Course Curriculum

(Course Structure and Syllabi)

for

Bachelor of Technology

in

Electronics and Communication Engineering

(Second Year Onwards)

Department of Electronics and Communication Engineering

National Institute of Technology Hamirpur

Hamirpur – 177 005 (India)

Second Year													
3rdSemester							4thSemester						
SN	Code	Subject	L	T	P	Credits	SN	Code	Subject	L	T	P	Credits
1	HS-203	Organizational Behaviour	3	0	0	3	1	MA-203	Engineering Mathematics-III	3	1	0	4
2	EC-211	Digital Electronics and Logic Design	3	1	0	4	2	EC-221	Linear Integrated Circuits	3	1	0	4
3	EC-212	Analog Electronics	3	1	0	4	3	EC-222	Analog Communication Systems	3	1	0	4
4	EC-213	Communication Theory	3	1	0	4	4	EC-223	Electromagnetic Field Theory	3	1	0	4
5	CS-201	Data Structures	3	1	0	4	5	EC-224	VLSI Technology	3	0	0	3
6	EC-214	Digital Electronics and Logic Design Lab	0	0	2	1	6	EC-225	Linear Integrated Circuits Lab	0	0	2	1
7	EC-215	Analog Electronics Lab	0	0	2	1	7	EC-226	Analog Communication Lab	0	0	2	1
8	CS-202	Data Structures Lab	0	0	2	1	8	EC-227	Circuit Design and Simulation lab	0	0	2	1
		Total Hours = 25				**22**			**Total Hours = 25**				**22**

Third Year													
5thSemester							6thSemester						
SN	Code	Subject	L	T	P	Credits	SN	Code	Subject	L	T	P	Credits
1	EC-311	Microprocessor Architecture and Applications	3	1	0	4	1	EC-321	Microcontroller and Embedded Systems	3	1	0	4
2	EC-312	Digital Communication and Systems	3	1	0	4	2	EC-322	Wireless Communication	3	1	0	4
3	EC-313	Digital Signal Processing	3	1	0	4	3	EC-323	VLSI Design Techniques	3	1	0	4
4	EC-314	Microwave Devices and Systems	3	0	0	3	4	EC-324	Antenna and Wave propagation	3	0	0	3
5	OET	Open Elective-I	3	0	0	3	5	OET	Open Elective-II	3	0	0	3
6	EC-315	Digital Communication Lab	0	0	2	1	6	EC-325	Microprocessor and Microcontroller Lab	0	0	2	1
7	EC-316	Microwave Devices and Systems Lab	0	0	2	1	7	EC-326	VLSI Design Lab	0	0	2	1
8	EC-317	Digital Signal Processing Lab	0	0	2	1	8	EC-329	Seminar	0	0	2	1
		Total Hours = 24				**21**			**Total Hours = 24**				**21**

Fourth Year												
7thSemester							8thSemester					
SN	Code	Subject	L	T	P	Credits	SN	Code	Subject	L	T	P	Credits
1	EC-411	Control System	3	0	0	3	1	HS-404	Engineering Economics and Accountancy	3	0	0	3
2	EC-412	Optical Communication Systems and Networks	3	0	0	3	2	EC-421	Data Communication and Computer Networks	3	0	0	3
3	DET	Professional Elective-I	3	0	0	3	3	DET	Professional Elective-III	3	0	0	3
4	DET	Professional Elective-II	3	0	0	3	4	DET	Professional Elective-IV	3	0	0	3
5	EC-418	Industrial Training Presentation	0	0	2	1	5	EC-428	General Proficiency	0	0	0	1
6	EC-419	Major Project (Stage-I)	0	0	12	6	6	EC-429	Major Project (Stage-II)	0	0	12	6
		Total Hours = 26				**19**			**Total Hours = 24**				**19**

Semester Wise Credits									
Semester	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**Total**
Credits	24	24	22	22	21	21	19	19	**172**
Hours/week	28	28	25	25	24	24	26	24	**204**

Professional Elective Courses

Professional Elective-I (Courses related to design, tools, techniques)

EC-430	Signal processing for Image and Video
EC-431	CAD of Integrated Circuits
EC-432	Electronics Device Modeling
EC-433	MEMS and Sensor Design
EC-434	Advanced IC Design
EC-435	Optimization Techniques

Professional Elective-II (Courses related to Instrumentation and Computing)

EC-450	Electronic Measurement and Instrumentation
EC-451	RF IC Design
EC-452	Radar and Navigational Aids
EC-453	Artificial Intelligence and Deep Learning
EC-454	Reliability Engineering
EC-455	Computer Architecture and Organization

Professional Elective-III (Courses related to Communication Engineering)

EC-440	Spread Spectrum and CDMA
EC-441	Wireless Sensor Networks
EC-442	Satellite Communication
EC-443	Mobile Communication
EC-444	Information Theory and Coding
EC-445	Internet of Things

Professional Elective-IV (Courses related to VLSI Devices and Circuits)

EC-460	FPGA and SoC Design
EC-461	Low Power VLSI Design Techniques
EC-462	VLSI Testing
EC-463	VLSI Interconnects and Packaging
EC-464	Nano Electronics: Devices and Materials
EC-465	Electromagnetic Interference and Compatibility

Open Elective Courses

Open Elective-I

EC-370	MEMS Design

Open Elective-II

EC-380	Microcontroller and its Applications

Course Name: **Organizational Behaviour**
Course Code: **HS-203**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the behavioural aspects related to professional organizations
- To introduce the fundamental concepts relevant to understanding of individual & group behavior in the organization
- To enable the students to understand the applied organizational themes like perception, motivation, interpersonal relationships, group dynamics, leadership theories, role of power & policies in organizational context, conflict and negotiation, organizational diversity, dynamics of personality, attitude and job satisfaction, etc.

Unit Number	Course Content	Lectures
UNIT-01	**Organizational Behavior (OB):** Concept, nature, characteristics, conceptual foundations, determinants and importance, management functions, role & skills, disciplines that contribute to the field of OB, Challenges & Opportunities for OB, diversity in Organizations, attitudes & Job satisfaction.	**04L**
UNIT-02	**Perception**: Concept, nature, process, importance, management and behavioral applications of perception. Personality: concept, nature, types and theories of personality shaping. Learning; concept and theories of learning.	**08L**
UNIT-03	**Motivation:** concept, principles, theories-content, process & contemporary, Monetary and non-monetary motivation, applications of motivation. Leadership: Concept, functions, styles, and theories of leadership- trait, behavioural, and situational.	**06L**
UNIT-04	**Group and Interpersonal Relationship:** Analysis of Interpersonal Relationship, developing interpersonal relationship, Group Dynamic: Definition of Group, stages of Group Development, Punctuated Equilibrium Model, Group Structure, Group Decision Making, understanding work teams.	**05L**
UNIT-05	**Organizational Power and Politics:** concept of power, structure of power, classification of power, contrasting leadership & power, dependence a key to power, causes & consequences of political behaviour. Organizational conflict: view of conflict, conflict process, negotiation & bargaining strategies.	**06L**
UNIT-06	**Conflict and Negotiation:** conflict definition in conflict thought: Traditional view, the Human relation view, interactionist view. Functional versus dysfunctional conflict, conflict process. Negotiation Bargaining strategies, the negotiation process and issues in negotiation.	**07L**

Course Outcomes

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

CO1: Identify the challenges of the present organization

CO2: Describe the organizational system

CO3: Apply the principles of organizational behavior to inculcate the habit of team work and which is essential for the organization

CO4: Assess the role of psychological and social principal in improvement of efficiency as well as quality of empoyee life

Books and References

1. Organizational Behavior by Robbins, S.P., Prentice Hall of India.
2. Organizational Behavior by Luthans F., McGraw-Hill.
3. Human Behavior at Work: Organizational Behavior by Davis K., Tata McGraw-Hill.

Course Name: **Digital Electronics & Logic Design**
Course Code: **EC-211**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about the concept of digital design, number system and codes.
- To introduce the fundamental concepts related to design of combinational logic circuits.
- To enable the students to understand the design of Sequential Circuits.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Analog versus Digital, Analog to Digital and Digital to Analog converter circuits; Number systems and their inter-conversion, Binary Arithmetic (Addition, Subtraction, Multiplication and Division), Diminished radix and radix compliments; BCD codes, Excess-3 code, Gray code, Hamming code, Error Detection and Correction.	**08L**
UNIT-02	**Logic Gates and Logic Families:** Digital Logic Gates, Various Logic Families: RTL, DTL, TTL and ECL; Working and their characteristics; MOS and CMOS devices.	**06L**
UNIT-03	**Combinational Logic Design:**Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Minimization of Logical functions, Karnaugh- Map method, Sum of Products and Product of Sums Simplification, NAND and NOR implementation, Incompletely Specified functions, VEM method, Tabulation method, Determination of Prime implicants, Selection of Essential Prime implicants, Iterative Consensus & Generalized Consensus method for minimization of Multiple Output Switching functions, Determination of Prime implicants, Selection of Essential Prime implicants and finding a minimal cover, Design of Combinational circuits with examples.	**08L**
UNIT-04	**MSI and PLD Components:** Binary Adder and Subtractor; Decoders and Encoders; Multiplexers and DE-Multiplexers circuits; Read Only Memory, Programmable Logic Arrays, Programmable Array Logic; Implementation of Combinatorial Logic using these devices.	**06L**
UNIT-05	**Sequential Logic Design:** Introduction and Classification of Sequential circuits, Flip-flops: Truth Table & Excitation Table of flip-flops, Interconversion of flip-flops, Design of Synchronous & Asynchronous Sequential circuits, Registers and Counters,	**08L**

Course Outcomes

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

CO1: Understand about the concept of digital system.
CO2: Apply principles of minimization techniques to simplify digital functions.
CO3: Design and analyse the combinational electronic circuit based on digital logic.
CO4: Design and analyse the sequential electronic circuit based on digital logic.

Books and References

1. Digital Design: M. Morris Mano, Prentice Hall of India.
2. Digital Principle and Applications: Malvino and Leach, Tata Mc-Graw Hill.
3. Fundamentals of Digital Electronics: Anand Kumar, Prentice Hall of India.
4. Modern Digital Electronic: R.P. Jain Tata Mc-Graw Hill.

Course Name: **Analog Electronics**
Course Code: **EC-212**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To introduce the fundamental concepts relevant to bipolar junction transistor.
- To impart knowledge about the electrical modeling and analysis of small- and large-signal amplifiers.
- To enable the students to understand the factors that cause the gain to roll-off at high frequencies.

Unit Number	Course Content	Lectures
UNIT-01	**Low Frequency Transistor Amplifier:** Equivalent Circuit of BJT using h-parameter for CB, CE and CC & configuration, Calculation of Transistor Parameter for CB, CE & CC using h-parameters, Comparison of Transistor Amplifier Configuration	**05L**
UNIT-02	**Multistage Amplifier:** General Cascaded System, RC Coupled Amplifier and its Frequency Response, Merits and Demerits, Cascade Amplifier, Darlington Compound Configuration, Multistage Frequency Effect	**05L**
UNIT-03	**High Frequency Response of Transistor Amplifier:** High Frequency Model for CE Configuration, Approximate CE High Frequency Model with Resistive Load, CE Short Circuit Current Gain, HF Current Gain with Resistive Load	**06L**
UNIT-04	**Large Signal Amplifier:** Analysis and Design of class A, B, AB, C Amplifiers, Push-pull Amplifiers, Transformer Less Output Stages, Distortion Calculations	**05L**
UNIT-05	**Tuned Amplifier:** General Behavior of Tuned Amplifiers, Series and Parallel Resonant Circuit, Calculations of Circuit Impedance at Resonance, Variation of Impedance with Frequency, Q Factor of a Circuit & Coil, Bandwidth of Series and Parallel Resonant Circuit, Single Tuned Amplifiers, Voltage Gain and Frequency Response of Single Tuned Amplifiers, Double Tuned Amplifiers	**05L**
UNIT-06	**Feedback Amplifier:** Feedback concept, Characteristics of Negative and Positive Feedback, Effect of Negative and Positive Feedback on Input Impedance, Output Impedance, Gain, Noise and Frequency Response	**05L**
UNIT-07	**Oscillators:** Classification of Oscillators, Frequency Stability of Oscillatory Circuits, Tuned based Oscillators, Hartley Oscillator, Colpitt Oscillators, Clapp Oscillator, Crystal Oscillator, Phase Shift Oscillator and Wien Bridge Oscillator	**05L**

Course Outcomes

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

CO1: Develop the ability to analyze and design analog electronic circuits using discrete components
CO2: Understand the use of small-signal models to predict gain and behavior in transistor amplifier
CO3: Describe the design trade-offs in analog amplifier circuits
CO4: Design tuned amplifiers and apply them in a communications system

Books and References

1. Integrated Electronics: Analog and Digital Circuits and Systems by J. Millman and C. Halkias, McGraw-Hill, Inc.
2. Electronic Devices & Circuit Theory by R. Boylestad and L. Nashelsky, Pearson.
3. Microelectronic Circuits by A. Sedra and K. Smith, Oxford University Press.
4. Electronic Fundamental Applications: Integrated and Discrete Systems by J.D. Ryder, Prentice Hall.

Course Name: **Communication Theory**
Course Code: **EC-213**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To understand basic components of communication systems.
- To prepare mathematical background for communication signal analysis.
- To analyze signals in presence various types of noise and estimation of channel capacity.

Unit Number	Course Content	Lectures
UNIT-01	**Frequency and Time Domain Representation and Analysis:**Introduction to Information, Messages & Signals, Classification of Signals., The Discrete and Continuous Spectrum, Power Spectrum, Energy Density Spectrum, Dirac Delta Functions, Sampling Theory and Approximations, Convolution of Signals, LTI Systems.	**10L**
UNIT-02	**Random Signal Theory :** Discrete Probability Theory, Continuous Random Variables, Statistically Independent Random Variables, Probability Density Functions of Sums, Transformation of Density Functions, Ergodic Process, Correlation Functions, Spectral Density and White Noise.	**10L**
UNIT-03	**Noise:** Atmospheric, Thermal, Shot and Partition noise, Noise Figure and Experimental Determination of Noise Figure, Shot Noise In Temperature Limited Diode and Space Charge Limited Diodes, Pulse Response and Digital Noise.	**05L**
UNIT-04	**Transmission Through Networks:** Networks with Random Input, Auto-correlations, Spectral Density and Probability Density Input-output Relationships, Optimum System and Non-linear Systems, Maximum Criterion, Equivalent Noise Bandwidth.	**05L**
UNIT-05	**Basic Information Theory:** Definition of Information, Units of Information, Entropy, Uncertainty and Information Rate of Communication, Redundancy, Relation Between System Capacity and Information Content of Messages, Shannon's Theorem, Discrete Noisy Channel, Channel Capacity for Different Discrete Channels.	**06L**

Course Outcomes

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

CO1: Perform the time and frequency domain analysis of the signals in a communication system.

CO2: Analyze the performance of communication system and need of information theory for information transfer.

CO3: Select the blocks in a design of communication system and system capacity.

Books and References

1. Elements of Communication Theory by J.C. Hancock, McGraw-Hill Education Publisher.
2. Principals of Communication System by Taub & Schilling, McGraw-Hill Education Publisher.
3. Communication Systems by S. Haykin, Wiley Publication.

Course Name: **Data Structures**
Course Code: **CS-201**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about linear and non-linear data structures as the foundational base for computer solutions to problems.
- To introduce the fundamental concepts relevant to binary trees, binary tree traversals, binary search trees and perform related analysis to solve problems.
- To enable the students to understand various types of sorting algorithms.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction:** Data types, data structures, abstract data types, the running time of a program, the running time and storage cost of algorithms, complexity, asymptotic complexity, big O notation, obtaining the complexity of an algorithm.	7L
UNIT-02	**Development of Algorithms:** Notations and Analysis, Storage structures for arrays - sparse matrices - structures and arrays of structures, Stacks and Queues: Representations, implementations and applications. Linked Lists: Singly linked lists, Linked stacks and queues, operations on Polynomials, Doubly Linked Lists, Circularly Linked Lists, Operations on linked lists- Insertion, deletion and traversal, dynamic storage management – Garbage collection and compaction.	10L
UNIT-03	**Trees:** Basic terminology, General Trees, Binary Trees, Tree Traversing: in-order, pre-order and post-order traversal, building a binary search tree, Operations on Binary Trees - Expression Manipulations - Symbol Table construction, Height Balanced Trees(AVL), B-trees, B+-trees.	7L
UNIT-04	**Graphs:** Basic definitions, representations of directed and undirected graphs, the single-source shortest path problem, the all-pair shortest path problem, traversals of directed and undirected graphs, directed acyclic graphs, strong components, minimum cost spanning tress, articulation points and biconnected components, graph matching.	6L
UNIT-05	**Sorting and Searching Techniques:** Bubble sorting, Insertion sort, Selection sort, Shell sort, Merge sort, Heap and Heap sort, Quick sort, Radix sort and Bucket sort, Address calculation, Sequential searching, Binary Searching, Index searching, Hash table methods.	6L

Course Outcomes

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

CO1: Interpret and compute asymptotic notations of an algorithm to analyze the time complexity.
CO2: Use of linear and non-linear data structures as the foundational base for computer solutions to problems.
CO3: Demonstrate the ability to implement various types of static and dynamic lists.
CO4: Implement binary trees, binary tree traversals, binary search trees and perform related analysis to solve problems.
CO5: Implement various types of sorting algorithms.

Books and References

1. An Introduction to Data Structures with applications by J.P. Tremblay and P.G. Sorenson, Tata McGraw Hill.
2. Data structures, Algorithms ad Applications in C++ by Sartaj Sahni, WCB/McGraw Hill.
3. Data Structures and Algorithms by Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft, Addison Wesley.
4. Data Structures using C by Y. Langsam, M. J. Augenstein and A. M. Tenenbaum, Pearson Education.
5. Data Structures – A Pseudocode Approach with C by Richard F. Gilberg and Behrouz A. Forouzan, Thomson Brooks /Cole.

Course Name: **Digital Electronics and Logic Design Lab**
Course Code: **EC-214**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- Familiarization with digital integrated circuits and equipment's.
- Implementation and design of combinational logic circuits using different gates.
- To understand concepts of sequential circuits and to analyze and design sequential circuits.

List of Experiments

1. To study about the logic gates and verify their truth table.
2. Realization of AND and OR gates using
   (i) Diodes and resistors.
   (ii) Universal gates
3. Design and implement half adder and full adder circuits and verifies the truth table using logic gates.
4. Design and implement half subtractor and full subtractor circuits and verifies the truth table using logic gates.
5. Design and implement 4-bit binary to gray code converter and gray to binary code converter circuits.
6. Design and implement BCD to excess-3 code converter and excess-3 to BCD code converter.
7. Design and implement

(i) 2-Bit magnitude comparator using basic gates
   (ii) 8-Bit magnitude comparator using IC 7485

8. Design and implement multiplexer and demultiplexer using logic gates and study of IC 74150 and IC 74154.
9. Design and implementation of the function using multiplexer
   (i) $F(A,B,C)=\Sigma m(1,2,5,6)$
   (ii) $F(A,B,C)=\Sigma m(0,2,5,6,7)$
10. Design and implement encoder and decoder using logic gates and study of IC 7445 and IC 74147.
11. Realization of SR, JK, D and T flip flop using gates.
12. Design and implement 3-bit synchronous up counter.
13. Design and implement 3-bit asynchronous up/down counter.
14. Design BCD to seven segment display with decoder Using IC 7447.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: Understand the digital signals, applications of ICs and logic circuits.
CO2: Develop skills for designing combinational logic circuits and their practical implementation on breadboard.
CO3: Analyze, design and implement sequential logic circuits.

