Revised T. Y. B. Tech

(Department of

Electronics & Tele-Communication Engineering)

Curriculum

Academic year 2020-21

Shri Guru Gobind Singhji Institute of Engineering and Technology, Nanded

(An Autonomous Institute of Government of Maharashtra)

Program Educational Objectives (PEOs)

PEO I: To study the physics of semiconductor device technology and develop proficiency in computational methods for advanced modeling and simulation (preparation).

PEO II: To study signal and image processing concepts (Core competence) and to design embedded and VLSI systems (Core competence).

PEO III: To study and design digital, analog, and mixed signal VLSI systems (Breadth). Understand the state of art in the recent areas of research in signal and image processing, pattern recognition and computer vision techniques (Breadth).

PEO IV: Provide academic environment aware of excellence, leadership, and ethical codes to students; and teach them lifelong learning skills including research component needed for successful professional career (Learning environment).

Program Outcomes (POs)

Engineering Graduates will be able to:

PO 1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3 **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO 10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1. Model and simulate electronics and telecommunication systems to conduct experiments and analyze the performance using modern tools.

PSO2. To meet realistic constraints like economic, social, environmental, ethical, health and safety of stakeholders by implementing Signal and Image Processing algorithms and their realization using VLSI and Embedded System knowledge.

PSO3. Engage in society need based innovations and contribute to make in India by gaining awareness of IPRs, Finance, Economics and Entrepreneurship etc in the field of electronics and telecommunication engineering.

Correlation Matrix (Correlation between the PEOs and the POs)

PO/PSO PEO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
PEO I	√	√	√	√	√								√	√	
PEO II	√			√	√		√						√	√	
PEO III	√	√		√		√			√		√				√
PEO IV	√	√	√			√			√	√	√	√		√	√

Note: The cells filled in with √ indicate the fulfillment /correlation of the concerned PEO with the PO.

Structure of curriculum

Semester - V						
Code	*Course Title*	*L*	*T*	*P*	*Credits*	
					Th.	*Pr.*
PCC-EC-301	Electromagnetic Engineering	3	1	0	4	0
PCC-EC-302	Control Systems	3	0	2	3	1
PCC-EC-303	Communication Systems Theory	3	0	2	3	1
PCC-EC-304	Signals and Systems	3	0	2	3	1
PEC-EC-3**	Program Elective - I	3	0	0	3	0
HMC392	Industrial Management for Engineers	2	0	0	2	0
SEM-EC-315	Seminar	0	0	2	0	1
	Total	**17**	**1**	**8**	**22**	
SEMESTER – VI						
Code	*Course Title*	*L*	*T*	*P*	*Credits*	
					Th.	*Pr.*
PCC-EC-316	Linear Integrated Circuits	3	0	2	3	1
PCC-EC-317	Digital Communication	3	0	2	3	1
PCC-EC-318	Digital Signal Processing	3	0	0	3	0
PCC-EC-319	Embedded Systems	3	0	2	3	1
PEC-EC-3**	Program Elective - II	3	0	2	3	1
PRJ-EC-330	Mini Project	0	0	4	0	2
		15	**0**	**12**	**21**	

N.B.: Lectures/Tutorials/Practical are mentioned in Hours/Week

Program Elective – I (Any one from the following)	**Program Elective - II** (Any one from the following)
PEC-EC-305 Probability and Statistics	PEC-EC-320 Machine Learning
PEC-EC-306 Computer Organization	PEC-EC-321 Computer Security
PEC-EC-307 Bio Medical Signal Processing	PEC-EC-322 Digital VLSI Design
PEC-EC-308 Microelectronics	PEC-EC-323 Robotics
PEC-EC-309 DSP Processors	PEC-EC-324 Satellite Communication
PEC-EC-310 Linear Algebra	PEC-EC-325 Power Electronics
PEC-EC-311 Antenna and Wave Propagation	PEC-EC-326 Consumer Electronics
PEC-EC-312 Digital Telephony	PEC-EC-327 System Software and Operating Systems
PEC-EC-313 Digital System Design with Verilog	PEC-EC-328 Electronic Design Automation Tools
PEC-EC-314 Physiology for Engineers	PEC-EC-329 Electronic Materials and Devices

**Practical for Electives can be converted in to either assignments, quizzes, surprise tests, mini projects, seminars, field work, etc., or any combination of the same decided by the course coordinators which should be announced at the commencement of the course. However, the midterm and end-term evaluation based on the performance of the students is compulsory as per the examination scheme of the courses.*

Semester V

PCC-EC-301	Electromagnetic Engineering	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory
Tutorial	1 hrs/week	In Semester Evaluation : 20 Marks
Practical	-- hrs/week	Mid Semester Examination : 30 Marks
Credit	4	End Semester Examination : 50 Marks

Course Objectives:

1.	To understand three dimensional geometry.
2.	To get the knowledge, communication takes place using electric and magnetic fields through free space.
3.	To understand the electric field and magnetic field.
4.	To get the knowledge of electric and magnetic field are propagated in free space and changes with respect to distance.
5.	To study the different theorems useful for signal propagation, like divergence theorem, Stokes's Theorem.
6.	To get the knowledge of different laws useful for propagation of signal in free space, like Gauss's law, Faraday's law, Coulomb's law, etc.
7.	To understand when charge moves there is change in energy and potential.
8.	To understand field component changes when medium changed.
9.	To study and understand how Maxwell's equation useful for communication.
10.	To understand the wave motion in free space and perfect dielectric

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

1.	Understanding the vector fields E, D, H & B.
2.	Cleared the Concepts Divergence and Stokes theorem
3.	Get an idea of the concepts: Work done, Potential, Potential gradient and dipole
4.	Get the idea of the terms Conductors, Dielectrics, boundary conditions and capacitance
5.	Understanding of Poisson's and Laplace's equations
6.	Get knowledge about Time Varying Field and Maxwell's Equations
7.	Get an idea of Uniform Plane Wave used for propagation

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO7	2	2	3	2	2	-	-	--	-	-	-	-	2	2	3
CO (total)	17	15	15	16	14	-	-	-	-	-	-	-	19	18	16
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	**Vector Analysis, Coulomb's Law, and Electric Field Intensity (10 hours)** Dot product, cross product, **c**oordinate systems, transformations, experimental law of Coulomb, electric field intensity of point charge, field of line charge, field of sheet of charge, field due to a continuous volume charge distribution, and streamlines.
Unit 2	**Electric Flux Density, Gauss's Law, and Divergence (4 hours)** Electric flux density, Gauss's law, applications of Gauss's law, divergence, and divergence theorem.
Unit 3	**Energy and Potential (7 hours)** Energy expended in moving a point charge in electric field, line integral, definition of potential difference and potential, potential field of a point charge and system of charges, potential gradient, the dipole, energy density in the electrostatic field.
Unit 4	**Conductors, Dielectrics and Capacitance (5 hours)** Current, current density, continuity of current, conductor properties and boundary conditions, boundary conditions for perfect dielectric materials, and capacitance.
Unit 5	**Poisson's and Laplace Equations (3 hours)** Poisson's and Laplace's equations, example of the solution of Laplace's and Poisson's equation.
Unit 6	**Steady Magnetic Field (6 hours)** Biot-Savart law, Ampere's circuital law, Curl, Stoke's theorem, magnetic flux and magnetic flux density, scalar and vector magnetic potentials.
Unit 7	**Time Varying Field, Maxwell's Equations, and Uniform Plane Wave (5 hours)** Faraday's law, displacement current, Maxwell's equations in point form and integral form, Equation and solution of wave equation, wave motion in free space and perfect dielectric.
Text/Reference Books:	
1.	W.H. Hayt, Engineering Electromagnetics, Tata McGraw Hill.
2.	R. K. Shevgaonkar, Electromagnetic Waves, McGraw Hill, 2005
3.	M.A. Wazed Miah, Fundamentals of Electromagnetics, Tata McGraw Hill.
4.	Engineering Electromagnetics by Nathan Ida, Springer
5.	Electromagnetic Engineering by A. V. Bakshi and U. A. Bakshi, Technical Publications

PCC-EC-302	Control Systems		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks	
Tutorial	-- hrs/week		
Practical	2 hrs/week		
Credit	4		

Course Objectives:

1.	To learn modeling of a physical system and express its internal dynamics and input- output relationships by means of block diagrams, mathematical model and transfer functions.
2.	To understand the relationships between the parameters of a control system and its stability, accuracy, transient behavior.
3.	Students should be able identify the parameters that the system is sensitive to. Determine the stability of a system and parameter ranges for a desired degree of stability using algebraic and frequency domain methods.
4.	Understanding concept of controllers like P, PD, PI, or PID controller based on the transient and steady state response criteria.

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

1.	Model a physical system and express its internal dynamics and input-output relationships by means of block diagrams, mathematical model and transfer functions.
2.	Understand and explain the relationships between the parameters of a control system and its stability, accuracy, transient behavior.
3.	Identify the parameters that the system is sensitive to. Determine the stability of a system and parameter ranges for a desired degree of stability.
4.	Plot the Bode, Nyquist, Root Locus diagrams for a given control system and identify the parameters and carry out the stability analysis.
5.	Determine the frequency response of a control system and use it to evaluate or adjust the relative stability.
6.	Design a P, PD, PI, or PID controller based on the transient and steady state response criteria.
7.	Model and analyze the control systems using state space analysis.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	-	-	-	-	-	-	-	3	2	3
CO2	3	3	2	2	2	-	-	-	-	-	-	-	3	2	2
CO3	2	2	2	2	2	-	-	-	-	-	-	-	3	2	3
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	2
CO5	3	2	2	1	2	-	-	-	-	-	-	-	3	3	2
CO6	2	2	3	2	2	-	-	-	-	-	-	-	3	3	3
CO7	3	2	2	2	2	-	-	-	-	-	-	-	3	2	2
CO (total)	19	17	17	15	15	-	-	-	-	-	-	-	21	17	17
CO(avg)	3	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	**Introduction to Control Systems** Definition, history, elements of control systems, examples of control systems, open loop and closed loop control systems, effect of feedback on overall gain, parameter variations, external disturbances or noise and control over system dynamics, regenerative feedback, linear versus nonlinear control systems, time- invariant versus time-varying systems, SISO and MIMO systems.
Unit 2	**Laplace Transform** Properties, transfer function, poles and zeros.
Unit 3	**Mathematical Modeling of Dynamic Systems** Introduction, canonical form of feedback control systems, transfer function and impulse response, differential equations and transfer functions of physical systems such as mechanical, electrical, electromechanical, thermal, pneumatic and liquid-level systems, analogous systems: force-voltage, force-current and torque-current analogies, linearization of nonlinear mathematical models, block diagram representation of control system, rules and reduction techniques, signal flow graph: elements, definition, properties, Masons gain formula, application of gain formula to block diagrams.
Unit 4	**Time-Domain Analysis of Control Systems** Standard test signals, transient response, error and error constants, time response of first and second order systems and transient response specifications, effect of adding poles and zeros to transfer functions, dominant poles of transfer function, basic control actions and response of control systems, effects of integral and derivative control action on system performance. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative (PID) control.
Unit 5	**Stability of Linear Control systems** Concept of stability, BIBO stability: condition, zero-input and asymptotic stability, Hurwitz stability criterion, Routh-Hurwitz criterion in detail, relative stability analysis, Root-locus technique: introduction, basic properties of the root loci, general rules for constructing root loci, root-locus analysis of control systems.
Unit 6	**Frequency Domain Analysis** Frequency response of closed loop systems, frequency domain specifications of the prototype second order system, correlation between time and frequency response, polar plots, Bode plots, phase and gain margin, stability analysis with Bode plot, Log magnitude versus Phase plots. Nyquist stability criterion: Mathematical preliminaries, stability and relative stability analysis.
Unit 7	**State Variable Analysis and Design** Concept of state, state variable, and state model, state model for linear continuous time system, diagonalisation, solution of state equation, concept of controllability and observability.
Text/Reference Books:	
1.	I J Nagrath and M Gopal, Control Systems Engineering, Fifth Edition, New age International Publishers, India, 2009.
2.	K. Ogata, Modern Control Engineering, Fourth edition, Pearson Education India, 2002.
3.	B.C. Kuo, Automatic Control Systems, Seventh Edition, Prentice–Hall of India, 2000.
4.	Norman S. Nise, Control systems Engineering, Third Edition, John Wiley and Sons Inc., Singapore, 2001.
5.	R.C. Dorf and R.H. Bishop, Modern Control Systems, Eighth edition, Addison-Wesley, 1999.

PCC-EC-303	Communication Systems Theory		
Teaching scheme:			**Examination scheme:**
Lecture	3 hrs /week		Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	0 hrs/week		
Practical	2 hrs/week		
Credit	4		

Course Objectives:

1.	Knowledge about the theory of random process statistical averages of random process.
2.	To understand modeling of noise in the communication system.
3.	To understand the behavior of analog and digital communication systems in presence of noise.
4.	Analyze the analog-to-digital conversion process with emphasis on Nyquist Sampling Criteria.
5.	To improve the communication system performance by understanding Matched filter and Inter symbol interference (ISI).

