



Bansilal Ramnath Agarwal Charitable Trust's

# Vishwakarma Institute of Technology

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

## Structure & Syllabus of

### **B. Tech.**

## **(Electronics & Telecommunication Engineering)**

Academic Year 2018-19

Prepared by: - Board of Studies in E&TC Engineering

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

Chairman – BOS

Signed by

Chairman – Academic Board



**Institute Vision:**

To be a globally acclaimed Institute in Technical Education and Research for holistic Socio-economical development

**Institute Mission:**

- To impart knowledge and skill based Education in Collaboration with Industry, Academia and Research Organizations.
- To strengthen global collaborations for Students, Faculty Exchange and joint Research
- To prepare competent Engineers with a spirit of Entrepreneurship
- To Inculcate and Strengthen Research Aptitude amongst the Students and Faculty

**Department Vision:**

To be a center of Academic Excellence in Electronics, Telecommunication and Related Domains through Continuous Learning and Innovation.

**Department Mission:**

- To provide state of art education in Electronics and Telecommunication Engineering to meet current and future needs of society, industry and academia.
- To strengthen collaborations with industries and institutes of repute to foster research culture among faculty members and students.
- To promote ethically conscious engineers demonstrating sustainable entrepreneurship and professional maturity in social context.

**Program Educational Objectives (PEOs):**

Graduates of the program will

- Have comprehensive knowledge of Electronics engineering fundamentals to face the challenges of real life complex problems
- Be professionals imbued with a spirit of leadership, ethical behavior and societal commitment
- Be compliant to constantly evolving technology through lifelong learning

**Program Outcomes:****Engineering Graduates will be able to:**

- 1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental

considerations.

- 4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- 5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- 6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- 7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- 8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- 11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

### **Program Specific Objectives (PSOs)**

E&TC Graduates will have Ability to:

1. Design, Develop and Analyze Complex Electronic Systems for Communication, Signal Processing, Embedded Systems and VLSI Applications.
2. Identify and Apply domain specific hardware and software tools to solve real-world problems in Electronics and Communication.

**Title: Course Structure**

**Branch: E&TC**

**Year: S. Y.**

**Academic Year: 2018-19**

**Semester: I**

**Module: NA**

**FF No. : 653**

**Pattern: B-18**

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)		Examination scheme					Total	Credits
			Theory	Lab	CA		MSE	ESA			
					HA	LAB		ESE	VIVA		
S1	ET2001	Electronic Circuits	3	2	10	30	10	30	20	100	4
S2	ET2003	Network Theory	3	2	10	30	10	30	20	100	4
S3	ET2005	Signals & Systems	3	2	10	30	10	30	20	100	4
S4	ET2007	Control Systems	3	2	10	30	10	30	20	100	4
S5	ET2009	Engineering Design & Development 1	2	4	-	-	50	50	-	100	4
S6	ET2011	Probability & Random Processes	2	-	20	-	30	30	20	100	2
<b>Total</b>											22

Abbreviations Used	
CA	Continuous Assessment
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
ESA	End Semester Assessment

**Title: Course Structure**

**FF No. : 653**

**Branch: E&TC**

**Year: S. Y.**

**Academic Year: 2018-19**

**Semester: II**

**Module: NA**

**Pattern: B-18**

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)		Examination scheme					Total	Credits
			Theory	Lab	CA		MSE	ESA			
					HA	LAB		ESE	VIVA		
S1	ET2002	Data Structures & Algorithms	3	2	10	30	10	30	20	100	4
S2	ET2004	Communication Engineering	3	2	10	30	10	30	20	100	4
S3	ET2006	Electromagnetic Engineering	3	2	10	30	10	30	20	100	4
S4	ET2008	Computer Architecture & Operating Systems	3	2	10	30	10	30	20	100	4
S5	ET2010	Engineering Design & Development 2	2	4	-	-	50	50	-	100	4
S6	ET2012	Multivariate Data Analysis	2	-	20	-	30	30	20	100	2
	ET2013	*Professional Development I	-	2							
	ET2014	**General Proficiency 2									
<b>Total</b>											22

Abbreviations Used	
CA	Continuous Assessment
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
ESA	End Semester Assessment

(\*) Irrespective of Module in second semester

(\*\*) Audit Course evaluated in second semester

**ET2001: Electronic Circuits****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Small signal equivalent circuits of diode, Analysis of diode circuits using diode models  
BJT configurations (CE, CB, CC), Input and output characteristics, applications of CE, CB, CC and comparison, their suitability in cascaded stages, BJT biasing, Determination of Q point, Small signal low frequency equivalent model, BJT amplifier analysis  
Introduction to JFET, MOS capacitor, MOSFET, I-V characteristics, drain current equation, Channel length modulation, Non ideal characteristics, MOSFET biasing, FET small signal AC equivalent model, CS, CG, CD amplifiers, Amplifier analysis, MOSFET as a switch

**Section 2:**

Design procedure for combinational logic circuits, Code conversion, Half Adder, Full Adder, 4-bit binary adder, BCD Adder, BCD Subtractor, Parity generator, Parity checker, Digital Comparator, Multiplexer and Demultiplexer, their use in combinational logic designs, multiplexer and Demultiplexer trees, Encoder and Decoder, Priority Encoder  
Latches and Flip-flops, conversion of flip flops, shift registers, bi-directional shift registers, Johnson and Ring counters, design and analysis of asynchronous and synchronous counters, up/down counters, modulo counters, concept of propagation delay, lock out condition, clock skew, sequence generators, Pseudo Random Binary Sequence (PRBS) generator.  
Introduction to state machine, Basic Design steps for these sequential circuits using state diagram, State Table, State assignment, finite state machine, Mealy machine and Moore machine representation and implementation, sequence detector, Design problems based on finite state machine.

**List of Practicals (Any Six):**

1. Diode clipping circuits
2. BJT CE Characteristics
3. CE Amplifier
4. MOSFET characteristics
5. CS Amplifier
6. Design & implement BCD Adder
7. Design & implement comparator
8. Design & implement combinational logic circuit using multiplexer/ demux

9. Design & implement 3-bit bidirectional shift register using D flip-flop
10. Verification of mod-n counters

**List of Project areas (Any one)**

1. MOSFET/ BJT switch
2. Cascaded amplifier
3. Code Convertor
4. Sequence generator

**Text Books**

1. Electronic Devices, Thomas L. Floyd, Pearson Education
2. Semiconductor Physics and Devices, Donald Neamen, McGraw Hill
3. M. Morris Mano, Digital Design - 3rd Edition (Pearson)

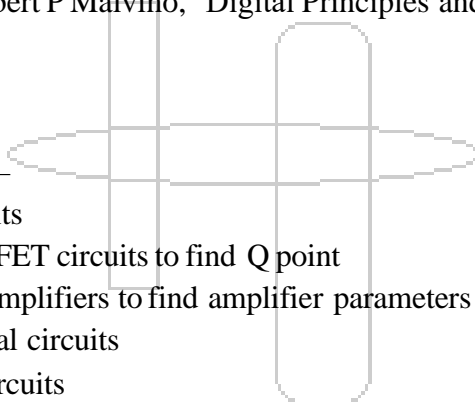
**Reference Books**

1. Electronic Devices & Circuit Theory, R. L. Boylestad, L. Nashelsky, PHI, New Delhi.
2. Donald P Leach, Albert P Malvino, 'Digital Principles and Applications' (TMGH), 6th Edition

**Course Outcomes:**

The student will be able to –

1. Analyze diode circuits
2. Analyze BJT / MOSFET circuits to find Q point
3. Analyze BJT/ FET amplifiers to find amplifier parameters
4. Design combinational circuits
5. Design sequential circuits
6. Design Finite state machines



**ET2003: Network Theory****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1**

Network Theorems: Superposition, Thevenin's Norton's and Maximum Power transfer Theorems. (DC and AC)

Concept of Network Topology, Terms used in Topology, Relation between Twigs and Links Properties of a Tree in a Graph, Formation of Incidence Matrix  $[A_i]$ , number of tree in Graph. Cut-Set Matrix, Network Equilibrium Equation.

Terminal characteristics of network:  $Z$ ,  $Y$ ,  $h$ , ABCD Parameters; Reciprocity & Symmetry conditions, Interrelation of Parameters, interconnection of parameters. Network functions for one port and two port networks. Pole-zeros of network functions and network stability

**Section 2:**

Classifications: Symmetrical and Asymmetrical networks. Properties of two port Network: Symmetrical Networks (T and  $\Pi$  only).  $Z_0$  and  $\gamma$  in terms of circuit components, open and short circuit parameters, Filter fundamentals, Constant K -LPF, HPF, BPF and BSF, m derived LPF and HPF, introduction to Neper and Decibel, Relation between Neper and Decibel, Symmetrical T and  $\Pi$  type attenuators, Lattice attenuator, Bridge T-attenuator. Asymmetrical Networks: Image Impedance and Iterative Impedance (L-Section only). Terminating half sections, Asymmetrical L-type.

Transient response of passive circuits, transient response of series RL, RC and RLC circuits with DC and sinusoidal excitation

Significance of Quality factor, Series Resonance: Impedance, Phase angle variations with frequency, Voltage and current variation with frequency, Bandwidth, Selectivity Resonant frequency and admittance variation with frequency, Bandwidth and selectivity. Magnification factor, Parallel resonance: General case: Resistance present in both branches

**List of Practicals (Any Six):**

1. To study and verify the Thevenin's Theorem and Norton's Theorem,
2. To study the Superposition Theorem and Maximum Power Transfer Theorem
3. To Measure and Verify of  $Z$ ,  $Y$ , Parameters of a Two-port Network
4. To determine equivalent parameters of parallel connection of two-port network.
5. To find critical frequencies (poles and zeros) of LC impedance driving point function.



6. To study the operation of low pass and high pass prototype filters.
7. To study the operation of band pass and band stop prototype filters
8. To study of T-type and  $\pi$ - type attenuator.
9. To study the transient response of a RL and RC circuit
10. To study the frequency response of a RLC series circuit

**List of Projects (Any One):**

1. Design Passive Prototype Low pass filter having cut-off frequency 2 KHz with design impedance  $600 \Omega$  in T and  $\pi$  section. Select frequency range up to 1 MHz with input voltage 5V
2. Design Passive Prototype High pass filter having cut-off frequency 10 KHz with design impedance  $600 \Omega$  in T and  $\pi$  section. Select frequency range up to 1 MHz with input voltage 5V
3. Design Passive Prototype Band pass filter having cut-off frequencies 3000 Hz and 6000Hz with design impedance  $600 \Omega$  in T and  $\pi$  section. Select frequency range up to 1 MHz with input voltage 5V
4. Design Passive Prototype Band pass filter having cut-off frequencies 2000 Hz and 5000Hz with design impedance  $600 \Omega$  in T and  $\pi$  section. Select frequency range up to 1 MHz with input voltage 5V
5. Design a  $\pi$ -type attenuator to give attenuation of 20 dB and characteristic resistance of  $500 \Omega$ .
6. Design a T-type attenuator to give attenuation of 20 dB and characteristic resistance of  $500 \Omega$

**Text Books:**

1. "Circuit Theory (Analysis and Synthesis)", Chakrabarti, Dhanpat Rai and Co.
2. "Electrical Networks", Ravish R Singh, Tata Mc-Graw Hill

**Reference Books:**

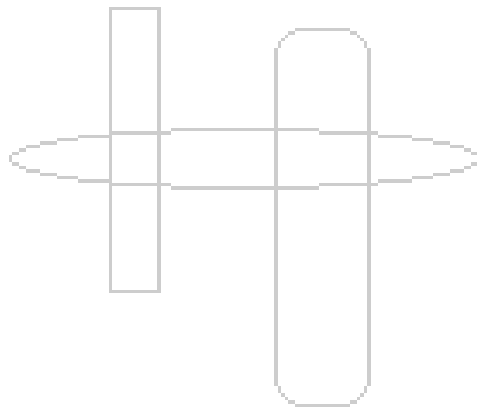
1. "Network Analysis", Van Valkenberg, PHI
2. "Kuo F. F., "Network Analysis and Synthesis", 2nd Ed., Wiley India.
3. "Engineering Circuit Analysis, Hayt W. H., Kemmerly J. E. and Durbin S. M., 6th Ed., Tata McGraw-Hill Publishing Company Ltd

**Course Outcomes:**

The students will be able to

1. Simplify networks and circuits using network theorems and graph theory
2. Simplify networks and circuits using graph theory and Network Topology
3. Find network parameters and network function

4. Design Attenuators and filters
5. Analyze RL, RC and RLC Circuits using steady state and transient response
6. Analyze Resonance Circuits



**ET2005: Signals and Systems****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Introduction to signals and systems, signal classification, elementary signals, signal operations on dependent and independent variables, sampling theorem. Classification of systems, time domain analysis of LTI systems: convolution integral, convolution sum, correlation. Continuous time Fourier series: Trigonometric, exponential form of Fourier series, Frequency spectrum of CT periodic signals, Gibbs phenomenon.

**Section2:**

Continuous time Fourier transform, existence of Fourier transform, properties, system analysis using Fourier transform. Introduction to energy spectral density (ESD) and power spectral density (PSD). Discrete time Fourier transform, discrete frequency spectrum, analysis of discrete-time LTI systems using DFT. Laplace transform, region of convergence, properties, Pole-zero plots, inverse Laplace transform, circuit analysis using Laplace transform.

**List of Practicals (Any Six):**

1. To generate different continuous time and discrete time signals like sinusoidal signal, ramp signal, step signals, exponential signal etc.
2. To perform different operations on the signals.
3. To find the response of a given discrete time system to any arbitrary discrete time input signal
4. To perform Fourier analysis of the given signal to find the spectral components.
5. To find autocorrelation and cross correlation of given sequences.
6. Generate a discrete time sequence by sampling the given continuous time signal by varying the sampling frequency and to observe the aliasing.
7. To obtain the step response and impulse response of the given system.
8. To analyze the given discrete time signal in frequency domain using DFT.
9. To obtain ESD and/or PSD of a given signal.
10. To perform the pole-zero analysis of the given system using Laplace Transform

**List of Projects (Any One):**

1. To separate voiced/unvoiced/silence part of the speech signal.

2. Design a MATLAB app to generate different continuous and discrete time signals and to plot their spectra.
3. Design a MATLAB app for Fourier series synthesis of different signals.
4. ECG signal Analysis
5. Isolated word recognition using correlation
6. Generation of different audio effects like echo, reverberation flanger etc.
7. Analysis of given CT-LTI system using Laplace transform
8. Analysis of different musical instruments (air instruments like harmonium, flute)
9. Analysis of different musical instruments (string instruments like guitar, sitar)

**Text Books:**

1. Alan V. Oppenheim, Alan S. Wiisky and S. Hamid Nawab, "Signals and systems," Pearson Education, 2004.
2. Ramesh Babu and Anandnatarajan, "Signals and Systems," Scitech Publication, Fourth Edition.

**Reference Books:**

1. Haykin Simon and Veen Barry Van, "Signals and Systems," New York. John Wiley & Sons.
2. Roberts Michael J, "Signals and Systems," Tata McGraw Hill Publishing Company Limited, 2003.
3. A. Nagoor Kani, "Signals and Systems," McGraw Hill, 2013.

**Course Outcomes:**

The student will be able to –

1. Perform operations on dependent and independent variable of one dimensional signals
2. Synthesize the signal using elementary signals
3. Classify the systems and determine response of given CT/DT LTI system to any arbitrary input using convolution integral/sum
4. Analyze the given CT deterministic signal in spectral domain using Fourier series/transform.
5. Apply sampling theorem to obtain a discrete time signal from a continuous signal and to find the spectral components of the discrete-time signal using discrete Fourier transform (DFT).
6. Analyze the given LTI systems using Laplace transform.

**ET2007: Control Systems****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Introduction, Terminology, Mathematical modeling of electrical, mechanical and electro mechanical systems, Transfer function, State space modeling of dynamical system. Block Diagram, Signal flow graph. Time domain analysis, response to step, ramp and parabolic input, steady state error, transient and steady state analysis. Introduction to PI, PD and PID Controller. Stability, Stability criterion, Root Locus Analysis, Construction of root loci.

**Section2:**

Frequency Domain Analysis:- correlation between time and frequency responses, Frequency domain specifications. Bode plots, Gain and Phase margin, Polar plot, Nyquist criterion and plot. Design of Compensators

**List of Practicals (Any Six):**

1. Using Matlab
  - a. find the transfer function from Poles and Zeros
  - b. find zero's and pole's from transfer function.
2. Using Matlab
  - a. Step response of transfer function.
  - b. Impulse response of transfer function.
  - c. Ramp response of transfer function.
3. Using Matlab find the time response of second order system.
4. Using Matlab
  - a. Transfer function from state model.
  - b. State model from transfer function.
  - c. Step and impulse response of a state model.
5. To perform stability analysis of the system and plot root locus from the transfer function.
6. To plot Bode plot from transfer function.
7. To plot Nyquist plot from transfer function.
8. To find the transfer function of DC motor.
9. To study and simulate PID Controller.
10. To study using Matlab
  - a. Lag Compensator

- b. Lead Compensator
  - c. Lead lag compensator
11. System identification of DC motor using Matlab.
  12. Simulation of any closed loop system.

**List of Projects (Any One):**

1. Model a given electrical / Mechanical system.
2. Closed loop control of D C Motor.
3. Design and implementation of filter.
4. Compensator design for a low pass filter ad realize using op amp.
5. Eyeball Controlled Automatic Wheelchair.
6. Health Condition Monitoring System.
7. Hardware realization and implementation of closed loop system using Matlab and microcontroller.
8. Implementation of Accelerometer Based Wireless Gesture Controlled Rover.

**Text Books:**

1. Ogata Katsuhiko, “Modern Control Engineering”, 5th Edition, PHI
2. Nagrath I. J. and M. Gopal, “Control Systems Engineering”, 6th edition, New Age International

**Reference Books:**

1. 1 Norman S. Nise, “Control System Engineering”, 6th Edition, Wiley.
2. F. Golnaraghi, B.C. Kuo, “Automatic Control Systems”, 10th Edition, McGraw-Hill.

**Course Outcomes:**

The student will be able to –

1. Model a given system using transfer function approach
2. Find steady state and transient response of control systems and understand the behavior of LTI systems qualitatively and quantitatively, both in the transient and steady-state region.
3. Analyze given system for stability using root locus.
4. Demonstrate various techniques of frequency domain analysis.
5. Analyze given system for stability in frequency domain.
6. Design proportional, proportional-integral, proportional-derivative, and proportional-integral-derivative feedback control systems meeting specific system performance requirements.

## **ET2009: 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 proposing solutions 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 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:

1. Formation of project group comprising of 4-5 students. Multidisciplinary groups are allowed
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 of the students.
3. To aware the group about time management.
4. 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:**

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 passively receiving instruction.
5. Students in PCL are actively constructing their knowledge and understanding of the situation 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 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**

- 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](http://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 environmental 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

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**CO attainment levels:**

CO1: - Level 3

CO2: - Level 4

CO3: - Level 3

CO4: - Level 4

**ET2011: Probability and Radom Processes****Credits: 2****Teaching Scheme: 2 Hours / Week****Section 1:**

Data basics – numerical and categorical variables, Observational studies and experiments, sampling and sources of bias - exploratory analysis and inference, sampling methods – simple, stratified, cluster and multistage sampling, experimental design – principles of experimental design, Experimental terminology – placebo, blinding etc., Measures of center and spread, data transformation

Probability basics; Independence; Conditional probability; Probability trees; Bayesian inference; Probability distributions such as Normal distribution, Binomial distribution etc.

**Section 2:**

Sampling variability and central limit theorem, Confidence interval for mean, hypothesis testing for mean, Inference, Inference for comparing means, ANOVA, Bootstrapping, Proportions, Hypothesis testing for proportions, Chi-square GOF test, Chi-square independence test Cumulative distribution function, probability density function, Random Processes such as Laplace, Erlang, Gamma, Chi-square etc.; conditional distributions and density functions; Expected value, moments, central moments; Joint Cumulative distribution function, joint probability density function, Probability mass function

**Text Books:**

1. Probability and Statistics for Engineers – Johnson, Gupta, Pearson Prentice Hall, 3<sup>rd</sup> edition
2. Applied statistics and probability for Engineers – Montgomery, Runger, Wiley India, 3<sup>rd</sup> Edition

**Reference Books:**

1. Probability and random processes – Miller, Childers, Elsevier, 2<sup>nd</sup> Edition.

**Course Outcomes:**

The Student will be able to-

1. Distinguish between various types of variables
2. Apply concepts of probability such as independence, conditional probability
3. Apply Normal distribution and Binomial distribution concepts in case studies
4. 4.Apply variance analysis tests for data analysis
5. Apply Central limit theorem and carry out hypothesis testing
6. Use and apply concepts of various Random Processes in modeling data

**ET2002: Data Structures & Algorithms****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Analysis of algorithms. Asymptotic analysis, asymptotic notations, Searching and sorting algorithms. Linear Data Structures: Stack, Queue, Linked list, Expression conversion and evaluation, Generalized linked list

**Section 2:**

Tree, Binary search tree, Tree traversal, threaded binary tree, implementation of tree using linked list, Expression tree, application of trees, Graphs, representation of graphs, Graph traversal, minimum spanning tree and algorithms, shortest path algorithms.

**List of Practicals (Any Six):**

1. Implement sorting algorithms
2. Implement searching algorithms
3. Create and manipulate Database using Array
4. Create and manipulate Database using Linked List
5. Addition of two single variable polynomials using Linked List.
6. Implementation of Stacks
7. Conversion of infix expression to postfix expression and evaluation of postfix expression
8. Implementation of Queue
9. Operations on Binary Search Tree.
10. Create a graph using adjacency list

**List of Projects (Any One):**

Project based on

1. Dijkstra's algorithm
2. Prim's algorithm
3. Kruskal algorithm
4. Binary Trees
5. Expression trees
6. Binary heap
7. Stack and its application

8. Queue and its application
9. Linked list based project.
10. Hash tables.

**Text Books:**

1. Tenenbaum A M &Langsam Y: Data Structure Using C. Prentice Hall Of India, New Delhi.
2. Horowitz E &Sahni S: Fundamentals of Data Structures. Gurgaon. Galgotia Book Source New Delhi.

**Reference Books:**

1. Kruse R L, Leung B P &Tondo C L: Data Structure And Programming Design In C. Prentice Hall Of India Pvt.ltd.
2. Data Structures : Schaum Outline Series, TMH

**Course Outcomes:**

The student will be able to –

1. Find time complexity using Big-O notation.
2. Explain the concept of sequential organization, ordered list and dynamic memory management.
3. Solve Engineering problems by employing Stack, Queue and Linked list data structure
4. Explain and analyze major Tree algorithms.
5. Explain and analyze major Graph algorithms.
6. Solve Engineering problems by employing trees and graph data structure

**ET2004: Communication Engineering****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:****1.1 Introduction To Communication System**

Analog & Digital Communication System Overview, The Electromagnetic & Optical Spectrum and its usage, Types of Electronic Communication, Need of modulation, Communication Channels, Classification of noise, Noise in Cascaded Stages.

**1.2 Analog Modulation Techniques**

Mathematical treatment for an AM and FM signal, Spectral Analysis, Modulation Index, Efficiency, Power calculations, DSB-SC and SSB-SC, FM generators, pre-emphasis and de-emphasis in FM signal.

**1.3 Analog Receivers**

TRF Receiver, Super Heterodyne Receiver, Intermediate Frequency and Image Frequency, Diode detector, DSB-SC and SSB-SC, FM Detector

**Section 2:****2.1 Sampling and Waveform Coding**

Sampling, ideal sampling, Flat top & Natural Sampling, Aliasing, Pulse amplitude modulation, Quantization, Pulse code modulation & reconstruction, Delta modulation, Line Coding, Companded PCM, ISI and eye diagram, Time division multiplexing.