Course Name: **Analog Electronics Lab**

Course Code: **EC-215**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide skills for designing various oscillator circuits
- To provide skills for understanding frequency stability in amplifiers
- To enable the students to plot the characteristic property of various transducers

1. To study the working of Hartley Oscillator and measure the frequency of oscillations
2. To study the working of Colpit's Oscillator and measure the frequency of oscillations
3. To study the functioning of Crystal Oscillator and measure the frequency of oscillations
4. To study the frequency response of two-stage RC coupled amplifier and find the voltage gain
5. To identify the type of feedback used in an amplifier and determine the voltage gain
6. To study the push-pull amplifier and plot the frequency response
7. To study the transformer coupled amplifier and determine the frequency response
8. To study the voltage gain and frequency response of FET amplifier
9. To study the astable, monostable and bistable multivibrators and their timing parameters.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: Analyze and design analog electronic circuits using discrete components

CO2: Design and implement an analog circuit project application utilizing knowledge and skills learned

CO3: Establish the biasing of an FET amplifier

CO4: Calculate power efficiency of large–signal amplifier

Course Name: **Data Structures Lab**
Course Code: **CS-202**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide skills for designing & writing algorithms.
- To provide skills for writing C/C++ programs.
- To enable the students to debug programs.

List of Experiments

1. Write a program to sort an array (make a dynamic array) using Bubble sort. Use 1-bit variable FLAG to signal when no interchange take place during pass. If FLAG is 0 after any pass, then list is already sorted and there is no need to continue.
2. WAP to search an ITEM (integer) in an array using binary search, if FOUND then delete that item from array and if NOT FOUND than insert that item in kth position (Input "k" from user).
3. WAP to enter records of Five students, which should contain fields like roll No., name, CGPI, semester.

a. List all record of all students having CGPI greater than k.
b. Insert a new record of student at kth position and print the final record.

4. Implement linked list and insert and delete an element into the list.
5. Evaluate a postfix algebraic expression with the help of stack.
6. Implement a circular queue by adding or deleting few elements. Make sure to incorporate "Queue Empty", "Queue Full" constraints in your program.
7. WAP to implement Binary Search Tree with insertion and deletion operation.
8. Implement any one of the tree traversing techniques.
9. Implement various sorting algorithms like Quick sort, Merge Sort, Insertion Sort, Selection Sort etc.
10. Implement hashing.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: To gain knowledge of popular available data stuctures.
CO2: To develop programming skills in students.
CO3: To impart knowledge of syntax and semantics of basic laungages.

Course Name: **Engineering mathematics-III**

Course Code: **MA-203**

Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To introduce the fundamental concepts relevant to function of complex variable, numerical differentiation and integration and numerical solution of linear, non-linear and system of equations.
- To have the idea of evaluation of real integrals using complex variable.
- To understand the concept of approximating & interpolating polynomials and finding values of function at arbitrary point.
- To impart knowledge of various numerical technique to solve ODE.

Unit Number	Course Content	Lectures
UNIT-01	**Functions of Complex Variable** Applications of De Moivre's theorem, Exponential, Circular, Hyperbolic and Logarithmic functions of a complex variable, Inverse Hyperbolic functions, Real and imaginary parts of Circular and Hyperbolic functions, Summation of the series-'C+iS' method. Limit and derivative of complex functions, Cauchy-Riemann equations, Analytic functions and its applications, Complex integration, Cauchy's theorem, Cauchy's integral formula, Series of complex function, Taylor series, singularities and Laurent's series, Cauchy's residue theorem and its application for the evaluation of real definite integrals.	**12L**
UNIT-02	**Interpolation** Least square curve fit and trigonometric approximations, Finite differences and difference operators, Newton's interpolation formulae, Gauss forward and backward formulae, Sterling and Bessel's formulae, Lagrange's interpolation.	**06L**
UNIT-03	**Numerical Integration** Integration by trapezoidal and Simpson's rules 1/3 and 3/8 rule, Romberg integration, and Gaussian quadrature rule, Numerical integration of function of two variables.	**05L**
UNIT-04	**Numerical Solution of Ordinary Differential Equations** Taylor series method, Picard's method, Euler's method, Modified Euler's method, Runge-Kutta method. Predictor corrector methods, Adam Bashforth and Milne's method, convergence criteria, Finite difference method.	**07L**
UNIT-05	**Numerical Solution of Linear and Non Linear Equations** Non Linear Equations: Bisection Method, Regula Falsi Method, Newton-Raphson Method, Iteration method. Linear Equations: Jacobi and Gauss Seidal Iteration methods, Relaxation method.	**06 L**

Course Outcomes: Upon successful completion of the course, the student will be able to:

CO1: Understand and analyze the concept of Numerical Solution of Linear and Non Linear Equations, Ordinary Differential Equations and Function of complex variable.

CO2: Identify an appropriate technique to solve the linear, non-linear equations, ordinary differential equations.

CO3: Formulate the problems on related topics and solve analytically.

CO4: Apply the concepts of linear, non-linear equations, differential equations and complex analysis in various engineering problems.

CO5: Demonstrate the concepts through examples and applications.

Books and References

1. Complex variables and Applications: by R. V. Churchill, T. J. Brown & R. F. Verhey, McGraw Hill.
2. A first course in complex analysis with applications: by Dennis D. Zill & P. D. Shanahan, Jones and Bartlett.
3. Numerical Methods for Scientific and Engineering Computations: by M. K. Jain, S. R. K. Iyenger and R. K. Jain, New Age International Publishers, New Delhi
4. Numerical Methods for Engineers and Scientists (2nd Ed.): by J D Hoffman, CRC Press.
5. Numerical Analysis Mathematics and Scientific computing (3rd ed.): by D. Kincaid and W. Cheney, American Mathematical Society.

Course Name: **Linear Integrated Circuits**
Course Code: **EC-221**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart strong foundation of IC based design.
- To introduce the various applications of operational amplifiers and its integration with other devices.
- To learn circuits design using op amps for power management, signal conditioning and communication

Unit Number	Course Content	Lectures
UNIT-01	**Differential And Cascode Amplifiers** Emitter coupled differential amplifiers & its circuit configurations, FET differential amplifier, Differential amplifier with swamping resistor, constant current bias & current mirror. Cascade differential amplifier stages. Level translator, Cascode configuration	**8L**
UNIT-02	**Introduction to Operational Amplifiers** The basic operational amplifier & its schematic symbol, Block diagram representation of OP-AMP, Power supply requirements of an OP-AMP, Evolution of OP-AMP, Specification of a typical OP-AMP(741).	**3L**
UNIT-03	**The Practical Op-Amp And Its Frequency Response** Input offset voltage, input bias current, input offset current. Total output offset voltage, thermal drift, error voltage, variation of OP-AMP parameter with temperature & supply voltage. Supply voltage rejection ration (SVRR), CMRR-Measurement of OP-AMP parameters, Frequency response of compensator networks, Open loop voltage gain as a function of frequency, Slew rate, causes of slew rates and its effects in application	**6L**
UNIT-04	**Operational Amplifier Configurations & Linear Application** Open loop OP-AMP configurations- The differential amplifier, inverting amplifier, non-inverting amplifier, negative feedback configurations - inverting and non-inverting amplifiers, voltage followers & high input impedance configuration, differential amplifiers, closed loop frequency response & circuit stability, single supply operation of OP-AMP, summing, scaling and averaging amplifier, voltage to current & current to voltage converters, integrators & differentiators, logarithmic & anti logarithmic amplifiers	**6L**
UNIT-05	**Active Filters & Oscillators** Advantages of active filters, classification of filters, response characteristics of butter worth, chebyshev, causal filters, first order and second order butter worth filters- low pass and high pass types. Band pass & band reject filters. Oscillator principles, types of oscillators - phase shift, Wien Bridge & quadrature. Square wave, triangular wave and saw tooth wave generators, voltage controlled oscillator	**5L**
UNIT-06	**Comparators & Converters** Basic comparator & its characteristics, zero crossing detector, voltage limiters, clippers & clampers, small signal half wave & full wave rectifiers, sample and hold circuit, ADC, DAC	**5L**
UNIT-07	**Voltage Regulators** Fixed Voltage Regulator, Adjustable voltage regulators, Switching regulators, special regulators	**3L**

Course Outcomes

Upon successful completion of this course students will be able to :

CO1: Understand and design the basic circuits using op-amp and perform operations and their troubleshooting

CO2: To learn how to detect, amplify, store, create and manipulate signals using operational amplifiers\

CO3: To design and analyze the responses of IC based designed circuits in the area of power management, signal conditioning, analog and digital communication

CO4 : To develop IC based projects in the above areas

Books and References

1. OP-AMP and Linear Integrated Circuits, Ramakant A. Gayakwad, PHI Publication.
2. Design with Operation Amplifiers and Analog Integrated circuits, Sergei Franco, TMH.
3. Integrated Electronics: Analog and Digital Circuits & System, Millman & Halkias, TMH.
4. Linear Integrated Circuits, D. Choudhari, S. Jain, New Age International limited.

Course Name:	**Analog Communication Systems**
Course Code:	**EC-222**
Course Type:	**Core**
Contact Hours/Week: **3L + 1T**	Course Credits: **04**

Course Objectives

- To introduce the concepts of analog communication systems.
- To equip students with various issues related to analog communication such as modulation, demodulation, transmitters and receivers and noise performance.
- Differentiate between different modulation techniques and necessities of the same.

Unit Number	Course Content	Lectures
UNIT-01	**Modulation Techniques** Various Frequency Bands Used for Communication, Types of Communication and Need of Modulation. Introduction to AM, FM, PM, Frequency Spectrum of AM Waves, Representation of AM, Power Relation in AM Waves, Need and Description of SSB, Suppression of Carrier, Suppression of Unwanted Side-bands, Independent Sideband System, Vestigial Sideband System, Mathematical Representation of FM, Frequency Spectrum of AM Waves, Phase Modulation, Comparison Between Analog and Digital Modulation, Wideband and Narrow Band FM.	**10L**
UNIT-02	**AM Transmitters and Receivers** AM Transmitters: Generation of AM, Low Level and High Level Modulation, AM Transmitter Block Diagram, Collector Class C Modulator, Base Modulator, Transistor Vander Bill Modulator, DSB S/C Modulator. AM Receiver: Tuned Radio Frequency (TRF) Receiver. Super Heterodyne Receiver, RF Section and Characteristics, Mixers, Frequency Changing and Tracking, IF Rejection and IF Amplifiers. Detection and Automatic Gain Control (AGC), AM Receiver Characteristics.	**10L**
UNIT-03	**FM Transmitters and Receivers** FM Transmitters: Basic Requirements and Generation of FM, FM Modulation Methods: Direct Methods, Variable Capacitor Modulator, Varactor Diode Modulator, FET Reactance Modulator, Transistor Reactance Modulator, Pre-emphasis, Direct FM Modulator, AFC in Reactance Modulator, Disadvantages of Direct Method, Indirect Modulators, RC Phase Shift Modulators, Armstrong FM Systems. FM Receivers: Limiters, Single and Double-Tuned Demodulators, Balanced Slope Detector, Foster-Seeley or Phase Discriminator, De-emphasis, Ratio Detector, Block Diagram of FM Receivers, RF Amplifiers, FM Receiver Characteristics.	**05L**
UNIT-04	**SSB Transmitters and Receivers** Generator of SSB, Balanced Modulator Circuit, Filter Method, Phase Shift Method, Third Method, Phase Cancellation Method, Demodulation of SSB, Product Demodulator, Diode Detection Technique of SSB.	**05L**
UNIT-05	**Pulse Modulation Techniques** Pulse Amplitude Modulation and Demodulation, Pulse Width Modulation and Demodulation, Pulse Position Modulation and Demodulation, Sampling Theorem, Time Division Multiplexing, Frequency Division Multiplexing.	**06L**

Course Outcomes

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

CO1: Differentiate AM and FM transmission.

CO2: To analyze various methods of base band /band pass analog transmission and detection.

CO3: Gain the knowledge of components of analog communication system

Books and References

1. Electronic communication Systems by G. Kennedy, McGraw-Hill Education Publisher.
2. Principals of Communication System by Taub & Schilling, McGraw-Hill Education Publisher.
3. Electronic communication Systems by S. Haykin, Wiley India Pvt. Limited Publisher.

Course Name: **Electromagnetic Field Theory**
Course Code: **EC-223**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To understand the basic concepts of vector analysis, co-ordinate transformation and space derivative.
- To introduce the fundamental concepts relevant to electrostatic field and application of Gauss' law.
- To introduce the fundamental concepts relevant to magnetostatic field and application of Biot-Savart's law.
- To introduce the concept of Maxwell's equations and how electromagnetic wave propagates.
- To give the understating of wave propagation in guided media.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Fundamental of vector algebra, Scalar &vector fields, Introduction and transformation on different coordinate systems: (rectangular, cylindrical and spherical co-ordinate system), introduction to line, Surface and volume integrals, Definition of gradient, Divergent and curl of a vector and their physical significance.	**04L**
UNIT-02	**Electrostatics:** Principle of Coulomb's law, Definition of electric field intensity from point charges, Field due to continuous distribution of charges on an infinite and finite line, Electric Field due to an infinite uniformly charged sheet, Gauss's law and its applications, Electric flux density, Potential fields duo to electric dipole, Laplace's and Poison's equations.	**07L**
UNIT-03	**Magnetostatics:** Definition and explanation on Magnetic Field intensity due to a finite and infinite wire carrying current, Magnetic field intensity on rectangular loop carrying current, Ampere's Circuital law and its applications, Biot-Savart's law, Lorentz force equation for a moving charge, Magnetic Vector Potential**.**	**07L**
UNIT-04	**Time Varying EM Field:** Maxwell's equation in differential and integral vector form and their interpretations, Continuity of currents, Conduction and displacement current, Boundary conditions, Helmholtz equations, uniform plane wave in dielectric and conductor media, Skin effect and depth of penetration, reflection and refraction of plane waves at boundaries for normal incidence and surface impedance, Energy Flow and Poynting theorem.	**08L**
UNIT-05	**Transmission Lines:** Transmission line model, Parameters and properties of transmission line equations, Reflections in transmission lines, Voltage, current and impedance relations-open, Short circuit and matched lines, Standing wave ratio, Impedance matching, Quarter and half wave lines, Single stub and double stub matching; Circle diagram – Smith-chart.	**10L**

Course Outcomes

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

CO1: Describe the fields using vector algebra and filed transformation from one co-ordinate system to other.
CO2: Describethe force between charges and equipotential surfaces and electrostatic shielding/ screening.
CO3: Describe the magnetic field due to a current element and force on a chage particle due to magnetic filed.
CO4: Describe the electriomagnetic wave phenomenon and power carried by an lectromagnetic wave.
CO5: Identify that the KVL and KCL law (Circuit theory) are not suitable to apply at microwave frequencies and Maxwell's equations (Field theory) are too complex to apply for each problem. And, how, the transmission line theory bridges the gap between circuit theory and field theory. Also, how to design PCB.

Books and References

1. Elements of Engineering Electromagnetics by Matthew N.O. Sadiku, Oxford University Press.
2. Engineering Electromagnetics by William Hayt, TATA McGraw-Hill.
3. Elements of Engineering Electromagnetics by Narayana Rao, N, Pearson Education.
4. Electromagnetic Waves and Radiating Systems by Jordan and Balmain, PHI, Second Ed.
5. Electromagnetics by J.D. Kraus, McGraw-Hill.

Course Name: **VLSI Technology**
Course Code: **EC-224**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives:

- To impart knowledge about the miniaturization of Electronic Systems.
- To introduce the fundamental concepts relevant to VLSI fabrication.
- To enable the students to understand the various VLSI fabrication techniques.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to VLSI:** Concept Miniaturization of Electronic Systems & its impact on characterization.	**03L**
UNIT-02	**Monolithic Fabrication Techniques:** Crystal growth: Source of silicon; Single crystalline and Poly crystalline; Requirement of purity for electronics industry; Electronics grade silicon production; Crystal growth techniques: Bridgeman method, Float zone method, Czocharalski method, Modified Czocharalski method; refining; Silicon Wafer Preparation & Crystal Defects. **Epitaxial Process:** Need of epitaxial layer; vapors phase epitaxy -reactor design, Chemistry of epitaxial process, Transport mechanism doping & auto doping; selective epitaxy, Epitaxial process induced defects, Molecular beam epitaxy, Merits and demerits among epitaxial processes; recent trends in Epitaxy. **Oxidation:** Importance of oxidation; types of oxidation techniques; growth mechanism & kinetics; factors affecting the growth mechanisms; silicon oxidation model, dry & wet oxidation; oxidation induced faults; recent trends in oxidation. **Lithography:** Basic steps in lithography; Lithography techniques-optical lithography, Electron beam lithography, X-ray lithography, Ion beam lithography; resists and mask preparation of respective lithographies, Printing techniques-contact, Proximity printing and projection printing; merits and demerits of lithographies; recent trends in lithography at nano regime. **Etching:** Performance metrics of etching; types of etching- wet and dry etching; dry etching techniques-ion beam or ion-milling, Sputter ion plasma etching and reactive ion etching (RIE); merits and demerits of etching; etching induced defects; recent trends in epitaxy. **Diffusion and Ion Implantation:** Diffusion mechanisms; diffusion reactor; diffusion profile; diffusion kinetics; parameters affecting diffusion profile; Dopants and their behavior, choice of dopants; Ion Implantation- reactor design, impurity distribution profile, Properties of ion implantation, Low energy and high energy ion implantation. **Metallization:** Desired properties of metallization for VLSI; metallization choices; metallization techniques – vacuum evaporation, Sputtering.	**21L**
UNIT-03	**Packaging of VLSI Chip:** Introduction to packaging; packaging process; package design considerations, Various packages types.	**04L**
UNIT-04	**Isolation Techniques in Monolithic Components:** Isolation techniques in Diodes, BJT and MOSFETs (Enhancement and depletion mode)	**04L**
UNIT-05	**Monolithic Components- Prototype Fabrication:** Prototype fabrication of Diodes, npn BJT, pnp BJT, MOSFETs (Enhancement and depletion mode), n-MOS, p-MOS, CMOS, Resistors and Capacitors.	**04L**

Course Outcomes

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

CO1: Identify the material properties and ambient conditions for chips fabrication.
CO2: Describe the analysis of technology scaling.
CO3: Understand the complexities involved in the integrated circuits.
CO4: Apply principles toIdentify and Analyze the various steps for the fabrication of various components
CO5: Assess the various reliability issues in VLSI technology

Books and References

1. VLSI Technology by S.M. Sze, Tata Mc-Graw Hill
2. VLSI Fabrication Principles by S.K. Gandhi, John Willey & Sons
3. Integrated Circuits by K. R. Botkar, Khanna Publishers
4. Micromachined Transducer by G.T.A. Kovacs, McGraw Hill, 1998
5. Principles of Microelectronics Technology by D. Nagchoudhary, PHI

Course Name: **Linear Integrated Circuits Lab**
Course Code: **EC-225**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To learn practical applications of operational amplifier.
- To design and develop circuits using operational amplifiers.
- To learn how to detect, amplify, store, create and manipulate signals using operational amplifiers.

