Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(*An Autonomous Institute affiliated to Savitribai Phule Pune University*)

Structure & Syllabus of
S.Y, T.Y and Final Year B. Tech.
(Electronics Engineering)

Pattern 'B_18'

Academic Year 2018-19

Prepared by: - Board of Studies in Electronics Engineering

Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune

Signed by

Chairman – Board Of Studies

B.R.A.C. TRUST ★ VISHWAKARMA INSTITUTE OF TECHNOLOGY ★ विश्वकर्मा इन्स्टिट्यूट पुणे-३७.

Chairman – Academic Board

Vishwakarma Institute of Technology												Issue 1 : Rev No. 1 : Dt. 01/07/18
Title: Course Structure												FF No. 653
Branch: Electronics Engineering		SY B.Tech		Academic Year 2018-19		Semester:		Module:III		Pattern: B-18		
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week))			Examination scheme						Credits
			Theory	Lab	Tutorial	CA		MSE	ESA		Total	
						HA	LAB		ESE	VIVA		
1	EL2001	Analog Electronics	3	2		10	30	10	30	20	100	4
2	EL2002	Control Systems	3	2		10	30	10	30	20	100	4
3	EL2003	Electronics Communication	3	2		10	30	10	30	20	100	4
4	EL2004	Data Structures and Algorithms	3	2		10	30	10	30	20	100	4
5	EL2005	Discrete Structures & Graph Theory	2			20		30	30	20	100	2
6	EL2071	EDD1	1	2	2							4
Total												22

Vishwakarma Institute of Technology												Issue 1: Rev No. 1: Dt. 01/07/18
Title: Course Structure												FF No. 653
Branch: Electronics Engineering		SY B.Tech		Academic Year 2018-19		Semester:		Module:IV		Pattern: B-18		
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Credits
			Theory	Lab	Tutorial	CA		MSE	ESA		Total	
						HA	LAB		ESE	VIVA		
1	EL2006	Antennas and Wave Propagation	3	2		10	30	10	30	20	100	4
2	EL2007	Network Theory	3	2		10	30	10	30	20	100	4
3	EL2008	Signals and Systems	3	2		10	30	10	30	20	100	4
4	EL2009	Digital Electronics	3	2		10	30	10	30	20	100	4
5	EL2010	Probability and Statistics	2			20		30	30	20	100	2
6	EL2072	EDD2	1	2	2							4
7	EL2073	*PD1										
8	EL2074	**GP2										
Total												22
(*) Irrespective of Module in second semester. (**) Audit Course evaluated in second semester												

Vishwakarma Institute of Technology												Issue 1: Rev No. 1: Dt. 01/07/18
Title: Course Structure												FF No. 653
Branch: Electronics Engineering		TY B.Tech		Academic Year: 2018-19			Semester:	Module:V			Pattern: B-18	
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination Scheme						Credits
			Theory	Lab	Tutorial	CA		MSE	ESA		Total	
						HA	LAB		ESE	VIVA		
		Elective-1										
1	EL3001	Microcontroller Applications	3	2		10	30	10	30	20	100	4
2	EL3025	Sensors & Actuators										
3	EL3003	Data Compression										
		Elective-2										
4	EL3004	Power Electronics	3	2		10	30	10	30	20	100	4
5	EL3026	Computer Architecture and Operating Systems										
6	EL3006	Computer Vision										
		Elective-3										
7	EL3007	Digital Integrated Circuit Design	3	2		10	30	10	30	20	100	4
8	EL3009	RF Circuit Design										
9	EL3027	OOPS										
		Elective-4										
10	EL3010	Wireless Technologies	3	2		10	30	10	30	20	100	4
11	EL3011	Artificial Intelligence										
12	EL3012	Electronics Product Design										
5	EL3077	EDD3	1	2	2							4
6	EL3075	Seminar										1
Total												21

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Title: Course Structure												FF No. 653
Branch:Electronics Engineering		TY B.Tech	Academic Year: 2018-19			Semester:		Module: VI			Pattern: B-18	
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Credits
			Theory	Lab	Tutorial	CA		MSE	ESA		Total	
						HA	LAB		ESE	VIVA		
		Elective-1										
1	EL3008	Data Base Management System	3	2		10	30	10	30	20	100	4
2	EL3014	Data Communication & Networking										
3	EL3002	Robotics										
		Elective-2										
4	EL3016	Digital System Design	3	2		10	30	10	30	20	100	4
5	EL3017	Embedded System Design										
6	EL3018	Digital Signal Processing										
		Elective-3										
7	EL3019	Machine Learning	3	2		10	30	10	30	20	100	4
8	EL3020	Ad Hoc Networks										
9	EL3021	Microwave Engineering										
		Elective-4										
10	EL3022	Internet of Things	3	2		10	30	10	30	20	100	4
11	EL3023	Industrial Automation										
12	EL3024	VLSI Technologies										
13	EL3078	EDD4	1	2	2							4
14	EL3076	Summer Training										1
Total												21

Vishwakarma Institute of Technology						Issue 1: Rev No. 1: Dt. 01/07/18						
Title: Course Structure									FF No. 653			
Branch: Electronics Engineering		Final Year B. Tech	Academic Year: 2018-19			Semester		Module: VII			Pattern: B-18	
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Credits
			Theory	Lab	Tutorial	CA		MSE	ESA		Total	
						HA	LAB		ESE	VIVA		
		Elective-1										
1	EL4003	Engineering Ethics	3			20	NA	30	30	20	100	3
2	EL4004	Renewable Energy										
		Elective-2										
3	EL4006	CMOS Mixed Signal Design	3	2		10	30	10	30	20	100	4
4	EL4013	Advanced Power Electronics										
		Elective-3										
5	EL4014	Artificial Neural Networks	3	2		10	30	10	30	20	100	4
6	EL4015	Antenna Theory										
7	EL4016	Advanced Digital Signal Processing										
8	EL4018	RF Integrated Circuit Design										
9	EL4019	Real Time Operating Systems										
10	EL4071	Major Project 1		8								4
11	EL4078	Professional Development 3 (Audit Course)										
Total												15

Vishwakarma Institute of Technology												Issue 1: Rev No. 1: Dt. 01/07/18
Title: Course Structure												FF No. 653
Branch: Electronics Engineering		Final Year B. Tech		Academic Year: 2018-19		Semester:		Module:VIII		Pattern: B-18		
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Credits
			Theory	Lab	Tutorial	CA		MSE	ESA		Total	
						HA	LAB		ESE	VIVA		
		Elective-1										
1	EL4074	Semester Internship										15
	EL4075	Global Internship										
	EL4080	Research Internship										
	EL 4081	Project Internship										
Total												15

Vishwakarma Institute of Technology												Issue 1 : Rev No. 1 : Dt. 01/07/18
Title: Course Structure												FF No. 653
OR												
Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)			Examination scheme						Credits
			Theory	Lab	Tutorial	CA		MSE	ESA		Total	
						HA	LAB		ESE	VIVA		
		Elective-1										
1	EL4003	Engineering Ethics	3			20	NA	30	30	20	100	3
2	EL4004	Renewable Energy										
		Elective-2										
3	EL 4006	CMOS Mixed Signal Design	3	2		10	30	10	30	20	100	4
4	EL4013	Advanced Power Electronics										
		Elective-3										
5	EL4014	Artificial Neural Networks	3	2		10	30	10	30	20	100	4
5	EL4015	Antenna Theory										
6	EL4016	Advanced Digital Signal Processing										
7	EL4018	RF Integrated Circuit Design										
8	EL4019	Real Time Operating Systems										
4	EL4072	Major Project 2		8								4
Total												15

FF No: 654

Course Code: EL2001 **Course Name: Analog Electronics**

Credits: 4 **Teaching Scheme:3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Diodes: P-N junction, modeling, characteristics, Zener diode, Special purpose diodes, Solar cell structure, BJT configuration and characteristics, biasing, FET configuration and characteristic biasing, MOS capacitor, MOSFET configuration and characteristic biasing, Switched Capacitors, Small signal equivalent circuits of diodes, BJTs and MOSFETs.

Section 2:

Diode application circuits, Amplifiers: mid-frequency small signal analysis and frequency response; Power amplifier, operational; Simple op-amp circuits; Sinusoidal oscillators: criterion for oscillation, single-transistor and op-amp configurations; Function generators, wave-shaping circuits, Power supplies.

List of Practicals:

1. BJT Characteristics
2. BJT Biasing
3. BJT CE Amplifier
4. BJT CC Amplifier
5. JFET characteristics
6. MOSFET characteristics
7. RC Oscillators
8. Design of Integrator and Differentiator circuit
9. Design of Comparator and Schmitt Trigger
10. Design of Waveform Generator
11. Design of Dual Power Supply

List of Project areas:

1. **Water Level Indicator and Controller:** The Water Level Indicator and Controller project employs a simple mechanism which helps to detect and indicate and Control the water level in an overhead tank or any other water container. It can be extended for various protection circuits required for motor. It can be used in Hotels, Factories, Homes Apartments, Commercial Complexes, Drainage, etc.

2. **Intelligent Unambiguous Night Lamp Switcher:** This is the project of unambiguous night lamp switch, which turns ON our domestic lights/ High Power LED automatically when it is dark, without human interference. It also avoids repeated frequent switching of the devices which is usually ignored in most similar circuits but may have a detrimental effect on our operating devices.

3. **Regulated power supply with current boosting:** This is the project of designing a regulated power supply with current boosting capability. It also provides the various protection circuits to improve the performance of circuit.

Text Books:

1. Thomas L. Floyd; Electronic Devices; 9th Edition; Pearson.
2. Ramakant Gaikwad; Op-amps and Linear Integrated circuits; Prentice Hall, New Delhi.
3. Jacob Millman and Christos Halkias; Integrated Electronics; Tata McGraw-Hill, New Delhi.

Reference Books:

1. Robert Boylestad, Louis Nashelsky; Electronics Devices and Circuit Theory; Prentice Hall.
2. Jacob Millman and A. Grabel; Microelectronics; Tata McGraw-Hill, New Delhi.
3. D. A. Neamen; Electronic Circuit Analysis and Design; 3rd edition; McGraw-Hill.
4. B.G. Streetman; Solid State Electronic Devices; Prentice Hall of India, New Delhi.
5. A.S. Sedra and K.C. Smith; Microelectronic Circuits; Saunder's College publishing.
6. J. Millman and A Grabel; Microelectronics; McGraw Hill, International.

Course Outcomes:

The student will be able to –
1. Understand the characteristics of basic electronics devices
2. Understand the operation of basic electronic circuits.
3. Analyze electronic circuit
4. Design electronics circuits for practical applications.

FF No: 654

Course Code: EL2002 **Course Name: Control Systems**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:
Concepts of control system, Representation of physical systems-electrical and mechanical, Transfer Function, Block Diagram Algebra, Signal flow graph, Time Domain Analysis: Standard test signals, Time response and specifications of first order and second order systems, Steady state analysis, Static error coefficients, Concept of stability, Pole-Zero plot, Hurwitz Criteria, Routh array, Root locus.

Section2:
Frequency Domain Analysis: Frequency response, frequency domain specifications, Bode plot, Polar plot, Polar plot for Type I, II and III system, Gain cross over and phase cross over frequency, Nyquist plot and stability criterion. Lead and Lag compensation circuits. State Variable Analysis.

List of practicals:
1. Transfer function from pole-zeros and vice versa.
2. Step, ramp and impulse response of transfer function.
3. Time response of second order system
4. Stability analysis and obtaining root locus of transfer function
5. Bode plot
6. Nyquist plot and system stability
7. Polar plot and system stability
8. Transfer of DC motor
9. PID controller
10. Lead Lag compensation

List of Projects:
1. Simulation of given electrical/mechanical system.
2. Linear System Analysis (Time-Domain Analysis, Error –Analysis) using MATLAB
3. Speed control of DC motor.
4. Implementation of op amp based PID controller for Temperature systems.
5. Designing of Lead-Lag Compensators for Systems

Text Books:
1. K. Ogata; Modern Control Engineering; Fourth edition; Pearson education India.

2. I.J. Nagarth and M. Gopal; Control Systems Engineering; Third Edition; New age International Publishers, India.

Reference Books:

1. B. C. Kuo; Automatic control systems; Seventh Edition; Prentice, Hall of India.
2. Norman S. Nise; Control systems engineering; Third Edition; John Wiley and sons, Inc, Singapore.

Course Outcomes:

The student will be able to –

1. Determine transfer function of a given physical system and analyze the response.
2. Solve system equations in state-variable form.
3. Demonstrate various techniques of frequency domain analysis.
4. Perform stability analysis of the given control system.

FF No: 654

Course Code: EL2003 **Course Name: Electronics Communication**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1: Analog Communication
Amplitude Modulation, Frequency Modulation, Phase Modulation, Receivers

Section 2:Digital Communication
Sampling Theorem, Source Coding,PAM,PCM, Modulation Techniques, Receivers,spread spectrum techniques

List of Practicals:

1. Study of Amplitude Modulation (DSBFC)
2. Study of Amplitude Modulation (DSBSC)
3. Study of Frequency Modulation
4. Study of PAM
5. Study of PCM
6. Study of QPSK modulator
7. Study of FSK
8. Study of line codes
9. Study of PN sequence
10. Study of DSSS

List of Projects areas:

1. TV Remote Controlled Appliances

   The project is designed to operate electrical loads using a TV remote. The remote transmits coded infrared data which is then received by a sensor interfaced to the control unit. The system operates electrical loads depending on the data transmitted from the TV remote.

2.Transmitter Systems
3. Receiver Systems

Text Books:

1. Louis E Frenzel; Principles of Electronic Communication Systems; Third Edition; Tata McGraw Hill Publications.
2. Wayne Tomasi; Electronics Communication System; Pearson Education India
3. H. Taub, D. Schilling; Principal of Communication System; Tata McGraw Hill Publications.

Reference Books:

1. Wayne Tomasi; Electronic Communication Systems; Fourth Edition; Pearson Education India

2. Bernard Sklar; Digital Communication; Pearson Education India.

Course Outcomes:

The student will be able to –

1. Describe analog modulation techniques.
2. Evaluate the performance of analog radio receivers.
3. Explain digital communication systems.
4. Estimate the performance of digital radio receivers.

FF No: 654

Course Code: EL2004 **Course Name: Data Structures and Algorithms**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours/Week

Section 1:
Design and Analysis of Algorithms [Time and Space Complexity]; Fundamentals of Data structures; Application of Arrays – Searching and Sorting Techniques; Static and Dynamic Memory; Linked List; LDS – Stacks, Queues.

Section2:
Application of LDS; Trees; Graphs

List of Practicals:
1. Implement Linear Search and Binary Search searching algorithms.
2. Implement Bubble, Quick and Insertion sorting algorithms
3. Create and manipulate Database using Structures
4. Implement Singly Linked List
5. Make use of Arrays and Linked List to implement Stacks
6. Implement Queues using Arrays and Linked List
7. Add of 2 single variable polynomials using Array/Linked List
8. Convert infix expression to postfix expression
9. Operate on Binary tree
10. Make use of Dijkstra's algorithm for finding shortest path in graph.