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

1.	Understand the mathematical modeling of noise.
2.	Analyze the behavior of Analog and Digital Modulation Systems In presence of noise;
3.	Analyze effect of channel noise on the digital communication system.
4.	Design the Optimum Filter like Matched Filter to optimize the detector performance.
5.	Understand the effect of Inter symbol interference (ISI) in channel modeling.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	2	3	1	0	1	0	0	0	2			
CO2	3	3	1	2	3	1	0	1	1	1	0	1			
CO3	2	1	3	2	1	0	0	1	1	1	0	0			
CO4	3	2	2	3	2	1	0	1	1	1	0	1			
CO5	2	3	1	1	1	1	0	1	1	1	0	2			
CO (total)	13	12	8	10	10	4	0	5	4	4	0	6			
CO(avg)	3	3	1	2	3	1	0	1	1	1	0	2			

Syllabus	
0Unit 1	**Introduction:** The communication process, Primary Communication resources, Sources of information, Communication networks, communication channels, modulation process, analog and digital types of communications, Shannon's information capacity theorem, Review of random variables and operations on multiple random variables.
Unit 2	**Random Processes:** Mathematical definition of a random process, Stationary processes, mean, correlation and covariance functions, Ergodic processes, Transmission of a random process through a linear time invariant filter, power spectral density, Gaussian random process.
Unit 3	**Noise Analysis:** Gaussian Noise, narrowband noise, representation of narrowband noise in terms of in-phase and quadrature components, representation of narrowband noise in terms of envelope and phase components, sine wave plus narrow band noise.
Unit 4	**Continuous-Wave Modulation:** Superheterodyne receiver, Noise in CW modulation systems, noise in linear receivers using coherent detection, noise in AM receivers using envelope detection, noise in FM receivers.
Unit 5	**Pulse Modulation:** Sampling process, quantization process, PCM. Noise considerations in PCM systems. TDM, digital multiplexers, virtues, limitations and modification of PCM, Delta modulation, Linear prediction, differential pulse code modulation (DPCM), Adaptive DPCM.
Unit 6	**Baseband Pulse Transmission:** Matched filter, error rate due to noise, inter-symbol interference, Nyqiest's criterion for distortion less baseband binary transmission, correlative-level coding, base band M-ary PAM transmission, digital subscriber lines, optimum linear receiver, adaptive equalization.
Text/Reference Books:	
1.	Haykin S., "Communications Systems", 4th Ed., John Wiley and Sons, 2001.
2.	Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3.	B. P. Lathi, Modern Analog and Digital Communication Systems, Prism Sounders.

PCC-EC-304	**Signals and Systems**	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	Coverage of continuous and discrete-time signals and systems, their properties and representations and methods that are necessary for the analysis of continuous and discrete-time signals and systems.
2.	Knowledge of time-domain representation and analysis concepts as they relate to difference equations, impulse response and convolution, etc.
3.	Knowledge of frequency-domain representation and analysis concepts using Fourier analysis tools, Z-transform
4.	Concepts of the sampling process.
5.	Build the Mathematical and computational skills and foundations needed in areas like communication, digital signal and image processing, control systems which will be taught in further courses.

Course Outcomes: On successful completion of this course, students will be able 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 Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO → ↓ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	0	2	2	0	0	0	1	1	0	1	2	2	2
CO2	3	3	0	2	2	0	0	1	1	1	0	1	2	2	2
CO3	3	3	2	2	2	0	0	0	1	1	0	1	2	2	2
CO4	3	3	0	2	2	0	0	1	1	1	0	1	2	2	2
CO5	3	3	0	2	2	0	0	1	1	1	0	1	2	2	2
CO6	3	3	3	2	2	0	0	1	1	1	0	1	2	2	2
CO7	3	3	2	2	2	0	0	1	1	1	0	1	2	2	2
CO (total)	21	21	7	14	14	0	0	5	7	7	0	7	14	14	14
CO(avg)	3	3	1	2	2	0	0	1	1	1	0	1	2	2	2

Syllabus	
Unit 1	**Introduction** 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.
Unit 2	**Linear Time-Invariant Systems** Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input output behaviour with aperiodic convergent inputs. Characterization of causality and stability of linear shift-invariant systems. System representation through differential equations and difference equations.
Unit 3	**Fourier Analysis for Continuous-Time Signals and Systems** 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.
Unit 4	The Laplace Transform, notion of Eigen functions of LSI systems, a basis of Eigen functions, region of convergence, poles and zeros of system, Laplace domain analysis, solution to differential equations and system behavior.
Unit 5	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.

Text/Reference Books:	
1.	A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983.
2.	R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
3.	Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
4.	B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.
5.	Douglas K. Lindner, "Introduction to Signals and Systems", McGraw Hill International Edition: c1999.
6.	Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, c1998.
7.	Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons, 1995.
8.	8. M. J. Roberts, "Signals and Systems - Analysis using Transform methods and MATLAB", TMH, 2003.
9.	9. J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, "Signals and Systems", TMH New Delhi, 2001.
10.	Ashok Ambardar,"Analog and Digital Signal Processing", 2nd Edition, Brooks/ Cole Publishing Company (An international Thomson Publishing Company), 1999.

Program Elective – I

PEC-EC-305	**Probability and Statistics**		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory	
Tutorial	-- hrs/week	In Semester Evaluation : 20 Marks	
Practical	-- hrs/week	Mid Semester Examination : 30 marks	
Credit	3	End Semester Examination : 50 marks	

Course Objectives:

1.	To study core concept of probability theory.
2.	To understand basic principles of statistical inference
3.	To understand conditional probabilities using Bayes theorem.
4.	To get the knowledge of uniform, normal, exponential distribution.
5.	To compute the co-variance and co-relation between jointly distributed variables.
6.	To create and interpret scatter plots and histogram.
7.	To understand the basic statistical concepts and measures.

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

1.	Understand the basic knowledge on fundamental probability concepts, including random variable, probability of an event, additive rules and conditional probability
2.	Apply the central limit theorem to sampling distribution and use estimation technique to determine point estimates confidence interval and sample size.
3.	Understand several well-known distributions, including Binomial, Geometrical, Negative Binomial, Pascal, Normal and Exponential Distribution.
4.	Perform and analyze hypotheses tests of means, proportions and variances using both one-and two-sample data sets.
5.	Compute and interpret all of the results of linear Regression.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	1	-	-	-	-	-	-	-	3	3	1
CO2	3	3	2	3	2	-	-	-	-	-	-	-	2	2	2
CO3	3	2	2	2	2	-	-	-	-	-	-	-	3	3	2
CO4	2	3	3	2	2	-	-	-	-	-	-	-	2	2	2
CO5	3	1	2	2	2	-	-	-	-	-	-	-	2	2	2
CO (total)	14	11	12	11	9								12	12	9
CO(avg)	3	2	3	2	2	-	-	-	-	-	-	-	2	2	2

Syllabus	
Unit 1	**Dealing with Uncertainty and Complexity in a Chaotic World** Introduction
Unit 2	**Quantifying Uncertainty With Probability-** Probability Principles, Simple Probability Distributions, Expectation of Random Variables, Bayesian Updating, Parameters, The Distribution Zoo
Unit 3	**Describing The World The Statistical Way** Classification of Variables, Data Visualisation, Descriptive Statistics - Measures of Central Tendency, Descriptive Statistics - Measures of Spread, The Normal Distribution, Variance of Random Variables
Unit 4	**Sampling** Introduction to Sampling, Random Sampling, Further Random Sampling, Sampling Distributions, Sampling Distribution of the Sample Mean, Confidence Intervals,
Unit 5	**Statistics:** Statistical Juries, Type I and Type II errors, P-values, Effect Size and Sample Size Influences, Testing a Population Mean Claim, The Central Limit Theorem, Proportions: Confidence Intervals and Hypothesis Testing
Unit 6	**Applications:** Decision Tree Analysis, Risk, Linear regression, Linear Programming.
Text/Reference Books:	
1.	An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md.E.Saleh.
2.	Introduction to Probability and Statistics by J.S. Milton & J.C.Arnold.
3.	Introduction to Probability Theory and Statistical Inference by H.J. Larson.
4.	Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross

PEC-EC-306	**Computer Organization**	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week	
Practical	-- hrs/week	
Credit	3	

Course Objectives:

1.	Provide the basic concepts of computer architecture and organization
2.	Provide the knowledge about input output system of computer
3.	Introduce with different systems of computer

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

1.	Understand, Classify and compute the performance of machines.
2.	Understand the basic of hardware and micro programmed control of the CPU.
3.	Learn about various I/O Devices n I/O interface.
4.	Apply arithmetic's for ALU implementation.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	1	2	-	-	-	-	-	-	-	2	2	2
CO2	3	2	1	1	2	-	-	-	-	-	-	-	2	2	2
CO3	3	2	-	1	2	-	-	-	-	-	-	-	2	2	2
CO4	2	2	1	1	2	-	-	-	-	-	-	-	2	2	2
CO (total)	11	8	2	4	8	-	-	-	-	-	-	-	08	08	08
CO(avg)	3	2	1	1	2	-	-	-	-	-	-	-	2	2	2

Syllabus	
Unit 1	**Introduction** Computer Types, Function and structure of a computer, Functional components of a computer, Interconnection of components, Performance of a computer.
Unit 2	**Representation of Instruction** Machine instructions, Operands, Addressing modes, Instruction formats, Instruction sets, Instruction set architectures - CISC and RISC architectures.
Unit 3	**Processing Unit** Organization of a processor - Registers, ALU and Control Unit, Data path in a CPU, Instruction cycle, Organization of a control unit - Operations of a control unit, Hardware control unit, Microprogrammed control unit.
Unit 4	**Memory Subsystem** Semiconductor memories, Memory cells - SRAM and DRAM cells, Internal Organization of a memory chip, Organization of a memory unit, Error correction memories, Interleaved memories, Cache memory unit - Concept of cache memory, Mapping methods, Organization of a cache memory unit, Fetch and write mechanisms, Memory management unit - Concept of virtual memory, Address translation, Hardware support for memory management
Unit 5	**Input/output Subsystem** Access of I/O devices, I/O ports, I/O control mechanisms - Program controlled I/O, Interrupt controlled I/O, and DMA controlled I/O, I/O interfaces – Serial port, Parallel port, PCI bus, SCSI bus, USB bus, Firewall and Infiniband, I/O peripherals - Input devices, Output devices, Secondary storage devices.
Text/Reference Books:	
1.	C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw-Hill, 2002.
2.	W. Stallings, "Computer Organization and Architecture - Designing for Performance", Prentice Hall of India, 2002.
3.	D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann, 1998.
4.	J .P. Hayes, "Computer Architecture and Organization", McGraw-Hill, 1998

PEC-EC-307	Bio Medical Signal Processing		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks	
Tutorial	-- hrs/week		
Practical	-- hrs/week		
Credit	3		

Course Objectives:

1.	To understand basic of various Biomedical signals.
2.	To study origin and characteristics of most commonly used biomedical signals, including ECG, EEG, evoked potential, and EMG.
3.	To understand sources and characteristics of noise and artifacts in bio signals.
4.	To understand use of bio signal for simple diagnosis, patient monitoring and physiological investigation.
5.	To explore the research in biomedical signal processing.
6.	To explore application of established engineering methods to complex biomedical signals problems.