**2.2 Digital Modulation Techniques**

Digital modulation techniques - Binary Phase Shift Keying, Quadrature Phase Shift Keying, Binary Frequency Shift Keying, Quadrature amplitude modulation, Minimum shift keying.

**2.3 Detection and Performance analysis of digital signal**

Base Band signal receiver, Derivation for Error prob of integrate & dump Filter, Optimum Filter, white noise matched filter, probability error of match filter, correlation.

**List of Practicals (Any Six):**

1. Observe spectral components of time-domain signal using Digital Storage Oscilloscope (DSO).
2. Experiment with Double side band suppressed carrier (DSBSC) modulator and demodulator.
3. Experiment with Single side band suppressed carrier (SSBSC) modulator and demodulator.
4. Experiment with Frequency modulator (FM).

5. Simulation of Analog communication system.
6. Experiment with Pulse Amplitude modulation.
7. Experiment with Pulse Code modulation and demodulation.
8. Experiment with Delta modulation and demodulation.
9. Experiment with Quadrature phase shift keying modulation and demodulation.
10. Experiment with frequency shift keying modulation and demodulation

**List of Projects (Any One):**

1. Simulation of Analog Communication System
2. Double Side Band –Suppressed Carrier
3. Implementation of Pre-emphasis and De-emphasis for FM
4. Implementation of Antialiasing filter
5. Implementation of Adaptive Delta modulator to avoid slope overload distortion
6. Generation of discrete PAM signal

**Text Books:**

1. “Principles of Electronic Communication Systems”, Louis E Frenzel, Tata McGraw Hill Publications, Third Edition.
2. “Electronic Communication”, Kennedy &Devis, Tata McGraw Hill Publications.
3. “Principles of Communication Systems”, Taub Schilling, Tata McGraw Hill Fourth Edition.

**Reference Books:**

1. “Electronic Communication”, Dennis Roddy & Coolen, Tata McGraw Hill Publications.
2. “Electronic Communication Systems”, Wayne Tomasi, Fourth Edition.
3. “Digital Communications”, Simon Haykin, Wiley Publications, Fourth Edition.
4. “Communication Systems”, Carlson, McGrawHill, Fourth Edition.
5. “Analog& Digital Communications”, Simon Haykin, Wiley Publications.
6. “Digital Communication”, B. Sklar, Pearson, Second Edition.

**Course Outcomes:**

The student will be able to –

1. Classify communication channels and noise.
2. Analyze amplitude and frequency modulated signal and their spectrum.
3. Explain working of analog receivers.
4. Discuss encoding of analog signals in digital formats.
5. Analyze modulation techniques with respect to bandwidth, Euclidian distance.
6. Evaluate performance of optimum filter.

**ET2006: Electromagnetic Engineering****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Vector Calculus basics; Gradient, Curl and Divergence; Co-ordinate systems; Coulomb's Law, Electric Field Intensity, Electric flux density, Gauss' law, Electrostatic potential, Boundary conditions, Laplace and Poisson's equations, Capacitance; Biot Savart law, Magnetic flux density, Magnetic field intensity, scalar and vector magnetic potential, Ampere's circuital law, boundary conditions, self inductance, continuity equation.

**Section2:**

Maxwell equation in differential form, point form, integral form; Phasor concept; time periodic fields; Poynting vector and concept of power flow; Helmholtz equations, Transverse Electromagnetic (TEM) wave, properties of Uniform Plane Wave, Intrinsic impedance; wave propagation ; Behavior of Uniform Plane wave at an interface between ideal medium and ideal conductor, concept of standing wave; Behavior at an interface between two dielectrics; Uniform Plane wave in a good dielectric, Uniform plane wave in a good conductor

**Text Books:**

1. Engineering Electromagnetics – William Hayt, J.A. Buck, 6<sup>th</sup> Edition, McGraw Hill publications
2. Elements of Electromagnetics – Matthew Sadiku, 3<sup>rd</sup> Edition, Oxford University Press

**Reference Books:**

1. Electromagnetic Waves and Radiating Systems – Pearson Education
2. Electromagnetic Field Theory Fundamentals – Guru, Hizioglu, Cambridge University Press

**List of Tutorials (Any Six):**

1. Co-ordinate systems and their conversions, Gradient & Divergence
2. Coulomb's Law, Electric Flux Density, Electric field intensity, Gauss' law
3. Electrostatic potential, Boundary conditions, Laplace and Poisson's equations
4. Magnetic flux density, Magnetic field intensity, scalar and vector magnetic potential
5. Ampere's circuital law, boundary conditions
6. Maxwell equation in differential form, point form, integral form

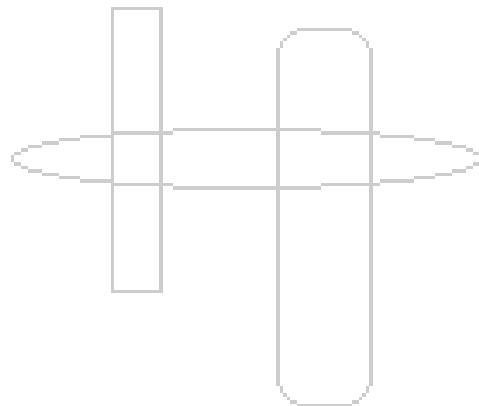


7. Phasor concept; time periodic fields; Poynting vector and concept of power flow
8. Helmholtz equations, Transverse Electromagnetic (TEM) wave, properties of Uniform Plane Wave
9. Intrinsic impedance; wave propagation
10. Behavior of Uniform Plane Wave at various interfaces; Behavior of Uniform Plane wave in a good dielectric & Uniform plane wave in a good conductor

**Course Outcomes:**

The Student will be able to-

1. Apply knowledge of Vector Calculus
2. Use Boundary conditions and Laplace equations for realization of capacitance
3. Use Boundary conditions and Laplace equations for realization of Inductance
4. Implement Maxwell's Equations in various forms
5. Apply Phasors and Power flow concept
6. Understand the concept of Uniform Plane wave propagation and behavior at interfaces.



**ET2008: Computer Architecture & Operating Systems****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Overview and instruction sets, arithmetic and Logic unit, Addition and subtraction, Multiplication, Division, Floating Point operations, processor and control unit, Basic MIPS implementation, Datapath, Control Signals and implementation scheme, Pipelining: Pipelined Datapath and control, Handling Data hazards & Control hazards, parallelism, Memory and input/output system.

**Section 2:**

Overview of basics of operating system, processor management: operations on processes, process states, concurrent processes, process control block, Interprocess Communication (IPC), Message Passing, Direct and Indirect, Semaphores: definition, init, wait, signal operations, Deadlock: prevention, detection, avoidance, banker's algorithm, memory management, Device management, File management

**List of Practicals (Any Six):**

1. Write an assembly language code to implement data transfer.
2. Write an assembly language code to implement arithmetic instructions.
3. Write an assembly language code to implement logical instructions.
4. Write an assembly language code to implement floating point arithmetic.
5. Write an assembly language code to implement stack and branch instruction
6. Shell programming 1: command syntax, simple function, basic tests, loops, patterns, expansions and substitution
7. Shell programming 2: patterns, expansions and substitution
8. Write programs using the following system calls of UNIX operating system: fork, exec, getpid, exit, wait, close, stat, opendir, readdir.
9. Write programs using the I/O system calls of UNIX operating system (open,read, write, etc)
10. Write C programs to simulate UNIX commands like ls, grep, etc.

**List of Projects (Any One):**

1. Design of ALU.
2. Design a high speed addition method and logic for 4-bit addition
3. CPU scheduling algorithms

4. File allocation
5. Memory management Techniques.
6. Process synchronization.

**Text Books:**

1. David A. Patterson and John L. Hennessey, “Computer Organization and Design“, Fifth edition, Morgan Kauffman / Elsevier, 2014.
2. Silberschatz & P.B. Galvin, ‘Operating System concepts and principles’, Wiley India, 8th ed., 2009

**Reference Books:)**

1. William Stallings “Computer Organization and Architecture”, Seventh Edition , Pearson Education, 2006.
2. W. Stallings, ‘Operating Systems: Internals and design Principles’, Pearson Ed., LPE, 6th Ed., 2009
3. V.Carl Hamacher, Zvonko G. Varanescic and Safat G. Zaky, “Computer Organisation“, VI edition, Mc Graw-Hill Inc, 2012.

**Course Outcomes:**

The student will be able to –

1. Explain the basics of computer hardware.
2. Design arithmetic and logic unit.
3. Design and analyze pipelined control units.
4. Design process scheduling & synchronization algorithms.
5. Design memory management scheme like best fit, worse fit etc.
6. Design device and file management scheme.

## **ET2010: 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](http://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 environmental 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

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**CO attainment levels:**

CO1: - Level 3

CO2: - Level 4

CO3: - Level 3

CO4: - Level 4

**ET2012: Multivariate Data Analysis****Credits: 2****Teaching Scheme: 2 Hours / Week****Section 1:**

An introduction to multivariate statistical models, Multivariate normal distributions-Multivariate Normal Density Function, Properties of Multivariate Normal Random Processes, Estimation in the Multivariate Normal. Discriminant analysis: The Discriminant Function for Two Groups, Discriminant Analysis for Several Groups, Standardized Discriminant Functions, Interpretation of Discriminant Functions. Classification analysis: Classification into Two Groups, Classification into Several Groups, Estimating Misclassification Rates, Improved Estimates of Error Rates, Subset Selection.

**Section2:**

Multivariate regression: Multiple Regression: Fixed  $x$ 's, Multiple Regression: Random  $x$ 's, Multivariate Multiple Regression: Estimation. Principal component analysis: Geometric and Algebraic Bases of Principal Components, Principal Components and Perpendicular Regression, Principal Components from the Correlation Matrix, Deciding How Many Components to Retain, Information in the Last Few Principal Components, Interpretation of Principal Components. Cluster Analysis: Measures of Similarity or Dissimilarity, Hierarchical Clustering, Nonhierarchical Methods, Choosing the Number of Clusters, Cluster Validity, Clustering Variables. Dimension reduction.

**Text Books:**

1. R.A. Johnson, D.W. Wichern, "Applied multivariate statistical analysis", Pearson prentice Hall 6<sup>th</sup> Edition.
2. W.K. Hardle, L. Simer, "Applied multivariate statistical analysis" Springer

**Reference Books:**

1. T. Hastie, R. Tibsirani, J. Friedman, "Element of statistical learning: Data mining, inference and prediction", Springer.

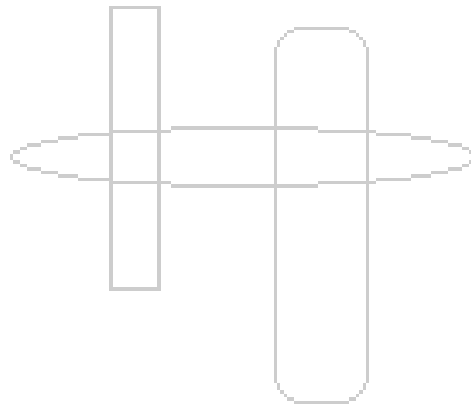
**Course Outcomes:**

The student will be able to –

1. Demonstrate knowledge and understanding of the basic ideas behind several common statistical techniques for analyzing multivariate data (Discriminant analysis, classification analysis, linear regression analysis, principal component analysis, cluster analysis)
2. Identify the most appropriate statistical techniques for analyzing multivariate dataset



3. Apply commonly used multivariate data analysis techniques for real data and interpret results
4. Describe the relationship between two or more independent variables and the dependent variable using a multiple regression equation.
5. Compare and contrast the methods for a given data analysis situation considering the benefits and the pitfalls of the methods
6. Select and apply an appropriate technique to achieve dimensionality reduction





**Bansilal Ramnath Agarwal Charitable Trust's**

# **Vishwakarma Institute of Technology**

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

**Structure & Syllabus of**

**T. Y. B. Tech.**

**(Electronics & Telecommunication Engineering)**

**Pattern 'C-18'**

**Academic Year 2018-19**

**Prepared by: - Board of Studies in E&TC Engineering**

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

**Signed by**

**Chairman – BOS**

**Chairman – Academic Board**

**Institute Vision:**

To be a globally acclaimed Institute in Technical Education and Research for holistic Socio-economical development

**Institute Mission:**

- To impart knowledge and skill based Education in Collaboration with Industry, Academia and Research Organizations.
- To strengthen global collaborations for Students, Faculty Exchange and joint Research
- To prepare competent Engineers with a spirit of Entrepreneurship
- To Inculcate and Strengthen Research Aptitude amongst the Students and Faculty

**Department Vision:**

To be a center of Academic Excellence in Electronics, Telecommunication and Related Domains through Continuous Learning and Innovation.

**Department Mission:**

- To provide state of art education in Electronics and Telecommunication Engineering to meet current and future needs of society, industry and academia.
- To strengthen collaborations with industries and institutes of repute to foster research culture among faculty members and students.
- To promote ethically conscious engineers demonstrating sustainable entrepreneurship and professional maturity in social context.

**Program Educational Objectives (PEOs):**

Graduates of the program will

- Have comprehensive knowledge of Electronics engineering fundamentals to face the challenges of real life complex problems
- Be professionals imbued with a spirit of leadership, ethical behavior and societal commitment
- Be compliant to constantly evolving technology through lifelong learning

**Program Outcomes:****Engineering Graduates will be able to:**

- 1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental

considerations.

- 4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- 5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- 6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- 7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- 8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- 11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

### **Program Specific Objectives (PSOs)**

E&TC Graduates will have Ability to:

1. Design, Develop and Analyze Complex Electronic Systems for Communication, Signal Processing, Embedded Systems and VLSI Applications.
2. Identify and Apply domain specific hardware and software tools to solve real-world problems in Electronics and Communication.

**Title: Course Structure**

**Branch: E&TC**

**Year: T. Y.**

**Academic Year: 2018-19**

**Semester: I**

**Module: NA**

**FF No. : 653**

**Pattern: C-18**

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)		Examination scheme					Total	Credits
			Theory	Lab	CA		MSE	ESA			
					HA	LAB		ESE	VIVA		
S1	ET3001	Real Time Embedded Systems	3	2	10	30	10	30	20	100	4
	ET3003	Power Electronics	3	2	10	30	10	30	20	100	
S2	ET3005	VLSI Design	3	2	10	30	10	30	20	100	4
	ET3007	Information Theory and Coding Techniques	3	2	10	30	10	30	20	100	
S3	ET3009	Data Communication & Networking	3	2	10	30	10	30	20	100	4
	ET3019	Computer Organization and Architecture	3	2	10	30	10	30	20	100	
S4	ET3021	Digital Image Processing	3	2	10	30	10	30	20	100	4
	ET3015	Analog Circuits	3	2	10	30	10	30	20	100	
S5	ET3017	Engineering Design & Development 1	2	4	-	-	50	50	-	100	4
S6	ET3023	Seminar	-	2	-	-	-	100	-	100	1
<b>Total</b>											21

Abbreviations Used	
CA	Continuous Assessment
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
ESA	End Semester Assessment

Title: Course Structure

Branch: E&amp;TC

Year: T. Y.

Academic Year: 2018-19

Semester: II

Module: NA

FF No. : 653

Pattern: C-18

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)		Examination scheme					Total	Credits
			Theory	Lab	CA		MSE	ESA			
					HA	LAB		ESE	VIVA		
S1	ET3002	Digital Signal Processing	3	2	10	30	10	30	20	100	4
	ET3004	Robotics	3	2	10	30	10	30	20	100	
S2	ET3006	Digital Design	3	2	10	30	10	30	20	100	4
	ET3008	Antenna & Microwave Theory	3	2	10	30	10	30	20	100	
S3	ET3010	Biomedical Electronics	3	2	10	30	10	30	20	100	4
	ET3012	Machine Learning & Computer Vision	3	2	10	30	10	30	20	100	
S4	ET3014	Wireless Communication	3	2	10	30	10	30	20	100	4
	ET3016	Sensors & Internet of Things	3	2	10	30	10	30	20	100	
S5	ET3018	Engineering Design & Development 2	2	4	-	-	50	50	-	100	4
S6	ET3022	Summer Training	-	-	-	-	-	100	-	100	1
	ET3019	**Professional Development 1	-	-	-	-	-	-	-	-	-
	ET3020	**General Proficiency 2	-	-	-	-	-	-	-	-	-
<b>Total</b>											21

Abbreviations Used	
CA	Continuous Assessment
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
ESA	End Semester Assessment

(\*\*) Audit Course evaluated in second semester

**ET3001: Real Time Embedded Systems****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

ARM - Advanced Microcontroller: Structure of ARM7TDMI, ARM Pipeline, ISA Architecture, ARM Buses, THUMB Instructions, Interrupt Handling, Exceptions in ARM, I/O ports, Timers, Interrupts, on-chip ADC, DAC, RTC modules, WDT, PLL, PWM, and I2C Communication Protocols: RS-485, CAN, Profibus, Bluetooth, IEEE 802.11, and USB  
Hardware Software Partitioning: Partitioning using Integer Programming, Partitioning using Genetic Algorithm, Particle Swarm Optimization, Power aware Partitioning on Reconfigurable Hardware

**Section 2:**

Real-Time Operating System

Real-Time Tasks, Task Periodicity, Task Scheduling, Clock Driven Scheduling, Event Driven Scheduling, Resource Sharing, Commercial RTOS

Structure of  $\mu$ COS – IIKernel Structure, Task Management, Time Management, Semaphore Management, Event Flag Management, Message Mailbox Management, Message Queue Management, Memory Management, and Porting of  $\mu$ COS- II, Application Development**List of Practicals (Any Six):**

1. Interfacing of LEDs
2. LCD & Keypad
3. ADC & DAC
4. UART
5. Task Scheduling for Input and Output Devices (4X4 Keyboard, 16X2 LCD display and ADC) using  $\mu$ COS- II Semaphore
6. Implementation of Mutual Exclusion, Mailbox and Message Queue for 3 Tasks.

**List of Projects (Any One):**

1. Design of a Digital Display
2. Touch Screen Control Panel for Stepper Motor
3. Water Level Controller
4. Landmark Recognition
5. Control of 3 Devices using RS-485 Standard
6. Control of 3 Devices using CAN Protocol
7. Control of 3 Devices using Profibus

**Text Books:**

1. ARM Developers Guide, Sloss Andrew
2. Embedded System Design, CMP Books, Arnold S. Berger
3. Jean J. Labrosse, "MicroC OS II, The Real-Time Kernel", 2<sup>nd</sup> edition, CMP Books.
4. S. K. Mitra, "Digital Signal Processing- A Computer Based approach," Tata McGraw Hill, 1998.

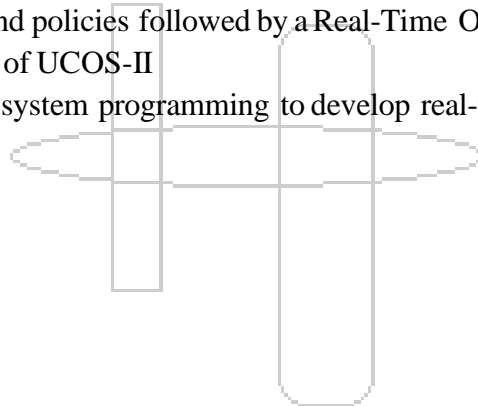
**Reference Books:**

1. Embedded / Real Time Systems Programming Black Book, Dreamtech Press, Dr. K.V.K.K. Prasad
2. Embedded System Design – A Unified hardware.
3. Software introduction" 3<sup>rd</sup> edition, Wiley, Frank Vahid and Tony Givargis.

**Course Outcomes:**

The student will be able to –

1. Comprehend architecture of ARM processor and its peripheral interfacing.
2. Implement RS-485, CAN and Profibus protocols
3. Understand approaches to solve hardware-software partitioning problems
4. Explain features and policies followed by a Real-Time Operating System.
5. Explain Structure of UCOS-II
6. Apply concepts of system programming to develop real-time embedded system





**ET3003: Power Electronics****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Power Devices:- SCR, Power Diode and BJT, Triac, MOSFET, IGBT- Structure, Characteristics, Selection criterion, Driver Circuits, Protection of power Devices: Snubber circuit, Series & parallel connection of devices.

DC Drives: Controlled bridge rectifiers and its analysis, DC Motors starting, characteristic and speed control, DC drive requirements.

AC Voltage Controllers: Configurations and operation, Applications.

**Section2:**

AC Drives: Single phase inverters – Working of push pull inverters, full bridge inverter with R and L load, Harmonic analysis of output voltage, Importance of PWM technique for voltage control

Induction motor- Starting, Characteristic and speed control, AC drive requirements.

Switched mode DC/DC Converters: Linear power supplies, switching power supplies without galvanic isolation- step down converters, step up converter, buck boost converter - continuous and discontinuous conduction. Switching dc power supplies with galvanic isolation - fly back converters, forward converters, push pull converters.

Applications: HF induction heating, RF heating, ON- line and OFF line UPS, battery selection and design considerations, Solar Photovoltaic (SPV) system.

**List of Practicals (Any Six): (Any 6)**

1. Driver circuit for SCR.
2. Single phase Half Controlled (Semi) converter
3. Single phase Fully Controlled (Full) converter
4. AC to AC Converter.
5. Single phase Bridge-inverter
6. MOSFET based PWM Chopper
7. Simulation of power electronic conversion system (AC-DC/ DC-DC), with suitable load.
8. Simulation of power electronic conversion system (DC-AC/AC-AC), with suitable load.
9. Study of SMPS
10. Study of UPS.

**List of Projects (Any One):**

1. Single phase Power Control (e.g. Fan speed regulator/ Lighting control)

2. Power Supply/Battery charger
3. DC motor speed control
4. Induction motor speed control
5. Emergency lighting system

**Text Books:**

1. M D Singh & K B Khanchandani, "Power Electronics", 2nd Edition, Tata McGraw Hill.
2. M. H. Rashid, "Power Electronics: Circuits, Devices, and Application", 2nd Edition, Prentice Hall (I)
3. B L Theraja & A K Theraja, "A Text Book of Electrical Technology - AC & DC machines", Volume II, S. Chand.

**Reference Books**

1. Ned Mohan, Tore Undeland, Williams Robbins, "Power Electronics: Converters, Applications, and Design", 2nd Edition, John Wiley & Sons.
2. P. C. Sen, Modern Power Electronics, S Chand & Co., New Delhi.

**Course Outcomes:**

The student will be able to –

1. Select power device for given voltage- current specifications.
2. Analyze DC Drives with controlled converter.
3. Analyze AC to AC converters
4. Analyze AC Drives with inverter.
5. Analyze, compare and select SMPS configuration.
6. Select power converters for real life applications.

**ET3005: VLSI Design****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

MOSFET: Introduction to MOSFET, MOSFET Capacitor, IV Characteristics, Motivation for Scaling, Types of Scaling, Short channel Effect, Velocity saturation, Mobility degradation, Subthreshold current, Threshold voltage variation, Drain induced barrier lowering (DIBL), Drain punch through, Hot carrier effect, Surface states and interface trapped charge. Combinational & Sequential Circuits, Semiconductor Memories: SRAM, DRAM cell, Access Time Consideration, ROMs

CMOS Fabrication & Layout: Inverter Cross-section, Fabrication Process – Twin well / Tub Technology, Silicon on Insulator (SOI), N-well / P-well Technology, Layout Design Rules, Gate layouts, Stick Diagrams, CMOS Inverter, CMOS logic Gates, Compound Gates.

Chip input and output circuits: ESD Protection, I/O circuits, On chip clock generation and distribution.

