. Characterization of causality and stability of linear shift invariant systems. System representation through differential equations.	06
Unit III	Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. The idea of signal space and orthogonal bases. The z-Transform for discrete time signals and systems- eigen functions, region of convergence, z-domain analysis.	08
Unit IV	Evolution of Transforms: Fourier Transform, Laplace Transform , Z-transform (single sided and Double sided) The Laplace Transform, notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, poles and zeros of system, , solution to differential equations and system behavior using Laplace Transformation	8
Unit V	The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.	4

Suggested Books:

1. A.V.Oppenheim, A.S.Willsky and S.H.Nawab -Signals &Systems, Pearson S.Haykin & B.V.Veen, Signals and Systems- John Wiley

2. P.Ramesh Babu & R.Anandanatarajan- Signals and Systems 4/e- Scitech References:

3. J.G.Proakis & D.G.Manolakis- Digital Signal Processing Principles, Algorithms and Applications, PHI.

4. C-T Chen- Signals and Systems- Oxford

5. .E WKamen &BS Heck- Fundamentals of Signals and Systems Using the Web and Matlab- Pearson

6. B.P.Lathi- Signal Processing & Linear Systems- Oxford

7. M.J.Roberts, Signals and Systems Analysis using Transform method and MATLAB, TMH 6..S Ghosh- Signals and Systems- Pearson

8. M.H.Hays- Digital Signal Processing ", Schaum's outlines, TMH 8.Ashok Ambardar, -Analog and Digital Signal Processing- Thomson. 9.Phillip, Parr & Riskin- Signal, Systems and Transforms- Pearson

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Analyze different types of signals
2. Represent continuous and discrete systems in time and frequency domain using different transforms
3. Investigate whether the system is stable
4. Sampling and reconstruction of a signal

Course Prerequisites: Basic knowledge of Electronics, Physics of Class-XII

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC303	Solid State and Opto-Electronic Devices	3L:0T:0P	3 credits

Unit	Topic	No. of Lectures
Unit I	Space lattice and unit cells, crystal system, Symmetry operation, Structures of common metallic, Semiconductor ceramic and, Miller Indices, Packing fractions, Structure determination using X-ray diffraction, Braggs law, and lattice parameter determination. Bonding in solids, coordination number, ceramics, silicates and clay structures, glass transition temperature, non-crystalline materials.	05
Unit II	Introduction to energy Bands (E-k) diagram. A brief description of Charge Carriers in Semiconductors, effective mass, wave vector. Explanation of Direct & indirect band-gap semiconductors; Carrier distribution, Fermi-level, Intrinsic & Extrinsic semiconductors, Non-equilibrium in carrier distribution; drift, diffusion. A short description to scattering. An introduction to Piezo & Hall effects. Description of carrier concentration in terms of bulk Density of states and Fermi-Dirac distribution. Concept of Fermi level and its shift with doping & temperature.	06
Unit III	Detailed description of homo junction, that is, Semiconductor-semiconductor p-n junction & rectification. Plot of junction voltage, field and depletion charge with distance by solving simple 1D Poisson's Equation (Gradual Channel & Depletion Approximations). Introduction to Junction capacitances in p-n diodes and their expressions, introduction to Varactor Diodes, Schottky contact & Schottky diode. Derivation for Forward and Reverse current, piece-wise linear diode-characteristics, concept of Diode resistance & Differential diode resistance, Diode switching & diode switch, properties of rectifier and switching diodes. Explanation of the importance of reverse current in optical detectors, photo-diodes, solar cells, Spontaneous emission & Stimulated emission in optical devices. An introduction to basic principle of Tunnel diode.	07
Unit IV	Detailed description of BJT as a current controlled device, amplification property of BJT, I-V characteristics (input & output) with derivation, input & output characteristics for CB. CE & CC mode, current amplification factors α for CB mode and β for CE mode. Explanation of physical mechanism, current gain, minority current distribution; Punch-through and avalanche effect.	4
Unit V	Introduction to Eber's Moll model for Static behaviour & Charge controlled model for dynamic behaviour, equivalent circuits. Introduction to PNPN transistors - simple working principle, I-V characteristics, triggering, mention of Triacs, Diacs & Thyristors.	4
Unit VI	Development of the concept of Field effect device, channel modulation & channel isolation, JFET - behaviour, characteristics, MOSFET - channel inversion, Ideal Threshold voltage. Explanation to the behaviour of MOS capacitances, depletion width, surface field and potential (by solving Poisson's equation with gradual channel & depletion approximations). I-V characteristics with expressions for saturation and non saturation, Equivalent circuit for MOSFET . introduction to MOSFET for VLSI - scaling issues.	4

Text Books :

1. Neamen- Semiconductor Physics and Devices TMH
2. Bhattacharya & Sharma- optoelectronic Electronic Devices- Oxford
3. Streetman & Banerjee- Solid State Electronic Devices- PHI

Reference Books :

1. Milman, Halkias & Jit- Electronics Devices and Circuits- TMH
2. S.M Sze-Physics of Semiconductor Devices- Wiley

3. Bell-Electronics Devices and Circuits-Oxford
4. Bhattacharya & Sharma- Solid State Electronic Devices- Oxford
5. Bogart, Bisley & Rice- Electronics Devices and Circuits- Pearson
6. Kasap-Principles of Electronic Materials and Devices- TMH
7. Boylestad & Nashelsky- Electronics Devices and Circuit Theory- Pearson
8. Salivahanan, Kumar & Vallavaraj- Electronics Devices and Circuits- TMH

Course Outcomes:

(1) Graduates will be able to apply knowledge of mathematics, science and engineering in the solution of electronics and communication engineering problems.

(2) Graduates will demonstrate an ability to identify, formulate, analyze and solve electronics and communication engineering problems.

(3) Graduates will demonstrate an ability to design electronic circuits, conduct experiments, analyze and interpret the resulting data.

(4) Graduates will demonstrate an ability to design a system, component or algorithms to meet desired needs within the context of electronics and communication engineering and considering realistic constraints.

(5) Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary task.

(6) Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.

(7) Graduates will have an understanding of professional and ethical responsibilities.

(8) Graduates will be able to communicate effectively.

(9) Graduate will show the understanding of impact of engineering solutions on the society, environment and awareness of contemporary issues.

(10) Graduates will develop confidence for self-education and ability for life-long learning.

(11) Graduates who can participate and succeed in competitive examination

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC391	Laboratories on Basic Electronics, Circuit Theory and Network and Data Structure	0L:0T:6P	2 credits

Laboratories on Basic Electronics:

There will be a couple of familiarization lectures before the practical classes are undertaken where basic concept of the instruments handled Eg: CRO, Multimeters etc will be given.

List of Experiments:

1. Familiarisation with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multimeters etc.
2. Familiarisation with measuring and testing equipment like CRO, Signal generators etc.
3. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs.
7. Study of Characteristic curves for CB, CE and CC mode transistors
8. Study of I-V characteristics of Field Effect Transistors.
9. Determination of input-offset voltage, input bias current and Slew rate of OPAMPs.
10. Determination of Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
11. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders, Integrators and Differentiators.

Course Outcomes:

1. Analyze the diode and transistor characteristics.
2. Understand the principles of rectifier circuits using diodes and implement them using hardware.
3. Design the biasing circuits like self biasing.
4. Design various amplifiers like CE, CC, common source FET amplifiers and implement them using hardware and also observe their frequency responses.
5. Understand the concepts of SCR and observe its characteristics.
6. Understand the concepts of unipolar junction transistor and observe its characteristics.

Laboratories on Circuit Theory and Network:

List of Experiments:

1. To determine and verify Thevenin's and Norton's theorem.
2. To calculate and verify 'Z' parameters of two-port network.
3. To calculate and verify 'Y' parameters of two-port network.
4. To calculate and verify 'ABCD' parameters of two-port network.
5. To calculate and verify 'H' parameters of two-port network.
6. To determine equivalent parameters of parallel connection of two-port network.
7. To determine equivalent parameters of parallel connection of two-port network.
8. To determine the equivalent parameters of series connection of two port network.
9. To determine the A'B'C'D' parameters of the cascade connection of two-port network.
10. Design a RLC resonance circuit & verify the transient response for different values of R, L &C

COURSE OUTCOMES:

1. The student will analyze the characteristics of Electrical circuits & PSpice Simulation.
2. To Perform Laboratory Experiments practically.

3. To carry out laboratory experiments on simulation & Networks.

4. To understand the fundamentals of electrical circuits & PSpice simulation.

Laboratories onData Structure:

List of Experiments:

1. Write A Program in C to Convert the Celsius value to Fahrenheit.
2. Write a Program in C to find the Factorial of a Given Number using Recursive Function.
3. Write a Program in C to Read-Write the Contents of a File.
4. Write a Program in C Using Standard I/O Library Function with Arguments and Return Value.
5. Write a Program in C to find the Size of Data Types.
6. Write a Program in C for Implementation of Stacks Using Linked Lists.
7. Write a Program in C to Implement Stacks Using Arrays.
8. Write a Program in C to Implement Queues Using Arrays.
9. Write a Program in C to Implement Binary-Tree Algorithm for Operations with INSERT, DELETE, and DISPLAY.
10. Write a Program in C Using the QSORT function to Implement
11. Linear Sorting on the Given Array Elements

COURSE OUTCOMES:

1. Implement various basic data structures and its operations.
2. Implement various sorting and searching algorithms.
3. Implement various tree operations.
4. Implement various graphs algorithms.
5. Develop simple applications using various data structures.
6. Develop algorithms using various searching and sorting techniques.

Course Prerequisites: No pre-requisite required, open to all.

SC	Subject Name	Contact Hrs/Week	Credits
MC-EC301	**Essence of Traditional Knowledge**	**3L:0T:0P**	**0 credits**

Unit	Topic	No. of Lectures
Unit I	Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge (Unani / Siddha/ Ayurveda), Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge.	**07**
Unit II	Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.	**07**
Unit III	Legal framework and TK: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.	**06**
Unit IV	Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Geographical Indications (GI).	**04**
Unit V	Traditional Knowledge in Different Sectors: Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK	**06**

Suggested Books:

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor.
3. Madhya Himalayi Sanskriti mein Gyan, Vigyan evam Paravigyan by Prof PC Pandey.

Course Outcomes:

At the end of the Course, Student will be able to:

1. Identify the concept of Traditional knowledge and its importance.
2. Explain the need for and importance of protecting traditional knowledge.
3. Illustrate the various enactments related to the protection of traditional knowledge.
4. Interpret the concepts of Intellectual property to protect the traditional knowledge.
5. Explain the importance of Traditional knowledge in Agriculture and Medicine.

CC	SC	Subject Name	Contact Hrs./Week	
			L–T-P-TO	Cr.
BSC	BS-M(EC)401	Mathematics – III	3-1-0-4	4
BSC	BS-CH(EC)401	Biology	2-0-0-2	2
ESC	ES-CS(EC)401	Design and analysis of Algorithm	3-0-0-3	3
PCC	PC-EC401	Analog Electronics	3-0-0-3	3
PCC	PC-EC402	Digital Electronics	3-0-0-3	3
PCC	PC-EC403	EM Theory & Antenna	3-0-0-3	3
PCC	PC-EC491	Laboratories on Analog Electronics, Digital Electronics and EM Theory	0-0-6-6	3
MC	MC-EC401	Environmental Science	3-0-0-3	0
Total			20-1-6-27	21

Course Prerequisites: Knowledge of matrices, differentiation, integration

SC	Subject Name	Contact	Credits

		Hrs/Week	
BS-M(EC)401	**Mathematics – III**	**4L:0T:0P**	**4credits**

Unit	Topic	No. of Lectures
Unit 1	Basic Probability: Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.	8
Unit 2	Continuous Probability Distributions: Continuous random varibales and their properties, distribution functions and densities, normal, exponential and gamma densities.	4
Unit 3	Bivariate Distributions: Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.	4
Unit 4	Basic Statistics: Measures of Central tendency: Moments, skewness and Kurtosis Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression - Rank correlation.	6
Unit 5	Applied Statistics: Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.	6
Unit 6	Small samples: Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.	4

Suggested Text/Reference Books:

(i) Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
(ii) P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
(iii) S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
(iv) W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed., Wiley, 1968.
(v) N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
(vi) B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
(vii) Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010.
(viii) Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Publishing House, New Delhi, 2018.
(ix) Manish Sharma & Amit Gupta, Business Statistics, Khanna Book Publishing Company, New Delhi, 2012.

Course Outcomes

The objective of this course is to familiarize the students with statistical techniques. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in the discipline.

The students will learn:

1. The ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
2. The basic ideas of statics including measures of central tendency correlation and regression.
3. The statistical methods of studying data samples.

Course Prerequisites: Knowledge of matrices, differentiation, integration

SC	Subject Name	Contact Hrs/Week	Credits
BS-CH(EC)401	Biology	2L:0T:0P	2credits

Unit	Topic	No. of Lectures
Unit 1	Introduction Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.	2
Unit 2	Classification Purpose: To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion - aminotelic, uricoteliec, ureotelic (e) Habitata- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus.	3
Unit 3	Genetics Purpose: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences" Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.	4
Unit 4	Biomolecules Purpose: To convey that all forms JoGf EliCfe_EhCasE tfhroemsa2m01e8-b1u9ilbdaintcgh blocks and yet the manifestations are as diverse as one can imagine Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.	4
Unit 5	Enzymes Purpose: To convey that without catalysis life would not have existed on earth Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyzereactions. Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.	4

Unit 6	Information Transfer Purpose: The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.	4
Unit 7	Macromolecular analysis Purpose: How to analyses biological processes at the reductionistic level Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements	5
Unit 8	Metabolism Purpose: The fundamental principles of energy transactions are the same in physical and biological world. Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergoinc reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO2 + H2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge	4
Unit 9	Microbiology Concept of single celled organism content of spices and stains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics.	3

References:

1) Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd
2) Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons
3) Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company
4) Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
5) Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

Course Outcomes:

1. After studying the course, the student will be able to:
2. Describe how biological observations of 18th Century that lead to major discoveries.
3. Convey that classification per se is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
4. Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
5. Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
6. Classify enzymes and distinguish between different mechanisms of enzyme action.
7. Identify DNA as a genetic material in the molecular basis of information transfer.
8. Analyse biological processes at the reductionistic level
9. Apply thermodynamic principles to biological systems.
10. Identify and classify microorganismsss

Course Prerequisites: Data structure

SC	Subject Name	Contact Hrs/Week	Credits
ES-CS 401	Design and Analysis of Algorithm	3L:0T:0P	3 credits

Unit	Topic	No. of Lectures
Unit I	**Introduction**: Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds - best, average and worst-case behaviour; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Masters' theorem.	04
Unit II	Branch and-Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem-Solving, Bin Packing, Knap Sack TSP. Heuristics -characteristics and their application domains.	06
Unit III	Graph and Tree Algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm, Algorithm for calculation maximum cost in the network	06
Unit IV	Divide and Conquer method: Divide and Conquer General method, Binary search, Finding the maximum and minimum, Merge sort, Quick sort, Performance measurement of quick sort, Selection, Strassens matrix multiplication	06
Unit V	Greedy Algorithm: General Characteristics of greedy algorithms, Kruskals algorithm, Prims algorithm, Dynamic programming: General method, Multistage graphs, All-pairs shortest path, Single source shortest path	06
Unit VI	Tractable and Intractable Problem, Computability of Algorithm, Computability classes: NP,NP-complete and NP-hard. Cook's theorem, Standard NP-complete problems and Reduction techniques.	02

Suggested Books:

1. Algorithm Design by Jon Kleinberg and Eva Tardos, Pearson Publication
2. Introduction to Algorithms by CLRS, PHI Publication
3. The Algorithm Design Manual by Steven Skiena, Springer Publication
4. Fundamentals of Algorithms: E.Horowitz et.al

Course Outcomes:

1. For a given algorithms analyze worst-case running times of algorithms based on asymptotic analysis and justify the correctness of algorithms.
2. Describe the greedy paradigm and explain when an algorithmic design situation calls for it. For a given problem develop the greedy algorithms.
3. Describe the divide and conquer paradigm and explain when an algorithmic design situations calls for it. Synthesize the divide and conquer algorithm. Derive and solve the recurrence relation.
4. Describe the dynamic-programming paradigm and explain when an algorithmic design situation calls for it. For a given problems of dynamic-programming and develop the dynamic programming algorithms, and analyze it to determine its computational complexity.
5. Explain the ways to analyze randomized algorithms (expected running time, probability of error).

Course Prerequisites: Knowledge of matrices, differentiation, integration

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC401	Analog Electronics	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	**Diode Circuits:** Rectifiers, Clipper, Clamper **Amplifier models:** Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier.	6
Unit 2	**Transistor Amplifiers:** **Biasing schemes for BJT and FET amplifiers:** Bias stability, various configurations (such as CE/CS, CB/CG, CC/CD) and their features, h-model of transistors, expression for voltage gain, current gain, input and output impedance, trans-resistance & trans-conductance; Emitter follower circuits, small signal analysis, low frequency model of transistors, high frequency model of transistors	6
Unit 3	**Feedback Amplifiers & Oscillators:** Feedback concept, negative & positive Feedback, feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., Berkhausen criterion, Colpitts, Hartley's, Phase shift, Wein bridge and crystal oscillators. Multivibrators (Monostable, Astable and Bistable)	6
Unit 4	**Power amplifiers:** Classification of power amplifier, Class A, B, AB, C amplifier, Conversion efficiency, Tuned Amplifier, cascode amplifier, RC coupled amplifier, derivation of voltage gain, current gain, input impedance and output impedance, frequency response characteristics, lower and upper half frequencies, bandwidth, and concept of wide band amplifier.	6
Unit 5	**Differential amplifier:** Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR. **OP-AMP:** Basic structure and characteristics, inverting and non-inverting amplifiers, Integrator and differentiator, summing amplifier, Log-Antilog amplifiers, , Schmitt trigger and its applications. **Active filters:** Low pass, high pass, band pass and band stop, design guidelines. **Special Functional Circuits:** VCO and PLL.	8

Text/Reference Books:

1. J. Millman and A. Grabel, Microelectronics, McGraw Hill

2. Sedra & Smith-Microelectronic Circuits- Oxford UP

3. A.K. Maini, Analog Electronics, Khanna Publishing House, New Delhi

4. Boylested & Nashelsky- Electronic Devices and Circuit Theory- Pearson/PHI

5. Millman & Halkias – Integrated Electronics, McGraw Hill.

6. Malvino—Electronic Principles ,McGraw Hill

7. Tobey & Grame – Operational Amplifier: Design and Applications, Mc GrawHill.

8. Razavi- Fundamentals of Microelectronic s- Wiley

9. Franco-Design with Operational Amplifiers & Analog Integrated Circuits ,McGraw Hill

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the characteristics of diodes and transistors
2. Design and analyze various rectifier and amplifier circuits
3. Design sinusoidal and non-sinusoidal oscillators
4. Understand the functioning of OP-AMP and design OP-AMP based circuits

Course Prerequisites: Basic Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC402	Digital Electronics	3L:0T:0P	3credits

Unit	Topic	No. of Lectures

Unit 1	**Number systems & Codes:** Signed and Unsigned Number, Representation of Decimal, Binary, Octal and Hexadecimal number systems and their conversions; BCD,ASCII, EBDIC, Gray codes and their conversions; Signed binary number representation with 1's and 2's complement methods, Binary arithmetic. **Boolean algebra:** Review of Boolean Algebra and De-Morgan's Theorem,Various Logic gates- their truth tables and circuits; Representation in SOP and POS forms, Canonical forms, Minimization of logic expressions by algebraic method, K-map method.	9
Unit 2	**Combinational Logic Circuits Design:** Binary Half and Full Adders, Subtractors, BCD Adder and Substractor , Series & Parallel Adder, Carry Look Ahead adder, BCD to 7-segment LED display, Multiplexers, De-Multiplexers, Comparators, Encoder, Decoder, , Parity generator & Checker.	7
Unit 3	**Sequential Logic Circuit Design:** Basic memory element-Latch, Flip Flops, S-R, J-K, Master-Slave, D and T Flip-flop, Edge triggered Flip-flop. Various types of Registers ,Synchronous & Asynchronous counters, Propagation delay through Counter, Irregular counter, State table and state transition diagram & their design, Finite state machines, Design of synchronous FSM.	7
Unit 4	**Logic Families:** TTL, ECL, CMOS families and their operation & specifications. **Semiconductor Memories:** Concept of Programming logic devices and gate arrays. (PLAs and PLDs), Basics of RAM, ROM, EPROM, EEROM. Different types of A/D and D/A conversion techniques. Sample & Hold Cirtcuit	7

Text/Reference Books:

1. Morries Mano- Digital Logic Design- PHI
2. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill.
3. R.J . Tocci, "Digital System: Principles and Application" Pearson.
4. Schilling & Belove, Digital Integrated Electronics, Tata McGraw Hill.
5. W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI.
6. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill.
7. R. Anand, "Digital Electronics", Khanna Publishing House, New Delhi
8. A.K. Maini, "Digital System: Principles and Integrated Circuits" Wiley.