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

1.	Model a biomedical system.
2.	Understand various methods of acquiring bio signals.
3.	Understand various sources of bio signal distortions and its remedial techniques.
4.	Analyze ECG, EEG and PCG signal.
5.	Have basic understanding of diagnosing bio-signals and classifying them by detecting various parameters.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	3	1	-	-	2	-	-	-	3	1	1
CO2	3	3	1	1	3	1	-	-	2	-	-	-	2	1	1
CO3	3	3	1	1	3	1	-	-	2	-	-	-	1	2	1
CO4	3	3	3	3	3	1	-	-	2	-	-	-	3	3	3
CO5	3	3	3	3	3	1	-	-	2	-	-	-	2	3	3
CO (total)	15	15	11	10	15	5	-	-	10	-	-	-	11	10	9
CO (avg)	3	3	2	2	3	1	-	-	2	-	-	-	2	2	2

Syllabus	
Unit 1	Essentials of continuous time signals and systems: Convolution, Fourier transform, system transfer functions; Discrete time signals and systems: sampling and quantization, the sampling theorem and signal reconstruction; Frequency analysis of discrete signals and systems: the discrete Fourier transform, power spectrum estimation and system identification
Unit 2	Discrete and continuous Random variables, Probability distribution and density functions. Gaussian and Rayleigh density functions, Correlation between random variables. Stationary random process, Ergodicity, Power spectral density and autocorrelation function of random processes. Noise power spectral density analysis, Noise bandwidth, noise figure of systems.
Unit 3	Data Compression Techniques: Lossy and Lossless data reduction Algorithms. ECG data compression using Turning point, AZTEC, CORTES, Hoffman coding, vector quantisation, DCT and the K L transform.
Unit 4	Cardiological Signal Processing: Pre-processing. QRS Detection Methods. Rhythm analysis. Arrhythmia detection Algorithms. Automated ECG Analysis. ECG Pattern Recognition. Heart rate variability analysis.
Unit 5	Adaptive Noise Canceling: Principles of Adaptive Noise Canceling. Adaptive Noise Canceling with the LMS adaptation Algorithm. Noise Canceling Method to Enhance ECG Monitoring. Fetal ECG Monitoring. Signal Averaging, polishing–mean and trend removal, Prony's method. Linear prediction. Yule–walker(Y–W) equations.
Unit 6	Neurological Signal Processing: Modeling of EEG Signals. Detection of spikes and spindles Detection of Alpha, Beta and Gamma Waves. Auto Regressive(A.R.) modeling of seizure EEG. Sleep Stage analysis. Inverse Filtering. Least squares and polynomial modeling.
Unit 7	Original Prony's Method. Prony's Method based on the Least Squares Estimate. Analysis of Evoked Potentials and PCG. Analysis of non-stationary processes: examples using Wavelet analysis and Time-series models; Examples of physiological signals and systems including feedback systems.
Text/Reference Books:	
1.	Rangaraj M. Rangayyan – Biomedical Signal Analysis. IEEE Press, 2001.
2.	D.C.Reddy, Biomedical Signal Processing- principles and techniques, Tata McGraw-Hill, 2005.
3.	Biomedical Digital Signal Processing, Willis J.Tompkins, PHI,
4.	Weitkunat R, Digital Bio signal Processing, Elsevier, 1991.
5.	Akay M , Biomedical Signal Processing, Academic: Press 1994
6.	Cohen.A, Biomedical Signal Processing -Vol. I Time and Frequency Analysis, CRC Press, 1986.

PEC-EC-308	**Microelectronics**		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory	
Tutorial	-- hrs/week	In Semester Evaluation	: 20 Marks
Practical	-- hrs/week	Mid Semester Examination	: 30 Marks
Credit	3	End Semester Examination	: 50 Marks

Course Objectives:

1.	Describe crystal structure of solid and Clarify basics of semiconductor.
2.	Analyzing carrier concentration and energy band diagrams of extrinsic, P type, N type semiconductor material under equilibrium condition.
3.	Explain different phenomenon like Charge neutrality principle, Hall effect, Mass action law, drift, diffusion, carrier generation and recombination.
4.	Explain terminal voltage and current characteristics of PN junction and MOSFET with the help of energy band diagrams
5.	A comprehensive understanding of manufacturing processes of PN junction and MOSFET and BJT.

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

1.	Understand the physics of semiconductor material and use the concept in designing of integrated circuit.
2.	Compute carrier concentration of semiconductor under various conditions.
3.	Compare conductivity and resistivity of semiconductor material under various conditions.
4.	Inspect terminal voltage and current characteristics of PN junction, MOSFET.
5.	Design integrated circuits with consideration of capabilities and limitations of fabrication technology.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1	1	-	-	1	1	-	-	3	1	2
CO2	3	3	2	3	2	1	-	-	1	1	-	-	3	1	2
CO3	3	2	1	2	1	1	-	-	1	1	-	-	3	1	2
CO4	3	1	1	1	1	1	-	-	1	1	-	-	3	1	1
CO5	3	2	3	2	2	1	-	-	1	1	-	-	3	1	1
CO (total)	15	10	8	9	7	5	-	-	5	5	-	-	15	5	9
CO(avg)	3	2	2	2	1	1	-	-	1	1	-	-	3	1	2

Syllabus	
Unit 1	The crystal structure of solids, the semiconductor materials, types of solids, space lattices, atomic bonding, imperfections and impurities in solids
Unit 2	Theory of solids, principles of quantum mechanics, Energy band theory, density of states function, statistical mechanics, semiconductor in equilibrium, carrier distribution in extrinsic semiconductors, statistics of donors and acceptors, carrier concentration-effect of doping, position of Fermi energy level- effect of doping and temperature.
Unit 3	Carrier transport and excess carrier phenomena, carrier drift, carrier diffusion, graded impurity distribution, carrier generation and recombination, Hall effect.
Unit 4	The pn junction and metal semiconductor contact, basic structure of pn junction, metal semiconductor contact, doped pn junction, device fabrication techniques,
Unit 5	Fundamentals of MOSFET, MOSFET action, MOS capacitor, potential differences in the MOS capacitor, CV characteristics, MOSFET operations, small signal equivalent circuit
Unit 6	MOSFET scaling, non-ideal effects, threshold voltage modifications, additional electrical characteristics. The BJT action, minority carrier distribution, low frequency common base current gain, nonideal effects, hybrid Pi equivalent circuit model, large signal switching
Text/Reference Books:	
1.	Donald Neamen, An introduction to semiconductor devices, McGraw Hill International Edition, 2006.
2.	Ben G. Streetman, S. Banerjee, Solid state electronic devices, Prentice Hall, 2000.
3.	R. F. Pierret, Semiconductor Device Fundamentals, Pearson Education, 2011.

PEC-EC-309	DSP Processors	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory
Tutorial	-- hrs/week	In Semester Evaluation : 20 Marks
Practical	-- hrs/week	Mid Semester Examination : 30 Marks
Credit	3	End Semester Examination : 50 Marks

Course Objectives:

1.	Provide understanding and working knowledge of design, of DSP Systems.
2.	Understanding for implementation and analysis of DSP systems.

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

1.	Recognize the fundamental architecture of DSP systems.
2.	Understand the architecture details and instructions sets of DSPs.
3.	Use DSP programming tools for applications.
4.	Use and apply detailed FPGA based DSP system.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	2	-	1	-	-	-	-	-	-	-	-	3	2	2
CO3	3	-	2	-	2	-	-	-	-	-	-	-	2	2	2
CO4	3	2	2	2	2	-	-	-	-	-	-	-	2	2	2
CO (total)	12	6	4	3	2	-	-	-	-	-	-	-	9	8	8
CO(avg)	3	2	2	2	2	-	-	-	-	-	-	-	2	2	2

Syllabus	
Unit 1	Introduction to Programmable DSPs: Comparison of GP Processors and DSP processor Architecture, Multiplier and MAC, Modified Bus structures and Memory Access schemes, Multiple Access Memory, Dual port memory, VLIW Architecture, Pipelining, Special Addressing Modes, On-Chip Peripherals, RISC Vs CISC design.
Unit 2	Architecture of TMS32054X: Introduction, Architecture, buses, Memory organization, CPU, ALU, Barrel Shifter, On-chip Peripherals, Address Generation Logic.
Unit 3	TMS32054X Assembly Language Instructions, Programmimg in Assembly language Application Programmes in C54X: Code Composer Studio, Application Programmes in C54X.
Unit 4	TMS320C6xx DSPs: Features, Architecture, Memory Interfacing, Addressing Modes, Pipeline operation, Peripheral, C-Programming and DSP Application development like Speech coding Image processing and coding applications**.**
Unit 5	Recent trends in DSP System design, Media processor, FPGA Based DSP System Design.
Text/Reference Books:	
1.	B. Venkatramani, M. Basker: Digital Signal Processors: Architecture, Programming and Applicaions, TMS, 2004.
2.	Shehrzad Qureshi, EMBEDDED IMAGE PROCESSING ON THE TMS320C6000™ DSP (Examples in Code Composer Studio™ and MATLAB), Springer Science 2005.

PEC-EC-310	Linear Algebra		
Teaching scheme:			**Examination scheme:**
Lecture	3 hrs /week		Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week		
Practical	2 hrs/week		
Credit	4		

Course Objectives:

1.	Work with matrices by performing operations with matrices, learn to solve systems of linear equations.
2.	Learn about and work with vector spaces and subspaces.
3.	Learn the concepts of norm and orthogonality.
4.	Learn to find use of eigen values and eigen vectors of matrix.

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

1.	Carry out matrix operations such as inverse and determinants and solve systems of linear equations using multiple methods, including Gaussian elimination and matrix inversion.
2.	Demonstration and understanding of the concepts of vector space and subspace.
3.	Understanding and application of the concepts of vector and matrix norm, inner product and orthogonality by various techniques such as orthogonal decomposition, least squares.
4.	Determine eigenvalues and eigenvectors and solve eigenvalue problems by similarity transformations and Jordon form and others.
5.	Carry out matrix operations such as inverse and determinants and solve systems of linear equations using multiple methods, including Gaussian elimination and matrix inversion.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	1	-	1
CO2	3	1	1	-	-	-	-	-	-	-	-	-	1	2	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	1	1	1
CO4	3	1	-	-	-	-	-	-	-	-	-	-	-	2	2
CO5	3	2	1	-	-	-	-	-	-	-	-	-	2	-	1
CO (total)	15	8	6	-	-	-	-	-	-	-	-	-	5	5	5
CO(avg)	3	2	1	-	-	-	-	-	-	-	-	-	1	1	1

Syllabus	
Unit 1	**Basic set theory** Set Theory, Set Operations, Set of sets, Binary relation, Equivalence relation, Mapping, Permutation, Binary Composition, Groupoid.
Unit 2	**Group Theory** Group, Order of an element, Subgroup, Cyclic Group, Subgroup operations
Unit 3	**Rings and Polynomial** Left cosets, right cosets, Normal subgroup, Rings, Field.
Unit 4	**Vector spaces over fields** Vector spaces, sub-spaces, linear span, basics of vector space, Dimension of vector space.
Unit 5	**Linear transformations and their matrices** Complement od subspace, Linear transformation, Linear space.
Unit 6	**Matrices and determinants** Rank of matrix, system of linear equations, Row rank and column rank,
Unit 7	**Eigen value and Eigen Vector** Eigen value of a matrix, Eigen vector, Geometric multiplicity, similar matrices.
Text/Reference Books:	
1.	Carl D. Meyer, Matrix and Applied linear Algebra, SIAM.
2.	Gilbert Strang, Linear Algebra and Its Applications, Cengage Learning

PEC-EC-311	Antenna and Wave Propagation	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week	
Practical	-- hrs/week	
Credit	3	

Course Objectives:

1.	Students will be introduced to antenna basics and principle of operation
2.	Students will be introduced fundamental parameters of antenna, Linear wire and loop antennas
3.	Introduce the students to Antenna arrays
4.	Students will be introduced to measurement of antenna parameters
5.	Students will be introduce to propagation of waves in different mediums

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

1.	Define various parameters of antenna
2.	Evaluate antennas for given specification
3.	Illustrate techniques for antenna parameter measurement
4.	To understand various types of antennas
5.	Discuss radio wave propagation

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	-	-	-	2	-	-	2	-	2	-	2	-	1
CO2	2	-	2	3	-	-	2	-	2	-	-	-	3	2	-
CO3	2	-	2	2	3	-	2	-	-	-	3	-	2	1	1
CO4	3	-	-	1	-	-	2	2	-	-	1	-	-	2	3
CO5	-	2	-	-	-	1	-	-	2	2	-	-	2	1	1
CO (total)	10	5	4	6	3	3	6	2	6	2	6	-	9	6	6
CO(avg)	2	1	1	1	1	1	1	1	1	1	1	-	2	1	1

Syllabus	
Unit 1	**Introduction to Antenna:** Resonance of antenna, Types of antenna, radiation mechanism of antenna in single wire, two wire and dipole.
Unit 2	**Fundamental Parameters of Antenna :** Power density, radiation intensity, radiated power, radiation intensity, gain directivity, efficiency, effective aperture, effective length, band width, polarization, antenna temperature.
Unit 3	**Linear Wire and Loop Antennas:** Infinitesimal dipole, small dipole, finite length dipole, half length dipole, small circular loop, polygonal loop, ferrite loop.
Unit 4	**Antenna Arrays:** Types of arrays, two element linear arrays, *n*-element linear arrays, continuous array, planar arrays.
Unit 5	**Different Antennas:** Folded dipole, Yagi-Uda antenna, long wire antenna, V antenna, inverted antenna, log periodic antenna, Helical antenna, Horn antenna, lens antenna.
Unit 6	**Antenna Measurements:** Measurement of impedance, gain, radiation pattern, phase, polarization, directivity, beam width, radiation resistance.
Unit 7	**Wave Propagation:** Modes of propagation, structure of atmosphere, ground wave propagation, sky wave propagation, duct propagation.
Text/Reference Books:	
1.	C. A. Balanis, Antenna theory: Analysis and design, Harper and Row Pow.(N.Y.)
2.	J.D. Kraus and R. J. Marahefka, Antennas for applications, Tata Mc-Graw Hill Pub.
3.	K. D. Prasad., Antenna and wave propagation, Satya Prakashan, New Delhi.