**Section 2:**

Propagation Delay in CMOS: CMOS Region of operation, Beta-n by beta-p ratio, Pseudo NMOS Inverter (Cascade pseudo NMOS, Saturated pseudo NMOS, Dependence of Propagation delay on Fan-in and Fan-out, RC-Delay, Elmore delay, Parasitic delay, Logical Effort – Basic logic circuits and multistage logic networks

Power Dissipation in CMOS: Effect of power dissipation, Temperature, Dynamic power dissipation - Activity Factor, Capacitance, Voltage, Frequency, Short-Circuit current; Static Power dissipation, multiple threshold voltages and oxide thicknesses, variable threshold voltages, input vectors control; Energy Delay optimization, Low Power CMOS logic circuits

Timing issues in digital circuits: Timing Classification of Digital Systems, Synchronous Interconnect, Synchronous Design, Self-Timed Circuit Design, Synchronizers and Arbiters, Clock Synthesis and Synchronization Using a Phase-Locked Loop.

**List of Practicals (Any Six):**

1. 2:4 Decoder
2. 3:2 priority encoder
3. 4 - bit adder
4. JK flip-flop
5. DRAM Cell
6. SRAM

**List of Projects (Any One):**

1. Design static CMOS circuit to realize FIFO / LIFO
2. Design static CMOS circuit to compute  $F = (A+B)(C+D)$ . Choose transistor sizes to achieve least delay and estimate this delay in T.
3. A static CMOS NOR gate uses four transistors, while a pseudo-nMOS NOR gate uses only three. Unfortunately, the pseudo-nMOS output does not swing rail to rail. If both the inputs and their complements are available, it is possible to build a 3-transistor NOR that swings rail to rail without using any dynamic nodes. Show how to do it.
4. Sketch a 3-input symmetric NOR gate. Size the inverters so that the pulldown is four times as strong as the net worst-case pullup. Label the transistor widths. Estimate the rising, falling, and average logical efforts.

**Text Books:**

1. Neil H. E. Weste, David Money Harris, CMOS VLSI Design, A circuits and Systems Perspective, Fourth Edition, Addison - Wesley
2. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Fourth Edition, Mc Graw Hill

**Reference Books:**

1. R. Jacob Baker, CMOS: Circuit Design, Layout and Simulation, Third Edition, Wiley
2. Neil H. E. Weste, Kamran Eshraghian, Principles of CMOS VLSI Design, Second Edition, Addison – Wesley
3. Douglas A Pucknell et al, Basic VLSI Design, 3rd Ed., Prentice Hall, 2004

**Course Outcomes:**

The student will be able to –

1. Determine MOSFET behavior under dimension scaling
2. Design CMOS based logic circuit
3. Demonstrate understanding of CMOS fabrication flow
4. Analyze delays in CMOS circuits
5. Understand power dissipation in CMOS circuits
6. Analyze clock signal variations and timing issues

**FF No. : 654****ET3007: Information Theory & Coding Techniques****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Introduction to Information theory, Discrete memory less channel, Entropy and its properties, Differential entropy and mutual Information, Information Capacity theorem.

Kraft's McMillan Inequality, Source coding theorem, Huffman coding, Shannon-Fano coding, Arithmetic Coding, Dictionary Techniques for lossless compression, Linear Block Codes- Syndrome and error detection, Error detection and correction capacity, Standard array and syndrome decoding, Encoding and decoding circuit, Single parity check codes

**Section 2:**

Cyclic Codes, generator polynomial, Generator matrix for systematic cyclic code, Encoding for cyclic code, Syndrome decoding of cyclic codes, Convolutional Codes, State diagram, Polynomial description of convolution code, Generator matrix of convolution code, Tree diagram, Trellis diagram, Viterbi decoding, Binary BCH code, Generator polynomial for BCH code, Decoding of BCH code, RS codes, generator polynomial for RS code, Decoding of RS codes.

**List of Practicals (Any Six):**

1. To determine Entropy and information rate for the given source.
2. To implement Huffman code.
3. To implement arithmetic code.
4. To implement LZ77 algorithm.
5. To implement LZ77 algorithm.
6. To implement LZW algorithm
7. To implement linear block codes.
8. To implement cyclic code.
9. To implement convolution code.
10. To implement Viterbi decoder

**List of Projects (Any One):**

1. Signal/Image compression with lossless/lossy compression techniques.
2. Text files compression with dictionary techniques.
3. Comparison of various channel coding Techniques.

**Text Books:**

1. “Information Theory coding and Cryptography”, Ranjan Bose , 2nd Edition , McGraw-Hill Publication.
2. “Analog and digital communications”, Hwei Hsu, second edition , Schaum’s outlines.

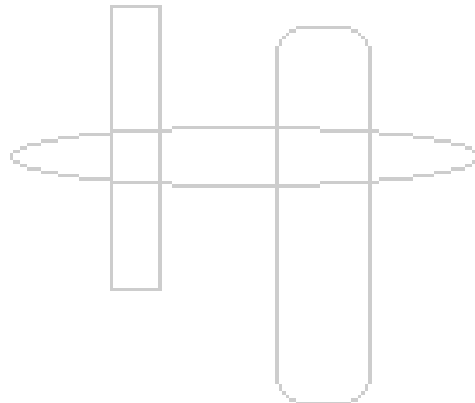
**Reference Books:**

1. “Digital Communication Fundamentals & applications”; Bernard Sklar, Second Edition , Pearson Education.
2. “Communication Systems”, Simon Haykin; Fourth Edition, John Wiley & Sons.
3. “Introduction to Data compression”, Khalid Sayood; Morgan Kaufmann Publisher.

**Course Outcomes:**

The student will be able to –

1. Evaluate the performance of source coding theorem based on entropy.
2. Analyze & implement lossless compression techniques.
3. Analyze linear block codes for error detection.
4. Decode cyclic code for error detection.
5. Generate Convolutional code & decode using Viterbi decoding.
6. Analyze RS code.



**FF No.: 654****ET3009: Data communication and Networking****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Network Architecture and OSI reference model

Introduction to Computer Networks, Topologies, Types of Networks, Layered Architecture of Computer Networks, OSI reference model, functions of each layer

Channel and MAC, Types of Channels, Signaling methods, Channel accessing methods, Error control and Flow control.

TCP/IP Protocol Suite: Introduction, Layers of TCP/IP protocol suite: Physical and Data Link Layers, Network Layer: Addressing, Ipv4 Addresses, Transport Layer: Process-to-Process Delivery, UDP, TCP, Application Layer.

**Section 2:**

LAN and WAN

Introduction to Local Area Networks, IEEE Standards for LANs, Wired LANs, Wireless LANs: IEEE 802.11, Channel Access Methods, Fast Ethernet, Gigabit Ethernet. SONET/SDH, Frame Relay, ATM, Wireless WANs

Network Management and Security

Network Management System, Network Management protocols, Network Security

Network applications and protocols

File transfer protocol, E-mail and the Web, multimedia applications such as IP telephony and video streaming- Overlay networks like peer-to-peer file sharing and content distribution networks- Web Services architectures for developing new application protocols.

**List of Practicals (Any Six):**

1. Prepare and test a straight through and crossover cable.
2. Implement a LAN for file/printer sharing
3. Implement Sliding window protocol
4. Implement Error correction and checking methods.
5. Design a client server environment to implement a web application.
6. Design a client server environment to implement a File transfer application.
7. Implement substitution and transposition algorithms
8. Implement a RSA algorithm
9. Implement a network and study for routing
10. Implement a network and study for addressing mechanism.

**List of Projects (Any One):**

1. Implementation of flow control protocols
2. Implementation of ARQ protocols
3. Design of a LAN for given conditions
4. Design of WAN for given condition
5. Implement a network and debug using network tools.
6. Development of Applications.

**Text Books:**

1. Computer Networks (3rd edition), Tanenbaum Andrew S., International edition,
2. Data communication and networking (4th edition), Behrouz A Forouzan, McGraw – Hill.

**Reference Books:**

1. Data and computer communication by William Stallings.
2. Computer Networking, James kurose& Keith Ross. , Low Price Edition.

**Course Outcomes:**

The student will be able to-

1. Describe OSI reference Model.
2. Design physical and data link layer functions and protocols of OSI model.
3. Analyze the TCP/IP Protocol Suite.
4. Design Local Area Networks and Wide Area Networks.
5. Describe management functions and security algorithms.
6. Develop application layer protocols.



**ET3019: Computer Organization and Architecture****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Basics: Functional Blocks in a Computer System, Number system and Computer Arithmetic and logic unit, Arithmetic and logical operation and implementation issues, Instruction Set and Addressing Modes, Machine instruction, Instruction formats, Instruction Execution Flow, CPU design, Processor organization, execution of complete instruction, design of control unit, micro programmed control unit.

**Section 2:**

Memory Architecture, Cache Memory, Memory Management, virtual memory, Input-Output, program controlled input output, interrupt control I/O, DMA, I/O buses, pipelining processors, Performance issues, branching, RISC processors, design issues of RISC.

**List of Practicals (Any Six):**

1. Write an assembly language code to implement data transfer.
2. Write an assembly language code to implement arithmetic instructions.
3. Write an assembly language code to implement logical instructions.
4. Write an assembly language code to implement floating point arithmetic.
5. Write an assembly language code to implement stack and branch instruction.
6. Study digital signal processor and its instructions.
7. Write a program to implement filter using DSP processor.
8. Study of logic analyzer.
9. Implement Booth's Multiplier.
10. Design and simulate Arithmetic Logic Unit.
11. Design and simulate Memory unit(4 x 4 RAM).

**List of Projects (Any One):**

1. Design a processor with minimum number of instructions, so that it can do the basic arithmetic and logic operations.
2. Simulate a word multiplier.
3. Simulate a word divider.
4. Construct an interpreter written in C language to interpret an assembly language based on the following basic instructions for a machine having only one register, which is accumulator, and all the operands are in memory X:
  - a. ADD X : Add content of X to accumulator
  - b. SUB X : Subtract content of X from accumulator

- c. MUL X : Multiply content of X with accumulator
  - d. DIV X : Divide content of X by accumulator
  - e. AND X : Logical AND, content of X with accumulator
  - f. NOT : invert the content of accumulator.
5. Design an instruction set for a limited functionality machine having all instructions of 8-bits fixed length only, including opcode and operands.
  6. Design a minimal CPU architecture for controlling the washing machine.
  7. Write program to generate assembly code from prefix code.
  8. Design a high speed addition method and logic for 4-bit addition.

**Text Books:**

1. William Stallings. "Computer organization and architecture: designing for performance". Pearson Education India, 2000
2. Carl Hamacher, Zvonko Vranesic and Safwat Zaky. "Computer Organization", McGraw Hill, 2011.

**Reference Books:**

1. David A. Patterson, John L. Hennessy. "Computer organization and design: the hardware/software interface". Elsevier, 2011.

**Course Outcomes:**

The student will be able to –

1. Explain the basics of computer hardware
2. Demonstrate basic operations with signed and unsigned integers in decimal and binary number systems.
3. Summarize basics of Instruction Set Architecture
4. Develop memory organization that uses banks for different word size operation
5. Outline the concept of input output organization.
6. Develop scheme for Performance Enhancement of Processor.

**FF No. : 654****ET3021: Digital Image Processing****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week**

**Prerequisite:** Students are expected to have knowledge in linear signals and systems, 1-D Fourier Transform, basic linear algebra, basic probability theory and basic programming techniques; knowledge of Digital Signal Processing is desirable.

**Section 1:**

Introduction to FFT and Digital Filters, Elements of visual perception, Image sampling & Quantization, Basic grey level transformations, histogram processing, enhancement using arithmetic and logic operators, spatial filtering – smoothing and sharpening filters, Median Filter, Inter pixel and image redundancy, 2-D Discrete Fourier Transform and Discrete Cosine Transform, Walsh Hadamard Transform, Fast Walsh Transform, Wavelet Transform, Hough Transform, Neighborhood concepts, adjacency and distance measures, dilation & erosion, opening & closing operations, basic morphological operations such as region filling, thinning, thickening, skeletons, Morphological operations for gray scale images

**Section2:**

Detection of discontinuities, edge linking and boundary detection, thresholding, Region based segmentation, use of watersheds, image representation- chain codes, boundary descriptors Compression Fundamentals, Image Compression Models, Error Free Compression, Lossless Predictive Coding, Lossy Predictive Coding, Image Compression Standards – Baseline JPEG, Various Noise Models, Inverse and Wiener Filtering, Image Registration, Mutual Information, Maximum entropy restoration

**List of Practicals (Any Six):**

1. Image quantization, bit plane slicing
2. Image histogram and thresholding
3. Image enhancement
4. Image filtering
5. Edge detection
6. Mathematical, logical operations
7. Morphological operations
8. Application of DFT, DCT
9. Inverse & Wiener filtering
10. Image Registration & Mutual Information

**List of Projects (Any One):**

1. Watershed based segmentation
2. Enhancement and thresholding of medical image
3. Currency recognition
4. Vehicle number plate extraction
5. Count number of similar objects in an image
6. Noise removal
7. Detection of annual rings in wood

**Text Books:**

1. Digital Image Processing, Gonzalez, Woods, Prentice Hall India, 2nd edition
2. Digital Image Processing, Pratt W.K., John Wiley, 2001

**Reference Books**

1. Fundamentals of Digital Image Processing, Jain A.K., Prentice Hall India, 1997
2. Image Processing, Analysis & Machine Vision, Milan Sonka, Thomson Publication

**Course Outcomes:**

The Student will be able to-

1. Perform various enhancement operations
2. Analyze image using morphological techniques
3. Apply segmentation techniques to divide image into parts
4. Use various image transforms to analyze and modify image
5. Apply image compression approaches
6. Apply image registration techniques

**FF No.: 654****ET3015: Analog Circuits****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Fundamentals of Op-amp: Introduction of operational amplifier, block diagram, voltage transfer characteristics, differential amplifier, current sources, level shifting stage, output stage, op-amp configurations.

Op-amp Parameters: Op-amp parameters like input offset voltage, output offset voltage input offset current, input bias current, CMRR, PSRR, slew rate, small signal and power bandwidth, ideal and practical op-amp, frequency compensation of op-amp, Comparison of op-amp ICs based on parameters, Selection of op-amp for different applications.

Linear Applications of Op-amp: Designing various mathematical operations such as summing, averaging, differencing integrating, differentiating using op-amp., Log and antilog amplifiers, temperature compensated log circuits, Analog multipliers, Instrumentation amplifier.

**Section 2:**

Non-Linear Applications of Op-amp: Open loop and closed loop comparators, Limitations of op-amp as comparator, Window comparator and its applications, Wave shaping circuits, Precision rectifiers, Analog Filters.

Oscillators: Positive feedback and Oscillators, RC Phase Shift Oscillator, Wien Bridge Oscillator, LC oscillators, Multi-vibrator circuits.

Phase Locked Loop: PLL fundamentals, VCO, block diagram, working principle, modes of operation, PLL IC, design problems, PLL Applications like frequency multiplier, FM demodulator, AM Demodulator.

**List of Practicals (Any Six):**

1. Design and testing of Summing Amplifier Circuit
2. Design and testing of Integrator Circuit
3. Design and testing of Differentiator Circuit
4. Design and testing of Open Loop Comparators
5. Design and testing of Closed Loop Comparators
6. Design and testing of Wien Bridge Oscillator
7. Design and testing of Precision Half Wave and Full Wave Rectifier
8. Design and testing of wave shaping circuits
9. Design and testing of Astable Multi-vibrator
10. Design and testing of Mono-stable Multi-vibrator

**List of Projects (Any One):**

1. Develop analog computer prototype
2. Water/Temperature level detector
3. Develop function generator with specified parameters
4. Develop applications of Window comparator Circuits
5. Develop audio control circuit
6. Develop applications using PLL

**Text Books**

1. D. Roy Choudhary, 'Linear Integrated Circuits', 4<sup>th</sup> edition, New age
2. Ramakant Gaikwad, 'Op amps and linear integrated circuits,' 4<sup>th</sup> edition, PHI.

**Reference Books**

1. Sergio Franco, 'Design with operational amplifiers and analog integrated circuits', TMH, 3<sup>rd</sup> edition.
2. Coughlin and Discroll, 'operational amplifiers and linear integrated circuits,' 6<sup>th</sup> Edition, PHI.

**Course Outcomes**

The students will be able to

1. Illustrate fundamentals of op-amp in terms of block diagram
2. Apply knowledge about parameters in practical applications.
3. Design linear applications of op-amp.
4. Design non-linear applications of op-amp.
5. Develop function generator circuits
6. Design phase locked loop applications.

**ET3017: Engineering Design & Development 1****Course Prerequisites:**

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

**Course Objectives:**

11. To develop critical thinking and problem-solving ability by exploring and proposing solutions to realistic/social problems.
12. To Evaluate alternative approaches, and justify the use of selected tools and methods,
13. To emphasize learning activities those are long-term, inter-disciplinary and student centric.
14. To engage students in rich and authentic learning experiences.
15. 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:

17. Formation of project group comprising of 4-5 students. Multidisciplinary groups are allowed
18. A supervisor/mentor teacher assigned to individual groups.
19. Carrying out literature survey
20. Finalization of problem statement
21. Planning the project execution
22. Execution of project and testing
23. Writing a report
24. Publication in the form of research paper/patent/copyright as found suitable by supervisor/mentor

**Teacher's Role in PCL:**

9. Teacher is not the source of solutions rather he will they act as the facilitator and mentor.
10. To utilize the principles of problems solving, critical thinking and metacognitive skills of the students.
11. To aware the group about time management.
12. 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:**

15. Students must have ability to initiate the task/idea they should not be mere imitators.
16. They must learn to think.
17. Students working in PCL must be responsible for their own learning.
18. Students must quickly learn how to manage their own learning, Instead of passively receiving instruction.
19. Students in PCL are actively constructing their knowledge and understanding of the situation in groups.
20. Students in PCL are expected to work in groups.
21. 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**

- 11) VLSI Design
- 12) Embedded Systems
- 13) Signal Processing
- 14) Communication
- 15) Machine learning

**Assessment Scheme:**

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

**MOOCs Links and additional reading material:**

[www.nptelvideos.in](http://www.nptelvideos.in)  
<https://worldwide.espacenet.com/>

**Course Outcomes:**

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

7. Review the literature to formulate problem statement to solve real world problems (PO2,PO4) :  
LEVEL 3
8. Apply knowledge of technology and modern tools to design solution considering sustainability and environmental issues (PO1, PO3, PO4,PO5, PO6, PO7, PO12) LEVEL 4
9. 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

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**CO attainment levels:**

CO1: - Level 3

CO2: - Level 4

CO3: - Level 3

CO4: - Level 4

FF No. : 654

**ET3002: Digital Signal Processing****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Basic elements of DSP and its requirements, advantages of Digital over Analog signal processing. Discrete Fourier transform, DFT properties, computation of linear convolution using circular convolution, Linear filtering using overlap add and overlap save method, FFT algorithms, decimation in time and decimation in frequency using Radix-2 FFT algorithm, Goertzel algorithm, Z transform, relation between Laplace transform and Z transform, relation between Fourier transform and Z transform, properties of Z transform, relation between pole locations and time domain behavior, causality and stability considerations for LTI systems, Inverse Z transform.

**Section 2:**

Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, design of linear phase FIR filter using windows and frequency sampling method. FIR filters realization using direct form and cascade form. Finite word length effect in FIR filters design. Design of IIR filters from analog filters, Impulse invariant method, relationship between analog and digital frequencies, Bi-linear Transformation Method, comparison of Impulse-variance and Bi- linear Transformations, IIR filter specifications, Realization of IIR filters-Direct I and Direct II form structure, cascade structure, Parallel form structure. Introduction to lattice structure. Introduction to multirate signal processing: Interpolation, decimation, implementation of sampling rate conversion: polyphase filter structure.

**List of Practicals (Any Six):**

1. Perform discrete time signal analysis using FFT.
2. To perform linear convolution of two sequence using DFT.
3. To filter the long data sequence using overlap add/save algorithm.
4. To determine z-transform from the given transfer function and its ROC
5. Test discrete time systems for stability and causality using Z-transform.
6. Implement different window functions and observe the effect of different windows on FIR filter response.
7. Design Butterworth filter (IIR) using bilinear transformation method and plot its frequency response.
8. To analyze coefficient quantization effects on the frequency response of an IIR filter.
9. Design sampling rate converter for given specification.

10. Design an appropriate filter to extract the information from noisy signal.

**List of Projects (Any One):**

1. ECG Signal Analysis
2. Speech Enhancement using Spectral Subtraction Method
3. Musical Instrument Identification
4. Audio Equalizer
5. Speech Recognition
6. DTMF Encoder and Decoder
7. Correcting the geometrical orientation of text in an image using discrete Fourier transform
8. Real time filtering using overlap-save or overlap-add method
9. Audio Effects Generation
10. Voice Activity Detector

**Text Books:**

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing-Principles, algorithms and applications," PHI, 1997.
2. E.C. Ifeachor and B.W. Jervis, "Digital signal processing – A practical approach," Pearson Edu., 2nd edition, 2002.
3. S. K. Mitra, "Digital Signal Processing- A Computer Based approach," Tata McGraw Hill, 1998.

**Reference Books:**

1. Ramesh Babu, "Digital Signal processing," Scitech publications, 2001.
2. Shalivahanan, Valavraj, Gnanapriya C., "Digital Signal Processing," TMH, 2001.
3. Li Tan, Jean Jiang, "Digital Signal Processing: Fundamentals and applications," Academic press.

**Course Outcomes:**

The student will be able to –

1. Apply DFT to analyze discrete time signals.
2. Compare computational complexity of DFT and FFT algorithm.
3. Analyze LTI systems using Z-transform.
4. Design linear phase FIR filter of given Specifications.
5. Design IIR filter of given Specifications from equivalent analog filter.
6. Implement sampling rate converter.

**ET3004: Robotics****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Basics of Robot :Specification of a Robot, Classification of Robots, Robot Components, Robot Degree of Freedom, Robot Coordinates, robot Programming, applications. Robot kinematics: Position and orientation representations, homogeneous transformations, frames, D- H convention, forward kinematics, inverse kinematic. Robot Sensors: Classes of tactile and non-tactile sensors, working principles, mathematical modelling of sensors, multi-sensor integration, control issue.

**Section2:**

Robot Actuators: Classes of robot actuators, working principles, mathematical modelling of actuators, mechanical construction and control issues. Path Planning: Path types, point-to-point-motion, continuous path motion, spline interpolation, trajectory planing. Robot Programming: Hardware and software architectures of robot controllers, robot programming paradigms, robot programming languages.

**List of Practicals (Any Six):**

1. Simulation of degree of freedom
2. Simulation of homogeneous transformation
3. Simulation of forward and inverse kinematic
4. Interfacing of proximity sensor with microcontroller
5. Interfacing of actuator with microcontroller
6. Simulation of point-to-point motion
7. Simulation of continuous path motion
8. Simulation of joint space trajectory trajectory
9. Simulation of Cartesian space trajectory
10. Simulation of joint space trajectory with via-points

**List of Projects (Any One):**

1. Harvest bot
2. Pick and place bot
3. Wall follower Bot
4. Maze solver bot
5. Obstacle avoidance bot
6. Line follower bot

**Text Books:**

1. John J. Craig “Introduction to robotics: Mechanics and Control”, Prentice Hall, 2004.
2. P. M. John, “Introduction to robotics”, Wesley, 1991.
3. M. W. Spon, M. Vidyasagar, “Robot Dynamics and Control”, Wiley and Sons, 1996.

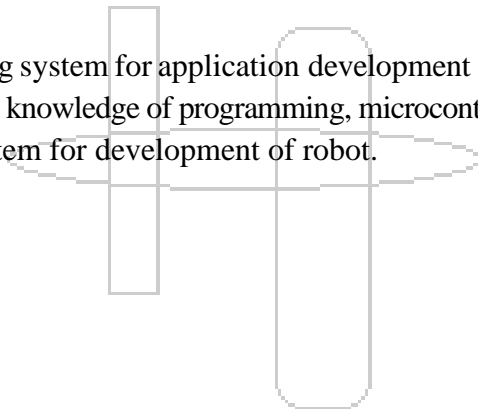
**Reference Books:**

1. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, “Robotics: Control, Sensing, Vision and Intelligence”, McGraw Hil Education (India Ed.).
2. T. R. Kurfess, “Robotics and Automation Handbook”, CRC Press.

