# UNDER GRADUATE SYLLABUS

# DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY AGARTALA

BARJALA, AGARTALA - 799046

राष्ट्रीय प्रौद्योगिकी संस्थान अगरतला

## B.TECH SYLLABUS FOR DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

**Course Structure of B.Tech in Electronics and Communication Engineering (3rd to 8th Semester) from 2019-2020 Admission Batch Onwards.**

| **3rd Semester** | | **L** | **T** | **P** | **Total CR** |
|---|---|---|---|---|---|
| 1 | Mathematics III | 3 | 0 | 0 | 3 |
| 2 | Data Structures and Algorithms | 3 | 0 | 2 | 3+1 |
| 3 | Semiconductor Devices | 3 | 1 | 2 | 4+1 |
| 4 | Analog Electronic Circuits-I | 3 | 0 | 2 | 3+1 |
| 5 | Network Analysis and Synthesis | 3 | 1 | 2 | 4+1 |
| 6 | Signals & Systems | 3 | 1 | 0 | 4 |
| | | | | | **25** |
| **4th semester** | | | | | |
| 1 | Engineering Economics & Accounts | 3 | 0 | 0 | 3 |
| 2 | Analog Electronic Circuits-II | 3 | 0 | 2 | 3+1 |
| 3 | Electromagnetic Theory & Antennas | 3 | 1 | 2 | 4+1 |
| 4 | Probability and Random processes | 3 | 0 | 0 | 3 |
| 5 | Digital Electronics | 3 | 1 | 2 | 4+1 |
| 6 | Control Systems | 3 | 1 | 2 | 4+1 |
| | | | | | **25** |
| **5th Semester** | | | | | |
| 1 | Industrial Management | 3 | 0 | 0 | 3 |
| 2 | Analog and Digital Communication | 3 | 1 | 2 | 4+1 |
| 3 | Electronic Instrumentation & Measurement | 3 | 1 | 2 | 4+1 |
| 4 | Digital Signal Processing | 3 | 1 | 2 | 4+1 |
| 5 | Microprocessor sand Microcontroller | 4 | 0 | 2 | 4+1 |
| | | | | | **23** |
| **6th semester** | | | | | |
| 1 | Microwave Engineering | 3 | 1 | 2 | 4+1 |
| 2 | Optical Fibre Communication | 3 | 1 | 2 | 4+1 |
| 3 | VLSI Technology | 3 | 0 | 2 | 3+1 |
| 4 | Information Theory & Coding | 3 | 0 | 0 | 3 |
| 5 | Data Communication Networks | 3 | 0 | 2 | 3+1 |
| | | | | | **21** |
| **7th Semester** | | | | | |
| 1 | Wireless Communication | 3 | 0 | 2 | 3+1 |
| 2 | Elective-I (Departmental) | 3 | 0 | 0 | 3 |
| 3 | Elective –II(Departmental/Open) | 3 | 0 | 0 | 3 |
| 4 | Project Preliminary | 0 | 0 | 6 | 2 |
| 5 | Industrial training and Seminar | 0 | 0 | 2 | 1 |
| | | | | | **13** |
| **8th semester** | | | | | |
| **FOR STUDENTS UNDERGOING PROJECT WORK IN THE INSTITUTE** | | | | | |
| 1 | Elective- IV(Departmental) | 3 | 0 | 0 | 3 |
| 2 | Elective-V (Departmental/Open) | 3 | 0 | 0 | 3 |
| 3 | Elective –VI (Departmental/Open) | 3 | 0 | 0 | 3 |
| 4 | Project | 0 | 0 | 9 | 3 |
| 5 | Comprehensive Viva | 0 | 0 | 0 | 1 |
| | | | | | **13** |
| **FOR STUDENTS UNDERGOING PROJECT WORK IN THE INDUSTRY** | | | | | |
| 1 | Industrial Project | 0 | 0 | 0 | 10 |

| | | | | | |
|---|---|---|---|---|---|
| 2 | Project Seminar | 0 | 0 | 0 | 2 |
| 3 | Comprehensive Viva | 0 | 0 | 0 | 1 |
| | | | | | **13** |
| | | **TOTAL** | | | **120** |

## ELECTIVE SUBJECTS OF 7$^{th}$ AND 8$^{th}$ SEMESTER

## DEPARTMENTAL ELECTIVE

| Sl. No. | Course title | L | T | P | CR |
|---|---|---|---|---|---|
| 1 | Advanced Digital Systems | 3 | 0 | 0 | 3 |
| 2 | Computer architecture | 3 | 0 | 0 | 3 |
| 3 | Embedded System Design | 3 | 0 | 0 | 3 |
| 4 | Advanced Semiconductor Devices | 3 | 0 | 0 | 3 |
| 5 | Advanced Control System | 3 | 0 | 0 | 3 |
| 6 | Low Power VLSI Circuits | 3 | 0 | 0 | 3 |
| 7 | Industrial Electronics | 3 | 0 | 0 | 3 |
| 8 | Detection and Estimation Theory | 3 | 0 | 0 | 3 |
| 9 | Radar & Navigation Systems | 3 | 0 | 0 | 3 |
| 10 | Smart Antenna | 3 | 0 | 0 | 3 |
| 11 | RF Circuits & Systems | 3 | 0 | 0 | 3 |
| 12 | Electronic System Design | 3 | 0 | 0 | 3 |
| 13 | Wireless Networks | 3 | 0 | 0 | 3 |
| 14 | Internet of Things | 3 | 0 | 0 | 3 |
| 15 | Adaptive Signal Processing | 3 | 0 | 0 | 3 |

## OPEN ELECTIVE

| Sl. No. | Course title | L | T | P | CR |
|---|---|---|---|---|---|
| 1. | Digital Image Processing | 3 | 0 | 0 | 3 |
| 2. | Machine learning & Artificial Intelligence | 3 | 0 | 0 | 3 |
| 3. | Fuzzy Logic and Neural Network | 3 | 0 | 0 | 3 |
| 4. | Laser and Nonlinear Optics | 3 | 0 | 0 | 3 |
| 5. | Nano-Technology | 3 | 0 | 0 | 3 |
| 6. | Cryptography & Network security | 3 | 0 | 0 | 3 |
| 7. | Biomedical signal Processing | 3 | 0 | 0 | 3 |
| 8. | Operating Systems | 3 | 0 | 0 | 3 |
| 9. | Computational Electro magnetics | 3 | 0 | 0 | 3 |
| 10. | Digital Speech Processing | 3 | 0 | 0 | 3 |
| 11. | Object Oriented Programming | 3 | 0 | 0 | 3 |
| 12. | Robotics | 3 | 0 | 0 | 3 |
| 13. | Smart Grid Communication | 3 | 0 | 0 | 3 |
| 14. | VLSI for Wireless Communication | 3 | 0 | 0 | 3 |

# $3^{rd}$ SEMESTER

# Mathematics-III

| Mathematics-III | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSES OBJECTIVE:**

The objectives of the course Engineering Mathematics-III are:

- The main objective of this course is to provide students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.
- Apply probability theory via Bayes' Rule
- Describe the properties of discrete and continuous distribution functions.
- Use method of moments and moment generating functions.
- Apply the Central Limit Theorem.
- Use statistical tests in testing hypotheses on data.
- Introduce students to partial differential equations, and to solve linear Partial Differential with different methods.
- Introduce students to some physical problems in Engineering and Biological models that results in partial differential equations.
- Introduce the Fourier series and its application to the solution of partial differential equations.

**COURSE CONTENT:**

**Module-1**

Probability and Random Variable: Axioms of probability, Conditional probability, Independent events, Baye's Theorem, Random variables, Probability mass function, Probability density function - properties, Moments, Moment generating functions and their properties.

**Module-2**

Standard Distributions: Binomial, Poisson Normal distribution and their properties,function of random variables.

**Module-3**

Two-dimensional random variables: Joint distribution, Marginal and conditional distribution, covariance, correlation and regression, Transformation of random variables, Central limit theorem.

**Module-4**

Testing of hypothesis**:** Sampling distribution, testing of hypothesis of mean, variance,proportion and differences using Normal, t and Chi-square.

**Module-5**

Fourier series**:** Periodic functions, Fourier series, Dirichlet's conditions, functiondefined in two or more sub-ranges, discontinuous functions, even function, odd function, halfrange series, and change of interval.

**Module-6**

Partial Differential Equations:Order, Method of forming Partial Differential Equations, Solution of Equation by Direct Integration, Lagrange's Linear equation, Method of Multipliers, Partial Differential equations non-linear in p,q, Charpits Method, Linear Homogeneous Partial Differential equation, Non-Homogeneous Linear Equations, Method of Separation of variables, Equation of vibrating string, Solution of wave equation byD'Alembert's method, One dimensional heat flow, Two dimensional Heat flow.