List of Experiments

1. To demonstrate the relationship between input and output in for the inverting and non-inverting configuration of the Op-Amp. 741.
2. To verify the function of OP-Amp's a summer and as a difference amplifier.
3. To perform the mathematical operation of differentiation using basic and practical circuit of Op-Amp's.
4. To perform the mathematical operation of integration using basic and practical circuit of Op-Amp's.
5. To study the half wave and full wave rectifier circuits using Op-Amp's
6. To design a first order butter worth low pass and high pass filter and determining its frequency response.
7. To plot the frequency response of the band pass filter for a specified frequency range.
8. To design a square, triangular and sawtooth wave generator using Op-Amp's.
9. To design the Wien Bridge oscillator using Op-Amp's.
10. To study the clipping and clamping circuits using operational amplifiers.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: To learn the basic applications of the operational amplifier

CO2: To learn how to detect, amplify, store, create and manipulate signals using operational amplifiers

CO3: To design and analyze the responses of IC based designed circuits in the area of power management, signal conditioning, analog and digital communication

Course Name: **Analog Communication Lab**

Course Code: **EC-226**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To understand practical implementation of various analog modulation schemes.
- To analyze and measure the performance of various analog modulation schemes.
- To understand practical implementation of pulse modulation, TDM and FDM.

List of Experiments

1. Amplitude Modulation and Demodulation
2. DSB SC Modulation and Demodulation
3. SSB SC Modulation and Demodulation
4. Frequency Modulation and Demodulation
5. To Observe and Measure Frequency Deviation and Modulation Index.
6. Pre Emphasis - De Emphasis.
7. PAM Generation and Reconstruction
8. PWM Generation and Reconstruction
9. PPM Generation and Reconstruction
10. Verification of Sampling Theorem
11. Time Division and Frequency Division Multiplexing
12. Phase Locked Loop

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: Design and implement AM and FM based analog communication systems.

CO2: Design and implement Pulse modulation systems.

CO3: Design and implement FDM and TDM systems.

CO4: Analyze the performance measure of Analog Communication Systems.

Course Name: **Circuit Design and Simulation Lab**

Course Code: **EC-227**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide skills for designing Electronics circuits in circuit simulator
- To provide skills for analyzing the electronics circuits
- To enable the students to be able to design a new electronic circuit.

List of Experiments

1. Introduction to Tanner and Cadence EDA simulation tool.
2. To study the time and frequency response of series RLC circuit.
3. To study the frequency response of common emitter configuration of BJT.
4. To simulate N-MOS transistor and obtain its transfer and output characteristics.
5. To simulate-MOS transistor and obtain its transfer and output characteristics.
6. To simulate MOS inverter using resistive load, CMOS inverter, pseudo NMOS inverter and enhancement mode CMOS inverter and obtain their VTC.
7. To simulate NAND and NOR logic gate using CMOS and study its performance.
8. To simulate EX-OR and EX-NOR logic gate using CMOS and study its performance.
9. To simulate half adder and Full adder using CMOS and study its performance.
10. Introduction to Physical simulation and TCAD.
11. Build a simulation mesh for diode and study its characteristics.
12. Build a simulation mesh for BJT and study its characteristics.
13. Build a simulation mesh for MOSFET and study its characteristics.
14. To study the CMOS inverter characterization using proto-type fabricated NMOS and PMOS.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: Identify and introduce simulate the electronic circuits

CO2: Design electronic circuit for a concerned application.

CO3: Write a TCAD program for the performance analysis of electronic device

Course Name: **Microprocessor Architecture and Applications**
Course Code: **EC-311**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about the architecture and instruction set of typical 8-bit microprocessor.
- To introduce the fundamental concepts relevant to, Assembly Language, Timers, Interrupts.
- Input-output techniques and important programmable support chips used in microprocessor-based systems are discussed in detail.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Microprocessors:** History and Evolution, types of microprocessors, Microcomputer Programming Languages, Microcomputer Architecture, Pipelining, Clocking, Intel 8085 Microprocessor, Register Architecture, Bus Organization, ALU, Control section, ISA of 8085, Instruction format, Addressing modes, Types of Instructions.	**06L**
UNIT-02	**Assembly Language Programming and Timing Diagram:** Assembly language programming in 8085, Macros, Labels and Directives, Microprocessor timings, Micro instructions, Instruction cycle, Machine cycles, T-states, State transition diagrams, Timing diagram for different machine cycles, Memory and I/O interface.	**08L**
UNIT-03	**Serial I/O, Interrupts:** Serial I/O using SID, SOD, Interrupts in 8085, RST instructions, Issues in implementing interrupts, Multiple interrupts and priorities, Daisy chaining, Interrupt handling in 8085, Enabling, Disabling & masking of interrupts.	**09L**
UNIT-04	**Data Transfer techniques:** Data transfer techniques, Parallel & Programmed data transfer using 8155, Programmable parallel ports & handshake input/output, Asynchronous and Synchronous data transfer using 8251, PIC (8259), PPI (8255), DMA controller (8257). Interfacing Traffic Light Interface, Stepper Motor, 4 Digit 7 Segment LED, stepper motor and LCD.	**06L**
UNIT-05	**16-Bit Microprocessors (Intel 8086):** Introduction to a 16 bit microprocessor, Memory address space and data organization, Segment registers and Memory segmentation, Generating a memory address, I/O address space, Addressing modes, Comparison of 8086 & 8088, Basic configurations of 8086/8088, Min. Mode, Max. Mode & System timing, Introduction to Instruction Set of 8086.	**07L**

Course Outcomes

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

CO1: Understand the architecture of 8085 and 8086
CO2: Impart the knowledge about the instruction set
CO3: Understand the basic idea about the data transfer schemes and its applications

Books and References

1. Microprocessor Architecture, Programming & Applications with the 8085/8080A by R.S. Gaonkar, Wiley Eastern Ltd.
2. Microprocessors & Interfacing by D.V. Hall, McGraw Hill.
3. Microprocessors: Theory & Applications (Intel & Motorola) by M. Rafiquzzman, PHI.
4. INTEL 8086/88, 80186, 286, 386, 486, Pentium Pro & Pentium IV by Berry B. Bray.

Course Name: **Digital Communication and Systems**
Course Code: **EC-312**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about the key modules of digital communication systems with emphasis on digital modulation techniques.
- To introduce the fundamental concepts relevant to reception of digital signals
- To enable the students to understand the concept and basics of information theory and the basics of channel coding/decoding.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Concepts of Digital Communication, Advantages/Disadvantages of Digital Communication Systems over Analog Communication Systems. Block Diagram of Basic Digital Communication Transmitter/Receiver.	**02L**
UNIT-02	**Analog to Digital Conversion:** Noisy Communications Channels, Sampling Theorem: Low Pass Signals And Band Pass Signals, Pulse Amplitude Modulation, Channel Bandwidth For PAM Signal, Natural Sampling, Flat Top Sampling, Signal Recovery & Holding, Quantization of Signal, Quantization Error, Pulse Code Modulation (PCM), Delta Modulation, Adaptive Delta Modulation.	**08L**
UNIT-03	**Digital Modulation Techniques:** Binary Phase Shift Keying, Differential Phase Shift Keying, Differential Encoded PSK, QPSK, Quadrature Amplitude Shift Keying (QASK), Binary Frequency Shift Keying.	**8L**
UNIT-04	**Data Transmission:** Base Band Signal Receiver, Probability of Error, Optimum Filter, White Noise- Matched Filter, Probability of Error of The Matched Filter, Coherent Reception: Correlation, Application of Coherent Reception In PSK And FSK. Correlation Receiver for QPSK.	**7L**
UNIT-05	**Noise in Pulse Code & Delta Modulation Systems:** PCM Transmission, Calculation of Quantization Noise, O/P Signal Power, The Effect of Thermal Noise, O/P Signal to Noise Ratio in PCM, Delta Modulation, Quantization Noise in Delta Modulation, The O/P Signal to Quantization Noise Ratio in Delta Modulation, O/P Signal to Noise Ratio in Delta Modulation.	**6L**
UNIT-06	**Information Coding and Decoding:** Coding for Error Detection and Correction, Basics of Block Coding and Decoding, Introduction to Cyclic Codes, Basic Convolution Coding /Decoding and Viterbi Algorithm.	**05L**

Course Outcomes

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

CO1: Apply the knowledge of statistical theory of communication and explain the conventional digital communication system.

CO2: Apply the knowledge of signals and system and evaluate the performance of digital communication system in the presence of noise.

CO3: Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code.

CO4: Design as well as conduct experiments, analyze and interpret the results to provide valid conclusions for digital modulators and demodulator using hardware components and communication systems using CAD tool.

Books and References

1. Principles of communication systems by Taub & Schilling, McGraw-Hill Education (India).
2. Communication Systems by Simon Haykin, John-Wiley & Sons, Inc.
3. Digital Communication by J.G. Proakis, McGraw – Hill.
4. Digital Communications: Fundamentals & Applications by B. Sklar, Pearson Education.
5. Introduction to Digital Communication by R.E. Zimer & R.L. Peterson, PHI.

Course Name: **Digital Signal Processing**
Course Code: **EC-313**
Course Type: **Core**

Contact Hours/Week: **3L+1T** Course Credits: **04**

Course Objectives

- Digital Signal processing explains the basics of discrete time signals and systems. It focuses on the operation on the signals in time and frequency domain. It covers the different design techniques for FIR and IIR filters and also their realization structures.

Unit Number	Course Content	Lectures
UNIT-01	**DISCRETE-TIME SIGNALS AND SYSTEMS** Basic Elements of a Digital Signal Processing System, Advantages of Digital Signal Processing, Classification of Signals, The Concept of Frequency In Continuous-Time and Discrete-Time Domain, Discrete-Time Signals and Systems, Analysis Of Discrete-Time Linear Shift-Invariant Systems, Linearity, Causality And Stability Criterion, Discrete-Time Systems Described By Difference Equations.	**07L**
UNIT-02	**DISCRETE-TIME FOURIER TRANSFORM** The Fourier Transform Of Discrete-Time Signals (DTFT), Properties Of The DTFT, The Frequency Response Of An LTI Discrete-Time System, The Fourier Series Of Discrete-Time Signals (DTFS).	**05L**
UNIT-03	**DISCRETE FOURIER TRANSFORM:** Frequency Domain Sampling And The DFT, Properties Of The DFT, Linear Filtering Methods Based On The DFT, Efficient Computation Of The DFT: Decimation-In-Time And Decimation-In Frequency Fast Fourier Transform Algorithms.	**07L**
UNIT-04	**Z-TRANSFORM** Introduction To The Z-Transform & The Inverse Z-Transform, Properties Of The Z-Transform, Relationship Between The Fourier Transform And The Z-Transform, Rational Z-Transforms & The System Function, Analysis Of Linear Time-Invariant Systems In The Z-Domain.	**05L**
UNIT-05	**DIGITAL FILTER STRUCTURES** Digital Filter Categories, Realization Structures For FIR & IIR Digital Filters, Representation Of Numbers: Fixed-Point, Floating Point, Error Resulting From Rounding And Truncation.	**04L**
UNIT-06	**DIGITAL FILTER DESIGN** General considerations; design of IIR filter from Analog filters: IIR filter design using Approximation of derivative, impulse invariant method, Bilinear transformation; Design of linear phase FIR digital filters: Symmetry and Anti-symmetry FIR filters, FIR digital filter design using the windowing method and the frequency-sampling method.	**08L**

Course Outcomes

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

CO1: Understand the discrete time signals and systems.
CO2: Understand the Fourier transform and Fourier series of discrete time signals.
CO3: Analysis the discrete time signals in frequency domain using DFT and FFT.
CO4: Understand the Z-Transform and its properties.
CO5: Understand the realization structures for FIR and IIR digital filters.
CO6: Analysis the design characteristic of FIR and IIR filters.

Books and References

1. Digital Signal Processing: Principles, Algorithms and Applications by John G. Proakis & Dimitris G. Manolakis, Pearson Education.
2. Digital Signal Processing by Sanjit K. Mitra, Tata McGraw Hill Publication.
3. Digital Signal Processing by P Ramesh Babu, SCITECH Publication (India) Pvt Lmt.

Course Name: **Microwave Devices and Systems**
Course Code: **EC-314**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the usage of microwave communication.
- To introduce the fundamental concepts relevant to waveguide problems, microwave devices and components.
- To enable the students to understand the factors that cause the power, frequency, operating limitations of the devices.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction on Microwaves:** Frequency Allocations and Frequency Plans, Microwave Waveguide, Rectangular Waveguide and its Analysis, Circular Waveguide, Modes of Propagation, Dominant Modes, Cut-off wavelength, Mode Excitation.	**06L**
UNIT-02	**Microwave Generators and Amplifiers:** Limitations of Conventional Tubes at Microwave Frequency, Reflex Klystron, Two and Multicavity Klystron Amplifiers and Oscillators and their Analysis, Basics on Magnetrons and Traveling Wave Tube and their Applications.	**06L**
UNIT-03	**Microwave Devices:** Scattering Matrix of Microwave Waveguide Junction, Properties of S-Matrix, E-Plane Tee, H-plane Tee, Magic Tee, Attenuators, Directional Couplers, Ferrite Devices, Faraday Rotation, Gyrator, Isolator, Circulators and Cavity Resonators	**06L**
UNIT-04	**Microwave Solid-State Devices:** Gunn Diode and its Modes of Operation, Avalanche IMPATT Diode, TRAPATT Diode, Operations and V-I Characteristics of Tunnel Diode, Schottky Diode, Backward Diode and Varactor Diodes, PIN Diode and its Applications.	**06L**
UNIT-05	**Micro-Strip Lines:** Introduction on Micro Strip Lines, Characteristic Impedance of Micro Strip Lines, Losses in Micro Strip Lines, Quality Factor of Micro Strip, Parallel Strip Lines, Coplanar Strip Lines and Shielded Strip Lines.	**06L**
UNIT-06	**Microwave Measurements:** Measurement of Standing Wave Ratio, Measurement of Wavelength and Frequency, Measurement of Power, Radiation Pattern Measurement of Antenna, Microwave Link.	**06L**

Course Outcomes

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

CO1: Identify the knowledge of generations and amplifications of the signals at high frequencies

CO2: Describe the microwave components, devices and system.

CO3: Apply principles of transmission lines at microwave frequencies, reflection and transmission of the wave.

CO4: Assess the usage of microwave spectrum, microwave measurement techniques.

Books and References

1. Microwave Engineering by David M. Pozar, Wiley Publication, New Delhi
2. Microwave Devices and Circuits by Samuel Y. Liao, Prentice-Hall, U.S.A
3. Microwave and Radar Engineering by M. Kulkarni, Umesh Publications, India.
4. Foundations for Microwave Engineering by R.E. Collins, Wiley Interscience, New York.
5. Microwave Engineering by Das and S. K. Das, McGraw-Hill, New Delhi.
6. Elements of Microwave Engineering by Rajeswari Chatterjee, Ellis Horwood Ltd.

Course Name: **Digital Communication Lab**

Course Code: **EC-315**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To understand practical implementation of various digital modulation schemes.
- To analyze and measure the performance of various digital modulation schemes.
- To understand practical implementation of line coding formats.

List of Experiments

1. Time Division Multiplexing & Demultiplexing.
2. Pulse Code Modulation & Demodulation.
3. Delta Modulation and Demodulation.
4. Adaptive Delta Modulation and Demodulation.
5. Binary Phase Shift Keying (BPSK) Modulation and Demodulation.
6. Frequency Shift Keying (FSK) Modulation and Demodulation.
7. Amplitude Shift Keying (ASK) Modulation and Demodulation.
8. Quadrature Phase Shift Keying (QPSK) Modulation and Demodulation
9. To Study Characteristics of Gaussian Noise and to Measure its Spectral Height in Frequency Band over Which Its Spectral Density is flat.
10. To Study Line Coding Techniques.
11. To Study The Characteristics of The Phase Shifter, Multiplier and The Integrate-And-Dump Filter.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: Design and implement BPSK, QPSK, ASK and BFSK based digital communication systems.

CO2: Design and implement PCM, DM and ADM based digital communication systems.

CO3: Analyze the performance measure of Digital Communication Systems.

Course Name: **Microwave Devices and Systems Lab**

Course Code: **EC-316**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide skills for operating microwave benches at designed X band setup
- To provide skills for usage of microwave sources
- To enable the students to practical know how the microwave measurements.

List of Experiments

1. To Study the Microwave Components, Sources and Different Types of Loads at X Band Setup.
2. To Study the Characteristics of Reflex Klystron Oscillator and Determine its Mechanical and Electronics Tuning Range.
3. To Study the V-I Characteristics of Gunn Diode and Determine its Negative Resistance.
4. To Determine the Insertion Loss Parameter and Isolation Parameter of a Ferrite Based Isolator and Circulators.
5. To Measure the Frequency in a Rectangular Waveguide and Demonstrate the Relationship among the Frequency, Free Space Wavelength and Guide Wavelength.
6. To Plot the Radiation Pattern of a Pyramidal Horn Antenna and determine its Gain and Beam width.
7. To Study the Characteristics of Various Tees, i.e. E-Plane Tee, H-Plane Tee and Magic Tees.
8. To Measure the Coupling and Directivity of a 3 dB, 10 dB and 20 dB Directional Couplers.
9. To Measure the Low, Medium, and High VSWR of DUT Using Slotted Lines Section.
10. To Measure the Unknown Impedances using Smith Chart.
11. To Measure of VSWR, Insertion Loss, Attenuation of Fixed and Variable Attenuators.
12. To Measure of Phase Shift of a Phase Shifter.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: Identify a practical approach for testing and measurement of these devices in real environment.

CO2: Design any microwave device and components at.

CO3: Understanding of basic requirements of microwave components and sources in real time applications

Course Name: **Digital Signal Processing Lab**
Course Code: **EC-317**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To perform the time domain and frequency operations on discrete signals in MATLAB software
- To impart the knowledge of TMS320C6713 Processor and various operation using it.

List of Experiments

1. Generation of Basic continuous and discrete signals.
2. Write a MATLAB program to find the linear convolution of two discrete signals.
3. Write a MATLAB program to find the correlation of two signals.
4. Write a MATLAB program to find the circular convolution of two discrete signals.
5. Write a MATLAB program to find the DFT and IDFT of a discrete signal using FFT algorithm.
6. Write a MATLAB program to find the Z-transform of a discrete signal.
7. Design a FIR filters (LPF, HPF, BPF and BSF) using windowing technique and plot their magnitude and phase spectrum.
8. Design a FIR filters (LPF, HPF, BPF and BSF) using frequency sampling technique and plot their magnitude and phase spectrum.
9. Design a Butterworth IIR filters (LPF, HPF, BPF and BSF) and plots their magnitude and phase spectrum.
10. Design a Cheby-I and Cheby-II IIR filters (LPF, HPF, BPF and BSF) and plot their magnitude and phase spectrum.
11. Design a filter to remove noise from a signal.
12. Introduction to TMS320C6713 Processor.
13. Addition, Subtraction and multiplication in fixed point representation.
14. Addition, Subtraction and multiplication in floating point representation.
15. Linear Convolution using DSP kit.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: Understand various signal operations in time and frequency domain.