List of Project Areas:
1. Database using Structures
2. Applications of Stacks
3. Applications of Queues
4. Applications of Trees
5. Applications of Graphs

Text Books:
1. Tenenbaum A M and Langsam Y.; Data Structure Using C; Prentice Hall of India New Delhi.
2. Horowits E and Sahni S; Fundamentals of Data Structures; Gurgaon, Galgotia Book Source New Delhi.

Reference Books:

1. Kruse R L, Leung B P and Tondo C L; Data Structure and programming Design In C; Prentice Hall of India Pvt.ltd.

2. Rajesh Shukla; Data Structures and Files; Vishwakarma publication.

3. Kakde O G and Deshpande; Data Structures and Algorithms; Indian Society for Technical

Course Outcomes:

The student will be able to –

1. Estimate time complexity using Big-O notation.
2. Describe the concept of sequential organization, ordered list and dynamic memory management.
3. Apply suitable operations on STACK and QUEUE data structure.
4. Make use of STACK and QUEUE data structure to solve engineering problems.
5. Demonstrate the usage of major Tree algorithms.
6. Explain major Graph algorithms.

FF No: 654

Course Code: EL2005 Course Name: Discrete Structure and Graph Theory

Credits: 2 Teaching Scheme: 2 Hours / Week

Section 1:

Propositions, Sets, algebra of set operation, cardinality of finite state, mathematical induction, Discrete probability, Relation, Poset, Lattice, chain, antichain, transitive closure and Warshalls algorithm , Functions, Recurrence relation, Analysis of algorithm

Section 2:

Graphs : Disjktras shortest path algorithm, connected graphs, cut-set, planer graph, Eulerian and Hamiltonian graph, path and circuit. Trees: Huffman algorithm to construct optimal tree, prefix codes, minimum spanning tree, fundamental circuit, fundamental cut set, Algebraic system : Boolean algebra, Number system:

Text Books:

1. *Kenneth Rosen; Discrete mathematics and its applications; Second edition; Mc Graw Hill publications.*
2. *Purna Biswal; Discrete mathematics and graph theory; Second edition; Eastern Economy Publications.*

Reference Books:

1. *C.L Lieu; Elements of discrete mathematics; second edition; Mcgraw hill publication.*
2. *Seymour Lipscheuz; Discrete mathematics; third edition; Schaums outline*

Course Outcomes:

The student will be able to –

1. Understand basics of sets, functions, and relations.
2. Apply basics of discrete probability and number theory in problem solving
3. Relate basic properties of graphs and trees with practical examples.
4. Appreciate number system and the basic principles of Boolean algebra,

EL2071: Engineering Design & Development 1

Course Prerequisites:

Basic Electronics, Physics, Engineering Mathematics, Statistics, Programming Languages

Course Objectives:

1. To develop critical thinking and problem-solving ability by exploring and proposingsolutions to realistic/social problems.
2. To Evaluate alternative approaches, and justify the use of selected tools and methods,
3. To emphasize learning activities those are long-term, inter-disciplinary and student centric.
4. To engage students in rich and authentic learning experiences.
5. To provide every student the opportunity to get involved either individually or as a groupto develop team skills and learn professionalism.

Credits: 4 **Teaching Scheme:** Lab 2 Hours/Week

Course Relevance:

Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice andstrengths. Students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City, Smart Energy and Swaccha Bharat Abhiyan. Students can be evaluated forhigher order skills of Blooms taxonomy like 'analyze, design and apply'. This course is capable of imparting hands on experience and self-learning to the students which will help them throughouttheir career. This is a step ahead in line with national policy of Atmanirbhar Bharat.

Preamble - The content and process mentioned below is the guideline document for the faculties and students to start with. It is not to limit the flexibility of faculty and students; rather they are free to explore their creativity beyond the guideline mentioned herewith. This course is designedto encourage and ensure application of technology for solving real world

problems using an interdisciplinary approach.

Students need to plan their work in following steps:

1. Formation of project group comprising of 4-5 students. Multidisciplinary groups areallowed
2. A supervisor/mentor teacher assigned to individual groups.
3. Carrying out literature survey
4. Finalization of problem statement
5. Planning the project execution
6. Execution of project and testing
7. Writing a report
8. Publication in the form of research paper/patent/copyright as found suitable by supervisor/mentor

Teacher's Role in PCL:

1. Teacher is not the source of solutions rather he will they act as the facilitator and mentor.
2. To utilize the principles of problems solving, critical thinking and metacognitive skills ofthe students.
3. To aware the group about time management.
4. Commitment to devote the time to solve student's technical problems and interested inhelping students to empower them better.

Student's Role in PCL:

1. Students must have ability to initiate the task/idea they should not be mere imitators.
2. They must learn to think.
3. Students working in PCL must be responsible for their own learning.
4. Students must quickly learn how to manage their own learning, Instead of passivelyreceiving instruction.
5. Students in PCL are actively constructing their knowledge and understanding of thesituation in groups.
6. Students in PCL are expected to work in groups.
7. They must develop interpersonal and group process skills, such as effective listening orcoping creatively with conflicts.

Core Technology domains identified for E&TC Engg are as below. However, this list can be extended as per the need of project and multidisciplinary approach

1) VLSI Design
2) Embedded Systems
3) Signal Processing
4) Communication
5) Machine learning

Assessment Scheme:

Mid Semester Examination - 30 Marks
End Semester Examination - 70 Marks

MOOCs Links and additional reading material:

www.nptelvideos.in
https://worldwide.espacenet.com/

Course Outcomes:

On completion of the course, learner will be able to–

1. Review the literature to formulate problem statement to solve real world problems (PO2,PO4) : LEVEL 3
2. Apply knowledge of technology and modern tools to design solution considering sustainability and nvironmental issues (PO1, PO3, PO4,PO5, PO6, PO7, PO12) LEVEL 4
3. Manage project ethically as team member/ lead. (PO4,PO8, PO9, P11, P12) LEVEL 3

4. Demonstrate effectively technical report/ research paper/ prototype/ patent (PO4,PO10, PO12) LEVEL 4

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	1	0	0	3	1	3	0	2	2	2
2	3	3	3	3	3	3	3	2	1	2	0	2	3	3
3	0	1	1	1	0	2	0	3	3	3	3	2	0	0
4	3	1	1	1	0	0	0	3	1	3	3	2	1	0

FF No: 654

Course Code: EL2006 **Course Name: Antennas and Wave Propagation**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Coordinate system, Curl, divergence, Gradient, Amperes Circuitary law, Biot Savart Law,Stokes theorem, Poission's equation, Maxwell's equations: differential and integral forms and their interpretation, Continuity equation, boundary conditions, wave equation, Poynting vector. Introduction to Antenna, Basic antenna parameters, Quarter wave Monopole and Half Wave Dipole, Loop Antennas Folded Dipoles & their characteristics. Helical Antennas,

Section 2:

Modes of propagation, Structure of atmosphere, Ground wave propagation, Tropospheric propagation , Duct propagation, Troposcatter propagation , Flat earth and Curved earth concept Sky wave propagation – Virtual height, critical frequency , Maximum usable frequency – Skip distance, Fading , Multi hop propagation.

List of Practicals:

1. Study the different parameter of Antennas.
2. Plot the radiation pattern of the Helical/ Log periodic/Yagi Uda Antenna.
3.Construct the dipole antenna and plot its radiation pattern.
4. Construct the horn antenna and plot its radiation pattern.
5. Construct the dipole antenna and plot its radiation pattern.
6. Design and simulate Helical antenna.
7. Design and simulate Monopole Wire antenna.
8. Design and simulate Loop antenna.
9. Design and simulate Wire antenna.
10. Construct and design reflector.

List of Projects:

1. Design, construct and simulate folded dipole antenna.
2. Design and construct Patch antenna.
3. Design and construct reflected antenna.
4. Design an antenna for the specific microwave frequency.
5.Design an antenna for the FM frequency.
6.Design an antenna for the FM frequency.

Text Books:

1. *John D Kraus; Antennas for All Applications; 3rd Edition; Mc Graw Hill, 2005.*
2. *K D Prasad; Antenna & Wave Propagation; Satya Prakashan; New Delhi.*

Reference Books:

1. EdwardC. Jordan and Keith G. Balmain; Electromagnetic Waves and Radiating Systems; Prentice Hall of India, 2006.

2. R.E. Collin; Antennas and Radiowave Propagation; McGraw Hill 1985.

3. Constantine.A. Balanis; Antenna Theory Analysis and Design; Wiley Student Edition, 2006.

4. Rajeswari Chatterjee; Antenna Theory and Practice; Revised Second Edition New Age International Publishers, 2006.

Course Outcomes:

The student will be able to –

1. Elaborate fundamental concepts of antenna and its types
2. Apply the principles of antennas in design and analysis.
3. Understand various configurations of antennas
4. Explain basic concept of wave propagation.

FF No: 654

Course Code: EL2007 **Course Name: Network Theory**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:
Fundamental concepts of circuit elements and energy sources, Node and mesh analysis, Graph Theory and Network Equations, Network Theorems: Superposition, Thevenin's, Norton's, Maximum Power Transfer. Sinusoidal Steady state analysis of RLC circuits, Analysis of Transient Response of passive circuits. Solution of Network Equation using Laplace Transform.

Section 2: function.
Network Functions: Ports and terminal pairs, Network functions, Poles and zeros; Necessary condition for driving point function, Necessary condition for transfer function. Passive Filters

List of Practicals:

1. To verify Thevenin's theorem for a given network.
2. To verify Maximum power transfer theorem for a given network and calculate maximum power.
3. Design and implement a Low pass filter, plot its frequency response.
4. Design and implement a high pass filter, plot its frequency response.
5. To measure and verify Z and Y parameters of a given two port networks.
6. To find critical frequencies of poles and zeros of LC impedance driving point function.
7. Design and implement a band pass filter, plot its frequency response.
8. Design and implement a band stop filter, plot its frequency response.
9. To observe transient response of second order system and determine the rise time, peak time, peak overshoot, delay time and settling time.
10. To find α, β and z0 of resistive and reactive network.

List of Project areas:

1. RLC circuit
2. Theorems
3. Filters

Text Books:

1. Abhijit Chakraworti; Circuit Theory Analysis and Synthesis; Dhanpat Rai and Co.
2. Ravish Singh; Network Analysis and Synthesis; McGraw Hill

Reference Books:

1. M. E. Valkenburg; Network Analysis; PHI
2. D. K. Roy Choudhary; Networks and Systems; New Age.

Course Outcomes:

The student will be able to –

1. Simplify different networks and circuits using network simplification techniques and Graph theory.
2. Analyze different networks and circuits using network parameters.
3. Analyze two port networks.
4. Design different type of filters.

FF No: 654

Course Code: EL2008 **Course Name: Signals and Systems**

Credits: 4 **Teaching Scheme: 3 Hours / Week**

Lab: 2 Hours / Week

Section 1:

Continuous-time signals and systems; Sampling; Discrete-time signals and systems Continuous linear time-invariant (LTI) systems: impulse response; convolution; linear constant- coefficient differential equations; Discrete-time LTI systems: convolution; difference equations.

Section 2:

Fourier series: Fourier transform; Laplace transform: system analysis; frequency response; Analog filters.

List of Practicals:

1. Plotting of various elementary signals
2. Fourier transform of sine, square and triangular signals
3. Verification of FT properties
4. Verification of sampling theorem
5. Convolution of two signals.
6. Implementation of convolution properties
7. Reconstruction of square wave signal from various sinusoidal signals
8. System stability using pole zero plot
9. Find initial and final values of a signal
10. Implement analog low pass and high pass filter. Observe the frequency response.

List of Project areas:

1. Analysis of various signals and systems

1. Acquire an ECG/Speech/vibration Signal.
2. Find out frequencies in the signal. Apply this signal to a filter.
3. Verify properties of designed filter system in time and frequency domain.
4. Obtaining impulse and step response of the given system and analyze it.
5. Use MATLAB to construct accurate frequency response plots

2. Discretization of continuous time signal using different sampling rate and observing aliasing effect of lower and higher sampling rates

1. Acquire an analog ECG/Speech signal. Convert it to discrete signal.
2. Analyze the effect of change in sampling rates in time and frequency domain

3. Fourier analysis of octaves of a music signal

1. Generate .wave files of all octaves (sa re ga ....)
2. Analyze individual octave amplitudes and frequencies in all scales of harmonium.
3. Play the Composed octaves of a Tune

Text Books:

1. *Simon Haykin, Barry Van Veen; Signals and Systems; Wiley Publication*
2. *Roberts Michael J.; Signals and Systems; New Delhi. Tata McGraw Hill Publishing Company Limited, 2003.*

3. P. Ramesh Babu and R. Anand Natarajan; Signals and Systems; Fourth Edition; ScitechPublications (INDIA) Pvt.Ltd.

Reference Books:

1. R.F. Ziemer, W.H. Tranter and D.R. Fannin; Signals and Systems - Continuous andDiscrete; 4th Edn; Prentice Hall, 1998.
2. A.V. Oppenheim, A.S. Willsky and I.T. Young; Signals and Systems; Prentice Hall, 1983.
3. B.P. Lathi; Signal Processing and Linear Systems; Oxford University Press, 1998.

Course Outcomes:

The student will be able to –

1. Represent and classify various signals and systems
2. Understand LTI systems
3. Find Fourier series and Fourier transform for different signals
4. Analyze continuous time system using Laplace transform.

FF No: 654

Course Code: EL2009 **Course Name-Digital Electronics**

Credits: 4 **Teaching Scheme: 3 Hours / Week**

Lab: 2 Hours / Week

Section 1:

Review of number system and Boolean algebra, Combinational logic design, Sequential logicdesign

Section 2:

FSM design, Memories and Programmable Logic Devices, Digital logic families.

List of Practicals:

1. Implement/simulate 4 bit binary/BCD adder.
2. Implement/simulate 2-bit carry save/skip adder.
3. Implement/simulate 4-bit digital comparator.
4. Implement/simulate 3/4 bit up/down counter.
5. Implement/simulate MOD n counters using standard ICs.
6. Implement/simulate up BCD MOD 12 counter.
7. Implement/simulate a sequence generator for the given sequence.
8. Implement/simulate a sequence generator for the given sequence using counterdesign/MUX based approach.
9. Implement/simulate Mealy based FSM for the given sequence.
10. Implement/simulate Moore based FSM for the given sequence.