**Course Outcomes:**

The student will be able to –

1. Translate specifications to the components of robots such as arms, linkage, drive system and end effector
2. Understand the mechanics and kinematics of robot
3. Select sensors for a given applications
4. Demonstrate use of engineering methods and problem solving toward design of specified robot.
5. Use robot operating system for application development
6. Apply pre-requisite knowledge of programming, microcontroller, sensor interfacing, and operating system for development of robot.



**FF No. : 654****ET3006: Digital Design****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Reconfigurable hardware

Design options for digital systems, Standard Chips, PLDs, FPGAs and ASICs. VLSI design flow. Role of hardware description languages, motivation. Concurrency in hardware, Concept of delta delay. Concept of Micro architecture.

Introduction to Verilog HDL: Levels of Design Description, Concurrency. Verilog Language Constructs and Conventions: Introduction, Keywords, Identifiers, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Operators

Gate Level Modeling: Introduction, Module Structure, Gate Primitives, Tristate buffers, Design of Flip-Flops with Gate Primitives, Net Types, Delay models.

Switch level modeling: MOS switches, CMOS switch, bidirectional switch.

Dataflow Modeling: Introduction, Continuous Assignment Structure, Delays and Continuous Assignments, Assignment to Vector, Operators, user defined primitives.

Test bench: Self checking test bench

Behavioral modeling: Procedural constructs- initial & always block, procedural assignments – blocking and nonblocking statements, difference in blocking and nonblocking statements, active region, inactive region, event scheduling under stratified event queue, event scheduling in Verilog, delay timing control, selection statements- if-else, case, iterative statements- while, for, repeat, forever loop.

**Section 2:**

Datapath and control path elements: Use of Tasks and functions to design FSM, Subsystem Design, Shifters, Adders, ALUs, Multipliers, Parity generators, Comparators, Zero/One Detectors, Counters, RAM, ROM.

Synthesis: Latch inference, code optimization, Coding guidelines for clocks and resets. High Level Synthesis.

Verification: Functional verification, formal and simulation based, test bench design, clock signal generation, reset signal generation, verificational coverage, Dynamic timing analysis, static timing analysis.

**List of Practicals (Any Six):**

1. To demonstrate the use of gate level modeling (FA)
2. To demonstrate the use of dataflow modeling (MUX , DMUX, LATCH)

3. To demonstrate the use of behavioral modeling (always statement, blocking & non blocking
4. statements, case statement, combinational circuit description) (MUX, DMUX, decoder, encoder, parity detector)
5. To demonstrate the use of behavioral modeling (always statement, case statement, combinational circuit description) (ALU, code converters)
6. To demonstrate the use of behavioral & structural modeling (flip flop, shift registers)
7. To demonstrate the use of behavioral modeling (up-down counter)
8. To demonstrate the use of behavioral modeling (consecutive ones counter)
9. To demonstrate the use of behavioral modeling (state machine based system)
10. To demonstrate the use of behavioral modeling (RAM, ROM)
11. To demonstrate the use of behavioral modeling (Multipliers, adders)

**List of Projects (Any One):**

Project based on design, verification and synthesis of functionality like I2C protocol, SPI protocol, RAM, FIFO, vending machine etc.

**Text Books:**

1. Samir Palnitkar; Verilog HDL; 2nd Edition, Pearson Education, 2009
2. Michel D. Ciletti; Advanced Digital Design with Verilog HDL; PHI, 2009

**Reference Books:**

1. Zainalabdien Navabi; Verilog Digital System Design; 2nd Edition, TMH
2. Stephen Brown, Zvonko Vranesic; Fundamentals of Digital Logic with Verilog Design; 2<sup>nd</sup> Edition, TMH
3. Sunggu Lee; Advanced Digital Logic Design using Verilog, State Machines & Synthesis for FPGA; Cengage Learning, 2012.

**Course Outcomes:**

The student will be able to –

1. Explain VLSI design flow and basics of Verilog HDL.
2. Develop functionality of combinational circuits using Verilog HDL.
3. Develop functionality of sequential circuits using Verilog HDL.
4. Propose breaking up of large procedures into smaller ones to make it easier to read and debug the source description.
5. Choose Verilog HDL statement for coding and synthesis optimization
6. Test and verify the functionality described by Verilog HDL



**FF No. : 654****ET3008: Antenna and Microwave Theory****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section1:**

Fundamental Concepts of Antennas:

Overview of Maxwell's Equation for time varying fields, Poynting's Theorem, Retarded Potential, Physical concept of radiation, Fields associated with Hertzian dipole, 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 &amp; Aperture Antennas

Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop. Huygens' principle, radiation from rectangular and circular apertures.

Microwave Transmission Lines

Overview of Microwave communication: Microwave communication system, Advantages and applications of Microwaves: Rectangular Waveguides – TE/TM mode analysis, Expressions for Fields, Characteristic Equation and Cut-off Frequencies, Dominant Modes. Mode Characteristics – Phase velocity and Group Velocity. Power Transmission and Power Losses in Rectangular Waveguide.

**Section 2:**

Waveguide Components and Applications

Cavity Resonators– Introduction, Rectangular and Cylindrical Cavities, Dominant Modes and Resonant Frequencies.

Waveguide Multiport Junctions – E plane Tee, Magic Tee.

Ferrite Components – Gyrotator, Isolator. Scattering Matrix– Significance, Formulation and Properties.

Microwave Tubes

Limitations and Losses of conventional tubes at microwave frequencies.

Microwave tubes – O type and M type classifications.

O-type tubes : 2 Cavity Klystrons – Structure, Velocity Modulation Process and Applegate Diagram, Bunching Process, Expressions for o/p Power and Efficiency.

HELIX TWTS: Significance, Types and Characteristics of Slow Wave Structures; Structure of TWT, Expressions for o/p Power and Efficiency.

M-type Tubes: Introduction, Cross-field effects, Magnetrons – Different Types, 8-Cavity Cylindrical Travelling Wave Magnetron – Hull Cut-off, Modes of Resonance and PI-Mode Operation, o/p characteristics.

Microstrip Antennas

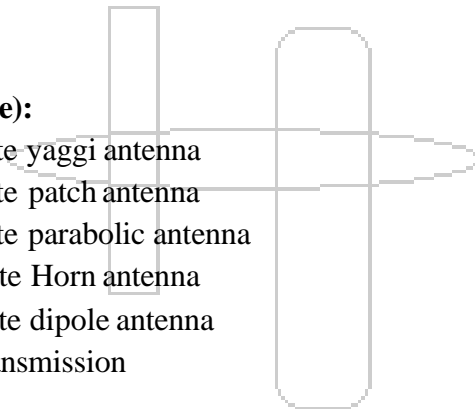
Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.

**List of Practicals (Any Six):**

1. Simulate antenna using HFSS software
2. Design and simulate of antenna arrays
3. Study of Microwave components
4. Study the characteristics of Reflex klystron
5. Study V-I characteristics of Gunn diode.
6. Study port parameters of Magic Tee.
7. Plot radiation pattern of Horn antenna using microwave bench.
8. Study port parameters of Circulator
9. Calculate port parameters of Circulator
10. Calculate Directivity, Coupling factor and insertion loss for 10 dB / 20 dB Directional Coupler

**List of Projects (Any One):**

1. Design and simulate yaggi antenna
2. Design and simulate patch antenna
3. Design and simulate parabolic antenna
4. Design and simulate Horn antenna
5. Design and simulate dipole antenna
6. Wireless power transmission

**Text Books:**

1. Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3rd Edition .
2. Micro Wave and Radar Engineering – M. Kulkarni, Umesh Publications
3. Antenna and Wave Propagation - K.D. Prasad, Satya Prakashan

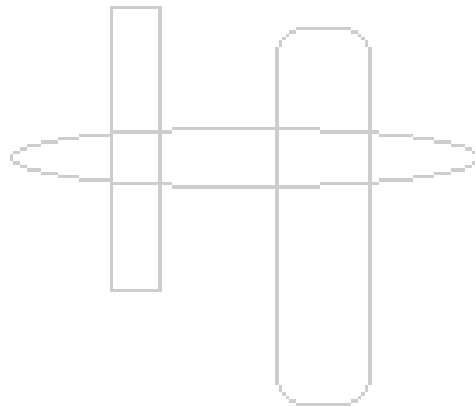
**Reference Books:**

1. Elements of Microwave Engineering – R. Chatterjee, Affiliated East-West Press Pvt. Ltd., New Delhi, 1988.
2. Microwave Engineering Passive Circuits – Peter A. Rizzi, PHI, 1999
3. Antennas For All Applications – John D.Kraus,3rd Edition
4. Antenna and wave propagation - A. R. Harish, M, Sachidananda

**Course Outcomes:**

The student will be able to –

1. Analyze antenna measurements to assess antenna's performance
2. Know the concept of radio wave propagation
3. Analyze microwave channel mathematically.
4. Analyze microwave components mathematically.
5. Interpret microwave sources mathematically.
6. Illustrate the different types of arrays and their radiation patterns.



**ET3010: Biomedical Electronics****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Diagnostic and Therapeutic Equipment: Cardiac Life support Equipment, Respiratory Care Equipment, ICU & Life Support Equipment, Haemodialyzers and Lithotripters, Diathermy and Radiotherapy. Medical device regulations and standards.

Cardiological Signal Processing:

Automated ECG analysis. QRS detection methods. Rhythm analysis. Arrhythmia detection algorithms. ECG pattern recognition. ECG acquisition and transmission. Noise canceling methods to enhance ECG monitoring.

Neurological Signal Processing:

Modeling of EEG signal. Linear production. Detection of spike and spindles. Detection of alpha, beta and gamma waves. Modeling of seizure EEG. Sleep stages.

**Section 2:**

Radiography: X-Ray, generation of CT, spiral CT, mammography, computed radiography (CR). Magnetic resonance imaging: image acquisition and reconstruction, fast imaging methods, functional imaging, FMRI

Ultrasonic Imaging and Nuclear Imaging: Generation and detection of ultrasound, B-mode, M-mode TM-mode processing, Data acquisition and reconstruction of Doppler image, pulsed wave Doppler, NMI-Radioactive decay modes, data acquisition.

Medical Optics: Optical properties of tissues, Biophotonic Diagnostics: optical biosensors, glucose analysis, flowcytometry, cellular tissue imaging, Optical Coherence Tomography. Photodynamic therapy applications: LASER tissue welding, LASER in dermatology, neurosurgery, ophthalmology and urology.

**List of Practicals (Any Six):**

1. Determination of Heart Axis by measuring QRS amplitude in the different leads (Lead I, Lead II and Lead III) and Plotting Einthoven Triangle.
2. To study and testing of ECG signal
3. To study and testing of EEG signal
4. Study, Design and measurement of respiration rate using different sensors.
5. Spectrum analysis & Noise removal of biomedical signals.

6. Algorithm for Adaptive Noise Canceling.
7. Implementation of Template matching algorithm for QRS detection.
8. Implement algorithm for Classification of EEG waves.
9. To measure the components in EEG Signal and Heart Rate Variability in ECG signal simultaneously to understand the inter-relations amongst various physiological parameters
10. Segmentation of lesions from the biomedical images

**List of Projects (Any One):**

1. Design a Heart rate meter
2. Design a SpO<sub>2</sub> sensor.
3. Design PFT sensor
4. Design and testing of Electronic stethoscopes.
5. Design and testing of Electronic Blood Pressure Meters
6. Design, testing and calibration of Digital pH meter using glass electrode.

**Text Books:**

1. Khandpur R. S., Handbook of Bio-Medical Instrumentation, Tata McGraw Hill, 2nd Ed., 2003.
2. Joseph J.Carr and John M. Brown, Introduction to Biomedical equipment technology, John Wiley and sons, New York, 1997
3. Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice-Hall, 1993.
4. S Webb, "The Physics of Medical Imaging", Adam Highler, Bristol Published by CRC Press, 1988
5. Ed., Tuan Volume Dinh, "Biomedical Photonics Handbook", CRC Press, 2003.

**Reference Books:**

1. John G. Webster Encyclopedia of Medical Devices and Instrumentation
2. Rangaraj M. Rangayyan, Akay Metin(Editor), Biomedical Signal Analysis: A Case Study Approach, Wiley Interscience, 2001.
3. Hykes, Heorick, Starchman, Ultrasound physics and Instrumentation MOSBY year book.
4. Zhi-Pei Laing and Paul C. Lauterbur, Principles of Magnetic Resonance imaging –A signal processing perspective, Metin Akay (Editor), IEEE press, New York, 2000.
5. Koebmer K R, "Lasers in Medicine", John Wiley & Sons.

**Course Outcomes:**

The student will be able to-

1. Design and test the basic Diagnostic and Therapeutic Equipment
2. Implement various algorithms for automatic ECG analysis.
3. Model and detect various EEG patterns.

4. Implement the image acquisition and reconstruction methods in radiography.
5. Demonstrate Data acquisition and reconstruction of Doppler image.
6. Develop applications of LASER in medical field.

**FF No. : 654****ET3012: Machine Learning and Computer Vision****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Human Vision System, Computer Vision System, Camera Geometry Fundamentals, Feature detection, feature extraction – representation and attributes, image representation – chain code, polygonal approximation, object description – boundary and region description, Image registration – feature matching, geometric transformation, mapping

**Section2:**

Introduction to machine learning, Linear Regression, Linear Classification, Bayesian Learning and Decision Trees, Linear Discriminant analysis, Support Vector machines, Evaluation Measures and learning models, Clustering, Reinforcement Learning, ANN: perceptron and BP algorithm

**List of Practicals (Any Six):**

1. Implementation of SIFT / HOG object detector
2. Implement KNN classifier
3. Implement object tracking
4. Implement image registration
5. Implement Naïve Bayes classifier
6. Implement chain code representation
7. Implement k means clustering
8. Implement SVM classifier
9. Neural Networks and Perceptron Example
10. Multilayer Perceptron and Application

**List of Projects (Any One):**

1. Naïve Bayes classification based projects.
2. Perceptron and linear SVM based projects.
3. Linearly non discriminant data based projects.
4. Clustering technique based projects.

**Text Books:**

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Publication.
2. Forsyth and Ponce, "Computer Vision-A Modern Approach", 2nd Edition, Pearson Education.
3. R. O. Duda, P.E.Hart, and D.G.Stork," Pattern Classification", 2nd edition, Springer, 2007.
4. Theodoridis and Koutrombas," Pattern Recognition", 4th edition, Academic Press, 2009

**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. Ludmila I.Kuncheva,"Combining pattern classifiers", John Wiley and sons Publication.
4. Ethem Alpaydin,"Introduction to Machine Learning",The MIT press.

**Course Outcomes:**

The student will be able to-

1. Develop feature vectors for object detection purpose.
2. Select algorithm for object recognition.
3. Discuss image registration techniques.
4. Discuss the concept of machine learning.
5. Classify data/ signal using supervised classifiers.
6. Classify data/ signal using unsupervised classifiers.



**FF No. : 654****ET3014: Wireless Communication****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Introduction to Wireless Communication Systems, Examples of Wireless Communication Systems, Trends in Cellular Radio and Personal Communications.

Modern Wireless Communication Systems: Second Generation (2G) Cellular Networks, 2.5G, Third Generation (3G) wireless Networks,

The Cellular Concept: Introduction, Frequency Reuse, Channel Assignment strategies, Hand off Strategies, interference and system capacity, improving coverage and capability in Cellular Systems.

Introduction to Radio wave propagation, free space propagation model, propagation mechanisms, Practical Link Budget design using path loss models, Outdoor propagation models, Indoor propagation models, signal penetration into buildings, Ray tracing and sitespecific modeling.

Small Scale Multi path propagation, small scale multi-path measurements, parameters of mobile multi path channels, Types of small scale fading, Examples of fading behavior.

**Section 2:**

Performance Evaluation, Signaling Evaluation, Measurement of Average received level & level crossings, Spectrum Efficiency Evaluation, Effects & interferences caused by portable units.

Mobility Management Functions, Mobile Location Management, Mobility Model, Mobile Registration, GSM Token-Based Registration, IMSI Attach and IMSI Detach (Registration and Deregistration) in GSM, Paging in GSM , Handoff , Handoff Techniques , Handoff Types , Handoff Process and Algorithms, Handoff Call Flows

Common Channel Signaling, Integrated Services Digital Network (ISDN), Introduction to Signaling System No.7(SS7), Global System for mobile (GSM), CDMA, Digital Cellular Standard (IS-95)

**List of Practicals (Any Six):**

1. Simulation of Rayleigh Fading Channel
2. Simulation of Rician Fading Channel
3. Implementation of IEEE 802.16d model.

4. Simulate Two Ray model to determine the free space loss and the power received
5. Simulate fading environment and loss based on Okumura Hata Model.
6. Simulate multipath fading channels based on COST 207 model.
7. Calculation of worst case cochannel interference ration for different constellations.
8. Simulate BER performance of DS-CDMA in multipath channel for single user case
9. simple OFDM system for transmitting audio data over frequency selective fading channel
10. Simulate multiple-input multiple-output (MIMO) multipath fading channels based on the IEEE® 802.16 channel models for fixed wireless applications.

**List of Projects (Any One):**

1. OFDM
2. Free Space Propagation
3. DS-CDMA
4. MIMO
5. Up & Down Conversion in Passband Communication
6. Fading

**Text Books:**

1. Wireless Communications- Principle and practice, Theodore S, Rappaport, Second edition, PHI
2. Mobile Communications, Jochen Schiller, Second Edition, Pearson Education.

**Reference Books:**

1. Heysik Kim, 'Wireless Communications Systems Design', Wiley Publications,
2. Vijay Garg, 'Wireless Communications & networking', Morgan Kaufman Series in networking.
3. Andrea Goldsmith, 'Wireless Communications', Cambridge University Press
4. William C.Y. Lee, 'Wireless & Cellular Telecommunication', McGraw Hil, 3<sup>rd</sup> Edition

**Course Outcomes:**

The student will be able to –

1. Differentiate four generations of wireless standard for cellular networks.
2. Determine the type and appropriate model of wireless fading channel based on the system parameters and the property of the wireless medium.
3. Spell the trade-offs among frequency reuse, signal-to-interference ratio, capacity, and spectral efficiency
4. Evaluate performance of systems
5. Explain mobility in wireless communication System.
6. Describe wireless standards

**FF No. : 654****ET3016: Sensors and Internet of Things****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Introduction to Internet of Things, Definitions and Frameworks, IoT Architecture: topologies, edge routers, client-server architecture, P2P, M2M, IoT functional blocks, Characteristics of IoT, Physical and Logical design of IoT.

Sensors: Working Principles, Selection of Sensors for Practical Applications, Introduction of Different Types of Sensors such as Displacement and position sensors, Proximity sensors, Velocity, Motion, Force and Pressure sensors, Temperature and Light sensors, etc., Signal Conditioning Devices, Equivalent circuit of Sensors and Modelling of Sensors.

Difference between smart sensor and intelligent sensor, Importance and Adoption of Smart Sensors, Architecture of Smart Sensors: Important components, their features, System design of an IoT System - Power supply, Processor, Memory Sensor Interface, Different hardware platforms for IoT.

**Section 2:**

IoT Communication Model, IoT networking: IPv6, 6LowPAN, CoAP, and various sensor networks protocols (collision avoidance, buffering, reliability), Sensors connectivity and network layer, Gateway layer, Device - device, Device - Cloud, Device - Gateway, Gateway - Cloud.

IoT Cloud platforms, Cloud computing: web services, HTTP, RESTful interactions, service discovery, databases, API, Introduction to Fog and Mist Computing.

Challenges in IoT: Design challenges, Development challenges, Security challenges, Design and development of Security and Privacy Technologies related to IoT.

**List of Practicals (Any Six):**

1. Setting up the Raspberry Pi
2. Temperature measurement using LM35
3. Intrusion Detection using IR transmitter-receiver
4. Distance measurement using Ultrasonic sensor
5. Temperature measurement using DHT11
6. Raspberry Pi as a webserver
7. Transferring the sensor data to webpages

8. Email alert using SMTP protocol
9. Twitter alert using HTTP protocol
10. Text transfer MQTT protocol on Raspberry Pi

**List of Projects (Any One):**

1. Smart Home
2. Mobility and Transport
3. Energy Usage Monitoring
4. Smart Grid
5. Air Quality Monitor
6. Anti-Lost Device
7. Smart Clock
8. Smart Parking

**Text Books:**

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", (CRC Press)
2. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", (Universities Press)

**Reference Books:**

1. Ovidiu Vermesan & Peter Friess "Internet of Things Applications - From Research and Innovation to Market Deployment", ISBN:987-87-93102-94-1, River Publishers
2. Joe Biron and Jonathan Follett, "Foundational Elements of an IoT Solution," by Joe Biron

**Course Outcomes:**

The student will be able to –

1. Demonstrate the fundamental concepts of Internet of Things.
2. Select sensors for different IoT applications.
3. Design IoT applications in different domains.
4. Apply basic protocols in Wireless Sensor Networks for communication.
5. Interface sensor data to cloud platforms.
6. Analyze different challenges in implementing IoT applications.

**ET3018: Engineering Design & Development 2****Course Prerequisites:**

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

**Course Objectives:**

16. To develop critical thinking and problem-solving ability by exploring and proposing solutions to realistic/social problems.
17. To Evaluate alternative approaches, and justify the use of selected tools and methods,
18. To emphasize learning activities those are long-term, inter-disciplinary and student centric.
19. To engage students in rich and authentic learning experiences.
20. 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:

25. Formation of project group comprising of 4-5 students. Multidisciplinary groups are allowed
26. A supervisor/mentor teacher assigned to individual groups.
27. Carrying out literature survey
28. Finalization of problem statement
29. Planning the project execution
30. Execution of project and testing
31. Writing a report
32. Publication in the form of research paper/patent/copyright as found suitable by supervisor/mentor

**Teacher's Role in PCL:**

13. Teacher is not the source of solutions rather he will they act as the facilitator and mentor.
14. To utilize the principles of problems solving, critical thinking and metacognitive skills of the students.
15. To aware the group about time management.
16. 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:**

22. Students must have ability to initiate the task/idea they should not be mere imitators.
23. They must learn to think.
24. Students working in PCL must be responsible for their own learning.
25. Students must quickly learn how to manage their own learning, Instead of passively receiving instruction.
26. Students in PCL are actively constructing their knowledge and understanding of the situation in groups.
27. Students in PCL are expected to work in groups.
28. 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**

- 16) VLSI Design
- 17) Embedded Systems
- 18) Signal Processing
- 19) Communication
- 20) Machine learning

**Assessment Scheme:**

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

**MOOCs Links and additional reading material:**

[www.nptelvideos.in](http://www.nptelvideos.in)  
<https://worldwide.espacenet.com/>

**Course Outcomes:**

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

- 10. Review the literature to formulate problem statement to solve real world problems (PO2,PO4) :  
LEVEL 3
- 11. Apply knowledge of technology and modern tools to design solution considering sustainability and environmental issues (PO1, PO3, PO4,PO5, PO6, PO7, PO12) LEVEL 4
- 12. 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

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**CO attainment levels:**

CO1: - Level 3

CO2: - Level 4

CO3: - Level 3

CO4: - Level 4





**Bansilal Ramnath Agarwal Charitable Trust's**

# **Vishwakarma Institute of Technology**

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

## **Structure & Syllabus of Final Year B. Tech. (Electronics & Telecommunication Engineering) Pattern 'D-18'**

**Academic Year 2018-19**

**Prepared by: - Board of Studies in E&TC Engineering**

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

**Signed by**

**Chairman – BOS**

**Chairman – Academic Board**

**Institute Vision:**

To be a globally acclaimed Institute in Technical Education and Research for holistic Socio-economical development

**Institute Mission:**

- To impart knowledge and skill based Education in Collaboration with Industry, Academia and Research Organizations.
- To strengthen global collaborations for Students, Faculty Exchange and joint Research
- To prepare competent Engineers with a spirit of Entrepreneurship
- To Inculcate and Strengthen Research Aptitude amongst the Students and Faculty

**Department Vision:**

To be a center of Academic Excellence in Electronics, Telecommunication and Related Domains through Continuous Learning and Innovation.