CO2: Design the FIR and IIR filters and will be able to remove noises from signal using filters.

CO3: Understand the TMS320C6713 Processor and various operations using it.

Course Name: **Microcontroller And Embedded Systems**
Course Code: **EC-321**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about the microcontrollers, its programming, interrupts timers and assembly language.
- The concepts of ARM architecture and real-time operating system.
- To provide experience to integrate hardware and software for microcontroller application system.
- To impart ability to put together processor, peripherals and memory and build a real time system.

Unit Number	Course Content	Lectures
UNIT-01	**Microcontroller:** Introduction to Microcontrollers, Evolution, Architectures, Implementations, Background and History of Embedded Systems, Characteristics of ES, Hardware/Software Co-Design, RISC vs CISC, MCS-51 Family Overview, Important Features, Architecture, 8051 Pin Functions, Architecture, Addressing Modes, Instruction Set, Instruction Types, Applications of ASIC and FPGA in ES.	**05L**
UNIT-02	**Programming:** Assembly Programming, Timer Registers, Timer Modes, Overflow Flags, Clocking Sources, Timer Counter Interrupts, Baud Rate Generation, Serial Port Register, Modes of Operation, Processing Interrupts, Interrupt Service Routines, Look-up Tables.	**10L**
UNIT-03	**Embedded Software Development:** Software development flow, Polling, Interrupt driven, Multi-tasking systems, Architecture of an RTOS, Important features of RTOS, Embedded Systems Programming, Locks and Semaphores, Operating System Timers and Interrupts, Exceptions, Tasks, Task states and scheduling, Task structures, Synchronization, Communication and concurrency, Semaphores, Real-time clock.	**08L**
UNIT-04	**32-Bit Cortex-M Architecture:** CPU architecture, Memory model, Registers, Modes, Exceptions, Interrupts, Exception handlers, interrupt controllers, Power modes, Hardware features and optimizations, Advanced bus standards like AMBA, The NVIC on ARM Cortex-M.	**07L**
UNIT-05	**Instruction Set of ARM:** Syntax, Addressing modes and operands, Memory access instructions, Logical operations, Shift operations, Arithmetic operations, Stack, Functions and control flow, Assembler directives, Thumb and arm instruction differences, Development with Keil and Mbed, Applications like IoT and machine learning with cortex-M.	**06L**

Course Outcomes

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

CO1: Write the programs for microcontrollers

CO2: Understand the role of embedded systems in industry.

CO3: Understand the design concept of embedded systems.

Books and References

1. The 8051 Microcontroller and Embedded Systems (2nd Ed.) by Mazidi Muhammad Ali, Pearson publications.
2. The Definitive Guide to ARM Cortex-M3 processors (3rd Ed.) by Joseph Yiu, Newnes publication.
3. Introduction to ARM Cortex-M Microcontrollers, Vol. 1 (5th Ed.) by Jonathan W. Valvano, Create Space.
4. Real-Time Interfacing to ARM Cortex-M Microcontrollers, Vol. 2 (4th Ed.) by Jonathan W. Valvano, Create Space.
5. Real-Time Operating Systems for ARM Cortex-M Microcontrollers, Vol. 3 (2nd Ed.) by Jonathan W. Valvano, Create Space.

Course Name: **Wireless Communication**
Course Code: **EC-322**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To understand the cellular concept of wireless communications
- To study large-scale and small-scale propagation effects in wireless channels
- To study different techniques that improve radio link performance in wireless communications
- To understand general concepts of various multiple access techniques used in wireless communication

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Evolution of wireless communication systems, Examples of wireless communication systems.	**2L**
UNIT-02	**The Cellular Concept – System Design Fundamentals:** Concept of frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Trunking and grade of service, Improving coverage and capacity in cellular systems.	**9L**
UNIT-03	**Propagation Models:** Free space propagation model, Two-ray ground reflection model, Distance power loss, Macrocell propagation model, Micro-cell propagation model, Shadowing model, Multipath effects in mobile communication, Models for multipath reception.	**8L**
UNIT-04	**Equalization, Diversity and Channel Coding:** Fundamentals of equalization, Adaptive equalizers, Linear and nonlinear equalization, Algorithms for adaptive equalization, Diversity techniques, Fundamentals of channel coding, Overview of error detection and correction codes.	**9L**
UNIT-05	**Multiple Access Techniques:** Introduction to multiple access, Frequency division multiple access, Time division multiple access, Spread spectrum multiple access, Space division multiple access, Packet radio, Orthogonal frequency division multiple access; Introduction to wireless systems and standards.	**8L**

Course Outcomes

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

CO1: Understand the operation of wireless and cellular communication systems
CO2: Analyze various design related issues associated with improving coverage and capacity of cellular systems
CO3: Analyze large-scale and small-scale radio propagation effects in mobile cellular systems
CO4: Understand the concepts of equalization, diversity and channel coding in wireless communications
CO5: Understand general concepts of various multiple access techniques for wireless communication

Books and References

1. Wireless Communications: Principles and Practice by Theodore S. Rappaport, Pearson / PHI Publication
2. Wireless Communications and Networks: 3G and Beyond by Iti Saha Misra, Tata McGraw Hill Publication
3. Mobile Cellular Telecommunications: Analog and Digital Systems by William C. Y. Lee, Tata McGraw Hill Publication
4. Wireless Digital Communications by Kamilo Feher, PHI Publication

Course Name: **VLSI Design Techniques**
Course Code: **EC-323**
Course Type: **Core**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To introduce the fundamental concepts relevant to MOSFETs and physical design of VLSI circuits.
- To impart knowledge about various CMOS VLSI Design styles.
- To design MOS memories and learn high performance design techniques.
- To enable the students understand the parameters on which the circuit performance depends and their control strategies.

Unit Number	Course Content	Lectures
UNIT-01	**MOSFETS**: Fundamentals of Enhancement Mode MOSFETs, Depletion Mode MOSFETs, Weak & strong Inversion Conditions, Threshold Voltage Concept in MOSFETs, Current-Voltage (IV), Characteristics of a MOSFET, Limitations in IV Model and MOSFET parasitics, Trends & Projections in VLSI Design & Technology, Flow of VLSI Circuit Design, Scaling in MOS devices.	**05L**
UNIT-02	**VLSI Design Styles**: NMOS, CMOS Process flow, Noise Margin, Inverter Threshold Voltage, NMOS Inverter design and characteristics, CMOS Inverter Design and Properties, Delay and Power Dissipation, Parallel & Series Equivalent circuits, Static CMOS Circuit Design.	**09L**
UNIT-03	**VLSI Physical Design**: Stick Diagrams, Physical Design Rules, Layout Designing, Euler's Rule for Physical Design, Reliability issues in CMOS VLSI, Latching.	**05L**
UNIT-04	**High Performance Logics:** Precharge-Evaluate logic, Dynamic CMOS logic, NORA logic, Complementary Pass Logic (CPL), Transmission gate logic.	**07L**
UNIT-05	**MOS Memory Design**: MOS memories: ROM design, SRAM Cell design and DRAMs.	**06L**
UNIT-06	**CMOS Amplifiers**: Single stage MOS Amplifiers: Common Source amplifier, Common Gate amplifier, Common Drain amplifier	**04L**

Course Outcomes

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

CO1: Comprehend and utilize digital and analog VLSI circuit design techniques and their advancements.
CO2: Identify, select and design any static and dynamic CMOS VLSI logic circuits for practical applications and memory design.
CO3: Analyse CMOS circuits with equivalent parameters and build upon the theoretical, mathematical and experimental models.
CO4: Use EDA tools and SPICE for analysis, verification and physical design simultaneously for efficient and optimal design of VLSI Circuits.
CO5: Generate interest and competence in self-directed continuing professional development and for sustainable research and Development in VLSI design for societal and global interest.

Books and References

1. CMOS Digital Integrated Circuits-Analysis & Design by S.M. Kang and Y. Leblebici, TMH.
2. Design of Analog CMOS Integrated Circuits by B. Razavi, TMH.
3. Solid State Electronic Devices by B.G. Streetman and S. Banerjee, PHI.
4. Principles of CMOS VLSI Design- A Systems Perspective by Neil H E Weste and K. Eshraghian.
5. Introduction to VLSI by K. Eshraghian and Pucknell, PHI.

Course Name: **Antenna and Wave Propagation**
Course Code: **EC-324**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the Electromagnetic radiation, antenna basic parameters, antenna arrays and their patterns, special antennas, wave propagation over ground, through troposphere and ionosphere.
- To introduce the fundamental concepts relevant to electromagnetic theory and its application to antennas and wave propagation.

Unit Number	Course Content	Lectures
UNIT-01	**Electromagnetic radiation:** Radiation phenomenon from an oscillation dipole in free space, Induction and radiation fields, Retarded potentials, Radiated power and radiation resistance from a short dipole, Half wave dipole and quarter wave monopole.	**06L**
UNIT-02	**Antenna Fundamentals:**Directional properties of antennas, Radiation patterns, Antenna gain and aperture, Antenna terminal impedance, Self and mutual impedance, Front to back ratio, Antenna beam width and bandwidth, Antenna efficiency, Antenna beam area, Polarization, Antenna temperature and Reciprocity properties of antennas.	**06L**
UNIT-03	**Antenna Arrays:** Classification of arrays, Linear arrays of two point sources, Linear arrays of n-point sources, Pattern multiplication, Array factor, Linear arrays of equal amplitude and spacing (Broad side and end fire arrays) of n-point sources, Directivity and beam width, Non-uniform arrays excitation using Binomial series.	**08L**
UNIT-04	**Special Antennas:** VLF and LF antennas(Hertz and Marconi antennas), Rhombic antennas, Loop antennas ,Folded dipole antennas, Yagi-Uda antenna, Horn antennas, Microwave dish antennas, Helical antennas, Microstrip Patch antennas, Fractal antennas.	**08L**
UNIT-05	**Ground Wave Propagation:** Characteristics for ground wave propagation, Reflection at the surface of a finitely conducting plane and on earth, Attenuation Calculation of field strength at a distance.	**03L**
UNIT-06	**Ionosphere Propagation:** The ionosphere structure, Effective characteristics of the various layers of ionosphere, Reflection and Refraction of waves by ionosphere, Virtual height, Maximum usable frequency, Skip distance, Regular and irregular variation of ionosphere, Fading and Diversity reception. **Space Wave Propagation:** Space wave range, Troposphere waves-reflection, Refraction, Duct propagation, Troposphere propagation link.	**05L**

Course Outcomes

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

CO1: Identify basic antenna parameters
CO2: Design and analyze wire antennas
CO3: Design and analyze antenna arrays
CO4: Analyze different antennas
CO5: To identify characteristics of radio wave propagation

Books and References

1. Antennas Theory by C.A. Balanis, Willey Publication.
2. Antennas by J. D. Kraus, McGraw Hill.
3. Antennas and Radio Propagation by R. E. Collins, McGraw-Hill.
4. Electromagnetic waves & radiating System, E. C. Jorden and B. C. Balmann, P.H.I.
5. Antenna & Wave Propagation, K. D. Prasad, Satya Prakashan New Delhi.

Course Name: **Microprocessor and Microcontroller Lab**

Course Code: **EC-325**

Contact Hours/Week: **2P** Course Credits:**01**

Course Objectives

- To provide skills for designing flowcharts and writing algorithms
- To provide skills for writing Embedded programs
- To enable the students to debug programs

List of Experiments

1. On 8085 kit, find the Factorial of a number
2. On 8085 kit, find if a number is prime or a perfect square
3. On 8051 kit, write a program to perform serial data transfer
4. On 8051 kit, generate square wave for a given frequency and duty cycle
5. On cortex M3, write a program to perform LED binking
6. On cortex M3, write a program to verify Digital out
7. On cortex M3, write a program to display clock on 7-segment display
8. On cortex M3, write a program to generate Analog output
9. On cortex M3, write a program to read in Analog input
10. On cortex M3, write a program to debug using serial pc
11. On cortex M3, write a program to generate PWM output
12. On cortex M3, write a program to perform counting on LCD counter
13. On cortex M3, write a program to learn Interrupt function
14. On cortex M3, write a program to understand 12c master and slave communication
15. On Intel Galileo Gen 2, plot a graph for analog input
16. On Intel Galileo Gen 2 write an Array in Arduino

Note: The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.

Course Outcomes

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

CO1: Write algorithms and programming task involved for a given problem

CO2: Design and develop modular programming skills

CO3: Trace and debug a program

Course Name: **VLSI Design Lab**

Course Code: **EC-326**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To learn Physical Design i.e. Layout making of VLSI circuits.
- Programming in SPICE and its use for design and analysis.
- To extract various design parameters from simulation results.
- Provide students with an opportunity to practice on EDA software & tools for VLSI Design.

List of Experiments

1. Familiarity with Tanner L-EDIT EDA Tools: To study the main features and utilities of the tools for design and physical design of circuits. Report the pros and cons of the tool.
2. To find dc and transient response of a CMOS Inverter Circuit and its Physical Design using minimum dimension criteria. Hence extract various design parameters from simulation results.
3. To simulate transient response of CMOS NAND Gate (Fig.1). Physical Design the logic gate or design the layout, using minimum dimension criteria.

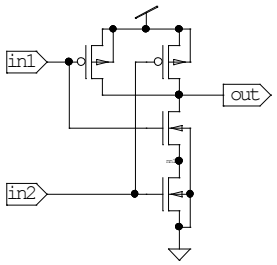

Fig.1. CMOS NAND Gate.

4. Simulate firstly minimum dimension CMOS inverter circuit using SPICE. Hence analyze and plot power and delay variations i) with voltage scaling, ii) For dimension, load and frequency variations.
5. Simulate CMOS NAND, NOR and XOR circuits using SPICE. Hence analyze and plot their power and delay variations i)with voltage scaling, ii)For dimension, load and frequency variations.
6. Design a differential amplifier circuit for a voltage gain of 10. Design its layout.
7. Physical Design of a complex circuit AOI/ OAI, making layout using Euler's method, for delay, power and area centric designs.
8. Design a four input CMOS NAND and NOR gates with the constraint propagation delay not exceeding 10ns. Compare LVS.
9. Familiarity with Cadence Familiarization with Cadence EDA Tools. To study the main features and utilities of the tools for design and physical layout design. Report the same in practical file.
10. Design NAND NOR, XOR circuits using Cadence EDA Tools, for delay and power centric design criteria.
11. Physical design a full adder circuit using minimum number of CMOS NAND gates.
12. Design triangular wave generator using OP-Amps in SPICE.
13. Familiarization with COMSOL Multiphysics Tool and its applications for Design and study of 1D Heat Transfer with Radiation model.

Note: *The concerned Course Coordinator will prepare the actual list of experiments/problems at the start of semester based on above generic list.*

Course Outcomes

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

CO1: Identify and abstract the programming task involved for a given VLSI problem.

CO2: Design and develop programming skills for VLSI circuit design.

CO3: Trace and debug any VLSI related program.

Course Name: **Control System**
Course Code: **EC-411**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To discuss basic concepts of linear systems.
- To provide a basic understanding of mathematical model of linear systems.
- To introduce the fundamental concept of different control components.
- To enable the students to understand the concepts of time and frequency domain analysis.
- The students can be able to learn stability analysis.
- To discuss the concept of state variable.

Unit Number	Course Content	Lectures
UNIT-01	**Basic Concepts:** Historical Review, Definitions, Classification, Relative Merits and Demerits of Open and Closed Loop Systems.	**03L**
UNIT-02	**Mathematical Models of Control System:** Linear and Non-Linear Systems, Transfer Function, Mathematical Modeling of Electrical, Mechanical and Thermal Systems, Analogies, Block Diagrams and Signal Flow Graphs.	**07L**
UNIT-03	**Control Components:** DC Servomotor, AC Servomotor, Potentiometers, Synchronous, Stepper-Motor.	**05L**
UNIT-04	**Time and Frequency Domain Analysis:** Transient and Frequency Response of First and Second Order Systems, Correlationship Between Time and Frequency Domain Specifications, Steady-State Errors and Error Constants, Concepts and Applications of P, PD, PI and PID Types of Control.	**07L**
UNIT-05	**Stability Analysis:** Definition, Routh-Hurwitz Criterion, Root Locus Techniques, Nyquist Criterion, Bode Plots, Relative Stability, Gain Margin and Phase Margins.	**07L**
UNIT-06	**State Variable Analysis:** Introduction, Concept of State, State Variables & State Models, State Space Representation of Linear Continuous Time Systems, State Models for Linear Continuous Time Systems, State Variables and Linear Discrete Time Systems, Solution of State Equations, Concept of Controllability & Observability.	**07L**

Course Outcomes

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

CO1: Demonstrate fundamentals of (feedback) control systems.
CO2: Explain mathematical model for different systems.
CO3: Explain different control components.
CO4: Explain the relation between time and frequency domain specification and employ controllers such as P, PD, PI and PID control design.
CO5: The use and significance of the different tools for control system design and analysis such as Nyquist plots, Bode plots, and Evans plots (root locus).
CO6: Demonstrate concept of state variable and state model.

Books and References

1. Discrete-Time Control Systems by K. Ogata, Prentice Hall India Learning Pvt. Ltd.
2. An Introduction to Control Systems by K. Warwick, World Scientific Publishing Co. Pvt. Ltd.
3. Control System Fundamentals by W. S. Levine, CRC Press.
4. Modern Control Systems by R. C. Dorf and R. H. Bishop, Prentice Hall.

Course Name: **Optical Communication Systems & Networks**
Course Code: **EC-412**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To introduce the students to various optical fibre modes, configurations and various signal degradation factors associated with optical fiber
- To study about various optical sources and optical detectors and their use in the optical communication system.