List of Projects:

1. Design and implement/simulate a digital calculator for
    a. 4-bit Binary addition
    b. Single digit BCD addition and subtraction
    c. 4-bit multiplication
    d. 4-bit subtraction
2. Design and simulate a digital clock.
3. Design a stop watch.
4. Design and simulate an object counter.
5. Design a LED display which will display “VIT ELEX DEPT”
6. Design a car code lock.
7. Design a tea/coffee vending machine.
8. Design a traffic light controller.

Text Books:

1.Morris Mano, Michael D. Ciletti; Digital Design; 4thedition; Prentice Hall.

2. Ronald J. Tocci, Neil S. Widmer, Gregory L. Moss; Digital System; 10th Edition; PearsonPrentice Hall.

Reference Books:

1. R P Jain; Modern Digital Electronics; 3rdEdition; Tata McGraw Hill.

2. Anand Kumar; Fundamentals of Digital Circuits; 3rdEdition; PHI.

Course Outcomes:

The student will be able to –

1. Analyze the combinational logic circuits.
2. Design the sequential logic circuits.
3. Design the synchronous finite state machine. .
4. Compare the basic programmable logic devices and memories.
5. Describe the characteristics of different logic families

FF No: 654

Course Code: EL2010 **Course Name-Probability and StatisticsCredits: 2**

Teaching Scheme: 2 Hours / Week

Section 1:

Probability, conditional probability, independent events , Bayes' rule; Statistics, Descriptive statistics ,Measure of central tendency; Random Variables : Continuous and Discrete Random Variables, probability distribution function , Cumulative distribution function, Expectations, variance and standard deviation. Standard distributions

Section 2:

Sampling theory : population and samples , population parameters , sample statistics; Estimation theory : unbiased estimates and efficient estimates, confidence interval estimate of population parameters; Regression and correlation : curve fitting and the method of least square, correlation theory

Reference Books

1. Murray R. Spiegel etal.; Schaum's outline of Theory and problems of statistics; Schaum'soutline series; 4th edition; McGraw-Hill.

2.Larry J. Stephens; Schaum's outline of Beginning statistics; Schaum's outline series; 2nd edition; McGraw-Hill.

3 Murray R. Spiegel etal; Schaum's easy outlines: Probability and statistics; Schaum'soutline series; McGraw-Hill.

Course outcomes

1. Explain events and perform set operations on events.
2. Make use of probability models for discrete and continuous random variables
3. Describe a data set in terms of statistical terms.
4. Estimate the values of parameters based on measured empirical data.
5. Examine the relationship between dependent and independent variable andto predict the dependent variable when the independent variable is known

EL2072: Engineering Design & Development 2

Course Prerequisites:

Basic Electronics, Physics, Engineering Mathematics, Statistics, Programming Languages

Course Objectives:

6. To develop critical thinking and problem-solving ability by exploring and proposing solutions to realistic/social problems.
7. To Evaluate alternative approaches, and justify the use of selected tools and methods,
8. To emphasize learning activities those are long-term, inter-disciplinary and student centric.
9. To engage students in rich and authentic learning experiences.
10. To provide every student the opportunity to get involved either individually or as a group to develop team skills and learn professionalism.

Credits: 4 **Teaching Scheme:** Lab 2 Hours/Week

Course Relevance:

Project Centric Learning (PCL) is a powerful tool for students to work in areas of their choice and strengths. Students can solve socially relevant problems using various technologies from relevant disciplines. The various socially relevant domains can be like Health care, Agriculture, Defense, Education, Smart City, Smart Energy and Swaccha Bharat Abhiyan. Students can be evaluated for higher order skills of Blooms taxonomy like ‘analyze, design and apply’. This course is capable of imparting hands on experience and self-learning to the students which will help them throughout their career. This is a step ahead in line with national policy of Atmanirbhar Bharat.

Preamble - The content and process mentioned below is the guideline document for the faculties and students to start with. It is not to limit the flexibility of faculty and students; rather they are free to explore their creativity beyond the guideline mentioned herewith. This course is designed to encourage and ensure application of technology for solving real world problems using an interdisciplinary approach.

Students need to plan their work in following steps:

9. Formation of project group comprising of 4-5 students. Multidisciplinary groups are allowed
10. A supervisor/mentor teacher assigned to individual groups.
11. Carrying out literature survey
12. Finalization of problem statement
13. Planning the project execution
14. Execution of project and testing
15. Writing a report
16. Publication in the form of research paper/patent/copyright as found suitable by supervisor/mentor

Teacher's Role in PCL:

5. Teacher is not the source of solutions rather he will they act as the facilitator and mentor.
6. To utilize the principles of problems solving, critical thinking and metacognitive skills of the students.
7. To aware the group about time management.
8. Commitment to devote the time to solve student's technical problems and interested in helping students to empower them better.

Student's Role in PCL:

8. Students must have ability to initiate the task/idea they should not be mere imitators.
9. They must learn to think.
10. Students working in PCL must be responsible for their own learning.
11. Students must quickly learn how to manage their own learning, Instead of passively receiving instruction.
12. Students in PCL are actively constructing their knowledge and understanding of the situation in groups.
13. Students in PCL are expected to work in groups.
14. They must develop interpersonal and group process skills, such as effective listening or coping creatively with conflicts.

Core Technology domains identified for E&TC Engg are as below. However, this list can be extended as per the need of project and multidisciplinary approach

6) VLSI Design
7) Embedded Systems
8) Signal Processing
9) Communication
10) Machine learning

Assessment Scheme:

Mid Semester Examination - 30 Marks
End Semester Examination - 70 Marks

MOOCs Links and additional reading material:

www.nptelvideos.in
https://worldwide.espacenet.com/

Course Outcomes:

On completion of the course, learner will be able to–

4. Review the literature to formulate problem statement to solve real world problems (PO2,PO4) : LEVEL 3
5. Apply knowledge of technology and modern tools to design solution considering sustainability and nvironmental issues (PO1, PO3, PO4,PO5, PO6, PO7, PO12) LEVEL 4
6. Manage project ethically as team member/ lead. (PO4,PO8, PO9, P11, P12) LEVEL 3

4. Demonstrate effectively technical report/ research paper/ prototype/ patent (PO4,PO10, PO12) LEVEL 4

CO PO Map

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	2	3	1	0	0	3	1	3	0	2	2	2
2	3	3	3	3	3	3	3	2	1	2	0	2	3	3
3	0	1	1	1	0	2	0	3	3	3	3	2	0	0
4	3	1	1	1	0	0	0	3	1	3	3	2	1	0

FF No: 654

Course Code: EL3001 **Course Name-Microcontroller Applications**

Credits: 4 **Teaching Scheme: 3 Hours / Week**

Lab: 2 Hours / Week

Section 1:
AVR Atmega32 Architecture, Instruction Set, Assembly Language Programming, Embedded C Programming, Simple I/O Interfacings

Section 2:
AVR Atmega-32 On-chip Peripherals, Communication Protocols, Interfacing Sensors & Actuators

List of Practicals:
1. Write an ALP code to flash LEDs connected to PORT
2. Write an ALP to display 0 to 9 numbers on 7-Segment Display using Timer
3. Write a C program to display message on 16 X 2 LCD
4. Write a C program to interface 4 X 4 matrix keypad
5. Write a C program to use on chip ADC
6. Write a C program to read/write on chip EEPROM.
7. Write a C program to control DC motor using PWM
8. Write a C program for serial communication using on chip UART
9. Write a C program to implement I2C protocol for RTC
10. Write a C program to read switch and control AC Lamp load using relay.

List of Project areas:
1. Industrial Automation
2. Home automation
3. Robotics
4. Medical Electronics
5. Communication
6. Automotive Electronics

Examples: - Design of Electronic Lock, Design of Temperature Controller

Text Books:-

1. Mohammad Ali Mazidi, Sarmad Naimi & Sepehr Naimi; The AVR Microcontroller and Embedded Systems using Assembly and C; 1stEdition; Pearson Education India.
2. Dhananjay Gadre; Programming and Customizing the AVR Microcontroller; 1 st Edition; McGraw Hill.

Reference Books:

1. Atmel 8-Bit AVR Microcontroller& ATmega32A Datasheet complete

Course Outcomes:

The student will be able to –

1. Explain AVR Microcontroller Architecture.
2. Develop an Assembly Language Program & Embedded C Program for AVR Microcontroller.
3. Make use of internal peripherals of AVR Microcontroller.
4. Develop an interface for Sensors and Actuators

FF No. : 654

Course Code : EL3025 **Course Name: Sensors and Actuators**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:
Sensor static and dynamic characteristics, Sensor selection criteria, Sensor operating principle: Temperature, linear and rotary displacement, optical, pressure and strain gauge. Smart sensors. Classification of actuators, Relays and solenoids, Relay circuits, Pneumatic and Hydraulic linear and rotary actuators, Control circuits for actuators.

Section2:
Analog signal processing circuits: Preamplifier, gain amplifier, Power amplifier. LNA, Op amp based signal conditioning circuits. Digital signal processing circuits: ADC and DAC, Types, selection criteria, designing with analog and digital signal processing circuits.

List of Practicals:

1. Rotary and linear encoder for displacement measurement.
2. Comparative study of temperature sensors.
3. Strain gauge with Wheatstone's' Bridge configurations.
4. Design and development of signal conditioning circuits.
5. Design and development of R-2R ladder 4 bit DAC.
6. Evaluation of ADC performance parameters.
7. Implementation of relay circuits.
8. Design and testing of fluid power circuits.
9. Co-ordinated motion of multiple actuators.
10. Simulation of P and H circuits.

List of Projects:

1. Automatic door opening closing system.

2. Designing of Automatic Weighing scale.
3. Designing Pneumatic circuit for sorting of jobs running on conveyor belt.
4. Data Acquisition System.

Text Books:

1. Ramon Pallas-Areny, John G. Webster; Sensors and Signal Conditioning; Second Edition; Wiley India.
2. Anthony Esposito; Fluid Power with Applications.
3. Walt Jung; Op Amp Application Handbook; Newnes.

Reference Books:

1. Analog Devices; Practical Design Techniques for Sensor Signal Conditioning.
2. FESTO Didactic; Basic Principles of Pneumatics and Electro pneumatics.
3. C. D. Johnson; Process Control Instrumentation Technology; Eighth Edition; Pearson.

Course Outcomes:

The student will be able to –

1. Understand sensors in terms of behavior or response to external physical variables.
2. Design application based on electro-pneumatic/electro-hydraulic circuits.
3. Experiment with analog signal conditioning circuits.
4. Demonstrate to interface between analog and digital domain.

FF No. : 654

Course Code: EL3003 **Course Name: Data Compression**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1: Lossless Compression Techniques

Introduction to Information Theory, Entropy, Uniquely Decodable Codes, Prefix Codes, Shannon Fano Coding, Huffman Coding, Extended Huffman Codes, Adaptive Huffman Codes, Golomb and Rice Codes, Linear block codes, Arithmetic Coding, Dictionary Techniques: Static and Adaptive Dictionary; Lempel Ziv Approaches: LZ77, LZ78, LZW; File Formats

Section 2:Lossy Compression Techniques

Uniform Quantizer, Adaptive Quantizer; Forward and Backward, Jayant Quantizer, Non-Uniform Quantizer, Vector Quantization, Linde-Buzo-Grey LBG Algorithm, Necessity of Transforms, Discrete Cosine, Hadamard Transform, Haar Transform, Wavelet Transform**,** Quantization and Coding of Transform Coefficients, Baseline JPEG Image Compression

List of Practicals:

1. Implement Unique Decodability Test
2. Implement Huffman Coding
3. Implement Arithmetic encoding and Decoding
4. Implement Golomb encoding Table
5. Implement LZ77 Dictionary Technique
6. Implement Discrete Cosine Transform(DCT)
7. Implement Walsh and Hadamard Transform
8. Implement Uniform Quantization
9. Implement vector quantization
10. Multiresolution analysis using Wavelet Transform

List of Project areas:

1. A photograph of large size required huge amount of memory to store and transmit. Hence compress the image using JPEG standard. Calculate compression ratio and MSQE. Also observe quantization effects on quality of decompressed image.

2. A text or bio-medical data needs to be stored and transmitted. To reduce the storage requirement, compress data using lossless methods like Huffman coding, Golomb, runlength, dictionary techniques. Compare results in terms of compression ratio, execution time, time complexity, suitability for the chosen data.

3. A photograph of crowd or natural scene requires huge amount of memory. Apply Transform based Lossy compression techniques for 1D or 2D images. Compare performance of Lossless and Lossy compression techniques.

4. Project based on Lossless Compression Methods

5. Project based on Lossy Compression Methods
6. Project based on Quantization effects on Signal/Image

Text Books:

1. Khalid Sayood; Introduction to Data Compression; 3rd Edition; Elsvier publication
2. Graham Wade; Coding Techniques – Introduction to compression and Error control; Palgrave Publications
3. Simon Hyakins; Communication systems; 4th Edition; Wiley Publications

Reference Books:

1. Ranjan Bose; Information Theory and cryptography; Tata McGraw Hill, 2002/2006
2. Saloman; Data compression – Complete reference; Springer Verlag; 3rd Edition
3. Levis W.J; Data compression; Springer; 2nd Edition
4. Nelson Mark, Gaily. Jean, Loup; Data Compression book; 2nd Edition; BPB Publication

Course Outcomes:

The student will be able to –
1. Explain encoding and decoding of lossless compression methods.
2. Calculate effect and efficiency of compression algorithms.
3. Explain encoding and decoding of lossy compression methods
4. Implement suitable Compression algorithms on Text/ Signal /Image.

FF No: 654

Course Code : EL3004 **Course Name: Power Electronics**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Power Devices- power diode, SCR, GTO, power BJT and MOSFET, IGBT- Structure, Characteristics, Selection criterion, Driver Circuits, Comparison.

Single phase-controlled converters (line commutated), Performance analysis for resistive and inductive load, Evaluation of average and rms load voltage, supply current harmonics, power factor, current distortion factor, device ratings

Single phase inverters-bridge and push-pull type, Performance analysis for resistive and inductive load, harmonic analysis of voltage for square-wave and PWM inverters.

Section 2:

Step down/ up DC-DC converters (Choppers), Analysis for resistive and inductive load, Load voltage calculations, Single, two and four quadrant operational analysis.

AC to AC controllers, Half and full cycle control, Analysis for resistive and inductive load, Load voltage estimation, Gating signal requirement for inductive load.

Fly back and Forward SMPS, Concept of resonant converter, ZVS and ZCS switches, On – line and Off-line UPS, Battery selection, HVDC transmission, Industrial applications of different converters.