**Department Mission:**

- To provide state of art education in Electronics and Telecommunication Engineering to meet current and future needs of society, industry and academia.
- To strengthen collaborations with industries and institutes of repute to foster research culture among faculty members and students.
- To promote ethically conscious engineers demonstrating sustainable entrepreneurship and professional maturity in social context.

**Program Educational Objectives (PEOs):**

Graduates of the program will

- Have comprehensive knowledge of Electronics engineering fundamentals to face the challenges of real life complex problems
- Be professionals imbued with a spirit of leadership, ethical behavior and societal commitment
- Be compliant to constantly evolving technology through lifelong learning

**Program Outcomes:**

**Engineering Graduates will be able to:**

- 1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 2. Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 3. Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental

considerations.

- 4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- 5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- 6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- 7. Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- 8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- 9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- 10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- 11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- 12. Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

#### **Program Specific Objectives (PSOs)**

E&TC Graduates will have Ability to:

1. Design, Develop and Analyze Complex Electronic Systems for Communication, Signal Processing, Embedded Systems and VLSI Applications.
2. Identify and Apply domain specific hardware and software tools to solve real-world problems in Electronics and Communication.

**Title: Course Structure  
Branch: E&TC**

**Year: Final Year**

**Academic Year: 2018-19**

**Semester: I/ II**

**Module: NA**

**FF No. : 653  
Pattern: D-18**

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)		Examination scheme					Total	Credits
			Theory	Lab	CA		MSE	ESA			
					HA	LAB		ESE	VIVA		
OE1	ET4001	Data Communication & Networking	3	2	10	30	10	30	20	100	4
	ET4002	RF Circuit Design	3	2	10	30	10	30	20	100	
	ET4024	Mobile Communication	3	2	10	30	10	30	20	100	
	ET4025	Fiber Optic Communication	3	2	10	30	10	30	20	100	
	ET4019	**Digital Signal Processing	3	2	10	30	10	30	20	100	
	ET4032	**Robotics	3	2	10	30	10	30	20	100	
OE2	ET4003	Wireless Communication	3	2	10	30	10	30	20	100	4
	ET4004	SoC Design & Verification	3	2	10	30	10	30	20	100	
	ET4026	Adaptive Signal Processing	3	2	10	30	10	30	20	100	
	ET4027	Speech & Audio Processing	3	2	10	30	10	30	20	100	
	ET4018	**Digital Design	3	2	10	30	10	30	20	100	
	ET4033	**Electromagnetic Engineering	3	2	10	30	10	30	20	100	
	ET4031	**Information Theory and Coding Techniques	3	2	10	30	10	30	20	100	
OE3	ET4005	Industrial Automation	3	2	10	30	10	30	20	100	4
	ET4006	Advances in Digital Communication	3	2	10	30	10	30	20	100	
	ET4017	Convergence Technologies	3	2	10	30	10	30	20	100	
	ET4020	**Real Time Embedded Systems	3	2	10	30	10	30	20	100	
	ET4028	Wavelets	3	2	10	30	10	30	20	100	
Major Project / Summer Internship	ET4007	Major Project 1	-	-	-	-	-	100	-	100	4
	ET4008	Major Project 2	-	-	-	-	-	100	-	100	
	ET4021	Summer Internship	-	-	-	-	-	100	-	100	
*PD1	ET4010	*Professional Development	-	-	-	-	-	-	-	-	-
<b>Total</b>										<b>16</b>	

(\*) Professional Development (Audit Course)

(\*\*) Courses added for Third Year Internship Students

**Title: Course Structure**

**Branch: E&TC**

**Year: Final Year**

**Academic Year: 2018-19**

**Semester: I/ II**

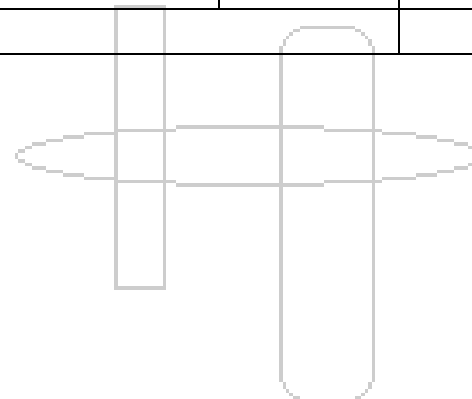
**Module: NA**

**FF No. : 653**

**Pattern: D-18**

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)		Examination scheme					Total	Credits
			Theory	Lab	CA		MSE	ESA			
					HA	LAB		ESE	VIVA		
Semester Internship	ET4012	Industry Internship	-	-	-	-	-	100	-	100	16
	ET4022	Research Internship	-	-	-	-	-	100	-	100	
	ET4023	Global Internship	-	-	-	-	-	100	-	100	
<b>Total</b>											16

Abbreviations Used	
CA	Continuous Assessment
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
ESA	End Semester Assessment



**ET4001: Data communication and Networking**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Network Architecture and OSI reference model

Introduction to Computer Networks, Topologies, Types of Networks, Layered Architecture of Computer Networks, OSI reference model, functions of each layer

Channel and MAC

Types of Channels, Signaling methods, Channel accessing methods, Error control and Flow control.

TCP/IP Protocol Suite

Introduction, Layers of TCP/IP protocol suite: Physical and Data Link Layers, Network Layer: Addressing, Ipv4 Addresses, Transport Layer: Process-to-Process Delivery, UDP, TCP, Application Layer.

**Section 2:**

LAN and WAN

Introduction to Local Area Networks, IEEE Standards for LANs, Wired LANs, Wireless LANs: IEEE 802.11, Channel Access Methods, Fast Ethernet, Gigabit Ethernet. SONET/SDH, Frame Relay, ATM, Wireless WANs

Network Management and Security

Network Management System, Network Management protocols, Network Security

Network applications and protocols

File transfer protocol, E-mail and the Web, multimedia applications such as IP telephony and video streaming- Overlay networks like peer-to-peer file sharing and content distribution networks- Web Services architectures for developing new application protocols.

**List of Practicals (Any Six):**

1. Prepare and test a straight through and crossover cable.
2. Implement a LAN for file/printer sharing
3. Implement Sliding window protocol
4. Implement Error correction and checking methods.
5. Design a client server environment to implement a web application.
6. Design a client server environment to implement a File transfer application.
7. Implement substitution and transposition algorithms
8. Implement a RSA algorithm
9. Implement a network and study for routing
10. Implement a network and study for addressing mechanism.

**List of Projects (Any One):**

1. Implementation of flow control protocols
2. Implementation of ARQ protocols
3. Design of a LAN for given conditions
4. Design of WAN for given condition
5. Implement a network and debug using network tools.
6. Development of Applications.

**Text Books:**

1. Computer Networks (3rd edition), Tanenbaum Andrew S., International edition,
2. Data communication and networking (4th edition), Behrouz A Forouzan, McGraw – Hill.

**Reference Books:**

1. Data and computer communication by William Stallings.
2. Computer Networking, James kurose& Keith Ross. , Low Price Edition.

**Course Outcomes:**

The student will be able to-

1. Describe OSI reference Model.
2. Design physical and data link layer functions and protocols of OSI model.
3. Analyze the TCP/IP Protocol Suite.
4. Design Local Area Networks and Wide Area Networks.
5. Describe management functions and security algorithms.
6. Develop application layer protocols.

**ET4002: RF Circuit Design**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

HF Resistors, HF Capacitors, HF Inductors, Chip Components. Circuit Board Considerations: Chip Resistors, Chip Capacitors, Surface Mounted Inductors.

Open Circuit Time Constant Method: Observations & Interpretations, Accuracy of OCTs, Considerations, Design examples. Short Circuit Time Constant Method: Background, Observations & Interpretations, Accuracy of SCTs, Considerations. Delay of a system in cascade, Rise time of systems in cascade, Relation Between Rise Time and Bandwidth.

Shunt Peaked Amplifier, Shunt Series peak Amplifier, Two port bandwidth enhancement, Design example. Bandwidth enhancement techniques. Tuned Amplifier: Common Source Amplifier with Single Tuned Load, Analysis of Tuned Amplifier. Neutralization and unilateralization. Characteristics of RF amplifier. Amplifier power relations. Bandwidth estimation using short circuit, Bandwidth group delay & peaking

**Section 2:**

MOSFET two port noise parameters, LNA topologies, Motivation First Cut Design, Power-constrained noise optimization. Design examples: Single ended LNA, Differential LNA. Linearity and large signal performance. Spurious free dynamic range.

Colpitts Oscillator: Describing Function Model and Start-up Model of Colpitts Oscillator. Resonators: Quarter-Wave Resonators, Quartz Crystals. Tuned Oscillators: Basic LC Feedback Oscillators, Crystal Oscillator.

Mixer: Conversion Gain, Noise Figure, Linearity and Isolation, Spurs. Non Linear Systems as Linear Mixers. Multiplier Based Mixers: Single Balanced Mixer, Linearization techniques of Mixer

Receivers: architectures – direct conversion, Heterodyne, Image reject receiver, VCOs, VCO design, Phase Noise – LTI & LTV analysis, Analog RF layout

**List of Practicals (Any Six):**

1. To plot frequency response of the impedance magnitude of series and parallel LC circuits.
2. To plot the resonant frequency behavior of parallel LC circuit, as a function of resistance R.
3. To determine stability regions of the device and sketch them in the Smith Chart. Assume suitable parameters.
4. To design, prepare layout and simulate CMOS amplifier for given voltage gain and bandwidth.



5. To design, prepare layout and simulate CMOS Collpitt oscillator.
6. To design, prepare layout and simulate CMOS mixer.
7. To design, prepare layout and simulate CMOS LNA.
8. To design, prepare layout and simulate double balance mixer.
9. To design, prepare layout and simulate diode Ring mixer.
10. To design, prepare layout and simulate local oscillator.

**List of Projects (Any One):**

1. RF Amplifier
2. Oscillators
3. Mixers
4. LNA
5. Mixers
6. MOSFET

**Text Books:**

1. Reinhold Ludwig, PavelBretchko, “RF Circuit Design Theory and Applications”, Pearson Education.
2. Thomas H. Lee, “The Design of CMOS Radio-Frequency Integrated Circuits”, Second Edition, Cambridge Publications.

**Reference Books:**

1. T. Yettrdal, Yunhg Cheng, “Devices modeling for analog and RF COMS circuits design”, John Wiley publication.
2. Calvin Plett, “Radio frequency Integrated Circuits Design”, Artech house.

**Course Outcomes:**

The student will be able to –

1. Understand behavior of passive components at high frequency and modeling of HF circuit.
2. Estimate bandwidth of RF system.
3. Design HF amplifiers with gain bandwidth parameters.
4. Model low noise amplifier
5. Simulate & model oscillators
6. Understand Mixer types and characteristics.

**ET4024: Mobile Communication**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

The Cellular Concept: Introduction, Frequency Reuse, Channel Assignment strategies, Hand off Strategies, interference and system capacity, improving coverage and capability in Cellular Systems. Practical Link Budget design using path loss models, Out door propagation models, Indoor propagation models, Small Scale Multi path propagation, parameters of mobile multi path channels

Equalization & Diversity: Generic Adaptive Equalizers, Linear & nonlinear equalizers, Algorithms for equalizers, Diversity techniques, Selection diversity improvement, Maximal ratio combining improvement, Space diversity reception methods, RAKE receiver

Coding for Mobile Communication: Linear Block Codes: Syndrome and error detection, Error detection and correction capability, Galois field, Primitive element & Primitive polynomial, Minimal polynomial and generator polynomial, Description of Cyclic Codes, Generator matrix & Encoding for cyclic code, Convolutional codes – Viterbi codes, TCM, BCH codes, RS codes. Coding for fading channel

**Section 2:**

MIMO: MIMO, Physical Modelling of MIMO receiver, Modelling of MIMO fading channels, MIMO System model & Zero forcing receiver, MIMO MMSE Receiver, SVD, SVD based optimal MIMO transmission & capacity, V-BLAST receiver

Mobile Network & Transport Layer: TCP/IP Suite, Network Layer in the internet, TCP enhancement for wireless network, implementation of wireless network, Mobile IP & SIP

Standardized wireless Systems: Cognitive radio - spectrum sensing, management, sharing, GSM – overview, air interface, channels, synchronization, coding, WiMAX/IEEE 802.16 – overview, modulation, channels, Multiple Antenna Techniques. 3GPP LTE

**List of Practicals (Any Six):**

1. Free space Propagation – Path Loss model to determine the free space loss and the power received
2. Implementation of Cyclic Redundancy code using MATLAB/Simulink
3. Implementation of Linear block code using MATLAB/Simulink
4. Implementation of Decision feedback Equalizer
5. Performance analysis of Rake Receiver
6. Performance analysis of Maximum Ratio combiner
7. Model a fading channel based on Rayleigh Fading.

8. Model a fading channel based on Rician Fading.
9. Model a fading channel based on Rayleigh & Rician Fading.

**List of Projects (Any One):**

1. Multiple Input Multiple output (MIMO) application in cognitive radio
2. Performance analysis of Single user Multiple Input Multiple output (MIMO) system
3. Performance analysis of Multiple user Multiple Input Multiple output (MIMO) system
4. Performance analysis of Orthogonal Frequency division multiplexing (OFDM).
5. Performance analysis of Single user Multiple Input Multiple output (MIMO) – Orthogonal Frequency division multiplexing (OFDM) system
6. Performance analysis of Multiple user Multiple Input Multiple output (MIMO) – Orthogonal Frequency division multiplexing (OFDM) system

**Text Books**

1. Wireless Communications- Principle and practice, Theodore S, Rappaport, Second edition, PHI
2. Mobile Communications, Jochen Schiller, Second Edition, Pearson Education.

**Reference Books**

1. David Tse, Pramod Wishwanath, 'Fundamentals of Wireless Communications', Cambridge University Press.
2. Vijay Garg, 'Wireless Communications & networking', Morgan Kaufman Series in networking
3. Andreas Molisch, 'Wireless Communications', Second Edition, Wiley Publications.
4. William C.Y. Lee, 'Wireless & Cellular Telecommunication', McGraw Hill, 3rd Edition

**Course Outcomes:**

The student will be able to –

1. Classify communication channels and noise.
2. Analyze amplitude and frequency modulated signal and their spectrum.
3. Explain working of analog receivers.
4. Discuss encoding of analog signals in digital formats.
5. Analyze modulation techniques with respect to bandwidth, Euclidian distance.
6. Evaluate performance of optimum filter.

**ET4025: Fiber Optic Communication**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Introduction to fiber optic communication

Overview of optical fiber communication: Fiber optic communication system, Advantages of optical fiber communication, Ray theory transmission, total internal reflection. Parameters of fiber optic cable: Acceptance angles, Numerical aperture, skew rays, Mode, Index Profile, V number. Types of fiber optic cable. Material of fiber optic cable, Manufacturing process of fiber optic cable.

Signal degradation in fiber optic cable

Signal distortion in optical fibers : Attenuation ,Material absorption ,Scattering losses (linear) Bending losses ,Dispersion present in FOC, Fiber attenuation measurement , Optical Time Domain reflectometer ( Principle, concept & applications).

Nonlinear scattering losses , Fiber dispersion measurement.

Optical sources , detectors and sensors

Light emitting diode: LED power and efficiency, LED structures, LED characteristics, Modulation. Light amplification by stimulated emission of Radiation : Basic concepts of LASER, Injection LASER structures. Optical detectors: Optical detection principles, Characteristics of optical detector, photodiode, PIN diode, Avalanche photodiode. Optical sensors : Phase and polarization fiber sensors, Intrinsic fiber sensors, Extrinsic fiber sensors, Optical Connectors & splices to connect Fiber optic cables.

**Section 2:**

Fiber optic system

Optical transmitter circuit, Optical receiver circuit, Link power budget, Rise time budget , Analog system design. Digital system design.

Real world applications of fiber optics : Study of fiber optics such as in i) Underwater communication ii) Telephone system iii) Military applications.

Optical Networks: SONET/ SDH , Wavelength Division multiplexing

**List of Practicals (Any Six):**

1. To measure numerical aperture
2. To measure attenuation and bending losses for various lengths of fiber optic cables
3. Experiment for transmission of analog signal through fiber optic cable
4. Experiment for transmission of digital signal through fiber optics cable
5. Experiment to plot V-I Characteristic of optical source

6. Experiment to measure frequency response of optical receiver
7. Experiment to transmit voice through fiber optic cable
8. Experiment to transmit frequency modulated signal through fiber optic cable
9. Study of Optical Fiber Connectorization Kit

**List of Projects (Any One):**

1. Implementation of optical transmitter
2. Implementation of optical receiver
3. Implementation of fiber optic system
4. Underwater communication through fiber optic cable
5. Telephone system using fiber optic cable

**Text Books**

1. “Optical Fiber Communications”, Gerd Keiser , McGraw Hill
2. John M. Senior, “Microwave and Radar engineering” M. Kulkarni, Umesh Publication

**Reference Books**

1. “Fiber Optic Communications”, D.K. Mynbaev , S.C. Gupta and Lowell L. Scheiner, Pearson Education, 2005.
2. “Fiber Optic Communication Systems”, Govind P. Agarwal , John Wiley, 3rd Edition, 2004.

**Course Outcomes:**

The student will be able to –

1. Explain the key aspects of propagation through different types of fiber.
2. Analyze losses of signals.
3. Describe fiber optic communication system.
4. Prepare the budget for implementing the fiber optic communication system.
5. Relate type of fiber optic communication to a specific application
6. Explain different real world applications of fiber optics.

**ET4019: Digital Signal Processing**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Basic elements of DSP and its requirements, advantages of Digital over Analog signal processing. Discrete Fourier transform, DFT properties, computation of linear convolution using circular convolution, Linear filtering using overlap add and overlap save method, FFT algorithms, decimation in time and decimation in frequency using Radix-2 FFT algorithm, Goertzel algorithm, Z transform, relation between Laplace transform and Z transform, relation between Fourier transform and Z transform, properties of Z transform, relation between pole locations and time domain behavior, causality and stability considerations for LTI systems, Inverse Z transform.

**Section 2:**

Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, design of linear phase FIR filter using windows and frequency sampling method. FIR filters realization using direct form and cascade form. Finite word length effect in FIR filters design. Design of IIR filters from analog filters, Impulse invariant method, relationship between analog and digital frequencies, Bi-linear Transformation Method, comparison of Impulse-invariance and Bi- linear Transformations, IIR filter specifications, Realization of IIR filters-Direct I and Direct II form structure, cascade structure, Parallel form structure. Introduction to lattice structure. Introduction to multirate signal processing: Interpolation, decimation, implementation of sampling rate conversion: polyphase filter structure.

**List of Practicals (Any Six):**

1. Perform discrete time signal analysis using FFT.
2. To perform linear convolution of two sequence using DFT.
3. To filter the long data sequence using overlap add/save algorithm.
4. To determine z-transform from the given transfer function and its ROC
5. Test discrete time systems for stability and causality using Z-transform.
6. Implement different window functions and observe the effect of different windows on FIR filter response.
7. Design Butterworth filter (IIR) using bilinear transformation method and plot its frequency response.
8. To analyze coefficient quantization effects on the frequency response of an IIR filter.
9. Design sampling rate converter for given specification.
10. Design an appropriate filter to extract the information from noisy signal.

**List of Projects (Any One):**

1. ECG Signal Analysis
2. Speech Enhancement using Spectral Subtraction Method
3. Musical Instrument Identification
4. Audio Equalizer
5. Speech Recognition
6. DTMF Encoder and Decoder
7. Correcting the geometrical orientation of text in an image using discrete Fourier transform
8. Real time filtering using overlap-save or overlap-add method
9. Audio Effects Generation
10. Voice Activity Detector

**Text Books:**

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing-Principles, algorithms and applications," PHI, 1997.
2. E.C. Ifeachor and B.W. Jervis, "Digital signal processing – A practical approach," Pearson Edu., 2nd edition, 2002.
3. S. K. Mitra, "Digital Signal Processing- A Computer Based approach," Tata McGraw Hill, 1998.

**Reference Books:**

1. Ramesh Babu, "Digital Signal processing," Scitech publications, 2001.
2. Shalivahanan, Vallavraj, Gnanapriya C., "Digital Signal Processing," TMH, 2001.
3. Li Tan, Jean Jiang, "Digital Signal Processing: Fundamentals and applications," Academic press.

**Course Outcomes:**

The student will be able to –

1. Apply DFT to analyze discrete time signals.
2. Compare computational complexity of DFT and FFT algorithm.
3. Analyze LTI systems using Z-transform.
4. Design linear phase FIR filter of given Specifications.
5. Design IIR filter of given Specifications from equivalent analog filter.
6. Implement sampling rate converter.

**ET4032: Robotics**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Basics of Robot :Specification of a Robot, Classification of Robots, Robot Components, Robot Degree of Freedom, Robot Coordinates, robot Programming, applications. Robot kinematics: Position and orientation representations, homogeneous transformations, frames, D- H convention, forward kinematics, inverse kinematic. Robot Sensors: Classes of tactile and non-tactile sensors, working principles, mathematical modelling of sensors, multi-sensor integration, control issue.

**Section2:**

Robot Actuators: Classes of robot actuators, working principles, mathematical modelling of actuators, mechanical construction and control issues. Path Planning: Path types, point-to-point-motion, continuous path motion, spline interpolation, trajectory planing. Robot Programming: Hardware and software architectures of robot controllers, robot programming paradigms, robot programming languages.

**List of Practicals (Any Six):**

1. Simulation of degree of freedom
2. Simulation of homogeneous transformation
3. Simulation of forward and inverse kinematic
4. Interfacing of proximity sensor with microcontroller
5. Interfacing of actuator with microcontroller
6. Simulation of point-to-point motion
7. Simulation of continuous path motion
8. Simulation of joint space trajectory trajectory
9. Simulation of Cartesian space trajectory
10. Simulation of joint space trajectory with via-points

**List of Projects (Any One):**

1. Harvest bot
2. Pick and place bot
3. Wall follower Bot
4. Maze solver bot
5. Obstacle avoidance bot
6. Line follower bot



**Text Books:**

1. John J. Craig “Introduction to robotics: Mechanics and Control”, Prentice Hall, 2004.
2. P. M. John, “Introduction to robotics”, Wesley, 1991.
3. M. W. Spong, M. Vidyasagar, “Robot Dynamics and Control”, Wiley and Sons, 1996.

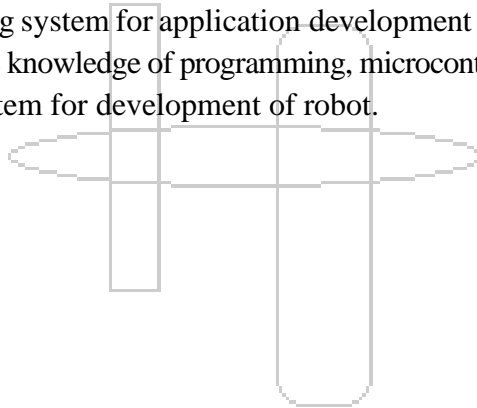
**Reference Books:**

1. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, “Robotics: Control, Sensing, Vision and Intelligence”, McGraw Hill Education (India Ed.).
2. T. R. Kurfess, “Robotics and Automation Handbook”, CRC Press.