## COURSE OUTCOME:

At the end of the course, students will be able to:
CO1: Understand the basic concepts of probability, random variables, probability distribution, and moments and moment generating functions.
CO2: Define the basic discrete and continuous distributions such as normal, binomial, Poisson, and make be able to apply them and simulate them in simple cases.
CO3: Explain the concepts of two dimensional random variable, independence, jointly distributed random variables and conditional distributions, and use generating functions to establish the distribution of linear combinations of independent random variables. Also State the central limit theorem, and apply it.
CO4: Explain the concepts of random sampling, statistical inference and sampling distribution, and state and use basic sampling distributions. Hypothesis testing and its application in real life problems.
CO5: Find the Fourier series representation of a function of one variable, and find the solution of the wave, diffusion and Laplace equations using the Fourier series.
CO6: Students familiarize with the fundamental concepts of Partial Differential Equations (PDE) which will be used as background knowledge for the understanding of specialized courses in Engineering. Students will master how solutions of PDEs are determined by conditions at the boundary of the spatial domain and initial conditions at time zero.

# Data Structures and Algorithm

| Data Structures and Algorithms | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE OBJECTIVES:**

- To impart a thorough understanding of linear data structures such as stacks, queues and their applications.
- To impart a thorough understanding of non-linear data structures such as trees, graphs and their applications.
- To impart familiarity with various sorting, searching and hashing techniques and their performance comparison.
- To impart a basic understanding of memory management.

**COURSE CONTENT:**

**Module-1**

Concepts of data Structures- Information & Meaning, Abstract data Types.

**Module-2**

Linear Data Structures – Sequential RepresentationsArrays and Lists, Stacks, Queues and Dequeues and their Applications; Linked Representations: Linear Linked List, Circular Linked List, Doubly Linked List and their Applications.

**Module-3**

Nonlinear Data structures: Trees : Basic Terminologies; Binary trees: Properties, Traversals and Threads, Expression.

**Module-4**

Tree, Binary search tree: Operations, Height Balanced Binary trees; M-Way Search Tree, B-Trees; Applications. Heaps & Priority Queues.

**Module-5**

Graphs: Graph Terminologies, Representation of graphs, Graph Traversals, Application of Graphs. Recursion – Design of Recursive Algorithms, Tail Recursion, When not to use recursion, Removal of Recursion.

**Module-6**

Sorting Algorithms: Insertion sorts : Straight insertion sort, Binary insertion of sort, Shell sort; Exchange sorts, Bubble sort, Quick sort, selection sorts: Straight Selection Sort, Heap Sort; Merge sort; Distribution Sorts : Bucket Sort, Radix Sort

**Module-7**

Searching: Sequential Search, Ordered Sequential Search, Binary Search, Interpolation Search.

**Module-8**

Hashing: Hashing Methods, Hash Function Implementations, Hash Tables, Scatter Tables, Scatter tables using Open Addressing.

**Module-9**

Programming Experiments based on: Arrays, Stacks, Queues, Linked lists, Trees, Recursion, Sorting, searching and Hashing data structures.

**TEXT/REFERENCE BOOKS**:


1. Lipschutz, S. (1987).Schaum's Outline of Data Structure. McGraw-Hill, Inc
2. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009).Introduction to algorithms. MIT press.


**COURSE OUTCOMES**

CO1: Summarize different categories of data Structures
CO2: Identify different parameters to analyze the performance of an algorithm.
CO3: Explain the significance of dynamic memory management Techniques.
CO4: Design algorithms to perform operations with Linear and Nonlinear data structures.
CO5: illustrate various technique to for searching, Sorting and hashing.
CO6: Choose appropriate data structures to solve real world problems efficiently.

# Semiconductor Devices

| Semiconductor Physics and Devices | L-3 T-1 P-0 | 4 credits |
|---|---|---|

**COURSES OBJECTIVE:**

- Foundation for qualitative and quantitative evaluation and understanding the different parameters governing the electronic properties and flow of currents in semiconductor materials.
- Introduction to the structure, principle of operation and justifying in terms of electronic parameters the characteristic devices like p-n Junction, BJT, MOS, MOSFET.
- Introduction to some basic optoelectronic devices.

**COURSE CONTENT:**

**Module – 1**

Bonding Forces in Solids, Energy Bands theory in crystals (Qualitative Analysis), Metals,Semiconductors, & Insulators, FermiLevel, Intrinsic, Extrinsic Semiconductors, Concept ofHoles, Carrier Conc. and Mobility, Recombination& generation of charge carriers.

**Module - 2**

Carrier drift, diffusion, graded impurity distribution, carrier generation and recombination, Built in fields, continuity equations, steady state carrier injection, Diffusion length.

**Module - 3**

Physical Description of p-n junction, Current flow at a junction, I –V characteristics, Quantitative analysis of p-n diode characteristics, equivalent circuit, temperature dependence, Capacitance of p-n junction diode (transition & storage), Junction Breakdown (Avalanche &Zener), Step and linearly graded junction, diode switching characteristics, M – S junction (Schottky barrier, Ohmic contact and rectifying contact), Hetero-junction.

**Module – 4**

Junction transistor, Charge transport in BJT, base narrowing (Early effect), Avalanchebreakdown& Punch through, transistor switching, Coupled-Diode model, Ebers-Moll equations,LF and HF model.

**Module - 5**

MOS structure, Basic operation of Enhancement & Depletion mode MOSFET, MOS capacitance (Operation with band diagram, threshold voltage & Characteristics), CCD and applications, LFand HF model.

**Module-6**

Optical absorption in semiconductors, photovoltaic effects, solar cells (p-n junction), Photoconductors, Photodiode, PIN photodiode, Avalanche photodiode, Phototransistor, LED, Semiconductor Laser (p-n junction)

## TEXT /REFERENCEBOOK:

1. Solid State Electronic Devices by Streetman & Banerjee
2. Semiconductor Physics and Devices: Donald Neaman
3. Integrated Electronics: Millman & Halkias
4. Semiconductor Optoelectronic Devices: Pallab Bhattacharaya
5. Semiconductor Physics: Device & Technology: S. M. Sze

## COURSE OUTCOME:

CO1: Understanding of the basic crystal structure, semiconductor material classification and introduction in general.
CO2: Understanding parameters governing the electronic properties of semiconductors, equilibrium carrier concentration, bond and band models of Intrinsic and extrinsic semiconductors.
CO3: Understanding carrier Transport phenomenon and non equilibrium excess carriers in Semiconductor.
CO4: Understanding the Theory of Junction and Interfaces.
CO5: Understanding Bipolar Junction Transistor characteristics and its operation.
CO6: Understanding the characteristics and operation of MOS, MOSFET and introduction to Optoelectronic Devices.

# Network Analysis and Synthesis

| Network Analysis and Synthesis | L-3 T-1 P-0 | 4 credits |
| --- | --- | --- |

**COURSE OBJECTIVE:**

- To understand and analyse electrical networks in time and frequency domain.
- To understand various network laws, techniques and theorems in solving the problems related to electrical networks.
- To learn the network graph theory.
- To know the basic concepts of coupled circuits and to understand the concept of resonance in series and parallel circuits.
- To describe and analyse two port networks.
- To understand synthesis of electrical network from a given impedance/admittance function.

**COURSE CONTENT:**

**Module- 1**
Network Concepts: Review of network / circuit concepts, Network elements, Types of Electrical Energy Sources: Independent and dependent voltage and current sources, voltage and current relations for Resistors, Inductors and Capacitors, Kirchoff's laws, Loop current and node voltage methods for network analysis, Concepts of super node and super mesh, Wye- Delta transformation.

**Module-2**
Initial conditions and Linear Differential Solution: Initial conditions in elements, behavior of circuit elements under switching condition and their representation, 1st order and 2nd order differential solution for Transient and steady state response of R-L, R-C, L-C and R-L-C circuits.

**Module-3**
Laplace Transformation and application: Concept of complex frequency, Definition and basic theorems of Laplace transform, Laplace transform of some basic functions, Gate function ,Wave form synthesis, inverse Laplace transform, Transient and steady state response of R-L, R-C, and R-L-C circuits with Laplace transforms .

**Module-4**
Network theorems: Superposition, Thevenin's, Norton's, Maximum power transfer, Reciprocity, Substitution and Compensation, Millman'stheorem, Tellegen's Theorem as applied to AC circuits.

**Module-5**

Coupled circuits: Self-inductance and Mutual inductance, Coefficient of coupling, dot convention, and Equivalent inductance of mutually coupled circuits, Analysis of single tuned and double tuned coupled circuits.

**Module-6**

Resonance: Behaviors of Series and parallel resonant circuits.

**Module-7**

Network Graph theory: Concept of a network graph, terminology, Incidence matrix and its properties , Tie-Set Matrix, Cut-Set Matrix, Graph theory for electric networks analysis, Dual of a network.

**Module-8**

Two port networks: Characterization in terms of Impedance, admittance, transmission and inverse transmission, hybrid and inverse hybrid parameters ,Interrelationship between the various parameters , Interconnection of two port networks- Series, parallel and cascade.