PEC-EC-312	Digital Telephony		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory	
Tutorial	-- hrs/week	In Semester Evaluation	: 20 Marks
Practical	-- hrs/week	Mid Semester Examination	: 30 Marks
Credit	3	End Semester Examination	: 50 Marks

Course Objectives:

1.	To get knowledge of fundamental structure of telephone switching system.
2.	To understand the working principle of telephone switching system.
3.	To understand traffic and losses in network.
4.	To Know the ISDN Technology.
5.	To understand the principle of digital Internet Protocol based telephony.
6.	To grasp the knowledge of new technology of transmitting voice over packet network.

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

1.	Understand telephone network.
2.	Analyze traffic in telephone network.
3.	Interpret working of different switching networks.
4.	Understand various techniques of transmitting digital data over telephone line.
5.	Understand terminology of exchange of voice, video, fax and other form of information using internet protocol over telephone network.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	-	-	2	-	1	-	-	-	-	-	-	2	-
CO2	3	2	1	1	-	1	-	1	-	-	2	-	-	3	1
CO3	2	-	2	2	1	2	-	2	-	-	2	-	-	2	1
CO4	1	2	-	-	2	1	-	-	-	1	-	-	-	1	1
CO5	3	2	-	2	1	2	-	-	-	-	2	2	1	-	2
CO(tot)	11	7	3	5	6	6	1	3	-	1	6	1	8	7	5
CO(avg)	2	1	1	1	1	1	1	1	-	1	1	1	2	1	1

Syllabus	
Unit 1	**Telephony Background** An overview of telephone networks, transmission system, switching system, signaling, echo cancellation, working principles of telephone, DC (pulse) and DTMF (tone) signaling.
Unit 2	**Traffic Analysis** Traffic characterization, loss systems, network blocking probabilities, delay systems.
Unit 3	**Digital Switching and Networks** Space division switching, time division switching, time space time (TST) switch, space time space (STS) switch, comparison of TST and STS switches, network synchronization, control and management timing, timing inaccuracies, network synchronization, network control, Network management.
Unit 4	**Digital Subscriber Access** Integrated service digital network (ISDN): ISDN overview, ISDN interfaces and functions, user network interface, ISDN protocol architecture, ISDN physical layer: basic user– network interface, primary rate user- network interface, ISDN data link layer: LPAD protocol, terminal adaptation, bearer channel data link control, ISDN network layer: basic call control, control of supplementary services.Broadband ISDN (B - ISDN) Architecture, Protocols. Digital subscriber loop (DSL): ADSL, HDSL, VDSL, Fiber in loop, wireless local loop (WLL) Signaling System Number 7 (SS7): SS7, architecture signaling date link level, signaling link level, network level, signaling connection control part.
Unit 5	**Introduction to IP Telephony and Related Protocols** Overview of TCP/IP protocol, Resource reservation protocol (RSVP), multiprotocol label switching, real time protocol (RTP), session initiation protocol (SIP), H.323 standard, media gateway control protocol.
Unit 6	**Voice Over Packet Networks** Voice over ATM, ATM cell format, ATM protocol stack, ATM adaptation layer, IP over ATM, frame relay over ATM
Text/Reference Books:	
1.	"Digital Telephony" by John C Bellamy, Wiley series in telecommunication and signal processing
2.	"Digital Telephony and Network Integration" by Bernard E Keiser and Eugene Strange
3.	"Digital Telephony" by Malhar Lakdawala

PEC-EC-313	Digital System Design with Verilog	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week	
Practical	-- hrs/week	
Credit	3	

Course Objectives:

1.	Introduction to Digital Design.
2.	Design of Combinational Circuits using Verilog HDL.
3.	Design of Sequential Circuits using Verilog HDL.
4.	Design of Datapath using Verilog HDL.
5.	Design of Control path using Verilog HDL.

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

1.	Understanding Digital Design trends and software design aspects.
2.	Understanding Combinational and Sequential design aspects.
3.	Implementation of Combinational and Sequential Circuits using Verilog HDL.
4.	Understanding Datapath and Control Path design aspects.
5.	Implementation of Datapath and Control Path using Verilog HDL.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	1	-	-	-	1	1	-	-	1	2	1
CO2	2	1	1	1	1	-	-	-	1	1	-	-	1	2	1
CO3	2	2	3	2	3	-	-	-	2	1	-	-	2	2	1
CO4	2	1	1	1	1	-	-	-	1	1	-	-	1	2	1
CO5	2	2	3	2	3	-	-	-	2	1	-	-	2	2	1
CO (total)	10	7	9	7	9	-	-	-	7	5	-	-	7	10	5
CO(avg)	2	1	2	1	2	-	-	-	1	1	-	-	1	2	1

Syllabus	
Unit 1	**Introduction** Introduction to digital design, analog Vs. digital, digital devices, electronic aspects of digital design, software aspects of digital design, programmable logic devices, ASICs, PCBs, digital design levels, PLDs, PLAs, Basic components and architecture of FPGA.
Unit 2	**Combinational Component Design** Adders: Full adders, Ripple carry adders, carry look ahead adders, pipelined adders, Two's complement binary numbers, Subtractor, ALU, decoder, Encoder, multipliers, comparator, Barrel shifters, multiplier design, Verilog implementation of combinational circuits.
Unit 3	**Sequential Circuit Design** Finite state machine (FSM) models, state diagram, analysis and synthesis of sequential circuits, controller design using FSMs, verilog implementation of sequential circuits, Shift registers, Counters: up/down, register files, SRAM, RTL design: Determining clock frequency, memory components, FIFOs,
Unit 4	**Data Path Design** Designing dedicated data path, general datapath design, timing issue, Verilog implementation of datapath.
Unit 5	**Control Unit design** Constructing the control unit, ASM charts and state action tables, Verilog implementation of control unit. Examples of manual design of dedicated microprocessors.
Unit 6	**Verilog HDL and Writing Test Benches:** Introduction to Verilog HDL, Gate Level Modeling, Data Flow Modeling, Behavioral Modeling, Procedural Constructs and Assignments, Event scheduling in Verilog, delay time control.
Text/Reference Books:	
1.	J. F. Wakerly, Digital design- Principles and Practices, Pearson India, Third edition.
2.	J. Bhasker, Verilog Primer, Pearson Education Asia, Third edition.
3.	M. Morris Mano, Digital Logic and Computer Design, PHI.
4.	Frank Vahid, Digital Design, Wiley Student Edition
5.	Samir Palnitkar, Verilog HDL , 2nd Edition, Pearson Education, 2009.
6.	M.D. Ercegovac, Digital Arithmetic, Elsevier.
7.	A. Anandnaga, Switching Theory and Logic design, PHI

PEC-EC-314	Physiology for Engineers		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks	
Tutorial	-- hrs/week		
Practical	-- hrs/week		
Credit	3		

Course Objectives:

1.	To learn basic aspects of human physiology.
2.	To develop an engineering approach towards understanding of biological function.
3.	Understand the integration and control of the different physiological systems and their roles in maintaining homeostasis.
4.	Apply engineering principles to physiological problems in biochemistry, smooth, cardiac, and skeletal muscle mechanics, as well as the cardiovascular, respiratory, neural, auditory, visual systems

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

1.	Describe organization of cell and tissues.
2.	Understand fundamental cell physiology for living organisms.
3.	Analyze structure of connective tissues, skeletal muscle, bones and joints.
4.	Recognize and describe the microscopic structure of various body systems.
5.	Understand function and interaction of human anatomy and physiology.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	1	-	-	-	-	-	-	1	1	1	1
CO2	2	1	1	1	1	-	-	-	-	-	-	1	1	1	1
CO3	2	2	3	2	3	-	-	-	-	-	-	1	1	1	1
CO4	2	1	1	1	1	-	-	-	-	-	-	2	1	1	1
CO5	2	2	3	2	3	-	-	-	-	-	-	3	1	1	1
CO (total)	10	7	9	7	9	-	-	-	-	-	-	8	5	5	5
CO(avg)	2	1	2	1	2	-	-	-	-	-	-	2	1	1	1

Syllabus	
Unit 1	**Introduction:** Introduction to the human body, physiology of human cell & tissues: Definition of anatomy and physiology, Terms related to anatomy and physiology, Anatomical planes and positions, Structural Organization, The internal environment and homeostasis, Structure And Function of Cell & Cell organelles, Elementary tissues of the body: epithelial, muscular, connective and nervous.
Unit 2	**Body Fluid (Blood):** Composition of Blood, Functions of Blood, Cellular Content of Blood: their properties and functions, Blood Groups, Hemoglobin and its estimation.
Unit 3	**Respiratory System:** Structure and function of various Organs of respiratory system, Mechanism of respiration, Muscles of respiration, Control of respiration Physiological variables affect in respiration, Physical principle of gas exchange, pulmonary volumes and capacities.
Unit 4	**Cardiovascular System:** External features and structure of heart, Blood vessels, Physiology and properties of cardiac muscle, Cardiac cycle, Cardiac output, Heart rate, Heart Sound, and Introduction to ECG, Blood pressure and blood pressure control.
Unit 5	**Nervous System:** Neurons, Synapse and neurotransmitters, Central and Peripheral nervous system, various parts of nervous system; Brain: Parts and functions; Spinal cord, CSF, Ventricles of the brain, Autonomic nervous system, Reflex action.
Unit 6	**Skeletal and muscular System:** Bone: Types, Functions Structure and Development of bone; Axial Skeleton: Skull, Cranial Cavity, Vertebral Column, Thoracic Cage Joints: Types of joints, Main synovial joints of the limbs Muscular System: Classification of muscles, Anatomy and Physiology of skeletal muscle, Muscle of body, Physiology of muscle contraction, Structure and physiology of smooth muscle, cardiac muscle, difference of cardiac muscle, smooth and cardiac muscle, Anatomy and Physiology of neuromuscular junction
Unit 7	**Special Senses:** Eye: Anatomy of Eye & Physiology of Vision, Ear: Structure of Ear & Physiology of Hearing, Nose: Sense of Smell, Tongue: Sense of Taste, Skin: Structure & Functions of skin.
Unit 8	**Digestive System:** Various organs of digestive system, movement of gastrointestinal tract, mastication, deglutination, physiological activities in mouth, pharynx, esophagus, stomach, pancreas, liver, gall bladder, small and large Intestine, Digestion and absorption.
Unit 9	**Excretory System:** Anatomy of Urinary System, Physiology of urine formation, physiology of micturition, Concentration and Dilution of urine, Composition of Urine. Skeletal and muscular.
Text/Reference Books:	
1.	Anatomy and Physiology in Health and Illness by Ross and Wilson
2.	Human Anatomy and Physiology by Dr. Padma Sanghani
3.	Text book of Medical Physiology by Guyton and Hall
4.	Human Physiology and Anatomy by Fox Staurt Ira
5.	Human Anatomy (Volume 1,2,3) by B.D.Chaurasia

HMC392	Industrial Management for Engineers		
Teaching scheme:			**Examination scheme:**
Lecture	2 hrs /week		Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week		
Practical	-- hrs/week		
Credit	2		
Course Objectives:			
1.	To introduce and develop the concept of startup as an organization		
2.	To establish the understanding of operation of an organization and various roles of management		
3.	To build the concept of various Industrial laws like Factories Act, Corporate Act, Payment of wages Act, Employees & State insurance Act, etc.		
4.	To understand the various roles of management in the financial, production and planning aspect.		
Course Outcomes: On successful completion of this course, students will be able to			
1.	Develop the understanding of Industrial Laws		
2.	Understand the concept of startup as an organization		
3.	Understand the operation of an organization and various roles of management.		
4.	Understand the various roles of management in the financial, production and planning aspect.		

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	-	2	-	-	-	-	1	1	-	2	1	1
CO2	3	-	2	2	-	2	1	2	-	-	-	-	2	3	-
CO3	2	2	-	1	2	-	-	-	-	-	-	-	2	-	1
CO4	3	1	2	-	1	-	1	-	-	2	1	-	1	2	-
CO (total)	12	7	6	3	5	2	2	2	-	4	2	-	9	7	3
CO(avg)	2	1	1	1	1	1	1	1	-	1	1	-	2	1	1

Syllabus	
Unit 1	**Introduction to management** Introduction to management, administration, organization, concept, definition, scope, and importance of management. Understanding of Principles of Management Division of labor, authority, responsibility, discipline, unity of command, and direction/centralization.
Unit 2	**Role of management** Functions of Management – planning, organizing, staffing, directing, controlling, coordination, decision making, locus of control innovation, materials management, quality assurance.
Unit 3	**Laws for management** Indian Factories Act, Corporate Act, Payment of wages act, Employees & State insurance Act, Strike and Lockouts, Causes, prevention, and settlements.
Unit 4	**Startup – an organization** Concept of startup, various types and scopes of startup Types of Organization Proprietorship, partnership, and joint stock Company, private limited, public sector, cooperatives, their comparison.
Unit 5	**Financial Management** Financial Management Concepts, capital structure, fixed capital, working capital, depreciation, assignment & management of budget, budgetary control, rent, interest and profits distinction between profits and interest.
Text/Reference Books:	
1.	Buffa Kooutz and O'Donnel, Principles of Management.
2.	O. P. Khanna, Industrial Engineering and Management.
3.	P. T. Ghan, Introduction to Industrial Organization.
4.	Banga and Sharma, TIDM.