Course Outcomes:

At the end of the course:

1) Use digital electronics in the present contemporary world
2) Design various combinational digital circuits using logic gates
3) Do the analysis and design procedures for synchronous and asynchronous sequential circuits
4) Use the semiconductor memories and related technology
5) Use electronic circuits involved in the design of logic gates

Course Prerequisites: Knowledge of Vectors, mathematics

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC403	EM Theory & Antenna	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	Vector calculus - orthogonal Coordinate System, Transformations of coordinate systems; Del operator; Gradient, Divergence, Curl - their physical interpretations; Laplacian operator	3
Unit 2	Coulomb's law, electric field intensity, charge distribution; Gauss' law, flux density and electric field intensity. Divergence theorem. Current Densities, Conductors, Poisson's	4

	& Laplace's equations. Uniqueness theorem, Biot-Savart law, Ampere's law, Relation between J & H, Vector magnetic Potential, Stokes' theorem	
Unit 3	Faraday's law & Lenz's law. Displacement Current, Jc - JD Relation, Maxwell's equation, Wave Equation, Boundary Conditions between media interface; Uniform Plane wave; Plane Wave Propagation in Lossy Dielectric, Loss-less Dielectric, Good Conductor, Free space; Poynting Theorem, Power flow, Poynting vector, Skin Depth, Surface Resistance; Reflection and Transmission for normal incidence.	10
Unit 4	Transmission Lines; Concept of Lumped parameters and Distributed parameters. Line Parameters, Transmission line equations and solutions, Physical significance of the solutions, Propagation constant, Characteristic Impedance; Wavelength; Velocity of Propagation; Distortion-less Line, Reflection and Transmission coefficients; Standing Waves, VSWR, Input Impedance, Smith Chart -Applications	10
Unit 5	Radiation concept, Antennas: elementary dipole, half-wave dipole, radiation patterns, directivity, gain, Image Theory, Friss Transmission Formula, pattern multiplication, other basic antennas, Microstrip Patch Antennas.	8

Recommended Textbooks:

1. M. N. O. Sadiku, "Principles of Electromagnetics", Oxford University Press

2. W. H. Hayt& J. A. Buck, "Engineering Electromagnetics", McGraw Hill

3. E. C. Jordan & K. G. Balmain, "Electromagnetic Waves & Radiating Systems", Prentice Hall

4. G. S. N. Raju, "Antenna and Wave Propagation", Pearson

5. J. A. Edminister and M. Nahmi, "Schaum's Outlines in Fundamentals of Electromagnetics", McGraw Hill

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand characteristics and wave propagation on high frequency transmission lines
2. Carryout impedance transformation on TL
3. Use sections of transmission line sections for realizing circuit elements
4. Characterize uniform plane wave
5. Calculate reflection and transmission of waves at media interface
6. Analyze wave propagation on metallic waveguides in modal form
7. Understand principle of radiation and radiation characteristics of an antenna

Course Prerequisites: Knowledge of Basic Electronics, Analog El;ectronics and EM Theory

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC491	**Laboratories on Analog Electronics, Digital Electronics and EM Theory**	**0L:0T:6P**	**3credits**

Laboratories on Analog Electronics:

List of Experiments:

1. Conduct experiment to test diode clipping (single/double ended) and clamping circuits (positive/negative).
2. Design and set up the following rectifiers with and without filters and to determine ripple factor and rectifier efficiency:
3. (a). Full Wave Rectifier (b). Bridge Rectifier
4. Design and set up the BJT common emitter amplifier using voltage divider bias with and without feedback and determine the gain- bandwidth product from its frequency response.
5. Set-up and study the working of complementary symmetry class B push pull power amplifier and calculate the efficiency
6. Conduct an experiment on Series Voltage Regulator using Zener diode and power transistor to determine line

and load regulation characteristics.

Course Outcomes:
Students will be able to:

1. Design and test rectifiers, clipping circuits, clamping circuits and voltage regulators.
2. Design, test and evaluate BJT amplifiers in CE configuration.
3. Design and test a power amplifier.
4. Design and test voltage regulators.

Laboratories on Digital Electronics:

List of Experiments:

1. Introduction to Digital Electronics Lab- Nomenclature of Digital Ics, Specifications, Study of the Data Sheet, Concept of Vcc and Ground, Verification of the Truth Tables of Logic Gates using TTL ICs.
2. Implementation of the Given Boolean Function using Logic Gates in Both Sop and Pos Forms.
3. Verification of State Tables of Rs, J-k, T and D Flip-Flops using NAND & NOR Gates
4. Implementation and Verification of Decoder/De-Multiplexer and Encoder using Logic Gates.
5. Implementation of 4x1 Multiplexer using Logic Gates.
6. Implementation of 4-Bit Parallel Adder Using 7483 IC.
7. Design , and Verify the 4- Bit Synchronous Counter
8. Design, and Verify the 4-Bit Asynchronous Counter.

Course Outcomes:
Students will be able to:

1. Learn the basics of gates.
2. Construct basic combinational circuits and verify their functionalities.
3. Apply the design procedures to design basic sequential circuit.
4. Learn about counters.
5. Learn about Shift registers
6. To understand the basic digital circuits and to verify their operation

Laboratories on EM Theory :

List of Experiments:

1. Plotting of Standing Wave Pattern along a transmission line when the line is open- circuited, short-circuited and terminated by a resistive load at the load end.
2. Input Impedance of a terminated coaxial line using shift in minima technique.
3. Study of Smith chart on Matlab platform.
4. Simulation study of Smith chart - Single and double stub matching.

Course Outcomes:

Students will be able to:

1. To differentiate different types of coordinate systems and use them for solving the problems of electromagnetic field theory.
2. To describe static electric and magnetic fields, their behavior in different media, associated laws, boundary conditions and electromagnetic potentials.
3. To use integral and point form of Maxwell`s equations for solving the problems of electromagnetic field theory.
4. To describe time varying fields, propagation of electromagnetic waves in different media, pyonting theorem, their sources & effects and to apply the theory of electromagnetic waves in practical problems.

Course Prerequisites: Basic knowledge of Science

SC	Subject Name	Contact Hrs/Week	Credits
MC-EC401	ENVIRONMENTAL SCIENCE	0L:0T:2P	0credit

Purpose:

We as human being are not an entity separate from the environment around us rather, we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times.

Idea of an activity-based course on environment protection is to sensitize the students on the above issues through following two type of activities.

(a) Awareness Activities:

i) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste

ii) Slogan making event

iii) Poster making event

iv) Cycle rally

v) Lectures from experts

(b) Actual Activities:

i) Plantation

ii) Gifting a tree to see its full growth

iii) Cleanliness drive

iv) Drive for segregation of waste

v) To live some big environmentalist for a week or so to understand his work

vi) To work in kitchen garden for mess

vii) To know about the different varieties of plants

viii) Shutting down the fans and ACs of the campus for an hour or so

Assessment: 1. Attendance: 15 2. Assignment: 15 3. Posters: 15 4. Participation in events: 25 5. Assesment by Teacher: 40

Suggested Text/Reference Books: M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House, New Delhi, 2019

Course Outcomes:

1. Understanding of issues related to environment and their impact on the human life.
2. Understanding on the solutions related to the environmental problems.
3. Understanding of different component of environment and their function and sustainable development.

3rd Year (5th semester)

CC: Course Code, SC: Subject Code. Cr.: Credit, L-T-P-T: Lecture-Tutorial-Practical-Total

CC	SC	Subject Name	Contact Hrs./Week	
			L –T-P-TO	Cr.
PCC	PC-EC501	Microprocessors & Microcontrollers	3-0-0-3	3
PCC	PC-EC502	Analog Communication	3-0-0-3	3
PCC	PC-EC503	Control system	3-0-0-3	3
PEC	PE-EC501	Professional Elective-I a) Electronic Measurement and Instrumentation b) Biomedical Instrumentation c) RF Components and Circuit Design d) MEMS and Applications	3-0-0-3	3
PEC	PE-EC502	Professional Elective-II a) Power Electronics b) Nano Electronics c) Computer Architecture & Organization d) Telecommunication Switching and Computer Networking	3-0-0-3	3
PEC	PE-EC503	Professional Elective-III a) Upper Atmospheric Propagation b) Fiber Optic Communication c) Information Theory & Coding d) Remote Sensing & GIS	3-0-0-3	3
PCC	PC-EC591	Laboratory on Microcontroller, Control System, Analog Communication	0-0-6-6	3
Total			18-0-6-24	21

Course Prerequisites: Digital electronics

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC501	Microprocessors & Microcontrollers	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	**UNIT-I 8085 Microprocessor** Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts.	6
Unit 2	**UNIT-II 8085 Programming:** Instruction -format and addressing modes – Assembly language format – Data transfer, data manipulation& control instructions – Programming: Loop structure with counting & Indexing – Look up tability - Subroutine instructions - stack.	6
Unit 3	**UNIT-III 8086 architecture**: 8086 architecture- functional diagram, Register organization, memory segmentation, programming model, Memory addresses, physical memory organization, Signal descriptions of 8086-common function signals, timing diagrams, Interrupts of 8086.	6
Unit 4	**UNIT-IV Peripheral Devies**: Architecture, configuration and interfacing, with ICs: 8255, 8259, 8254, 8279, - A/D and D/A converters &Interfacing with 8085& 8051.	5
Unit 5	**UNIT-V 8051 Microcontroller** Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts- Data Transfer, Manipulation, Control Algorithms& I/O instructions	5
	UNIT-VI Microcontroller Programming & applications: Simple programming exercises- key board and display interface –Control of servo motor- stepper motor control- Application to automation systems.	5

Recommended Textbooks:

1. R.S. Gaonkar, 'Microprocessor Architecture Programming and Application', with 8085, Wiley Eastern Ltd., New Delhi, 2013.
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 5th Indian reprint, 2003

3. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051,McGraw Hill Edu,2013.
4. Ajay V.Deshmukh, 'Microcontroller Theory &Applications', McGraw Hill Edu,2016
5. Douglas V.Hall, 'Microprocessor and Interfacing', McGraw Hill Edu,2016.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the internal architecture and organization of 8086
2. Analyze the Assembly language programs of 8086
3. Analyze the internal architecture and real time control of 8051
4. Discuss the input /output ,memory interface , Serial Communication and Bus Interface devices

Course Prerequisites: Analog Electronics, Digital Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC502	Analog Communication	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	Basic on Signals- Step, Impulse, Rectangular and Sinc signal. Fourier Series and Fourier Transform, FT Properties, Energy and Power Signal, Spectrum, Bandwidth, Passband and Band Pass Signal, Signal Transmission through linear system, Noise & Distortion, Distortion less Transmission, Ideal vs. Practical Filters	4
Unit 2	Elements of communication system - Transmitters, Transmission channels & receivers, Concept of modulation, its needs. Continuous Wave Linear Modulation: a) Amplitude modulation (AM-DSB/FC): Time domain representation of AM signal (expression derived using a single tone message), modulation index , frequency domain (spectral) representations, illustration of the carrier and side band components; transmission bandwidth for AM; Phasor diagram of an AM signal; Calculation of Transmitted power & sideband power & Efficiency ; concept of under, over and critical modulation of AM-DSB-FC. Other Amplitude Modulations: Double side band suppressed carrier (DSBSC) modulation: time and frequency domain expressions, bandwidth and transmission power for DSB. Single side band modulation (SSB) both FC & SC and only the basic concept of VSB, Spectra and band-width.	8
Unit 3	Generation of AM: Concept of i) Square law modulator, ii) Balanced Modulator, iii) Ring Modulator. Generation of SSB: Filter method, Phase shift method. Demodulation for Linear Modulation: Demodulation of AM signals: Synchronous detection for AM-SC, Effects of Frequency & Phase mismatch, Corrections, Costas Receiver. Principle of Super heterodyne receivers: Super heterodyning principle, intermediate frequency, Local oscillator frequency, image frequency.	4
Unit 4	Frequency Modulation (FM) and Phase Modulation (PM): Time and Frequency domain representations, Spectral representation of FM and PM for a single tone message, Bessel's functions and Fourier series; Frequency Deviation, Modulation Index, Carson Rule Phasor diagram; Generation of FM & PM: Narrow and Wide-band angle modulation, Basic block diagram representation of generation of FM & PM, Concept of VCO & Reactance modulator, Demodulation of FM and PM: Concept of frequency discriminators , Phase Locked Loop (PLL), Stereo - FM: Basic concepts with block diagrams	8
Unit 5	a) Time Division Multiplexing (TDM) and Frequency Division Multiplexing (FDM) b) Random Signals and Noise in Communication System: i) Noise in Communication systems - Internal & External noise, Noise Temperature, Signal-to-Noise ratio, White noise, thermal noise, Figure of Merit. ii)Noise performance in Analog Communication systems: SNR calculation for DSB/TC, DSB-SC, SSB-TC, SSB-SC & FM	6

Recommended Textbooks:

1. Communication Systems, Simon Haykin, John Willey & Sons
2. Communication Systems (Analog and Digital), Sanjoy Sharma, Katson
3. Modern Analog and Digital Communication System, BP Lathi, Oxford
4. Principles of Communication Systems, Taub and Schilling, Mc-Graw Hill

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. To introduce he communication system and need of modulation.
2. To explain the concepts of Amplitude Modulation and its types (DSB-SC, SSB and VSB).
3. To explain the concepts of Angular Modulation,FM and types of FM
4. To describe the behaviour of analog communications in the presence of noise and also the basics of analog pulse modulation techniques
5. To classify and discuss the different types of transmitters and receivers

Course Prerequisites: Engineering Mathematics, Signals and systems

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC503	Control system	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	Introduction: Concept of control system, Examples of control systems, open loop and closed loop control systems and their differences with examples.	2L
Unit 2	Mathematical modelling: Mathematical modelling of mechanical and electrical systems, Differential equation modelling, Transfer function modelling, Impulse response, State space modelling, Block Diagram representation of control systems, block diagram reduction method, Signal flow graph, Mason's gain formula.	8L
Unit 3	Time response analysis: Standard test signals - Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems - Time domain specifications – Steady state response - Steady state errors and error constants.	6L
Unit 4	Feedback control system: Stability concept, Routh-Hurwitz criteria, proportional (P), integral (I) and derivative (D)controller, Realization of PID controllers with op-amp and digital implementation	4L
Unit 5	Frequency response analysis: Bode plot, Nyquist plot, Nyquist stability criterion, gain and phase margins, and robustness.	6L
Unit 6	Design of compensators: Lead compensator, lag compensator, lead-lag/lag-lead compensators, and their design.	4L
Unit 7	State variable analysis: Concepts of state, state variable, State Transition Matrix (STM), Solution for state variable of homogeneous and nonhomogeneous state equations, Transfer function with state space approach, Concepts of controllability and observability of systems.	4L

Recommended Textbooks:

1) Automatic Control Systems 8th edition– by B. C. Kuo 2003– John Wiley and son's.,
2) Franklin G.F., Powell J.D., Emami-Naeini A., Feedback Control of Dynamic Systems, Pearson, Upper Saddle River, New Jersey, 5th edition, 2006.
3) Control Systems Engineering – by I. J. Nagrath and M. Gopal, New Age International (P) Limited, Publishers, 2nd edition.
4) Modern control engineering, Katsuhito Ogata, PHI

Course Outcomes:

At the end of this course students will demonstrate the ability to

- Derive a working mathematical model of linear systems.
- Investigate system's response in time and frequency domain.
- Check stability of systems.
- Design various controllers with design specifications.

Course Prerequisites: Knowledge of Vectors, mathematics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC501A	Electronic Measurement and Instrumentation	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	Basic Measurement Techniques: Construction and Principle of Operation of Moving Coil, Moving Iron, Dynamometer, Thermal and Rectifier type Deflecting Instruments, DC ammeter, Ammeter shunts, DC Voltmeter, Voltmeter multiplier.	5
Unit 2	Errors in Measurement: Definition of Accuracy, Precision, Fidelity, Speed of Response, Non-linearity, techniques of Linearization, Classification of errors, Statistical analysis.	5
Unit 3	Measurements of Resistances: Measurement of low, medium and high Resistances (Wheat Stone Bridge, Kelvin Bridge), Kelvin's Double Bridge.	4
Unit 4	AC Bridges: Measurement of Inductances, Capacitance and Frequency by A.C. Bridges – Maxwell Bridge, Hay's Bridge, Anderson Bridge, Owen's Bridge, De Sauty's Bridge, Schering, Wien Bridge.	4
Unit 5	Cathode Ray Oscilloscope: C.R.O Construction & Principle of Operation. Time base circuits, Lissajous figures, Delay line, Measurements of Time period & frequency, Cathode Ray Tube (CRT), Digital Storage Oscilloscopes, Frequency Domain Instruments: Wave Analyzer, Spectrum Analyzer, Special Purpose Instruments: Signal Generators, Q-meter.	6
Unit 6	Transducers Classification: Piezoelectric transducer, LVDT, Stain Gauges, Thermistor, Thermocouple, Hotwire Anemometers, Synchros, Special Thermometers, Data Acquisition System.	4
Unit 7	Measurement of Physical Parameters: Flow measurement, Displacement meters, Liquid level measurement, Measurement of Humidity and moisture, velocity, Pressure	4

Recommended Textbooks:

1. Golding E.W. & Wides F.C. : Electrical Measuring Instruments & Measurements ; Wheeler.
2. Sawhney A K: A course in Electrical & Electronic Measurements & Instruments, Dhanpat Rai & Co.
3. S K Singh : Industrial Instrumentation & Control , Tata McGraw Hill. New Delhi.
4. H. S. Kalsi : Electronic Instrumentation and Measurements , Tata Mc-Graw Hill.
5. Heltrick A.D. & Cooper W.D.: Modern Electronic Instrumentation & Measuring Instruments; Wheeler.
6. Patranabis D: Sensors & Transducers, Wheeler 96.
7. Bell, David : Electronic Instrumentation & Measurement, Reston Publishers.
8. R K Rajput: Electronic Measurements and Instrumentation; S Chand.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1: Appreciate a system to determine appropriate instruments by type and range to

measure different quantities in the system.

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CO2: Measure various electrical quantities like R.L.C, Voltage, Current, Frequency, Power and Energy for AC and DC quantities using analog and digital meters.

CO3: Balance various AC and DC bridges to find unknown values.

CO4: Use Sensors & Transducers for measurement of various parameters.

CO5: Use CRO with confidence to measure different quantities and viewing signal waves.

CO6: Use techniques and skills to locate the fault of underground cables.

CO7: Take up projects to apply the learned techniques and skills.

Course Prerequisites: measurement and instrumentation**,** mathematics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC501B	Biomedical Instrumentation	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	Brief introduction to human physiology and basic anatomy Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential dissolved ions and gases. Bio-electrodes and bio-potential amplifiers for ECG, EMG, EEG, ERG, EOG etc. .	7
Unit 2	Cardiovascular system: Measurement of blood temperature, pressure and flow. .	4
Unit 3	Respiratory system: lung volume and capacities, Spirometer, Impedance plethysmography, inhaler, nebulizer	5
Unit 4	Diagnostic Techniques: Ultrasonic, Xray and nuclear imaging, ophthalmic scans, Radiography, tomography, Opthalmology instrument: opthalmoscope, tonometer	6
Unit 5	Nervous system: Neuronal Firing measurements, EEG and EMG measurements	4
	Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects.	6

Recommended Textbooks:

1. J.G. Webster, Medical Instrumentation
2. R S khandpur, Biomedical Instrumentation
3. Onkar Pandey &Rakesh Kumar, Bio-Medical Electronics and Instrumentation

Reference Books :

1. Biomedical Electronics and Instrumentation Made Easy G.S. Sawhney
2. Biomedical Instrumentation and Measurements, R.Ananda Natarajan

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the application of the electronic systems in biological and medical applications.
2. Understand the practical limitations on the electronic components while handling bio-substances
3. Understand and analyse the biological processes like other electronic processes

Course Prerequisites: Network Theory, Analog Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC501C	RF Components and Circuit Design	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	Introduction: Radio frequency and Microwave circuit applications, Radio frequency waves, RF and Microwave circuit design considerations, Introduction to component basics, Microstrip line, Formulation and properties of S-parameters, Signal Flow graphs, Smith chart Concepts, Types	
Unit 2	Applications of Smith chart: Distributed circuits– Transmission lines, Microstrip lines, Lumped element circuits– RC, RL, RLC circuits, Noise, gain and Stability analysis	
Unit 3	Impedance Matching networks: Goal of impedance matching, Components for matching, Design of Matching Networks - Matching network design using Lumped elements- RC, RL, RLC circuits, Design of Matching Networks using Distributed Elements- Transmission lines, Microstrip lines, Stubs	
Unit 4	Couplers and Power dividers - Basic properties, Types, Power combining efficiency, Wilkinson Power divider- equal and unequal types, 90° Hybrids, Branch line couplers, N-way combiners, Corporate structures, Spatial combining, Phase shifters – Types, Transmission line type, Reflection types phase shifters.	
Unit 5	RF Resonators and Filters - Basic Resonator types, transmission line resonators, Resonant waveguide cavities, Excitation of resonators, RF Filters: Basic filter configurations, Special Filter Realizations, Filter Implementation, Coupled Filter	

Recommended Textbooks:

1. Mathew M. Radmanesh, “Radio Frequency and Microwave Electronics”, Pearson Education Asia, 2001.
2. Reinhold Ludwig, Pavel Bretchko, "RF circuit design, theory and applications", Pearson Asia Education, 2nd Edition, 2012.
3. D. Pozar, "Microwave Engineering", John Wiley & Sons, New York, 2005
4. Inder J Bahl, “ Fundamentals of RF and Microwave Transistor Amplifiers”, John Wiley & sons Inc, 2009

Course Outcomes:

At the end of this course students will demonstrate the ability to

- CO1: Apply S-parameters signal flow graphs and Smith chart for design of passive circuits
- CO2: Analyze the performance parameters of RF passive components
- CO3: Design RF passive circuit for communication applications
- CO4: Evaluate the performance of RF passive circuits using EDA tools

Course Prerequisites: Solid State Devices, CMOS VLSI

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC501D	MEMS and Applications	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	**Properties of silicon:** Crystal structure – Orientation effects – crystal defects – Impurities in Silicon – Properties of Silicon and Gallium Arsenide - Starting materials – Bridgeman techniques for crystal growth.	4
Unit 2	**Bulk MicroMachining:** wet etching of silicon-Isotropic etching-anisotropic etching-alkali hydroxide etchants-ammonium hydroxide-tetra methyl ammonium hydroxide (TMAH)-ethylene diamine pyrochatechol (EDP)-ultrasonic agitation in wet etching- stop layers for dopant elective etchants. Porous-silicon formation –anistrophic wet etching of porous aluminum-anistrophic wet etching - quartz-vapour phase etches. RLE-laser driven bulk processing	6
Unit 3	**Surface Micromachining:** Thin film processes-nonmetallic thin film for micromachining –silicon dioxide – silicon nitride - silicon carbide - polycrystalline diamond - polysilicon and other semiconductors and thin film transition – wet etching of non-metallic thin film-metallic thin film for micromachining - Resistive evaporation – E - beam evaporation-sputter deposition-comparison of evaporation and sputtering - CVD of metals - adhesion layer for metals - electro deposition (E plating) - Electrodeposition mechanism: - DC electroplating-pulsed electroplating-Agitation for electroplating-black metal film-electro less plating.	6
Unit 4	**Bonding Processes:** Anodic Bonding-Anodic bonding using deposited glass-silicon fusion bonding-other bonding and techniques-compound processes using bonding.	4
Unit 5	**Sacrificial Processes and Other Techniques:** Sticking problem during wet releasing-prevention of sticking-phase change release methods-geometry-examples of sacrificial processes - Sacrificial LIGA process	4
Unit 6	**Advanced MEMS for Sensing and Actuation:** Electromechanical effects: Piezoresistance - Piezoelectricity - Shape memory alloy-Thermal effects: Temperature	4

	coefficient of resistance - Thermo-electricity – Thermocouples – Micro fluidics: - Squeeze film damping - Surface tension and bubbles -Devices: pumps, valves, mixers - Integrated fluidic systems: BioMEMS.	
Unit 7	**Design of Pressure Sensors:** Piezoreistive Pressure Sensor: Sensing Pressure, Piezoresistance- Analytic Formulation in Cubic Materials-Longitudinal and Transverse Piezoresistance -Piezoresistive Coefficients of Silicon- Structural Examples- Signal Conditioning and Calibration.	4

Recommended Textbooks:

1. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, Micro and Smart Systems, Wiley India, First Edition, 2010..