**Module-9**

Network functions and passive network synthesis: Driving points and transfer functions for one port and two port network, poles and zeros of immittance function, Hurwitz polynomial, positive real function and their properties, Synthesis of LC, RC and RL Networks, Foster Forms and Cauer Forms.

**TEXT/ REFERENCES:**


1. Van, Valkenburg.; "Network analysis"; 3rd Ed., Prentice Hall International Edition, 2007.
2. Sudhakar, A., Shyammohan, S. P.; "Circuits and Network"; Tata Mcgraw-Hill New Delhi, 1994
3. Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed.,Tata McGraw-Hill Publishing Company Ltd.,2008.
4. Van Valkenberg M.E., Introduction to Modern Network Synthesis, John Wiley and Sons, Inc, 1960.
5. F.F. Kuo, "Network analysis and Synthesis", Wiley International Edition ,2008.
6. B.S.Nair and S.R.Deepa, "Network analysis and Synthesis", Elsevier,2012.
7. DeCalro and Lin "Linear Circuit Analysis", 2nd Ed. Oxford University Press, Indian Edition(2004).

**COURSE OUTCOME:**

CO1: Acquire knowledge to understand the fundamentals of electrical networks.

CO2: Ability to use various network laws, techniques and theorems in analyzing complex networks.

CO3: Acquire knowledge to analyze electrical networks using graph theory.

CO4: Ability to analyze magnetically coupled circuits and series and parallel resonant circuits

CO5: Ability to express given electrical network in terms of various two port parameters and to relate various two port parameters for finding network solution.

CO6: Ability to synthesis electrical networks using immittance functions.

# Analog Electronic Circuits-I

| Analog Electronic Circuits-I | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE OBJECTIVE:**

- To make the students understand the fundamentals of electronic circuits.

**COURSE CONTENT:-**

**Module-1:**
Review of BJT operation and its characteristics, need of biasing and different types of biasing circuits for BJT & FET, stability analysis, small signal Amplifier analysis of BJT & FET, estimation of voltage gain, input resistance, output resistance etc.

**Module-2:**
Feedback concept, Feedback amplifier topologies, General characteristics of negative feedback amplifier, input and output resistance with negative feedback, Method of analysis of feedback amplifiers with practical examples.

**Module-3:**
RC and Direct coupling Amplifier, Low and High Frequency response of Amplifier circuit, Gain and Frequency response of Multi stage Amplifier, Darlington pair.

**Module-4:**
Definition of class A, B and C power amplifiers, Distortion analysis, Series fed and transformer coupled power amplifier, Push-pull amplifiers, Conversion efficiency.

**Module-5:**
Basic operation of differential Amplifier, Different configuration of differential Amplifier, Calculation of gain, impedance etc. Biasing of differential Amplifier, calculation of differential gain, common mode gain, CMRR.

**Module-6:**
Review of the basic concept for oscillation, Barkhausen criterion, Sinusoidal Oscillator, LC Oscillators, RC phase shift oscillator, Crystal Oscillator.

**TEXT/REFERENCES**


1. Microelectronic Circuits Theory and Application-Sedra and Smith, 7$^{th}$ Ed, Oxford publication.
2. Electronic Circuit Analysis and Design- Donald A. Neamen, McGraw-Hill Education
3. Electronic Principles- Albert Malvinoand David Bates,7$^{th}$ Ed, McGraw Hills
4. Electronic Devices and Circuits- David A. Bell, 5$^{th}$ Ed, PHI
5. Electronic Device and Circuits - J. Millman, CCHalkias and S. Jit
6. Electronics: Circuits and Analysis - Dinesh C. Dube, 2$^{nd}$Ed, NAROSA publication

**COURSE OUTCOMES:-**

At the end of the course student will be able
CO1: illustrate about rectifiers, transistor and FET amplifiers and its biasing. Also compare the performances of its low frequency models.
CO 2: discuss about the frequency response of FET and BJT amplifiers.
CO 3: illustrate about differential amplifiers and its characteristics.
CO4: discuss about the feedback concepts and construct feedback amplifiers and oscillators. Also summarizes its performance parameters.
CO 5: explain about power amplifiers and its types and also analyze its characteristics.

# Signals & Systems

| Signals & Systems | L-3 T-1 P-0 | 4 credits |
|---|---|---|

**COURSES OBJECTIVE:**

- To understand the basics of time and frequency domain signals.
- To understand the basics of time and frequency domain systems.
- To study the analysis of different signals and systems.
- To study Fourier series, Fourier Transform, Laplace Transform, Z- Transform.
- To study different sampling procedure of signals.
- To study different modulation techniques for communication systems.

**COURSE CONTENT:**

**Module-1:**
Introduction: signal and system in everyday life. Types of signals: Continuous-time and discrete time signals. Energy and Power signal, Transformations of the independent variable, Exponential and sinusoidal signals, Module- impulse and Module- step, Continuous-time and Discrete time systems and Basic system properties.

**Module-2:**
Linear time-invariant systems: Discrete and Continuous time systems, convolution sum, convolution Integral, Properties, causality and stability of linear time invariant systems. System representation by differential equations and difference equations, singularity function.

**Module-3:**
Fourier series and Fourier transform: analysis of continuous-time and discrete time signals by Fourier series, properties. Representation of aperiodic signals by Fourier Transform: Continuous-time and discrete-time signals, Properties, System characterized by linear constant coefficient differential equation. Discrete time Fourier transform and discrete Fourier transform, Parseval's theorem.

**Module-4:**
Laplace Transform for continuous-time signal and systems: Eigen functions of LTI systems, region of convergence, system functions, pole and zero of system functions and signals. Laplace domain analysis, differential equation solution, Parseval's theorem representation.

**Module-5:**
Z-transform of discrete time signals and systems: Eigen functions, region of convergence, system function, poles and zeros representation of systems, z-domain analysis, Parseval's theorem representation.

**Module-6:**

Sampling: Sampling theorem, Impulse train sampling, Sampling with zero order hold, Reconstruction of signal from its samples using interpolation, Aliasing. Discrete time processing of continuous time signals, Digital differentiator, half sample delay, Sampling of Discrete-time signals, Decimation and interpolation.

**Module-7:**

Advanced topics: modulation for communication, filter, and time-frequency representation of uncertainty principle, short-term Fourier transform and wavelet transform.

**COURSE OUTCOME:**

After successful completion of the course the students will be able to:

CO1: Realize the significance of studying signals and systems and their properties.

CO2: Understand the concept to analyze different signals.

CO3: Understand the concept to analyze different systems.

CO4: Understand the way to sample different signals.

CO5: Understand different modulation scheme for modern communication.

# $4^{th}$ SEMESTER

# Engineering Economics and Accounts

| Engineering Economics and Accounts | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSES OBJECTIVE:**

- ❖ To make the Engineering student know about the basic concepts and law of Economics and their application to understand the behaviour of agents present in the market. The subject will address the requirement of evaluating the commercial viability of projects undertaken by graduate engineers
- ❖ To make the Engineering student know about the basic concepts of cost and costing, Accounts and financial statements and their application to understand the issue of commercial viability of any projects.

**COURSE CONTENT:**

**Module- 1:**
Engineering Economics- meaning, nature, scope and subject matter

**Module-2:**
Utility- definition, total, marginal and average; cardinal utility theory; indifference curves theory; Demand- factors effecting demand, elasticity of demand- different types of elasticity, classification of goods based on various elasticity of demand

**Module – 3:**
Production- Production function; Iso-quant; returns to scale; Total, Average & Marginal Product; law of variable proportions; Cobb-Douglas production function; Iso-cost curve; Derivation of cost curve from production function; Production optimization; expansion path

**Module – 4:**
Cost- short run and long run cost (the 'Envelope Curve'); shape of different types of cost curves; Revenue- total revenue and marginal revenue, relation between marginal revenue and price elasticity of demand.

**Module – 5:**
Firm- different types of firm and its characteristics; traditional theory of firm; objectives of firm

**Module – 6:**
Introduction to Accounting- Definition of Accounting and accountancy, objectives of accounting, users of accounting information, Double Entry system of Book-Keeping, Journal and Ledger, Cash book, Trial balance.

**Module – 7:**
Final Accounts- Basic concepts, uses and preparation of Trading account; Profit and Loss account; and Balance Sheet. Issue and for feature of Share and Re-Issue of Company.

**Module – 8:**
Introduction to Costing - Elements of Cost, Direct Materials, Direct Labour, Direct Expenses, Overheads, Production, Office and Administration, Selling and Distribution, Allocation of overhead, machine hour rate, labour hour rate, practical problems.

## COURSE OUTCOME:

CO1: Be able to identify and explain economic concepts and theories related to the behavior of economic agents present in market.
CO2: Be able to analyse the impact of various government policies in production and profitability of the company.
CO3: Be able to identify the basic features of alternative representations of human behavior in economics.
CO4: Be able to understand the impact various decisions or transactions will have on the company's statements and financial health.
CO5: Be able to comfortably communicate with senior financial and non-financial leaders about financial statement issues and the financial impact of business decisions.