SEM-EC-315	Seminar	
Teaching scheme:		**Examination scheme:**
Lecture	-- hrs /week	Theory
Tutorial	-- hrs/week	In Semester Evaluation : 20 Marks
Practical	2 hrs/week	Mid Semester Examination : 30 Marks
Credit	1	End Semester Examination : 50 Marks

Course Objectives:

1.	Develop abilities to search information, Convey ideas through seminar.
2.	Collect data, information from various resources.
3.	Develop planning of seminar activities, to communicate the problems and solutions.
4.	Develop skill to prepare reports, presentation skills

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

1.	Develop knowledge in the Electronics and telecommunication field through independent learning and collaborative study.
2.	Identify, understand and discuss current, real-world issues in the field of social and electronics and telecommunications.
3.	Improve oral communication, written communication and presentation skills.
4.	Explore creative avenues of expression, solve problems, and make consequential decisions with principles of ethics.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	1	1	3	1	1	1	1	3	1	2	2	2
CO2	3	3	1	3	1	3	1	1	3	1	1	1	2	2	2
CO3	1	3	1	1	1	1	3	1	1	2	1	1	2	2	2
CO4	3	3	1	1	3	1	3	3	2	1	2	1	2	2	2
CO (total)	10	12	6	6	6	8	8	6	7	5	7	4	8	8	8
CO(avg)	3	3	2	2	2	2	2	2	2	1	2	1	2	2	2

Syllabus	
	It should be based on latest technical topics in Electronics and Telecommunication Engineering and related fields.

Semester VI

PCC-EC-316	**Linear Integrated Circuits**	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	To study fundamentals of OPAMP.
2.	Study linear integrated circuits and their use in design of different circuits for various applications.
3.	To study and design different voltage regulator circuits.
4.	To study and design active filters
5.	To study and design oscillators

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

1.	Learn the basic principle of op-amp, construction, characteristics, parameter, limitations, and various configurations.
2.	Understand the need and use of linear and non linear op-amp circuits and their applications.
3.	Work out the practical and design implementation of different voltage regulators.\
4.	Design different audio power amplifiers.
5.	Work out on design implementation of different waveform circuits and specialized ICs.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	-	2	-	-	-	-	1	1	-	2	1	1
CO2	3	-	2	2	-	2	1	2	-	-	-	-	2	3	-
CO3	2	2	-	1	2	-	-	-	-	-	-	-	2	-	1
CO4	3	1	2	-	1	-	1	-	-	2	1	-	1	2	-
CO5	2	3	1	-	-	-	-	-	-	1	-	-	2	1	1
CO (total)	12	7	6	3	5	2	2	2	-	4	2	-	9	7	3
CO(avg)	2	1	1	1	1	1	1	1	-	1	1	-	2	1	1

Syllabus	
Unit 1	**Operational Amplifier** OpAmp (741), specifications, packaging, characteristics, ac and dc parameters and their measurements, noise and frequency compensation.
Unit 2	**Linear OpAmp Circuits** Inverting and non-inverting amplifiers, summing amplifier, differential amplifier, instrumentation amplifier and its applications, voltage to current converters and current to voltage converters, low voltage ac and dc voltmeter.
Unit 3	**Nonlinear OpAmp Circuits** Differentiator, integrator, comparator and its characteristics, Schmitt trigger, window detector, peak detector, precision rectifier, log and antilog amplifier.
Unit 4	**Voltage Regulators** Design of series voltage regulator using discrete components, protection circuits and pre-regulator, design of fixed voltage regulators (IC 78xx and 79xx), adjustable regulators (LM 317, 337), precision voltage regulators (IC 723), design of switching regulators (IC 78s40).
Unit 5	**Active Filters** Introduction, active filters, first order and second order low pass, high pass band pass, band reject and all pass filters.
Unit 6	**Waveform Generators** Square wave, triangular wave and sawtooth wave generator, phase shift and Wein bridge oscillators and its design, function Generator using ICL 8038.
Unit 7	**Specialized ICs and Their Applications** Design of IC 555 and its applications, PLL IC 565 and its applications, design of voltmeter using 7106/07, monolithic power amplifiers LM 380 and TBA 810
Text/Reference Books:	
1.	Ramakant Gaikwad, OPAMPS and Linear Integrated Circuits, PHI/Pearson Education.
2.	S.N. Talbar and T.R. Sontakke, Electronic Circuit Design, SadhuSudha Prakashan, Nanded
3.	K.R. Botkar, Integrated Circuits, Khanna Publishers, Delhi.

PCC-EC-317	Digital Communication	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	Knowledge of signal representation in graphical manner and to develop the different digital modulation techniques.
2.	Knowledge about mathematical background for Information and Coding Theory.
3.	Analyze the linear and convolution block codes.
4.	To understand the concept of spread spectrum communication system.
5.	Build the Mathematical and computational skills and foundations needed in areas like MIMO ,5G, Cognitive Radio Networks which will be taught in further courses.

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

1.	Understand the principles of digital communications systems.
2.	Characterize communication signal and system.
3.	Explain importance and use of channel coding in digital communication.
4.	Work out the design implementation of different types of encoding and decoding techniques.
5.	Understand the working principle of multi-user systems.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	0	1	0	1	1	0	0	1	0	2	2	2	2
CO2	2	2	0	2	0	1	0	0	0	1	0	2	2	2	2
CO3	1	1	0	2	0	1	1	0	1	1	0	2	2	2	2
CO4	1	2	3	3	0	1	0	0	1	1	0	1	2	2	2
CO5	1	2	0	2	0	1	1	0	0	1	0	1	2	2	2
CO (total)	8	7	3	10	0	5	3	0	2	5	0	8	10	10	10
CO(avg)	2	1	1	2	0	1	1	0	1	1	0	2	2	2	2

Syllabus	
Unit 1	**Signal Space Analysis:** Geometric representation of signal, Conversion of the continuous AWGN channel into a vector channel. Maximum likelihood Decoding. Correlation receiver. Probability of error.
Unit 2	**Passband Digital Transmission:** Passband Transmission model. Coherent phase-shift keying. Hybrid amplitude/phase modulation schemes. Coherent frequency shift-keying. Detection of signal with unknown phase.
Unit 3	**Introduction to Information Theory:** Mathematical models for information sources, a logarithmic measure of information, Lossless coding for information sources, Lossy data compression, Channel models and channel capacity**.**
Unit 4	**Linear Block and Convolutional Channel Codes:** Basic Definition, General properties of linear block codes, Some specific linear block codes, Cyclic codes, BCH codes, Reed-Solomon codes. The structure of convolution codes, Decoding of convolution codes
Unit 5	**Spread Spectrum Techniques:** Models of spread spectrum digital communication system, direct sequence spread spectrum signals, frequency-hopped spread spectrum signals, other types of spread spectrum signals.
Unit 6	**Multiuser Communication:** Introduction to multiple access techniques, capacity of multiple access methods, Multiuser detection in CDMA systems, Multiuser MIMO Systems for broadcast channels, Random access methods.
Unit 7	**Advanced Communication Systems:** 5G, Cognitive Radio Networks, Dynamic Spectrum Access, Cooperative Communication.
Text/Reference Books:	
1.	J. G. Proakis, Digital Communication, Fourth Edition, McGraw Hill
2.	Simon Haykin, Digital Communication, John Wiley & Sons Pvt. Ltd.
3.	B. P. Lathi, Modern Analog and Digital Communication Systems, Prism Sounders.
4.	Haykin S., "Communications Systems", 4th Ed., John Wiley and Sons, 2001.

PCC-EC-318	Digital Signal Processing		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks	
Tutorial	-- hrs/week		
Practical	-- hrs/week		
Credit	3		

Course Objectives:

1.	Coverage of Characterization and classification of signals, signal processing operations.
2.	Knowledge of Discrete time Fourier transform, Discrete Fourier Transform, Discrete Fourier Transform properties, Computation of the DFT of real sequences
3.	Knowledge of Z-transform, ROC of the rational Z-transform, Inverse Z-transform, Z-transform properties.
4.	Concepts of digital filters, All pass Transfer function, Minimum phase and maximum phase transfer functions, Complementary transfer functions.
5.	Study of Block diagram representation, equivalent structures, Basic FIR structures, Basic IIR structures, FIR and IIR filter design

Course Outcomes: On successful completion of this course, students will be able 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 Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	3	3	2	2	2	2	2	2	3	3	2	2
CO2	2	3	2	3	3	2	2	2	2	2	2	3	3	2	2
CO3	2	3	2	3	3	2	2	2	2	2	2	3	3	2	2
CO4	2	3	3	3	3	2	2	2	2	2	2	3	3	2	2
CO (total)	8	12	9	12	12	8	8	8	8	8	8	12	12	8	8
CO(avg)	2	3	2	3	3	2	2	2	2	2	2	3	3	2	2

Syllabus	
Unit 1	Signals, Systems, and Signal Processing, Classification of Signals, The Concept of Frequency in Continuous-Time and Discrete-Time Signals, Analog-to-Digital and Digital-to-Analog Conversion.
Unit 2	Discrete-Time Signals, Discrete-Time Systems, Analysis of Discrete-Time Linear Time-Invariant systems, Discrete-Time Systems Described by Difference Equations, Implementation of Discrete-Time Systems, Correlation of Discrete-Time Signals
Unit 3	The z-Transform, Properties of the z-Transform, Rational z-Transforms, Inversion of the z-Transform, Analysis of Linear Time Invariant Systems in the z-Domain.
Unit 4	Frequency Analysis of Continuous-Time Signals: Fourier Series and Fourier Trabsform, Frequency Analysis of Discrete-Time Signals: The Discrete Time Fourier Series (DTFS), The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem, Frequency-Domain and Time-Domain Signal Properties, Properties of the Fourier Transform for Discrete-Time Signals
Unit 5	Frequency Domain Sampling : The Discrete Fourier Transform, Properties of the DFT, Linear Filtering Methods Based on the DFT, Frequency Analysis of Signals Using the DFT, Efficient Computation of the DFT: FFT Algorithms : Decimation in frequency and Decimation in Time radix 2 algorithms.
Unit 6	Design of FIR frequency selective Filters (LP, HP, BP, BS filters), Window method, Frequency Sampling methods (Type I and Type – II methods), Design of IIR Filters From Analog Filters, Butterworth approximation, Bilinear transformation, Introduction to multirate signal processing, Applications of DSP.
Text/Reference Books:	
1.	S. K. Mitra, Digital signal processing- A computer based approach, Tata McGraw Hill, 2002
2.	A. V. Oppenheim, R, W, Schafer, Discrete time signal processing, PHI
3.	J. G. Proakis, D. G. Manolakis, Digital signal processing –Principles, algorithms and applications, PHI
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.