Unit Number	Course Content	Lectures
UNIT-01	**OVERVIEW :** The Electromagnetic Spectrum, Properties of Light, Dual Nature of Light Concept of A Photon, Wave Model, Characteristics of Light Waves. Concepts of Information, General Communication Systems, Evolution of Basic Fiber Optic Communication System, Benefits and Disadvantages of Fiber Optics. Transmission Windows. Transmission Through Optical Fiber, The Laws of Reflection and Refraction, Light Rays and Light Waves, Reflection of Light From Optical Surfaces, Refraction of Light From Optical Interfaces, The Numerical Aperture (NA), The Optical Fiber, Types of Fiber.	**07L**
UNIT-02	**LOSSES IN OPTICAL FIBER:** Attenuation, Material Absorption Losses, Linear and Non Linear Scattering Losses, Fiber Bend Loss, Dispersion Viz. Inter Modal Dispersion and Intra Modal Dispersion, Overall Fiber Dispersion and Polarization, Dispersion Shifted and Dispersion Flattened Fibers, Attenuation and Dispersion Limits in Fibers, Kerr Nonlinearity, Self Phase Modulation, Combined Effect of Dispersion and Self Phase Modulation	**07L**
UNIT-03	**FIBER MATERIAL, COUPLERS AND CONNECTORS**: Preparation of Optical Fiber: Liquid-Phase Techniques, Vapor Phase Deposition Techniques, Connector Principles, Fiber End Preparation, Splices, Connectors.	**06L**
UNIT-04	**OPTICAL SOURCES AND DETECTORS**: Sources: Basic Principle of Surface Emitter LED and Edge Emitter LED- Material Used Structure, Internal Quantum Efficiency and Characteristics, LASER Diode - Material Used Structure, Internal Quantum Efficiency and Characteristics, Working Principle and Characteristics of Distributed Feedback (DFB) Laser. Detectors: PIN Photodiode - Material Used, Working Principle & Characteristics, Avalanche Photodiode: - Material Used Working Principle and Characteristics.	**05L**
UNIT-05	**ADVANCED TOPICS:** Optical TDM, SCM, WDM And Hybrid Multiplexing Methods, Fiber Optic Networks, Trans receivers for Fiber-Optic Networks, Semiconductor Optical Amplifiers, Erbium Doped Fiber Amplifiers (EDFAs).	**05L**
UNIT-06	**OPTICAL NETWORKS:** Elements and Architecture of Fiber-Optic Network, SONET/SDH, ATM, IP, Optical Line Terminals (OLT), Optical Add-Drop Multiplexers, Optical Cross Connects.	**06L**

Course Outcomes

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

CO1: Learn the basic elements of optical fiber transmission link, fiber modes configurations and structures

CO2: Understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors.

CO3: Learn the fiber optical receivers such as PIN APD diodes, noise performance in photodetector, receiver operation and configuration

CO4: Learn the various optical source materials, LED structures, quantum efficiency, Laser diodes

CO5: Understand the optical multiplexing techniques.

CO6: Understand the optical network and its architecture.

Books and References

1. Fiber Optic Communications (Fifth Ed.) by J.C. Palais, Pearson Prentice Hall, 2005
2. Optical Fiber Communications (Third Ed.) by Gerd Keiser, McGraw-Hill, 2000
3. Optical Networks: A Practical Perspective (Third Ed.) by R Ramaswamiand and K.N. Sivarajan, Morgan Kaufman Publishers

Course Name: **Engineering Economics and Accountancy**
Course Code: **HS-404**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the Economics and its applicability to the Engineers
- To introduce the fundamental concepts of economics
- To enable the students to understand the factors that causes the changes in economic conditions of the entrepreneur

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Engineering Economics:** Definitions, Nature, Scope and application; Difference between Micro Economics and Macro Economics; Theory of Demand & Supply: Meaning, Determinants, Law of Demand, Elasticity of demand, Demand Forecasting, Law of Supply, Equilibrium between Demand & Supply.	**06L**
UNIT-02	**Production and Cost**: Production functions, Isoquant, Least Cost combination, Laws of Returns to Scale. Economics and Diseconomies of Scale of production, Cost and Cost curves, Revenue and Revenue curve, Break even analysis.	**06L**
UNIT-03	**Costing and Appraisal:** Cost elements, Economic cost, Accounting cost, Standard cost, Actual cost, Overhead cost, Cost control, Criteria of project appraisal, Social cost benefit analysis	**05L**
UNIT-04	**Markets**: Meaning, Types of Markets, Characteristics (Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly) Price and Output Determination; Product Differentiation; Selling Costs; Excess Capacity.	**05L**
UNIT-05	**Money**: Meaning, Functions, Types; Monetary Policy- Meaning, Objectives, Tools; Fiscal Policy:-Meaning, Objectives, Tools. **Banking:** Meaning, Types, Functions, Central Bank: its Functions, concepts CRR, Bank Rate, Repo Rate, Reverse Repo Rate, SLR.	**04L**
UNIT-06	**Depreciation:** Meaning of depreciation, causes, object of providing depreciation, factors affecting depreciation, Methods of Depreciation: Straight line method, Diminishing balance method, Annuity method and Sinking Fund method	**04L**
UNIT-07	**Financial Accounting:** Double entry system (concept only), Rules of Double entry system, Journal(Sub-division of Journal) , Ledger, Trial Balance Preparation of final accounts-Trading Account. Profit and Loss account, Balance Sheet.	**06L**

Course Outcomes

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

CO1: Identify the challenges of the economy as entrepreneur/manufacturer as well as consumer
CO2: Describe the economic system at the micro and macro level
CO3: Apply principles of economics and accountancy in the professional, personal and societal life
CO4: Assess the role of engineering economics and accounting in attaining economic efficiency

Books and References

1. Principles of Micro Economics by Mceachern & Kaur, Cengage Publication.
2. Managerial Economics by Craig Peterson & W Cris Lewis, PHI Publication.
3. Modern Microeconomics by A. Koutsoyiannis, Macmillan.
4. Managerial Economics Theory and Applications by D. M. Mithani, Himalaya Publication House.
5. Fundamental of Managerial Economics by Mark Hirschey, South Western Educational Publishing.
6. Engineering Economics by Degramo, Prentice Hall.
7. Financial Accounting–A Managerial Perspective by R. Narayanaswamy, PHI.
8. Introduction to Accounting by J.R. Edwards and Marriot, Sage Publication.
9. Cost Accounting by Jawahar Lal, Tata McGraw Hill.
10. Project Planning Analysis, Selection, Implementation and Review by Prasanna Chandra, Tata McGraw Hill

Course Name: **Data Communication & Computer Networks**
Course Code: **EC-421**
Course Type: **Core**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To introduce basic concepts of Data communication with different models. Enumerate the physical layer, Data Link Layer, Network Layer, Transport Layer and Application Layer, explanation of the function(s) of each layer.
- Understanding of switching concept and different types of switching techniques.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Data Communication:** Goals and Applications of Networks, Wireless Network, Interfaces and services. Reference Models: The OSI reference model, TCP/IP reference model.	**04L**
UNIT-02	**Physical Layer:** Analog and Digital, Analog Signals, Digital Signals, Analog versus Digital, Data Rate Limit, Transmission Impairments, Line Coding, Block Coding, Sampling, Transmission Mode, Modulation of Digital Data, Telephone Modems, Modulation of Analog Signal, FDM, WDM, TDM, Guided Media, Unguided Media, Switching.	**06L**
UNIT-03	**Data Link Layer:** Data Link Layer Design Issues, Services Provided to Network Layers, Framing, Error Control, Flow Control, Error Detection and Correction, Elementary Data Link Protocols, An Unrestricted Simplex Protocol, A Simplex Stop-and-Wait Protocol, Simplex Protocol for a Noisy Channel, Sliding Window Protocols, A protocol using go-back-N, A Protocol using Selective Repeat, Example Data Link Protocol-HDLC, PPP.	**06L**
UNIT-04	**Medium Access Sublayer:** Channel Allocations, Random Access, ALOHA, Carrier Sense Multiple Access Protocols, Collision Free Protocols, Limited Contention Protocols, Controlled Access, Channelization, Wired LANs: Ethernet, Wireless LANs.	**06L**
UNIT-05	**Network Layer:** Internetworks, Addressing, Routing, ARP, IP, ICMP, IPV6, Unicast Routing, Unicast Routing Protocol, Multicast Routing, Multicast Routing Protocols**.**	**05L**
UNIT-06	**Transport Layer:** Process to Process Delivery, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Data Traffic, Congestion, Congestion Control, Quality of Service, Techniques to Improve QOS, Integrated Services, QOS in Switched Networks	**05L**
UNIT-07	**Application Layer:** Design Issues of the Layer, Domain Name Systems, File Transfer, http, Web Documents, Virtual Terminals.	**04L**

Course Outcomes

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

CO1: Give the basic information of how a network can be designed, possible choice of various models for designing a network.

CO2: Understand the protocol layer specific communication between two trusted entities.

CO3: Analyse the possible attacks on a network to interrupt the transmission and mislead the communication between different entities.

CO4: Analyse the shortest path over which data can be transmitted, able to design a routing protocol implementing security mechanisms for secure transmission of data from sender to the receiver**.**

CO5: Understand the subject based on course work, assignments and through implementation on a specific platform

CO6: Design a network topology with the available networking elements and can implement a routing protocol along with secure mechanisms ensuring the error free transmission of data.

Books and References

1. Data Communications and Networking by Behrouz A Ferouzan, TATA McGraw Hill.
2. Data and Computer Communication by Stallings William, Pearson Education.
3. An Engineering Approach on Computer Networking by S. Keshav, Addison Welsey.
4. Introduction to Data Communications and Networking by Wayne Tomasi, Pearson.
5. Computer Networks by A.S. Tanenbaum, PHI.

Course Name: **Signal Processing for Image and Video**
Course Code: **EC-430**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To study basic techniques for digital image and video processing.
- To study of techniques based on different models of the image and the type of application.
- To understand linear and non-linear filtering, enhancement and restoration, coding as well as vision systems for industrial and biomedical applications.
- To extend the image analysis principles and techniques to video processing.

Unit Number	Course Content	Lectures
UNIT-01	**Fundamentals of Image Processing:** Basic Steps of Image Processing System Sampling and Quantization of an Image –Basic Relationship Between Pixels Image Transforms: 2 –D Discrete Fourier Transform, Discrete Cosine Transform (DCT), Discrete Wavelet Transforms.	**04L**
UNIT-02	**Image Processing Techniques:** Image Enhancement: Spatial Domain Methods: Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters Frequency Domain Methods: Basics of Filtering in Frequency Domain, Image Smoothing, Image Sharpening, Selective Filtering Image Segmentation: Segmentation Concepts, Point, Line and Edge Detection, Thresholding, Region Based Segmentation.	**08L**
UNIT-03	**Image Compression:** Image Compression Fundamentals–Coding Redundancy, Spatial and Temporal Redundancy. Compression Models: Lossy and Lossless, Huffmann Coding, Arithmetic Coding, LZW Coding, Run Length Coding, Bit Plane Coding, Transform Coding, Predictive Coding , Wavelet Coding, JPEG Standards.	**08L**
UNIT-04	**Basic Steps of Video Processing:** Analog video, Digital Video, Time varying Image Formation Models : 3D Motion Models, Geometric Image formation, Photometric Image Formation, Sampling of Video Signals, Filtering Operations.	**08L**
UNIT-05	**2-D Motion Estimation:** Optical Flow, General Methodologies, Pixel Based Motion Estimation, Block Matching Algorithm, Mesh Based Motion Estimation, Global Motion Estimation, Region Based Motion Estimation, Multi Resolution Motion Estimation. Waveform Based Coding, Block Based Transform Coding, Predictive Coding, Application of Motion Estimation in Video Coding.	**08L**

Course Outcomes

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

CO1: Create simple image processing systems
CO2: Create simple video processing systems
CO3: Compare image processing tools
CO4: Compare video processing tools
CO5: Select appropriately optimal image and video processing tools
CO6: Use MatLab to perform fundamental image processing applications such as image filtering
CO7: Use MatLab to perform video processing applications such motion estimation

Books and References

1. Digital Image Processing by Gonzaleze and Woods (Third Ed.), Pearson.
2. Video Processing and Communication by Yao Wang, Joem Ostarmann and Ya –Quin Zhang, PHI.
3. Digital Video Processing by M. Tekalp, PHI.

Course Name: **CAD of Integrated Circuits**
Course Code: **EC-431**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the fundamentals of computer aided design tools for the modeling, design, analysis of VLSI systems.
- To introduce the fundamental concepts relevant to test, verification of VLSI systems.
- To enable the students to understand the FPGs based synthesis.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Hierarchical and Structured Design:** Role of CAD Tools in the VLSI design process, CAD Algorithms for switch level and circuits simulation, Techniques and algorithms for symbolic layout, Algorithms for physical design – Placement and routing Algorithms, Compaction, Circuit extraction and Testing.	**04L**
UNIT-02	**Specification of Combinational Systems Using HDL:** Introduction to HDL, Basic language element of HDL, Behavioral Modeling, Data flow modeling, Structural modeling, Subprograms and HDL description of gates, Barrel shifters, arithmetic and logic units, Binary decoder, Binary encoder, Multiplexers applications, Floating Point arithmetic-representation of floating point number, Floating point multiplication, Adders, Multipliers.	**06L**
UNIT-03	**Language Constructs and their Hardware Synthesis:** Digital hardware modeling: logic and system level modeling, Hardware description languages, RTL simulation, Synchronous and asynchronous system design.	**07L**
UNIT-04	**Design of Sequential Circuits:** Shifters, Design of a Serial adder, Serial multiplier, Booth's multiplier, Sequential detectors, Vending machines, Signed and unsigned multipliers, Design of a binary divider.	**07L**
UNIT-05	**Data Subsystems:** Storage modules, Functional modules, Data paths, Control subsystems, Micro programmed controller, Memory subsystem, static timing analysis, Processors, Operation of the computer and cycle time.	**06L**
UNIT-06	**FPGA based synthesis:** Multilevel logic synthesis, Logic optimization, Logic simulation, Compiled and event simulators, Relative advantages and disadvantages, Xilinx Zynq FPGA architecture, Features and applications, Design considerations of SoC and FPGA synthesis, Introduction to testing and DFT.	**06L**

Course Outcomes

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

CO1: Establish comprehensive understanding of the various phases of CAD for digital electronic systems, from digital logic simulation to physical design, including test and verification.

CO2: Demonstrate knowledge and understanding of fundamental concepts in CAD.

CO3: Demonstrate the knowledge of computational and optimization algorithms and tools applicable to solving CAD related problems.

Books and References

1. A VHDL Primer by J. Bhaskar, Addison Wesley, 1999
2. Verilog HDL by Joseph Yiu, Samir Palnitkar (Second Ed.), Pearson Education, 2004.
3. Digital System Design using VHDL by H. Roth, PWS Publishing.
4. Synthesis and Optimization of Digital Circuits by G. DeMicheli, McGraw Hill.
5. Digital Design-Principles and Practices by J.F. Wakerly, PHI
6. VHDL by Douglas Perry, McGraw Hill.

Course Name: **Electronics Device Modeling**
Course Code: **EC-432**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To bring home knowledge of basics and fundamentals of electronics device modeling.
- Build upon the theoretical, mathematical and physical analysis of electronic devices used in VLSI, for proper understanding of e-circuit design, simulation and working.
- To provide students with an opportunity to understand and practice on SPICE platform.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Device Modeling**: Introduction, physical significance of device modeling, various devices used in device modeling. Material used in device modeling. Trends & projections in device modeling.	**05L**
UNIT-02	**Junction Diodes**: Depletion region of a p-n junction, Depletion-region capacitance, DC, small signal, large signal, high frequency model of diodes. Measurement and extraction of diode model parameters.	**08L**
UNIT-03	**Bipolar Junction Transistors**: DC, small signal, high frequency models of bipolar junction transistors. Ebers Moll model. Extraction of BJT model parameters, transistor frequency response.	**05L**
UNIT-04	**MOSFETs**: MOSFET fundamentals, Types of MOSFETs, Concept of threshold voltage, Large signal behavior MOSFETs, Comparison of operating regions of Bipolar and MOS Transistors, Shichman Hodges and Level-1 MOS Models, Introduction to Charge–Sheet Models.	**08L**
UNIT-05	**Short & Narrow Channel Effects in MOSFETs**: Velocity saturation from horizontal field, Mobility degradation from the vertical field, Weak Inversion in MOS Transistors, Narrow & Short Channel Effects in MOSFETs.	**05L**
UNIT-06	**Modern VLSI Devices**: Principle of hetro-junction devices, High speed devices compound devices, opto devices.	**05L**

Course Outcomes

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

CO1: Comprehend the insight of electronic devices so as to provide appropriate and economically viable solutions to electronics engineering community and society at large.

CO2: Identify the new state of art electronic devices models to solve the real world research problems.

CO3: Apply principles of usage of EDA tools & techniques for experimentation for effective & efficient design of e-devices in particular & e-circuits in general.

CO4: Assess performance of electronic devices without actual fabrication so as to deal with e-designing for practical aspects and generate interest and competence in self-directed continuing professional development.

Books and References

1. CMOS Digital Integrated Circuits-Analysis & Design by S.M. Kang & Y. Leblibici, TMH.
2. Physics of Semiconductor Devices by S.M. Sze, Wiley Pub.
3. Introduction to PSPICE by H.M. Rashid, PHI.
4. Solid State Electronic Devices by B.G. Streetman & S. Baneerjee, PHI.

Course Name: **MEMS and Sensor Design**
Course Code: **EC-433**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the need and applications of microsystem in engineering.
- To introduce the fundamental concepts relevant to fabrication and machining process of MEMS sensors and actuators.
- To enable the students to understand the various sensing and actuation mechanisms.
- To enable the students to design, analysis, fabrication, characterization of MEMS technology based devices

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Introduction to MEMS and Microsystems, MEMS Classification, MEMS versus Microelectronics, Applications of MEMS in Various Industries, Some Examples of Microsensors, Microactuators, and Microsystems, Materials for MEMS, Laws of Scaling in miniaturization	**05L**
UNIT-02	**MEMS Fabrication:** Structure of Silicon, Single Crystal Growth Techniques, Photolithography, Oxidation, Diffusion, Ion Implantation, Physical Vapor Deposition, Chemical Vapor Deposition, Bulk Micromachining: Overview of Etching, Isotropic and Anisotropic Etching, Wet Etchants, Etch Stop Techniques, Dry Etching, Surface Micromachining, LIGA, SLIGA, Wafer Bonding, Electroplating	**10L**
UNIT-03	**Microsensors and Microactuators**: Basic Modeling Elements in Mechanical, Electrical and Thermal Systems, Types of Beams: Fixed-Free (Cantilevers), Fixed-Fixed (Bridges), Fixed-Guided beams, Electrostatic sensing and Actuation: Parallel plate capacitor, Applications of parallel plate capacitors: Inertial sensor, Pressure sensor, Flow sensor, Parallel plate Actuators, Piezoresistive Sensors: Origin and Expressions of Piezoresistivity, Piezoresistive Sensor Materials, Applications of Piezoresistive Sensors, Piezoelectric Sensing and Actuation, Thermal Sensing and Actuation: Sensors and Actuators based on Thermal Expansion, Thermocouples, Thermoresistors, Shape Memory Alloy, Applications: Inertial sensors, Flow sensors, Infrared sensors	**12L**
UNIT-04	**Layout, Simulation Tools, Packaging and Characterization techniques:** Introduction of layout, Simulation Tools, Packaging and Various Characterization Techniques for MEMS Devices	**04L**
UNIT-05	**RF-MEMS:** MEMS devices for RF Applications: High-Q Capacitors and Inductors and Their Applications in RF Circuits, Mechanical, Electromechanical and Electromagnetic modeling of SPST, SPDT devices and their applications	**05L**

Course Outcomes

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

CO1: Identify structural and sacrificial materials for MEMS.
CO2: Describe the fabrication steps in designing of various MEMS devices.
CO3: Apply principles for the design of Sensor and actuators.
CO4: Apply MEMS for different applications in various fields of engineering.