2. Chang Liu, Foundations of MEMS, (ILLINOIS ECE Series), Pearson Education International, 2006.

3. Gregory TA Kovacs, Micro machined Transducers Source Book, WCB McGraw Hill, Singapore, 1998.

4. Tai-Ran-Hsu, MEMS & Microsystems Design and Manufacture, TATA McGraw-Hill, New Delhi, 2002.

5. Sorab. K.Ghandhi, VLSI Fabrication Principles, Wiley Inter Science Publication, New York, 1994.

6. M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 2000.

Course Outcomes:

At the end of this course students will demonstrate the ability to

- The students will be introduced the basic concepts of micro systems and advantages of miniaturization.
- The various materials and their properties used for micromachining techniques will be studied
- The students will be able to get the knowledge of the basic concept of electromechanical effects, thermal effects Micro fluidics and Integrated fluidic systems.
- The exposure to different MEMS devices will be given.
- The students will be able to acquire expertise in the design of sensors for any practical applications

Course Prerequisites: Basic Electronics, Analog Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC502A	Power Electronics	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	**POWER ELECTRONICS DEVICES:** Characteristics of power devices –Power Transistors- Power MOSFETs, characteristics of SCR(Silicon Controlled Rectifier), DIAC(diode for alternating current'), TRIAC(Triode for alternating current'), SCS(Silicon Controlled Switch), GTO(Gate turn off thyristor)–FETs – LASCR(Light Activated SCR) – two transistor model of SCR – Protection of thyristors against over voltage – over current, dv/dt and di/dt.	8
Unit 2	**TRIGGERING TECHNIQUES:** Turn on circuits for SCR – triggering with single pulse and train of pulses – synchronizing with supply – triggering– forced commutation – different techniques – series and parallel operations of SCRs.	6
Unit 3	**CONTROLLED RECTIFIERS:** Converters – single phase – three phase – half controlled and fully controlled rectifiers – Waveforms of load voltage and line current under constant load current – effect of transformer leakage inductance – dual converter.	6
Unit 4	**INVERTERS and CHOPPERS:** Voltage and current source inverters, resonant, Series inverter, PWM inverter. AC and DC choppers – DC to DC converters – Buck, boost and buck – boost.	5

Unit 5	**INDUSTRIAL APPLICATIONS:** DC motor drives – Induction and synchronous motor drives – switched reluctance and brushless motor drives – Battery charger – SMPS – UPS – induction and dielectric heating.	5

Recommended Textbooks:

1. MuhamedH.Rashid,Power Electronics Circuits, Devices and Applications, 3rd Edn. 2004 PHI..
2. P C Sen, Power Electronics, 2nd Edition, 1992, McGraw-Hill Inc
3. Ned Mohan, Tore M.Undeland, William P. Robbins, Power Electronics, 3rd Edition 2002, Wiley.
4. G.K.Dubey,Thyristorised power controllers, Wiley Eastern,
5. Joseph Vithayathil, Power Electronics–Principles and applications, McGrawHill, 1995.
6. T. J Maloney, Modern Industrial Electronics, 5th Edition, Prentice Hall, 2003.

Course Outcomes:

At the end of this course students will demonstrate the ability to

- Understand the differences between signal level and power level devices. Analyse controlled rectifier circuits.
- Analyse the operation of DC-DC choppers.
- Analyse the operation of voltage source inverters.

Course Prerequisites: Solid State Devices, CMOS VLSI

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC502B	Nano Electronics	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	Introduction to nanotechnology, Mesoscopic physics.	6
Unit 2	Trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence. Schrodinger's Equation, wave function, Low dimensional structures Quantum wells, Basic properties of two dimensional semiconductor nanostructures, Quantum wires and quantum dots,carbon nano tube, grapheme.	10
Unit 3	Introduction to methods of fabrication of nano-layers, Introduction to characterization of nanostructures.	6
Unit 4	X-Ray Diffraction analysis, MOSFET structures, Quantum wells, modulation doped quantum wells, multiple quantum wells, The concept of super lattices, Transport of charge in Nanostructures under Electric field, Transport of charge in magnetic field, Nanoelectonic devices.	8

Recommended Textbooks:

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Materialand Novel Devices), Wiley-VCH, 2003.
3. K.E. Drexler, Nanosystems, Wiley, 1992.
4. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
5. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003

Course Outcomes:

At the end of this course students will demonstrate the ability to

- The students will be able to understand basic concepts of nanoelectronic devices and nano technology.
- The students can be able to go for research and further advanced studies in this very subject.

Course Prerequisites: Basic knowledge of Computer system

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC502C	Computer Architecture & Organization	3L:0T:0P	3 credits

Unit	Topic	No. of Lectures
Unit I	**Basic functional blocks of a computer:** CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU - registers, instruction execution cycle, RTL interpretation of instructions, addressing modes, instruction set, instruction cycle	05
Unit II	**Data representation:** signed number representation, fixed and floating point representations, character representation, floating point arithmetic.	02
Unit III	**CPU design:** Instruction formats, Addressing modes, Control word, general register organization, stack organization, Program control, RISC & CISC architecture	06
Unit IV	**Memory organization**: Memory interleaving, concept of hierarchical memory organization, cache memory, cache size vs block size, mapping functions, concept of virtual memory and associative memory	07
Unit V	**I/O Organization:** Input-output subsystems, modes of transfer, I/O transfers-program controlled, interrupt driven and DMA, interrupt based transfer	05
Unit VI	**Control unit design:** Microprogram concepts, Control unit design, Microoperations **Pipelining:** Basic concepts of pipelining , throughput and speedup, pipeline hazards.	06

Text Books :

1. Carl Hamachar, Zvonco Vranesic and Safwat Zaky, Computer Organization, McGraw Hill.
2. M.M.Mano, "Computer System Architecture", Edition

Reference Books :

1. John P. Hayes, Computer Architecture and Organization, McGraw Hill.
2. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson Education.
3. C.W.Gear, "Computer Organization and Programming", McGraw Hill, N.V. Edition

Course Outcomes:

(12) Graduates will be able to apply knowledge of Computer architecture in the field of hardware designing of a computer..

(13) Graduates will demonstrate an ability to identify, formulate, analyze and solve electronics and communication engineering problems.

(14) Graduates will demonstrate an ability to design electronic circuits, conduct experiments, analyze and interpret the resulting data.

(15) Graduates will demonstrate an ability to design a system, component or algorithms to meet desired needs within the context of electronics and communication engineering and considering realistic constraints.

(16) Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary task.

(17) Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.

(18) Graduates will have an understanding of professional and ethical responsibilities.

(19) Graduates will be able to communicate effectively.

(20) Graduate will show the understanding of impact of engineering solutions on the society, environment and awareness of contemporary issues.

(21) Graduates will develop confidence for self-education and ability for life-long learning.

(22) Graduates who can participate and succeed in competitive examination

Course Prerequisites: Basics of Computer, Digital Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC502D	Telecommunication Switching and Computer Networking	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	**Switching Systems:** Evolution of Telecommunications; Basics of a Switching System; Functions of a Switching System; Crossbar Switching-Principle of Crossbar Switching; Crossbar Switch Configurations; Cross-Point Technology; Crossbar Exchange Organization; A General Trucking; Electronic Switching; Digital Switching Systems. Telecommunications Traffic: Introduction; The Unit of Traffic; Congestion; Traffic Measurement; A Mathematical Model; Lost-Call Systems Theory; Traffic Performance; Loss Systems in Tandem; Use of Traffic Tables; Queuing Systems-The Second Erlang Distribution; Probability of Delay; Finite Queue Capacity; Some Other Useful Results; Systems with a Single Server; Queues in Tandem; Delay Tables; Applications of Delay Formula.	
Unit 2	**Switching Networks:** Single Stage Networks; Grading-Principle; Two Stage Networks; Three Stage Networks; Four Stage Networks Time Division Switching: Basic Time Division Space Switching; Basic Time Division Time Switching; Time Multiplexed Space Switching; Time Multiplexed Time Switching; Combination Switching; Three Stage Combination Switching. Control of Switching Systems: Call Processing Functions-Sequence of Operations; Signal Exchanges; State Transition Diagrams; Common Control; Reliability; Availability and Security; Stored Program Control.	
Unit 3	**Switching Networks:** Single Stage Networks; Grading-Principle; Two Stage Networks; Three Stage Networks; Four Stage Networks Time Division Switching: Basic Time Division Space Switching; Basic Time Division Time Switching; Time Multiplexed Space Switching; Time Multiplexed Time Switching; Combination Switching; Three Stage Combination Switching. Control of Switching Systems: Call Processing Functions-Sequence of Operations; Signal Exchanges; State Transition Diagrams; Common Control; Reliability; Availability and Security; Stored Program Control.	
Unit 4	**Traffic Engineering:** Network Traffic load and parameters, Grade of service and blocking probability, Modeling Switching Systems, Incoming Traffic and Service Time Characterization, Blocking Models and Loss Estimates, Delay systems.	
Unit 5	**Signaling:** Introduction; Customer Line Signaling; Audio Frequency Junctions and Trunk Circuits; FDM Carrier Systems-Out band Signaling; in band (VF) Signaling; PCM Signaling; Inter Register Signaling; Common Channel Signaling,	

	PrinciplesGeneral Signaling Networks; Signaling System Number, Signaling System Number 7; The High Level Data Link Control Protocol; Signal Units.	
	Data networks: Block Diagram, features, working of EPABX Systems, Data transmission in PSTNs, Data Rates in PSTNs, Modems, Switching Techniques for data Transmission, Circuit Switching, Store and Forward Switching Data communication Architecture, ISO-OSI Reference Model, Satellite based data networks, LAN, Metropolitan Area network, Fiber optic networks, and Data network standards.	
	Integrated Services Digital Networks: Motivation for ISDN, New services, Network and Protocol architecture, Transmission Channels, User Network Interface, signaling, Numbering and Addressing, Service characterization, Interworking ,ISDN standards, Broadband ISDN , Voice data Integration(VoIP).	

Recommended Textbooks:

1. J. E Flood, “Telecommunications Switching and Traffic Networks” Pearson Education, 1st Edition, 2007.
2. Tyagarajan Viswanathan, “Telecommunications Switching Systems and Networks” Prentice Hall of India Pvt. Ltd., Printing Edition, 2006.
3. John C Bellamy, “Digital Telephony”. John Wiley International, 3rd Edition, 2000.
4. O Hersent, D Gurle, J P Petit “IP Telephony” Pearson.
5. A Gokhale “Introduction to Telecommunication”- Cengage Learning.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Telephone system is described which includes PSTN, modern telephone system, telephone network.
2. Working principle of Telephone exchange is described by considering different switching system and power control mechanism.
3. Multiple access systems and different network protocol are described.

Course Prerequisites: Basic knowledge of EM Theory and Wave Propagation

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC503A	Upper Atmospheric Propagation	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit I	**Introduction:** Frequency bands and propagation mechanisms. Physical structure of the upper atmosphere. Temperature structure of the atmosphere. Long wave radiation and Radiative Balance in upper atmosphere. Greenhouse effect in the upper atmosphere.	04
Unit II	**Troposphere:** Field strength of Tropospheric wave. Scattering and absorption of a wave by a single particle. Effects of rain, snow, and ice on microwaves and millimeter waves.	04
Unit III	**Stratosphere:** Stratospheric ozone layer. Destruction of ozone and ozone problem. Stratospheric Circulation.	04
Unit IV	**Ionosphere:** The production of ionization. Chapman ionization profile. Ionization mechanisms. Solar cycle effects on the ionosphere. Currents in the ionosphere. Virtual heights, critical frequencies, refractive index of ionized region, reflection and refraction of radio waves in ionosphere, influence of earth's magnetic field, loss of energy in ionosphere, skip distance and maximum usable frequency (MUF), single hop and multiple hop transmissions, optimum frequency, abnormal atmospheric behavior, Ionospheric storms, radio fade out, Dellinger's effect, Effect of solar eclipse, scattering of radio waves, Luxemburg effect. Determination of TEC using GPS systems.	10
Unit V	**Magnetosphere:** Magnetic field of the Earth. Formation of the magnetosphere. Magnetic merging. Currents in the magnetosphere.	3
Unit VI	**Aurora:** Formation, height, intensity. Storms and sub storms.	2
Unit VII	**Introduction to Upper Atmospheric Models:** Introduction to current Upper Atmospheric Models. Solar and cosmic effects on climate and Short and long term changes of Upper Atmosphere	4

Reference Books :

1. Electromagnetic waves & Radiating Systems, Jordan & Balman, PHI
2. Antenna & Wave Propagation, KD Prasad
3. Upper Atmosphere, S. K. Mitra, Asiatic Society, Kolkata
4. Fundamentals of Atmospheric Physics, M.L. Salby, Academic Press
5. The Earth's Ionosphere, M. Kelley, Academic Press

Course Outcomes:

1. To impart the basic and advanced knowledge of various processes and phenomena in the field of Atmosphere Science.

2. To provide skills in theory, numerical modelling of Atmospheric processes and their applications in weather forecasting and development of early warning systems for extreme weather events.

3. To train the students with quantitative and scientific reasoning skills for operational organizations, academia, research & development organizations.

4. To produce trained manpower in providing solutions to various challenges and issues related to atmospheric sciences and other interdisciplinary areas.

Course Prerequisites: Analog Electronics, Opto- Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC503B	Fiber Optic Communication	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	Introduction to vector nature of light, propagation of light, propagation of light in a cylindrical dielectric rod, Ray model, wave model.	6L
Unit 2	Different types of optical fibers, Modal analysis of a step index fiber. Signal degradation on optical fiber due to dispersion and attenuation. Fabrication of fibers and measurement techniques like OTDR.	6L
Unit 3	Optical sources - LEDs and Lasers, Photo-detectors - pin-diodes, APDs, detector responsivity, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties.	6L
Unit 4	Optical switches - coupled mode analysis of directional couplers, electro optic switches. Optical amplifiers - EDFA, Raman amplifier.	6L
Unit 5	WDM and DWDM systems. Principles of WDM networks.	3L
Unit 6	Nonlinear effects in fiber optic links. Concept of self-phase modulation, group velocity dispersion-based communication.	3L

Recommended Textbooks:

1. J. Keiser, Fibre Optic communication, McGraw-Hill, 5th Ed. 2013 (Indian Edition).
2. T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
3. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
4. S.E. Miller and A.G. Chynoweth, eds., Optical fibres telecommunications, Academic Press, 1979.
5. G. Agrawal, Nonlinear fibre optics, Academic Press, 2nd Ed. 1994.
6. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1997
7. F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York (1990).

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the principles fiber-optic communication, the components and the bandwidth advantages.
2. Understand the properties of the optical fibers and optical components.
3. Understand operation of lasers, LEDs, and detectors

4. Analyse system performance of optical communication systems

5. Design optical networks and understand non-linear effects in optical fibers

Course Prerequisites: Digital Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC503C	Information Theory & Coding	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	**Information Theory**: Introduction, Measure of information, Information content of message, Average Information content of symbols in Long Independent sequences, Markov Statistical Model of Information Sources, Entropy and Information rate of Mark off Sources	6
Unit 2	**Source Coding**: Source coding theorem, Kraft McMillan Inequality property –Encoding of the Source Output, Shannon Fano Codes, Huffman codes, Arithmetic Coding, Lempel – Ziv Algorithm, LZW algorithm – Audio: Perceptual coding, Masking techniques,	6
Unit 3	**Information Channels**: Communication Channels, Channel Models, Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, System Entropies, Mutual Information, Channel Capacity, Channel Capacity of :Binary Symmetric Channel, Binary Erasure Channel, Muroga's Theorem	6
Unit 4	**Error Control Coding**: Introduction, Examples of Error control coding, methods of Controlling Errors, Types of Errors, types of Codes, Linear Block Codes: matrix description of Linear Block Codes, Error Detection and Error Correction Capabilities of Linear Block Codes, Single Error 08 Correcting hamming Codes, Table lookup Decoding using Standard Array. Binary Cyclic Codes: Algebraic Structure of Cyclic Codes, Encoding using an (n-k) Bit Shift register, Syndrome Calculation, Error Detection and Correction	6
Unit 5	**Some Important Cyclic Codes**: Golay Codes, BCH Codes, Convolution Codes: Convolution Encoder, Time domain approach, Transform domain approach, Code Tree, Trellis and State Diagram, The Viterbi Algorithm)	6

Recommended Textbooks:

1. Gravano Salvatore, "Error Correcting Codes" , Oxford University Press

2. Ranjan Bose, "Information Theory and Coding", TMH

3. T. M. Cover, J. A. Thomas, "Elements of information theory", Wiley

4. Reza, "An Introduction to Information Theory", Dover

5. R. W. Hamming, "Coding and information theory," Prentice Hall Inc

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Explain concept of Dependent & Independent Source, measure of information, Entropy, Rate of information and Order of a source

2. Represent the information using Shannon Encoding, Shannon Fano, Prefix and Huffman Encoding Algorithms
3. Model the continuous and discrete communication channels using input, output and joint probabilities
4. Determine a code word comprising of the check bits computed using Linear Block codes, cyclic codes & convolutional codes

Course Prerequisites: Knowledge of Vectors, mathematics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC503D	Remote Sensing & GIS	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	Basic of remote sensing, Electromagnetic Radiation principles, Reflection, Absorption and Transmission, Atmospheric window, Indian Earth Observation Satellites for land, ocean & atmosphere, Active, Passive, Imaging, Non Imaging, ground based and space based remote sensing system.	8
Unit 2	Spatial, spectral, Radiometric and temporal resolution, satellite sensors, detectors and scanning technique, FOV and error sources, Remote Sensing Data Errors, Data Products and data sources, Image analysis and Interpretation weather RADAR, LIDAR, acoustic sounding systems, TRMM, AURA-MLS, Megha Tropiques Alitmeter , Scatterometer, Radiometer.	10
Unit 3	Remote Sensing of Atmosphere and Earth Resources: Spectral response of water, Sea surface temperature, wind speed, colour monitor, clouds and aerosal, water vapor, convective system, Trace gases. GPS based remote sensing: Ground based and radio occultation techniques.	8
Unit 4	Basic Concepts and overview of GIS, GIS data: spatial and non-spatial, spatial data model, Spatial data acquisition, Spatial and non-spatial data editing functions, Quality of spatial data, GIS analysis functions, GIS presentation functions, Internet GIS, Applications of Internet GIS.	8

Recommended Textbooks:

1. B. Bhatta; Remote Sensing and GIS; Oxford university press

2. J.R. Jenson; Remote sensing of the Environment; Pearson

3. George Joseph; Fundamentals of Remote Sensing; Universities Press India Pvt Ltd,

Hyderabad,India

4. M. Anji Reddy; Remote Sensing and Geographical Information Systems; BS Publications, Hyderabad,India

5. Lillesand, Kiefer, Chipman; Remote Sensing and Image Interpretation; 7th Edition, Wiley.

6. Qihao Weng; Remote Sensing and GIS Integration-Theories, Methods, and Applications; McGraw-Hill

7. A.M Chandra, S.K Ghosh; Remote Sensing and Geographical Information Systems; 2nd Edition, Narosa

8. S.Kumar; Basics of Remote Sensing and GIS; Laxmi Publications, New Delhi, India

Course Outcomes:

At the end of this course students will demonstrate the ability to

Course Prerequisites: Knowledge Microprocessor, Microcontroller, Control System and Communication Engineering

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC591	Laboratory on Microprocessor and Microcontroller, Control System, Analog Communication	**0L:0T:6P**	**3credits**

Laboratory on Microprocessor and Microcontroller:

Design PI, PD and PID controller for specified system requirements.