## TEXT/REFERENCES:


1. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2002.
2. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2002
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 1984
4. Grant.E.L.,Ireson.W.G., and Leavenworth, R.S, "Principles of Engineering Economy", Ronald Press, New York,1976.
5. Smith, G.W., "Engineering Economy", Lowa State Press, Iowa, 1973.

# Electromagnetic Theory & Antenna

| Electromagnetic Theory & Antenna | L-3 T-1 P-0 | 4 credits |
|---|---|---|

**COURSES OBJECTIVE:**

- To understand the basics of electrodynamics.
- To understand the application of electrodynamics in waves.
- To study the fundamentals of antennas.
- To study wire and loop antennas.
- To study antenna array.
- To study microstrip and broadband antennas.

**COURSE CONTENT:**

**Module-1:**
Electrodynamics: Electromagnetic induction, inductance, continuity equation, displacement current, Maxwell's equations, boundary conditions, Poynting's theorem, energy and momentum in 0electromagnetic field.

**Module-2:**
Electromagnetic Waves: EM waves in vacuum and in matter, plane waves, wave polarization, group velocity, normal and oblique incidence of uniform plane electromagnetic waves at conducting boundary, dielectric boundary.

**Module-3:**
Fundamental Concepts Antenna: Physical concept of radiation, Radiation pattern, near-and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions

**Module-4:**
**Radiation from Wires and Loops:** Infinitesimal dipole, finite-length dipole, monopole antennas, small circular loop, radiation from apertures.

**Module-5:**
Antenna Arrays: Analysis of array of uniformly spaced elements, uniform and non-uniform excitation, extension to planar arrays, synthesis of antenna arrays

**Module-6:**
Micro strip Antennas: Basic characteristics of micro strip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.

**Module-7:**
Broadband Antennas: Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas.

## COURSE OUTCOME:

After successful completion of the course the students will be able to:

CO1: Realize the significance of studying electrodynamics.
CO2: Understand the generation of electromagnetic waves.
CO3: Understand the fundamental concept of antennas.
CO4: Understand the analysis of different wire antenna, loop antenna, antenna array, microstrip and broadband antenna.

# Probability & Random Process

| Probability & Random Process | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE OBJECTIVE:**

To expose the students to the basics of probability theory and random processes which is an prerequisite for their consequent study of basic and advanced communication courses.

**Module-1**
Axioms of probability theory. Probability spaces. Joint and conditional probabilities. Bayes' Theorem-Independent events.

**Module-2**
Random variables and random vectors. Distributions and densities. Independent random variables. Functions of one and two random variables.

**Module-3**
Moments and characteristic functions. Inequalities of Chebyshev and Schwartz. Law of large numbers, Central limit theorem, Convergence concepts.

**Module-4**
Random processes. Stationarity and ergodicity. Strict sense and wide sense stationary processes. Covariance functions and their properties. Spectral representation. Wiener-Khinchine theorem.

**Module-5**
Gaussian processes. Processes with independent increments. Poisson processes. Low pass and Band pass noise representations

**TEXT/REFERENCE:**

1. Davenport," Probability and Random Processes for Scientist and Engineers", McGraw-Hill.
2. Papoulis. A.," Probability, Random variables and Stochastic Processes", McGraw Hill.
3. E.Wong, "Introduction to Random Processes", Springer Verlag.
4. W.A.Gardner, "Introduction to Random Processes", (2/e), McGraw Hill.
5. H.Stark&J.W.Woods, "Probability, Random Processes and Estimations Theory for Engineers", (2/e), Prentice Hall.


**COURSE OUTCOME:**

After successful completion of the course the students will be able to:

CO1: Understand the Axiomatic Theory of Probability and realize the importance of random variables as an intrinsic need for the analysis of random phenomena.

CO2: Characterize probability models and function of random variables based on single & multiple random variables.

CO3: Evaluate and apply moments & characteristic functions and understand the concept of inequalities and limits in Probability.

CO4: Understand the concept of random processes and determine different statistical parameters related to stationary random processes
CO5: Be familiar with the usage of random process in telecommunication engineering and to solve the corresponding problems.

# Digital Electronics

| Digital Electronics | L-3 T-1 P-0 | 4 credits |
|---|---|---|

**COURSE OBJECTIVES:**

This course intends to impart the following knowledge to the students:
- ❖ To present the Digital fundamentals, Boolean algebra and its applications in digital systems.
- ❖ To familiarize with the design of various combinational digital circuits using logic gates.
- ❖ To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits.
- ❖ To explain the various semiconductor memories and related technology.
- ❖ To introduce the electronic circuits involved in the making of logic gates.

**COURSE CONTENT:**

**Module- 1:**
Binary arithmetic, Codes—BCD, Gray, Excess-3, Error detection & Correcting Code-Hamming code, Logic Gates, Boolean Algebra, Basic theorems & properties of Boolean Algebra, K-map representation, Q-M Method, simplification and realization with logic gates.

**Module- 2:**
Code Converters, Adders (Half and Full adders, parallel binary adders, look ahead carry adder generator, BCD Adder), Subtractor (Half and Full subtractor), Combined adder/subtractor block, Magnitude comparator, decoders and Encoders, Priority Encoder, Multiplexer and Multiplexer-tree, De-multiplexer, Parity generator/checkers.

**Module- 3:**
Latches, Flip-Flops (SR, D, JK, T and Master Slave JK), Conversion of Flip-Flops, Glitches, Shift Register (SISO, SIPO, PIPO, PISO, Bidirectional), Counter (ripple and synchronous, Ring and Johnson Counters), Model of Finite State Machine---State diagram, Mealy and Moore models.

**Module- 4:**
Memory concepts, RAM, ROM, UV-EPROM, EEROM, Flash memory, Optical memory.

**Module- 5:**
PAL, PLA, PROM, CPLD, FPGA and Programmable ASIC.

**Module-6:**

Transistor as switch, Characteristics (Propagation delay, Speed-power product, Noise margin, Fan-in, Fan-out), Standard logic families (RTL, TTL, ECL, CMOS), Gate Design using TTL/ CMOS.

## TEXT/REFERENCES:


1. A. Anand Kumar, Fundamentals of Digital Logic, PHI.
2. M. Morris Mano, Digital Logic and Computer Design, PHI.
3. R.P. Jain, Modern Digital Electronics, McGraw Hill Education.
4. T. L. Floyd & Jain, Digital Fundamentals, Pearson Education.
5. Malvino & Leach, Digital Principles and Applications, McGraw Hill Education.


## COURSE OUTCOME:

Upon completion of the course students are expected to demonstrate knowledge, skill and abilities in the following areas:

CO1: Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.

CO2: To understand and examine the structure of various number systems and its application in digital design.

CO3: The ability to understand, analyze and design various combinational and sequential circuits.

CO4: Ability to identify basic requirements for a design application and propose a cost effective solution.

CO5: The ability to identify and prevent various hazards and timing problems in a digital design.

CO6: To develop skill to build, and troubleshoot digital circuits.

# CONTROL SYSTEM

| Control System | L-3 T-1 P-0 | 4 credits |
|---|---|---|

**COURSE OBJECTIVES:**

- To understand the concept of control system and modeling of physical systems using differential equation, transfer function, block diagram, signal flow graph and state variables.
- To examine the feedback control systems using transient and steady-state responses.
- To analyze the stability of a system in time domain and frequency domain
- To analyze the behavior of closed loop systems using root locus technique.
- To design various controllers and compensator to meet desired system performance specification
- To derive state variable model for dynamical system and to analyze controllability and observe ability.

**COURSE CONTENT:**

**Module-1**
Introduction: Elements of control systems, concept of open loop and closed loop systems, effects of feedback on parameter variation.

**Module-2**
Mathematical Models of Systems: Differential Equations of Physical Systems, Transfer function concepts, Block Diagram Models, Determination of transfer function by block diagram reduction techniques, Signal-Flow Graph Models, Mason's Gain formula.

**Module-3**
Mathematical Modeling of Physical Systems: Modeling of Electric systems, Liquid level system, Translational and rotational mechanical systems.

**Module-4**
Control System Components: DC servomotors, Stepper motors and synchros.

**Module-5**
Time Response analysis: Standard test signals, time response of first and second order systems, time response specifications, steady state errors, error coefficients, P, PI and P-I-D type controllers.

**Module-6**
Stability and Algebraic Criteria: Concept of stability, Assessment of stability from pole positions, Routh-Hurwitz Stability criteria and limitations.

**Module-7**
Root Locus Technique: The root locus concept, Root locus construction rules.

**Module-8**
Frequency Response Analysis and frequency domain methods: Frequency response, correlation between time and frequency responses, Closed loop frequency response ,polar and inverse polar plots, Nyquist plot, Bode plots, constant M & N circles , All pass systems, Minimum-phase and Non-minimum-phase systems, Illustrative examples.