**Course Outcomes:**

The student will be able to –

1. Translate specifications to the components of robots such as arms, linkage, drive system and end effector
2. Understand the mechanics and kinematics of robot
3. Select sensors for a given applications
4. Demonstrate use of engineering methods and problem solving toward design of specified robot.
5. Use robot operating system for application development
6. Apply pre-requisite knowledge of programming, microcontroller, sensor interfacing, and operating system for development of robot.



**ET4003: Wireless Communication**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Introduction to Wireless Communication Systems, Examples of Wireless Communication Systems, Trends in Cellular Radio and Personal Communications.

Modern Wireless Communication Systems: Second Generation (2G) Cellular Networks, 2.5G, Third Generation (3G) wireless Networks,

The Cellular Concept: Introduction, Frequency Reuse, Channel Assignment strategies, Hand off Strategies, interference and system capacity, improving coverage and capability in Cellular Systems.

Introduction to Radio wave propagation, free space propagation model, propagation mechanisms, Practical Link Budget design using path loss models, Outdoor propagation models, Indoor propagation models, signal penetration into buildings, Ray tracing and sitespecific modeling.

Small Scale Multi path propagation, small scale multi-path measurements, parameters of mobile multi path channels, Types of small scale fading, Examples of fading behavior.

**Section 2:**

Performance Evaluation, Signaling Evaluation, Measurement of Average received level & level crossings, Spectrum Efficiency Evaluation, Effects & interferences caused by portable units.

Mobility Management Functions, Mobile Location Management, Mobility Model, Mobile Registration, GSM Token-Based Registration, IMSI Attach and IMSI Detach (Registration and Deregistration) in GSM, Paging in GSM , Handoff , Handoff Techniques , Handoff Types , Handoff Process and Algorithms, Handoff Call Flows

Common Channel Signaling, Integrated Services Digital Network (ISDN), Introduction to Signaling System No.7(SS7), Global System for mobile (GSM), CDMA, Digital Cellular Standard (IS-95)

**List of Practicals (Any Six):**

1. Simulation of Rayleigh Fading Channel
2. Simulation of Rician Fading Channel
3. Implementation of IEEE 802.16d model.
4. Simulate Two Ray model to determine the free space loss and the power received
5. Simulate fading environment and loss based on Okumura Hata Model.
6. Simulate multipath fading channels based on COST 207 model.
7. Calculation of worst case cochannel interference ration for different constellations.

8. Simulate BER performance of DS-CDMA in multipath channel for single user case
9. simple OFDM system for transmitting audio data over frequency selective fading channel
10. Simulate multiple-input multiple-output (MIMO) multipath fading channels based on the IEEE® 802.16 channel models for fixed wireless applications.

**List of Projects (Any One):**

1. OFDM
2. Free Space Propagation
3. DS-CDMA
4. MIMO
5. Up & Down Conversion in Passband Communication
6. Fading

**Text Books:**

1. Wireless Communications- Principle and practice, Theodore S, Rappaport, Second edition, PHI
2. Mobile Communications, Jochen Schiller, Second Edition, Pearson Education.

**Reference Books:**

1. Heysik Kim, 'Wireless Communications Systems Design', Wiley Publications,
2. Vijay Garg, 'Wireless Communications & networking', Morgan Kaufman Series in networking.
3. Andrea Goldsmith, 'Wireless Communications', Cambridge University Press
4. William C.Y. Lee, 'Wireless & Cellular Telecommunication', McGraw Hill, 3<sup>rd</sup> Edition

**Course Outcomes:**

The student will be able to –

1. Differentiate four generations of wireless standard for cellular networks.
2. Determine the type and appropriate model of wireless fading channel based on the system parameters and the property of the wireless medium.
3. Spell the trade-offs among frequency reuse, signal-to-interference ratio, capacity, and spectral efficiency
4. Evaluate performance of systems
5. Explain mobility in wireless communication System.
6. Describe wireless standards

**ET4004: SoC Design and Verification**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Introduction to the System Approach:

System Architecture, Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity.

Processors: Introduction, Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors.

Memory Design for SOC: Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation, SOC Memory System, Models of Simple Processor – memory interaction.

**Section 2:**

Interconnect Customization and Configuration: Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time.

SOC Customization: An overview, Customizing Instruction Processor, Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance- Specific design, Customizable Soft Processor, Reconfiguration – overhead analysis and trade-off analysis on reconfigurable Parallelism.

Application Studies / Case Studies: SOC Design approach, AES algorithms, Design and evaluation, Image compression – JPEG compression.

**List of Experiments & Projects:**

**Text Books:**

1. Computer System Design System-on-Chip - Michael J. Flynn and Wayne Luk, Wiley India Pvt. Ltd.

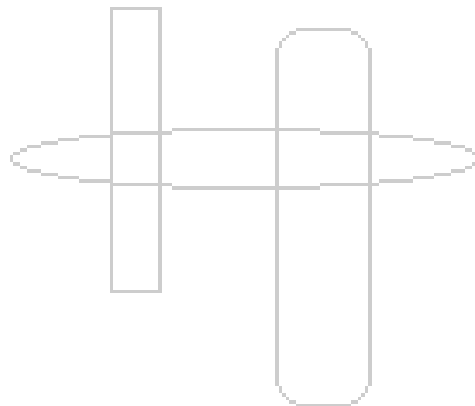
**Reference Books: (As per IEEE format)**

1. ARM System on Chip Architecture – Steve Furber – 2 nd Ed., 2000, Addison Wesley Professional.

**Course Outcomes:**

The student will be able to –

1. Understand basic concept of System Design and Interconnections
2. Implement instruction for various Processor Architecture.
3. Design Memory for SOC.
4. Solve issues related to interconnection and Bus models.
5. Analyze concepts related to SOC customization.
6. Design algorithms.



**ET4026: Adaptive Signal Processing**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Stochastic Processes: ensemble averages, jointly distributed random variables, joint moments, independent, uncorrelated and orthogonal random variables, linear mean square estimation. Random processes: ensemble averages, stationary processes, autocorrelation and auto-covariance matrices, ergodicity.

Signal Modeling: Least square method, Pade approximation, Prony's method. Finite data records: autocorrelation and covariance method, Stochastic Models: Autoregressive moving average models, autoregressive models, moving average models.

Linear Prediction: Forward linear prediction, backward linear prediction, Levinson-Durbin algorithm, lattice filter, predictive modeling of speech

**Section2:**

Wiener Filters: Minimum mean square error (MMSE) and orthogonality principle, digital Wiener filter and Wiener-Hopf equations. Applications: filtering, noise cancellation, linear prediction.

Adaptive filtering: FIR adaptive filters: the steepest descent adaptive filter, Least-Mean-Square (LMS) adaptive filters, convergence of LMS algorithm, normalized LMS. Applications: noise cancellation, channel equalization, adaptive recursive filters.

Spectrum Estimation: Nonparametric methods: Periodogram, modified periodogram, Bartlett's method, Welch's method. Parametric methods: autoregressive spectrum estimation, moving average spectrum estimation, autoregressive moving average spectrum estimation

**List of Practicals (Any Six):**

1. Computing the probability density function of a Gaussian random sequence with specified mean and variance
2. Simulation of Autoregressive moving average model.
3. Implementation of Lattice Structure
4. Program to convert Direct form coefficient to Lattice Form
5. Program to convert Lattice form coefficient to Direct Form
6. Implementation of Levinson Durbin Algorithm
7. Deconvolution using Wiener Filter.
8. Simulation of Linear predictive model
9. Simulation of LMS algorithm for adaptive noise cancellation
10. Power Spectrum Estimation

**List of Projects (Any One):**

1. Spectrum estimation using autoregressive modeling
2. Echo cancellation in telephone circuits
3. Adaptive prediction for speech coding
4. System identification and inverse filtering
5. Active noise cancellation
6. Channel Equalization

**Text Books:**

1. Simon Haykin, "Adaptive Filter Theory", 4th edition, Pearson Education
2. Monson Hayes, "Statistical Digital Signal Processing and Modeling", Wiley India Edition

**Reference Books:**

1. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing", McGrawHill, 2000
2. Bernard Widrow and Samuel Stearns, "Adaptive Signal Processing", Pearson Education Asia, 2002

**Course Outcomes:**

The student will be able to –

1. Apply basic probability theory to model random signals in terms of Random Processes.
2. Find a model to provide an accurate estimation of the signal.
3. Represent speech signal using linear predictive coding (LPC) algorithm.
4. Formulate the Wiener filter as a constrained optimization problem.
5. Determine suitable LMS step size to trade off convergence time and misadjustment.
6. Derive the power spectrum of random signals.

**ET4027: Speech and Audio Processing**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Anatomy and physiology of speech production. Acoustic phonetics, classification of phonemes used in American English based on continuant/non-continuant properties. Acoustic theory of speech production, sound propagation. Lossless tube model. Time-dependent speech processing. Short-time energy and average magnitude. Short-time average zero crossing rate, frequency-domain audio features, Spectral centroid, spectral spread, spectral entropy, spectral flux, spectral roll-off. Narrow and wide band spectrogram. Speech Vs. silence discrimination. Short-time autocorrelation function, short-time average magnitude difference function. Pitch period estimation. Peripheral auditory system, simplified model of cochlea. Sound pressure level and loudness. Sound intensity and Decibel sound levels. Concept of critical band and introduction to auditory system as a filter bank.

**Section 2:**

Basic principles of linear predictive analysis. Solution of LPC equations: Cholesky decomposition, Durbin's recursive solution, lattice formulations and solutions. Applications of LPC parameters as pitch detection and formant analysis. Vcoders, LPC- 10 algorithm, Real Cestrum: Long-term real cepstrum, short-term real cepstrum, pitch estimation, format estimation, Mel cepstrum. Complex cepstrum: Long-term complex cepstrum, short-term complex cepstrum. LPCC and MFCC feature extraction. Applications as complete system for speech recognition or speaker recognition

**List of Practicals (Any Six):**

1. To generate single tone, multi-tone stationary and non-stationary sine wave and to observe the spectrum to know the limitations of Fourier representation of non-stationary signals.
2. Record different vowels as /a/, /e/, /i/, /o/ etc. and extract the pitch as well as first three formant frequencies. Perform similar analysis for different types of unvoiced sounds and comment on the result.
3. Write a program to identify voiced, unvoiced and silence regions of the speech signal.
4. 4. Record a speech signal and perform the spectrographic analysis of the signal using wideband and narrowband spectrogram.
5. To extract pitch of the given voiced speech segment using autocorrelation and AMDF method



6. To extract the formants of speech signal using LPC and to observe the effect by changing the LPC order.
7. To implement Levinson-Durbin Algorithm for LPC parameter extraction.
8. To perform the cepstral analysis of the speech signal to extract the pitch
9. To implement limited vocabulary word recognition system.
10. To implement speaker identification system for small population (10/15 people).

**List of Projects (Any One):**

1. Speaker identification/verification System
2. Speech enhancement: Enhance noisy speech signal using spectral subtraction method.
3. MATLAB app development for speech signal analysis
4. Vocal Suppression
5. Low bit rate coding
6. Audio steganography
7. Speech synthesis system
8. Voice tracking system

**Text Books:**

1. Deller J. R. Proakis J. G. and Hanson J. H., "Discrete Time Processing of Speech Signals," Wiley Interscience
2. Thomas F. Quateri, "Discrete-Time Speech Signal Processing: Principles and Practice," Pearson

**Reference Books: (As per IEEE format)**

1. L. R. Rabiner and S.W. Schafer, "Digital processing of speech signals," Pearson Education.
2. Ben Gold and Nelson Morgan, "Speech and audio signal processing," Wiley
3. Shaila Apte, "Speech and audio processing," Wiley India Publication

**Course Outcomes:**

The student will be able to –

1. Demonstrate discrete time model of speech production system.
2. Detect voiced, unvoiced and silence part of a speech signal.
3. Implement algorithms for processing speech signals considering the properties of acoustic signals and human hearing.
4. Analyze speech signal to extract the characteristic of vocal tract (formants) and vocal cords (pitch).
5. Extract LPC Parameters using Levinson Durbin algorithm
6. Formulate and design a system for speech recognition and speaker recognition

**ET4018: Digital Design**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Reconfigurable hardware

Design options for digital systems, Standard Chips, PLDs, FPGAs and ASICs. VLSI design flow. Role of hardware description languages, motivation. Concurrency in hardware, Concept of delta delay. Concept of Micro architecture.

Introduction to Verilog HDL: Levels of Design Description, Concurrency. Verilog Language Constructs and Conventions: Introduction, Keywords, Identifiers, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Operators

Gate Level Modeling: Introduction, Module Structure, Gate Primitives, Tristate buffers, Design of Flip-Flops with Gate Primitives, Net Types, Delay models.

Switch level modeling: MOS switches, CMOS switch, bidirectional switch.

Dataflow Modeling: Introduction, Continuous Assignment Structure, Delays and Continuous Assignments, Assignment to Vector, Operators, user defined primitives.

Test bench: Self checking test bench

Behavioral modeling: Procedural constructs- initial & always block, procedural assignments – blocking and nonblocking statements, difference in blocking and nonblocking statements, active region, inactive region, event scheduling under stratified event queue, event scheduling in Verilog, delay timing control, selection statements- if-else, case, iterative statements- while, for, repeat, forever loop.

**Section 2:**

Datapath and control path elements: Use of Tasks and functions to design FSM, Subsystem Design, Shifters, Adders, ALUs, Multipliers, Parity generators, Comparators, Zero/One Detectors, Counters, RAM, ROM.

Synthesis: Latch inference, code optimization, Coding guidelines for clocks and resets. High Level Synthesis.

Verification: Functional verification, formal and simulation based, test bench design, clock signal generation, reset signal generation, verificational coverage, Dynamic timing analysis, static timing analysis.

**List of Practicals (Any Six):**

1. To demonstrate the use of gate level modeling (FA)
2. To demonstrate the use of dataflow modeling (MUX , DMUX, LATCH)
3. To demonstrate the use of behavioral modeling (always statement, blocking & non blocking)

4. statements, case statement, combinational circuit description) (MUX, DMUX, decoder, encoder, parity detector)
5. To demonstrate the use of behavioral modeling (always statement, case statement, combinational circuit description) (ALU, code converters)
6. To demonstrate the use of behavioral & structural modeling (flip flop, shift registers)
7. To demonstrate the use of behavioral modeling (up-down counter)
8. To demonstrate the use of behavioral modeling (consecutive ones counter)
9. To demonstrate the use of behavioral modeling (state machine based system)
10. To demonstrate the use of behavioral modeling (RAM, ROM)
11. To demonstrate the use of behavioral modeling (Multipliers, adders)

**List of Projects (Any One):**

Project based on design, verification and synthesis of functionality like I2C protocol, SPI protocol, RAM, FIFO, vending machine etc.

**Text Books:**

1. Samir Palnitkar; Verilog HDL; 2nd Edition, Pearson Education, 2009
2. Michel D. Ciletti; Advanced Digital Design with Verilog HDL; PHI, 2009

**Reference Books:**

1. Zainalabdien Navabi; Verilog Digital System Design; 2nd Edition, TMH
2. Stephen Brown, Zvonko Vranesic; Fundamentals of Digital Logic with Verilog Design; 2<sup>nd</sup> Edition, TMH
3. Sunggu Lee; Advanced Digital Logic Design using Verilog, State Machines & Synthesis for FPGA; Cengage Learning, 2012.

**Course Outcomes:**

The student will be able to –

1. Explain VLSI design flow and basics of Verilog HDL.
2. Develop functionality of combinational circuits using Verilog HDL.
3. Develop functionality of sequential circuits using Verilog HDL.
4. Propose breaking up of large procedures into smaller ones to make it easier to read and debug the source description.
5. Choose Verilog HDL statement for coding and synthesis optimization
6. Test and verify the functionality described by Verilog HDL

**ET4033: Electromagnetic Engineering**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Vector Calculus basics; Gradient, Curl and Divergence; Co-ordinate systems; Coulomb's Law, Electric Field Intensity, Electric flux density, Gauss' law, Electrostatic potential, Boundary conditions, Laplace and Poisson's equations, Capacitance; Biot Savart law, Magnetic flux density, Magnetic field intensity, scalar and vector magnetic potential, Ampere's circuital law, boundary conditions, self inductance, continuity equation.

**Section 2:**

Maxwell equation in differential form, point form, integral form; Phasor concept; time periodic fields; Poynting vector and concept of power flow; Helmholtz equations, Transverse Electromagnetic (TEM) wave, properties of Uniform Plane Wave, Intrinsic impedance; wave propagation ; Behavior of Uniform Plane wave at an interface between ideal medium and ideal conductor, concept of standing wave; Behavior at an interface between two dielectrics; Uniform Plane wave in a good dielectric, Uniform plane wave in a good conductor

**List of Tutorials (Any Six):**

1. Co-ordinate systems and their conversions, Gradient & Divergence
2. Coulomb's Law, Electric Flux Density, Electric field intensity, Gauss' law
3. Electrostatic potential, Boundary conditions, Laplace and Poisson's equations
4. Magnetic flux density, Magnetic field intensity, scalar and vector magnetic potential
5. Ampere's circuital law, boundary conditions
6. Maxwell equation in differential form, point form, integral form
7. Phasor concept; time periodic fields; Poynting vector and concept of power flow
8. Helmholtz equations, Transverse Electromagnetic (TEM) wave, properties of Uniform Plane Wave
9. Intrinsic impedance; wave propagation
10. Behavior of Uniform Plane Wave at various interfaces; Behavior of Uniform Plane wave in a good dielectric & Uniform plane wave in a good conductor

**Text Books:**

1. Engineering Electromagnetics – William Hayt, J.A. Buck, 6<sup>th</sup> Edition, McGraw Hill publications
2. Elements of Electromagnetics – Matthew Sadiku, 3<sup>rd</sup> Edition, Oxford University Press

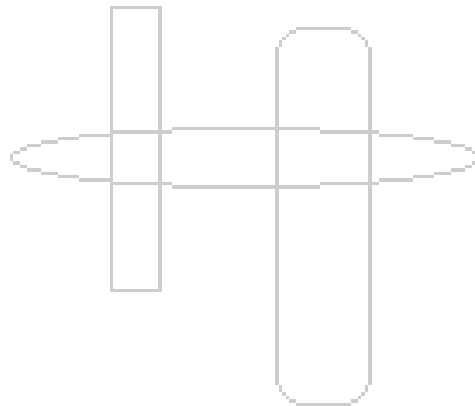
**Reference Books:**

1. Electromagnetic Waves and Radiating Systems – Pearson Education
2. Electromagnetic Field Theory Fundamentals – Guru, Hiziroglu, Cambridge University Press

**Course Outcomes:**

The Student will be able to-

1. Apply knowledge of Vector Calculus
2. Use Boundary conditions and Laplace equations for realization of capacitance
3. Use Boundary conditions and Laplace equations for realization of Inductance
4. Implement Maxwell's Equations in various forms
5. Apply Phasors and Power flow concept
6. Understand the concept of Uniform Plane wave propagation and behavior at interfaces.



**ET4031: Information Theory & Coding Techniques**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Introduction to Information theory, Discrete memory less channel, Entropy and its properties, Differential entropy and mutual Information, Information Capacity theorem.

Kraft's McMillan Inequality, Source coding theorem, Huffman coding, Shannon-Fano coding, Arithmetic Coding, Dictionary Techniques for lossless compression, Linear Block Codes- Syndrome and error detection, Error detection and correction capacity, Standard array and syndrome decoding, Encoding and decoding circuit, Single parity check codes

**Section 2:**

Cyclic Codes, generator polynomial, Generator matrix for systematic cyclic code, Encoding for cyclic code, Syndrome decoding of cyclic codes, Convolutional Codes, State diagram, Polynomial description of convolution code, Generator matrix of convolution code, Tree diagram, Trellis diagram, Viterbi decoding, Binary BCH code, Generator polynomial for BCH code, Decoding of BCH code, RS codes, generator polynomial for RS code, Decoding of RS codes.

**List of Practicals (Any Six):**

1. To determine Entropy and information rate for the given source.
2. To implement Huffman code.
3. To implement arithmetic code.
4. To implement LZ77 algorithm.
5. To implement LZ77 algorithm.
6. To implement LZW algorithm
7. To implement linear block codes.
8. To implement cyclic code.
9. To implement convolution code.
10. To implement Viterbi decoder

**List of Projects (Any One):**

1. Signal/Image compression with lossless/lossy compression techniques.
2. Text files compression with dictionary techniques.
3. Comparison of various channel coding Techniques.

**Text Books:**

1. “Information Theory coding and Cryptography” , RanjanBose , 2ndEdition ,McGraw-Hill Publication.
2. “Analog and digital communications”, Hwei Hsu, second edition , Schaum’s outlines.

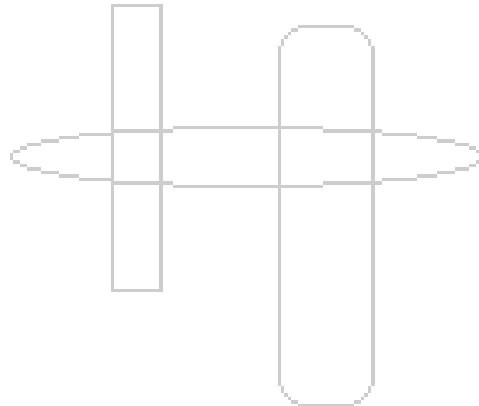
**Reference Books:**

1. “Digital Communication Fundamentals & applications”; Bernad Sklar, Second Edition , Pearson Education.
2. “Communication Systems”, Simon Haykin; Fourth Edition, John Wiley & Sons.
3. “Introduction to Data compression”, Khalid Sayood; Morgan Kaufmann Publisher.

**Course Outcomes:**

The student will be able to –

1. Evaluate the performance of source coding theorem based on entropy.
2. Analyze & implement lossless compression techniques.
3. Analyze linear block codes for error detection.
4. Decode cyclic code for error detection.
5. Generate Convolutional code & decode using Viterbi decoding.
6. Analyze RS code.



**ET4005: Industrial Automation**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Introduction to Industrial Automation and Control, Architecture of Industrial Automation Systems, types, pyramid of automation, advantages and disadvantages, Measurement systems – static and dynamic , Measurement of Temperature, Pressure and Force, Measurement of Displacement and Speed, Introduction to Process Control, P-I-D Control, Implementation of P-I-D Controllers, PLC Hardware Environment, Software Environment and Programming of PLCs, Ladder Programming

**Section 2:**

Hydraulic and Pneumatic control Systems - Principles and Components, Actuators- Hydraulic, pneumatic and electrical, DC motor, Servo motor, stepper motor and drives, Fuzzy logic in control applications- concepts, membership functions, fuzzy inference, Fuzzy controller in automation, Case studies of Industrial automation systems

**List of Practicals (Any Six):**

1. Simulate analog and digital function blocks for DCS
2. Study hardware and software used in PLC
3. Implementation Logic Gates
4. Implementation of On-Delay Timer
5. Implementation of Up-Down Counter
6. Implementation of PLC Arithmetic Instructions
7. Logic implementation for traffic Control Application
8. Logic implementation for Bottle Filling Application
9. Temperature measurement
10. Speed measurement using encoder

**List of Projects (Any One):**

1. Design of PID Controller
2. Design of Fuzzy Controller

**Text Books:**

1. Mechatronics, W. Bolton, 4th Ed, Pearson
2. A course in Electrical and Electronic Measurements and Instrumentation, A.K. Sawhney, Dhanpat Rai and Co.