List of Practicals:

1. Study of Triggering/ Driver Circuit for SCR
2. Study of Triggering/ Driver Circuit for MOSFET
3. Study of Single Phase Controlled Converter (Half controlled) with Load
4. Study of Single Phase Controlled Converter (Fully Controlled) with Load
5. Study of DC-DC Converter (Step down with MOSFET/ IGBT) with Load
6. Study of DC-DC Converter (Step up with MOSFET/ IGBT) with Load
7. Study of DC-AC Converter (Single Phase Bridge) with Load
8. Study of Single Phase AC-AC Controllerwith Load
9. Simulation of Single Phase Converter (AC-DC/ DC-DC) with R, RL Load
10. Simulation of Single Phase Converter (AC-AC/ DC-AC) with R, RL Load

List of Projects:

1. Develop a switching/triggering circuit for a power device (SCR / power BJT / power MOSFET / IGBT)
2. PWM generation for device switching

Develop a single-phase power converter for utility application as listed below (Any one). Source available is AC Mains/ DC battery.

3. Battery charger

4. Fan regulator
5. Intensity control of lighting
6. Inverter
7. SMPS
8. Power control by Integral Cycle Switching
9. Verify, through simulation, the performance of AC-DC/ DC-DC power conversion systems for suitable load. Comment on the results.
10. Verify, through simulation, the performance of DC-AC/ AC-AC power conversion systems for suitable load. Comment on the results.

Text Books:

1. M D Singh, K B Khanchandani; Power Electronics; 2 nd Edition; TMH.
2. M. H. Rashid; Power Electronics Circuits, Devices and Applications; 3 rd Edition; PHI.

Reference Books:

1. N. Mohan, T. M. Undeland and W.P. Robbins; Power Electronics: Converters, Applications, and Design; 3rd edition; John Willey and Sons, Singapore.
2. P. C. Sen; Modern Power Electronics; S. Chand and Co, New Delhi.

Course Outcomes:

The student will be able to –

1. Describe the operation, characteristics and applications of power devices like power diode, SCR, power BJT, power MOSFET, and IGBT.
2. Analyze controlled converter and inverter circuits in terms of performance parameters.
3. Analyze dc-dc converter and ac controller circuits in terms of performance parameters.
4. Illustrate the role of Power Electronics in utility-related applications.

FF No: 654

Course Code: EL3026 Course Name: Computer Architecture & Operating System

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Functional Units of a Computer: ALU, Control Unit, Memory, IO Units; Software Hardware Interaction/Interface; Basic Structure of a CPU: Overview of X 86 Family, Multicore, Mics and Gpgpus; CPU Bus Architecture; Advancement in Computer Architectures

ALU: Block Diagram, Data Representation: Computer Arithmetic with Signed/Unsigned Numbers, Multiplication with Signed Numbers: Booths Algorithm, Control Unit, *I*/O Module Functions and I/O Block Diagram, Accessing I/O Devices, Direct Memory Access

Section 2:

Memory System :Characteristics, CPU Memory Interaction, Hierarchical Memory System, Types and Characteristics of Memories: Cache Memories, Memory Management Techniques: Virtual Memory, Paging, Segmentation, Associative Memories.

OS: Architecture, Goals and Structures of OS., Hardware Abstraction Layer, Types of OS: Process Management, Resource Management, Deadlock, Uniprocessor Scheduling; Types of Scheduling: Scheduling Algorithms

List of Practicals:

1. Arithmetic and logical operations with signed and unsigned numbers
2. Design 2bit CPU instructions for performing data transfer operation
3. Design any five CPU instructions for performing arithmetic operations
4. Design any five CPU instructions for performing logical operations
5. Implement Booth's Multiplier.
6. Design control unit for generating various control signals for any five instructions
7. Design 2bit arithmetic and logical unit
8. Design and implement 4 bit look ahead carry generator
9. Design and simulate Memory unit(4 x 4 RAM).
10. Study of logic analyzer.

List of Projects

1. Design an instruction set for a limited functionality machine having all instructions of 8-bits fixed length only, including opcode and operands.
2. Simulate a word multiplier.
3. Simulate a word divider
4. Design a minimal cpu architecture for controlling the washing machine.
5. Design a 2 bit CPU which can execute minimum five instructions

Text Books:

1. Carl Hamacher and Zaky; Computer Organization; 5th Edition; Mcgraw Hill publication.

2. William Stallings; Computer organization and architecture; 9th Edition; Pearson Publication.

3. William Stalling; Operating Systems; 5th Edition; Pearson Education.

Reference Books:

1. A. Tanenbaum; Structured Computer Organization; 4th Edition; Prentice Hall of India.

2. Abraham Silberschatz, Peter Baer Galvin; Operating system concepts; John Wiley and Sons, 6th Edition.

Course Outcomes:

The student will be able to –

- Elaborate basic concepts of computer architecture.
- Describe functional units of the CPU including the ALU and control unit.
- Explain the organization of memory and memory management techniques.
- Understand the role of the operating system in interfacing with the computer hardware

FF No: 654

Course Code: EL3006 **Course Name : Computer Vision**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours/ Week

Section 1:

Human Vision System; Computer Vision System; Camera Geometry Fundamentals, Probability Distribution Models. Geometric Primitives and Transformations; Photometric Image Formation; Digital Camera; Point Operators; Neighborhood Operators; Pyramids and Wavelets. Feature Detection and matching; Hough Transform; Edge Linking.

Section 2:

Object Recognition, Segmentation and Classification, Global Methods; Active Contours; Normalized Cuts; Support Vector Machine; Histogram of Oriented Gradients; Adaboost Classifiers. Triangulation; Two-Frame Structure from Motion; Factorization; Bundle Adjustment; Translational Alignment; Motion estimation techniques; Tracking, Stereo Vision. Real-world Computer Vision Systems applications.

List of Practicals:

1. Develop an algorithm for pre-processing of an input image for geometric transformation of image.
2. Develop an algorithm for pre-processing of an input image for enhancement of image.
3. Develop an algorithm for feature extraction of an input image using point detector
4. Develop an algorithm for segmentation of an input image
5. Develop an algorithm for recognition of an object from input image
6. Develop an algorithm for motion estimation from given video sequence.
7. Design an algorithm for SVM classifier
8. Design an algorithm for adaboost classifier
9. Line detection using Hough transform
10. To design and develop optical flow algorithm for motion estimation

List of Project areas:

Select any one project from the list below and execute it.

1. Develop an application for vision-based security system during day/night time. The system should trigger an audio- visual alarm upon unauthorized entry.
2. Develop motion estimation/ tracking system to recognize object of interest related to one of the following applications. (Automobile tracking/ face tracking/ human tracking)
3. Develop motion estimation/ tracking system to recognize object of interest related to one of the following applications. (Space vehicle tracking/ solar energy tracking/ crowd pattern tracking)

Text Books:

1.Richard Szeliski; Computer Vision: Algorithms and Applications; Springer.

2. Forsyth, Ponce; Computer Vision-A Modern Approach; Low Price Edition, Pearson Education.

3. Bernd Jahne and Host HauBecker; Computer Vision and applications-A Guide for Students and Practitioners; Elsevier.

Reference Books:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle; Image Processing, Analysis, and Machine Vision; Thomson Learning

2. Robert Haralick and Linda Shapiro; Computer and Robot Vision; Vol I, II, Addison Wesley, 1993.

3. Dana H Ballard and Christopher M. Brown; Computer Vision; Prentice Hall

Course Outcomes:

The student will be able to –

1. Explain camera geometry fundamentals and image formation.
2. Apply pre-processing algorithms to acquired images
3. Develop feature descriptor for object detection purpose.
4. Make use of Computer Vision algorithms to solve real-world problems

FF No: 654

Course Code: EL3007 **Course Name: Digital Integrated Circuit Design**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours/ Week

Section 1:

Introduction to MOSFET, I-V, CLM, Body bias and sub-micron effects

CMOS Inverter - DC Analysis, VTC, Propagation Delay, Components of Power, Transistor Sizing, Inverter Layout; Impact of Technology ScalingCombinational Circuits - static CMOS, Ratioed Logic, Pass Transistor, Transmission Gate Logic, DCVSL, Introduction to Dynamic Logic – DOMINO and NORA, Cascading Dynamic Logic Gates, Sequential Circuits - Sequential Logic, Bi-stability, Latches vs Registers, MUX based Latch, Setup/Hold Timing, clocked MOS logic - C^2MOS, TSPC, Issues of Clock Overlapping, Pipelining.

Section 2:

Arithmetic Structures - Adders, Multipliers, Shifters Semiconductor Memories - MOS NOR and NAND ROM, EEPROM, 6-T SRAM Cell, DRAM Cell, Sense AmplifierHardware Description Language - Introduction to HDL, Hardware Concurrency, Notion of Delta Delay, Combinational Logic Design, VHDL for Sequential Circuit, Introduction to Verilog, Sample Coding in Verilog

Fabrication and Layout - Basic CMOS Fabrication Flow, N well, Twin tub, Design of process flow, Stick diagram, Standard Cell, Design rules, Layout of Combinational/Sequential Circuits

List of Practicals:

All laboratory exercises must be completed; these are intended to prepare the students for the term project. In doing these exercises, each student works individually first and then in a group. It is strongly recommended that each student must use his/her own machine, install the free VLSI TCAD tools which will be discussed in class or laboratory session. Typical assignments as follows:

1. Simulation of I-V characteristics of MOSFET to see the effect of CLM and body bias on the performance of the device
2. Design of symmetrical VTC CMOS inverter, Pre-layout simulation, Parasitic extraction, Post layout simulation.
3. Simulation of static and dynamic logic gates
4. Simulation of latch and flip-flop
5. Simulation of arithmetic structures – adders, shifters
6. Simulation of combinational and sequential circuits in VHDL/Verilog
7. Layout of CMOS inverter
8. Layout of combinational circuit
9. Layout of sequential circuit

10. Post layout (back annotation) simulation of combinational and/or sequential circuit

List of Projects:

The most important assignment is the Term Project, about which more detailed instructions will be issued in class. In doing this assignment, students will work in group(s). They should begin finding their partner(s) early in the term. The term project requirements must be completed in accordance with the schedule given in the instructions. Students must make a presentation of their part of the project to the rest of the class. They must demonstrate/present their work in the term project even if it does not fully function. Typical projects as follows:

1. Multi Precision Arithmetic Adders
2. Efficient Floating-Point Multiplier

Text Books:

1. *Rabaey Jan, Anantha Chandrakasan, and Bora Nikolic; Digital Integrated Circuits: A Design Perspective; Prentice Hall*
2. *Jayram Bhasker; VHDL Primer*

Reference Books:

1. *Sung-Mo Kang and Yusuf Leblebici; CMOS Digital Integrated Circuits*
2. *N. Weste and K.Eshraghian; Principles of CMOS VLSI Design*
3. *Zainalabedin Navabi; VHDL*
4. *Charles H. Roth; Fundamentals of Logic Design*

Course Outcomes:

The students will be able to

1. Calculate the output voltage of pass transistor
2. Identify combinational function implemented in CMOS logic
3. Differentiate between latch and flip-flop
4. Implement logic function in MOS ROM
5. Draw logic gate circuit from VHDL code
6. Draw stick diagram from Euler's path

FF No: 654

Course Code: EL3009 **Course Name: RF Circuit Design**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:
High Frequency behavior of components, HF device models, Transmission Line Analysis, Filter Design, Use of Smith Chart

Section 2:
Impedance transformation, Impedance matching, Y and S parameters, RF amplifier design, RF Transformer.

List of Practicals:
1. To study the behavior of R, L, C components at high frequency. Plot the frequency response and comment.
2. To determine the network parameters and small signal response of a given RF circuit.
3. To study the behavior of conductors at high frequency.
4. To design an impedance matching circuit
5. To simulate and test a low pass / high pass RF filter for given specifications.
5. To simulate and test a band pass / band stop RF filter for given specifications.
6. To simulate and test a RF mixer for given specifications.
7. To simulate and test a RF amplifier for given specifications.

List of Projects:
1. Design of RF Filter for given specifications
2. Design of Impedance matching circuits under given conditions
3. To develop RF Amplifier for given specifications.

Text Books:
1. Reinhold Ludwig, Pavel Bretchko; RF Circuit Design: Theory and Applications; Pearson.
2. Chris Bowick; RF Circuit Design; Newnes, Butterworth-Heinemann

Reference Books:
1. Fred Lefrak, How RF Transformers Work and How They are Measured, an-20-001 rev: b m150261 04/15/15) file: an20001.w61. This document and its contents are the property of mini-circuits
2. Jens Vidkjær, RF-CIRCUITS, Class Notes, 31415 RF-Communication Circuits

Course Outcomes:
The student will be able to –

1. Understand high frequency behavior of components

2. Demonstrate transmission line analysis.
3. Design RF filter.
4. Develop impedance matching circuits.
5. Design RF amplifier.
6. Explain RF transformer.

FF No: 654

Course Code: EL3027 **Course Name: Object Oriented Programming Systems**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 hrs / week

Section 1:

Introduction to Object Oriented Programming, Basic Concepts of Object-Oriented Programming – Classes, objects, data abstraction and encapsulation, inheritance, polymorphism, dynamic binding and message passing, Benefits of OOP, Applications of OOP.Java Fundamentals:Features of Java, Comparison of Java with other programming languages, Java Environnent, Simple Java Program, Java Tokens, Java Statements, Constants, variables, data types. Control statements- Decision making & branching, Decision making & looping. Classes, Methods & Objects in Java,Constructors, Destructors.

Section 2:

Inheritance:Types of Inheritance: Single, Multilevel, Hierarchical, Method Overloading and Method Overriding, Interface and Package, Multithreading, Life Cycle of Thread, Priority in Multithreading, Concept of Exception handling: Introduction, Types of errors, Exception handling syntax, Multiple catch statements.

List of Practicals:

1. Write some simple programs in Java such as
   a) Find first N even numbers and its sum.
   b) Find first 10 prime numbers
2. Write a C++ program to define a class to represent a bank account.
3. Write a program in C++ to implement a Calculator with simple arithmetic operations
4. WAP to implement following constructors.
   a) Default constructor
   b) Parameterized constructor
5. Write a C++ program based on concept of Inheritance.
6. Write a C++ program which use try and catch for exception handling.
7. Create a class named 'Rectangle' with two data members 'length' and 'breadth' and two methods to print the area and perimeter of the rectangle respectively. Its constructor having parameters for length and breadth is used to initialize length and breadth of the rectangle. Let class 'Square' inherit the 'Rectangle' class with its constructor having a parameter for its side (suppose s) calling the constructor of its parent class as 'super(s,s)'. Print the area and perimeter of a rectangle and a square.
8. Create a class to print the area of a square and a rectangle. The class has two methods with the same name but different number of parameters. The method for printing area of rectangle has two parameters which are length and breadth respectively while the other method for printing area of square has one parameter which is side of square.
9. Write a program to create multiple threads and demonstrate how two threads communicate with each other.

10. Write a c++ program which use try and catch for exception handling.

Project areas:

1. Design an application such as calculator, notepad, using OOP concepts.

Text Books:

1. Herbert Schildt; Java: The complete reference; 7th Edition; Tata McGraw Hill.

2. Yashwant Kanitkar; Let Us Java; 2nd Edition; BPB Publications.

Reference Books:

1.T. Budd; Understanding OOP with Java; Pearson Education.