PCC-EC-319	Embedded Systems		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory	
Tutorial	-- hrs/week	In Semester Evaluation	: 20 Marks
Practical	2 hrs/week	Mid Semester Examination	: 30 Marks
Credit	4	End Semester Examination	: 50 Marks

Course Objectives:

1.	Knowledge of design and development of an embedded system
2.	Learn architecture of ARM and embedded programming
3.	Learn interfacing with external devices and programming
4.	Knowledge of different wired and wireless protocols
5.	Understanding of RTOS and its use for engineering applications

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

1.	Explain ARM based microcontroller architecture
2.	Write embedded C programs for ARM based microcontroller
3.	Identify built-in peripherals and write programs for interfacing of I/O devices
4.	Understand the different wired and wireless communication interfaces
5.	Design real world applications using the concepts of RTOS.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	1	2	-	2	-	-	-	-	-	-	-	-	-	-
CO4	1	2	1	-	1	-	-	-	-	-	-	-	-	-	-
CO5	1	1	3	-	1	-	-	-	-	-	-	-	-	-	-
CO (total)	7	7	8	-	4	-	-	-	-	-	-	-	-	-	-
CO(avg)	1	1	2	-	1	-	-	-	-	-	-	-	-	-	-

Syllabus	
Unit 1	**Introduction to Embedded System:** Embedded system definition, Examples, Design metrics, Processor Technologies, IC Technologies, Design Technologies, Custom Single Purpose Processor design: Basic architecture, FSM and FSMD with example, General purpose processor architecture, Classification-GPP, ASIP, DSP.
Unit 2	**Embedded Firmware Design and Development:** Super Loop based Approach, Embedded Operating System based Approach, Embedded Firmware development Languages-Assembly Level based development, High Level Language based Development, Integrated Development Environment, Editor, Assembler, Liker, Loader, Compiler, Cross compiler, Embedded C-Data types, Arithmetic and Logical operations, Brach and Loop operations, Array and Pointers, Character and string, Functions, Pre-processor and Macros, Coding ISRs, Recursive and Re-entrant functions.
Unit 3	**ARM Processor Architecture and Interfacing** ARM Features, detail Architecture, operating modes, LPC-2148 Architecture, GPIO and its interfacing with LED and Key switch with programming, Interrupt structure and its programming.
Unit 4	**LPC 2148 Interfacing:** On chip devices like-Timer/Counter, Watchdog Timer, PWM, ADC, DAC, Serial Interfacing, Interfacing of Keypad, Relays and Stepper Motor.
Unit 5	**Real Time Operating System:** Fundamentals of Real Time Operating System(RTOS concepts), Multitasking, Kernel structure, Task Management system, TCB, Scheduling, Inter-process communication, Introduction of MUCOS-II.
Unit 6	**Communication protocol:** LPC 2148 on chip wired communication standards like SPI, I2C, CAN, USB, Wireless communication standards: IrDA, Bluetooth(BLE), WiFi (IEEE802.11), Zigbee, RF modules, Embedded Application (Washing Machine, Automatic Vending Machine, Digital Camera, Automotive Embedded Systems, Robotics, etc.) development using Raspberry Pi.
Text/Reference Books:	
1.	Frank Vahid, Embedded System, Wiley India, 2002
2.	Shibu K. V, Introduction to Embedded System, TMH, 2017
3.	Rajkamal, Embedded Systems, TMH, 2008
4.	Sloss, Symes, Wright, ARM System Developers Guide, Elsevier Morgan Kaufman,2005
5.	LPC2148 User Manuals and data sheets

Program Elective - II

PEC-EC320	**Machine Learning**		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory	
Tutorial	-- hrs/week	In Semester Evaluation	: 20 Marks
Practical	2 hrs/week	Mid Semester Examination	: 30 Marks
Credit	4	End Semester Examination	: 50 Marks

Course Objectives:

1.	To study basic concepts in Machine Learning.
2.	To provide knowledge of models, methods and tools used to solve regression, classification, feature selection and density estimation problems.
3.	To understand Machine Learning theories, such as Bayes classifier, linear discriminant analysis.
4.	To explore knowledge of recognition, decision making and statistical learning problems.
5.	To provide hands-on experience in analyzing and applying Machine Learning techniques in practical problems.

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

1.	Describe concepts of Machine Learning and its system, learning and adaptation for the classification.
2.	Understand the principles of Bayesian and Maximum-likelihood parameter estimation and apply them in relatively simple probabilistic models such as Gaussian Model.
3.	Perform data clustering in an unsupervised manner by means of various algorithms, such as parzen window density estimate
4.	Understand the concept of classification using K-means and K-nearest neighbour and its applications

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	2	2	1	2	-	-	-	-	-	-	-	2	2	2
CO3	3	2	2	1	2	-	-	-	-	-	-	-	2	2	2
CO4	3	-	-	1	2	-	-	-	-	-	-	-	2	2	2
CO (total)	12	4	4	3	6	-	-	-	-	-	-	-	8	8	8
CO(avg)	3	2	2	1	2	-	-	-	-	-	-	-	2	2	2

Syllabus	
Unit 1	**Introduction** Machine perception, pattern recognition example, pattern recognition systems, the design cycle, learning and adaptation.
Unit 2	**Bayesian Decision Theory** Introduction, continuous features – two categories classifications, minimum error-rate classification- zero–one loss function, classifiers, discriminant functions, and decision surfaces.
Unit 3	**Normal Density** Univariate and multivariate density, discriminant functions for the normal densitydifferent cases, Bayes decision theory – discrete features, compound Bayesian decision theory and context.
Unit 4	**Un-supervised Learning and Clustering** Introduction, mixture densities and identifiability, maximum likelihood estimates, application to normal mixtures, K-means clustering. Date description and clustering – similarity measures, criteria function for clustering.
Unit 5	**Parameter Estimation** Introduction, maximum likelihood estimation, Bayesian estimation, Bayesian parameter estimation–Gaussian case**,** Introduction, Discrete–time markov process, extensions to hidden Markov models, three basic problems for HMMs
Unit 6	**Dimensionality reduction:** Principal component analysis, non-linear component analysis; Low dimensional representations and multi dimensional scaling.
Text/Reference Books:	
1.	Pattern classifications, Richard O. Duda, Peter E. Hart, David G. Stroke. Wiley Pub, Second Edition.
2.	Fundamentals of speech Recognition, Lawerence Rabiner, Biing, Hwang Juang Pearson education.
3.	Pattern Recognition and Image Analysis – Earl Gose, Richard John baugh, Steve Jost PHI 2004
4.	T. M. Ross, Fuzzy logic, Mc-Graw Hill Inc.

PEC-EC-321	Computer Security	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week	
Practical	-- hrs/week	
Credit	3	

Course Objectives:

1.	To develop a basic understanding of cryptography, how it has evolved, and some key encryption techniques used today.
2.	To gain the knowledge about Network Security Devices (Firewall, IDS, etc).
3.	To understand and analyze network traffic and protocols.
4.	To understand security requirements of database systems..
5.	To develop understanding of security policies and protocols for implementation of these policies.

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

1.	Understand necessity of computing security.
2.	Describe the various encryption and description terminology.
3.	Identify major types of threats and attack to computer security and develop the strategy to protect computer organization from treats and attacks.
4.	Understand how security policies, standards and practices are developed.
5.	Understand security model in program, network and data base.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	2	3	2	2	2	2	2	2	2	3	2	2	2
CO2	2	3	2	3	3	2	2	2	2	2	2	3	2	2	2
CO3	2	3	2	3	3	2	2	2	2	2	2	3	3	2	2
CO4	2	3	6	2	2	2	2	2	2	2	2	3	2	2	2
CO5	2	3	3	2	2	2	2	2	2	2	2	3	2	2	2
CO (total)	10	15	12	13	12	10	10	10	10	10	10	15	11	10	10
CO(avg)	2	3	2	3	2	2	2	2	2	2	2	3	2	2	2

Syllabus	
Unit 1	**Elementary Cryptography** Terminology and Background, Substitution Ciphers, Transpositions, Making Good Encryption Algorithms, Data Encryption Standard, AES Encryption Algorithm, Public Key Encryption, Cryptographic Hash Functions, Key Exchange, Digital Signatures, Certificates.
Unit 2	**Program Security** Secure programs, Non-malicious Program Errors, Viruses, Targeted Malicious code, Controls against Program Threat, Control of Access to General Objects, User Authentication, Good Coding Practices, and Open Web Application Security Project Top 10 Flaws, Common Weakness Enumeration Top 25 Most Dangerous Software Errors.
Unit 3	**Security In Networks** Threats in networks, Encryption, Virtual Private Networks, PKI, SSH, SSL, IPSec, Content Integrity, Access Controls, Wireless Security, Honeypots, Traffic Flow Security, Firewalls, Intrusion Detection Systems, Secure e-mail.
Unit 4	**Security In Databases** Security requirements of database systems, Reliability and Integrity in databases, Two Phase Update, Redundancy/Internal Consistency, Recovery, Concurrency/Consistency, Monitors, Sensitive Data, Types of disclosures, Inference.
Unit 5	**Security Models And Standards** Secure SDLC, Secure Application Testing, Security architecture models, Trusted Computing Base, Bell-LaPadula Confidentiality Model, Biba Integrity Model, Graham-Denning Access Control Model, Harrison-Ruzzo-Ulman Model, Secure Frameworks, COSO, CobiT, Compliances, PCI DSS, Security Standards - ISO 27000 family of standards, NIST.
Text/Reference Books:	
1.	Charles P. Pfleeger, Shari Lawrence Pfleeger, “Security in Computing”, Fourth Edition, Pearson Education, 2007.
2.	Matt Bishop, “Introduction to Computer Security”, Addison-Wesley, 2004.
3.	Michael Whitman, Herbert J. Mattord, “Management of Information Security”, Third Edition, Course Technology, 2010.
4.	William Stallings, “Cryptography and Network Security: Principles and Practices”, Fifth Edition, Prentice Hall, 2010.
5.	Michael Howard, David LeBlanc, John Viega, “24 Deadly Sins of Software Security: Programming Flaws and How to Fix Them”, First Edition, Mc Graw Hill Osborne Media, 2009.
6.	Matt Bishop, “Computer Security: Art and Science”, First Edition, Addison-Wesley, 2002.
7.	https://www.pcisecuritystandards.org/security_standards/pci_dss.shtml
8.	http://cwe.mitre.org/top25/index.html
9.	William Stallings, “Cryptography and Network Security: Principles and Practices”, Fifth Edition, Prentice Hall, 2010.

PEC-EC-322	Digital VLSI Design		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory	
Tutorial	-- hrs/week	In Semester Evaluation	: 20 Marks
Practical	2 hrs/week	Mid Semester Examination	: 30 Marks
Credit	4	End Semester Examination	: 50 Marks

Course Objectives:

1.	Understanding CMOS digital integrated circuits.
2.	To find propagation delay, noise margins, and power dissipation in the digital VLSI circuits.
3.	Design of combinational and sequential circuits using various logic styles.
4.	Designing SRAM and DRAM in VLSI circuits.
5.	To introduce architecture and design concepts underlying modern complex VLSIs and system-on-chips.

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

1.	Understanding trends in semiconductor technology, and how it impacts scaling and performance.
2.	To analyze the performance and characteristics of CMOS inverter.
3.	Analyze different performance issues and the inherent trade-offs involved in system design (viz. power vs. speed etc).
4.	Implement digital logic designs of various types using VLSI circuits.
5.	Design and simulate VLSI design project having a set of objective criteria and design constraints

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	1	-	-	1	1	-	-	1	1	-
CO2	3	3	2	1	2	1	-	-	2	1	-	-	2	2	-
CO3	3	3	2	1	2	1	-	-	2	1	-	-	2	2	-
CO4	3	3	2	1	2	1	-	-	2	1	-	-	2	2	-
CO5	3	3	2	1	2	1	-	-	2	1	-	-	1	3	-
CO (total)	15	15	10	5	10	5	-	-	9	5	-	-	8	10	-
CO(avg)	3	3	2	1	2	1	-	-	2	1	-	-	1	2	-

Syllabus	
Unit 1	**Introduction** Issues in digital IC design; Quality metrics of a digital design. CMOS IC manufacturing processes; Design rules; Packaging ICs.
Unit 2	**The manufacturing process and Devices:** The diode; The MOS(FET) transistor; Process variations. Interconnect parameters; Electrical wire models; SPICE wire models.
Unit 3	**The CMOS inverter**: The static CMOS inverter; Evaluating robustness of CMOS inverter; Dynamic performance of CMOS inverter; Power, energy and energy delay; Technology scaling and its impact on the inverter metrics.
Unit 4	**Designing Combinational logic gates in CMOS:** Static CMOS design; Dynamic CMOS design; Perspectives.
Unit 5	**Designing sequential logic circuits:** Static latches and registers; Dynamic latches and registers; Alternative register styles; Pipelining - an approach to optimize sequential circuits; Non-bistable sequential circuits; Perspectives-choosing a clocking strategy.
Unit 6	Implementation strategies for digital ICs: From custom to semicustom and structured array design approaches; Custom circuit design; Cell-based design methodology; Array-based implementation approaches.
Unit 7	Datapath in digital processor architectures; The adder; The multiplier; The shifter; Other arithmetic operators; Power and speed trade-off in data path structures; Perspectives-design as trade-off. SRAM; DRAM; Associated circuits.
Text/Reference Books:	
1.	Digital integrated circuits: a design perspective, Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, PHI
2.	Inroduction to VLSI circuits and systems, John P. Uyemura, Wliey
3.	CMOS VLSI Design, Weste and Harris, Addison Wesley.
4.	Modern VLSI Design - System-on-chip Design, Wayne Wolf, Prentice Hall India/Pearson Education
5.	CMOS Digital Integrated Circuits, Analysis andDesign, Sung-Mo Kang andYusuf Lablebici, Tata McGraw-Hill Edition

PEC-EC-323	**Robotics**		
Teaching scheme:			**Examination scheme:**
Lecture	3 hrs /week		Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week		
Practical	2 hrs/week		
Credit	4		

Course Objectives:

1.	To learn exciting fields of Unmanned Aerial Robotics and quadrotors
2.	To understand basics of control strategies and selection of components.
3.	To understand the concept of kinematics of quadrotors
4.	To derive the dynamic equations of motion for quadrotors
5.	Develop planar and 3-D quadrotors
6.	To enable quadrotors to perform more agile maneuvers and to operate.