1. Familiarization with 8085 & 8051simulator on PC.
2. Study of prewritten programs using basic instruction set (data transfer, Load/Store, Arithmetic, Logical) on the KIT. Assignments based on above
3. *Programming using kit and simulator for:*
   i) Table look up
   ii) Copying a block of memory
   iii) Shifting a block of memory
   iv) Packing and unpacking of BCD numbers
   v) Addition of BCD numbers
   vi) Binary to ASCII conversion
   vii) String Matching, Multiplication using shift and add method and Booth's Algorithm
4. Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit e.g. subroutine for delay, reading switch state and glowing LEDs accordingly.
5. Study of timing diagram of an instruction on oscilloscope..
6. Interfacing of 8255: Keyboard and Multi-digit Display with multiplexing using 8255
7. Study of 8051 Micro controller kit and writing programs as mentioned in S/L3. Write programs to interface of Keyboard, DAC and ADC using the kit.
8. Serial communication between two trainer kits

Laboratory on Control System:

1. Familiarization with MATLAB control system toolbox and representation of pole zero and transfer function of control system.
2. Determination of impulse & step response for 2nd order under damped system on CRO & calculation of control system specifications for variation of system design.
3. Determination of root Locus from transfer function and evaluation of system parameters like marginal value of gain, frequency etc. of a given control system.
4. Drawing of Nyquist plot and Bode plot from transfer function of a control system and estimation of relative system parameters like gain margin, phase margin etc.
5. Evaluation of steady-state error, setting time, percentage peak overshoots, gain margin, phase margin with addition of lead compensator in forward path transfer functions using MATLAB.
6. Study of position control system using servomotor.
7. Study of position control system using servomotor.
8. Design and hardware implementation of a temperature controller using microprocessor/microcontroller.

Laboratory on Analog Communication:

1. Measurement of modulation index of an AM signal.
2. Measurement of output power with varying modulation index an AM signal(for both DSB- & SSB).
3. Measurement of distortion of the demodulated output with varying modulation index of an AM signal (for both DSB-SC & SSB).
4. Measurement of power of different frequency components of a frequency modulated signal & the measurement of the bandwidth.
5. Design and set up a PLL using VCO & to measure the lock frequency.
6. Design and set up a FM demodulator using PLL.
7. Measurement of SNR of a RF amplifier.
8. Measurement of selectivity, sensitivity, fidelity of a superheterodyne receiver.
9. One innovative experiment.

CC	SC	Subject Name	Contact Hrs./Week	
			L –T-P-TO	Cr.
HUM	HM-HU(EC)601	Principles of Management	2-0-0-2	2
PCC	PC-EC601	Digital Communication	3-1-0-4	4
PCC	**PC-EC602**	Digital Signal Processing	3-0-0-3	3
PCC	**PC-EC603**	VLSI	3-0-0-3	3
PEC	PE-EC601	Professional Elective-IV a) VLSI Technology b) Embedded System c) FPGA & Reconfigurable Computing d) Mobile communication and Network	3-0-0-3	3
OEC	OE-CS(EC)601	Open Elective-1 a) Object Oriented Programming b) Data Base Management c) Internet of Things (IoT) d) Numerical Methods in Engineering	3-0-0-3	3
PCC	PC-EC691	Laboratory on Digital Communication, DSP and VLSI	0-0-6-6	2
Proj	PR-EC681	Design	0-0-2-2	1
Total			17-1-6-24	21

Course Prerequisites: Knowledge of Science

SC	Subject Name	Contact Hrs/Week	Credits
HM-HU(EC)601	Principles of Management	**2L:0T:0P**	**2credits**

Unit	Topic	No. of Lectures
Unit 1	Basic concepts of management: Definition – Essence, Functions, Roles, Level.	3
Unit 2	Functions of Management: Planning – Concept, Nature, Types, Analysis, Management by objectives; Organization Structure – Concept, Structure, Principles, Centralization, Decentralization, Span of Management; Organizational Effectiveness.	5
Unit 3	Management and Society– Concept, External Environment, CSR, Corporate Governance, Ethical Standards.	4
Unit 4	People Management– Overview, Job design, Recruitment & Selection, Training & Development, Stress Management. Managerial Competencies– Communication, Motivation, Team Effectiveness, Conflict Management, Creativity, Entrepreneurship	5
Unit 5	Leadership: Concept, Nature, Styles. Decision making: Concept, Nature, Process, Tools & techniques.	4
Unit 6	Economic, Financial & Quantitative Analysis– Production, Markets, National Income, Accounting, Financial Function & Goals, Financial Statement & Ratio Analysis, Quantitative Methods – Statistical Interference, Forecasting, Regression Analysis, Statistical Quality Control.	5
Unit 7	Customer Management– Market Planning & Research, Marketing Mix, Advertising & Brand Management.	3
Unit 8	Operations & Technology Management– Production & Operations Management, Logistics & Supply Chain Management, TQM, Kaizen & Six Sigma, MIS.	3

Text Books:

1. Management: Principles, Processes & Practices – Bhat, A & Kumar, A (OUP).
2. Essentials for Management – Koontz, Revised edition, Tata McGraw Hill (TMH)
3. Management – Stoner, James A. F. (Pearson)
4. Management - Ghuman, Tata McGraw Hill(TMH)

Outcomes:

Upon completion of the course , students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling and have some basic knowledge on international aspect of management.

Course Prerequisites: Knowledge of Vectors, mathematics

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC601	Digital Communication	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	Introduction to Digital Communication and Sampling Theorem: Digital Communication System, Advantages, Syllabus, Sampling Theorem, Mathematical Analysis, Numerical Problem, Ideal Reconstruction of Signal from the sampled signal, Practical and Natural Sampling, Sample and Hold Circuit, Aliasing or Spectral Folding, Anti-Aliasing Filter, Pulse Modulation: PAM, PWM, PPM	4
Unit 2	Source Encoding Pulse Code Modulation (PCM), Uniform Quantization, Midrise and Midtread Quantization, Quantization Error, Numerical Problem, Non-Uniform Quantization, Companding, A-law and μ-law, Bandwidth of PCM, Numerical Problem, Bit Rate vs. Baud Rate, Linear Predictor, Differential Pulse Code Modulation (DPCM), Advantages of DPCM, Adaptive DPCM, Delta Modulation and Demodulation, Advantages of DM, Practical Implementation of DM, Different Noise of DM: Slop Overload and Granular Noise, Threshold Condition DM, Adaptive Delta Modulation, Sigma-Delta Modulation	10
Unit 3	Line Coding Line Coding, Properties DC or Baseband wandering, RZ and NRZ, Unipolar or ON-OFF, Polar, Bipolar or AMI, MANCHESTER, Differential, M-array, Timing Signal Extraction Property for Line Coding, Regenerative Repeater, Inter Symbol Interference (ISI), Nyquist Criterion for Zero ISI, Zero Forcing Equalizer, Eye Diagram	6
Unit 4	Digital Modulations Digital Modulation, Geometric Representation of Signal, Signal-space Diagram Amplitude Shift Keying (ASK), PSD of ASK, Generation and Detection of ASK, Binary Frequency Shift Keying (BFSK) Generation, Detection, BW, Error Probability of FSK, Binary Phase Shift Keying (BPSK), Waveform, Signal Space Diagram, Generation and Detection, Differential Phase Shift Keying (DPSK) Generation and Detection Bandwidth Calculation Advantages and Disadvantages, Quadrature Phase Shift Keying (QPSK), Waveform, Signal-Space Diagram Generation and Detection Bandwidth Calculation, MSK: Waveform and Mathematical Expression Generation and Detection BW calculation, Signal-Space Diagram	10
Unit 5	Channel Property and Filter Integrate and Dump Filter, SNR Calculation, Probability of Error, Optimum and Matched Filter	2

Text Books:

1. Communication Systems, Simon Haykin, John Willey & Sons
2. Communication Systems (Analog and Digital), Sanjoy Sharma, Katson
3. Modern Analog and Digital Communication System, BP Lathi, Oxford
4. Principles of Communication Systems, Taub and Schilling, Mc-Graw Hill

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Design PCM systems
2. Design and implement base band transmission schemes

3. Design and implement band pass signaling schemes
4. Analyze the spectral characteristics of band pass signaling schemes and their noise performance
5. Design error control coding schemes

Course Prerequisites: Knowledge of Vectors, mathematics, Signal and Systems

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC602	Digital Signal Processing	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	**Z-Transform:** Z-Transform and Inverse Z-Transform, Z-Transform of some common sequences, Convergence and ROC, ROC of some common sequences, Various properties of Z-Transform, Mapping between z-plane and s-plane, Relation between Z-Transform and Fourier Transform, Initial Value Theorem, Parseval's Relation, Various methods of inverse Z-Transform, Output response of a system using Z-Transform, Pole-Zero representation and stability analysis.	6
Unit 2	**Fast Fourier Transform:** Introduction, Computational complexity of Direct Computation of DFT, DIT-FFT Algorithm, DIF-FFT Algorithm, Comparison between DIT and DIF algorithms, Inverse DFT using FFT algorithms, Linear filtering approach for computing DFT.	4
Unit 3	**Filters:** Introduction, frequency response and filter characteristics, zero phase filter, linear phase filter, simple Finite Impulse Response(FIR) digital filters, simple Infinite Impulse Response(IIR) digital filters, all pass filters, minimum maximum and mixed phase systems, system identification and deconvolution, averaging filters, comb filters, digital resonators, notch filters, digital sinusoidal oscillators.	4
Unit 4	**Realization of Digital Filters:** Introduction, non-recursive and recursive structures, factors influencing choice of structures, block diagram representation and signal flow graph, FIR filter structures, IIR filter structures, Lattice structures.	4
Unit 5	**Finite Impulse Response Digital Filter:** Introduction to digital filters, desirability of Linear-Phase filters, frequency response of linear-phase FIR filters, filter specifications, impulse response of ideal filters, design techniques for linear-phase FIR filters, Gibbs Phenomenon, Windowing method, half-band FIR filters.	6
Unit 6	**Infinite Impulse Response Digital Filter:** Introduction, design of IIR filters from analog filters, IIR filter design by impulse-invariant method, matched z-transformation method, step-invariant method, bilinear transformation method, IIR filter specifications, specifications of low-pass filters, Analog-Butterworth Filters, Analog-Chebyshev filters, frequency transformation in analog domain, frequency transformation in digital domain.	6
Unit 7	**Typical DSP Hardware:** Texas Instruments family of DSP processors, study of TMS320C5416 Processor's architecture, extensive parallel operations, MAC operations, different addressing techniques, common instructions used for extensive DSP applications, familiarity with Code Composer Studio.	4

Text/Reference Books:

1. S.K.Mitra, Digital Signal Processing: A computer based approach.TMH

2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms And Applications, Prentice Hall, 1997.
4. L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, 1992.
5. J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
6. D.J.DeFatta, J. G. Lucas andW.S.Hodgkiss, Digital Signal Processing, John Wiley& Sons, 1988.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Represent signals mathematically in continuous and discrete time and frequency domain
2. Get the response of an LSI system to different signals
3. Design of different types of digital filters for various applications

Course Prerequisites: Analog Electronics, Digital Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC603	VLSI	3L:0T:0P	3 credits

Unit	Topic	No. of Lectures
Unit I	VLSI Design Concepts, Moor's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI– basic idea only), Design principles (Concept of Regularity, Granularity etc), Design Domains (Behavioral, Structural), Review of MOSFET characteristics, scaling and small-geometry effects.	5
Unit II	CIRCUIT DESIGN PROCESSES: MOS layers. Stick diagrams. Design rules and layout – lambda-based design and other rules. Examples. Layout diagrams. Symbolic diagrams. Tutorial exercises. Basic Physical Design of Simple logic gates	4
Unit III	Analog VLSI Circuits: Analog VLSI design steps; Basic building blocks of Analog VLSI chips; MOS switch; Active load / resistors; Voltage dividers; CMOS Current source & sink; CMOS Voltage references/voltage dividers; CMOS Differential amplifier; Output amplifiers; CMOS OPAMP; Switched capacitor filter.	6
Unit IV	CMOS for Digital VLSI Circuits: CMOS, CMOS inverter characteristics; CMOS logic circuits, NAND & NOR Gates, Complex logic circuits, CMOS Full Adder, CMOS Transmission GATE, Advanced CMOS Logic circuits; Sequential CMOS logic circuits; SR Latch circuit, clocked JK Latch/ Master-Slave JK, CMOS D-latch & Edge triggered flip-flop.	6
Unit V	CMOS Complementary Logic, Bi CMOS Logic, Pseudo-nMOS Logic, Dynamic CMOS Logic, Clocked CMOS Logic, Pass Transistor Logic, CMOS Domino Logic Cascaded Voltage Switch Logic (CVSL).	6
Unit VI	General considerations. Process illustration. ALU subsystem. Adders. Multipliers, Timing considerations. Memory elements. Memory cell arrays.	3

Text Books :

1. Kamran Ehraghian, Dauglas A. Pucknell and Sholeh Eshraghiam, "Essentials of VLSI Circuits and Systems" – PHI, EEE, 2005 Edition
2. Neil H. E. Weste and David. Harris Ayan Banerjee,, "CMOS VLSI Design" - Pearson Education, 1999.

Reference Books :

1. Sung-Mo Kang, Yusuf Leblebici,"CMOS Digital Integrated Circuits" TMH 2003
2. Jan M. Rabaey, "Digital Integrated Circuits" Pearson Education, 2003

3. Wayne Wolf, “Modern VLSI Design ", 2nd Edition, Prentice Hall,1998.

Course Outcomes:

1. An ability to design logic circuit layouts for both static CMOS and dynamic clocked CMOS circuits.

2. An ability to extract the analog parasitic elements from the layout and analyze the circuit timing using a logic simulator and an analog simulator.

3. An ability to build a cell library to be used by other chip designers.

4. An ability to insert elementary testing hardware into the VLSI chip.

5. An ability to analyze VLSI circuit timing using Logical Effort analysis.

6. An ability to design elementary data paths for microprocessors, including moderate-speed adders, subtracters, and multipliers.

7. An ability to estimate and compute the power consumption of a VLSI chip.

8. An ability to assemble an entire chip and add the appropriate pads to a layout

9. An ability to explain the chip technology scaling process

Course Prerequisites: Analog Electronics, Digital Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC601A	VLSI Technology	3L:0T:0P	3 credits

Unit	Topic	No. of Lectures
Unit I	Introduction to VLSI Technology: Classification of ICs, Scale of integration, semiconductor and hybrid ICs Features of ICs. **CRYSTAL GROWTH**: monolithic and hybrid ICs, crystal growth, Czochralski technique of crystal growth, wafer preparation and specifications, testing, measurements of parameters of crystals, Fabrication steps, **OXIDATION**: Theory of growth of Silicon di oxide layer, calculation of SiO2thickness and oxidation kinetics, Dry wet and high pressure oxidation, plasma oxidation, properties of oxidation, defects induced due to oxidation.	5
Unit II	EPITAXIAL PROCESS: Epitaxy and its concept, Growth kinetics of epitaxy, epitaxial growth, Low-temperature epitaxy, Si-epitaxy-growth chemistry of Si epitaxial layer, auto-doping apparatus forepitaxial layer, apparatus for epitaxy, MBE system **DIFFUSION PROCESS**: Diffusion models of solid, Fick's theory of diffusion, Solution of Fick`s law, diffusion parameters measurements schemes, **ION IMPLANTATION**: Scattering phenomenon, range theory, channeling, implantation damage, ion-implantation systems, Annealing	4
Unit III	**LITHOGRAPHY**: photolithography and pattern transfer, Optical and non-optical lithography, electron, X-ray and ion-beam lithography, contact/proximity and projection printers, alignment. Photoresist and **ETCHING**: Types of photoresist, polymer and materials, Etching-Dry & Wet etching, basic regimes of plasma etching, reactive ion etching and its damages, lift-off, and sputter etching.	6
Unit IV	**METALLIZATION**: Applications and choices, physical vapor deposition, patterning, problem areas. **VLSI PROCESS INTEGRATION**: PMOS,NMOS and CMOS IC technology, MOS memory IC technology, bipolar IC fabrication.	6
Unit V	**ASSEMBLY TECHNIQUE AND PACKAGING**: Package types, packaging design consideration, VLSI assembly technologies. **YIELD AND RELIABILITY**: Yield loss in VLSI, yield loss modeling, reliability requirements, accelerated testing	6

Text Books :

1. S.M. SZE/ VLSI Technology / M Hill. 2009/2ndEdition
2. S. K. Gandhi/VLSI Fabrication Principles/Wiley/2ndedition
3. S.A. Campbell / The Science and Engineering of Microelectronic Fabrication / Oxford 2008/2ndedition

Reference Books :

1. Sedra & Smith/ Microelectronic Circuits 2004/Oxford/5thedition
2. James D. Plummer/ Silicon VLSI Technology: Fundamentals, Practice, and Modeling/Pearson/2nded

Course Outcomes:

CO1: Identify the various IC fabrication methods.

CO2 : Express the Layout of simple MOS circuit using Lambda based design rules.

CO3 : Apply the Lambda based design rules for subsystem design.

CO4 : Differentiate various FPGA architectures.

CO5: Design an application using Verilog HDL.

CO6 : Concepts of modeling a digital system using Hardware Description Language.

Course Prerequisites: Knowledge of Microprocessors and Microcontrollers, Operating System

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC601B	Embedded System	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	INTRODUCTION TO EMBEDDEDSYSTEMS History of embedded systems, Classification of embedded systems based on generation and complexity, Purpose of embedded systems, The embedded system design process-requirements, specification, architecture design, designing hardware and software, components, system integration, Applications of embedded systems, and characteristics of embedded systems.	7
Unit 2	TYPICAL EMBEDDED SYSTEM Core of the embedded system-general purpose and domain specific processors, ASICs, PLDs, COTs; Memory-ROM, RAM, memory according to the type of interface, memory shadowing, memory selection for embedded systems, Sensors, actuators, I/O components: seven segment LED, relay, piezo buzzer, push button switch, other sub-systems: reset circuit, brownout protection circuit, oscillator circuit real time clock, watch dog timer.	7
Unit 3	COMMUNICATION INTERFACE Onboard communication interfaces-I2C, SPI, CAN, parallel interface; External communication interfaces-RS232 and RS485, USB, infrared, Bluetooth, Wi-Fi, ZigBee, GPRS, GSM.	4
Unit 4	EMBEDDED FIRMWARE DESIGN AND DEVELOPMENT Embedded firmware design approaches-super loop based approach, operating system based approach; embedded firmware development languages-assembly language based development, high level language based development.	7
Unit 5	RTOS BASED EMBEDDED SYSTEM DESIGN Operating system basics, types of operating systems, tasks, process and threads, multiprocessing and multitasking, task scheduling: non-pre-emptive and pre-emptive scheduling; task communication-shared memory, message passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/ Synchronization Issues, Task Synchronization Techniques	7

TEXT BOOKS:

1. Introduction to Embedded Systems - shibu k v, Mc Graw Hill Education.

2. Computers as Components –Wayne Wolf, Morgan Kaufmann (second edition).

REFERENCE BOOKS:

1. Embedded System Design -frank vahid,tonygrivargis, john Wiley.

2. Embedded Systems- An integrated approach - Lyla b das, Pearson education2012.

3. Embedded Systems – Raj Kamal,TMH

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Understand the design process of an embeddedsystem
2. Understand typical embedded System & itscomponents
3. Understand embedded firmware designapproaches
4. Learn the basics of OS andRTOS

Course Prerequisites: Digital Electronics, Analog Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC601 C	FPGA & Reconfigurable computing	3L:0T:0P	3 credits

Unit	Topic	No. of Lectures
Unit I	Introduction to Reconfigurable Computing Systems: Objectives, Expectations, Logistics, characterization of Reconfigurable Computing & Reconfigurable Hardware, Reconfigurable Software, RC architectures- Fine Grain and Coarse Grain, Hybrid and Embedded Architectures	5
Unit II	FPGA and its internal architecture, computing elements, LUT, BRAM, interconnects, I/O Blocks, programming of FPGA and interfacing case study, ALU design, designing with embedded processors, introduction to Power PC and ARM processors, basics of system on chip, architecture of ZYNQ processor.	6
Unit III	Design cycle, algorithms, Hardware Description Language, VHDL, different design styles: data flow, structural and behavioral and practical logic circuit implementation example on FPGA, debugging, writing test bench, High level synthesis and Low level synthesis.	5
Unit IV	High level synthesis for reconfigurable devices. Modelling, Dataflow graph, sequencing graph, Finite State Machine with Datapath, Temporal Partitioning, Temporal Partitioning Algorithms, Network Flow, Local optimization: Context Switching, Time Multiplexing and Configuration Switching	6
Unit V	Temporal placement, Offline and online temporal placement, Managing the Device's Free Space with Empty Rectangles, Managing the Device's Occupied Space	4
Unit VI	RC for DSP, DSP application building blocks, RC for Image processing, Bioinformatics and Network Security	4

Text Books :

1. C. Bobda, Introduction to Reconfigurable Computing : Architectures, Algorithm and Applications,
2. C. Maxfield ; The design Warrior's Guide to FPGAs: Devices, Tools and Flows, Newnes, 2004
3. M. Gokhale and P. Graham; Reconfigurable Computing: Accelerating Computation with FPGAs, Springer

Reference Books :

1. W. Wolf , FPGA Based Systems Design, PHI, 2004
2. P. Lysagt and W. Rosenstiel, New Algorithms, Architectures and Applications for Reconfigurable Computing, Springer,2005

Course Outcomes:

CO1: Identify mapping algorithms into architectures.