**Module-9**

Stability in the Frequency Domain: Introduction, Mapping Contours in the s-Plane, Principle of Argument, Nyquist stability criterion, Bode plots, assessment of relative stability: gain margin and phase margin.

**Module-10**
Compensator Design: Lag, lead and lag-lead compensation.

**Module-11**
State space representation: Concepts of state, state variables and state model, Transfer Function from the State Equation, The Time Response and the State Transition Matrix, Concept on Controllability and Observe ability and their testing.

## TEXTS/REFERENCES:


1. Kuo B.C. Automatic Control System, PHI
2. Nagrath I J & Gopal M : Control Systems Engineering, New Age International Pub.
3. Ogata K : Modern Control Engg. PHI
4. Dorf R C & Bishop R.H.: Modern Control System ; Addison – Wisley
5. Gopal: Modern Control System Theory, New Age International
6. Gibsen JF, "Control System Components," Mcgraw Hill.
7. D.Roy Choudhary, "Modern Control Engineering", Prentice Hall of India.
8. Norman S. Mise, Control System Engineering, Wiley Publishing Co.
9. Ajit K Mandal, "Introduction to Control Engineering" New Age International.
10. R.T. Stefani, B.Shahian, C.J.Savant and G.H. Hostetter, "Design of Feedback Control Systems" Oxford University Press.
11. .Samarjit Ghosh, " Control Systems theory and Applications", Pearson Education


## COURSE OUTCOME:

CO1: Acquire knowledge to develop mathematical model of the physical system and represent them in various forms.
CO2: Ability to analyze time response of different order system for standard test inputs and to analyze the stability in time domain.
CO3: Ability to apply Root-locus technique to analyze the stability of control system.
CO4: Ability to design various controllers and compensators.
CO5: Acquire knowledge to analyze the stability of a system by frequency domain techniques.
CO6: Ability to develop and analyze state space model.

# Analog Electronic Circuits-II

| Analog Electronic Circuits-II | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE OBJECTIVE:**

❖ To introduce the theoretical & circuit aspects of an Op-amp.

**COURSE CONTENT:**

**Module-1:**
Review of differential Amplifier. Basic information of OP-AMP, Characteristic of OP-AMP, Application of OP-AMP-inverting , non-inverting and differential amplifiers, voltage follower, Current to voltage converter, mathematical application of OP-AMP-, sign changer, summing, scaling and averaging Amplifier, Instrumentation amplier, Logarithmic amplifier, integrator and differentiator, Active filters: Low pass, high pass, band pass and band stop, design guidelines.

**Module-2:**
Non-linear application of OP-AMP in designing comparators, application of comparator such as zero crossing detector, window detector, etc. Regenerative comparator (Schmitt Trigger), Square wave generator (Astable Multivibrator), Monostable Multivibrator, Triangular wave generator.Design of Oscillator using OP-AMP, RC phase shift oscillator, Wien Bridge Oscillator, LC Oscillator, Colpitt's and Hartley Oscillator.

**Module- 3:**
Design of Voltage regulator using OP-AMP, Series and Switching regulator. Basic of Operational Trans conductance Amplifier (OTA), Function of 555 timer, 555 timer for Monostable and Astable operation. Block diagram representation of Phase-locked loop (PLL) and use of PLL.

**Module- 4:**
Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog-to-digital converters (ADC): Single slope, dual slope, successive approximation, flash etc. Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.

**TEXT/REFERENCES**


1. Tobey, Graeme , Huelsman , "Operational amplifiers, Design and applications", McGraw Hills, Edition
2. Gaikwad R.A "Operational Amplifiers and Linear Integrated Circuits", PHI 1990 Edition
3. D. Ray Choudhury&Shail Jain "Linear Integrated Circuits" New Age, 5th Edition.
4. Design with OPAMPS and Analog ICs-Fransis S, McGraw Hills
5. OPAMPS and Linear ICs -Fiore J.M,Delmer-Thomson, USA 2001.
6. Microelectronic Circuits Theory and Application-Sedra and Smith, 7th Ed, Oxford publication.
7. Design of Analog CMOS Integrated Circuits-Behzad Razavi, McGraw Hills

## COURSE OUTCOMES:

At the end of the course student will be able to
CO1: infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.
CO2: elucidate and design the linear and nonlinear applications of an op-amp and special application ICs.
CO3: explain and compare the working of multi vibrators using special application IC 555 and general purpose op-amp.
CO4: classify and comprehend the working principle of data converters.
CO5: illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.

# 5th SEMESTER
# Industrial Management

| Industrial Management | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSES OBJECTIVE:**

- To make the Engineering student know about the basic concepts, functions, principles and techniques of management and their application, which complement the technical skills to execute their capabilities successfully.
- To make the Engineering student know about the basic concepts of finance in carrying out any project

**COURSE CONTENT:**

**Module- 1:**
Basic Concepts and functions of management: planning, nature, purpose and objective of planning; organizing: nature and purpose, authority and responsibility, staff bug; supply of human resources, performance appraisal. Controlling: system and process of controlling, control techniques.

**Module- 2:**
Human resource Management and Marketing Management: nature and scope of human resource of planning, planning and development, recruitment and selection, career growth, grievances, motivation and its type, needs for motivation, reward and punishment, models of motivation. Leaders: kinds of leaders, leadership styles, roles and functions of leader; conflict management: kinds and causes of conflict, settlement of conflict, Group and team working, organizational design and development.

**Module – 3:**
Financial Management: Need of finance, kinds and sources of capital shares and debentures, fixed and working capital , capital structure of a firm, operating and financial leverage, EBIT and EPS analysis, financial ratio analysis : uses and natures, liquidity coverage ratios, practical problems.

**Module – 4:**
Investment decisions and forecasting of working capital: Kinds of capital Budgeting decisions, evaluation of proposals, capital discounting and non discounting based methods. Practical problems. Definition and importance of working capital. Working capital operating cycle, factors affecting Working capital, inventory management

**Module – 5:**
Cost Analysis and Cost Control: elements of cost, types of cost, direct and indirect, variable and fixed, labour cost, material cost, overhead cost, cost control techniques. Budget: meaning, kinds, budgetary controls, break even analysis, practical problems.

**Module – 6:**
Perfect Competition- Perfect Competition, Features; Short run and long run equilibrium of firm and industry, shut down point.

**Module – 7:**
Monopoly- features, monopoly power, pricing under monopoly, price discrimination.

**Module – 8:**
Oligopoly- Features, kincked demand Curve, Cournot's Duoploy Model Cartels, Price leadership.

**Module – 9:**
Monopolistic Competition- Features, Pricing under monopolistic competition, Product differentiation.

**Module – 10**
Macroeconomics- Inflation; Function of Central & Commercial Banks.

## COURSE OUTCOME:

CO1: Be able to understand the principles of management and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
CO2: Be able to make a plan how to organize, control and motivate people.
CO3: Be able to understand the Cost analysis in the context of short and long term decision making and the use of discounted cash flow analysis.
CO4: Be able to identify and explain economic concepts and theories related to the markets, industry and firm structures.
CO5: Be able to pursue the larger objectives of the firm besides profit maximization.

## TEXT/REFERENCES:

1. M. Adhikari, Business Economics, Excel Books, 2004
2. S. K. Misra & V.K.Puri, Economic Environment of Business, HPH, 2003
3. L.M.Prasad, Priciples and Practice of Management, S.Chand & Sons.
4. P.Chandra, Financial Management Theory and Practice (3/e), TMH, 2004

# Analog and Digital Communication

| Analog And Digital Communication | L-3 T-1 P-0 | 4 credits |
|---|---|---|

**COURSE OBJECTIVE:**

- To understand the fundamentals of analog and digital communication.
- To study the different Linear Modulation or Amplitude Modulation (AM) schemes.
- To study the different Angular Modulation schemes, i.e. Frequency Modulation (FM) and Phase Modulation (PM).
- To study about the sampling theorem, different analog and digital pulse modulations.
- To study different Digital Modulation schemes.
- To make students aware of noise and interference (Inter Symbol Interference (ISI)) in digital modulated signal and method of minimizing it.
- To study the different types of digital Amplitude, Frequency and Phase Keying techniques.

**COURSE CONTENTS:**

**Module- 1:**
Introduction to analog modulation, Theory of Amplitude Modulation (AM)- With Large Carrier, DSB-SC, SSB-SC, VSB, Basic of Anguler Modulation; Frequency Modulation (FM) and Phase modulation (PM).Frequency Division Multiplexing (FDM), Super-heterodyne Radio Receiver.