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

1.	Introduce to the exciting fields of Unmanned Aerial Robotics(UARs) and quadrotors
2.	Learn about basics of control strategies and realize how careful component selection and design affects the vehicles' performance
3.	Develop linear controllers, planar and 3-D models of Quadrotors
4.	Know how to enable Quadrotors to perform more agile maneuvers and operate.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	-	-	-	-	-	-	-	2	2	2
CO2	3	2	2	2	2	-	-	-	-	-	-	-	3	3	3
CO3	3	3	1	2	3	-	-	-	-	-	-	-	3	3	2
CO4	3	2	2	2	2	-	-	-	-	-	-	-	2	2	3
CO (total)	12	10	8	8	9	-	-	-	-	-	-	-	10	10	10
CO (avg)	3	3	2	2	3	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	**Introduction to Robotics** Introduction - brief history, types, classification and usage, Science and Technology of robots, Some useful websites, textbooks and research journals.
Unit 2	**Aerial Robotics** Unmanned Aerial Vehicles, Quadrotors, Key Components of Autonomous Flight, State Estimation, Applications, Meet the TAs, Basic Mechanics, Dynamics and 1-D Linear Control, Design Considerations, Agility and Manoeuvrability, Component Selection, Effects of Size, Supplementary Material: Introduction, Supplementary Material: Dynamical Systems, **Supplementary Material: Rates of Convergence**
Unit 3	**Geometry and Mechanics** Transformations, Rotations, Euler Angles, Axis/Angle Representations for Rotations, Angular Velocity, Supplementary Material: Rigid-Body Displacements, Formulation, Newton-Euler Equations, Principal Axes and Principal Moments of Inertia, Quadrotor Equations of Motion.
Unit 4	**Planning and Control** 2-D Quadrotor Control, 3-D Quadrotor Control, Time, Motion, and Trajectories, Motion Planning for Quadrotors, Supplementary Material: Minimum Velocity Trajectories from the Euler-Lagrange Equations, Solving for Coefficients of Minimum Jerk Trajectories, Minimum Velocity Trajectories, Linearization of Quadrotor Equations of Motion.
Unit 5	**Advanced Topics** Nonlinear Control, Control of Multiple Robots
Text/Reference Books:	
1.	Fu, K., Gonzalez, R. and Lee, C. S. G., Robotics: Control, Sensing, Vision and Intelligence¸ McGraw - Hill, 1987.
2.	Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2nd reprint, 2008.
3.	“Anatomy of Automation” – Amber G.H & P.S. Amber, PrenticeHall.
4.	J.J. Craig, Robotics, Addison-Wesley, 1986.
5.	This course is available on https://www.coursera.org/

PEC-EC-324	**Satellite Communication**		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory	
Tutorial	-- hrs/week	In Semester Evaluation : 20 Marks	
Practical	2 hrs/week	Mid Semester Examination : 30 Marks	
Credit	4	End Semester Examination : 50 Marks	

Course Objectives:	
1.	To be conversant with orbital aspects of satellite communication.
2.	To be able to design satellite link 3.
3.	To be knowing about digital satellite links.
4.	To be familiar with multi-access schemes.
5.	To be familiar with earth station technology.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Understand the principles of satellite communications system.
2.	To understand different satellite orbits.
3.	To understand the construction of satellite systems (Space Segment)
4.	To understand the communication link between satellite and ground station
5.	To understand the satellite Navigation systems

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	0	0	2	2	0	0	1	0	2	2	2	2
CO2	3	3	3	2	0	1	0	0	0	1	0	2	2	2	2
CO3	2	2	2	2	1	1	0	0	0	1	0	1	2	2	2
CO4	3	3	3	2	1	1	1	0	1	1	0	1	2	2	2
CO5	1	1	0	1	2	1	1	0	1	1	0	1	2	2	2
CO (total)	11	10	10	7	4	6	4	0	2	5	0	7	10	10	10
CO(avg)	3	2	2	1	1	1	1	0	1	1	0	1	2	2	2

Syllabus	
Unit 1	**Basic Principles** General features, frequency allocation for satellite services, properties of satellite communication systems.
Unit 2	**Satellite Orbits** Introduction, Kepler's laws, orbital dynamics, orbital characteristics, satellite spacing and orbital capacity, angle of elevation, eclipses, launching and positioning, satellite drift and station keeping.
Unit 3	**Satellite Construction (Space Segment)** Introduction; altitude and orbit control system; telemetry, tracking and command; power systems, communication subsystems, antenna subsystem, equipment reliability and space qualification.
Unit 4	**Satellite Links** Introduction, general link design equation, system noise temperature, uplink design, downlink design, complete link design, effects of rain. Earth Station Introduction, earth station subsystem, different types of earth stations.
Unit 5	**The Space Segment Access and Utilization** Introduction, space segment access methods, TDMA, FDMA, CDMA, SDMA, assignment methods.
Unit 6	**Satellite Navigation** Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers and Codes, Satellite Signal Acquisition, GPS Navigation Messages, GPS Signal Levels, Timing Accuracy, GPS Receiver Operation, Differential GPS, Introduction to Indian Regional Navigation Satellite System (IRNSS)-NAVIC.
Text/Reference Books:	
1.	Timothy Pratt, Charles W. Bostian, Satellite Communications, John Wiley & Sons.
2.	Dennis Roddy, Satellite Communications, 3rd Ed., Mc. Graw-Hill International Ed. 2001.

PEC-EC-325	Power Electronics		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks	
Tutorial	-- hrs/week		
Practical	2 hrs/week		
Credit	4		

Course Objectives:

1.	To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics
2.	To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
3.	To provide strong foundation for further study of power electronic circuits and systems.

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

1.	Design & implement a triggering / gate drive circuit for a power converters
2.	Design and analyze different line commutated converter, inverters circuits.
3.	Understand the fundamental principles and applications of power electronics circuits.
4.	Solve problems and design switching regulators according to specifications.
5.	Design a single phase AC voltage controller i.e. light dimmer / fan regulator
6.	To understand the operation of Dual converters, Cyclo converters and Multilevel inverters.
7.	Understand the operation of Dual converters, Cyclo converters and Multilevel inverters.
8.	Design a step down chopper

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	-	-	2	2	-	1	2	1	-	2	1
CO2	2	2	3	2	1	2	2	-	1	2	1	-	2	1	2
CO3	2	3	2	-	-	1	-	-	-	2	1	-	1	-	1
CO4	2	2	3	2	1	2	-	2	1	-	2	1	1	2	2
CO5	2	3	2	1	2	-	-	1	2	-	2	1	2	-	-
CO6	2	2	2	-	2	1	-	-	1	-	-	-	1	1	2
CO7	1	2	2	-	-	-	-	1	-	-	-	-	1	-	-
CO8	3	2	2	2	-	-	2	-	-	2	1	2	2	-	2
CO (total)	17	18	17	8	6	6	6	6	5	7	9	5	10	6	10
CO(avg)	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1

Syllabus	
Unit 1	**Power Semiconductor Devices** Power diodes, power transistor, power MOSFET and IGBT-construction, operation, steady state and switching characteristics.
Unit 2	**Thyristor Families and Triggering Devices** SCR, TRIAC, GTO, LASCR, UJT, PUT and DIAC – construction, steady state and switching characteristics, performance parameters, SCR protection circuits.
Unit 3	**Triggering and Commutation of SCR** R and RC triggering, UJT triggering circuits, different commutation techniques – circuits and principles of operation.
Unit 4	**Controlled Converters** 1phase and 3phase fully and half controlled converters, their harmonic and power factor analysis, dual converters, effect of load and source inductance, power factor improvement techniques.
Unit 5	**AC Voltage Controllers** Principles of on/off control and phase control, 1phase ac voltage controllers with R and RL loads, cyclo-converters, reduction of output harmonics in cyclo-converters.
Unit 6	**DC Choppers** Principles of operation of step-down and step-up choppers, 2–Quadrant and 4–Quadrant choppers, voltage and current commutated choppers, use of source filter.
Unit 7	**Inverters** Parallel inverters, series inverters, 3phase inverters.
Text/Reference Books:	
1.	M.H. Rashid, Power Electronics, PHI.
2.	P.S. Bimbra, Power Electronics, Khanna Publishers.
3.	M. Ramamoorthy, An Introduction to Thyristor and Their Applications, Affiliated East West Press.
4.	P.C. Sen, Power Electronics, Tata McGraw Hill.
5.	General Electric, SCR Manual, Prentice Hall.
6.	Edward Hughes, Electrical Technology, ELBS/Longman.

PEC-EC-326	Consumer Electronics	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	Basic characteristics of sound signals.
2.	Knowledge of audio amplifiers, microphones and speakers.
3.	Knowledge of public address system.
4.	Television (TV) fundamentals and TV transmitter & receiver
5.	To understand working principle of various home appliances.

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

1.	Troubleshoot different types of microphones and speakers.
2.	Maintain audio systems.
3.	Analyze the composite signal used in TV signal transmission.
4.	Troubleshoot color TV receivers.
5.	Maintain various consumer electronics appliances.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	3	1	1	2	3	1	1	1	1	1	2	2	2
CO2	3	1	3	2	1	2	2	1	1	1	1	1	2	2	2
CO3	3	1	3	2	1	2	2	1	1	1	1	1	2	2	2
CO4	3	1	3	2	1	2	2	1	1	1	1	1	2	2	2
CO5	3	1	3	1	1	2	2	1	1	1	1	1	2	2	2
CO (total)	15	5	15	8	5	10	10	5	5	5	5	5	10	10	10
CO(avg)	3	1	3	2	1	2	2	1	1	1	1	1	2	2	2

Syllabus	
Unit 1	**Audio fundamentals:** Basic characteristics of sound signal: level and loudness, pitch, frequency response, fidelity, sensitivity and selectivity etc. Audio amplifiers: mono, stereo. Microphone: working principle and characteristics, Types: carbon, condenser, crystal, electrets and tie clip etc. Speakers: working principle and characteristics, Types: electrostatic, dynamic, permanent magnet etc., woofers, tweeter and mid range, wireless, Troubleshooting procedure.
Unit 2	**Audio systems:** Block diagram and operation of CD player, types of CD player Components used for CD mechanism: CD pick-up assembly, gear system, drive motors, CD lens Block diagram of Hi Fi amplifier and its working Public address (PA) System: block diagram and operation, speaker impedance matching and characteristics Home theater system, troubleshooting procedure of audio systems, block diagram and working of MP3.
Unit 3	**Television fundamentals and transmitter:** Concept: Aspect ratio, image continuity, interlaces scanning. Scanning periods-horizontal and vertical, vertical and horizontal resolution. Vestigial sideband transmission, bandwidth for color signal, characteristics of color signal, compatibility. Colour theory, grassman's law, additive and substractive color mixing, composite video signal-pedestal height, blanking pulse, color burst, horizontal sync pulse details, vertical sync pulse details, equalizing pulses. CCIR-B standards for color signal transmission and reception, positive and negative modulation, merits and demerits of negative modulation Block diagram of color TV transmitter, Troubleshooting procedure of color TV transmitter.
Unit 4	**Television Receivers:** Block diagram and operation of color TV receiver, Operation of PAL-D decoder, HDTV: Development of HDTV, NHK MUSE system and NHK broadcast LCD/LED Technology: Principle and working of LCD and LED TV Direct to Home Receiver (DTH): Concept, receiver block diagram, indoor and outdoor point Block diagram and working of OLED Troubleshooting procedure of Color TV Receiver systems.
Unit 5	**Consumer Electronic Appliances:** Photocopier block diagram and working Microwave oven: types, single chip controllers, block diagram, types and wiring and safety instructions, electrical specifications Washing machines: block diagram, types: automatic and semiautomatic, electrical specifications Digital camera and cam coder: pick up devices, picture processing, and picture storage electrical specification.

Text/Reference Books:

1.	Bali S.P. “Consumer Electronics”, Pearson Education India, Delhi 2007
2.	Gupta R.G. “Audio video systems principles, maintenance and troubleshooting” , McGraw Hill, New Delhi, India 2010
3.	Gulati R. R , “ Modern Television Practice: Transmission, Reception and Applications”, New Age International, New Delhi, India 2015
4.	Dhake A.M. , “ Television and Video Engineering” , McGraw Hill, New Delhi, India 2006

PEC-EC-327	System Software and Operating Systems		
Teaching scheme:		**Examination scheme:**	
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks	
Tutorial	-- hrs/week		
Practical	2 hrs/week		
Credit	4		

Course Objectives:

1.	Learn tools for software development and software programming.
2.	Study of fundamentals of operating systems and function.
3.	Learn memory management and IO organization.
4.	Learn basics of file systems, protection and distributed operating systems.