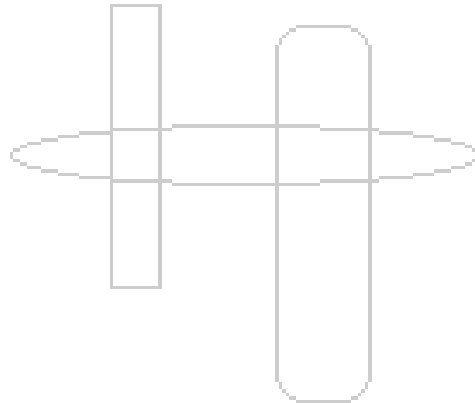
**Reference Books:**

1. Industrial instrumentation, control and automation, S. Mukhopadhyay, S. Sen & A. K. Deb, Jaico Publishing House

**Course Outcomes:**

The student will be able to –

1. Describe Architecture of Industrial Automation Systems
2. Explain Measurement systems
3. Demonstrate ladder programming skills
4. Compare Hydraulic/ Pneumatic control Systems
5. Compare Actuators
6. Design fuzzy controller



**ET4006: Advances in Digital Communication**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Introduction-Digital communication system , Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure. M-ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms. Receiver in additive white Gaussian noise channels-Coherent and non coherent demodulation-Matched filter, Correlator demodulator, Detector- Optimum rule for ML and MAP detection Performance- Bit error rate, symbol error rate for coherent and non coherent schemes. Synchronization-Different synchronization techniques (Early-Late Gate, MMSE, ML and spectral line methods)

**Section 2:**

Equalization-Zero-forcing equalizer, Decision feedback equalization, MMSE equalization. Multichannel and Multicarrier Systems-Multichannel Digital communications in AWGN channels, Multicarrier communications - Capacity of Non ideal linear filter channel, an FFT-based multicarrier system, minimizing peak to average ratio in the multicarrier systems . Communication over fading channels-Characteristics of fading channels, Rayleigh and Rician channels, receiver performance-average SNR, outage probability, amount of fading and average bit/symbol error rate.

**List of Practicals (Any Six):**

1. Implementation of binary communication systems.
2. Implementation of matched filter receiver in additive white Gaussian noise channel.
3. Implementation of correlator receiver in additive white Gaussian noise channel.
4. Implementation of symbol synchronizer.
5. Estimation of carrier phase using PLL.
6. Implementation of Zero-forcing equalizer .
7. Implementation of MMSE equalizer.
8. Implementation of FFT-based multicarrier system.
9. Study Rayleigh fading effect.
10. Study Rician fading effect.

**List of Projects (Any One):**

1. Comparison of various signaling techniques FSK ,PSK ,QAM etc on the basis of BER ,Bandwidth efficiency , peak-to-average power ratio.
2. Simulation of QAM system with decision –feedback carrier recovery.
3. Simulation of QPSK system with carrier phase recovery using costas loop.

4. OFDM simulation in MATLAB.
5. OFDM signal spectrum sensing for the cognitive radio applications.
6. Performance analysis of Rayleigh and Rician fading channels.

**Text Books:**

1. J. G. Proakis, “Digital Communications”, Fifth Edition, Mc GrawHill,

**Reference Books:**

1. John G. Proakis and Masoud Salehi, “Communication systems Engineering”, Second edition, PHI Learning.
2. Simon Haykin, “Digital Communications”, Fourth edition, Wiley Publications.
3. B. Sklar, “Digital Communication”, Second edition, Pearson.

**Course Outcomes:**

The students will be able to

1. Represent signals using the Gram-Schmidt orthogonalization procedure
2. Design and study performance characteristics of optimum receiver for the various modulating methods.
3. Derive carrier and symbol synchronization
4. Analyze performance characteristics of equalizer algorithms.
5. Analyze performance of multichannel and multicarrier systems
6. Evaluate performance of digital signaling techniques for communication over fading multipath channels

**ET4020: Real Time Embedded Systems**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

ARM - Advanced Microcontroller: Structure of ARM7TDMI, ARM Pipeline, ISA Architecture, ARM Buses, THUMB Instructions, Interrupt Handling, Exceptions in ARM, I/O ports, Timers, Interrupts, on-chip ADC, DAC, RTC modules, WDT, PLL, PWM, and I2C Communication Protocols: RS-485, CAN, Profibus, Bluetooth, IEEE 802.11, and USB  
Hardware Software Partitioning: Partitioning using Integer Programming, Partitioning using Genetic Algorithm, Particle Swarm Optimization, Power aware Partitioning on Reconfigurable Hardware

**Section 2:**

Real-Time Operating System

Real-Time Tasks, Task Periodicity, Task Scheduling, Clock Driven Scheduling, Event Driven Scheduling, Resource Sharing, Commercial RTOS

Structure of  $\mu$ COS – II

Kernel Structure, Task Management, Time Management, Semaphore Management, Event Flag Management, Message Mailbox Management, Message Queue Management, Memory Management, and Porting of  $\mu$ COS- II, Application Development

**List of Practicals (Any Six):**

1. Interfacing of LEDs
2. LCD & Keypad
3. ADC & DAC
4. UART
5. Task Scheduling for Input and Output Devices (4X4 Keyboard, 16X2 LCD display and ADC) using  $\mu$ COS- II Semaphore
6. Implementation of Mutual Exclusion, Mailbox and Message Queue for 3 Tasks.

**List of Projects (Any One):**

1. Design of a Digital Display
2. Touch Screen Control Panel for Stepper Motor
3. Water Level Controller
4. Landmark Recognition
5. Control of 3 Devices using RS-485 Standard
6. Control of 3 Devices using CAN Protocol
7. Control of 3 Devices using Profibus

**Text Books:**

1. ARM Developers Guide, Sloss Andrew
2. Embedded System Design, CMP Books, Arnold S. Berger
3. Jean J. Labrosse, "MicroC OS II, The Real-Time Kernel", 2<sup>nd</sup> edition, CMP Books.
4. S. K. Mitra, "Digital Signal Processing- A Computer Based approach," Tata McGraw Hill, 1998.

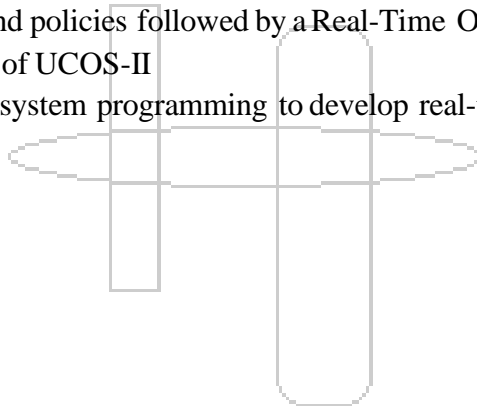
**Reference Books:**

1. Embedded / Real Time Systems Programming Black Book, Dreamtech Press, Dr. K.V.K.K. Prasad
2. Embedded System Design – A Unified hardware.
3. Software introduction" 3<sup>rd</sup> edition, Wiley, Frank Vahid and Tony Givargis.

**Course Outcomes:**

The student will be able to –

1. Comprehend architecture of ARM processor and its peripheral interfacing.
2. Implement RS-485, CAN and Profibus protocols
3. Understand approaches to solve hardware-software partitioning problems
4. Explain features and policies followed by a Real-Time Operating System.
5. Explain Structure of UCOS-II
6. Apply concepts of system programming to develop real-time embedded system



**ET4028: Wavelets**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Introduction to wavelet transform, comparison with DFT and DCT. Introduction to time frequency analysis, Definition of CWT, properties of continuous wavelet transform, CWT as correlation, CWT as an operator, Inverse CWT. Approximation of Vectors in linear vector subspaces, Basis for approximating sub spaces and Haar Scaling function, Digital filter implementation of Haar Wavelet Decomposition. Definition of MRA, Construction of general orthonormal MRA, Wavelet Basis for MRA, Digital Filtering Interpretation, Examples of Orthogonal Basis-generating Wavelets, Interpreting orthonormal MRAs for Discrete time Signal.

**Section 2:**

Introduction to time frequency analysis Different families of wavelets, mathematical preliminaries, windowed Fourier transform, short-time Fourier transform, Haar wavelet, Daubechies Wavelets, Wavelet packet analysis, Haar wavelet packets, introduction to orthogonal and bi-orthogonal wavelets. Transform Coding, Image compression using DTWT, Audio Compression, and Video Coding using MRA. Application of wavelet theory to signal de-noising, transient detection, speckle removal, edge detection and object isolation, image fusion, image enhancement, feature extraction, communication applications like scaling functions as signaling pulses and multi-tone modulation.

**List of Practicals (Any Six):**

1. To study various wavelets families.
2. To study Haar wavelets filter banks.
3. To study the Continuous Wavelet Transform: composition and decomposition.
4. To study the Discrete Wavelet Transform: composition and decomposition.
5. To write and verify code for signal/image smoothing using wavelet transform.
6. To write and verify code for signal/image de-noise using wavelet transform.
7. To write and verify code for signal/image compression using wavelet transforms.
8. To write and verify code for signal/image edge detection using wavelet transforms.
9. To write and verify code for signal/image matching using wavelet transforms.
10. To write and verify code for signal/image fusion using wavelet transforms.

**List of Projects (Any One):**

1. Data(Image, audio/video) compression
2. Speech processing

3. Noise/trend reduction
4. Texture analysis
5. Pattern recognition
6. Image processing

**Text Books:**

1. Raghuvver Rao , Ajit Bopardikar , “Wavelet Transforms: Introduction to Theory and Applications”, Pearson Education.
2. K P Soman, K I Ramchandran , "Insight Into Wavelets - From Theory to Practice", PHI publication (2nd edition), Prentice Hall of India.

**Reference Books:**

1. Wavelet Analysis –by Springer Publication.
2. Ten lectures on wavelets –by Daubechies I (CBMS-NSF, SIAM, 1982).
3. “Multirate Systems and Filter Banks”, P. P. Vaidyanathan, Pearson Education.

**Course Outcomes:**

The student will be able to –

1. Understand fundamentals of continuous and discrete wavelet transform.
2. Interpret multi resolution analysis.
3. Familiarize with different wavelet families.
4. Apply wavelet transform for various signal processing applications.
5. Write a program for edge detection, object isolation, image fusion, image enhancement.
6. Formulate and design a system for image compression.

**ET4007: 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 -

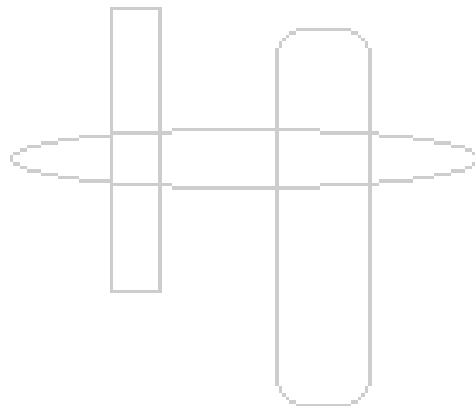
1. Identify Real World Problems, develop realistic expectations, set achievable goals.
2. Design, implement and test the prototype / algorithm, interpret the results to solve conceived problem.
3. Develop organisational skills as decision making, planning, preparations and record keeping.
4. Develop 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 Grid / Smart Gram / Swach Bharat / etc.)



**ET4008: Major Project 2**

**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:**

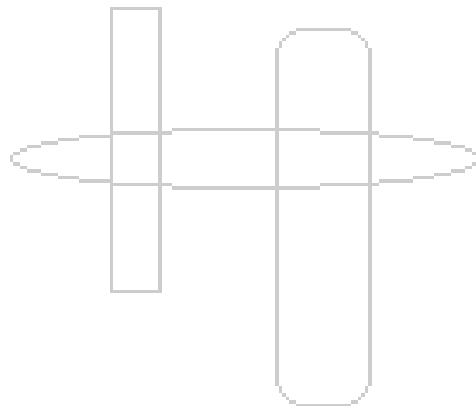
The graduates will be able to -

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 Grid / Smart Gram / Swachh Bharat / etc.)



**ET4012: Industry Internship**

**Credits: 16**

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.

**ET4022: Research Internship**

**Credits: 16**

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.

**ET4023: Global Internship**

**Credits: 16**

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.





Bansilal Ramnath Agarwal Charitable Trust's

# Vishwakarma Institute of Technology

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

Structure & Syllabus of

**F. Y. M. Tech.**

**(Electronics & Telecommunication Engineering)**

Pattern 'A-18'

Academic Year 2018-19

Prepared by: - Board of Studies in E&TC Engineering

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

Chairman – BOS

Signed by

Chairman – Academic Board





**Institute Vision:**

To be a globally acclaimed Institute in Technical Education and Research for holistic Socio-economical development

**Institute Mission:**

- To impart knowledge and skill based Education in Collaboration with Industry, Academia and Research Organizations.
- To strengthen global collaborations for Students, Faculty Exchange and joint Research
- To prepare competent Engineers with a spirit of Entrepreneurship
- To Inculcate and Strengthen Research Aptitude amongst the Students and Faculty

**Department Vision:**

To be a center of Academic Excellence in Electronics, Telecommunication and Related Domains through Continuous Learning and Innovation.

**Department Mission:**

- To provide state of art education in Electronics and Telecommunication Engineering to meet current and future needs of society, industry and academia.
- To strengthen collaborations with industries and institutes of repute to foster research culture among faculty members and students.
- To promote ethically conscious engineers demonstrating sustainable entrepreneurship and professional maturity in social context.

**Program Educational Objectives (PEOs):**

Graduates of the program will

- Have comprehensive knowledge of Electronics engineering fundamentals to face the challenges of real life complex problems
- Be professionals imbued with a spirit of leadership, ethical behavior and societal commitment
- Be compliant to constantly evolving technology through lifelong learning

**Title: Course Structure**

**Branch: E&TC**

**Year: F. Y. M. Tech.**

**Academic Year: 2018-19**

**Semester: I**

**Module: NA**

**FF No. : 653**

**Pattern: A-18**

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)		Examination scheme					Total	Credits
			Theory	Lab	CA		MSE	ESA			
					HA	LAB		ESE	VIVA		
S1	ET5001	Advanced Engineering Mathematics	4	-	20	-	30	30	20	100	4
S2	ET5003	Adaptive Signal Processing	3	2	10	30	10	30	20	100	4
S3	ET5005	Industrial Automation	3	2	10	30	10	30	20	100	4
S4	ET5007	Advances in Digital Communication	3	2	10	30	10	30	20	100	4
S5	ET5009	Engineering Design & Development I	2	4	-	-	50	50	-	100	4
<b>Total</b>											20

Abbreviations Used	
CA	Continuous Assessment
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
ESA	End Semester Assessment

**Title: Course Structure**

**Branch: E&TC**

**Year: F. Y. M. Tech.**

**Academic Year: 2018-19**

**Semester: II**

**Module: NA**

**FF No. : 653**

**Pattern: A-18**

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)		Examination scheme					Total	Credits
			Theory	Lab	CA		MSE	ESA			
					HA	LAB		ESE	VIVA		
S1	ET5002	HSS*	3	2	10	30	10	30	20	100	4
S2	ET5004	Data Science	3	2	10	30	10	30	20	100	4
	ET5011	RF Circuit Design	3	2	10	30	10	30	20	100	
S3	ET5006	Computer Vision	3	2	10	30	10	30	20	100	4
	ET5012	Mobile Communication	3	2	10	30	10	30	20	100	
S4	ET5008	Digital Integrated Circuit Design	3	2	10	30	10	30	20	100	4
	ET5013	Speech Processing	3	2	10	30	10	30	20	100	
S5	ET5010	Engineering Design & Development 2	2	4	-	-	50	50	-	100	4
<b>Total</b>											20

Abbreviations Used	
CA	Continuous Assessment
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
ESA	End Semester Assessment

(\* HSS- Section1(Economics), Section 2(Soft skills and QA)

**ET5001: Advanced Engineering Mathematics**

**Credits: 4**

**Teaching Scheme: 4 Hours / Week**

**Theory: 4 Hours / Week**

**Section 1:**

Vector spaces and subspaces, linear dependence and independence, spanning set, basis, change of basis, inner product, length, orthogonality, orthogonal sets, orthogonal projections, Gram–Schmidt process, least square problem, applications of linear models. Inner product spaces, Eigen values and Eigen vectors, applications of eigenvalues and eigenvectors, diagonalization, PCA, SVD.

**Section2:**

Multivariate Data and Multiple Random Variables, pmf/pdf, cdf, conditional and marginal distributions, Multivariate Normal Distribution, linear models for regression, logistic regression, linear models for classification, mixture models for EM: k-means clustering, mixture of Gaussians.

**Text Books:**

1. David C. Lay, “Linear Algebra and its Applications,” 12th impression 2011, Pearson Education Inc.,
2. Christopher M. Bishop, “Pattern Recognition and Machine Learning,” Springer

**Reference Books:**

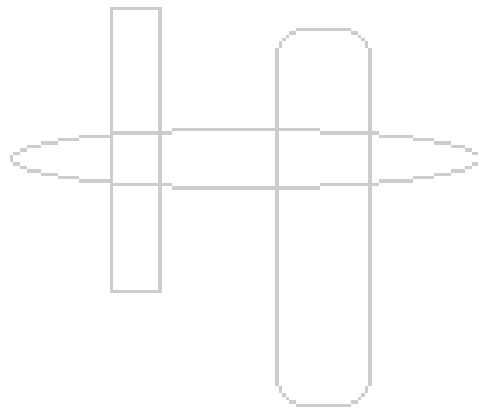
1. Gilbert Strang, “ Linear Algebra and its Applications,” 10th Indian reprint 2011, Cengage Learning (Indian Edition).
2. Ron Larson and David C. Falvo, “ Linear Algebra: An Introduction,” First Indian reprint 2010, Brooke/Cole, a part of Cengage Learning (Indian Edition).
3. Kevin P. Murphy, “Machine Learning A Probabilistic Perspective,” MIT press
4. Johnson, R. A., Wichern, D. W., “Applied Multivariate Statistical Analysis,” Fifth Edition, Prentice-Hall.

**Course Outcomes:**

The student will be able to –

1. Formulate and solve problems in linear algebra using general vector spaces and linear transformations
2. Use various inner products and the Gram-Schmidt process to handle problems involving distance, orthogonality and projection
3. Determine the eigenvalues and eigenvectors of a square matrix using the characteristic polynomial and will demonstrate how to diagonalize a matrix
4. Classify the given data samples.

5. Analyze and interpret probability distributions and perform regression analysis for statistical data.
6. Solve problems which involve setting up probabilistic models.



**ET5003: Adaptive Signal Processing**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Stochastic Processes: ensemble averages, jointly distributed random variables, joint moments, independent, uncorrelated and orthogonal random variables, linear mean square estimation.

Random processes: ensemble averages, stationary processes, autocorrelation and auto-covariance matrices, ergodicity.

Signal Modeling: Least square method, Pade approximation, Prony's method. Finite data records: autocorrelation and covariance method, Stochastic Models: Autoregressive moving average models, autoregressive models, moving average models.

Linear Prediction: Forward linear prediction, backward linear prediction, Levinson-Durbin algorithm, lattice filter, predictive modeling of speech

**Section 2:**

Wiener Filters: Minimum mean square error (MMSE) and orthogonality principle, digital Wiener filter and Wiener-Hopf equations. Applications: filtering, noise cancellation, linear prediction.

Adaptive filtering: FIR adaptive filters: the steepest descent adaptive filter, Least-Mean-Square (LMS) adaptive filters, convergence of LMS algorithm, normalized LMS. Applications: noise cancellation, channel equalization, adaptive recursive filters.

Spectrum Estimation: Nonparametric methods: Periodogram, modified periodogram, Bartlett's method, Welch's method. Parametric methods: autoregressive spectrum estimation, moving average spectrum estimation, autoregressive moving average spectrum estimation

**List of Practicals (Any Six):**

1. Computing the probability density function of a Gaussian random sequence with specified mean and variance
2. Simulation of Autoregressive moving average model.
3. Implementation of Lattice Structure
4. Program to convert Direct form coefficient to Lattice Form
5. Program to convert Lattice form coefficient to Direct Form
6. Implementation of Levinson Durbin Algorithm
7. Deconvolution using Wiener Filter.
8. Simulation of Linear predictive model
9. Simulation of LMS algorithm for adaptive noise cancellation
10. Power Spectrum Estimation

**List of Projects (Any One):**

1. Spectrum estimation using autoregressive modeling
2. Echo cancellation in telephone circuits
3. Adaptive prediction for speech coding
4. System identification and inverse filtering
5. Active noise cancellation
6. Channel Equalization

**Text Books:**

1. Simon Haykin, “Adaptive Filter Theory”, 4th edition, Pearson Education
2. Monson Hayes, “Statistical Digital Signal Processing and Modeling”, Wiley India Edition

**Reference Books:**

1. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, “Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing”, McGrawHill, 2000
2. Bernard Widrow and Samuel Stearns, “Adaptive Signal Processing”, Pearson Education Asia, 2002

**Course Outcomes:**

The student will be able to—

1. Apply basic probability theory to model random signals in terms of Random Processes.
2. Find a model to provide an accurate estimation of the signal.
3. Represent speech signal using linear predictive coding (LPC) algorithm.
4. Formulate the Wiener filter as a constrained optimization problem.
5. Determine suitable LMS step size to trade off convergence time and misadjustment.
6. Derive the power spectrum of random signals.

**ET5005: Industrial Automation**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Introduction to Industrial Automation and Control, Architecture of Industrial Automation Systems, types, pyramid of automation, advantages and disadvantages, Measurement systems – static and dynamic , Measurement of Temperature, Pressure and Force, Measurement of Displacement and Speed, Introduction to Process Control, P-I-D Control, Implementation of P-I-D Controllers, PLC Hardware Environment, Software Environment and Programming of PLCs, Ladder Programming

**Section 2:**

Hydraulic and Pneumatic control Systems - Principles and Components, Actuators- Hydraulic, pneumatic and electrical, DC motor, Servo motor, stepper motor and drives, Fuzzy logic in control applications- concepts, membership functions, fuzzy inference, Fuzzy controller in automation, Case studies of Industrial automation systems

**List of Practicals (Any Six):**

1. Simulate analog and digital function blocks for DCS
2. Study hardware and software used in PLC
3. Implementation Logic Gates
4. Implementation of On-Delay Timer
5. Implementation of Up-Down Counter
6. Implementation of PLC Arithmetic Instructions
7. Logic implementation for traffic Control Application
8. Logic implementation for Bottle Filling Application
9. Temperature measurement
10. Speed measurement using encoder

**List of Projects (Any One):**

1. Design of PID Controller
2. Design of Fuzzy Controller

**Text Books:**

1. Mechatronics, W. Bolton, 4th Ed, Pearson
2. A course in Electrical and Electronic Measurements and Instrumentation, A.K. Sawhney, Dhanpat Rai and Co.



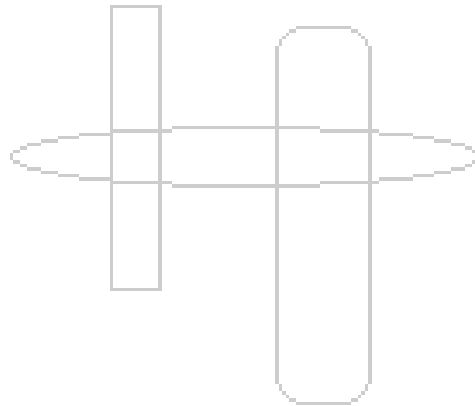
**Reference Books:**

1. Industrial instrumentation, control and automation, S. Mukhopadhyay, S. Sen & A. K. Deb, Jaico Publishing House

**Course Outcomes:**

The student will be able to –

1. Describe Architecture of Industrial Automation Systems
2. Explain Measurement systems
3. Demonstrate ladder programming skills
4. Compare Hydraulic/ Pneumatic control Systems
5. Compare Actuators
6. Design fuzzy controller



**ET5007: Advances in Digital Communication**

**Credits: 4**

**Teaching Scheme: 5 Hours / Week**

**Theory: 3 Hours / Week**

**Lab/ Project: 2 Hours / Week**

**Section 1:**

Introduction-Digital communication system , Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure. M-ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms. Receiver in additive white Gaussian noise channels-Coherent and non coherent demodulation-Matched filter, Correlator demodulator, Detector- Optimum rule for ML and MAP detection Performance- Bit error rate, symbol error rate for coherent and non coherent schemes. Synchronization-Different synchronization techniques (Early-Late Gate, MMSE, ML and spectral line methods)

**Section 2:**

Equalization-Zero-forcing equalizer, Decision feedback equalization, MMSE equalization. Multichannel and Multicarrier Systems-Multichannel Digital communications in AWGN channels, Multicarrier communications - Capacity of Non ideal linear filter channel, an FFT-based multicarrier system, minimizing peak to average ratio in the multicarrier systems . Communication over fading channels-Characteristics of fading channels, Rayleigh and Rician channels, receiver performance-average SNR, outage probability, amount of fading and average bit/symbol error rate.