CO2: Summarize various delays in combinational circuit and its optimization methods. CO3: Summarize circuit design of latches and flip-flops.

CO4: Construct combinational and sequential circuits of medium complexity, that is based on VLSIs, and programmable logic devices.

CO5: Summarize the advanced topics such as reconfigurable computing, partially reconfigurable, Pipeline reconfigurable architectures and block configurable.

Course Prerequisites: Knowledge of Communication Engineering

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC601D	Mobile communication and Network	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	**Operation of Mobile Communication Networks**: Operation of first, second, and third generation wireless networks: cellular systems, medium access techniques, Mobile networks Elementary Principles of cellular Telephony Channel Division Techniques (TDMA, FDMA, CDMA) Cellular Coverage Methods Network Planning and Resource Allocation, Network Dimensioning, Mobility Management Procedures	7
Unit 2	**Propagation Models and Air Protocols**: Radio propagation models, error control techniques, handoff, power control, soft handover, Forward link, Reverse link, common air protocols (AMPS, IS-95, IS-136, GSM, GPRS, EDGE, WCDMA, CDMA2000, etc)	5
Unit 3	**Mobile Network Architecture:** General Architecture definition, Mobile Terminals (MT, SIM) Radio Section (BTS, BSC) Core Network (MSC, G-MSC, VLR, HLR, AuC) User and Control Plane Protocol Stack, MAP & SS#7, the Key Role of Signalling Interfaces and Network Entities Relation The Physical Channel, The Logical Channels Terminal, Call and Network Management Procedures, Network Planning.	7
Unit 4	**Wireless Local Area Networks:** Wireless Local Area Networks, General Characteristics of the Hyper LAN System, 802.11 Standard, Basic DCF access scheme DCF Access Scheme with Handshaking, PCF Access Scheme, The 802.11a Standard, Mobile Ad Hoc Networks, Wireless Sensor Networks, Routing Energy Efficiency, Localization, Clustering.	6
Unit 5	**Security Issues In Wireless Networks**: Security in Wireless Networks, Secure routing, Key Pre-distribution and Management, Encryption and Authentication, Security in Group Communication, Trust Establishment and Management, Denial of Service Attacks, Energy-aware security mechanisms, Location verification, Security on Data fusion.	7

Course Prerequisites: Introduction to computing

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS(EC)601A	Object Oriented Programming	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	paradigm: Evolution of programming paradigm, structured versus object-oriented development, Introduction to Object oriented programming concepts: Objects, classes, encapsulation and abstraction, inheritance, polymorphism, dynamic binding, message passing.	4
Unit 2	Moving from C to C++: Introduction to C++, streams based I/O, name space, scope resolution operator (::), variable declaration at the point of use, variable aliases-reference variables, strict type checking, parameter passing by reference, inline function, function overloading, default arguments.	4
Unit 3	Object and Classes: Specifying and using classes, access specifies: private, public, functions and data members, default arguments, function overloading, friend functions, static members. Objects: memory considerations for objects, new and delete operators. **Constructors** - default constructor, parameterized constructor, constructor with dynamic allocation, copy constructor, destructors. **Operator overloading**- overloading through friend and member functionsBinary operators: arithmetic, relational, assignment , insertion, extractionUnary operators: unary minus , post and pre-increment, post and pre- decrement, Conversion functions : class to basic, basic to class, class to class.	8
Unit 4	Inheritance: Derived and base classes, Class hierarchies, public, private, and protected derivations, constructors in derived classes, destructors in derived classes, constructors invocation and data members initialization in derived classes, classes within classes, virtual base class.	6
Unit 5	Polymorphism: Pointer to objects, pointer to derived class object, this pointer, run time and compile time polymorphism, virtual functions, pure virtual functions, abstract class, virtual destructor. **Files and Streams:** Introduction to file handling, hierarchy of file stream classes, opening and closing of files, file modes, file pointers and their manipulators, sequential access, random access.	6
Unit 6	Exception handling and Templates : Introduction to exception handling, throw point outside try, Multiple catch, Catch-all, throwing objects. Introduction to templates, class templates, function templates	4

Text Book

1. Object Oriented Programming with C++, E. Balaguruswamy, 6th Edition, 2013 TMG Hill
2. Object Oriented Programming with C++, R.S. Salaria, Khanna Publishing House, New Delhi.

Reference Book

1. Object Oriented Programming with C++, Reema Thareja, OXFORD University Press, 1st Edition, 2015.
2. C++ completes reference, Herbert Schildt, TMG Hill, 4th Edition, 2002.
3. C++ How to Program, Deitel and Deitel, Pearson Education Asia, 8th Edition, 2011.
4. Object Oriented Programming with Ansi and Turbo C++, Ashok N Kamthane, Pearson Education, 1stEdition, 2003.
5. Object-Oriented Programming in C++, Robert Lafore, CourseSams Publishing, 4th Edition

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

- differentiate between structures oriented programming and object oriented programming.
- use object oriented programming language like C++ and associated libraries to develop object orientedprograms.
- understand and apply various object oriented features like inheritance, data abstraction, encapsulation andpolymorphism to solve various computing problems using C++ language.
- apply concepts of operator-overloading, constructors and destructors.
- apply exception handling and use built-in classes from STL.

Course Prerequisites: Knowledge of Computer Fundamentals, Data Structure

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS(EC)601B	Data Base Management	**3L:0T:0P**	**3credits**

sss	Topic	No. of Lectures
Unit 1	Introduction:Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.	**3**
Unit 2	Entity:Relationship Model:Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.	**4**
Unit 3	Relational Model:Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views,Modifications Of the database.	**4**
Unit 4	SQL and Integrity Constraint:Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.	**5**
Unit 5	Relational Database Design:Functional Dependency, Different anamolies in designing a Database., Normalization using funtional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Nomalization using multi-valued depedencies, 4NF, 5NF	**5**
Unit 6	Internals of RDBMS:Physical data structures, Query optimization : join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management : transaction model properties, state serializability, lock base protocols, two phase locking.	**5**
Unit 7	Internals of RDBMS:Internals of RDBMS	**4**
Unit 8	File Organization & Index structures:File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree .	**4**

Text Book

1.. Henry F. Korth and Silberschatz Abraham, “Database System Concepts”, Mc.Graw Hill.
2, Elmasri Ramez and Novathe Shamkant, “Fundamentals of Database Systems”, Benjamin Cummings Publishing. Company.
3. Ramakrishnan: Database Management System , McGraw-Hill
4. Gray Jim and Reuter Address, “Transaction Processing : Concepts and Techniques”, Moragan Kauffman Publishers.
5. Jain: Advanced Database Management System CyberTech
6. Date C. J., “Introduction to Database Management”, Vol. I, II, III, Addison Wesley.
7. Ullman JD., “Principles of Database Systems”, Galgottia Publication. Reference:
8. James Martin, “Principles of Database Management Systems”, 1985, Prentice Hall of India, New Delhi
9. “Fundamentals of Database Systems”, Ramez Elmasri, Shamkant B.Navathe, Addison Wesley Publishing Edition
10. “Database Management Systems”, Arun K.Majumdar, Pritimay Bhattacharya, Tata McGraw Hill

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

1. Use the basic concepts of Database Systems in Database design.
2. Apply SQL queries to interact with Database.
3. Design a Database using ER Modelling.
4. Apply normalization on database design to eliminate anomalies.
5. Analyze database transactions and can control them by applying ACID properties.

Course Prerequisites: Knowledge of Vectors, mathematics

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS(EC)601C	Internet of Things (IoT)	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	The Internet of Things: an Overview: The flavour of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things,Enchanted Objects, Who is Making the Internet of Things?	
Unit 2	Design Principles for Connected Devices: Calm and Ambient Technology, Magic as Metaphor, Privacy, Web Thinking for Connected Devices, Affordances.	4
Unit 3	Internet Principles: Internet Communications: An Overview (IP, TCP, The IP Protocol Suite (TCP/IP), UDP), IP Addresses (DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6), MAC Addresses, TCP and UDP Ports, Application Layer Protocols.	4
Unit 4	Prototyping: Thinking About Prototyping: Sketching, Familiarity, Costs versus Ease of Prototyping, Prototypes and Production, Open Source versus Closed Source, Tapping into the Community. Prototyping Embedded Devices: Electronics, Embedded Computing Basics, Developing on the Arduino, Raspberry Pi, Beaglebone Black, Electric Imp, Mobile Phone and Tablets, Plug Computing: Always-on Internet of Things.	6
Unit 5	Prototyping the Physical Design: Preparation, Sketch, Iterate, and Explore, Non-digital Methods, Laser Cutting, 3D Printing, CNC Milling, Repurposing/Recycling. Prototyping Online Components: Getting Started with an API, Writing a New API, Real-Time Reactions, Other Protocols.	6
Unit 6	Prototype to Reality: Business Models: A Short History of Business Models, The Business Model Canvas, Who Is The Business Model For Models, Funding an Internet of Things Startup, Lean Startups. Moving to Manufacture: What Are You Producing?, Designing Kits, Designing Printed Circuit Boards, Manufacturing Printed Circuit Boards, Mass-Producing the Case and Other Fixtures, Certification, Costs, Scaling Up Software, Ethics: Characterizing the Internet of Things, Privacy, Control, Environment, Solutions. **Techniques for Writing Embedded Code:** Memory Management, Performance and Battery Life, Libraries, Debugging.	10

Text Book

1. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley publication, 1st Edition, November 2013.

2. Jeeva Jose, Internet of Things, Khanna Publishing House, New Delhi (AICTE Recommended – 2018)

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

1. understand the application areas of IOT.
2. realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
3. understand building blocks of Internet of Things and characteristics.

Course Prerequisites: Basic Mathematics, Programming in C, C++

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS(EC)601D	Numerical Methods in Engineering	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	Approximation in numerical computation: Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors. Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation. Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms.	12
Unit 2	Numerical solution of a system of linear equations: Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method. Numerical solution of Algebraic equation: Bisection method, Regula-Falsi method, Newton-Raphson method.	10
Unit 3	Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor- Corrector methods and Finite Difference method.	8

Text Books:

1. C.Xavier: C Language and Numerical Methods.
2. R.S. Salaria, Computer Oriented Numerical Methods, Khanna Publishing House.
3. Dutta & Jana: Introductory Numerical Analysis.
4. J.B.Scarborough: Numerical Mathematical Analysis.
5. Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).

References:

1. Balagurusamy: Numerical Methods, Scitech.
2. Baburam: Numerical Methods, Pearson Education.
3. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
4. Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
5. Srimanta Pal: Numerical Methods, OUP.

Course Prerequisites: Knowledge of Digital Communication, DSP and VLSI

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC691	Laboratory on Digital Communication, DSP and VLSI	**3L:0T:0P**	**3credits**

Laboratory on Digital Communication:

- Design, implementation and study of all the properties of 7-length and 15-length pn sequences using shift register.
- Study of PAM and demodulation.
- Study of PCM and demodulation.
- Study of line coders: polar/unipolar/bipolar NRZ ,RZ and Manchester.
- Study of delta modulator and demodulator.
- Study of adaptive delta modulator and demodulator.
- Study of BPSK modulator and demodulator.
- Study of BFSK modulator and demodulator.
- Study of ASK modulator and demodulator.
- Study of QPSK modulator and demodulator.
- Simulation study of probability of symbol error for BPSK modulation.
- Simulation study of probability of symbol error for BFSK modulation.

Laboratory on Digital Signal Processing

Simulation Laboratory using standard Simulator:

1. Sampled sinusoidal signal, various sequences and different arithmetic operations.
2. Convolution of two sequences using graphical methods and using commands verification of the properties of convolution.
3. Z-transform of various sequences - verification of the properties of Z-transform.
4. Twiddle factors - verification of the properties.
5. DFTs / IDFTs using matrix multiplication and also using commands.
6. Circular convolution of two sequences using graphical methods and using commands, differentiation between linear and circularconvolutions.
7. Verifications of the different algorithms associated with filtering of long data sequences and Overlap -add and Overlap-save methods.
8. Butterworth filter design with different set of parameters.
9. FIR filter design using rectangular, Hamming and

Blackman windows. Hardware Laboratory using DSP

Processor and Xilinx FPGA

Laboratory on VLSI

Laboratory 1. Familiarity with Spice simulation tool (3 Hrs.)
Laboratory 2. Spice Simulation of Inverter , NAND , NOR Gates. (3 Hrs.)
Laboratory 3 Familiarity with EDA tools for VLSI design /FPGA based system design (6 Hrs.) Laboratory 4. Layouts ,Transistors and tools (3 Hrs.)
Laboratory 5. Standars cell Design (3 Hrs.)
Laboratory 6. Design of CMOS XOR/XNOR Gates. (3 Hrs.)
Laboratory 7. Design of CMOS Full adder (3 Hrs.)
Laboratory 8. Design of CMOS Flip flops (R-S ,D , J-K) (3 Hr.s) Laboratory 9. Design of 8 bit synchronous Counter (3 Hrs.)
Laboratory 10. Design of 8 bit bi-directional register with tri-stated input/output bus (3 Hrs.) Laboratory 11. Design of a 12 bit CPU with few instructions and implementation and validation on FPGA (15 Hrs.)

SC	**Subject Name**	**Contact Hrs/Week**	**Credits**
PR-EC681	Design	**0L:0T:2P**	**2credits**

There shall be a Mini Project Design, which the student shall carryout immediately after Third year first semester examinations and pursue it during 6th semester. One supervisor will be assigned to each group of students. Groups will be formed by the Project coordinator of the department. Mini Project Design shall be submitted in a report form, duly approved by the departmental internal evaluation committee, and presented before the examination committee at the end of 6th semester. It shall be evaluated for 100 marks as sessional. The examination committee consists of different faculty members of the department, Head of the Department, supervisor of the mini project design. There shall be no internal marks for Mini Project/ design.

4th Year

CC	SC	Subject Name	Contact Hrs./Week	
			L –T-P-TO	Cr.
PCC	PC-EC701	Microwave & Radar	3-0-0-3	3
PEC	PE-EC702	Professional Elective-V d) Mixed signal VLSI design e) Electronics Design and Automation f) Satellite Communication g) d)Architectural Design of ICs	3-0-0-3	3
OEC	OE-CS (EC)701	Open Elective-II e) Artificial Intelligence f) Software Engineering g) Cryptography and CyberSecurity h) Consumer Electronics	3-0-0-3	3
OEC	OE-EC (EC)702	Open Elective-III a) Digital Image Processing b) Robotics c) Adhoc Networks d) Operating Systems	3-0-0-3	3
OEC	OE-EC (EC)703	Open Elective-IV e) Biomedical SignalProcessing f) SYSTEMS BIOLOGY:MODELING AND CONTROL g) Internet Technology h) Renewable Energy	3-0-0-3	3
PCC	PC-EC791	Laboratories on Microwave and Antenna Lab.	0-0-4-4	2
Proj	PR-EC781	Project-I	0-0-8-8	4
Total Credit			15-0-12-27	21

Course Prerequisites: Network Theory, Electromagnetism, Solid State Devices.

SC	Subject Name	Contact Hrs/Week	Credits
PC-EC701	**Microwave and Radar**	**3L:0T:0P**	**3 credits**

Unit	Topic	No. of Lectures
Unit I	Introduction: RF & Microwave Spectrum, Historical Background, Advantages and Disadvantages of Microwaves, Typical applications of RF & Microwaves	2
Unit II	Microwave Waveguides: Limitations of two wire transmission lines in microwave propagation, Introduction to waveguides, Rectangular and Circular Waveguides– Mode structures, Cut-off frequency, Propagation Characteristics, wall currents, Attenuation constant, waveguide excitations.	4
Unit III	Waveguide Passive Components: Waveguide Resonators – Rectangular & Cylindrical; Resonant frequencies, Mode structures, Q-factor, Co-axial Resonators; Excitation & coupling of cavities, Design of resonators.	3
Unit IV	N-port networks – circuit representations, Z-matrix, Y-matrix, S-matrix, transmission matrix,; their relationships; attenuators, phase shifter, directional couplers, Bethe-hole coupler, E- and H-plane Tee, Magic tee, hybrid ring, circulators, isolators	4
Unit V	Microwave Tubes: Limitations of conventional tubes in microwaves; Two Cavity Klystron, Multi-cavity Klystron, Reflex klystron; Magnetron, Travelling wave tube, Backward wave oscillator – working principles, characteristics.	4
Unit VI	Semiconductor Microwave Devices: Tunnel diode; Gunn diode–design considerations for their waveguide mount. Avalanche diode – IMPATT, TRAPATT, Microwave bipolar transistor, hetero-junction bipolar transistor, Microwave field-effect transistor–JFET, MOSFET, MESFET, Parametric amplifiers; ICs	5
Unit VII	Radar systems – Radar block diagram, radar equation, detection of signals in noise and signal-to-noise ratio, Probabilities of detection & False alarm, integration of radar pulses, radar cross section, distributed targets, Transmitted power, pulse-repetition frequency, antenna parameters & system losses, introduction to radar clutter. Pulsed radar, CW radars, MTI, ILS, Tracking radars, Altimeter- Principles of operation.	4
Unit VIII	Microwave Measurements: Microwave Bench, Slotted line, Tunable Probe, VSWR Meter, Slide screw tuner, Variable shorted line – operating principles with diagrams. Measurements of VSWR – Low, Medium and High, Measurement of Power – Calorimetric method, Thermocouple, Bolometers, Frequency measurement, Impedance measurement by shift in minima. Network Analyzers, TDR, and Spectrum analyzer.	4

Text Books :

4. Microwave Devices and Circuits by Samuel Y. Liao - PHI
5. Microwave Engineering by Sushrut Das - Oxford
6. Microwave Engineering by Monojit Mitra- Dhanpat Rai and Co.

Reference Books :

9. Microwave Engineering by David M. Pozar- John Wiley and Sons, Inc.
10. Fundamentals of Microwave and Radar Engineering by K.K.Sharma – S Chand and Co.
11. Foundations for Microwave Engineering by RE Collin- John Wiley and Sons, Inc.
12. Fundamentals of Radar, Sonar and Navigation Engineering by K.K.Sharma – S.K Kataria and Sons
13. Electronic Communication Systems by Kennedy, Davis-Tata McGraw-Hill

Course Outcomes:

(23) Graduates will gain a brief idea about microwaves.

(24) Graduates will gain an adequate knowledge about waveguides.

(25) Graduates will be able to design microwave networks which is useful in the areas of communication engineering, radar.

(26) Graduates will be able to design high frequency amplifiers, filters, oscillators which are nescessary in communication engineering.

(27) Graduates will gain an adequate knowledge of microwave semiconductor devices.

(28) Graduate will gain an adequate knowledge about radar engineering which is useful in the areas of communication engineering, military, airport, etc.

(29) Graduates will gain an adequate knowledge about the measuring instruments in microwave engineering.

Course Prerequisites: Basic knowledge of Electronics, VLSI circuits and systems

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC702A	**Mixed Signal VLSI Design**	**3L:0T:0P**	**3 credits**

Unit	Topic	No. of Lectures
Unit I	Analog and discrete-time signal processing, introduction to sampling theory;Analog continuous-time filters: passive and active filters; Basics of analog discrete-time filters and Z-transform.	06
Unit II	Switched-capacitor filters- Nonidealities in switched-capacitor filters; Switched-capacitor filter architectures; Switched-capacitor filter applications.	06
Unit III	Basics of data converters; Successive approximation ADCs, Dual slope ADCs,Flash ADCs, Pipeline ADCs, Hybrid ADC structures, High-resolution ADCs, DACs.	06
Unit IV	Mixed-signal layout, Interconnects and data transmission; Voltage-mode signalling and data transmission; Current-mode signaling and data transmission.	06
Unit V	Introduction to frequency synthesizers and synchronization; Basics of PLL, Analog PLLs; Digital PLLs; DLLs.	06

Text Books :

1. Behzad Razavi , Design of analog CMOS integrated circuits, McGraw-Hill, 2003.
2. R. Jacob Baker, CMOS mixed-signal circuit design, Wiley India, IEEE press, reprint 2008.

Reference Books :

1. R. Jacob Baker, CMOS circuit design, layout and simulation, Revised second edition, IEEE press, 2008.
2. Rudy V. dePlassche, CMOS Integrated ADCs and DACs, Springer, Indian edition, 2005.
3. Arthur B. Williams, Electronic Filter Design Handbook, McGraw-Hill, 1981.
4. R. Schauman, Design of analog filters by, Prentice-Hall 1990 (or newer additions).
5. M. Burns et al., An introduction to mixed-signal IC test and measurement by, Oxford university press, first Indian edition, 2008.