**Module- 2:**
Pulse Modulation –PAM, PWM & PPM. Pulse Code Modulation , Linear quantizer, Quantization noise power calculation, Signal to Quantization noise ratio, Non-uniform quantizer, A law & u- law, companding; encoding and Bandwidth of PCM, Differential pulse code modulation, Delta modulation, Idling noise and slope overload, Adaptive delta modulation, DPCM, Comparison of PCM and DM. Time Division Multiplexing(TDM)

**Module- 3:**
Line Coding & its properties. NRZ & RZ types, signaling format for unipolar, Polar, bipolar (AMI) & Manchester coding and their power spectra, HDB and B8ZS signaling, ISI, Nyquist criterion for zero ISI & raised cosine spectrum, Matched filter receiver, Derivation of its impulse response and peak pulse signal to noise ratio, Correlation detector decision threshold and error probability for binary unipolar (on-off) signaling.

**Module- 4:**
Types of digital modulation, Wave forms for Amplitude, Frequency and Phase Shift Keying, Method of generation and detection of coherent & non-coherent binary ASK, FSK & PSK, Differential phase shift keying, Quadrature modulation techniques, M-ary FSK, Minimum Shift Keying (MSK), Probability of error and comparison of various digital modulation techniques. Coherent reception, Coherent reception of ASK, PSK and FSK, Non-Coherent reception of ASK, FSK, PSK and QPSK, Calculation of error probability of BPSK and BFSK, Error probability for QPSK.

## TEXTS/ REFERENCES:


1. Haykin Simon, “Communication Systems”, 4th Edition, Wiley publication.
2. Lathi B P, “Digital and Analog Communication Systems”, Oxford University Press.
3. U. Madhow, “Fundamentals of Digital Communication”, Cambridge University Press.
4. H.Taub, D. L. Schilling, G.Saha “Principles of Communication Systems” 3rd Edition, Mc Graw –Hill.
5. Proakis J G, M. Salehi, “Communication Systems Engineering”, Prentice Hall.
6. R.E. Zeimer, “ Principles of Communication” , John Wiley


## COURSE OUTCOMES:

After successful completion of this course, students
CO1: Will gathered knowledge about the fundamentals of analog and digital communication, advantages and disadvantages and their applications.
CO2: Will learn design linear and angular modulators and demodulators for communication.
CO3: Will earn sufficient knowledge regarding signal sampling to understand multiplexing and digital modulation schemes for modern communication.
CO4: Will enhance knowledge regarding signal dispersion and fading, and their impact (ISI) due to channel characteristics and accordingly will learn how to take correct decision in presence of ISI, and learn to design optimum receivers to obtain correct decision in presence of channel (AWGN) noise
CO5: Will familiar with different digital carrier modulation/ switching techniques highly required for modern high speed advanced digital communication.

# Electronic Instrumentation and Measurement

| Electronic Instrumentation And Measurement | L-3 T-1 P-0 | 4 credits |
|---|---|---|

**COURSE OBJECTIVES:**

- ❖ To introduce students to Monitor, Analyze and Control any Physical System and Basic Measurement Techniques.
- ❖ To understand different errors in measurement.
- ❖ To understand the construction & operation of different analog and digital instruments adopted for measurement of Resistance, Inductance, Capacitance, Frequency, Power, Energy etc.
- ❖ To understand different Sensors, Transduces and Digital Measurement Techniques.
- ❖ To know the industrial practices of locating the cable faults.
- ❖ To understand the Construction & Operation of Frequency Domain & Special Purpose Instruments.
- ❖ To introduce students a knowledge to use modern tools necessary for Electrical & Electronic projects.

**COURSE CONTENTS:**

**Module-1:**
Basic Measurement Techniques: Construction and Principle of Operation of Moving Coil, Moving Iron, Dynamometer, Thermal and Rectifier type Deflecting Instruments, DC ammeter, Ammeter shunts, DC Voltmeter, Voltmeter multiplier.

**Moduel-2:**
Errors in Measurement: Definition of Accuracy, Precision, Fidelity, Speed of Response, Non-linearity, techniques of Linearization, Classification of errors, Statistical analysis.

**Module-3:**
Measurements of Resistances: Measurement of low, medium and high Resistances **(**Wheat Stone Bridge, Kelvin Bridge**)**, Kelvins Double Bridge.

**Module-3:**
Localization of Cable faults: Murray and Varley Loop Methods.

**Module-4:**
AC Bridges: Measurement of Inductances, Capacitance and Frequency by A.C. Bridges – Maxwell Bridge, Hay’s Bridge, Anderson Bridge, Owen’s Bridge, De Sauty’s Bridge, Schering, Wein Bridge.

**Module-5:**
Measurement of Power & Energy: Measurements of Power in Polyphase Circuits, various Wattmeter connections, A.C. and D.C. Energy Meters.

**Module-6:**
Cathode Ray Oscilloscope: C.R.O Construction &Principle of Operation. Cathode Ray Tube (CRT), Digital Storage Oscilloscopes.

**Module-7:**
Sensors & Transducers: Piezoelectric Sensors, LVDT, Stain Gauges, Thermistors, Thermocouple, Actuators A/D, D/A Conversion Techniques; S/H and Multiplexers; Isolation Amplifiers; Data Acquisition System, Sampling Concepts, ADC and DAC.

**Module-8:**
Digital Instrumentation: Block diagram of Instrumentation Schemes, DVM, DMM, and Frequency Counter.

**Module-9:**
Frequency Domain Instruments: Wave Analyzer, Spectrum Analyzer.

**Module-10:**
Special Purpose Instruments: Signal Generators, Q-meter.

## TEXTS/ REFERENCES:


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


## COURSE OUTCOMES:

After successful completion of the course the students will be able to:
CO1: Appreciate a system to determine appropriate instruments by type and range to measure different quantities in the system.
CO2: Measure various electrical quantities like R.L.C, Voltage, Current, Frequency, Power and Energy for AC and DC quantities using analog and digital meters.
CO3: Balance various AC and DC bridges to find unknown values.
CO4: Use Sensors & Transducers for measurement of various parameters.
CO5: Use CRO with confidence to measure different quantities and viewing signal waves.
CO6: Use techniques and skills to locate the fault of underground cables.
CO7: Take up projects to apply the learned techniques and skills.

# Digital Signal Processing

| Digital Signal Processing | L-3 T-1 P-0 | 4 credits |
|---|---|---|

**COURSE OBJECTIVE:**

- The primary objective of this course is to provide a comprehensive understanding and working knowledge of analysis, design & implementation of DSP systems.

**COURSE CONTENTS:**

**Module- 1:**
Fourier analysis of discrete-time signals and systems: Discrete Fourier Series, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT) - Properties; Approximation of Fourier transform through DFT, Fast algorithms for DFT: The FFT algorithm – Prime factor algorithms, Convolution; Linear and circular convolution, Practical implementation, Overlap-save and overlap-add methods.

**Module- 2:**
Design of Digital Filters: Linear Phase FIR filters; Design methods for FIR filters, FIR filter design using windows; IIR filter design by Impulse Invariance, Bilinear Transformation, Matched Z-Transformation, Frequency Transformation in the Analog and Digital Domain, Filter structures for IIR and FIR filters, direct form I and II, parallel and cascade forms, frequency sampling structure for FIR filters

**Module-3:**
Finite length register effects: Limit cycles, Overflow oscillations, State variable model for overflow, Round-off noise in IIR digital filters, Computation of output round-off noise, Methods to prevent overflow, Scaling rules and scaling operations, Scaling state variable description, Trade-off between round-off and overflow noise, Measurement of coefficient quantization effects through pole-zero movement, Dead-band effects, Constant input limit cycles.

**Module- 4:**
Introduction to multirate DSP: Decimation and interpolation, polyphase decomposition, uniform DFT filter banks, quadrature mirror filters and perfect reconstruction
Digital Signal Processors: Architecture and types of instructions, Addressing schemes and Interface details of one of the latest, commonly used Digital Signal Processors.

**TEXTS/ REFERENCES:**

1. J.G.Proakis, D.G. Manolakis, "Digital Signal Processing", (4/e) Pearson, 2007.
2. A.V.Oppenheim & R.W.Schafer, "Discrete Time Signal processing", (2/e), Pearson Education, 2003.
3. S.K.Mitra, "Digital Signal Processing (3/e)", Tata McGraw Hill, 2006.

**COURSE OUTCOME:**

CO1: To understand the key theoretical principles underpinning DSP in a design procedure
CO2: Implementation and applications of digital signal processing concepts and algorithms

CO3: Ability to design & analyze DSP systems like FIR and IIR Filters etc.
CO4: To give an exposure to the various fixed point & a floating point DSP architectures and to develop applications using these processors
CO5: Analysis and Design of Practical Systems for Communication Engineering and Signal Processing.

# Microprocessors and Microcontrollers

| Microprocessors And Microcontrollers | L-4 T-0 P-0 | 4 credits |
|---|---|---|

**COURSES OBJECTIVE:**

- To have an understanding of Microprocessor Architecture Basics (8085 and 8086)
- To get familiar with Assembly Language Programming, Memory Systems and I/Os.
- To have knowledge of Advanced Microprocessors.
- To understand Architecture of Microcontrollers.
- To understand the basics of interfacing.