Books and References

1. MEMS and Microsystems design and manufacture by Tai-Ran Hsu, Tata McGraw Hill.
2. MEMS by N. P. Mahalik, Tata McGraw Hill.
3. Foundations of MEMS by Chang Liu, Pearson Prentice Hall.
4. Sensors and Transducers by M. J. Usher, McMillian Hampshire.
5. Analysis and Design Principles of MEMS Devices by Minhang Bao, Elsevier.
6. Fundamentals of Microfabrication by M. Madou, CRC Press.
7. Microsensors by R.S. Muller, Howe, Senturia and Smith, IEEE Press.
8. Semiconductor Sensors by S. M. Sze, Willy Inderscience Publications.

Course Name: **Advanced IC Design**
Course Code: **EC-434**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart strong foundation of IC based design.
- To introduce the various applications of operational amplifiers and its integration with other devices.
- To learn biomedical application of op-amp design and other related applications.

Unit Number	Course Content	Lectures
UNIT-01	**Operational Amplifier Design** using CMOS as well as Bipolar technologies. Linear and non-linear applications of operational amplifiers. Active filters, response characteristics of Butter worth, Chebyshev and causal filters. Design and analysis of higher order filters of all types.	**07L**
UNIT-02	**Design of Super Buffer Circuits** for driving large capacitive loads. Design and analysis of CMOS Schmitt trigger circuit.	**06L**
UNIT-03	**Comparators** and their characteristics zero crossing detector, voltage limiters, absolute value detectors, sample and hold circuit.	**07L**
UNIT-04	**Biomedical applications** of instrumentation amplifier. Design and analysis of multi-vibrator circuits using transistors, Op-Amps and 555 Timer.	**05L**
UNIT-05	**Design and analysis of oscillator circuits** using transistors and Op-Amps. Phase shift, Wien Bridge and quadrature oscillators. Square wave, triangular wave, saw tooth wave generators and voltage controlled oscillator.	**06L**
UNIT-06	**Differential and Feedback Amplifiers**	**05L**

Course Outcomes

Upon successful completion of this course students will be able to :

CO1: Understand and design the advanced ICs using op-amp and perform operations and their troubleshooting

CO2: To learn how to detect, amplify, store, create and manipulate signals using operational amplifiers

CO3: To design and analyze the responses of IC based designed circuits in the area of power management, signal conditioning, analog and digital communication

CO4: To develop IC based projects in the above areas.

Books and References

1. CMOS Analog Circuit Design by P. E. Allen and D. R. Holberg
2. CMOS Digital Integrated Circuits-Analysis & Design by S. M. Kang & Y. Leblebici, Tata McGraw Hill
3. Design of Analog CMOS Integrated Circuits by B. Razavi, Tata McGraw Hill

Course Name: **Optimization Techniques**
Course Code: **EC-435**
Course Type: **Professional Elective-I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To teach basics and fundamentals of optimization.
- To build upon the theoretical and mathematical models for optimization techniques.
- To provide students with an opportunity to understand and practice optimized designing.

Unit Number	Course Content	Lectures
UNIT-01	**Single Variable Non-Linear unconstrained optimization**: One dimensional Optimization methods, Uni-modal function, Elimination methods, Fibonacci method, Golden section method, Interpolation methods, Quadratic & cubic interpolation methods.	**07L**
UNIT-02	**Multi Variable Non-linear unconstrained optimization**: Direct search method – Univariant method, pattern search methods, Powell's- Hook -Jeeves, Rosenbrock search methods- Gradient methods, Gradient of function, Steepest decent method, Fletcher Reeves method, Variable metric method.	**08L**
UNIT-03	**Linear Programming**: Formulation–Sensitivity analysis, Change in the constraints, Cost coefficients, Coefficients of the constraints, Addition and deletion of variable, Constraints.	**05L**
UNIT-04	**Integer Programming**: Introduction – formulation, Gomory cutting plane algorithm, Zero or one algorithm, Branch and bound method , Stochastic programming, Basic concepts of probability theory, Random variables–distributions–mean, Variance, Correlation, Co–variance, Joint probability distribution, Stochastic linear, Dynamic programming.	**08L**
UNIT-05	**Geometric Programming**: Polynomials, arithmetic, Geometric inequality, Unconstrained, Non-traditional optimization Techniques: Genetic Algorithms–Steps–Solving simple problems Comparisons of similarities and dissimilarities between traditional and non-traditional techniques, Particle Swarm Optimization.	**08L**

Course Outcomes

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

CO1: Comprehend the insight of optimization requirements for any system.

CO2: Identify the conventional and new state of the art optimization techniques.

CO3: Apply principles of usage of optimization techniques for electronic design.

CO4: Assess and analyse the performance of optimized designs.

Books and References

1. Optimization Theory & Applications by S. S. Rao, John Wiley & Sons, 1978.
2. Optimization for Engineering Design: Algorithms and Examples by K. Deb, Prentice Hall India Learning Private Limited, 2012.
3. Optimization: Theory and Practice by M. C. Joshi and K. M. Moudgalya, Cambridge Alpha Science International Ltd., 2004.

Course Name: **Electronic Measurement and Instrumentation**
Course Code: **EC-450**
Course Type: **Professional Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To introduce the various methods of instrumentation and parameters
- To impart knowledge about the various AC and DC measurement instruments
- To enable the students to understand the various types and transducers, display and indicating devices, signal generators and their use for measurements

Unit Number	Course Content	Lectures
UNIT-01	**Instrumentation Scheme & Characteristics:** Definition, Application and Methods of Measurements, Instrument Classification, Functional Elements of an instrument, Input Output Configuration of Measuring Instruments, Methods of Correction for Interfering and Modifying Inputs, Standards, Calibration, Accuracy, Precision, Loading Effects, Selection of Instruments, Measurement Systems–Static and Dynamic Characteristics, Zero Order, First Order and Second Order Systems and their Response	**07L**
UNIT-02	**Error analysis:** Types of Errors, Methods of Error Analysis, Uncertainty Analysis, Statistical Analysis, Gaussian Error Distribution, Rejection of Data, Method of Least Square, Curve Fitting, Graphical Analysis, General Consideration in Data Analysis	**07L**
UNIT-03	**DC & AC Measurement:** Analog Ammeter, Voltmeter and Ohmmeters, PMMC, Moving Iron, Electro-dynamometer, Electrostatic, Ohmmeter, Digital type voltmeter, AC Voltmeter using Rectifier, True RMS Voltmeter, Digital VOM Meter	**05L**
UNIT-04	**Transducers:** Principles, Classification, Guidelines for Selection, Requirements, Types and Application of Transducers, Resistance, Capacitance, Inductance Transducers, Potentiometer, Strain Gauges, LVDT, Piezo Electric Transducers, Resistance Thermometers, Thermocouples, Thermistors, Photosensitive Device, Capacitive Transducer, Hall Effect Transducers, Pyroelectric Sensors, Thermo Sensors using Semiconductor Devices, Thermal Radiation Sensor, Measurement of Force, Pressure, Velocity, Humidity, Moisture, Speed, Proximity and Displacement	**08L**
UNIT-05	**Display and Indicating Devices:** Telemetry and Remote sensing, Geographical Information System, Digital Display Devices and Recorders, CRO	**04L**
UNIT-06	**Signal Generators and Analyzers:** Function Generators, RF Signal Generators, Sweep Frequency Generator, Frequency Synthesizer, Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer	**05L**

Course Outcomes

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

CO1: Describe basic principles of instrumentations and measurements associated with engineering, design and the general technology applications
CO2: Use and calibrate common errors in instruments and their analysis.
CO3: Selecting appropriate sensors, instruments, display devices and analyzers for the task under consideration.
CO4: Understanding various transducers available, their operating principles, strengths and weaknesses.
CO5: Select optimum transducer, analyzers and display devices to assemble a system for routine measurements of environmental and dynamic phenomena

Books and References

1. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper, Prentice Hall.
2. Instruments and Measurements by C.N. Herrick, Mc Graw Hill.
3. Electrical and Electronic Measurements and Instrumentation by A. K Sawhney, Dhanpat Rai Publishing.

Course Name: **RF IC Design**
Course Code: **EC-451**
Course Type: **Professional Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about Characteristics of Passive IC Components at RF Frequencies, High Frequency Amplifier Design, Low Noise Amplifier Design, Mixers, RF power amplifiers, Oscillators & synthesizers.

Unit Number	Course Content	Lectures
UNIT-01	**Characteristics of Passive IC Components at RF Frequencies:** Interconnects, Resistors, Capacitors, Inductors and Transformers – Transmission lines, Noise – classical two-port noise theory, Noise models for active and passive components.	**06L**
UNIT-02	**High Frequency Amplifier Design:** Zeros as bandwidth enhancers, Shunt-series amplifier, FT doublers, Neutralization and Unilateralization.	**06L**
UNIT-03	**Low Noise Amplifier Design:** LNA topologies, Power constrained noise optimization, Linearity and large signal performance.	**06L**
UNIT-04	**Mixers:** Nonlinear systems as linear mixers, Multiplier-based mixers, Subsampling mixers, Diode-ring mixers.	**06L**
UNIT-05	**RF power amplifiers:** Class A, AB, B, C, D, E and F amplifiers, Modulation of power amplifiers, Design and linearity considerations.	**05L**
UNIT-06	**Oscillators & synthesizers:** Basic topologies, VCO, Describing functions, Resonators, Negative resistance oscillators, Synthesis with static moduli, Synthesis with dithering moduli, Combination synthesizers – Phase noise considerations.	**07L**

Course Outcomes

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

CO1: Understand the Characteristics of Passive IC Components at RF Frequencies.
CO2: Design and analyse the High Frequency Amplifier.
CO3: Design and analyse Low Noise Amplifier and Mixers
CO4: Design and analyse RF power amplifiers
CO5: Design and analyse Oscillators & synthesizers.

Books and References

1. The Design of CMOS Radio-Frequency Integrated Circuits by Thomas H. Lee, 2nd Ed., Cambridge University Press, 2004.
2. RF Microelectronics by Behzad Razavi, 2nd Ed., Prentice Hall, 1998.
3. Integrated Circuits for Wireless Communications by A.A. Abidi, P.R. Gray and R.G. Meyer, IEEE Press, 1999.
4. RF Circuit Design, Theory and Applications by R. Ludwig and P. Bretchko, Pearson, 2000.

Course Name:	**Radar and Navigational Aids**
Course Code:	**EC-452**
Course Type:	**Professional Elective-II**
Contact Hours/Week: **3L**	Course Credits: **03**

Course Objectives

- To introduce the basic functioning of a radar system and to make the students understand this by taking a specific example of MTI and PULSE Doppler radar.
- Implement the usage of these systems with the help of Navigation Aids.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Introduction to Radar, Applications of Radar, Radar Frequencies, Working Principle of Radar, Radar block diagram, Simple form of Radar Equation, Minimum detectable signal, Range to a target, Pulse repetition frequency and range ambiguities.	**10L**
UNIT-02	**Radar System:** Maximum radar range, Detection of Signals in Noise, Receiver noise and SNR, Integration of radar pulse, Radar cross section of targets, RADAR detection, Range & Doppler measurements, tracking.	**06L**
UNIT-03	**MTI and Pulse Doppler Radar:** Concept of Doppler Effect, Introduction to Doppler and MTI Radar, Doppler frequency shift, CW Doppler radar, MTI radar, Delay line cancellers, Staggered PRF, pulse Doppler radar, FM-CW radar, Tacking Radar, Sequential lobing, Conical Scan, Monopulse, Acquisition, Comparison of Track, Detection of Radar signals in noise, Matched filter criterion-detection criterion, Extraction of information and waveform design, Propagation of radar waves, Radar clutter.	**10L**
UNIT-04	**Navigation Aids:** Radio Direction Finding, Loop Antenna, Loop Input Circuits, Aural Null Direction Finder, Goniometer, Errors in Direction Finding, Adcock Direction Finders, Direction Finding at Very High Frequencies, Automatic Direction Finders, Commutated Aerial Direction Finder, Range and Accuracy of Direction Finders Radio Ranges, LF/MF Four course Radio Range, VHF Omni Directional Range(VOR), VOR Receiving Equipment, Range and Accuracy of VOR, Recent Developments, Global Positioning System (GPS).	**12L**

Course Outcomes

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

CO1: Understand the basic working of RADAR.

CO2: Understand the working of a Moving target Indicator (MTI) on the basis of Doppler shift.

CO3: Understand the working of a MTI, Pulse Doppler Radar and Tracking radar

CO4: Understand and identify different Navigational Techniques and Aids

Books and References

1. Introduction to Radar Systems by Skolnik, Tata McGraw Hill.
2. Electronic Navigation by Nagaraja, Tata McGraw Hill.
3. Radar Principles by Peyton Z. Peebles, John Wiley and Sons (2004).
4. Radar Foundation for Imaging & Advanced Concepts by R.J Sullivan, PHI, 2004.

Course Name: **Artificial Intelligence and Deep Learning**

Course Code: **EC-453**

Course Type: **Professional Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the Artificial Neural networks and deep learning.
- To introduce the fundamental concepts relevant to ANN architectures and deep learning algorithms.
- To introduce applications and usage of deep learning architectures

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** History of Deep Learning, Deep Learning fundamentals, Training Deep Architectures, Intermediate Representations: Sharing Features and Abstractions across Tasks, Sigmoid Neurons, Gradient Decent, Feed forward Neural Networks, Dropout, Back propagation, Regularization, Batch normalization.	**05L**
UNIT-02	**Deep learning with Tensor flow:** Principal component, Analysis and its interpretations, Singular Value Decomposition, Greedy Layer wise Pre-training, Better activations, Better weight initialization methods, Batch Normalization, Introduction of deep learning, How deep learning works, Introduction to Tensor flow.	**08L**
UNIT-03	**Deep Learning Algorithms:** Gradient Descent and Back propagation, Improving deep network, Multi-Layer Neural Networks, CNN, Deep Generative Architectures, Mini-batches, Unstable Gradients, and Avoiding Overfitting, Applying deep net theory to code, Introduction to convolutional neural networks for visual recognition.	**09L**
UNIT-04	**Advanced Deep Architectures:** RNNs, RNNs in practice, LSTMs and GRUs, LSTMs and GRUs in practice, Reinforcement Learning, GANs.	**06L**
UNIT-05	**Natural Language Processing:** Natural Language Processing and understanding, Word Vectors, Basic RNN Models, Attention based models, evaluation functions.	**05L**
UNIT-06	**Applications of deep learning:** Self-driving cars, healthcare, voice services, translation, text and audio generation, image recognition, advertising and finance.	**03L**

Course Outcomes

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

CO4: Describe the key components of AI field and its relation and role in computer science.

CO5: Apply architectures and optimize parameters to practical objectives.

CO6: Understand the use cases and build solutions to unsolved problems.

Books and References

1. Deep Learning: Methods and Applications by Li Deng and Dong Yu.
2. Neural Networks and Deep Learning by Michael Nielsen.
3. Hands-On Learning with Scikit-Learn and Tensor flow by Aurelien Geron, Oreilly.
4. Pattern Recognition and Machine Learning by Christopher Bishop.
5. Deep Learning by Ian Goodfellow and Yoshua Bengio and Aaron Courville, An MIT Press Book.

Course Name: **Reliability Engineering**
Course Code: **EC-454**
Course Type: **Professional Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To introduce the concepts of Reliability in engineering with different mathematical models. To study different types of system along with their evaluation.
- To study Reliability improvement and gain knowledge about maintainability and availability of the system

Unit Number	Course Content	Lectures
UNIT-01	**Reliability: I**ntroduction to Reliability, Definition of Reliability, Reliability Components and Their Classifications, Reliability Measures, Failure Data Analysis, Failure, Causes of Failures, Characteristic and Types of Failures, Causes and Modes of failures, Components and Systems, Hazards and its Models, Distribution Function (i) Normal (ii) Log-normal (iii) Exponential and Wibull and their Importance in Reliability Theory.	**09L**
UNIT-02	**Reliability Evaluation:** Introduction to System Reliability for Non-Maintained and Maintained System having Functional Blocks in (i) Series (ii) Parallel (iii) Series Parallel (iv) Non Series Parallel.	**06L**
UNIT-03	**Reliability Improvement:** Improvement of Components: Redundancy, Stand by with Perfect and Imperfect Switching, Comparison of Component Redundancy to System Redundancy, Optimization, Redundancy Techniques for Reliability Optimization.	**07L**
UNIT-04	**Maintainability:** Concept and Definition of Maintainability, Objective of Maintenance, Classification of Maintenance, Measures of Maintainability, Factors Effecting Maintenance Levels, Maintenance Personnel, Preventive Maintenance, Provisioning of Spares.	**07L**
UNIT-05	**Availability:** Concept and Definition of Availability, Types of Availability, Measure of Availability and Factors Affecting it.	**07L**

Course Outcomes

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

CO1: Give the basic information of how reliability theory and its models.
CO2: Understand the reliability evaluation.
CO3: Analyse various methods for reliability improvement.
CO4: Understand the concept of maintainability along with its classifications.
CO5: Analysis of Availability concept.

Books and References

1. Reliability Engineering by L. S. Srinath (Fourth Ed.), East- West Press Private Limited.
2. Reliability Engineering by K. K Agarwal, Springer.
3. Reliability Engineering by A. K. Govil, Tata McGraw – Hill.

Course Name: **Computer Architecture And Organization**
Course Code: **EC-455**
Course Type: **Professional Elective-II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To conceptualize the basics of organizational and architectural issues of a digital computer
- To analyze processor performance improvement using instruction level parallelism.
- To study various data transfer techniques in digital computer.

Unit Number	Course Content	Lectures
UNIT-01	**Basics of Computer Architecture**: Codes, Number System, Logic gates, Flip flops, Registers, Counters, Multiplexer, Demultiplexer, Decoder, Encoder etc, Register transfer, Bus & memory transfer, Logic micro operations, and Shift micro operation.	**05L**
UNIT-02	**Basic Computer Organization**: Instruction codes, Computer instructions, Timing & control, Instruction Cycles, Memory reference instruction, Input/output and Interrupts, Complete computer description & design of basic computer.	**07L**
UNIT-03	**ARM Processor Fundamentals:** AR M core data flow model, Architecture, ARM General Purpose Register set, Exceptions, Interrupts, Vector Table, ARM processors family.	**08L**
UNIT-04	**Central Processing Unit:** General register organization, Stack organization, Instruction format, Data transfer & manipulation, Program control, RISC, CISC, Addition & subtraction, Multiplication Algorithms, Division algorithms, Peripheral devices, I/O interface Data transfer schemes, Program control, Interrupt, DMA transfer, I/O processor.	**07L**
UNIT-05	**Memory Unit**: Memory hierarchy, Processor vs. memory speed, High-speed memories, Cache memory, Associative memory, Interleave, Virtual memory, Memory management.	**05L**
UNIT-06	**Introduction to Parallel Processing**: Pipelining, Characteristics of multiprocessors, Interconnection structures, Inter-processor arbitration, Inter-processor communication & synchronization.	**04L**

Course Outcomes

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

CO1: Identify and compare different methods for computer I/O mechanisms.
CO2: Categorize memory organization and explain the function of each element of a memory hierarchy.
CO3: Demonstrate control unit operations and conceptualize instruction level parallelism.