Course Outcomes:

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

1. Understand the practical situations where mixed signal analysis is required.

2. Analyze and handle the inter-conversions between signals.

3. Design systems involving mixed signals

Course Prerequisites: VLSI

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC702B	Electronics Design and Automation	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit I	**Introduction:**General Purpose Computing, Domain Specific Processors, Application Specific Processors, Reconfigurable Computing, Fields of Application	5
Unit II	**Implementation:** Integration, FPGA Design Flow, Logic Synthesis	5
Unit III	Revisit of High level Synthesis, Modeling, Temporal Partitioning Algorithms, Temporal Placement: Off-Line Temporal Placement, On-Line Temporal Placement	7
Unit IV	ON-LINE COMMUNICATION: Direct Communication, Communication Over Third Party, Bus-based Communication, Circuit Switching, Network on Chip, The Dynamic Network on Chip (DyNoC)	7
Unit V	PARTIAL RECONFIGURATION DESIGN: Partial Reconfiguration on Virtex Devices, Bitstream Manipulation with *JBits*, The Modular Design Flow, The Early Access Design Flow, Creating Partially Reconfigurable Designs, Partial Reconfiguration using Handel-C Designs, Platform design, Enhancement in the Platform Design	6

Text Books :

1. Practical Problems in VLSI Physical Design Automation, Sung Kyu Lim, Springer, 2008, ISBN 978-1402066269
2. M. Gokhale and P. Graham; Reconfigurable Computing: Accelerating Computation with FPGAs, Springer

Reference Books :

1. VLSI Physical Design Automation: Theory and Practice, Sadiq M. Sait and Habib Youssef, World Scientific, 1999, ISBN 978-9810238834

Course Outcomes:

1. Write their own computer aided design tools
2. Implement common algorithms to design circuit and systems
3. Transform a circuit from a structural to a gate-level representation.
4. Create a tool for circuit partitioning and floorplanning
5. Understand how to perform placement and routing
6. Analyze the complexity of design automation algorithms

Course Prerequisites: EM Theory, Communication engineering

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC702C	Satellite Communication	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	**Introduction to Satellite Communication:** Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications and frequency bands used for satellite communication.	3
Unit 2	**Orbital Mechanics:** Orbital equations, Kepler's laws, orbital parameters, orbital perturbations, station keeping, Geo-stationary and Non-Geo-stationary orbits, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc. of a satellite, concepts of Solar day and Sidereal day, Geo-stationary satellites and Non geostationary satellites.	6
Unit 3	**Space Segment:** Study of Architecture and Roles of various sub-systems of a satellite system such as power sub-systems, Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Thermal control, Communication sub-system, power sub-systems etc. **Typical Phenomena in Satellite Communication:** Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.	
Unit 4	**Satellite link budget:** Basic link analysis,Power Budget equation, Interference analysis, Transmission Losses, Rain induced attenuation and interference, Ionospheric characteristics,Uplink and Downlink, Link Design with and without frequency reuse. Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions.	
Unit 5	**Satellite Access and Coding:** Modulation and Multiple Access methods, Various modulation schemes used in satellite communication, Meaning of Multiple Access, Multiple access schemes based on time, frequency, and code sharing namely TDMA, FDMA and CDMA, compression and encryption, Coding Schemes.	

Text Books:

1. Timothy Pratt Charles W. Bostian, Jeremy E. Allnutt: Satellite Communications: Wiley India. 2nd edition 2002
2.Tri T. Ha: Digital Satellite Communications: Tata McGraw Hill, 2009
3.Dennis Roddy: Satellite Communication: 4th Edition, McGraw Hill,2009

Reference Books:

1. Wilbur L. Pritchard, Hendri G. Suyderhoud, Robert A. Nelson: Satellite Communication Systems Engineering, Prentice Hall/Pearson, 2007.
2. Bruce R. Elbert: The Satellite Communication Applications, Hand Book, Artech House Bostan London, 1997.
3. G.B. Bleazard: Introducing Satellite communications, NCC Publication, 1985.
4. M. Richharia:Satellite Communication Systems-Design Principles, Macmillan 2003.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the basics of satellite orbits
2. Visualize the architecture of satellite systems as a means of high speed, high range communication system.
3. State various aspects related to satellite systems such as orbital equations, sub-systems in a satellite, link budget, modulation and multiple access schemes of satellites.
4. Solve numerical problems related to orbital motion and design of link budget for the given parameters and conditions.

Course Prerequisites: EM Theory, Communication engineering

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC702D	Architectural Design of ICs	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	VLSI Design flow, general design methodologies, Mapping algorithms into Architectures: Signal flow graph, data dependences, data-path synthesis, control structures, critical path and worst case timing analysis, concept of hierarchical system design; Data-path element: Data-path design philosophies, fast adder, multiplier, driver etc	9
Unit 2	Data-path optimization, application specific combinatorial and sequential circuit design, CORDIC unit; Pipeline and parallel architectures: Architecture for real time systems, latency and throughput related issues, clocking strategy, power conscious structures, array architectures; Control strategies: Hardware implementation of various control structures, micro-programmed control techniques, VLIW architecture	9
Unit 3	Testable architecture: Controllability and observability, boundary scan and other such techniques, identifying fault locations, self-reconfigurable fault tolerant structures.	8
Unit 4	Trade-off issues: Optimization with regard to speed, area and power, asynchronous and low power system design, ASIC (application specific integrated circuits) and ASISP (application specific instruction set processors) design	6

Text Books:

1. U. Meyer-Baese, Digital Signal Processing with Field Programmable Gate Arrays, Springer-Verlag, 2001.
2. S. Y. Kung, VLSI Array Processors.Prentice, Prentice-Hall, 1988.
3. K. Parhi, VLSI Digital Signal Processing Systems, Wiley & Sons, 1999.
4. J. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits: A Design Perspective, Prentice Hall, Second Edition, 2003.

Course Outcomes:

At the end of this course students will demonstrate the ability to

Apply algorithm, architecture and circuit design trade-offs to optimize for power, performance and area.

Course Prerequisites: Basic of Mathematics and Statistics

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS(EC)-701A	**Artificial Intelligence**	**3L:0T:0P**	**3 credits**

Unit	Topic	No. of Lectures
Unit I	History of artificial intelligence, The birth of artificial intelligence, AI Winters, Todays' AI, Historical milestones in the development of AI, Great contributors, People who have influenced AI , Differences between strong AI and weak AI, Artificial Intelligence definitions, Emergence of AI – Technological advances, Difference between Machine Learning, Deep Learning, AI, Functions of AI, Characteristics of artificial intelligence, Applications of AI, Cognitive science and AI, Cognition and process of Cognition	03
Unit II	Problems, Problem Space & search: Defining the problem as state space search, production system, problem characteristics, issues in the design of search programs. Breadth first search and depth first search techniques. Heuristic search Techniques: Hill Climbing, Iterative deepening DFS, bidirectional search. Analysis of search methods. A* algorithm, and their analysis. genetic algorithms; constraint satisfaction problems, local search for constraint satisfaction problems. Adversarial search: Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.	10
Unit III	Knowledge Representation, Problems in representing knowledge, propositional and predicate logic, logical consequences, syntax and semantics of an expression, semantic Tableau. Forward and backward reasoning. Proof methods, substitution and unification, conversion to clausal form, normal forms, resolution, refutation, deduction, theorem proving, in monotonic and non monotonic reasoning.	04
Unit IV	Fuzzy sets – Crisp and fuzzy relations – Cardinality – properties and operations – Composition – Tolerance and equivalence relations – Simple problems –Features of membership function – Standard forms and boundaries – Fuzzification – Membership value assignments – Fuzzy to crisp conversions – Lambda cuts for fuzzy sets and relations –Defuzzification methods.	5
Unit V	Probability, Basic concepts, Probability of an event, Example on Sample Space, counting rules, Event relations, Conditional Probabilities, Defining Independence, The Law of Total Probability, Bayes' Rule	3
Unit VI	Expert systems: Representing and using domain knowledge, expert system shells, knowledge acquisition. Introduction to Artificial Neural Network. Planning: Overview, components of a planning system, Goal stack planning, Hierarchical planning, other planning techniques.	4
Unit VII	Application of AI, Natural language processing: Introduction, Syntactic processing, semantic analysis, discourse & pragmatic processing.	2

Text Books :

1. Artificial Intelligence, Ritch & Knight, TMH
2. Artificial Intelligence A Modern Approach, Stuart Russel Peter Norvig Pearson
3. Introduction to Artificial Intelligence & Expert Systems, Patterson, PHI

Course Outcomes:

Upon completion of this course, the students will be able to
1. Understand the concept of Artificial Intelligence.
2. Familiarize with Knowledge based AI systems and approaches.
3. Apply the aspect of Probabilistic approach to AI.
4. Identify the Neural Networks and NLP in designing AI models.
5. Recognize the concepts of Machine Learning and its deterministic tools.

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS(EC)701B	Software Engineering	**3L:0T:0P**	**3 credits**

Unit	Topic	No. of Lectures
Unit I	**Introduction to Software Engineering:** The evolving role of software, changing nature of software, software myths. **A Generic view of process:** Software engineering- a layered technology, a process framework, the capability maturity model integration (CMMI), process patterns, process assessment, personal and team process models. **Process models:** The waterfall model, incremental process models, evolutionary process models, the unified process.	07
Unit II	**Software Requirements:** Functional and non-functional requirements, user requirements, system requirements, interface specification, the software requirements document. **Requirements engineering process:** Feasibility studies, requirements elicitation and analysis, requirements validation, requirements management. **System models:** Context models, behavioral models, data models, object models, structured methods.	07
Unit III	**Design Engineering:** Design process and design quality, design concepts, the design model. **Creating an architectural design:** software architecture, data design, architectural styles and patterns, architectural design, conceptual model of UML, basic structural modeling, class diagrams, sequence diagrams, collaboration diagrams, use case diagrams, component diagrams.	06
Unit IV	**Testing Strategies:** A strategic approach to software testing, test strategies for conventional software, black-box and white-box testing, validation testing, system testing, the art of debugging. **Product metrics:** Software quality, metrics for analysis model, metrics for design model, metrics for source code, metrics for testing, metrics for maintenance.	06

Unit V	**Metrics for Process and Products:** Software measurement, metrics for software quality. **Risk management:** Reactive Vs proactive risk strategies, software risks, risk identification, risk projection, risk refinement, RMMM, RMMM plan.	04
Unit VI	**Quality Management:** Quality concepts, software quality assurance, software reviews, formal technical reviews, statistical software quality assurance, software reliability, the ISO 9000 quality standards	02

TEXT BOOKS:

1. Software Engineering, A practitioner's Approach- Roger S. Pressman, 6th edition, Mc Graw Hill International Edition.
2. Software Engineering- Sommerville, 7th edition, Pearson Education.
3. The unified modeling language user guide Grady Booch, James Rambaugh, Ivar Jacobson, Pearson Education.

REFERENCE BOOKS:

1. Software Engineering, an Engineering approach- James F. Peters, Witold Pedrycz, John Wiley.
2. Software Engineering principles and practice- Waman S Jawadekar, The Mc Graw-Hill Companies.
3. Fundamentals of object-oriented design using UML Meiler page-Jones: Pearson Education.

COURSE OUTCOMES:

- Ability to translate end-user requirements into system and software requirements, using e.g. UML, and structure the requirements in a Software Requirements Document (SRD).
- Identify and apply appropriate software architectures and patterns to carry out high level design of a system and be able to critically compare alternative choices.
- Will have experience and/or awareness of testing problems and will be able to develop a simple testing report

Course Prerequisites: Basic knowledge of Network, Algorithms, Mathematics.

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS(EC)701C	**Cryptography & Cyber Security**	**3L:0T:0P**	**3 credits**

Unit	Topic	No. of Lectures
Unit I	Basics of Algebra and Number Theory: Integer ArithmeticModular Arithmetic-Algebraic structures – Prime Numbers - Fermat's and Euler's Theorem – Factorization - Chinese Remainder Theorem - Linear and Quadratic Congruence - Discrete Logarithms	02
Unit II	Introduction to Security:-Security Goals – Security services (Confidentiality, Integrity, Authentication, Non-repudiation, Access control) – Security Mechanisms (Encipherment, Data Integrity, Digital Signature, Authentication Exchange, Traffic Padding, Routing Control, Notarization, Access control) - 7 15% Security Principles. Introduction to Cryptography:- Kerckhoff's Principle - Classification of Cryptosystems, Cryptanalytic attacks- Cipher Properties (Confusion, Diffusion).	05
Unit III	Traditional Secret Key Ciphers:- Substitution Ciphers (mono alphabetic ciphers, poly alphabetic ciphers)-Transposition Ciphers-Stream and Block Ciphers. Modern Secret Key Ciphers:- Substitution Box-Permutation Box-Product Ciphers	02
Unit IV	Data Encryption Standard (DES) (Fiestel and Non-Fiestel Ciphers, Structure of DES, DES Attacks, 2-DES, 3-DES) - Advanced Encryption Standard (AES) (Structure, Analysis)- Cryptographic Hash Functions– Properties - Secure Hash Algorithm-Message Authentication Code (MAC).	03
Unit V	Public Key Cryptosystems (PKC): - Types of PKC –Trapdoor - one way functions -RSA Cryptosystem (Integer Factorisation Trapdoor, Key Generation, Encryption, Decryption) - El Gamal Cryptosystem (Discrete Logarithm Trapdoor, Key Generation, Encryption, Decryption) - Diffie-Hellman Key Exchange Protocol, Man in the Middle attack on Diffie-Hellman Protocol.	04
Unit VI	Digital Signature:-Signing – Verification - Digital signature forgery (Existential forgery, Selective forgery, Universal forgery) - RSA Digital Signature Scheme - ElGamal Signature Scheme - IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security PayloadIntruders, Intrusion Detection, Distributed Denial of Service attacks	04
UNIT VII	Digital Signatures: Digital Signatures, Elgamal Digital Signature Techniques, Digital signature standards (DSS), proof of digital signature algorithm. Introduction to Cyber Crime and security: Cyber Crimes, types of Cyber Crime, hacking, attack vectors, Cross Site Scripting (XSS), XSS Consequences. Cyber Space and criminal behaviour, traditional problems associated with Cyber Crime, Introduction to Incident Response, Digital Forensics – Phishing.	05

Text Books :

1. Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography & Network Security, Second Edition, Tata McGraw Hill, New Delhi, 2010
2. Douglas R. Stinson, "Cryptography: Theory and Practice", Third Edition, CRC Press.
3. William Stallings, "Cryptography and Network Security – Principles and Practices", Pearson Education, Fourth Edition, 2006.

Reference Books :

14. Atul Kahate, "Cryptography and Network Security", 2nd Edition, Tata McGraw Hill, 2003.
15. Bruce Schneier, "Applied Cryptography: Protocols, Algorthms, and Source Code in C", Second Edition, John Wiley and Sons Inc, 2001.
16. Wenbo Mao, " Modern Cryptography- Theory & Practice", Pearson Education, 2006.
17. Thomas Mowbray, "Cybersecurity : Managing Systems Conducting Testing, and Investigating Intrusions", John Wiley, 2013
5. Nina Godbole and Sunit Belpure, Cyber Security: Understnding Cyber Crimes, Computer Foreinsics ans legal Perspectives, Wiley India Pvt. Ltd
6 .Dr T R Padmanabhan N Harini,"Cryptography and Security Paperback", Wiley India

Course Outcomes:

(30) Graduates will be able to apply knowledge of mathematics behind Cyber security in the solution.

(31) Graduates will demonstrate an ability to identify, formulate, analyze and solve security problems.

(32) Graduates will demonstrate an ability to design Cyber security, conduct experiments, analyze and interpret the resulting data.

(33) Graduates will demonstrate an ability to design a system create an awareness for the design of various cryptographic primitives

(34) Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary task.

(35) Graduate will demonstrate skills to use modern engineering software and equipment to analyze problems.

(36) Graduates will have an understanding of professional and ethical responsibilities.

(37) Graduates will be able to communicate effectively.

(38) Graduate will show the understanding of impact of engineering solutions on the society, environment and awareness of contemporary issues.

(39) Graduates will develop confidence for self-education and ability for life-long learning.

(40) Graduates who can participate and succeed in competitive examination

Course Prerequisites: Basic knowledge of Electronics, Analog Electronics, Digital Electronics,opto/photo electronics

SC	***Subject Name***	**Contact Hrs/Week**	**Credits**
OE-CS (EC)701D	*Consumer Electronics*	**3L:0T:0P**	**3 credits**

Text Books / Reference Books :

1. Consumer Electronics, S.P.Bali, PEI, Delhi
2. Audio Video system Principles maintenance and troubleshooting, R.G.Gupta, Mc Graw Hill, New Delhi
3. Audio video systems: Principle Practices and Troubleshooting, S.P.Bali and Rajeev, S,P.Bali ,Khanna publishing
4. Modern Television Practice: Transmission, Reception and Applications, R.R. Gulati, New Age International, New Delhi
5. Television and video Engineering, A.M.Dhake, Mc Graw-Hill, New Delhi

Course Outcomes:

1. Graduates will be able to apply knowledge of Trouble shoot different types of microphones and speakers
2. Graduates will demonstrate an ability to identify, analyze Trouble shoot different types of microphones and speakers

Unit	Topic	No. of Lectures
Unit I	Audio Fundamental: Basic Characteristics of sound signal, Audio Amplifier, Microphone, Speakers, Troubleshooting procedure	4
Unit II	Audio system: Concept about CD player, Hi-Fi amplifier, Public Address system, Home theatre system, Troubleshooting procedure of audio system,MP3, MP4	5
Unit III	Television Fundamentals & Transmitters: Concept: Aspect ratio, image continuity, interlaces scanning, scanning periods, vestigial sideband transmission, colour signal characteristics, colour theory, Grassman's law, additive and subtractive colour mixing Composite video signal-Pedestal height, Blanking pulse, colour burst, Horizontal and vertical sync pulse details, equalizing pulses, CCIR-B standards for colour signal transmission and reception, positive and negative modulation, Colour TV Transmitter, Troubleshooting procedure of Colour TV Transmitter	07
Unit IV	Television Receivers: Color TV receiver, PAL-D decoder, HDTV- NHK MUSE system NHK broadcast, LCD/LED Technology, DTH, Troubleshooting procedure of colour TV receiver system, OLED	4
Unit V	Consumer Electronics Appliances: Photocopier, Microwave Oven, Washing Machine, Digital camera and cam coder	7

3. Graduates will demonstrate an ability to maintain audio system
4. Graduates will analyses the composite video signal used in TV signal transmission and considering realistic constraints.
5. Graduates will demonstrate an ability to visualize and work on Trouble shoot colour receivers
6. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
7. Graduates will have an understanding of professional and ethical responsibilities.
8. Graduates will be able to communicate effectively.
9. Graduate will show the understanding of impact of engineering solutions on the society, environment and awareness of contemporary issues.
10. Graduates will develop confidence for self-education and ability for life-long learning.
11. Graduates who can participate and succeed in project based work
12. Graduates can maintain various consumer electronics appliances

Course Prerequisites: Digital Electronics

SC	Subject Name	Contact Hrs/Week	Credits
OE-EC(EC)702A	**Digital Image Processing**	**3L:0T:0P**	**3 credits**

Text Books :

R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education 3rd edition 2008

Reference Books :

1. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd edition 2004.
2. Murat Tekalp , Digital Video Processing" Prentice Hall, 2nd edition 2015

Course Outcomes:

7. Mathematically represent the various types of images and analyze them.
8. Process these images for the enhancement of certain properties or for optimized use of the resources.
9. Develop algorithms for image compression and coding

Unit	Topic	No. of Lectures
Unit I	Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels - neighbourhood, adjacency, connectivity, distance measures.	5
Unit II	Image Enhancements and Filtering-Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters - linear and order-statistics, pixel-domain sharpening filters - first and second derivative, two-dimensional DFT and its inverse, frequency domain filters -low-pass and high-pass.	5
Unit III	Color Image Processing-Color models-RGB, YUV, HSI; Color transformations-formulation, color complements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation. Image Segmentation-Detection of discontinuities, edge linking and boundary detection, thresholding - global and adaptive, region-based segmentation.	5
Unit IV	Wavelets and Multi-resolution image processing- Uncertainty principles of Fourier Transform, Time frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Subband filter banks, wavelet packets.	5
Unit V	Image Compression-Redundancy-inter-pixel and psycho-visual; Lossless compression - predictive, entropy; Lossy compression-predictive and transform coding; Discrete Cosine Transform; Still image compression standards-JPEG and JPEG-2000.	5
Unit VI	Fundamentals of Video Coding-Inter-frame redundancy, motion estimation techniques - full-search, fast search strategies, forward and backward motion prediction, frame classification - I, P and B; Video sequence hierarchy Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards - MPEG and H.26X. Video Segmentation-Temporal segmentation-shot boundary detection, hard-cutsand soft-cuts; spatial segmentationmotion-based; Video object detection and tracking.	5

Course Prerequisites: Digital Electronics, Microprocessor

SC	Subject Name	Contact Hrs/Week	Credits
OE-EC (EC)702B	Robotics	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	Introduction to Robotics]: Brief history-Types of Robot–Technology, Robot classifications and specifications, Design and control issues, Various manipulators,	7

	Sensors , work cell, Programming languages: On-line and off-line programming, programming examples.	
Unit 2	[Rigid Body Transformation]: Overview of Rigid Body Kinematics; Homogeneous Transformation, Link Transformation Matrices, Mathematical representation of Robots, Position and orientation, Various joints, Degrees of freedom-Direct kinematics-Inverse kinematics	6
Unit 3	[Manipulator Differential Motion and statics]: Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and armsingularity - Static analysis - Force and moment Balance.	5
Unit 4	[Path Planning]: Joint space technique, Use of p-degree polynomial, Cubic polynomial, Cartesian space technique, Parametric descriptions, Straight line and circular paths, Position and orientation planning control of robots: Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT,Motion Interpolations, Adaptive control.	8
Unit 5	Robotic vision sensors and their interfacing	4

Textbooks:

1) Fu. K.S., Gonzalez R.C. and Lee C.S.G., Robotics: Control, Sensing, Vision and Intelligence, Tata McGraw Hill, 2008.