**List of Practicals (Any Six):**

1. Implementation of binary communication systems.
2. Implementation of matched filter receiver in additive white Gaussian noise channel.
3. Implementation of correlator receiver in additive white Gaussian noise channel.
4. Implementation of symbol synchronizer.
5. Estimation of carrier phase using PLL.
6. Implementation of Zero-forcing equalizer .
7. Implementation of MMSE equalizer.
8. Implementation of FFT-based multicarrier system.
9. Study Rayleigh fading effect.
10. Study Rician fading effect.

**List of Projects (Any One):**

1. Comparison of various signaling techniques FSK ,PSK ,QAM etc on the basis of BER ,Bandwidth efficiency , peak-to-average power ratio.
2. Simulation of QAM system with decision –feedback carrier recovery.
3. Simulation of QPSK system with carrier phase recovery using costas loop.

4. OFDM simulation in MATLAB.
5. OFDM signal spectrum sensing for the cognitive radio applications.
6. Performance analysis of Rayleigh and Rician fading channels.

**Text Books:**

1. J. G. Proakis, “Digital Communications”, Fifth Edition, Mc GrawHill,

**Reference Books:**

1. John G. Proakis and Masoud Salehi , “Communication systems Engineering ”, Second edition , PHI Learning.
2. Simon Haykin , “Digital Communications”, Fourth edition , Wiley Publications.
3. B. Sklar, “Digital Communication”, Second edition, Pearson.

**Course Outcomes:**

The students will be able to

1. Represent signals using the Gram-Schmidt orthogonalization procedure
2. Design and study performance characteristics of optimum receiver for the various modulating methods.
3. Derive carrier and symbol synchronization
4. Analyze performance characteristics of equalizer algorithms.
5. Analyze performance of multichannel and multicarrier systems
6. Evaluate performance of digital signaling techniques for communication over fading multipath channels

**ET5009: 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 proposing solutions 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 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:

1. Formation of project group comprising of 4-5 students. Multidisciplinary groups are allowed
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 of the students.
3. To aware the group about time management.
4. 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:**

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 passively receiving instruction.
5. Students in PCL are actively constructing their knowledge and understanding of the situation 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 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**

- 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](http://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 environmental 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

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**CO attainment levels:**

CO1: - Level 3

CO2: - Level 4

CO3: - Level 3

CO4: - Level 4

**ET5004: Data Science****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Introduction to Data Science, Big Data and Data Science, Introduction to R Programming, Optimization, Typology of data science problems and a solution framework, Simple linear regression and verifying assumptions used in linear regression, Multivariate linear regression, model assessment, assessing importance of different variables, subset selection, Supervised and unsupervised learning.

**Section 2:**

Classification using logistic regression, Classification using knn and k-means clustering, Introduction to ANN, Artificial neuron model, Single-Layer Perceptrons, Implementing Learning Algorithms for the Perceptron, Multilayer Perceptrons, Back propagation learning, Implementing the Backpropagation Algorithm, Convolution Neural Network (CNN).

**List of Practicals (Any Six):**

1. Linear regression & its paper and programming based solution.
2. Multivariate linear regression example's paper and programming based solution.
3. Form the regression model that has multiple variables, find the most important variables based on goal. Solve on paper and by coding.
4. Selection of algorithm for subset selection. Solve example on paper and by coding.
5. K-means based clustering implemented by coding
6. Neural network based classification implementation by coding
7. CNN based identification or classification.

**List of Projects (Any One):**

1. Work on real life dataset for prediction using multivariable regression model.
2. Work on real life dataset for feature selection and optimization.
3. Work on real life dataset for classification using KNN
4. Work on real life dataset for classification or clustering using CNN

**Course Outcomes:**

1. Define a flow process for data science problems.
2. Use linear regression for prediction.
3. Apply supervised and unsupervised learning for classification of data.
4. Apply clustering algorithms for data science problem.
5. Select classification algorithms for given data.
6. Compare performance of different algorithms.



**ET5011: RF Circuit Design****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

HF Resistors, HF Capacitors, HF Inductors, Chip Components. Circuit Board Considerations: Chip Resistors, Chip Capacitors, Surface Mounted Inductors.

Open Circuit Time Constant Method: Observations & Interpretations, Accuracy of OCTs, Considerations, Design examples. Short Circuit Time Constant Method: Background, Observations & Interpretations, Accuracy of SCTs, Considerations. Delay of a system in cascade, Rise time of systems in cascade, Relation Between Rise Time and Bandwidth.

Shunt Peaked Amplifier, Shunt Series peak Amplifier, Two port bandwidth enhancement, Design example. Bandwidth enhancement techniques. Tuned Amplifier: Common Source Amplifier with Single Tuned Load, Analysis of Tuned Amplifier. Neutralization and unilateralization. Characteristics of RF amplifier. Amplifier power relations. Bandwidth estimation using short circuit, Bandwidth group delay & peaking

**Section 2:**

MOSFET two port noise parameters, LNA topologies, Motivation First Cut Design, Power-constrained noise optimization. Design examples: Single ended LNA, Differential LNA. Linearity and large signal performance. Spurious free dynamic range.

Colpitts Oscillator: Describing Function Model and Start-up Model of Colpitts Oscillator. Resonators: Quarter-Wave Resonators, Quartz Crystals. Tuned Oscillators: Basic LC Feedback Oscillators, Crystal Oscillator.

Mixer: Conversion Gain, Noise Figure, Linearity and Isolation, Spurs. Non Linear Systems as Linear Mixers. Multiplier Based Mixers: Single Balanced Mixer, Linearization techniques of Mixer

Receivers: architectures – direct conversion, Heterodyne, Image reject receiver, VCOs, VCO design, Phase Noise – LTI & LTV analysis, Analog RF layout

**List of Practicals (Any Six):**

1. To plot frequency response of the impedance magnitude of series and parallel LC circuits.
2. To plot the resonant frequency behavior of parallel LC circuit, as a function of resistance R.
3. To determine stability regions of the device and sketch them in the Smith Chart. Assume suitable parameters.
4. To design, prepare layout and simulate CMOS amplifier for given voltage gain and

bandwidth.

5. To design, prepare layout and simulate CMOS Collpitt oscillator.
6. To design, prepare layout and simulate CMOS mixer.
7. To design, prepare layout and simulate CMOS LNA.
8. To design, prepare layout and simulate double balance mixer.
9. To design, prepare layout and simulate diode Ring mixer.
10. To design, prepare layout and simulate local oscillator.

**List of Projects (Any One):**

1. RF Amplifier
2. Oscillators
3. Mixers
4. LNA
5. Mixers
6. MOSFET

**Text Books:**

1. Reinhold Ludwig, PavelBretchko, "RF Circuit Design Theory and Applications", Pearson Education.
2. Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", Second Edition, Cambridge Publications.

**Reference Books:**

1. T. Yettredal, Yunhg Cheng, "Devices modeling for analog and RF COMS circuits design", John Wiley publication.
2. Calvin Plett, "Radio frequency Integrated Circuits Design", Artech house.

**Course Outcomes:**

The student will be able to –

1. Understand behavior of passive components at high frequency and modeling of HF circuit.
2. Estimate bandwidth of RF system.
3. Design HF amplifiers with gain bandwidth parameters.
4. Model low noise amplifier
5. Simulate & model oscillators
6. Understand Mixer types and characteristics.

**FF No. : 654****ET5006: Computer Vision****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Image Formation and Low-Level Processing: Human Vision System, Computer Vision System, Fundamentals of Image Formation, Stereo Vision, Transformation: Orthogonal, Euclidean, Affine, Projective, Convolution and Filtering, Image Enhancement, Histogram Processing.

Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Harris Corner detector, SIFT, HOG, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Feature Matching and tracking.

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation.

**Section2:**

Object Recognition: Global Methods; Active Contours; Split and Merge; Mean Shift and Mode Finding; Normalized Cuts, Histogram of Oriented Gradients, Change Detection.

Classifiers: Clustering: K-Means, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA.

Motion Estimation: Triangulation; Two-frame structure from motion; Optical flow; Tracking.

**List of Practicals (Any Six):**

1. Perform different Image Enhancement operations.
2. Perform fixed and adaptive thresholding of an image.
3. Implement different types of filters on images.
4. Apply HOG for Edge detection.
5. Extract SIFT features.
6. Implement object detection using Hough transform / Template matching.
7. Segment image using k-means clustering.
8. Implement KNN classification algorithm.
9. Implement block-based motion estimation.
10. Implement object tracking using optical flow.

**List of Projects (Any One):**

1. Human Detection using HOG or SIFT.
2. Line detection in video

3. Motion Estimation in video
4. Retail Product Recognition on Supermarket Shelves
5. Detection of stairs
6. Digital Object Insertion
7. Video Stabilization

**Text Books:**

1. “Computer Vision: Algorithms and Applications”, Richard Szeliski, Springer
2. “Computer Vision-A Modern Approach”, Forsyth, Ponce, Low Price Edition, Pearson Education.
3. “Computer Vision and applications-A Guide for Students and Practitioners”, Bernd Jahne and Host HauBecker, Elsevier.

**Reference Books:**

1. “Image Processing, Analysis, and Machine Vision”, Milan Sonka, Vaclav Hlavac, Roger Boyle, Thomson Learning
2. "Computer and Robot Vision", Robert Haralick and Linda Shapiro, Vol I, II, Addison-Wesley, 1993.
3. “Computer Vision”, Dana H Ballard and Christopher M. Brown, Prentice Hall.

**Course Outcomes:**

The student will be able to –

1. Compare human and computer vision system.
2. Enhance the image quality by applying different transforms.
3. Segment the image to identify the region of interest.
4. Develop an algorithm to recognize the specified objects in the given image.
5. Classify the data as per the labeled classes.
6. Apply optical flow motion estimation technique to estimate the object motion in videos.

**ET5012: Mobile Communication****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

The Cellular Concept: Introduction, Frequency Reuse, Channel Assignment strategies, Hand off Strategies, interference and system capacity, improving coverage and capability in Cellular Systems. Practical Link Budget design using path loss models, Out door propagation models, Indoor propagation models, Small Scale Multi path propagation, parameters of mobile multi path channels

Equalization & Diversity: Generic Adaptive Equalizers, Linear & nonlinear equalizers, Algorithms for equalizers, Diversity techniques, Selection diversity improvement, Maximal ratio combining improvement, Space diversity reception methods, RAKE receiver

Coding for Mobile Communication: Linear Block Codes: Syndrome and error detection, Error detection and correction capability, Galois field, Primitive element & Primitive polynomial, Minimal polynomial and generator polynomial, Description of Cyclic Codes, Generator matrix & Encoding for cyclic code, Convolutional codes – Viterbi codes, TCM, BCH codes, RS codes. Coding for fading channel

**Section 2:**

MIMO: MIMO, Physical Modelling of MIMO receiver, Modelling of MIMO fading channels, MIMO System model & Zero forcing receiver, MIMO MMSE Receiver, SVD, SVD based optimal MIMO transmission & capacity, V-BLAST receiver

Mobile Network & Transport Layer: TCP/IP Suite, Network Layer in the internet, TCP enhancement for wireless network, implementation of wireless network, Mobile IP & SIP

Standardized wireless Systems: Cognitive radio - spectrum sensing, management, sharing, GSM – overview, air interface, channels, synchronization, coding, WiMAX/IEEE 802.16 – overview, modulation, channels, Multiple Antenna Techniques. 3GPP LTE

**List of Practicals (Any Six):**

1. Free space Propagation – Path Loss model to determine the free space loss and the power received
2. Implementation of Cyclic Redundancy code using MATLAB/Simulink
3. Implementation of Linear block code using MATLAB/Simulink
4. Implementation of Decision feedback Equalizer
5. Performance analysis of Rake Receiver
6. Performance analysis of Maximum Ratio combiner
7. Model a fading channel based on Rayleigh Fading.

8. Model a fading channel based on Rician Fading.
9. Model a fading channel based on Rayleigh & Rician Fading.

**List of Projects (Any One):**

1. Multiple Input Multiple output (MIMO) application in cognitive radio
2. Performance analysis of Single user Multiple Input Multiple output (MIMO) system
3. Performance analysis of Multiple user Multiple Input Multiple output (MIMO) system
4. Performance analysis of Orthogonal Frequency division multiplexing (OFDM).
5. Performance analysis of Single user Multiple Input Multiple output (MIMO) – Orthogonal Frequency division multiplexing (OFDM) system
6. Performance analysis of Multiple user Multiple Input Multiple output (MIMO) – Orthogonal Frequency division multiplexing (OFDM) system

**Text Books**

1. Wireless Communications- Principle and practice, Theodore S, Rappaport, Second edition, PHI
2. Mobile Communications, Jochen Schiller, Second Edition, Pearson Education.

**Reference Books**

1. David Tse, Pramod Wishwanath, 'Fundamentals of Wireless Communications', Cambridge University Press.
2. Vijay Garg, 'Wireless Communications & networking', Morgan Kaufman Series in networking
3. Andreas Molisch, 'Wireless Communications', Second Edition, Wiley Publications.
4. William C.Y. Lee, 'Wireless & Cellular Telecommunication', McGraw Hill, 3rd Edition

**Course Outcomes:**

The student will be able to –

1. Classify communication channels and noise.
2. Analyze amplitude and frequency modulated signal and their spectrum.
3. Explain working of analog receivers.
4. Discuss encoding of analog signals in digital formats.
5. Analyze modulation techniques with respect to bandwidth, Euclidian distance.
6. Evaluate performance of optimum filter.

**FF No. : 654****ET5008: Digital Integrated Circuit Design****Credits: 4****Teaching Scheme: 5 Hours / Week****Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Static CMOS Inverter

MOS device physics, threshold voltage, body bias, I-V characteristics and design equations, the actual device – secondary and short-channel effects, MOS SPICE models. The Static CMOS Inverter — An Intuitive Perspective, The Static Behavior, Switching Threshold, Noise Margins, static and dynamic power consumption, introduction to layout.

Combinational Logic

Static and Dynamic Design, CMOS Logic structures – Pseudo NMOS, Complementary CMOS, Ratioed Logic, Pass-Transistor Logic, and Transmission Gate with examples, Dynamic Logic – Basic Principle, DOMINO, NORA, Speed and power dissipation of dynamic logic gate, Issues in dynamic design, cascading dynamic gates, layout of few combinational/sequential circuits, Euler path to optimize layout.

Sequential Logic Circuits

Static and Dynamic Design, The bi-stability principle, CMOS Clocked Latches, CMOS Multiplexer based Latches, Flip-flops, Clocked CMOS Logic (C2MOS), TSPC Latches, pipelining of logic blocks.

**Section 2:**

Integrated Memories

Static Random-Access Memories, Static Random-Access 6-T Memory Cell, design equations, DRAM cells, Sense Amplifier, Read-Only Memories- NAND and NOR structures, CAM.

Logical Efforts

Delay and Electrical Efforts of a gate, defining logical efforts, Multi-stage logic network, choosing path, applying logical efforts to design circuit for speed.

Modern MOS Devices

Technology node – concept and scaling, effect of scaling on performance of device and circuit, LDD MOSFET, sub-micron MOSFET, SOI MOSFET, FinFET, Mutli-gate MOSFETs.

**List of Practicals (Any Six):**

1. Simulate and analyze 2:4 Decoder
2. Simulate and analyze 3:2 priority encoder
3. Simulate and analyze 4 - bit adder
4. Simulate and analyze JK flip-flop

5. Simulate and analyze DRAM Cell
6. Simulate and analyze SRAM

**List of Projects (Any One):**

1. Simulate and analyze combinational logic circuit
2. Simulate and analyze sequential logic circuit
3. Simulate and analyze memory circuit

**Text Books:**

1. Neil H. E. Weste, David Money Harris, CMOS VLSI Design, A circuits and Systems Perspective, Fourth Edition, Addison - Wesley
2. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits, Fourth Edition, Mc Graw Hill

**Reference Books:**

1. R. Jacob Baker, CMOS: Circuit Design, Layout and Simulation, Third Edition, Wiley
2. Neil H. E. Weste, Kamran Eshraghian, Principles of CMOS VLSI Design, Second Edition, Addison – Wesley
3. Douglas A Pucknell et al, Basic VLSI Design, 3rd Ed., Prentice Hall, 2004

**Course Outcomes:**

The student will be able to-

1. Demonstrate understanding of static CMOS.
2. Design & simulate combination circuits.
3. Design & simulate sequential circuits.
4. Design & simulate Memory circuits.
5. Analyze CMOS logic circuit for speed optimization.
6. Design and simulate a small digital circuit/system.



**ET5013: Speech Processing****Credits: 4****Teaching Scheme: 5 Hours / Week Theory: 3 Hours / Week****Lab/ Project: 2 Hours / Week****Section 1:**

Anatomy and physiology of speech production. Discrete time model for speech production. Classification of phonemes used in American English. Time-dependent speech processing. Short-time energy and average magnitude. Short-time average zero crossing rate. Speech Vs. silence discrimination. Short-time autocorrelation function, short-time average magnitude difference function. Pitch period estimation. Lossless tube model, multitube lossless model. Peripheral auditory system, simplified model of cochlea. Concept of critical band and introduction to auditory system as a filter bank. Speech perception: vowel perception.

**Section 2:**

Basic principles of linear predictive analysis. Solution of LPC equations: Cholesky decomposition, Durbin's recursive solution, lattice formulations and solutions. Applications of LPC parameters as pitch detection and formant analysis. Vocoders, LPC- 10 algorithm, Real Cepstrum: Long-term real cepstrum, short-term real cepstrum, pitch estimation, format estimation, Mel cepstrum. Complex cepstrum: Long-term complex cepstrum, short-term complex cepstrum. LPCC and MFCC feature extraction. Applications as complete system for speech recognition or speaker recognition

**List of Practicals (Any Six):**

1. To generate single tone, multi-tone stationary and non-stationary sine wave and to observe the spectrum to know the limitations of Fourier representation of non-stationary signals.
2. Record different vowels as /a/, /e/, /i/, /o/ etc. and extract the pitch as well as first three formant frequencies. Perform similar analysis for different types of unvoiced sounds and comment on the result.
3. Write a program to identify voiced, unvoiced and silence regions of the speech signal.
4. Record a speech signal and perform the spectrographic analysis of the signal using wideband and narrowband spectrogram.
5. To extract pitch of the given voiced speech segment using autocorrelation and AMDF method.
6. To extract the formants of speech signal using LPC and to observe the effect by changing the LPC order.
7. To implement Levinson-Durbin Algorithm for LPC parameter extraction.
8. To perform the cepstral analysis of the speech signal to extract the pitch.
9. To implement limited vocabulary word recognition system.
10. To implement speaker identification system for small population (10/15 people).

**List of Projects (Any One):**

1. Speaker identification/verification System
2. Speech enhancement: Enhance noisy speech signal using spectral subtraction method.
3. MATLAB app development for speech signal analysis
4. Vocal Suppression
5. Low bit rate coding
6. Audio steganography
7. Speech synthesis system
8. Voice tracking system

**Text Books:**

1. Deller J. R. Proakis J. G. and Hanson J. H., "Discrete Time Processing of Speech Signals," Wiley Interscience
2. Thomas F. Quateri, "Discrete-Time Speech Signal Processing: Principles and Practice," Pearson

**Reference Books:**

1. L. R. Rabiner and S.W. Schafer, "Digital processing of speech signals," Pearson Education.
2. Ben Gold and Nelson Morgan, "Speech and audio signal processing," Wiley
3. Shaila Apte, "Speech and audio processing," Wiley India Publication

**Course Outcomes:**

The student will be able to –

1. Demonstrate discrete time model of speech production system.
2. Detect voiced, unvoiced and silence part of a speech signal.
3. Implement algorithms for processing speech signals considering the properties of acoustic signals and human hearing.
4. Analyze speech signal to extract the characteristic of vocal tract (formants) and vocal cords (pitch).
5. Extract LPC Parameters using Levinson Durbin algorithm
6. Formulate and design a system for speech recognition and speaker recognition



**ET5010: 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](http://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 environmental 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

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

**CO attainment levels:**

CO1: - Level 3

CO2: - Level 4

CO3: - Level 3

CO4: - Level 4



**Bansilal Ramnath Agarwal Charitable Trust's**

# **Vishwakarma Institute of Technology**

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

**Structure & Syllabus of**

**S. Y. M. Tech.**

**(Electronics & Telecommunication Engineering)**

**Pattern 'A-18'**

**Academic Year 2018-19**

**Prepared by: - Board of Studies in E&TC Engineering**

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

**Signed by**

**Chairman – BOS**

**Chairman – Academic Board**



**Institute Vision:**

To be a globally acclaimed Institute in Technical Education and Research for holistic Socio-economical development

**Institute Mission:**

- To impart knowledge and skill based Education in Collaboration with Industry, Academia and Research Organizations.
- To strengthen global collaborations for Students, Faculty Exchange and joint Research
- To prepare competent Engineers with a spirit of Entrepreneurship
- To Inculcate and Strengthen Research Aptitude amongst the Students and Faculty

**Department Vision:**

To be a center of Academic Excellence in Electronics, Telecommunication and Related Domains through Continuous Learning and Innovation.

**Department Mission:**

- To provide state of art education in Electronics and Telecommunication Engineering to meet current and future needs of society, industry and academia.
- To strengthen collaborations with industries and institutes of repute to foster research culture among faculty members and students.
- To promote ethically conscious engineers demonstrating sustainable entrepreneurship and professional maturity in social context.

**Program Educational Objectives (PEOs):**

Graduates of the program will

- Have comprehensive knowledge of Electronics engineering fundamentals to face the challenges of real life complex problems
- Be professionals imbued with a spirit of leadership, ethical behavior and societal commitment
- Be compliant to constantly evolving technology through lifelong learning

**Title: Course Structure**

**Branch: E&TC**

**Year: F. Y. M. Tech.**

**Academic Year: 2018-19**

**Semester: III**

**Module: NA**

**FF No. : 653**

**Pattern: A-18**

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)		Examination scheme					Total	Credits
			Theory	Lab	CA		MSE	ESA			
					HA	LAB		ESE	VIVA		
Semester Internship / Dissertation	ET6001	Internship1	-	-	-	-	-	100	-	100	12
	Or										
	ET6003	Dissertation1	-	-	-	-	-	100	-	100	
<b>Total</b>											12

Abbreviations Used	
CA	Continuous Assessment
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
ESA	End Semester Assessment

**Title: Course Structure**

**Branch: E&TC**

**Year: F. Y. M. Tech.**

**Academic Year: 2018-19**

**Semester: IV**

**Module: NA**

**FF No. : 653**

**Pattern: A-18**

Sr. No.	Subject Code	Subject Name	Teaching Scheme (Hrs/Week)		Examination scheme					Total	Credits
			Theory	Lab	CA		MSE	ESA			
					HA	LAB		ESE	VIVA		
Semester Internship / Dissertation	ET6002	Internship 2	-	-	-	-	-	100	-	100	12
	Or										
	ET6004	Dissertation 2	-	-	-	-	-	100	-	100	
<b>Total</b>											12

Abbreviations Used	
CA	Continuous Assessment
HA	Home Assignment
MSE	Mid Semester Examination
ESE	End Semester Examination
ESA	End Semester Assessment