Books and References

1. Computer System Architecture by Morris M. Mano and Yu Dong, Prentice Hall.
2. Computer Architecture A Quantitative Approach by J. L. Hennessy, D. A. Patterson and D. Goldberg, 3rd ARM Edition.
3. Computer Architecture and Organization by J. P. Hayes, McGraw Hill.
4. System Architecture: Software and Hardware Concepts by W. E. Leigh and D. L. Ali, South Wester Publishing.

Course Name: **Spread Spectrum and CDMA**
Course Code: **EC-440**
Course Type: **Professional Elective-III**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the basic spread spectrum techniques that are used in CDMA based cellular communication systems, including direct sequence spread spectrum and frequency-hopped spread spectrum.
- To introduce the fundamental mathematical concepts relevant to design aspects of the PN sequence generators.
- To enable the students to understand the factors that affect the practical implementation of IS-95, CDMA-2000 and WCDMA systems

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Concept of Multiple Access Systems, Narrowband and Broadband Systems, Advantages of Spread Spectrum Systems.	**02L**
UNIT-02	**Principles of Direct Spread Spectrum:** Direct Spectrum System: Definition and Concepts, Spreading Sequences and Waveforms, Random Binary Sequence, Shift-Register Sequences, Periodic Auto Correlations, Polynomials over The Binary Field, Systems with PSK Modulation, Power Spectral Density of DSS-CDMA, Pulsed Interference, De-Spreading with Matched Filter.	**10L**
UNIT-03	**Spreading Code Acquisition and Tracking:** Initial Code Acquisition, Acquisition Strategy: Serial Search, Parallel Search, Multi-Dwell Detection, False Alarm and Miss Probability for Matched Filter Receiver, False Alarm and Miss Probability for Radiometer, Mean Overall Acquisition Time for Serial Search.	**06L**
UNIT-04	**Performance of Spread Spectrum System:** Link Performance of Direct Sequence Spread Spectrum CDMA In (I) Additive White Noise Channel (Ii) Multipath Fading Channel. Concept of Rake Receiver, Performance of RAKE Receiver in Multipath Fading.	**06L**
UNIT-05	**Frequency Hoped Systems:** Concepts and Characteristics, Modulations, MFSK, Hybrid Systems, Frequency Synthesizers, Direct Frequency Synthesizer, Digital Frequency Synthesizer, Indirect Frequency Synthesizers.	**06L**
UNIT-06	**CDMA systems:** CDMA-IS-95: Forward link Channels, Reverse link Channels, Power Controls and Handoff Procedure in IS-95, Overview of CDMA based 3G Systems (CDMA-2000 and WCDMA).	**06L**

Course Outcomes

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

CO1: Identify spread spectrum techniques that are used in CDMA based cellular communication systems, including direct sequence spread spectrum and frequency-hopped spread spectrum.
CO2: Apply the principles of linear algebra to design PN sequence generators.
CO3: Analyze the performance of CDMA systems in various wireless Channels
CO4: Assess thepractical implementation of IS-95, CDMA-2000 and WCDMA systems

Books and References

1. Principles of Spread Spectrum Communication Systems by Don Torrieri, Springer Science & Business Media, Inc.
2. CDMA: Principles of Spread Spectrum Communication by Andrew J. Viterbi, Addison- Wesley Publishing Company.
3. Introduction to CDMA Wireless Communications by Mosa Ali Abu-Rgheff, Elsevier Academic Press.
4. Code Division Multiple Access-CDMA by R. Michael Buehrer, Morgan & Claypool Publishers Series.
5. CDMA Systems Engineering Handbook by Jhong S. Lee and Leonard E. Miller, Artech House Publishers.
6. IS-95 CDMA and CDMA-2000 by Vijay K Garg, Pearson Education.
7. OFDM for Wireless Communications Systems by Ramjee Prasad, Artech House, Inc.

Course Name: **Wireless Sensor Networks**
Course Code: **EC-441**
Course Type: **Professional Elective –III**

Contact Hours/Week: **3L + 1T** Course Credits: **04**

Course Objectives

- To impart knowledge about wireless sensor networks and its application area.
- To introduce the fundamental concepts relevant to deployment and localization of wireless sensor networks.
- To enable the students to understand the synchronization and dissemination of information using wireless sensor network about the target area.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Wireless Sensor Networks: The Vision, Networked Wireless Sensor Devices, Applications of Wireless Sensor Networks, Key Design Challenges,	**06L**
UNIT-02	**Network Deployment:** Structured Versus Randomized Deployment, Network Topology, Connectivity in Geometric Random Graphs, Connectivity using Power Control, Coverage Metrics, Mobile Deployment,	**06L**
UNIT-03	**Localization And Time Synchronization:** Key Issues, Localization Approaches, Coarse-Grained Node Localization Using Minimal Information, Fine-Grained Node Localization Using Detailed Information, Network- Wide Localization, Theoretical Analysis of Localization Techniques, Key Issues of Time Synchronization, Traditional Approaches, Fine-Grained Clock Synchronization, Coarse grained Data Synchronization,	**08L**
UNIT-04	**Wireless Characteristics And Medium-Access:** Wireless Link Quality, Radio Energy Considerations, The SINR Capture Model For Interference, Traditional MAC Protocols, Energy Efficiency In MAC Protocols, Asynchronous Sleep Techniques, Sleep-Scheduled Techniques, and Contention-Free Protocols, Sleep-Based Topology Control and Energy-Efficient Routing: Constructing Topologies for Connectivity, Constructing Topologies for Coverage, Set Kcover Algorithms, Cross-Layer Issues, Metric-Based Approaches, Routing with Diversity, Multi-Path Routing, Lifetime-Maximizing Energy-Aware Routing Techniques, Geographic Routing, Routing to Mobile Sinks,	**10L**
UNIT-05	**Data-Centric Networking:** Data-Centric Routing, Data-Gathering with Compression, Querying, Data-Centric Storage and Retrieval, Database Perspective on Sensor Networks.	**06L**

Course Outcomes

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

CO1: Have an understanding of the principles and characteristics of wireless sensor networks.
CO2: Apply knowledge of wireless sensor networks to various application areas.
CO3: Analyse WSN protocols in terms of their energy efficiency and design new energy efficient protocols.

Books and References

1. Networking Wireless Sensors by Bhaskar Krishnamachari, Cambridge University Press.
2. Wireless Sensor Networks-An Information Processing Approach by Feng Zhao and Leonidas Guibas, Morgan Kauffman.
3. Wireless Sensor Networks-Technology, Protocols and Applications by K. Sohraby, D. Minoli and T. Znati, John Wiley & Sons.

Course Name: **Satellite Communication**
Course Code: **EC-442**
Course Type: **Professional Elective-III**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the Orbital Mechanism, satellites and satellite system, satellite link design, earth station and satellite navigation systems.

Unit Number	Course Content	Lectures
UNIT-01	**Orbital Mechanism:** Satellite orbit and orbital equations, Kepler's laws of planetary motion, Locating satellite in the orbit, Locating satellite with respect to earth, Look angle calculation, Coverage angle and slant range, Orbital perturbations, Satellite launching, Orbital effects in communication subsystem performance.	**07L**
UNIT-02	**Satellites:** Satellite subsystems, Attitude and orbit control system, Telemetry tracking command and monitoring, Power system, communication subsystem, Satellite antennas.	**06L**
UNIT-03	**Satellite Link Design:** Basic link analysis, Interference analysis, Terrestrial interference, Inter-modulation interference, Inter-symbol interference and rain induced attenuation, Uplink power control, system availability, System design for link without frequency reuse and system design for link with frequency reuse.	**10L**
UNIT-04	**Earth Station:** Earth station antenna types, Antenna gain, Antenna gain to noise temperature ratio, G/T measurement, Frequency division multiple access, FDM-FM-FDMA, Single channel per carrier.	**07L**
UNIT-05	**Satellite based Navigation System:** Principle of measuring signal transit time, Basic principles of satellite navigation, Signal travel time Determining position, The effect and correction of time error, Functional segments of GPS, Improved GPS: DGPS, SBAS, A-GPS and HSGPS.	**06L**

Course Outcomes

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

CO1: Understand the orbital and functional principles of satellite communication systems
CO2: Architect, interpret, and select appropriate technologies for implementation of specified satellite communication systems
CO3: Analyze and evaluate a satellite link and suggest enhancements to improve the link performance.
CO4: Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.
CO5: Understand the Satellite based Navigation and different Systems.

Books and References

1. Digital Satellite Communications by Tri. T. Ha, Tata McGraw Hill.
2. Satellite Communications by Timothy Pratt and Jeremy E., Willey.
3. Satellite Communications by Dennis Roddy, Tata McGraw Hill.
4. Global Navigation Satellite Systems by G. S. Rao, Tata McGraw Hill.
5. Electronic Navigation by Nagaraja, Tata McGraw Hill.
6. The Global Positioning System & Inertial Navigation by Jay Farrell, Tata McGraw Hill.

Course Name: **Mobile Communication**
Course Code: **EC-443**
Course Type: **Professional Elective-III**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To understand the basic cellular system concepts.
- To have an insight into the interference, frequency management and handoff management in cellular mobile system.
- To go in depth for understanding the popular GSM cellular mobile standard and wireless standards.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Wireless Communication Systems, Applications of Wireless Communication Systems, Types of Wireless Communication Systems, Trends in Mobile Communication Systems.	**05L**
UNIT-02	**Cellular Mobile Systems:** Basic Cellular Systems, Performance Criteria, Uniqueness of Mobile Radio Environment, Operation of Cellular Systems, Analog& Digital Cellular Systems.	**07L**
UNIT-03	**Elements of Cellular Radio System Design:** Concept of Frequency Reuse Channels, Co-channel Interference Reduction Factor, Desired C/I From a Normal Case in an Omnidirectional Antenna System, Handoff Mechanism, Cell Splitting.	**05L**
UNIT-04	**Interference in Cellular Mobile System:** Co-channel Interference, Design of an Omnidirectional Antenna System in the Worst Case, Design of a Directional Antenna System, Lowering the Antenna Height, Power Control, Reduction in C/I by Tilting Antenna, Umbrella Pattern Effect, Adjacent-Channel Interference, Near-end, Far-end Interference, Effect on Near-end Mobile Units.	**05L**
UNIT-05	**Frequency Management, Channel Assignment and Handoffs:** Frequency Management, Frequency-Spectrum Utilization, Set-up Channels, Fixed Channel Assignment Schemes, Non-Fixed Channel Assignment Schemes, Concept of Handoff, Initiation of a Hard Handoff, Delaying a Handoff, Forced Handoffs, Queuing of Handoffs, Power Difference Handoffs, Mobile Assisted Handoff, Soft Handoffs, Cell-site Handoff, Intersystem Handoff, Dropout Calls.	**05L**
UNIT-06	**GSM System Overview:** GSM System Architecture, GSM Radio Subsystem, GSM Channel Types, Frame Structure for GSM, Signal Processing in GSM, GPRS and EDGE.	**05L**
UNIT-07	**Wireless Networks:** Overview of Wi-Fi, WiMAX and Bluetooth Technology: Basic Features and Physical Specifications.	**04L**

Course Outcomes

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

CO1: Discuss cellular radio concepts.
CO2: To have knowledge of the mobile system specifications.
CO3: Classify frequency and handoff management techniques in mobile communication.
CO4: Outline cellular mobile communication standards.
CO5: Analyze various methodologies to improve the cellular capacity.

Books and References

1. Mobile Cellular Telecommunications: Analog and Digital Systems by W. C. Y. Lee; Tata McGraw Hill Publication.
2. Wi-Fi, Bluetooth, Zigbee and WiMax by H. Labiod, H. Afifi and C. D. Santis, Springer.
3. Wireless Communications: Principles and Practice by T. S. Rappaport; Pearson Publication.
4. Wireless Communications and Networks: 3G and Beyond by I. S. Misra; Tata McGraw Hill Publication.
5. Wireless and Digital Communications by K. Feher; PHI Publication.

Course Name: **Information Theory and Coding**
Course Code: **EC-444**
Course Type: **Professional Elective- III**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about measuring the amount of information, capacities calculation of different channels in communication systems
- To understand the theorems and inequalities used in information and coding theory field.
- To enable the students to design the source coding algorithms for improving transmission efficiency.
- To enable the students to design the block based error control coding algorithms for improving error performance of communication systems.

Unit Number	Course Content	Lectures
UNIT-01	**Measures of Information and Channel Capacity:** Entropy, Relative Entropy and Mutual Information, Basic Inequalities: Jensen Inequality and its Physical Application), Log–Sum Inequality and its Physical Application, Fano Inequality and its Physical Application, Data Processing Theorem and its Physical Application, Consequences of the Inequalities in the Field of Information Theory.	**05L**
UNIT-02	**Entropy Rate and Channel Capacity:** Stationary Markov Sources: Entropy Rate and Data Compression, Definition of Capacity and its Computation of Discrete Memory Less Channels (BNC, BSC, BEC, Cascaded Channels, Noiseless Channels, Noisy Typewriter), The Channel Coding Theorem and the Physical Significance of Capacity.	**04L**
UNIT-03	**Data Compression:** Unique Decodability and the Prefix Condition, Kraft's Inequality, Relationship of Average Codeword Length to Source Entropy, Examples of Coding Techniques: Huffman, Shannon–Fano–Elias, Lempel–Ziv and Universal.	**07L**
UNIT-04	**Design of Linear Block Codes:** Introduction of Linear Block Codes, Syndrome and Error Detection, Minimum Distance of a Block Code, Error Detecting and Error Correcting Capability of a Block Code, Design of Encoder and Syndrome Decoder for Linear Block Codes.	**07L**
UNIT-05	**Design of Cyclic Codes:** Description Cyclic Codes, Generator and Parity Check Matrices of Cyclic Codes, Encoding of Cyclic Codes, Syndrome Computation and Error Detection, Decoding of Cyclic Codes, Cyclic Hamming Codes.	**07L**
UNIT-06	**Convolutional Codes**: Encoding of Convolutional Codes, Structural Properties of Convolutional Codes, Distance Properties of Convolutional Codes, Design of Encoder and Decoder for Convolutional Codes.	**06L**

Course Outcomes

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

CO1: Understand the various terminologies to estimate information content in the communication system.
CO2: Apply various inequalities and quantities to evaluate the information content and entropy rate of a discrete memory-less source.
CO3: Design lossless source codes for discrete memory-less source to improve the efficiency of information transmission.
CO4: Design block based error control codes for improving the error performance of information transmission systems.

Books and References

1. Elements of Information Theory by T. M. Cover and J. A. Thomas, John Wiley, 1991.
2. Error Control Coding by S. Lin and D. J. Costello, Pearson Education, 2010.
3. Information Theory and Reliable Communication by R. G. Gallager, John Wiley & Sons, 1969.

Course Name: **Internet of Things**
Course Code: **EC-445**
Course Type: **Professional Elective-III**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the concepts of IOT.
- To learn different protocols used in IOT and to learn how to analyse the data in IOT.
- Introduce the tools and techniques that enable IOT solutions and security aspects.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** IoT Example, IoT Devices vs. Computers, Trends in the Adoption of IoT, Societal Benefits of IoT, Risks, Privacy, and Security, Overview of IoT and High level architecture.	**07L**
UNIT-02	**IoT Workflow:** Open source IoT Platform and Cloud platform options, IoT Cloud building blocks, Device configuration and addressing, MQTT Server, Engines, Handling database, Data monitoring, visualization and IoT Analytics, Rest API interface, Application Service.	**06L**
UNIT-03	**Networking and Internet:** WAN Structure, Networking components, Internet structure, IoT Communication Models and Protocols, Protocol stack, TCP/IP Application Layer, Request-Response, Publish-Subscribe, Push-Pull, Exclusive Pair, Application Protocols: HTTP, CoAP, MQTT, AMQP, Communication APIs: REST-based, Web Socket-based, Network Layer: IPv4, IPv6, 6LoWPAN.	**10L**
UNIT-04	**Interfaces and programming:** Ethernet, Wifi, Bluetooth communication protocols and implementation, Overview of Linux subsystem, process, memory management, multi-threading, IPC, C/C++ vs Python programming and libraries.	**06L**
UNIT-05	**Performance and Security in IoT:** Benchmarking IoT applications and Platforms, MQTT vs HTTP performance, Security considerations, Firmware updates, Cryptography basics, Cryptography in IoT, Privacy considerations and design guidelines.	**07L**

Course Outcomes

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

CO1: Apply IOT concepts to different applications
CO2: Design some IOT based prototypes.
CO3: Analysis and evaluate the data received through sensors in IOT, application development.

Books and References

1. Computer networking: a top-down approach by James Kurose (Fifth Ed.), Pearson, 2010.
2. Internet of Things A Hands-on Approach (First Ed.) by Vijay Madisetti and Arshdeep Bahga, VPT, 2014.
3. Rethinking the Internet of Things: A Scalable Approach to Connecting Everything by Francis da Costa (First Ed.), Apress Publications, 2013.

Course Name: **FPGA and SoC Design**
Course Code: **EC-460**
Course Type: **Professional Elective-IV**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To give the student an understanding of issues and tools related to FPGA design and implementation.
- To give the student an understanding of basics of System on Chip and Platform based design.
- To impart knowledge about the System-level and SoC design methodologies and tools.

Unit Number	Course Content	Lectures
UNIT-01	**Revision of basic Digital Systems:** Combinational Circuits, Sequential Circuits, Timing, Power Dissipation. Current state of the field, SoC, IP Design, SoPC, Design methodology, System Modeling, Hardware-Software Co-design, Device Technology and Application Domains.	**07L**
UNIT-02	**Digital System Design:** Top down Approach to Design, Case study, Data Path, Control Path, Controller behavior and Design, Case study Mealy & Moore Machines, Timing of sequential circuits, Pipelining, Resource sharing, FSM issues (Starring state, Power on Reset, State diagram optimization, State Assignment, Asynchronous Inputs, Output Races, fault Tolerance.	**08L**
UNIT-03	**HDL for Synthesis:** Introduction, Behavioral, Data flow, Structural Models, Simulation Cycles, Process, Concurrent Statements, Sequential Statements, Loops, Delay Models, Sequential Circuits, FSM Coding, Library, Functions, Procedures, Test benches.	**08L**
UNIT-04	**FPGA Design:** Introduction, Logic Block Architecture, Routing Architecture, Programmable Interconnections, Design Flow, Xilinx Virtex-V (Architecture), Boundary Scan, Programming FPGA's, Constraint Editor, Static Timing Analysis, One hot encoding, Applications, Tools, Embedded System on Programmable Chip, Hardware-software co-simulation, Bus function models, BFM Simulation, Debugging FPGA Design.	**08L**
UNIT-05	**SoC Design:** Writing Effective HDL, Analyzing the RTL Design, SoC like Design start, Applications with Zynq FPGA, Software Interface, Register Address Map, Hardware/Software Co-Design and Verification, High performance algorithms for ASICS/ SoCs as case studies.	**05L**

Course Outcomes

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

CO1: Demonstrate VLSI tool-flow and appreciate FPGA architecture
CO2: Understand the basics of system on chip and on chip communication architectures.
CO3: Understand the issues involved in ASIC design, including technology choice, design management, tool-flow.