2) Ghosal A. Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.

3) Craig J.J., Introduction to Robotics – Mechanics and Control, Pearson Prentice Hall, 2005.

4) Murray, Li and Sastry, A Mathematical Introduction to Robot Manipulation, CRC Press, 1994. References:

1) Spong M.W., Hutchinson S. and Vidyasagar M., Robot Modeling and Control, John Wiley Sons & Inc., 2005.

2) Saha. S.K., Introduction to Robotics, McGraw Hill Education (India) Private Limited, 2014.

Course Outcome (CO):

- After completing the course the students will be able
- To analyze Instrumentation systems and their applications
- To understand basic concept of robotics.
- To know about the differential motion add statics in robotics
- To know about the dynamics and control in robotics industries.
- To know about the various path planning techniques.

Course Prerequisites: Communication Engineering, Computer Network

PAPER CODE	Subject Name	Contact Hrs/Week	Credits
OE-EC(EC)702C	**ADHOC NETWORKS**	**3L:0T:0P**	**3 credits**

- **Course Objectives:** To analyse various issues and challenges in the layered architecture of Ad-hoc wireless network.
- **Course Content:**
  - Cellular and ad hoc wireless networks, Applications of ad hoc wireless networks. Issues in ad hoc wireless networks-medium access scheme, routing, transport layer protocols, security and energy management. Ad-hoc wireless internet.
  - Design goals of a MAC protocol, Contention based protocols; Contention based protocols with reservation mechanisms and scheduling mechanisms, MAC protocols using directional antennas.
  - Table driven routing protocols, On demand routing protocols, hybrid routing protocols, Hierarchical routing protocols, Power aware routing protocols, Tree based and mesh based multicast routing protocols

- Network security requirements-Issues and challenges, network security attacks, key management, secure routing protocols.
- Energy management schemes-Battery management, transmission power management, system power management schemes. Quality of service solutions in ad hoc wireless networks.

Unit	Topic	No. of Lectures
Unit I	d Hoc Networking : An introduction, Model of operation, symmetric Links, Layer2 Ad Hoc solutions, Proactive versus reactive protocols, multicast, commercial Applications of Ad Hoc networking, conferencing, Home Networking, Emergency services, personal Area Networks and Bluetooth, Embedded Computing Applications, Sensor Dust, Automotive/PC Interaction. Factors Affecting Ad Hoc Networks, Scalability, Wireless Data Rates, DARPA packet Radio network, Survivable Radio Networks.	05
Unit II	d Hoc Wireless Media Access Protocols: Issues in Designing a MAC protocol for Ad Hoc Wireless networks. Design Goals of a MAC Protocol for Ad Hoc Wireless Networks. Classifications of MAC Protocols. Contention Based Protocols, Contention-Based Protocols with reservation Mechanisms. Contention –Based MAC Protocols with Scheduling Mechanisms. MAC protocols that use Directional Antennas. Other MAC Protocols	6
Unit III	verview of Ad Hoc Routing Protocols: Table-Driven Approaches, Destination Sequenced Distance Vector (DSDV) , Wireless Routing Protocol (WRP), Cluster Switch Gateway Routing (CSGR) , Source-Initiated On – Demand Approaches . Ad Hoc On-Demand Distance Vector Routing (AODV) , Dynamic Source Routing (DSR) , Temporally Ordered Routing Algorithm (TORA), Signal Stability Routing (SSR) , Location-Aided Routing (LAR) , Power – Aware Routing (PAR), Zone Routing Protocol (ZRP), Source Tree Adaptive Routing (STAR) , Relative Distance Micro diversity Routing (RDMAR) , Multicast Routing in Mobile Ad Hoc Networks, Existing Ad Hoc Multicast Routing Protocols, ABAM : Associativity-Based Ad Hoc Multicast	7
Unit IV	ransport Layer for Ad Hoc Wireless Network : Introduction , Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocols for Ad Hoc Wireless Networks	4
Unit V	uality of service in Ad-hoc wireless networks: Issues and challenges in providing QoS in Ad Hoc Wireless Networks, Classification of QoS Solutions, MAC Layer Solutions, MAC Layer Solutions, Network Layer Solutions, Qos Frameworks for Ad Hoc Wireless Networks.	4
Unit VI	nergy Conservation : Power Life Issues: Power Management, Advances in Device Power Management, Advances in Protocol Power Management, Power Conservation by mobile Applications, Periodic Beaconing On Battery Life, Standalone Beaconing, HF Beaconing with Neighbouring Nodes, Comparison of HF Beaconing with and without Neighbours, LF Beaconing with Neighbouring Nodes, Comparison of LF Beaconing with and without Neighbours, Deductions, Conclusions, Smart Batteries and Battery Characteristics, Effects of Beaconing on Battery Life.	6
Unit VII	ensor Network: Sensor Network Architecture, Network Protocols, Data Storage and Manipulation, Localization and Management, Data Dissemination, Data Gathering, MAC protocols for Sensor Networks, Location Discovery, Quality of a Sensor Network, Evolving Standards.	5
Unit VIII	ecurity issues in Ad Hoc Network: Security in Ad Hoc Wireless Network, Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Key Management, and Secure Routing in Ad Hoc Wireless Networks.	5

Text Books / Reference Books :

1. Ad Hoc Mobile Wireless Networks : Protocols and Systems, C. K. Toh, Springer.

2. Ad Hoc Network, C E Perkins, Pearson Education.
3. Ad Hoc Wireless Networks : Architectures and protocols, C, Siva Ram Murthy and B.S. Manoj, Pearson Education.
4. *Charles E.Perkins ,"Ad hoc networking", Addison Wesley,2001*
5. *George Aggelou,"Mobile ad hoc networks-From wireless LANs to 4G networks, McGraw Hill publishers, 2005*

Course Outcomes:

Students are able to:

- **CO1:** compare the differences between cellular and ad hoc networks and the analyse the challenges at various layers and applications
- **CO2**: summarize the protocols used at the MAC layer and scheduling mechanisms
- **CO3:** compare and analyse types of routing protocols used for unicast and multicast routing
- **CO4:** examine the network security solution and routing mechanism
- **CO5:** evaluate the energy management schemes and Quality of service solution in ad hoc networks

Course Prerequisites: Basic knowledge of Computer system

SC	Subject Name	Contact Hrs/Week	Credits
OE-EC(EC)702D	Operating systems	3L:0T:0P	3 credits

Text Books :

1. Operating System Concepts, A. Silverschwatz, P. Galvin & G.Gange , Willey

2. Operating System Concepts, Ekta Walia, Khanna Publishing House.

Reference Books :

1. William Stallings, Operating Systems: Internals and Design Principles, Prentice Hall of India.
2. D. M. Dhamdhere, Operating Systems: A Concept-Based Approach, Tata McGraw-Hill.

Course Outcomes:

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

1. understand the difference between different types of modern operating systems, virtual machines and their structure of implementation and applications.

2. understand the difference between process & thread, issues of scheduling of user-level processes / threads and their issues & use of locks, semaphores, monitors for synchronizing multiprogramming with multithreaded systems and implement them in multithreaded programs.

3. understand the concepts of deadlock in operating systems and how they can be managed / avoided and implement them in multiprogramming system.

4. understand the design and management concepts along with issues and challenges of main memory, virtual memory and file system.

Unit	Topic	No. of Lectures
Unit I	**Introduction:** Basic functional blocks of a computer: Operating system and functions, Evolution of operating system, Batch, Interactive, Time Sharing, Real Time System, Multi-Threading System.	04
Unit II	**Process Management:** System Components, Concept of process and Process synchronization, Process Management and Scheduling,	04
Unit III	**Concurrent Processes:** Process concept, Principle of Concurrency, Critical Section problem, Semaphores, Mutex locks, Classical problems in Concurrency, Inter Process Communication, Introduction to monitor, Process Generation, Process Scheduling.	04
Unit IV	**CPU Scheduling:** Scheduling Concept, Performance Criteria Scheduling Algorithm, Evolution, Multiprocessor Scheduling.	05
Unit V	**Deadlock:** System Model, Deadlock Characterization,Methods of handling deadlocks, Prevention, Avoidance and Detection, Recovery from deadlock	05
Unit VI	**Memory Management:** Multiprogramming with fixed partition, Multiprogramming with variable partition, Paging, Segmentation, Virtual memory concept, Demand paging, Performance, Page replacement algorithms, Thrashing, Designs of I/O systems, Kernel I/O subsystem, Streams.	06
Unit VII	**File System:** File concept, Access methods, Directory Structure, Directory organization, File system mounting, File Sharing and Protection; File System Implementation- File System Structure, Directory implementation, Allocation Methods, Free Space Management, Efficiency and Performance.	05
Unit VIII	**Operating system Protection & Security:** Introduction to distributed operating system, Case Studies - The UNIX operating system	03

Course Prerequisites: Signals and system, DSP

SC	Subject Name	Contact Hrs/Week	Credits
OE-EC (EC)703A	**Biomedical signal Processing**	**3L:0T:0P**	**3 credits**

TEXT BOOKS

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4 th Edition, Prentice Hall, 2000.
2. R. Rangayan, "Biomedical Signal Analysis", Wiley 2002.
3. John L Semmlow, "Bio-signal and Biomedical Image Processing", Marcel Dekker

Unit	Topic	No. of Lectures
Unit I	Bioelectric Signals and Electrodes: Bio-potentials and their origin: ECG, EEG, EMG, ENG, ERG, EOG, MEG. Biomedical Instrumentation System, biomedical transducers, electrodes and their characteristics. Origin of bio potentials. Sources and contamination of Noise in bio signals. Motion artifacts and skin Impedance. Classification of biomedical signals.	5
Unit II	Cardio Vascular and Nervous System - Cardio Vascular System: Cardiovascular system, Coronary and Peripheral Circulation, Electrical Activity of the heart, Lead configurations , ECG data acquisition, ECG recorder, Concept of Blood Pressure Measurement, Cardiac output, Heart Sounds. Nervous System: Nervous System, Structure and functions of Neurons, Electrical activity of nerve cell, Synapse, Reflex action and Receptors.	4
Unit III	Analysis of Electrical Activity of Heart - ECG signal parameters & their estimation - Use of multiscale analysis for ECG parameters estimation, Noise & Artifacts, ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection, Highlight the Feature points of ECG and its classification for Normal and Abnormal state using Multilayer Perceptron.	4
Unit IV	Analysis of Electrical Activity of Brain - Electroencephalogram – Structure of brain, EEG signal acquisition,10-20 electrode placement, EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Use of Fourier Transform in EEG Signal Analysis.	4
Unit V	Analog Signal Processing - Basics of Instrumentation Amplifier, Isolation amplifier, Grounding and shielding techniques. Integer Filters: Basic design Concept, Low Pass and High Pass Filters, Band Pass, Band Stop and Band Reject Filters. Its application in Biomedical field. Adaptive Filters: Basic Concept, Principle noise cancellation model, removal of periodic events using adaptive cancellation, adaptive cancellation of maternal ECG from fetal ECG of Interest.	5
Unit VI	Digital signal Processing 6L Characteristics, frequency domain representation; Stationary and non-stationary bio-signals, waveform detection, Sampling Theory, Finite data considerations (Edge effects), Z Transform, FIR and IIR filters specific to event detection of ECG.Computation of diagnostic signal parameters of ECG like Heart rate and QRS detection using Multivariate analysis like PCA and ICA.	5

REFERENCES BOOKS

1. R.S.Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003, Edition-II.

2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", 4 th Edition, Prentice Hall, 2000.

3. Bruce, “Biomedical Signal Processing & Signal Modeling,” Wiley, 2001

4. Sörnmo, “Bioelectrical Signal Processing in Cardiac & Neurological Applications”, Elsevier. 5. C.Reddy “Biomedical Signal Processing: Principles and techniques”, Tata McGraw Hill, New Delhi, 2005.

6. Willis J Tompkins, “Biomedical Signal Processing”, ED, Prentice – Hall, 1993

Course Outcomes:

After successfully completing the course students will be able to:

- The student will be able to model a biomedical system.
- The student will be able to understand various methods of acquiring bio signals.
- The student will be able to understand various sources of bio signal distortions and its remedial techniques.
- The students will be able to analyse ECG and EEG signal with characteristic feature points. • The student will have a basic understanding of diagnosing bio-signals and classifying them.

Course Prerequisites: Basic knowledge of Biology

SC	Subject Name	Contact Hrs/Week	Credits
OE-EC(EC)703B	System Biology: Modeling and Control	3L:0T:0P	3 credits

Text Books :

1. System Modeling in Cellular Biology: Edited by Zoltan Szallasi, Jorg Stelling, Vipul Periwal, MIT Press, 2006.

Reference Books :

- Foundations of Systems Biology: Edited by Hiroaki Kitano, MIT Press, 2001.
- Introduction to Genomic Signal Processing with Control, A. Datta and E. R. Dougherty, CRC Press, 2006.

Course Outcomes:

- Construct and analyze computational models of biological systems.
- Understand common mathematical approaches to study biological problems.
- Summarize and critique papers from the literature describing systems biology approaches and analysis

Course Prerequisites: EM Theory, Communication engineering

SC	Subject Name	Contact Hrs/Week	Credits
OE-EC (EC)703C	Internet Technology	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit I	**Molecular biology overview**: Cell, DNA, RNA, protein, central dogma of molecular biology, genetic code, mutation, evolution. **Gene-Protein interactive networks**: Signal transduction pathways, feedback, oscillation, stability, positive feedback and multistability, homeostasis, cell cycle, proliferation, apoptosis, cancer	5
Unit II	**Dynamic system modelling**: Time, space and determinism, stochastic differential equation, Boolean network, Markov chain, Hidden Markov Model. **Model estimation:** Theory and experimentation	6
Unit III	**Active and passive experiments**: Polymerase chain reaction (PCR), microarray, green fluorescent protein (GFP), statistical biology	3
Unit IV	**Data acquisition and manipulation**: Curse of dimensionality, optimization algorithms, NP completeness, polynomial time in probability, gene and protein sequencing, next generation sequencing (NGS).	4
Unit V	**Probabilistic approach**: Static modelling, directed acyclic graphs and Bayesian network, dynamic Bayesian network and Markov network. **Disease diagnosis and prevention**: Image processing as a tool of diagnosis, classification, clustering, preventive medicine	8
Unit VI	**Therapeutic Control:** Dynamic programming, optimal control, experimental design and validation**. Cancer - a case study:** Modelling mutations and therapy	4

Unit	Topic	No. of Lectures
Unit 1	Introduction to WWW : Protocols and programs, secure connections, application and development tools, the web browser, Web Design: Web site design principles, planning the site and navigation	4
Unit 2	Introduction to HTML : The development process, Html tags and simple HTML forms, web site structure Introduction to XHTML : XML, Move to XHTML, Meta tags, Character entities, frames and frame sets, inside browser.	5
Unit 3	Style sheets : Need for CSS, introduction to CSS, basic syntax and structure, using CSS, background images, colors and properties, manipulating texts, using fonts, borders and boxes, margins, padding lists, positioning using CSS, CSS2	5
Unit 4	Javascript : Client side scripting, What is Javascript, How to develop Javascript, simple Javascript, variables, functions, conditions, loops and repetition DHTML : Combining HTML, CSS and Javascript, events and buttons, controlling your browser.	6
Unit 5	XML : Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas, Well formed, using XML with application.XML, XSL and XSLT. Introduction to XSL, XML transformed simple example, XSL elements, transforming with XSLT	3

	Web Hosting : registering domains, parking websites, publishing with FTP	2
	PHP : Starting to script on server side, Arrays, function and forms, advance PHP Databases : Basic command with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PHP myadmin and database bugs.	5

Text Books:

1. Steven Holzner,"HTML Black Book" Dremtech press.
2. Web Technologies, Black Book, dreamtech Press
3. Web Applications : Concepts and Real World Design, Knuckles, Wiley-India
4. Internet and World Wide Web How to program, P.J. Deitel & H.M. Deitel. Pearson.

Course Outcome (CO):

After studying that subject students would have capability

- To make own web site and host their own web site on internet.
- To know about what are the technologies used in internet.

Course Prerequisites: Basic knowledge of Electronics, Physics of Class-XII

SC	Subject Name	Contact Hrs/Week	Credits
OE-EC (EC)703 D	**Renewable energy**	**3L:0T:0P**	**3 credits**

Text Books :

3. Non conventional Energy sources, G.D. Rai, Khanna Publishers.
4. Renewable energy sources and conversion technology, Bansal Keemann, Meliss, Tata Mc Graw Hill.
5. Non conventional Energy, Ashok V. Desai, New Age International Publishers Ltd

Reference Books :

1. Renewable energy resources and emerging technologies, D.P. Kothari, Prentice Hall of India Pvt. Ltd.

Course Outcomes:

(41) Define, explain and develop research topics of different sources of non-conventional energy systems

(42) Analyze and discuss the energy scenario of our country

(43) Discuss and conclude different ways of renewable energy generation.

Unit	Topic	No. of Lectures
Unit I	Introduction to renewable and non-conventional energy sources, energy usage and its impact on environment, energy consumption by sectors, overview of renewable energy sources. Potential of renewable energy sources.,	04
Unit II	Solar energy- Introduction to solar energy, Status and prospectus of solar energy, Solar spectrum, solar energy and the semiconductor, p-n junction diode, fabrication of basic silicon p-n junction solar cell, interaction of solar radiation with p-n junction, collection probability, quantum efficiency, spectral response, the photovoltaic effect, I-V characteristics of PV cell, efficiency calculation, fill factor, effect of series and shunt resistance on PV cell performance.	08
Unit III	Solar energy materials- single crystal Si p-n junction solar cell, amorphous Si solar cell, Tandem solar cell, thin film solar cell, Schokley Quiser limit, organic solar cell, DSSC solar cell, quantum dot and perovskite solar cell.	06
Unit IV	Thermoelectricity- overview and potential of thermoelectricity as renewable energy source. Seebeck and Peltier effect, Thermoelectric energy conversion, waste heat recovery, materials for thermoelectric generator,	06
Unit V	Fuel cells, Types of fuel cells, Design principle and operation of fuel cell, conversion efficiency of fuel cell, application of fuel cells	4
Unit VI	Other renewable energy sources- wind, geo thermal, biomass, hydro.	4

Course Prerequisites: EM Theory, Communication engineering, Microwave Engineering

SC	Subject Name	Contact Hrs/Week	Credits
C-EC791	Laboratories on Microwave and Antenna	**0L:0T:4P**	**2credits**

Laboratories on Microwave:

Books :

1. Basic microwave techniques and laboratory manual by M.L.Sisodia and G.S.Raghuvanshi-New Age International Publishers.

Laboratories on Antenna:

Sl No.	Experiment
1	Introduction to various instruments in microwave engineering laboratory.
2	Study of the characteristics of reflex klystron tube (power vs. repeller voltage).
3	To determine the frequency and wavelength in a rectangular waveguide working in TE_{10} mode using reflex klystron.
4	To determine the frequency and wavelength in a rectangular waveguide working in TE_{10} mode using Gunn Diode.
5	Study the I-V characteristics of Gunn Diode.
6	Study the voltage vs. power characteristics of Gunn Diode.
7	Study the function of multiple directional coupler by measuring the following parameters – i) coupling factor, ii) insertion loss, iii) isolation, iv) directivity.
8	Study of Magic Tee by measuring the following parameters – i) coupling factor, ii) isolation.
9	To determine the standing-wave ratio and reflection coefficient.

Sl No.	Experiment
1	Radiation Pattern and Half Power Beam Width of Dipole Antenna.
2	Radiation Pattern and Half Power Beam Width of Yagi-Uda Antenna
3	Radiation Pattern and Half Power Beam Width of Parabolic Reflector
4	Radiation Pattern and Half Power Beam Width of Horn Antenna
5	Radiation Pattern and Half Power Beam Width of Broad Side Array
6	Radiation Pattern and Half Power Beam Width of End Fire Array
7	To measure unknown impedence usingthe Smith Chart

SC	Subject Name	Contact Hrs/Week	Credits
PR-EC781	Project-I	**0L:0T:8P**	**4credits**

The object of Project Work I is to enable the student to take up investigative study in the broad field of Electronics & Communication Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or two/three students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem relating to the assigned topic;
3. Conducting preliminaryAnalysis/Modeling/Simulation/Experiment/Design/Feasibility;
4. Preparing a Written Report on the Study conducted for presentation to the Department;
5. Final Seminar, as oral Presentation before a departmental committee.