2. E Balagurusamy; Programming with Java A Primer;3rd. Edition; Tata McGraw Hill.

Course Outcomes:

The student will be able to –

1. Identify potential benefits of object-oriented programming.
2. Code a program using C++ constructs.
3. Apply the concepts of classes, methods to write programs C++.
4. Develop programming application using inheritance, exception handling.

FF No: 654

Course Code: EL3010 **Course Name: Wireless Technologies**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 hours / week

Section 1:

Modern Wireless Communication Technologies: 2G, 2.5G, 3G, 4G, LTE, 5G, Cellular Technology ; Multiple Access Technologies for Wireless Communication: TDMA, FDMA, CDMA, CSMA, SDMA

Section 2:

Wireless Systems and Standards: GSM, DECT, PACS; Wireless Application Protocol, IEEE 802.x based wireless Technologies: Bluetooth, Wireless LANs; Planning and designing of Wireless Systems

List of Practicals

1. Installation of ns-2
2. Simulation of wired networks
3. Simulation of multi-node network.
4. Performance evaluation of 802.11 protocol
5. Performance evaluation of 802.15.4(Channel access protocols)
6. Comparative analysis of 802.11 and 802.15.4 protocols
7. Detection of dead zone free 802.11x based system

List of Projects:

1. Development of Apps for Cellular phone
2. Design of Cellular Networks
3. Performance improvement of Channel access protocols
4. Communication system using GSM
6. Design of Appliance control using Bluetooth
7. Design of Access control using Bluetooth
8. Planning and design of Wireless Systems

Text Books:

1. T.S. Rappaport; Wireless Communications; 2nd Edition; Pearson.

2. Wireless Network Evolution 2G to 3G; 3rd edition; Pearson.

Reference Books:

1. Dr. Sunil Kumar.S. manvi; Wireless and Mobile Networks; 2nd edition; Wiley.

Course Outcomes:

The student will be able to –

1. Design Cellular Networks
2. Analyze the Wireless Channel Access Protocols
3. Compare the 802.11x and 802.15.x wireless technologies
4. Plan and design wireless systems.

FF No: 654

Course Code: EL3011 **Course Name: Artificial Intelligence**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 hrs / week

Section 1:

Introduction to Artificial Intelligence :- AI task domain, problem representation in AI, Problem characteristics. Game playing using AI.

Searching Techniques: - A.I. search process, non-heuristic and heuristic search techniques, constrain satisfaction and their applications.

Knowledge Representation: - Hierarchy of knowledge, types of knowledge, knowledge representation, methods for knowledge representation, predicate logic, Problems on predicate logic.

Section 2:

Planning :- Components of planning system, goal stack planning technique. Nonlinear Planning using Constraint Posting.

AI Tools:- Expert System Shells, Explanation, and Knowledge Acquisition. Human expert behaviors, Expert system components, structure of expert system, the production system, Expert system development for application.

Natural language processing: - Introduction, Syntactic Processing, Semantic Analysis, . Architectures and functions in ANN, various learning rules. Building an ANN.

List of Practicals:

1. Develop a medical system using expert system.
2. Develop crypto-arithmetic puzzles.
3. Develop a system for Robotics planning.
4. Develop a knowledge representation system.
5. Implement the Breadth first search.
6. Implement the Depth first search.
7. Implement the Best first search.
8. Implement the A* first search.
9. Implement the AO* breadth first search.
10. Implement the search.

List of Projects:

1. Develop a project for the expert system.
2. Design a robotic arm using A I Technique.

Text Books:

1. Elain Rich and Kevin Knight; Artificial Intelligence; Third edition; Tata McGraw- Hill

Publishing Company Limited.

2. Kishan Mehrotra, Chilukurik Mohan, Sanjay Rankia; Elements of Artificial Neural Networks; Second edition; Penram International Publishing (India) Pvt. Ltd.

Reference Books:

1. Kishan Mehrotra, Sanjay Rawika, K. Mohan; Artificial Neural Network; Second Edition; Pearson Publication.
2. Rajendra Akerkar; Introduction to Artificial Intelligence; Second Edition; Prentice Hall Publication.
3. Relevant IEEE papers.

Course Outcomes:

The student will be able to –

1. Identify real world problems of AI domain.
2. Write algorithms for searching techniques.
3. Develop an AI tool for practical application.
4. Develop an expert system

FF No: 654

Course Code: EL3012 **Course Name: Electronics Product Design**

Credits: 4 **Teaching Scheme: 4 Hours / Week**
Lab 2 Hours / Week

Section 1:
Product specifications, feasibility analysis, Hardware Design, Software Design

Section 2:
System Reliability, Aesthetics and Ergonomics of product, EMI & EMC Consideration in Product design.

List of Practicals:
1. Define the specifications for the given product.
2. Carryout market feasibility analysis of giving product.
3. Draw and explain ERD of the given product.
4. Draw and explain the CFD / DFD of the given product.
5. Build and test the circuit of the given product.
6. Design the enclosure for the product. Ensure aesthetic and ergonomic design.
7. Draw and explain the component layout plan of the product.
8. Draw the power supply –grounding plan of the product.
9. Develop marketing plan of the product
10. Carryout profit loss analysis of developed product.

List of Projects:
Design and model a Prototype for
1. Coffee making machine
2. Cruise control
3. Ticket dispensing system
4. Power Supply
5. Attendance Monitoring System etc.

Text Books:
1. *Kevin Otto, Kristin Wood; Product Design – Techniques in Reverse Engineering and New Product Design; Pearson.*
2. *Roger Pressman; Software Engineering – A Practitioner's Approach; McGraw Hill.*

Reference Books:
1. *Karl Ulrich, Steven Eppinger; Product Design and Development; McGraw Hill.*

Course Outcomes:

The student will be able to –

1. Understand hardware design methodology.
2. Understand software design techniques.
3. Model a prototype of product.
4. Develop reliable products ergonomically and aesthetically under Emi / EMC constraints.

FF No: 654

Course Code: EL3008 **Course Name: Database Management Systems**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Introductory concepts of DBMS: Introduction, purpose and applications of DBMS, Database System architecture- levels

Entity-Relationship model: Entity, Relationship and Attribute types, Design issues, E-R diagrams, extended E-R features

Relational Model and Design Theory: Structure of relational databases, Relational algebra, and Mapping of ER diagram to Relational Schemas, Codd's Twelve Rules, Normalization

Section 2:

SQL Concepts: Basics of SQL, DDL,DML, Primary key, foreign key, functions, Built-in functions, sub-queries, , transaction control commands

Storage and Query Processing: Storage and file structures, indexed files, single level and multi level indices, B+ trees, Query processing

Transaction Management and emerging trends: Transaction concepts, state diagram, deadlock, NoSQL, RDBMS vs NoSQL, NewSQL, Distributed database, Parallel database, Data warehouse and data mining.

List of practicals:

1. Implementation of DDL commands of SQL: Create function, Alter function, Drop function, Insert function
2. Implementation of DML commands: Insert function, Update function, Delete function
3. Implementation of functions in SQL: Number function , Aggregate function , Character function, Convergence function, Date function
4. Implementation of operators in SQL: Arithmetic operator, Logical operator, Set operator (IN and NOT IN), Comparison operator
5. Study and implementation of different types of JOINS like Inner join, Outer join, Nature join
6. Study and implementation of different types clause: GROUP BY clause, HAVING clause, ORDER BY clause, Indexing clause
7. Study and implementation of sub queries and views
8. Study and implementation of SQL queries (creating database/table and managing users)
9. Study and implementation of PL/SQL
10. Study of standard database models

List of project areas:

1. Student information system
2. Library management

3. Courier service

4. Hospital management
5. Employee database management
6. MSRTC database management
7. Inventory database management
8. Exam database management

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan; Database System Concepts; 6th Edition, McGraw-Hill Education
2. Ramez Elmasri, Shamkant B. Navathe; Fundamentals of Database Systems; 6th Edition; Pearson

Reference Books:

1. Thomas M. Connolly, Carolyn E. Begg; Database Systems: A Practical Approach to Design, Implementation, and Management; 6th Edition; Pearson
2. Raghu Ramakrishnan, Johannes Gehrke; Database Management Systems; 3rd Edition; McGraw Hill Education
3. Kristina Chodorow, Mongo; DB The definitive guide; O'Reilly Publications, ISBN: 978-93-5110-269-4, 2nd Edition.
4. Dr. P. S. Deshpande; SQL and PL/SQL for Oracle 10g Black Book; DreamTech.

Course Outcomes:

The student will be able to –

1. Differentiate database systems from file systems by enumerating the features provided by database systems and describe each in both function and benefit.
2. Transform an information model into a relational database schema and to use a data definition language and/or utilities to implement the schema using a DBMS
3. Design ER diagrams for new databases and read (understand) ER diagrams.
4. Read/write - Extended Relational Algebra, Simple SQL, Embedded SQL, SQL Queries Using Embedding Operators, SQL Queries With GROUP BY, HAVING

FF No: 654

Course Code: EL3014 **Course Name: Data Communication and Networking**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:
Data Communication; TCP/IP Protocol Suite; Local Area Networks

Section 2:
Wide Area Networks; Personal Networks; Network Management

List of Projects:
1. Measurement and analysis of Signal strength to Identify WLAN dead zones in a campus and optimize the WLAN infrastructure:
2. Implementation of Remote login
3. Performance analysis of wireless LANs using simulation tools like ns-2.
4. Create wireless personal networks using IEEE 802.15.1 compliant devices.
5. Create wireless personal networks using IEEE 802.15.4 compliant devices.

Text Books:
1. *Behrouz A. Forozan; Data Communications and Networking; 4th edition; TMH.*
2. *A.S. Tenenbaum; Computer Networks; Pearson Education.*

Reference Books:
1. *William Stallings; Data and Computer Communication*
2. *James Kurose and Keith Ross; Computer Networking; Low Price Edition.*

Course Outcomes:
The student will be able to –
1. Describe how the Data Communication happens across the network layers.
2. Explain functions of all the layers of the TCP/IP Protocol suite.
3. Develop a plan for campus wide networking with total coverage.
4. Analyze different wide area networks
5. Create different personal networks
6. Interpret different network management functions.

FF No. : 654

Course Code: EL3002 **Course Name: Robotics**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Introduction to robotics, Safety and economics of robots, Specifications, Robot Anatomy, Degrees of freedom, Robot Coordinate systems, Joints, workspace, Singularity, Representation of position and orientation by Homogeneous Transformation, Forward and inverse kinematics of robot, D-H convention, Jacobeans and dynamics of robot. End effectors-Grippers and tools. Gripper force analysis.

Section2:

Path planning, Trajectory Planning, Joint space and Cartesian space trajectories. Linear function with parabolic blends, Higher order polynomials, Robot sensing and vision system. Machine vision, Robot programming: Lead through, offline; Hardware and software of robot controller, Robot operating system.

List of Practicals:

1. Understanding GUI of Robo Analyzer
2. Understanding coordinate frames and transformations
3. Virtual Models of Industrial Robots
4. Virtual Models of Industrial Robots with teach pendant and Blue Tooth
5. Forward kinematics of robots
6. Creating robot joint trajectories
7. Control a virtual robot using a joystick
8. Pre-processing of image- implementation of histogram, filters, Thresholding.
9. Morphological processing
10. Image segmentation

List of Projects:

1. Designing of gripper for cylindrical objects
2. Design of pick and place robot for a given pay load capacity
3. Integration of machine vision with robot for industrial application.
4. Rubik Cube solving by Lego.
5. Writing a welding profile using virtual robot.
6. Performing “YOGA” by Humanoid robot.

Text Books:

1. Saeed Niku; Introduction to Robotics analysis, Systems, Applications; Prentice-Hall.

2. Mikell P. Groover; Industrial Robotics Technology Programming and Applications; McGraw Hill.

3. S. K. Saha; Introduction to Robotics; Tata Mcgraw Hill.

Reference Books:

1. Klafter R.D, Chmielewski T.A. and Noggins; Robot Engineering: An Integrated Approach; Prentice Hall.

2. Fu K.S., Gonzalez R.C., & Lee, C.S.G; Robotics control, sensing, vision and intelligence; McGraw Hill.

3. Craig J. J; Introduction to Robotics mechanics and control; Addison-Wesley, London.

Course Outcomes:

The student will be able to –

1. Evaluate forward and inverse kinematics of robot.
2. Describe various types of robot end effectors.
3. Compute trajectories in joint and Cartesian space.
4. Familiar with robot sensing and vision system for industrial applications.

FF No: 654

Course Code: EL3016 **Course Name: Digital System Design**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Interconnects - signal interconnect models: lumped, distributed, transmission-line, delay, crosstalk, power, clock distribution; Decomposition of a system into data and control paths - Mealy/Moore state machines, RTL descriptions, Implementation; Decomposition of the control path - Additive decomposition, Multiplicative decomposition, control synchronization, deadlocks

Section 2:

Parallelism and system decomposition - pipelines: control-flow and data-flow; Communication between sub-systems; Queuing models of systems, performance estimation; Resource contention; Memory sub-systems - Memory architecture, Shared memory, Data hazards, Consistency, Mutual Exclusion; Test and verification.

List of Practicals:

All laboratory exercises must be completed; these are intended to prepare the students for the term project. In doing these exercises, each student works individually first and then in a group. It is strongly recommended that each student must use his/her own machine, install the free VLSI TCAD tools which will be discussed in class or laboratory session. Typical assignments as follows:

1. Design and simulation of an inverter chain for optimized performance.
2. Simulation of Differential and Single Ended Signal

For a given design(s) discussed in class -

Sketch proto-RTL for the given Design, Code the design using VHDL/Verilog, write a testbench to test the code, verify that the design works as expected, Synthesize the design.

Typical circuits/systems to be implemented are as follows:

1. Sequence detector Moore/Mealy Machine
2. Priority Encoder
3. Booth's Multiplier
4. Barrel Shifter
5. Queues
6. Pipelines
7. Memory – CAM, Dual port, Shared, LIFO, FIFO, etc.
8. Logic decoder

List of Projects:

The most important assignment is the Term Project, about which more detailed instructions will be issued in class. In doing this assignment, students will work in group(s). They should begin finding their partner(s) early in the term. The term project requirements must be completed in accordance with the schedule given in the instructions. Students must make a presentation of their part of the project to the rest of the class. They must demonstrate/present their work in the term project even if it does not fully function. Typical projects as follows:

1. Design a 16-entry queue with data width as 32 bits.
2. Design a system with one 32-bit data input and four 32-bit data outputs. The system is expected to broadcast the input 32-bit data to all outputs.