Books and References

1. Verilog, Analysis and Modeling of Digital Systems by Zainalabedin Navabi, McGraw-Hill.
2. System C: From the Ground Up by D. Black and J. Donovan, Springer, 2004.
3. Digital Design: Principles and Practices by Jon F Wakerly, Prentice Hall.
4. Synthesis and Optimization of Digital Circuits by G. De Micheli, McGraw-Hill, 1994.

Course Name: **Low Power VLSI Design Techniques**
Course Code: **EC-461**
Course Type: **Professional Elective-IV**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the dominant sources of power dissipation in VLSI circuits.
- To introduce the fundamental concepts for optimization of power at all design levels: technology, circuit, logic, and architectural level.
- To enable the students to aware of power estimation by various means.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:** Need for Low Power VLSI Chips, Sources of Power Dissipation in Digital Integrated Circuits, Physics of Power Dissipation in CMOS Devices, Dynamic Dissipation in CMOS, Leakage Power Dissipation, Low Power Figure of Merits, Impact of Technology Scaling, Device Innovation and Channel Engineering	**05L**
UNIT-02	**Low Power Circuit Level Design:** Circuit Level Transistor and Gate Sizing, Circuit Techniques for Leakage Power Reduction, Transistor Stacking, Supply Voltage Scaling Techniques, DTCMOS, MTCMOS, Network Restructure and Reorganization, Flip Flops and Latches Design, and Low Power Digital Cell Library	**07L**
UNIT-03	**Low Power Logic Level Design:** Gate Reorganization, Multi Stage Logic Design, Signal Gating, Logic Encoding, State Machine Encoding, and Pre-Computation Logic	**07L**
UNIT-04	**Low Power Architecture and System Level Design**: Power and Performance Management, Switching Activity Reduction, Parallel Architecture with Voltage Reduction, and Flow Graph Transformation.	**07L**
UNIT-05	**Power Estimation:** Simulation Power Analysis: SPICE Circuit Simulators, Gate Level Logic Simulation, Capacitive Power Estimation, Static State Power, Gate Level Capacitance Estimation, Data Correlation Analysis in DSP Systems, Monte Carlo Simulation, Probabilistic Power Analysis: Random Logic Signals, Probability and Frequency, and Probabilistic Power Analysis Techniques	**05L**
UNIT-06	**Special Techniques:** Low Power Clock Distribution, Single Driver vs Distributed Buffers, Various Clock Distribution Networks, Power Reduction in Clock Networks, Low Power Bus, CMOS Floating Nodes, and Adiabatic Logic.	**05L**

Course Outcomes

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

CO1: Identify sources of power dissipation in VLSI systems.
CO2: Analyze various circuit and logic design techniques for dynamic and leakage power reduction.
CO3: Design arithmetic circuits, latches and flip flops with different logic styles.
CO4: Understand the concepts of probability and random logic signals for estimation of capacitance and power dissipation.
CO5: Understand power management through architectural level techniques.

Books and References

1. Practical Low Power Digital VLSI Design by Gary K. Yeap, Kluwer Academic Press.
2. Low-Power CMOS VLSI Circuit Design by Kaushik Roy, and Sharat Prasad, Wiley.
3. Low Power VLSI CMOS Circuit Design by A. Bellamour, and M. I. Elmasri, Kluwer Academic Press.
4. Low Power Design Methodologies by J. M. Rabaey and M. Pedram, Kluwer Academic Press.
5. Low-Voltage Low-Power VLSI subsystems by Kait-Seng Yeo and Kaushik Roy, Tata McGraw-Hill.
6. Low Power Digital CMOS Design by Anantha P. Chandrakasan and Robert W. Brodersen, Kluwer Academic Press.

Course Name: **VLSI Testing**
Course Code: **EC-462**
Course Type: **Professional Elective-IV**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the basics of testing techniques for VLSI circuits and Test Economics
- To introduce the fundamental concepts of Design for Testability.
- To enable the students to generate the test patterns.

Unit Number	Course Content	Lectures
UNIT-01	**Basics of Testing And Fault Modeling:** Introduction to Testing, Test process and ATE, Faults in digital circuits, Modeling of faults, Logical Fault Models, Fault detection, Fault location, Fault dominance, Logic Simulation, Types of simulation, Delay models, Gate level Event-driven simulation.	**02L**
UNIT-02	**Test Generation For Combinational and Sequential Circuits:** Logic simulation and fault simulation, Testability measures, Test generation for combinational logic circuits, Testable combinational logic circuit design, Test generation for sequential circuits, Design of testable sequential circuits.	**8L**
UNIT-03	**Design For Testability:** Ad-hoc design, Generic scan based design, Classical scan based design – System level DFT approaches, Memory test.	**9L**
UNIT-04	**Self-Test and Test Algorithms Built-In Self-Test:** Test pattern generation for BIST, Circular BIST, BIST Architectures, Testable Memory Design, Test algorithms, Test generation for Embedded RAMs, Logic BIST and EDT, Boundary Scan, System test and core test.	**12L**
UNIT-05	**Fault Diagnosis Logic Level Diagnosis:** Diagnosis by UUT reduction, Fault Diagnosis for Combinational Circuits, Self-checking design, System Level Diagnosis.	**05L**

Course Outcomes

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

CO1: Apply the concepts in testing which can help them design a better yield in IC design.

CO2: Tackle the problems associated with testing of semiconductor circuits at earlier design levels so as to significantly reduce the testing costs.

CO3: Identify the design for testability methods for combinational & sequential CMOS circuits

Books and References

1. Digital Systems and Testable Design by M. Abramovici, M. A. Breuer and A. D. Friedman, Jaico Publishing House.
2. Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits by M. L. Bushnell and V. D. Agrawal, Kluwer Academic Publishers.
3. Digital Circuit Testing and Testability by P. K. Lala, Academic Press.
4. Design Test for Digital IC's and Embedded Core Systems by A. L. Crouch, Prentice Hall International.

Course Name: **VLSI Interconnects and Packaging**
Course Code: **EC-463**
Course Type: **Professional Elective – IV**

Contact Hours/Week:**3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the importance of electrical on-chip interconnects in modern VLSI circuits
- To introduce the various equivalent circuit models of interconnects and their comparison
- To understand the short-channel model of CMOS repeater driving interconnect and its analysis
- To enable the students to understand the advanced interconnect techniques

Unit Number	Course Content	Lectures
UNIT-01	**Interconnects:** *Interconnect Parameters*: Resistance, Inductance, and Capacitance, *Interconnect RC Delays*: Elmore Delay Calculation. *Interconnect Models*: Lumped RC Model, Distributed RC Model, Transmission Line Model. *SPICE Wire Models*: Distributed RC Lines in SPICE, Transmission Line Models in SPICE, Gate and Interconnect Delay	**07L**
UNIT-02	**CMOS Repeater:** *Static Behavior*: Switching Threshold, Noise Margins. The Dynamic Behavior-Computing the Capacitances. *Propagation Delay*: First order analysis, Propagation Delay from a Design Perspective. *Power, Energy and Energy-Delay*: Dynamic Power Consumption, Static Consumption, Analyzing Power Consumption using SPICE	**06L**
UNIT-03	**Driving Interconnects for Optimum Speed and Power:** *Short Channel Model of CMOS Repeater*: Transient Analysis of an RC Loaded CMOS Repeater, Delay Analysis. *Analytical Power Expressions*: Dynamic Power, Short Circuit Power, Resistive Power Dissipation. *CMOS Repeater Insertion*: Analytical Expressions for Delay and Power of a Repeater Chain Driving an RC Load	**05L**
UNIT-04	**Advanced Interconnect Techniques:** Reduced-swing Circuits, Current Mode Transmission Techniques	**05L**
UNIT-05	**Crosstalk:** Theoretical Basis and Circuit Level Modeling of Crosstalk, *Energy Dissipation due to Crosstalk*: Model for Energy Calculation of two Coupled Lines. Contribution of Driver and Interconnect to Dissipated Energy. *Crosstalk effects in logic VLSI circuits*: Static Circuits, Dynamic Circuits and Various Remedies	**07L**
UNIT-06	**IC Packaging:** Package Types, Packaging Design Considerations, VLSI Assembly Technology, Package Fabrication Technology	**06L**

Course Outcomes

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

CO1: Develop the ability to analyze and design electrical interconnect using equivalent circuit models
CO2: Understand the use of CMOS repeater to predict delay and power in interconnects
CO3: Describe the design trade-offs in driver-interconnect-load system
CO4: Design crosstalk and delay aware repeater driven interconnect system using advanced signaling techniques

Books and References

1. Analysis and Design of Digital Integrated Circuits – A Design Perspective by Jan M. Rabaey, Tata Mc-Graw Hill.
2. Interconnection Noise in VLSI Circuits by F. Moll and M. Roca, Kluwer Academic Publishers.
3. Introduction to VLSI Circuits and Systems by J. P. Uymera, Wiley Student Edition.
4. CMOS Digital Integrated Circuits – Analysis and Design by S. M. Kang and L. Yusuf, Tata Mc-Graw Hill.

Course Name: **Nano Electronics: Devices and Materials**
Course Code: **EC-464**
Course Type: **Professional Elective –IV**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To make the student able to know physics of the short channel effects in Nano MOS devices and possible solutions..
- To know the scaling of transistors and other devices to smaller and smaller sizes.
- To understand the various devices in nano regime.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction to Nanoelectronics:** Physical and Technological Limitations of Microelectronics, Transitioning from Microelectronics to Nanoelectronics	**02L**
UNIT-02	**Small scale MOSFET Fundamental:** Review of MOSFET working and C-V I-V analysis, MOS Scaling theory, Issues in scaling MOS transistors, scaling effects (short channel, narrow channel effects, drain induced barrier lowering), Nonideal effects (poly depletion, surface charges). High field effects (tunneling, breakdown).Channel velocity limitations (saturation velocity, interface scattering, mobility models). Hot carrier effects (impact ionization, gate/substrate currents, threshold voltage degradation, velocity overshoot, ballistic effects). On/Off currents. Channel doping profiles (Implanted channel, buried channel, retrograde wells, S/D extension, HALO/LATID structures. Work function pinning. Radiation effects, Technology node, Metal gate transistor - Motivation, requirements, Integration Issues.	**10L**
UNIT-03	**Advanced MOSFET Structures** Raised source/drain MOSFET, SiGe & strained Si MOSFET, Metal source/drain junctions MOS, SOI-PDSOI and FDSOI; Ultrathin body SOI-double gate transistors, integration issues; Vertical transistors – FinFET and Surround gate FET, Carbon	**07L**
UNIT-04	**Non classical MOS transistor**: Nanotube Transistors (CNT), Tunnel FET and Semiconductor Nanowire FETs, Germanium Nano MOSFETs, Hetero structure MOSFETs.	**07L**
UNIT-05	**Emerging Nano Material:** Semiconductor heterostructures, Inorganic nanowires, Organic semiconductors, Carbon nanomaterials-nanotubes and fullerenes, Graphene.	**05L**
UNIT-06	**Characterization Techniques for Nanomaterials:** FTIR, XRD, AFM, SEM, TEM, EDAX etc. Applications and interpretation of results.	**05L**

Course Outcomes

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

CO1: Understanding the insight of Nanoelectronics device Physics so as to provide appropriate and economical viable solution to electronics engineering community and society at large.
CO2: Identifying different techniques to improve the state of art electronic device so as to solve the real world research problems.
CO3: Identifying different devices so as to meet out the present design, health, safety and environmental challenges

Books and References

1. Fundamentals of Modern VLSI Devices, Y. Taur and T Ning, Cambridge University Press.
2. Nanoscale Transistors-Device Physics, Modeling and Simulation by Mark Lundstrom and Guo Jing, Springer
3. Modern Semiconductor Device Physics by S.M. Sze, Wiley.
4. Encyclopedia of Materials Characterization, Edited by Richard C. Brundle, Charles A. Evans (Jr.), Shaun Wilson, Elsevier.
5. Advanced MOS Devices by Dieter K. Schroder, Addison-Wesley Pub. Co.

Course Name: **Electromagnetic Interference and Compatibility**
Course Code: **EC-465**
Course Type: **Professional Elective-IV**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the Electromagnetic radiation, antenna basic parameters, antenna arrays and their patterns, special antennas, wave propagation over ground, through troposphere and ionosphere.
- To familiarize with the fundamentals that are essential for electronics industry in the field of EMI / EMC
- To understand EMI sources and its measurements.
- To understand the various techniques for electromagnetic compatibility.

Unit Number	Course Content	Lectures
UNIT-01	**Basic Concepts:** Introduction and Definition of EMI and EMC with examples, Various parameters, Sources of EMI, EMI coupling modes - CM and DM, ESD Phenomena and effects, Transient phenomena and suppression, Various issues of EMC, EMC Testing categories.	**07L**
UNIT-02	**Coupling Mechanism:** Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radiative coupling, Ground loop coupling, Cable related emissions and coupling.	**09L**
UNIT-03	**EMI Mitigation Techniques:** Working principle of Shielding and Murphy's Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems.	**10L**
UNIT-04	**Standard and Regulations:** Need for Standards, Standards for EMI/EMC, National and International EMI Standardizing Organizations: IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC and ACEC, Electro Magnetic Emission and susceptibility standards and specifications.	**05L**
UNIT-05	**Measurement Methods and Instrumentation:** EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber, Shielded anechoic chamber, EMI measuring instruments.	**05L**

Course Outcomes

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

CO1: Real-world EMC design constraints and make appropriate tradeoffs to achieve the most cost-effective design that meets all requirements.

CO2: Designing electronic systems that function without errors or problems related to electromagnetic compatibility

CO3: Diagnose and solve basic electromagnetic compatibility problems.

Books and References

1. Introduction to Electromagnetic Compatibility by Clayton R. Paul, Wiley & Sons.
2. Principles of Electromagnetic Compatibility by B. Keiser, Artech House.
3. Engineering EMC Principles, Measurements and Technologies by V. P. Kodali, New York.

Course Name: **MEMS Design**
Course Code: **EC-370**
Course Type: **Open Elective – I**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the need and applications of microsystem in engineering.
- To introduce the fundamental concepts relevant to fabrication and machining process of MEMS sensors and actuators.
- To enable the students to understand the various sensing and actuation mechanisms.

Unit Number	Course Content	Lectures
UNIT-01	**Introduction:**Introduction to MEMS and Microsystems, MEMS Materials, Structural and Sacrificial Materials, Properties of Silicon, Polymers, Ceramics, and Composites, Basic Modeling of Elements in Electrical and Mechanical Systems, Sensors/Transducers, Sensors Characterization and Classifications, Microactuators, Application of MEMS	**04L**
UNIT-02	**MEMS Fabrication:** Silicon Growth, Additive Techniques: Oxidation, Physical Vapor Deposition, Chemical Vapor Deposition, Thin Film Deposition, Photolithography, Etching, Bulk and Surface Micromachining, Etch Stop Technique and Microstructure, Microstereolithography LIGA, and Wafer Bonding	**10L**
UNIT-03	**Mechanical Sensors and Actuators:** Beam and Cantilever, Capacitive Sensors, Modeling a Capacitive Sensor, Capacitive Accelerometer, Pressure Sensors, Piezoresistance Effect and Its Modeling, Piezoresistive Sensor, Flow Measurement, Piezoelectricity, Piezoactuators, Inertial Sensors, Micro accelerometer, MEMS Gyroscope, and Parallel-Plate Actuator.	**08L**
UNIT-04	**Thermal Sensors:** Need and Classification, Temperature Coefficient of Resistance, Thermo-Electricity, Thermocouples, Thermal and Temperature Sensors, Heat Pump, Gas sensors, Micromachined Thermocouple Probe, Thermo-resistive Sensor, Thermal Flow Sensors, Pyroelectricity, Shape Memory Alloy, and Thermal Actuators	**08L**
UNIT-05	**Micro-opto-electromechanical Systems:** Properties of Light, Light Modulators, Beam Splitter, Microlens, Micromirrors, Digital Micromirror Devices, Light Detectors, Grating Light Valve, and Optical Switch	**06L**

Course Outcomes

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

CO1: Identify structural and sacrificial materials for MEMS.
CO2: Describethe fabrication steps in designing of various MEMS parts.
CO3: Apply principles for the design of Sensor and actuators.
CO4: Apply MEMS for different applications in various fields of engineering.

Books and References

1. Introductory MEMS Fabrication and Applications by T. M. Adams and R. A. Layton, Springer Publications.
2. Sensors and Transducers by M. J. Usher, McMillian Hampshire.
3. MEMS by N. P. Mahalik, Tata McGraw Hill.
4. Microsensors by R.S. Muller, Howe, Senturia and Smith, IEEE Press.
5. Analysis and Design Principles of MEMS Devices by Minhang Bao, Elsevier.
6. Semiconductor Sensors by S. M. Sze, Willy –Interscience Publications.

Course Name: **Microcontroller and its Applications**
Course Code: **EC- 380**
Course Type: **Open Elective - II**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the architecture and instruction set of typical 8-bit microprocessor .
- To introduce the fundamental concepts relevant to, Assembly Language, Timers, Interrupts.
- To learn to make use of computer for real world applications

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction to Microprocessors:** History and Evolution, types of microprocessors, Microcomputer Programming Languages, Microcomputer Architecture, Pipelining, Clocking, Intel 8085 Microprocessor, Register Architecture, Bus Organization, ALU, Control section, ISA of 8085, Instruction format, Addressing modes, Types of Instructions.	**06L**
UNIT-02	**Assembly Language Programming and Timing Diagram:** Assembly language programming in 8051, Macros, Labels and Directives, Microprocessor timings, Micro instructions, Instruction cycle, Machine cycles, T-states, State transition diagrams, Timing diagram for different machine cycles, Memory and I/O interface.	**08L**
UNIT-03	**Basic Function Blocks:** Instruction Set, Instruction Usage Examples, implementation of various structures like loop, switch, functions, subroutines.	**09L**
UNIT-04	**Interrupts and Serial Data Transfer:** Interrupts in 8051, Serial interrupts, RST instructions, Issues in implementing interrupts, Multiple interrupts and priorities, Daisy chaining, Interrupt handling in 8051, Enabling, Disabling & masking of interrupts.	**07L**
UNIT-05	**Applications:** Low power sensor networks, LEDs 7 segment, LCD, and ADCs, Defining Buses and Protocols, Embedded Computing	**06L**

Course Outcomes

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

CO1: Understand the architecture of 8051

CO2: Impart the knowledge about the instruction set and program components

CO3: Understand the basic idea about the practical applications

Books and References

1. The 8051 Microcontroller and Embedded Systems by Mazidi Muhammad Ali, Pearson Publications, Second Ed.
2. The Definitive Guide to ARM Cortex-M3 processors by Joseph Yiu, Newnes Publication Third Ed.
3. Computer Systems: An Embedded Approach by Ian Vince McLoughlin, McGraw-Hill Education.
4. 8051 Microcontroller by Scott MacKenzie, Parson Publications, 4th Ed.