4th Year

CC	SC	Subject Name	Contact Hrs./Week	
			L–T-P-TO	Cr.
HUM	HM-HU(EC)801	Financial Management and Accounts	3-0-0-3	3
PEC	PE-EC801	Professional Elective-VI e) Wireless Communication f) Semiconductor DeviceModelling g) Speech and Audio Processing h) Electronic Device and Material Characterization	3-0-0-3	3
OEC	OE- CS(EC)801	Open Elective-V c) Machine Learning d) Hardware Security C) FOUNDATIONS OF EDUCATIONAL TECHNOLOGY d) Deep Learning	3-0-0-3	3

Proj	PR-EC881	Project-II	0-0-12-12	6
Proj	PR-EC882	Viva	0-0-0-0	2
Proj	**PR-EC883**	Internship Evaluation	0-0-0-0	0
			9-0-12-21	17

Course Prerequisites: Knowledge of basic Mathematics

SC	Subject Name	Contact Hrs/Week	Credits
HM-HU(EC)801	Financial Management and Accounts	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	Introduction: Financial Management, Financial Planning and Capitalization- definitions, objectives, changing roles and functions, Financial Decision.	4
Unit 2	Capital Budgeting: Nature of Investment decision, Importance of Capital Budgeting, The Capital. Budgeting Process -Investment Criterion, Pay-back period, Accounting, ROR (Rate of Return) Method, Discounting Cash flow method, Net - present value method, IRR (Internal Rate of Return) method, The benefit-Cost Ratio method.	6
Unit 3	Management of Working Capital: Various concepts, Elements, Classification, Financing and importance of working capital, Investment analysis, Cash flow determination, cost of capital, capital budgeting methods.	4
Unit 4	Budgeting Control Technique: Concepts of Budget, budgeting and budgetary control, Objectives, Functions, Uses, Advantages, Limitations; Master Budget and Report.	4
Unit 5	Cost - Volume - Profit Analysis: Classification of costs, Allocation, apportionment and absorption, Cost centers, different costing systems, Cost analysis for managerial decisions, Meaning of Linear CVP analysis, Objectives, Assumptions, Break- Even analysis, determining the Break-Even point profit, Volume graph profit, Volume ratios margin of Safety.	6
Unit 6	Introduction to Accounting: Basic accounting concepts, important definitions, uses, limitations, advantages; types of Accounting, Financial statements, introduction to Journal Accounting; different types of Vouchers, double entry bookkeeping, different types of transactions related to Financial Accounting.	5
Unit 7	Financial Control: Posting of Ledgers and preparation of Trial Balance; preparation of Balance Sheet and Profit and Loss Accounts; Controlling other departments by Financial Accounting (A practical Approach).	4

Text Books:

1. Financial Management and Accounting - P. K. Jain, S. Chand & Co.
2. Management & Accounting: Principles and Practice- R. K. Sharma & Shashi Kumar Gupta, Kalyani Publishers.
3. Advanced Management Accounting - Kaplan & Atkinson, PHI.
4. Fundamentals of Financial Management - Van Home,PE.
5. Financial Mgmt Accounting, Gupta,Pearson
6. Financial Mgmt, I.M. Pandey, Vikas
7. Financial Mgmt., Khan & Jain, TMH
8. Financial Mgmt ,Mcmenamin, OUP
9. Financial Mgmt& Policy, Van Horne, PHI
10. Financial Mgmt, Kulkarni&Satyaprasad, Himalaya

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. To understand the accounting process in business.
2. To gain a knowledge on application of concepts and principles in preparing
3. To evaluate the tactical decisions of middle level managers relating to cost and management accounting
4. To analyze the financial statements and evaluate the decisions for better investment.

Course Prerequisites: EM Theory, Communication engineering

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC801A	Wireless Communication	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	**WIRELESS CHANNELS** Large scale path loss – Path loss models: Free Space and Two-Ray models -Link Budget design – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters-Coherence bandwidth – Doppler spread & Coherence time, fading due to Multipath time delay spread – flat fading – frequency selective fading – Fading due to Doppler spread – fast fading – slow fading.	6
Unit 2	**CELLULAR ARCHITECTURE** Multiple Access techniques – FDMA, TDMA, CDMA – Capacity calculations–Cellular concept- Frequency reuse – channel assignment- hand off- interference & system capacity trunking & grade of service – Coverage and capacity improvement.	6
Unit 3	**DIGITAL SIGNALING FOR FADING CHANNELS** Structure of a wireless communication link, Principles of Offset-QPSK, p/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle – Cyclic prefix, Windowing, PAPR.	6
Unit 4	**MULTIPATH MITIGATION TECHNIQUES** Equalisation – Adaptive equalization, Linear and Non-Linear equalization, zero forcing and LMS Algorithms. Diversity – Micro and Macro diversity, Diversity combining techniques, Error probability in fading channels with diversity reception, Rake receiver.	6
Unit 5	**MULTIPLE ANTENNA TECHNIQUES** MIMO systems – spatial multiplexing -System model -Pre-coding – Beam forming – transmitter diversity, receiver diversity- Channel state information-capacity in fading and non-fading channels.	6

Text Books:

1. Wireless Networks: Applications and Protocols, T. S. Rappaport, Pearson Education
2. Wireless Communication and Networks : 3G and Beyond,
3. I. Saha Misra, TMH Education.Wireless Communications

Course Outcomes:

At the end of this course students will demonstrate the ability to

- To understand the design of a cellular system
- To study the various digital signalling techniques and multipath mitigation techniques
- To understand the concepts of multiple antenna techniques

Course Prerequisites: Basic Electronics, Analog Electronics

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC801B	Semiconductor Device Modelling	3L:0T:0P	3credits

Unit	Topic	No. of Lectures
Unit 1	**Quantitative analysis of Semiconductors:** Atomic picture of Silicon and Germanium – Electric current, free electron density and mobility in Semiconductors – Effect of doping on minority carrier density in Semiconductors – Energy band picture of P and N type Semiconductors – Temperature dependence of conductivity – Degeneracy. Calculation of free electron density and hole density in a Semiconductor – Determination of position of Fermi level for a given Semiconductor – Carrier density expressed in terms of departure of Fermi level from intrinsic Fermi level – Fermi level in N-type and P-type samples as measured from intrinsic Fermi level – Very lightly doped samples – representation of energy band diagram in terms of potential – Equation governing potential distribution in a Semiconductor – Equation governing distribution of hole density and electron density – Continuity equation for Semiconductors – Determination of steady state excess carrier density – Concepts of Quasi Fermi level.	8
Unit 2	**Quantitative analysis of P-N junction Diode:** P-N junction under thermal equilibrium – P-N junction under Forward bias – P-N junction under Reverse bias – Behavior under large forward voltage – Temperature dependence of P-N junction characteristics – Break down under reverse bias – Thermal Break down, Zener Break down and Avalanche Break down – Transition capacitance of a P-N junction. Band diagram for a Semiconductor with an applied voltage – P-N junction in thermal equilibrium – Minority carrier densities in a P-N junction under Forward bias – Expression for total current in a P-N junction – Calculation of carrier density and current in a reverse biased junctioN- P-N junction behavior in terms of minority carrier stored charge – Calculation of electric field and voltage drop in the bulk.	8
Unit 3	**Quantitative analysis of Bipolar Junction Transistor:** Operation of a BJT – Performance parameters – Effect of collector junction voltage on current – Dependence of IC on VE and IE. Uniform Base PNP transistor with Forward biased B-E junction and Reverse biased C-B junction – Calculation of performance parameters – Transit time of minority carriers through base – Effect of floating collector on transistor V-I characteristics – Effect of floating emitter junction characteristics – Collector current with base floating – Temperature effects in Transistors – Effect of device geometry on the transistor performance – Ebermoll's equation.	6
Unit 4	**Junction Transition capacitance and junction Break down voltages:** Electric field and potential distribution in P-N junction at thermal equilibrium – transition capacitance and Break down voltages in linearly graded junction and an abrupt junction – CT in PIN Diode – Break down voltage in transistor.	4
Unit 5	**Quantitative analysis of Photo diodes and Photo transistors:** Carrier generation by light in a uniform piece of semiconductor – P-N junction photo diode for light detection – Open circuit photo voltages – Short circuit current in photo diode – Photo diode current under combined action of light and reverse bias – Photo diode current under combined action of light and forward bias – Photo transistor – Expression for current in photo transistor – Solar cells using photo diodes.	6

Text Books:

1. M.K. Achuthan and K. N. Bhat, Fundamentals of Semiconductor devices, *Tata McGraw Hill*, New Delhi, 2007.

2. Ben G Streetman, Solid State Electronics, *Prentice Hall*, 1999.

3. S.M.Sze, Modern Semiconductor Devices Physics, *John Wiley and Sons*, 1998.

4. Donald A. Meamen, Semiconductor Physics and Devices – Basic Principles, McGraw Hill, 2003.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Describe the equations based on energy band diagrams, acceptable approximations and for intrinsic, p and N type semiconductors.
2. Explain the operation of p-n junction diodes quantitatively and qualitatively.
3. Describe the fabrication, device operation of a BJT quantitatively and model its characteristics from basic principles
4. Understand the effects of junction capacitance and break down voltages on the performance of P-N junction diodes and BJTs the Classify and describe the semiconductor devices for special applications
5. To analyze and develop models of optoelectronic devices such as Solar Cells and LEDs.

Course Prerequisites: Communication engineering

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC801C	Speech and Audio Processing	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit 1	Introduction- Speech production and modeling - Human Auditory System;General structure of speech coders; Classification of speech coding techniques - parametric, waveform and hybrid ; Requirements of speech codecs -quality, coding delays, robustness.	4
Unit 2	Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters,convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.	4
Unit 3	Linear Prediction of Speech- Basic concepts of linear prediction; LinearPrediction Analysis of nonstationary signals -prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction.	4
Unit 4	Speech Quantization- Scalar quantization-uniform quantizer, optimum quantizer,logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization - distortion measures, codebook design, codebook types	4
Unit 5	Scalar Quantization of LPC- Spectral distortion measures, Quantization based onreflection coefficient and log area ratio, bit allocation; Line spectral frequency - LPC to LSF conversions, quantization based on LSF.	4
Unit 6	Linear Prediction Coding- LPC model of speech production; Structures of LPCencoders and decoders; Voicing detection; Limitations of the LPC model.	4
Unit 7	Code Excited Linear Prediction-CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search - state-save method, zero- input zero-state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP.	5
Unit 8	Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729standards	3

Text/Reference Books:

1. "Digital Speech" by A.M.Kondoz, Second Edition (Wiley Students‟ Edition), 2004.
2. "Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", W.C. Chu, WileyInter science, 2003

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Comprehend the speech production and hearing models.
2. Design and apply models for speech and audio signal processing.
3. Apply speech coding, speech enhancement and speaker recognition algorithms for speech and audio processing.
4. Implement the methods for speech enhancement and speech coding for speech signals.

Prerequisite: Solid state electronic devices, VLSI

SC	Subject Name	Contact Hrs/Week	Credits
PE-EC801D	Semiconductor material and device characterization	**3L:0T:0P**	**3credits**

MODULE 1 Introduction Basics of semiconductor materials, p-n junction diodes, BJT, MOSFET, fabrication process of solid state electronic materials and devices.	5
MODULE 2 Electrical Characterization Resistivity measurement, Capacitance-Voltage(C-V) Measurement, Current-Voltage (I-V) measurement, Hall Effect	6
Module 3 Optical Characterization Optical Microscopy, Infrared Spectroscopy, Photoluminescence , Raman Spectroscopy,	4
Module 4: Chemical and Physical Characterization: Electron Beam Techniques, Ion Beam Techniques: Secondary Ion Mass Spectrometry (SIMS), Rutherford Backscattering (RBS), X-Ray Photoelectron Spectroscopy (XPS)	4
Module 5: Material Characterization Defects, Oxide and Interface Trapped Charges, Oxide Thickness, Mobility, Carrier Lifetimes	6
Module 6: Device characterization Contact Resistance and Schottky Barriers, Series Resistance, Channel Length and Width, and Threshold Voltage	6

Course outcome:

At the end of this course students will be able to

- Understand most of the characterization techniques used in semiconductor industry.
- Understand the importance of material and device characterization in solid state electronic device fabrication.

Books:

5) Semiconductor Material and Device Characterization , 3rd Edition , D. K. Schroder , John wiley & Sons
6) W.R. Runyan and T.J. Shaffner, Semiconductor Measurements and Instrumentation, McGraw-Hill, 1998.
7) C.R. Brundle, C.A. Evans, Jr. and S. Wilson, Eds., Encyclopedia of Materials Characterization,
John Wiley & Sons, 1992.
8) S. Cristoloveanu and S. S. Li, Electrical Characterization of Silicon-on-Insulator Materials and
Devices, Kluwer Academic, Boston, 1995

Course Prerequisites: Basic of Artificial Intelligence and Mathematics/Statistics

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS(EC)-801A	**Machine Learning**	**3L:0T:0P**	**3 credits**

Unit	Topic	No. of Lectures
Unit I	**Introduction** Definition of learning systems. Goals and applications of machine learning. Aspects of developing a learning system: training and testing data, The concept learning task, Concept learning as search through a hypothesis space, Choosing a Machine Learning Algorithm - Thinking about the Input Data, Thinking about Types of Machine Learning Algorithms.	02
Unit II	**Decision Tree Learning:** Representing concepts as decision trees. Recursive induction of decision trees. Picking the best splitting attribute: entropy and information gain. Searching for simple trees and computational complexity. Occam's razor. Overfitting, noisy data, and pruning.	4
Unit III	**Artificial Neural Networks** Neurons and biological motivation. Linear threshold units. Perceptrons: representational limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations. Overfitting, learning network structure, recurrent networks.	5
Unit IV	**Support Vector Machines:** (Paper handouts) Maximum margin linear separators. Quadractic programming solution to finding maximum margin separators. Kernels for learning non-linear functions.	4
Unit V	**Bayesian Learning:** Probability theory and Bayes rule. Naive Bayes learning algorithm. Parameter smoothing. Generative vs. discriminative training. Logisitic regression. Bayes nets and Markov nets for representing dependencies.	4
Unit VI	**Clustering:** Learning from unclassified data. The Clustering Task and the Requirements for Cluster Analysis , Overview of Some Basic Clustering Methods,. k-means clustering. Semi-supervised learning with EM using labeled and unlabled data.	4
Unit VII	**Regression Analysis:** Introduction to Simple Linear Regression, Simple Linear Regression Model Building, Estimation of Parameters Using Ordinary Least Squares, Interpretation of Simple Linear Regression Coefficients, Validation of Simple Linear Regression Model, Coefficient of Determination (R-squared) and Adjusted R-Squared, Spurious Regression, Hypothesis Test for Regression Coefficients (t-Test), Analysis of Variance (F-Test), Residual Analysis.	4
Unit VIII	**Optimization:** Concept of Optimization, Fitness Function, Classification, Simulated Annealing (SA), Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Application	5

Text Books :

1. Introduction to Machine learning, Nils J.Nilsson
2. Machine learning for dummies, IBM Limited ed, by Judith Hurwitz and Daniel Kirsch
3. Introduction to Machine Learning with Python A guide for data scientists, Andreas, C.Muller & Sarah Guido, O'Reilly

Course Outcomes:

Upon completion of this course, the students will be able to

1 Understand the concept of Machine Learning.

2. Familiarize with Simple Linear Regression and Logistic Regression.

3. Identify and apply the Classification algorithms.

4. Apply the Clustering algorithms for developing applications.

Course Prerequisites: EM Theory, Communication engineering

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS (EC)801B	Hardware Security	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit I	Overview of Different Issues of Hardware Security. Preliminaries: Algebra of Finite Fields, Basics of the Mathematical Theory of Public Key Cryptography, Basics of Digital Design on Field-programmable Gate Array (FPGA), Classification using Support Vector Machines (SVMs)	5
Unit II	Useful Hardware Security Primitives: Cryptographic Hardware and their Implementation, Optimization of Cryptographic Hardware on FPGA, Physically Unclonable Functions (PUFs), PUF Implementations, PUF Quality Evaluation, Design Techniques to Increase PUF Response Quality	5
Unit III	Side-channel Attacks on Cryptographic Hardware: Basic Idea, Current-measurement based Side-channel Attacks (Case Study: Kochers Attack on DES), Design Techniques to Prevent Side-channel Attacks, Improved Side-channel Attack Algorithms (Template Attack, etc.), Cache Attacks	5
Unit IV	Testability and Verification of Cryptographic Hardware: Fault-tolerance of Cryptographic Hardware, Fault Attacks, Verification of Finite-field Arithmetic Circuits	5
Unit V	Modern IC Design and Manufacturing Practices and Their Implications: Hardware Intellectual Property (IP) Piracy and IC Piracy, Design Techniques to Prevent IP and IC Piracy, Using PUFs to prevent Hardware Piracy, Model Building Attacks on PUFs (Case Study: SVM Modeling of Arbiter PUFs, Genetic Programming based Modeling of Ring Oscillator PUF)	5
Unit VI	Hardware Trojans: Hardware Trojan Nomenclature and Operating Modes, Countermeasures Such as Design and Manufacturing Techniques to Prevent/Detect Hardware Trojans, Logic Testing and Side-channel Analysis based Techniques for Trojan Detection, Techniques to Increase Testing Sensitivity Infrastructure Security: Impact of Hardware Security Compromise on Public Infrastructure, Defense Techniques (Case Study: Smart-Grid Security)	5

Text Books :

Debdeep Mukhopadhyay and Rajat Subhra Chakraborty, "Hardware Security: Design, Threats, and Safeguards", CRC Press

Reference Books :

3. Ahmad-Reza Sadeghi and David Naccache (eds.): Towards Hardware-intrinsic Security: Theory and Practice, Springer.
4. Ted Huffmire et al: Handbook of FPGA Design Security, Springer.
5. Stefan Mangard, Elisabeth Oswald, Thomas Popp: Power analysis attacks - revealing the secrets of smart cards. Springer 2007.
6. Doug Stinson, Cryptography Theory and Practice, CRC Press.

Course Outcomes:

10. This course will focus on the importance of addressing different security threats on modern hardware design, manufacturing, installation, and operating practices.
11. In particular, the threats would be shown to be relevant at scales ranging from a single user to an entire nation's public infrastructure.
12. Through theoretical analyses and relevant practical world case studies, the threats would demonstrate, and then state-of-the-art defense techniques would be described.
13. The course would borrow concepts from diverse fields of study such as cryptography, hardware design, circuit testing, algorithms, and machine learning.

Course Prerequisites: NONE

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS (EC)801C	FOUNDATIONS OF EDUCATIONAL TECHNOLOGY	**3L:0T:0P**	**3credits**

Unit	Topic	No. of Lectures
Unit I	Learning theories. Learning objectives and Blooms taxonomy; constructivist and situated theories of learning; factors affecting and facilitating learning; learning styles.	6
Unit II	Technologies for creating new resources. Examples include video, multimedia, animations and simulations, Web 2.0/3.0.	04
Unit III	Instructional Design (ID). Basic ID models (eg ADDIE model), ID models for e-learning and blended learning (eg Dick and Carey model), online course development using ID.	06
Unit IV	Technologies for content delivery. Examples include Learning Management Systems (e.g. Moodle) classroom management systems (e.g. Jhoomla), Open Education Resources, intelligent tutoring systems. Throughout the course, we will illustrate theories with practical examples such as NPTEL, OCW, OSCAR, PhET.	06
Unit V	ICT for education	06

Text Books :

1. Educational Technology: A Primer for the 21st Century, Ronghuai Huang, J. Michael Spector, Junfeng Yang · 2019
2. Essentials Of Educational Technology, S. K. Mangal, Uma Mangal · 2019
3. EDUCATIONAL TECHNOLOGY AND ICT IN EDUCATION, HIMANSHU TRIPATHI · 2019

Reference Books :

1. Foundations of Educational Technology : Integrative Approaches and Interdisciplinary Perspectives, By J. Michael Spector, J. Michael Spector · 2015

Course Outcomes:

(44) Identify, describe, and apply emerging technologies in teaching and learning environments

(45) Learn to develop online course modules using various instructional designs(ID)

Course Prerequisites: Basic of Artificial Intelligence and Machine Learning

SC	Subject Name	Contact Hrs/Week	Credits
OE-CS(EC)-801D	**Deep Learning**	**3L:0T:0P**	**3 credits**

Unit	Topic	No. of Lectures
Unit I	Introduction to Deep Learning, Bayesian Learning, Decision Surfaces Linear Classifiers, Linear Machines with Hinge Loss Optimization Techniques, Gradient Descent, Batch Optimization	06
Unit II	Introduction to Neural Network, Multilayer Perceptron, Back Propagation Learning, Unsupervised Learning with Deep Network, Autoencoders Convolutional Neural Network, Building blocks of CNN, Transfer Learning	8
Unit III	Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam Effective training in Deep Net- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, Fully Connected CNN etc.	8
Unit IV	Classical Supervised Tasks with Deep Learning, Image Denoising, Semanticd Segmentation, Object Detection etc. LSTM Networks, Generative Modeling with DL, Variational Autoencoder, Generative Adversarial Network Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam	8

Text Books :

1.Deep Learning- Ian Goodfelllow, Yoshua Benjio, Aaron Courville, The MIT Press
2.Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc
3. Deep Learning (IBM ICE Publications).

Course Outcomes:

On completion of the course students will acquire the knowledge of applying Deep Learning techniques like CNN, LSTM to solve various real life problems like Computer Vision, Image Processing, Natural Language Processing and Classifications.

SC	Subject Name	Contact Hrs/Week	Credits
PR-EC881	Project-II	**0L:0T:12P**	**6credits**

The object of Project Work II & Dissertation is to enable the student to extend further the investigative study taken up under EC P1, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership. The assignment to normally include:

1.In depth study of the topic assigned in the light of the Report prepared under EEP1;

2. Review and finalization of the Approach to the Problem relating to the assigned topic;

3. Preparing an Action Plan for conducting the investigation, including team work;

4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;

5. Final development of product/process, testing, results, conclusions and future directions;

6. Preparing a paper for Conference presentation/Publication in Journals, if possible;

7. Preparing a Dissertation in the standard format for being evaluated by the Department.

8. Final Seminar Presentation before a Departmental Committee.

SC	Subject Name	Contact Hrs/Week	Credits
PR-EC882	Viva	**0L:0T:0P**	**2credits**

Each student has to appear for final viva.

SC	Subject Name	Contact Hrs/Week	Credits
PR-EC883	Internship Evaluation	**0L:0T:0P**	**2credits**

Minimum of six weeks in an Industry / Research Institute / Educational Institution. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.