Text / Reference Books:

1. *J. M. Rabaey; Digital Integrated Circuits, A Design Perspective; Prentice Hall India.*
2. *W. J. Dally, J. W. Poulton; Digital Systems Engineering; Cambridge University Press, 1998.*
3. *S. H. Hall, G. W. Hall, J. A. McCall; High-Speed Digital System Design; John Wiley and Sons, 2000.*
4. *H. G. Cragon; Memory Systems and Pipelined Processors; Narosa, 1996.*

Course Outcomes:

The students will be able to

1. identify the type of state machine
2. calculate delay of transmission line
3. write RTL description for a circuit/system
4. estimate performance of queue
5. analyze data hazards

FF No: 654

Course Code: EL3017 **Course Name: Embedded System Design**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Types, Design metrics and optimization goals, Hardware architecture ,Processor memory IO devices, ADC,DMA controller, Debug port, Interrupt Service Mechanism ,Context switching, Device Drivers, Software architecture, development tools. ARM architecture,nomenclature, operating modes, Exception Handling ,ARM and thumb instruction set and assembly language programs, LPC 2148 feature, PLL, watch dog timer, Timer/ counter ,Serial Communication, ADC, DAC

Section 2:

Communication protocols: CAN, Bluetooth, MODBUS, USB. OS: Architecture, objectives and functions, ,Types of OS ,RTOS: Characteristics, Critical section of code, race condition , Shared resource, multitasking, Task scheduling, Context switching , Intertask Communication, Mutual Exclusion, Semaphores , preemptive and non-preemptive kernel, Priority Inversion, Deadlock, memory management, ISR, Timer. µCOS IIOS: Kernel structure, services

List of Practicals:

1. Interfacing and programming LED with LPC 2148 using on chip timer
2. LCD interfacing
3. Keypad interfacing
4. Serial communication programming
5. ADC programming
6. DAC programming
7. PLL programming
8. external interrupt programming
9. Multitasking using RTOS
10. Resource sharing with semaphore

List of projects

1. Digital counter using proximity sensor
2. Wireless electronic notice board
3. Lab attendance monitoring system
4. System for communication availability/ non-availability of authority to visitor
5. Water quality measurement system

Text Books:

1. *Raj Kamal; Embedded Systems; TMH*

2. *Andrew Sloss; ARM system Developers Guide; Elsevier publication*

3. *Santanu Chatopadhyay; Embedded system design; Second edition,*

Reference Books:

1. *Dr. K.V.K.K. Prasad; Embedded / Real Time Systems; Dreamtech Publication*
2. *Iyer, Gupta; Embedded Real systems programming; Tata Mcgraw Hill Publication*
3. *Steve Heath; Embedded System Design; Neuwans.*
4. *Frank Vahid; Embedded System Design.*

Course Outcomes:

The student will be able to –

1. Explain embedded system architecture.
2. Elaborate architecture of ARM
3. Experiment with ARM7
4. Compare various communication protocols used in embedded application
5. Relate RTOS kernel functions with general purpose OS functions

FF No: 654

Course Code: EL3018 **Course Name: Digital Signal Processing**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:
Z-Transform, Properties and Applications, analysis of LTI systems in Z domain, Discrete Fourier Transform (DFT), Properties of DFT, Overlap Add and Overlap Save Methods, Fast Fourier Transform, FFT Algorithms: Decimation in Time, Decimation in Frequency

Section 2:
FIR filter Design and Applications, FIR Filter Structures, IIR filter Design and Applications, IIR Filter Structures, Multirate Signal Processing- Decimation and Interpolation

List of Practicals:

1. Verification of sampling theorem. Plot Magnitude and Phase Response of Discrete Time Signal
2. Verification of Properties of DFT
3. Implement Decimation in Time FFT Algorithm.
4. Design of FIR Filter
5. Design of IIR Filter
6. Study the effects of up sampling and down sampling in time and frequency domain
7. Verification of properties of Z Transform
8. Check stability of System using pole zero plot
9. Implement Convolution and correlation of two signals
10. Decimation and Interpolation of signal

List of Project areas:

1. A signal (ECG/Speech) is contaminated with power line interference noise. Design a Notch filter to remove 50Hz Notch frequency from noisy signal. Observe frequency response of designed filter and analyze the filtered signal.
2. Design of Multirate system for the given sampling rate and specifications of filter required for sound recording system to compose and mix high and low frequency signals generated from different instruments in a Recording studio.
3. A signal (ECG/Speech) is contaminated with noise. Design FIR and IIR filters for given specifications to remove noise from signal. Compare results of FIR and IIR filters. Implement using DSP Processor.
4. Project based on Multirate signal processing
5. Project based on Filter Design for noise removal
6. Project based on Transform properties

Text Books:

1. Sanjit Mitra; Digital Signal Processing; TMH, 3rd edition

2. John Proakis, Dimitri Manolakis; Digital Signal Processing – Principles, Algorithms and Applications; PHI

Reference Books:

1. Ramesh Babu; Digital Signal Processing; Scitech publications 2001.

2. *Shalivahanan, Vallavraj, Gnanapriya C; Digital Signal Processing; TMH 2001.*

Course Outcomes:

The student will be able to –

1. Demonstrate use of Z Transform in analyzing LTI systems.
2. Determine DFT coefficients using FFT algorithms to minimize hardware complexity. 3. Analyze FIR filters for the given Specifications.
4. Analyze IIR filters for the given Specifications.
5. Design practical sampling rate converters.

FF No: 654

Course Code: EL3019 **Course Name-Machine Learning**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:
Data preprocessing; Regression – simple linear, multiple linear, polynomial, decision tree, random forest, evaluating regression model performance; Classification – logistic regression, K-nearest neighbors, support vector machine, kernel SVM, naïve bays; Clustering – k-means, hierarchical

Section2:
Reinforcement learning; Natural language processing; Artificial neural network; Dimensionality reduction – Principal Component Analysis, Linear Discriminant Analysis; Model Selection

List of Practicals:
1. Build linear regression model.
2. Build a classifier model using logistic regression / K-NN / SVM
3. Studyofrandomforestregressionmodel
4.Developdecisiontreetosolvetheproblem
5. DevelopnaiveBayesclassifiermodel
6.Studyofhierarchicalclusteringapproach
7.Develop K-means clustering technique
8. Design and develop a model for natural language processing
9.Construct model using Artificial neural network
10. Build model using Principal Component Analysis

List of Project areas:
1. Plant disease classification
2. Prediction for commercial success
3. Restaurant recommendation system
4. Improve healthcare
5. Natural language processing

Text Books:-

1. *Tom Mitchell; Machine Learning; TMH, 2018*
2. *Stefen Marsland; Machine Learning; CRC Press, 2011*
3. *Peter Flach; Machine Learning: The Art and Science of Algorithms that make sense of Data; Cambridge University Press, 2012*
4. *T. Hastie, R. Tibshirani, J. Friedman; Introduction to Statistical Machine Learning with applications in R Springer; 2nd edition.*

Reference Books:

1. *Ethem Alpaydin; Introduction to Machine Learning; PHI 2nd edition, 2013*
2. *Lorenza Saitta, Attilio Giordana; Phase Transitions in ML; Cambridge Press.*
3. *C. M. Bishop; Pattern Recognition and Machine Learning; Springer 1st Edition-2013*
4. *T. Hastie, R. Tibshirani, J. Friedman;the Elements of Statistical Learning; 2nd 2008.*

Course Outcomes:

The student will be able to –

1. Select regression model to solve business problems
2. Choose a classifier model for building applications
3. Apply clustering techniques to solve real world problems
4. Design reinforcement learning model
5. Develop deep learning model using artificial neural network
6. Design and implement various machine learning algorithms in a range of real-world applications

FF No: 654

Course Code: EL3020 **Course Name: AdHoc Networks**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1: Ad Hoc Wireless Networks
Cellular and Ad Hoc Wireless Networks, MAC Protocols, Routing Protocols Applications, Issues,

Section 2: Implementation and performance of Ad-hoc Network
Quality of service, Performance parameters, route discovery time, end to end delay, throughput, packet loss, repair time, power life issues.

List of Practicals:

1. Study of different simulators available.
2. Installation of Linux and NS-2 network simulator.
3. Simulation of 2 node wired topology.
4. Simulation of 2 node wireless topology.
5. To generate trace file and study its contents
6. To create output file.
7. To create X-graph
8. To study re-routing phenomenon
9. To generate wired- wireless hybrid topology.
10. To create classes in NS-2

List of Projects:
1. To analyze the performance of a wireless Ad-Hoc Network.

Text Books:

1. *C.K. Toh; Ad Hoc Mobile Wireless Networks Protocols and Systems; Pearson.*
2. *C. Siva Ram Murthy, B.S. Manoj; Ad Hoc Wireless Networks Architecture and Protocols; Pearson Education.*
3. *Sudip Misra, Isac Woungang, Subhas Chandra Misra; Guide to Wireless Adhoc Network; Springer.*

Reference Books:

1. *Jagannathan Sarangpani; Wireless Ad Hoc and Sensor networks: Protocols, performance and Control; CRC Press.*
2. *Carlos De Morais Cordeiro, Dharma Prakash Agrawal; Ad Hoc and Sensor Networks: Theory and applications.*
3. *Relevant IEEE Papers*.

Course Outcomes:

The student will be able to –

1. Understand MAC protocols.
2. Study performance issues in Ad-hoc networks.
3. Design wireless Ad-hoc Networks.
4. Write a paper on current research going in Infrastructure less wireless communication.

FF No: 654

Course Code: EL3021 **Course Name: Microwave Engineering**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Microwave transmission lines; Overview of Microwave communication: Microwave communication system , Advantages and applications of Microwaves. Rectangular Waveguides – TE/TM mode analysis, Waveguide components and applications. Ferrite Components, Scattering matrix of microwave devices.
Microwave tubes: O type and M type classifications.

Section 2 :

Microwavesolid state devices: Gunn Diode , Tunnel Diode, PIN diode, Varactor diode, MASER. IMPATT and TRAPATT. Real world applications of microwave engineering in Radars, Communication, Industrial applications
Microwave Measurement – Bolometer Method. Measurement of Attenuation, Frequency, VSWR, Q of a Cavity Resonator. Impedance Measurements

List of Practicals:

1. Study of different Microwave components.
2. Derive the expressions for Waveguide parameters.
3. Mathematical analysis of Reflex klystron.
4. Study the characteristics of Reflex klystron.
5. Study the domain formation in Gunn diode.
6. Study V-I characteristics of Gunn diode.
7. Calculate Scattering matrix for Magic Tee.
8. Study port parameters of Magic Tee.
9. Study construction details of Circulator.
10. Calculate port parameters of Circulator. .

List of Projects:

1. Plot radiation pattern of different antennas.

Text Books:

1. Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3rd Edition
2. Micro Wave and Radar Engineering – M. Kulkarni, UmeshPublications

Reference Books:

1.R. Chatterjee; Elements of Microwave Engineering; Affiliated East-West Press Pvt. Ltd; New Delhi, 1988.

2. *Peter A. Rizzi; Microwave Engineering Passive Circuits; PHI, 1999.*

Course Outcomes:

The student will be able to-

1. Analyze microwave channel mathematically.
2. Analyze microwave components mathematically.
3. Interpret microwave sources mathematically.
4. Describe microwave solid state devices.
5. Describe real time applications of microwave engineering.
6. Explain different microwave measurements.

FF No: 654

Course Code: EL3022 **Course Name: Internet of Things**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1: IoT Overview

Introduction, IoT Architecture: a. Node Structure B. Networking, Communication Technologies, **Industrial Network Evolution** IT-OT Manufacturing Convergence Industrial IoT TCP/IP & OSI Networking Models Fundamentals of LAN & WAN, Fundamentals of IP Addressing, **Switching-** Ethernet LAN Switching Ethernet Switch Configuration, Practical Example discussion, **Routing-** Routing Between Vlans Routing Protocols-RIP, EIGRP,OSPF, Case Study.

Section 2:Case studies and Implementation

Smartness ,IoT Fabricator, Hands-on in IoT: Projects based on some Hardware (Raspberry pi, Arduino, Intel, IITH Mote, Smartphones), Software (Contiki, TinyOS, Android) or Implementation of above concept using simulation-based software like packet tracer.

List of Practicals:

1. Install Packet Tracer/ study of Arduino/ Study of Raspberry Pi
2. Building the LAN Network
3. Building Switch & Router Network
4. Develop a network and work with application layer : DHCP, DNS and HTTP.
5. Configure a CISCO switch/ Arduino based project
6. Configure speed, Duplex and VLAN settings on CISCO switch interfaces/ Arduino based project
7. Configure VTP
8. Implement Spanning Tree protocol.
9. Implement routing algorithm.
10. Troubleshoot Ethernet Network

List of Project:

1. Smart Irrigation System using IoT

Text Books:

1. *Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann; Interconnecting Smart Objects with IP: The Next Internet.*
2. *Adrian McEwen, Hakim Cassimally; Designing the Internet of Things.*
3. *Dr. Ovidiu Vermesan, Dr. Peter Friess; Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems; River Publishers*
4. *Vijay Madisetti, Arshdeep Bahga; Internet of Things (A Hands-on-Approach); 1st Edition, VPT, 2014*

5. *Zach Shelby, Carsten Bormann; 6LoWPAN: The Wireless Embedded Internet; Wiley*

6. *Daniel Minoli John; Building the internet of things with ipv6 and mipv6, The Evolving World of M2M Communications; Wiley & Sons*

Reference Books:

1. *Francis da Costa; Rethinking the Internet of Things: A Scalable Approach to Connecting Everything; 1st Edition; Apress Publications, 2013*
2. *Cuno Pfister; Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-44939357-1*

Course Outcomes:

The student will be able to –

1. Understand the vision of IoT from a global context.
2. Use of Devices, Gateways and Data Management in IoT.
3. Building state of the art architecture in IoT.
4. Application of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.

FF No: 654

Course Code: EL 3023 **Course Name: Industrial Automation**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Automation overview, types of Automation, Hierarchical levels of automation, Plant wide control systems and Automation Strategy. PLC: Architecture, I/O module, Scan cycle, Set, Reset, Timer and counter instructions. Advanced PLC programming: Logical, math, Branching etc. Standalone and Distributed PLCs.

Section 2:

SCADA, HMI: Concepts, functionality and programming techniques. Introduction to DCS, Communication and networking protocols: Devise Net, Control Net, HART, Profibus PA, Field Bus H1, IEEE 1394, Introduction to EtherCAT, Condition monitoring, Intelligent control. Case Studies .

List of Practicals:

1. Ladder program realizing Boolean logic.
2. Sequencing operation using bit logic.
3. Performing delayed operation of lamp using PLC timers
4. Performing UP/DOWN counters with RESET instruction.
5. Program control- Jump and subroutine.
6. Sensor interfacing to PLC
7. PLC interfacing with SCADA and status read/command transfer operation.
8. Alarm annunciation using SCADA.
9. GUI development for industrial application.
10. RTU / MTU communications.