**COURSE CONTENT:**

**Module- 1**
Microprocessor architecture: 8-bit (e.g.8085) and 16-bit (e.g. 8086/8088).

**Module- 2**
Addressing modes of microprocessors, instruction set of 8-bit (8085) and 16-bit microprocessors (8086/8088).

**Module- 3**
Instruction cycle, timing diagram, Subroutine, assembly language programming.

**Module- 4**
Types of memories and their organizations (RAM, ROM, stack, secondary etc.).

**Module- 5**
Interrupt, DMA, Principle of data transfer (synchronous and asynchronous). Serial data communication, RS-232 standard. Peripheral interface: PPI, DMA controller, interrupt controller, programmable timer, USART.

**Module-6**
Introduction to advanced microprocessors (16 bit, 32 bit & 64 bit), Architecture of advanced microprocessors-80186, 80286, 80386, 80486,Pentium processor.

**Module- 7**
Microcontrollers and its applications (e.g.8051).

**TEXTS/ REFERENCES:**


1. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085, Penram.
2. B. Ram, Fundamentals Microprocessor and Microcontrollers, Dhanpat Rai Publications.
3. Barry B. Brey, The INTEL Microprocessors, Pearson.
4. Mazidi, The 8051 Microcontroller and Embedded Systems.

**COURSE OUTCOMES:**

After the completion of the course, the students:
CO1: Will have an idea about some basic and advanced microprocessors.
CO2: Will learn assembly language programming.
CO3: Will learn about various I/O chips and interfacing.
CO4: Will have knowledge of different interrupts.
CO5: Will have a basic idea about microcontrollers.

# 6th SEMESTER

# Optical Fibre Communication

| Optical Fibre Communication | L-3 T-1 P-0 | 4 credits |
|---|---|---|

**COURSES OBJECTIVE:**

- To introduce basic overview of optical communication in telecommunication system, fundamental data communication concept used in optical communications.
- To understand the purpose and performance characteristics of major elements in optical link: Optical fibers, types, physical structures, constituent materials, fabrication methods, and attenuation behaviour, loss and dispersion mechanisms.
- To understand the working principles of Optical sources: Operating characteristics, direct and external modulation techniques, temperature effects, device lifetime considerations, noise, etc.
- To know about Power Launching and Coupling: Source to fibre power launching, fibre to fibre joints, couplers, multiplexers and splices
- To understand the purpose and working of Detectors: Structures and response of photo-detectors, operational characteristics, concept of signal detection and eye diagram measurement schemes
- To acquire knowledge of design methods for digital and analog links, discussion of link power budget and bandwidth limitation; wavelength converters, coherent and WDM schemes, Grating structures, etc.
- To understand te working of Optical amplifiers (EDFA, etc); Raman Scattering, Brillouin Scattering, stimulated Raman Scattering, Solution, etc.

**COURSE CONTENT:**

**Module-1**
Overview of Optical Fiber Communication: Introduction, Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, Ray theory, cylindrical fiber, single mode fiber, cutoff wave length, mode filed diameter. Optical Fibers: fiber materials, photonic crystal, fiber optic cables specialty fibers.

**Module-2**
Transmission Characteristics of Optical Fibers: Introduction, Attenuation, absorption, scattering losses, bending loss, dispersion, Intra model dispersion, Inter model dispersion.

**Module-3**
Optical Sources and Detectors: Introduction, LED's, LASER diodes, Photo detectors, Photo detector noise, Response time, double hetero junction structure, Photo diodes, comparison of photo detectors.

**Module-4**
Fiber Couplers and Connectors: Introduction, fiber alignment and joint loss, single mode fiber joints, fiber splices, fiber connectors and fiber couplers.

**Module-5**

Optical Receiver: Introduction, Optical Receiver Operation, receiver sensitivity, quantum limit, eye diagrams, coherent detection, burst mode receiver, operation, and Analog receivers.

**Module-6**

Analog And Digital Links: Analog links – Introduction, overview of analog links, CNR, multichannel transmission techniques, RF over fiber, key link parameters, Radio over fiber links, microwave photonics. Digital links – Introduction, point–to–point links, System considerations, link power budget, resistive budget, short wave length band, and transmission distance for single mode fibers, Power penalties, nodal noise and chirping.

**Module-7**

WDM Concepts and Components: WDM concepts, overview of WDM operation principles, WDM standards, Mach-Zehender interferometer, multiplexer, Isolators and circulators, direct thin film filters, active optical components, MEMS technology, variable optical attenuators, tunable optical fibers, dynamic gain equalizers, optical drop multiplexers, polarization controllers, chromatic dispersion compensators, tunable light sources.

**Module-8**

Optical Amplifiers and Networks: Optical Amplifiers and Networks – optical amplifiers, basic applications and types, semiconductor optical amplifiers, EDFA. OPTICAL NETWORKS: Introduction, SONET / SDH, Optical Interfaces, SONET/SDH rings, High – speed light – waveguides.

**TEXTS/ REFERENCES:**


1. G. Keiser, Optical Fibre Communications, McGraw Hill, 2008.
2. John M. Senior, Optical Fiber Communications: Principles and Practice, PHI, 2008
3. Jones, William B. Jones, Introduction to Optical Fiber Communications Systems, Oxford University Press (1995).
4. A. J. Rogers, Understanding Optical Fiber Communications, Artech House (2001).
5. J. C. Palais, Fiber optic communication, 5th edition, Prentice Hall, 2004


**COURSE OUTCOMES:**

After successful completion of the course the students will be able to:

CO1: Express the basic concepts of Fiber optic communication link

CO2: Analyse the operating characteristics of light sources, analysing the performance and modulation characteristics

CO3: Develop the concept of coupling light source to fiber and how to join two or more fibers in order to ensure a low optical power loss at the joints; fiber couplers, multipliers and splicing.

CO4: Design structure, configuration and responses of light-wave receivers (photo-detectors) - principles, functions and operational characteristics; developing concepts of signal-detection statistics and eye-diagram measurement schemes.

CO5: Design methods for digital and analog links, link power budgets and bandwidth limitations, error control methods for digital links, etc. Principles of WDM, examples of active and passive WDM devices, fiber Bragg grating, waveguide grating, diffraction gratings, etc.

CO6: Take up projects using different concepts for creating Optical amplification, origin and effects of nonlinear processes in optical fibers, system performance and control, solution etc.

# VLSI Technology

| VlSI Technology | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSES OBJECTIVE:**

- ❖ Providing exposure to different steps involved in the fabrication of ICs using MOS transistor, CMOS transistors and passive components.
- ❖ To explain electrical properties of MOS devices to analyze the behavior of inverters designed with various loads.
- ❖ Give exposure to the design rules to be followed to draw the layout of any logic circuit.
- ❖ Providing concept for design different types of logic gates using CMOS inverter and analyze their transfer characteristics.
- ❖ Giving design concepts to design building blocks of data path of any system using gates.

**COURSE CONTENT:**

**Module- 1:**
Introduction to VLSI design, Moore's Law, VLSI Design flow, Design hierarchy, VLSI Design style: Full custom, Gate array, standard-cell, Macrocell based design, Field programmable devices, design quality.

**Module -2:**
Electrical characteristics of MOSFET, Body effect, MOSFET scaling, Short-channel effects.
Unit – 3: Unit process in VLSI: Wafer preparation, Oxidation, Diffusion, Ion implantation, Deposition, Metallization, Etching and Lithography.

**Module– 3:**
IC fabrication: nMOS fabrication, n-well and p-well process, Stick diagram. Layout and Layout design rules.

Module – **4:**
CMOS Digital Circuits: General CMOS logic structure, VTC of inverter, noise margin, Different types of inverter (resistive load, enhancement and depletion nMOS load and CMOS), Switching characteristic (propagation delay and parasitic capacitance estimation), switching power, latch-up, sizing for large capacitive load, NAND, NOR and other complex CMOS logic circuits. Dynamic CMOS logic circuits (Domino and NORA logic). Introducing sequential CMOS logic circuits.

**Module-5:**
CMOS analog circuits: Differential Amplifier – Source coupled pair, CMRR, Basic CMOS op-Amp design.

**Module-6:**
Physical Design Automation: Objectives and goals of partitioning, floor planning and placement, Global routing.

**Module-7:**
Advanced topic: Low power VLSI Design and Testing.

## TEXTS/ REFERENCES:


1. Neil Weste& Kamran Eshraghian, Principles of CMOS VLSI Design: A Systems Perspective, Addison-Wesley Publishing Company,(1993).
2. Sung-Mo (Steve) Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis & Design, McGraw Hill Education; 3 edition (2002).
3. Simon Sze, Vlsi Technology,McGraw Hill Education; 2nd Edition (2017).
4. Sedra A.S. & Smith K.C., Microelectronic Circuits, Oxford University Press (2015).
5. Samir Palnitkar,VerilogHdl, Pearson Education; 2 edition (2003).
6. J. Bhasker, A Verilog HDL Primer, Star Galaxy Publishing ; 2nd Edition (1999).