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

1.	Understanding of the basic concepts for system software development and programming tools.
2.	Comprehends the fundamentals of operating systems, real time operating systems.
3.	Interpretation of various functions of operating systems such as process, scheduling, deadlocks and interprocess communication.
4.	Distinguish between memory management techniques, I/O organization and programming.
5.	Description of file systems, file protection and security and basics of distributed operating systems.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	2	1	-	-	-	-	-	-	-	3	3	1
CO2	3	3	2	3	2	-	-	-	-	-	-	-	2	2	2
CO3	3	2	2	2	2	-	-	-	-	-	-	-	3	3	2
CO4	2	3	3	2	2	-	-	-	-	-	-	-	2	2	2
CO5	3	1	2	2	2	-	-	-	-	-	-	-	2	2	2
CO (total)	14	11	12	11	9								12	12	9
CO(avg)	3	2	3	2	2	-	-	-	-	-	-	-	2	2	2

Syllabus	
Unit 1	**Language Processors and Data Structures** Introduction, Language processing activities, Fundamentals of language processing and specifications, Language processor development tools, Search data structures, Allocation data structures, Scanning and Parsing.
Unit 2	**Assemblers and Macroprocessors** Assemblers: Elements of assembly language programming, Simple assembly scheme, Pass structure of assemblers, Design of two pass assembler, Single pass assembler for PC Macroprocessor: Macro definition and call, Macro expansion, Nested macro calls, Advanced macro facilities, Design of macroprocessor.
Unit 3	**Compilers, Interpreters and Linkers** Compilers and Interpreters: Aspects of compilation, Memory allocation Compilation of expressions and control structures, Code optimization, Interpreters. **Linkers:** Relocation and linking concept Design of a linker, Self-relocating programs, Linker for MS DOS, Linking for overlays. Loaders
Unit 4	**Software Tools** Software tools for program development, Editors, Debug monitors, Programming environments, User interfaces **Evolution of OS Functions** OS functions and their evolution, Batch processing systems, Multiprogramming systems, time sharing systems, real time operating systems, OS structure
Unit 5	**Processes, Scheduling, and Deadlocks** Processes: Process definition, Process control, Interacting processes, Implementation of interacting processes, Threads Scheduling: Scheduling policies, Job scheduling, Process scheduling, Process management in UNIX, Scheduling in multiprocessor OS Deadlock: Definitions, Resource status modeling, Handling deadlocks, Deadlock detection and resolution, Deadlock avoidance, Mixed approach to deadlock handling.
Unit 6	**Process Synchronization and Interprocess Communication** Process Synchronization: Implementing control synchronization, Critical sections, Classical process synchronization problems, Evolution of language features for process synchronization, Semaphores, Critical reasons, Conditional critical reasons, Monitors Interprocess Communication: Interprocess messages, Implementation issues, Mail boxes, Interprocess messages in Unix.
Unit 7	**Memory Management** Memory allocation preliminaries, Contiguous and Noncontiguous memory allocations, Virtual memory using paging and segmentation. **I/O Organization and I/O Programming** I/O organization, I/O devices, Physical IOCS (PIOCS), Fundamental file organization, Advanced I/O programming, Logical IOCS, File processing in Unix
Text/Reference Books:	
1.	Dhamdhere D. M., System Programming and Operating Systems, TMH Pub.
2.	William Stallings, Operating system: Internals and design principles, Pearson education.
3.	Silberschatz and Galvin, Operating system concepts, Addison Wesley.

PEC-EC-328	Electronic Design Automation Tools	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	To make the students exposed to Front-end and Back-end VLSI CAD tools.
2.	Introduction to SPICE, modelling, and different types of analyses for simulation.
3.	To make students aware and learn EDA Tools.
4.	An overview of the features of practical CAD tools for simulation, synthesis and verification.

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

1.	Implement design problems in of EDA tool environment.
2.	Develop EDA tools usage skills in designing analog, digital, and mixed signal VLSI circuits.
3.	Implement functional design and verify using an industry standard EDA tools.
4.	Execute the special features of VLSI front-end and back-end CAD tools.
5.	Implement small VLSI design project using EDA tools.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	2	3	-	-	-	2	1	-	-	1	2	1
CO2	2	2	3	1	3	-	-	-	1	1	-	-	2	2	1
CO3	2	2	3	2	3	-	-	-	2	1	-	-	2	2	1
CO4	2	2	3	1	3	-	-	-	1	1	-	-	2	2	1
CO5	2	2	3	2	3	-	-	-	2	1	-	-	2	2	1
CO6	10	10	15	8	15	-	-	-	8	5	-	-	9	10	5
CO (total)	2	2	3	2	3	-	-	-	2	1	-	-	2	2	1
CO(avg)	2	2	3	2	3	-	-	-	2	1	-	-	1	2	1

Syllabus	
Unit 1	**Introduction to EDA:** The need for EDA, Hardware description languages, The design process, Semi-custom design tools, Design entry, Design verification, Design layout, Full custom design tools, Design entry, Design layout, Design verification, Low and high level tools.
Unit 2	**EDA Tools Family:** VLSI Design Automation tools, An overview of the features of practical CAD tools, SPICE, FPGA Technology & Tools (Modelsim, Leonardo spectrum, Xilinx ISE, Quartus II), ASIC Technology & Tools (Pyxis, Cadence, Mentor, Synopsys and Microwind).
Unit 3	**SPICE Concepts:** The role of circuit simulators, A brief history of SPICE, Circuit components, Coding a circuit for simulation, Simulating a circuit, Types of analysis (DC analysis, AC analysis, Transient analysis), Obtaining results, DC convergence problems, Transient analysis problems, Representing semiconductor devices, Coding semiconductor devices, The diode model, The bipolar transistor model, The junction field effect transistor model, The metal oxide semiconductor field effect transistor model.
Unit 4	**Fault Simulation and Test Pattern Generation:** The Need for Testing, Role of the Fault Simulator, Fault Simulator Operation, Fault Simulation in the Design Process, Basic Testing Concepts (The SA0 and SA1 Fault Model, Controllabilty and Observability, Fault Categories, Fault Simulation), Test pattern Generation, Fault Simulation of Sequential Circuits, Behavioral Fault Simulation.
Unit 5	**FPGA based Synthesis Tools:** Design flow in EDA tools for FPGA based design and ASIC based Design, Placement and routing, delay optimization, Interfacing Matlab Simulink with Xilinx ISE - DSP Application using Xilinx System Generator.
Unit 6	**ASIC Design Tools:** Design Flow in ASIC Design Tools, Cadence/Mentor Tools introduction for analysis, VLSI Layout, Design Rules, Stick Diagram, Example Layout of analog, digital and mixed signal circuits using EDA Tools.
Text/Reference Books:	
1.	Ming-Bo Lin, Digital System Designs and Practices using Verilog HDL and FPGAs, Wiley,2012.
2.	Samir Palnitkar, Verilog HDL, Pearson Education, 2nd Edition, 2004.
3.	M.H.Rashid, Spice for Circuits and Electronics using Pspice, PHI 1995.
4.	M.J.S.Smith, Application Specific Integrated Circuits, Pearson Education, 2008.
5.	J.Bhaskar, A VHDL Primer, Prentice Hall, 1998.
6.	J.Bhaskar, A Verilog Primer, Prentice Hall, 2005.

PEC-EC-329	Electronic Materials and Devices	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory In Semester Evaluation : 20 Marks Mid Semester Examination : 30 Marks End Semester Examination : 50 Marks
Tutorial	-- hrs/week	
Practical	2 hrs/week	
Credit	4	

Course Objectives:

1.	To develop an understanding of the materials, devices, and processing techniques used in the current semiconductor industry.
2.	To understand the basic physics behind semiconductor materials, types of semiconductors, and the reason for the dominance of silicon in the electronics industry.
3.	To familiarize the basics of devices with emphasis on their electronic characteristics.
4.	To familiarize with Optical devices like LEDs, lasers, solar cells, will also be explained
5.	To introduce the current manufacturing processes in the silicon based semiconductor industry, starting from silicon wafer production to final IC (integrated circuit) development, will be explained.
6.	To know the industry challenges during miniaturization and the role of materials in overcoming the challenges.

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

1.	After completion of course students will understand materials, devices, and processing techniques used in the current semiconductor industry.
2.	Get the knowledge of the basic physics behind semiconductor materials
3.	Students will be familiarized with the basics of devices
4.	Will be able to understand the current manufacturing processes in the silicon based semiconductor industry, the industry challenges

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	1	-	-	-	-	-	-	-	2	3	1
CO2	3	3	3	3	2	-	-	-	-	-	-	-	2	2	2
CO3	3	2	2	2	2	-	-	-	-	-	-	-	3	3	2
CO4	2	3	2	2	2	-	-	-	-	-	-	-	3	2	2
CO (total)	11	11	10	9	7								10	10	7
CO(avg)	3	2	3	2	2	-	-	-	-	-	-	-	2	2	2

Syllabus	
Unit 1	Introduction to chemical bonding and development of band gap. 1 2. Introduction and types of semiconductors. Explanation of density of states, Fermi energy, and band occupancy. 2 3. Problem set on bonding, density of states, and Fermi statistics.
Unit 2	Intrinsic semiconductors, carrier concentration, mobility, temperature dependence. Problem set on intrinsic semiconductors . Extrinsic semiconductors. Dopant types and materials. Conductivity, Fermi energy position, temperature dependence. Problem set on extrinsic semiconductors.
Unit 3	Metal-semiconductor junctions. Schottky vs. Ohmic junctions. Band gap diagrams. I-V characteristics. Problem set on metal-semiconductor junctions p-n junctions. Equilibrium and under bias (forward and reverse).Band diagrams. I-V characteristics. Junction breakdown. Hetero junctions. Problem set on pn junctions.
Unit 4	Transistors-BJT,JFET,MOSFET. Transistor action. Basics of BJT and JFET. Channel formation in MOSFET. I-V behavior. Depletion and inversion layer calculation. Problem set on transistors.
Unit 5	Optoelectronic materials. Introduction. LEDs, LASERs, photodetectors, solar cells. Problem set on optical properties. Problem set on optoelectronic devices.
Unit 6	Introduction to semiconductor manufacturing. History, overview of process flow, manufacturing goals. Scaling. 1 18. Wafer manufacturing. Si ingot preparation. Poly to single crystal conversion. Czochralski vs. float zone method.
Unit 7	IC device manufacturing overview. Thermal oxidation. Doping. Lithography. Etching and growth. Metallization and growth, Process and device evaluation. Yield monitoring and control, Clean room design. Contamination control, Devices and IC formation. IC circuit logic and packaging.

Text/Reference Books:	
1.	Principles of Electronic Materials and Devices,S.O. Kasap, 3rd edition, McGraw-Hill Education (India) Pvt. Ltd., 2007..
2.	Semiconductor devices:Physics and Technology,S.M. Sze, 2nd edition, Wiley, 2008.
3.	VLSI technology,S.M.Sze, 2nd edition, McGraw-Hill Education (India) Pvt. Ltd., 2003.
4.	Solid State Electronic Devices,B.G.Streetman and S. Banerjee, 6th edition,PHI Learning, 2009
5.	Introduction to solid state physics, C.Kittel, 8th edition, Wiley, 2012.
6.	Microchip Fabrication,Peter van Zant, 5th edition, McGraw-Hill, 2004.
7.	Fundamentals of semiconductor manufacturing and process control, G.S. May and C.J.Spanos, Wiley-IEEE press, 2006.

PRJ-EC-330	Mini Project		
Teaching scheme:		**Examination scheme:**	
Lecture	-- hrs /week	Theory	
Tutorial	-- hrs/week	In Semester Evaluation	: 20 Marks
Practical	4 hrs/week	Mid Semester Examination	: 30 Marks
Credit	2	End Semester Examination	: 50 Marks

Course Objectives:

1.	To identify and define problems in the area of Electronics and Telecommunication
2.	Plan and execute a Mini Project with team.
3.	Prepare a technical report based on the Mini project & Present technical seminar based on the Mini Project work carried out.

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

1.	Demonstrate the ability to locate and apply technical information from multiple sources.
2.	Acquire practical knowledge within the chosen area of technology for project development.
3.	Acquire practical knowledge within the chosen area of technology for project development.
4.	Identify, analyze, formulate and handle hardware and software projects with a comprehensive and systematic approach in the field of electronics and telecommunication.
5.	Contribute as an individual or in a team in development of technical projects within time bounds.
6.	Develop effective communication skills for presentation of project related activities

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	3	3	2	3	2	3	3	2	3	3	3	2	3
CO2	2	3	3	3	3	3	2	2	3	3	3	3	3	2	3
CO3	2	3	3	3	3	3	3	2	3	2	3	3	3	2	3
CO4	2	3	3	3	3	2	2	2	3	3	3	3	3	2	3
CO5	2	2	2	3	3	3	3	1	3	3	3	3	2	2	2
CO (total)	10	14	14	15	14	14	12	10	15	13	15	15	14	20	20
CO(avg)	5	3	3	3	3	3	2	2	3	3	3	3	3	2	2

Syllabus	
	A student or a group of students should carry out a mini-project related to the field of electronics and Telecommunication engineering. It may be a hardware or a software project.