List of Projects:

1. Simulation of conveyor belt industrial application using PLC.
2. PLC controlled robotic arm.
3. Automatic car parking system.
4. PLC, SCADA and HMI for waste water treatment and distribution plant.
5. PLC, SCADA and HMI for Building automation systems
6. Wireless SCADA application for remote Industrial plant.

Text Books:

1. Frank D Petruzella; Programmable logic controller; McGraw-Hill Education.

2. Poppovik and Bhatkar; Distributed Computer Control for Industrial Automation; Dekkar Publication.

3. SCADA by Stuart a Boyer: ISA 1999

Reference Books:

1. Krishna Kant; Computer Based Process Control; Prentice Hall of India.

2. A. D. Rodić; Automation and Control- Theory and Practice; In Tech.

3. *Srinivas Medida; Pocket Guide on IndustrialAutomation- For Engineers and Technicians.*

Course Outcomes:

The student will be able to –

1. Develop PLC programs for industrial applications.
2. Apply advanced instruction of PLC to solve complex automation applications.
3. Understand the functionality of SCDA, HMI and DCS systems.
4. Describe and apply protocols needed for industrial communication and networking.

FF No: 654

Course Code: EL3024 **Course Name: VLSI Technology**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Introduction, MOSFET Fabrication for IC, Silicon Crystal Structure, Defects in Crystal, Crystal growth, Oxidation, Kinetics of Oxidation, Oxidation rate constants, Dopant Redistribution, Oxide Charges, Epitaxy, Molecular Beam Epitaxy, Diffusion, theory of Diffusion, Infinite Source, Actual Doping Profiles, typical diffusion systems, Ion Implantation Process, Annealing, Masking, Lithography.

Section 2:

Etching - Wet Chemical and Dry Etching, Plasma Etching, Etching of Si, SiO_2, SiN and other materials, Deposition, Plasma Deposition, Metallization, Issues in Aluminum Metal contacts, Isolation, LOCOS, Issues in LOCOS, Trench isolation, BJT Fabrication and Realization of Circuits, MOSFET – Metal gate vs Self-aligned, Poly-gate, Tailoring of Device Parameters, CMOS Technology, latch up in CMOS, BICMOS Technology.

List of Practicals:

All laboratory exercises must be completed; these are intended to prepare the students for the term project. In doing these exercises, each student works individually first and then in a group. It is strongly recommended that each student must use his/her own machine, install the free VLSI TCAD tools which will be discussed in class or laboratory session.

Typical Lab experiments as follows:

Design and simulate process flow for

1. NMOSFET
2. PMOSFET
3. Resistive NMOS Inverter
4. CMOS Inverter
5. RC Filter
6. LOCOS
7. STI
8. SOI MOSFET
9. P-N Junction
10. BJT

List of Projects

The most important assignment is the Term Project, about which more detailed instructions will be issued in class. In doing this assignment, students will work in group(s). They should begin finding their partner(s) early in the term. The term project requirements must be completed in accordance with the schedule given in the instructions. Students must make a presentation of their part of the project to the rest of the class. They must demonstrate/present their work in the term project even if it does not fully function. Typical projects as follows:

1. Design, Simulate and Optimize the performance of a FINFET
2. Design, Simulate and Optimize the performance of a FDSOI/PDSOI

Text Books:

1. *S. K. Gandhi ; VLSI Fabrication Principles*
2. *S. M. Sze; VLSI Technology*
3. *J. D. Plummer, M. Deal and P. D. Griffin; Silicon VLSI Technology*

Material is also referred from the relevant International Journals and Conference proceedings.

Course Outcomes:

The students will be able to

1. Locate the defect in Silicon crystal
2. Differentiate between deposition and ion implantation
3. Calculate thickness of oxide in oxidation process
4. Design process flow for the given structure
5. Identify the profile of etching
6. Draw the structure from process flow

FF No: 654

Course Code: EL4003 **Course Name: Engineering Ethics**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:
Introduction to Ethical Reasoning and Engineer Ethics, Professional Practice in Engineering, Ethics as Design - Doing Justice to Moral Problems, Central Professional Responsibilities of Engineers**.**

Section 2:
Computers, Software, and Digital Information, Rights and Responsibilities Regarding Intellectual Property, Workplace Rights and Responsibilities, Responsibility for the Environment

List of Projects:
1. Case Study: Based on Theory of GroupThink
2. Case Study: Halting a Dangerous Project
3. Case Study: Related to Innocent comments, Late Confessions etc.
4. Case study: Related to assessment schemes, teaching methodology, EDD, lab conduction

Text Books:
1. Ethics in Engineering practice and Research (2nd Edition) by Caroline Whitbeck Cambridge.
2. Ethics in Engineering MW Martin and R Schinzinger MC Graw Hill Engineering Ethics and Environment P a Vesilind and AS Gunn Cambridge.

Reference Books:
1.Engineering Ethics, Concepts and Cases; charles e. Harris, michael s. Pritchard, Michael J. Rabins, wadsworthCengage Learning

Course Outcomes:
The student will be able to –
1. Perform their professional responsibilities as Engineers.
2. Recognize through ethically significant problem situations that are common in Engineering
3. Think through ethically significant problem situations

4. Evaluate the existing ethical standards for ENGINEERING Practice.

FF No: 654

Course Code: EL4004 **Course Name: Renewable Energy**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1: Creating Energy

Conventional and Non-Conventional Energy like Wind Power, Solar Power, Geothermal energy, Tidal/Hydro Power, Biomass, Challenges, Production, Transmission and use of energy.

Section 2:Sustainable Energy

Technologies to generate Energy from Wind, Solar, Hydro, Biomass. Integration of Renewable energy in the electrical Power System, Energy Storage.

List of Practicals:

1. Collect the information about Energy Conservation Building Code.2007
2. Prepare a write up on role of Energy Manager and Energy Auditor.
3. Collect information from by market survey and prepare report on rating, luminous output, cost, list of manufacturers of various types of energy efficient luminaries (FTL, CFL, LED, Sodium Vapour, HPMV etc.)
4. Make a comparative study of energy efficient control gears and ballasts used in lighting system based on energy efficiency, cost, life, energy saving and saving in energy bill
5. Visit to any organization where energy conservation program is implemented (Hospitals, workshops, institutes, commercial building, residential building etc.
6. Using various energy audit instruments used for measurement of electrical, mechanical and thermal energy parameters, carryout energy audit and prepare a report as a case study for Residence, Small workshop, Public Library, Hospital etc.(Inclusive of Data Collection processes)
7. Visit a dealer in Electric Home Appliances to know and understand STAR Rating
8. Testing of solar cells for I-V characteristics
9. Design of Off Grid Solar System
10. Design of grid connected rooftop system

List of Project areas:

1. Case study of the biggest planned renewable energy projects in the world.
2. Testing of solar cell

Text Books:

1. *Solanki C. S; Solar Photovoltaics - Fundamentals, Technologies and Applications; 3rd edition; PHI.*
2. *S. Sukhatme, J Nayak;Solar Energy: Principles of Thermal Collection and Storage; 3rd edition; Mc Graw Hill.*

Reference Books:

1. *Michael Boxwell;The Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy: How to Design and Install Photovoltaic Solar Electric Systems 2017; internet linked.*
2. *Solanki;Renewable Energy Technologies: A Practical Guide for Beginners; PHI*

Course Outcomes:

The student will be able to –

1. Obtain the overview of the global energy scenario, understand need on non-conventional energy resources.
2. Global Challenges and their limited resources.
3. Calculate the potential attribution of different sources of renewable energy like wind, solar and biomass and how to integrate them in an energy system
4. Design a plan for a 100% sustainable energy system technique.

FF No: 654

Course Code: EL4006 **Course Name: CMOS Mixed Signal Design**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Two stage amplifiers, Cascode – Folded and Telescopic, DC and AC behavior, Current and Voltage references, Current mirrors, Bandgap references, Analog and discrete-time signal processing, sampling circuits, different types of sampling switches, Sample and Hold Architectures, Open loop & closed loop architectures, switched capacitor filter, Interconnects.

Section 2:

Basics of data converters, Analog to digital converters (ADC), Digital to analog converters (DAC), Successive approximation ADCs, Dual slope ADCs, High-speed ADCs - flash ADC, pipeline ADC and related architectures, High-resolution ADCs - delta-sigma converters, DACs – Resistor Ladder architectures, Current steering architectures, CMOS comparator, Analog Multiplier, Phase Locked Loops (PLL), Charge Pump PLL, Delay Locked Loops.

List of Practicals:

All laboratory exercises must be completed; these are intended to prepare the students for the term project. In doing these exercises, each student works individually first and then in a group. It is strongly recommended that each student must use his/her own machine, install the free VLSI TCAD tools which will be discussed in class or laboratory session. Typical assignments as follows:

1. Simulation of two-stage amplifier
2. Simulation of Sample and Hold circuit
3. Measuring the performance parameters of cascade amplifier
4. Measuring the performance parameters of folded cascode amplifier
5. Simulation of OTA
6. Simulation of PLL signal generators
7. Simulation of Switch Capacitor Filter
8. Simulation of Resistor Ladder DAC
9. Simulation of basic charge pump circuit
10. Simulation of an analog multiplier

List of Projects:

The most important assignment is the Term Project, about which more detailed instructions will be issued in class. In doing this assignment, students will work in group(s). They should

begin finding their partner(s) early in the term. The term project requirements must be

completed in accordance with the schedule given in the instructions. Students must make a presentation of their part of the project to the rest of the class. They must demonstrate/present their work in the term project even if it does not fully function. Typical projects as follows:

1. Design of high speed CMOS comparator
2. Design of higher order Sigma Delta modulator

Text Books:

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

Reference Books:

1. *Baker, Li, Boyce; CMOS: Circuit Design, layout and Simulation; PHI, 2000.*
2. *R. Gregorian and G. Temes; Analog MOS Integrated Circuit for signal processing; John Wiley & Sons.*

Material is also referred from the relevant International Journals and Conference proceedings.

Course Outcomes:

The students will be able to
1. Draw small signal model of an amplifier stage
2. Calculate current in current mirror circuit
3. Identify feedback loop in sample and hold circuit
4. Find quantization noise in data converter
5. Draw basic architecture of PLL
6. Differentiate various architectures of ADCs

FF No: 654

Course Code: EL4013 **Course Name: Advanced Power Electronics**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Three phase-controlled converters, Analysis for resistive and inductive load.
Effect of Source Impedance (Ls) on single phase converter operation, Single and Three Phase Dual Converter: Control Schemes and analysis.
Three phase transistorized voltage source inverter (VSI), Analysis of operational modes.
PWM Inverters: Techniques, Comparison, Harmonic Analysis, Voltage Control and Harmonic Reduction in Inverters, Power Factor Improvement techniques: PAC, SAC, EAC and PWM

Section 2:

Series and parallel operation of power devices, String efficiency and Derating factor, Equalizing networks, Protection circuits, Sensing & measurement of sinusoidal/ non-sinusoidal voltage & current signals.
DC motor drives: - Performance parameters, speed control and braking techniques,
AC motor drives: - Performance parameters, Speed control (Stator voltage, Frequency, V/F), Effect of non-sinusoidal supply on motor performance, Selection of drive, Protection circuits for AC/DC Motor Drives.
Power Quality: -Types, Sources, measurement and preventive techniques of power line disturbances

List of Practicals:

1. Study of 3 Phase Inverter with Load
2. Study of Stator Voltage Control of 3 Phase IM
3. Speed Control of DC Drive (Controlled Converter/ Chopper Based)
4. Study of Protection Circuits for Drives (OV/ OC)
5. Study of Protection Circuits for Drives (Soft start/ Soft stop)
6. Study of Voltage/ Frequency Control of 3 Phase IM
7. Study of Power Factor Improvement Technique (SAC/ PAC)
8. Simulation of three Phase Controlled Converter with R, RL Load
9. Simulation of three Phase Inverter with R, RL Load
10. Simulation of dual converter with suitable Load

List of Projects:

1. Switching circuit for a power device for 3 phase power conversion systems (SCR /

power BJT / power MOSFET / IGBT)

2. PWM generation for device switching

Develop a 3-phase power converter for utility applications as listed below (Any one). Source available is AC Mains/ DC battery.

3. UPS
4. Speed control of DC Motor
5. Speed control of AC Motor
6. Develop sensing and protection circuit for converter/ AC or DC drive (over voltage/ over current/ soft start and soft stop)
7. Dual converter (switching circuit)
8. Solid state relay/ Programmable Ac power control
9. Verify, through simulation, the performance of 3 phase AC-DC power conversion systems for suitable load. Comment on the results.
10. Verify, through simulation, the performance of 3 phase DC-AC power conversion systems for suitable load. Comment on the results.

Text Books:

1. M D Singh, K B Khanchandani; Power Electronics; 2 nd Edition, TMH.
2. M. H. Rashid; Power Electronics Circuits, Devices and Applications; 3 rd Edition, PHI.

Reference Books:

1. N. Mohan, T. M. Undeland and W P Robbins; Power Electronics: Converters, Applications, and Design; 3 rd edition, John Willey and Sons, Singapore.
2. Dubey, Doralda, Joshi and Sinha; Thyristorised Power Controllers; New Age International.
3. P. C. Sen; Thyristor DC Drives; John Wiley.
4. B. K. Bose; Modern Power Electronics and AC Drives; Pearson Education, 2002.

Course Outcomes:

The student will be able to –

1. Analyze three phase AC-DC/ DC-AC power converters in terms of performance parameters.
2. Analyze power factor in AC/DC converters.
3. Describe series and parallel connection of power devices.
4. Describe the role of converters in speed control DC & AC motors.

FF No: 654

Course Code: EL4014 **Course Name: Artificial Neural Networks**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Introduction to ANN: History of Neural networks, Neural net architecture, Neural learning, Evaluation of networks, Implementation. Supervised Learning: Perceptions, Linear separability, preceptron training algorithms, modifications, Support vector machines, multilevel discrimination, back propagation algorithm. Adaptive multilayer networks, predication networks, Polynomial Networks.

Section 2:

Unsupervised & Associative Learning: Winner-Takes All network, learning vector quantization, counter propagation networks, Adaptive Resonance theory, Topological Organized networks , Distance based learning, Max Net, Competitive Net, Principal Component Analysis, Associative Learning: Associative non-iterative procedures for association, hop field networks, Optimization, Learning using Hopfield networks, Introduction to Fuzzy logic.

List of Practicals:

1. To study the neural network tool box.
2. To study how to train the database.
3. Design the support vector machine.
4. Design the support probabilistic networks.
5. Write down the algorithms and implement back propagation algorithm.
6. Write down the algorithms and implement predication network algorithm.
7. Design and simulate the probabilistic network.
8. Design and simulate the Max Net.
9. Design and simulate the Competitive Net.
10 Design and simulate the Hopfield networks.

List of Projects:

1. Study the relevant IEEE papers based on the Principal Component Analysis and implement it for any of the application.
2. Study the relevant IEEE papers based on the Support Vector Machine and implement it for any of the application.

Text Books:

1 Kishan Malhotra, Chilukurik. Mohan, Sanjay Ranka; Elements of Artificial Neural Networks; Second edition; Penram International Publishing (India) Pvt. Ltd.
2 John Yen, Reza Langari; Fuzzy Logic; First edition; Pearson Educations.

Reference Books:

1. Bart Kosko, John c. Burgess; Neural Network and Fuzzy system.
2. M.H. Hassoun; Fundamental of Artificial Neural Networks.
3. M Zurada; Introduction to Artificial Neural Network system.
4. Relevant IEEE Papers

Course Objectives:

The student will be able to –

1. Study architecture of different Neural algorithms
2. Solve problems using unsupervised, associative learning techniques.
3. Solve problems using associative learning techniques.
4. Provide an understanding of the basics of fuzzy logic

FF No: 654

Course Code: EL4015 **Course Name: Antenna Theory**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Fundamental Concepts: Physical concept of radiation, Radiation pattern, near- and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.
Radiation from Wires and Loops: Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.Aperture Antennas: Huygens Principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts.

Section 2:

Broadband Antennas: Broadband concept, Log-periodic antennas, frequency independent antennas.Microstrip Antennas: Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas, .Antenna Arrays: Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays. And basic concepts of Smart antennas.

List of Practicals:

1. Study the Friss transmission formula.
2. Design and simulate the circular loop antenna.
3. Design and simulate the dipole for mobile.
4. Design and simulate the antenna for the specific microwave frequency.
5. Study and design the reflector and director for the Yagi Uda antenna.
6. Study and design the patch antenna.
7. Study and design the circular patch antenna.
8. Study and design the Log Periodic antenna.
9. Simulate Microstrip antenna
10. Study antenna radiation pattern.

List of Projects:

1 Project based on the loop Antenna
2. Project based on the Rectangular Patch antenna

Text Books:

Constantine A. Balanis; Antenna Theory: Analysis and Design, 3rd Edition; John Wiley, 2005 (or 2nd Ed.).

Reference Books:

1. W. L. Stutzman, and G.A. Thiele; Antenna Theory and Design; 2nd Edition; John Wiley & Sons., 1998.

2. R.S. Elliot; Antenna Theory and Design; Revised edition; Wiley-IEEE Press., 2003.

Course Outcomes:

Students will be able to

1. Understand standard antenna characterization parameters.
2 Explore electromagnetic radiation mechanisms for common antenna structures.
3. Design simple antennas for specified performance.
4. Design antenna arrays with required radiation pattern characteristics.

FF No: 654

Course Code: EL4016 **Course Name: Advanced DSP**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:
Random Signals, Time Averages for DT Random Process, Multirate DSP- Decimation, Interpolation, Design of Practical Sampling Rate Conversion, Adaptive Filters LMS, RLS.

Section 2:
Linear Prediction and Optimum Linear Filters, Wiener Filter for Filtering and Prediction, Power Spectrum Estimation, Wavelet Transform and Applications- Multiresolution Analysis, Denoising Using DWT, Signal Compression, Signal Filtering, Sampling Rate Conversion.

List of Practicals:

1. Record an audio signal with and without noise. Display time and frequency domain representation
2. Study the effects of up sampling and down sampling in time and frequency domain
3. write a program to design Adaptive filter for Noise cancellation
4. Implement Linear prediction algorithm
5. Power spectrum estimation of Vowels of a speech signal
6. Sub band filtering of signal using Wavelet Transform
7. Design and implement Sampling rate converters
8. Implement Weiner Filter
9. Study random signal and study its power spectrum estimation
10. Implement signal compression using Wavelet Transform.

List of Project areas:

1. Design of Multirate system for the given sampling rate and specifications of filter required for sound recording system to compose and mix high and low frequency signals generated from different instruments in a Recording studio.
2. Design and implement Adaptive filter for reverberation/echo cancellation /speech signal and audio signal processing / image processing
3. Collect Speech/ECG signal which is contaminated with noise. Apply Wavelet transform for denoising, compression, feature extraction and Analysis of signal.
4. Project based on Adaptive filters
5. Project based on Multirate signal processing

6. Project based on prediction algorithm

Text Books:

1. E C Ifleachor and B W Jervis; Digital Signal Processing – A practical approach; 2nd Edition, Pearson Education

2. John G Proakis, Monolakis; Digital Signal Processing – Principles, Algorithms and Applications; Pearson education

Reference Books:

1. P Vaidyanathan; Multirate Systems and Filter Banks; PHI

2. B Venkatramani, M Bhaskar; Digital Signal Processors, Architecture, Programming and Applications; TMH

3. Simon Haykin; Adaptive Filter Theory; 4th Edition Pearson Education

Course Outcomes:

The student will be able to –

1. Explain random signals and random processes.
2. Demonstrate decimation and interpolation of signals
3. Apply the concept of adaptive filtering.
4. Implement the principles of linear prediction
5. Estimate spectral density
6. Use wavelet transform for signal processing

FF No: 654

Course Code: EL4018 **Course Name: RF Integrated Circuit Design**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:

Basic concepts in RF Engineering: Architecture, noise, nonlinear effects, sensitivity and dynamic range; Transmission media reflections, Maximum Power Transfer, Matching, Passive Components, Transmission lines, High Frequency Amplifier, MOSFET device review, MOS Capacitances.

Section 2:

Noise – Various sources, Noise in MOSFET; Low Noise Amplifier – Design, Various topologies; Mixers; Oscillators; RF Power Amplifiers.

List of Practicals:

All laboratory exercises must be completed; these are intended to prepare the students for the term project. In doing these exercises, each student works individually first and then in a group. It is strongly recommended that each student must use his/her own machine, install the free VLSI TCAD tools which will be discussed in class or laboratory session.

Typical Lab experiments as follows:

1. Semiconductor Devices at High/Radio Frequencies.
2. RF-gain enhancement by inductor or by LC tank.
3. Design of CE and CS tuned amplifiers.
4. Design of CB and CD tuned amplifiers.
5. Stability problems in tuned amplifiers and Neutralization.
6. RF Power Amplifiers in Class A, B and C
7. First and second order Filters.
8. Basic topology of CG LNA
9. CS emitter degenerated LNA
10. Reflection coefficients of transmission line.

List of Projects:

The most important assignment is the Term Project, about which more detailed instructions will be issued in class. In doing this assignment, students will work in group(s). They should begin finding their partner(s) early in the term. The term project requirements must be completed in accordance with the schedule given in the instructions. Students must make a

presentation of their part of the project to the rest of the class. They must demonstrate/present their work in the term project even if it does not fully function. Typical projects as follows:

1. Design of 2 - 5 GHz LNA with variable gain
2. Design of Double Cross-Coupled VCO with AGC

Text Books:

1. *Behzad Razavi; RF Microelectronics; 2nd Ed; Pearson, 2012.*
2. *Thomas H. Lee; The design of CMOS radio-frequency integrated circuits; 2nd Ed; Cambridge University Press, 2004.*

Course Outcomes:

1. Understand the basic concepts of RF engineering.
2. Describe the behavior of components at RF.
3. Design low noise devices
4. Design low noise circuits.

FF No: 654

Course Code: EL4019 **Course Name: Real Time Operating Systems**

Credits: 4 **Teaching Scheme: 3 Hours / Week**
Lab: 2 Hours / Week

Section 1:
Real-Time kernel concept, µC/OS-II Kernel Structure, Tasks, task states, task control blocks, Task Management

Section 2:
µC/OS-II'S Services, Inter task Communication and Synchronization, semaphores, message mailboxes and message queues, Memory Management,Linux Kernel, Embedded Linux

List of Practicals:

1. Programming to demonstrate Task Scheduling using Task Management
2. Programming to demonstrate Task Scheduling using Time Management
3. Programming to demonstrate multitasking using Task management.
4. Programming for demonstrating resource sharing using Semaphores
5. Programming for demonstrating resource sharing using Mutex
6. Programming for demonstrating Inter-process communication using Mailbox.
7. Programming for demonstrating Inter-process communication using Message Queues
8. Porting UCOS-II based applications on Embedded targets (PIC/ARM)
9. Programming for demonstrating Linux Tool Chain Building for ARM platform
10. Programming for making own root file system for ARM based Linux

List of Project areas:
1. Design RTOS based Embedded System for Bar Code Scanner

Text Books:
1. Jean J. Labrosse; µC/OS, The Real-Time Kernel; Paul Temme 2002
2. Linux Device Drivers (Nutshell Handbook); O'Reilly Publishers 2000
3. Craig Hollabaugh; Embedded Linux: Hardware, Software, and Interfacing; Addison Wesley 2002

Reference Books:

1. Sreekrishnan Venkateswaran; Essential Linux Device Drivers; Prentice Hall 2008

2. Christopher Hallinan; Embedded Linux Primer: A Practical, Real-World Approach; Prentice Hall, 20063. µC/OS-II User Manual

Course Outcomes:

The student will be able to –

1. Explain RTOS Architecture.
2. Understand task management
3. Develop Multitasking Embedded System using RTOS services.
4. Understand synchroniz

FF No. : 654

EL4075: Global Internship

Credits: 15

Industry/ Research/ Global Internship is an educational innovation seeking to link industry experience with university instruction. Internship enables students to acquire learning by applying the knowledge and skills they possess in open-ended real-life situations of a rapidly changing needs and challenges in a professional workplace. Internship provides the required platform for experiential and cooperative learning and education, by providing students with an opportunity to work on industry assignments, under the guidance of professional experts and under the supervision of faculty. Students are offered 18 weeks industry internship to enhance their skillset and get exposure of industry front. Internship facilitates and promotes partnership and intellectual exchange between academia and industry.

Course Outcomes:

Upon successful completion of Industry Internship, student will be able to

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, analyse, formulate and develop projects with a comprehensive and systematic approach.
3. Cooperate with diverse teams and effectively communicate with all the stake holders.
4. Produce solutions within the technological guidelines and standards.
5. Develop effective communication skills for presentation of project related activities.

FF No. : 654

EL4080: Research Internship

Credits: 15

Industry/ Research/ Global Internship is an educational innovation seeking to link industry experience with university instruction. Internship enables students to acquire learning by applying the knowledge and skills they possess in open-ended real-life situations of a rapidly changing needs and challenges in a professional workplace. Internship provides the required platform for experiential and cooperative learning and education, by providing students with an opportunity to work on industry assignments, under the guidance of professional experts and under the supervision of faculty. Students are offered 18 weeks industry internship to enhance their skillset and get exposure of industry front. Internship facilitates and promotes partnership and intellectual exchange between academia and industry.

Course Outcomes:

Upon successful completion of Industry Internship, student will be able to

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, analyse, formulate and develop projects with a comprehensive and systematic approach.
3. Cooperate with diverse teams and effectively communicate with all the stake holders.
4. Produce solutions within the technological guidelines and standards.
5. Develop effective communication skills for presentation of project related activities.

FF No. : 654

EL4081: Project Internship

Credits: 15

Industry/ Research/ Global Internship is an educational innovation seeking to link industry experience with university instruction. Internship enables students to acquire learning by applying the knowledge and skills they possess in open-ended real-life situations of a rapidly changing needs and challenges in a professional workplace. Internship provides the required platform for experiential and cooperative learning and education, by providing students with an opportunity to work on industry assignments, under the guidance of professional experts and under the supervision of faculty. Students are offered 18 weeks industry internship to enhance their skillset and get exposure of industry front. Internship facilitates and promotes partnership and intellectual exchange between academia and industry.

Course Outcomes:

Upon successful completion of Industry Internship, student will be able to

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, analyse, formulate and develop projects with a comprehensive and systematic approach.
3. Cooperate with diverse teams and effectively communicate with all the stake holders.
4. Produce solutions within the technological guidelines and standards.
5. Develop effective communication skills for presentation of project related activities.

FF No. : 654

EL4080: Semester Internship

Credits: 15

Industry/ Research/ Global Internship is an educational innovation seeking to link industry experience with university instruction. Internship enables students to acquire learning by applying the knowledge and skills they possess in open-ended real-life situations of a rapidly changing needs and challenges in a professional workplace. Internship provides the required platform for experiential and cooperative learning and education, by providing students with an opportunity to work on industry assignments, under the guidance of professional experts and under the supervision of faculty. Students are offered 18 weeks industry internship to enhance their skillset and get exposure of industry front. Internship facilitates and promotes partnership and intellectual exchange between academia and industry.

Course Outcomes:

Upon successful completion of Industry Internship, student will be able to

1. Acquire practical knowledge within the chosen area of technology for project development.
2. Identify, analyse, formulate and develop projects with a comprehensive and systematic approach.
3. Cooperate with diverse teams and effectively communicate with all the stake holders.
4. Produce solutions within the technological guidelines and standards.
5. Develop effective communication skills for presentation of project related activities.

FF No. : 654

EL4071: Major Project 1

Credits: 4 Teaching Scheme: 5 Hours / Week Theory: 3 Hours / Week

Lab/ Project: 2 Hours / Week

Major project course is effective in preparing students for their project work. It emphasizes on learning by doing for a complete project life cycle, requirement analysis, realistic planning and transforming ideas into product.

Major-Project Guidelines:

1. The Major-project is a team activity having 3-4 students in a team. This is electronic product design work.
2. The Major-project may be a complete hardware or a combination of hardware and software work. The software part in Major-project should be less than 50% of the total work.
3. After interactions with course instructor and based on comprehensive literature survey / requirement analysis, the student shall identify the title and define objectives of the Major-project.
4. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
5. The student is expected to meet the timelines on design, development and testing of the proposed work.
6. The student is instructed to have discussion with faculty instructor on standard practices used for electronic circuit / product design, converting the circuit design into a complete electronic product, PCD design using suitable simulation software, estimation of power budget analysis of the product, front panel / user interface design and mechanical aspects of the product.
7. Completed Major-project and documentation in the form of Major-project report is to be submitted at the end of the semester. The project group will deliver the presentation of the Project Work which will be assessed by the panel.

Course Outcomes:

The graduates will be able to -

1. Identify Real World Problems, develop realistic expectations, set achievable goals.
2. Design, implement and test the prototype / algorithm, interpret the results to solve conceived problem.
3. Develop organisational skills as decision making, planning, preparations and record keeping.
4. Develop team working skills, communication, organization and leadership.

Note:

The student needs to identify a technological problem in the following sectors:

1. Social relevance (Agriculture/ Water Management / Transportation / Waste Management / etc.)
2. Renewable Energy (Solar / Wind / Waves / etc.)
3. Green Technology (Carbon footprint / Pollution control / etc)
4. Assistive System for Weaker People (Blind / Deaf / Handicap assistive)
5. Security Enhancement (Cyber Security / Forensics)
6. Government Projects (Smart City / Smart Gri