## COURSE OUTCOME:

CO1: Acquire qualitative knowledge about different VLSI design styles and fabrication process.
CO2: Gain knowledge about the electrical characteristics of MOSFET.
CO3: Develop knowledge about the electrical characteristics CMOS inverter.
CO4: Acquire concepts digital and analog circuit design with CMOS, pseudo N-MOS etc. and layout design.
CO5: Develop concepts of VLSI physical design automation.
CO6: Develop the knowledge of low power design and fault testing.
CO7: Get acquainted with digital circuit design using HDL.

# Information Theory and Coding

| Information Theory And Coding | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSES OBJECTIVE:**

- To expose the students to the basics of Information Theory and Coding Theory.
- To analyze the performance of different types of source and channel coding.
- To introduce the students to the basics of Network Information Theory.

**COURSE CONTENT:**

**Module- 1**
Information Measure, Source Extension, Joint and Conditional Entropy, Mutual Information, Differential Entropy, Asymptotic Equipartition Property, Source coding theorem, Kraft McMillan Inequality, Arithmetic coding, Huffman and Lempel Ziv Algorithms, Rate Distortion function and optimum quantizer design, lossless and lossy image compression.

**Module- 2**
Modeling of discrete memory less channels, Binary symmetric Channel and Binary Erasure Channel, Shannon Channel coding theorem, lossless, distortion less and useless channel, Gaussian channel capacity Theorem, Shannon Limit, Water-Filling Algorithm, rate distortion theory.

**Module- 3**
Network Information Theory.

**Module- 4**
Motivation behind channel coding, Coding gain, Difference between hard decoding and soft decoding. Linear block codes: design, syndrome detection and performance issues, Hamming bound, Hamming code, cyclic codes, Convolution code: state diagram, Trellis Tree, Impulse response of encoder. Maximum likelihood detection, Bounds on error probability, Introduction to LDPC code, TURBO code and TRELLIS coded Modulation.

**TEXTS/ REFERENCES:**


1. Information Theory and Coding by Ranjan Bose
2. Communication System Engineering by Proakis and Salehi
3. Cryptography and Network Security by Forouzan and Mukhopadhaya
4. Cryptography and Network Security by William Stallings


**COURSE OUTCOME:**
CO1: Understand the basic concepts of Information and Coding theories.
CO2: Analyze channel performance using Information Theory.
CO3: Comprehend various sources and channel coding techniques and analyze their performance.
CO4: Use various Coding and Decoding Techniques for error detection and correction.
CO5: Be familiar with the basic concepts of Network Information Theory.

# Data Communication Networks

| Data Communication Networks | L-3 T-0 P-0 | 3 credits |
| --- | --- | --- |

**COURSE OBJECTIVE:**

- To know the Standard Layered network Architecture (OSI and TCP/IP).
- To get acquainted with the functionalities of Each Layer.
- To understand the basics of Switching and subsequent advances in switching technologies.
- To get an overview of security issues in a network.
- To get an insight of network performance analysis.

**COURSE CONTENT:**

**Module-1**
7-Layer/4- Layer network Architecture, Network Protocol Concepts.
Protocol Examples: Link layer protocols- X.25, RS232, RS485, Access protocols- IEEE 802.1, IEEE 802.2, IEEE 802.3 Ethernet, IEEE 802.4, IEEE 802.5, IEEE 802.11 WLAN, IEEE 802.15, Routing protocols- OSPF, BGP, RIP. Drawbacks of layered architecture and motivation to cross-layer optimization.

**Module-2**
Error control: CRC fundamentals. Concepts of finite field, Link layer protocols and performance analysis, physical layer aware link layer performance.

**Module-3**
Network performance analysis, Queueing theory basics, Application of queueing analysis, Multiaccess performance.

**Module-4**
Graph concepts of network, Network routing performance analysis.

**TEXTS/ REFERENCES:**


1. 1.Forouzan, Data Communications and Networking, McGraw Hill Education.
2. 2.Kurose and Ross, Computer Networking: A Top Down Approach, Pearson.


**COURSE OUTCOME:**

After the completion of the course, students:
CO1: Will have knowledge of OSI and TCP/IP layered architecture and their functionalities.
CO2: Will learn about wireless networking.
CO3: Will be familiar with various routing algorithms and switching techniques.
CO4: Will learn different error control and flow control techniques.
CO5: Will have knowledge of network performance analysis.

# Microwave Engineering

| Microwave engineering | L-3 T-1 P-0 | 4 credits |
|---|---|---|

**COURSES OBJECTIVE:**

- ❖ To understand the basics of transmission line.
- ❖ To understand the basics of waveguides.
- ❖ To study the analysis of different microwave components.
- ❖ To study different waveguide resonators.
- ❖ To study klystron amplifier.
- ❖ To study different semiconductor microwave devices.

**COURSE CONTENT:**

**Module- 1**
Transmission lines –TEM and Quasi-TEM analysis, characteristic impedance, standing wave ratio, impedance matching techniques, Smith Chart.

**Module- 2**
Modal analysis of rectangular waveguides –TE and TM modes, guide wavelength, cut-off, mode excitation, circular waveguides.

**Module- 3**
Passive microwave components – S matrix formalism, directional coupler, rat-race coupler, waveguide tees, isolator, circulator, phase shifter, impedance matching.

**Module- 4**
Microwave Resonators – waveguide cavity resonators and transmission line resonators, analysis of Q factor.

**Module- 5**
Vacuum tube microwave devices – Klystron - velocity modulation and bunching, Reflex klystron, traveling wave tube - slow wave structure and Brillouin diagram, Magnetron.

**Module- 6**
Semiconductor microwave devices – Tunnel diode, Gunn diode, IMPATT diode, CCD, heterojunction bipolar transistors – principle, characteristics, noise figure.

**COURSE OUTCOME:**
After successful completion of the course the students will be able to:
CO1: Realize the significance of studying transmission line.
CO2: Realize the significance of studying waveguide.
CO3: Understand the concept to analyze different microwave components.
CO4: Understand the way to generate and amplify microwave signals

# 7$^{TH}$ SEMESTER

# Wireless Communication

| Wireless Communication | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE OBJECTIVE:**

- To make students familiar with fundamentals of wireless and mobile communication systems and to impart an introduction to radio wave propagation techniques for mobile wireless radio.
- To discuss various multiple access techniques for wireless communication and choose system (TDMA/FDMA/CDMA) according to the complexity, installation cost, speed of transmission, channel properties etc.
- To understand the concept ofpropagation mechanism
- To identify the requirements of mobile communication as compared to static communication.
- To understand the concept of Teletraffic Theory

**COURSE CONTENT:**

**Module- 1**

Wireless Standards: Overview of 2G, 3G & 4G cellular standards. Cellular concepts- frequency reuse, co-channel interference, adjacent channel interference -power control for reducing interference, improving capacity in cellular systems – cell splitting, sectoring, hand off strategies, channel assignment strategies, Teletraffic Theory.

**Module- 2**

Signal propagation-Propagation mechanism- reflection, refraction, diffraction and scattering,large scale signal propagation and log normal shadowing. Link Budget Analysis. Fading channels-Multipath and small scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate.

**Module- 3**

Notion of channel Capacity, capacity of fading channel, outage Probability analysis

**Module- 4**

QAM, MSK, GMSK, MC-modelling, DSSS, Introduction to space modulation's index, advantage, application, DVOR, Doppler Effect. OFDM, OFDMA, SCMA, Multiple access schemes- FDMA, TDMA, CDMA and SDMA.

**Module- 5**

Resource allocation and optimization

**Module- 6**

Receiver structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive DFE. Transmit diversity- Altamouti scheme. MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing trade off.

## TEXT BOOK/REFERENCES:


1. Wireless Communications: Principles and Practice, Theodore Rappaport , Prentice Hall.
2. Wireless Communications: Andrea Goldsmith, Cambridge University Press.
3. Fundamentals of Wireless Communications, David Tse and Pramod Viswanath, Cambridge University Press


## COURSE OUTCOME:

After successful completion of the course the students will be able to:
CO1: To make students familiar with Wireless Standards& cellular communication.
CO2: To understand different issues regarding channels (fading etc.)
CO3: To understand the concept of Propagation mechanism.
CO4: Knowledge of the concept of.GSM architecture.
CO5: To make students familiar with cellular system
CO6: To understand the concept of Tele traffic Theory
CO7: Knowledge of Multiple access schemes.
CO8: To differentiate various Wireless LANs.

# ELECTIVE SUBJECTS OF 7$^{TH}$&8$^{TH}$SEMESTER

# Adaptive Signal Processing

| Adaptive Signal Processing | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module 1**
Background from linear algebra, vector spaces, inner product, projection theorem, singular value decomposition and Moore Penrose pseudo-inverse

**Module 2**
Random processes and signal modeling. Discrete time random processes, correlation and power spectrum. Models: linear processes, harmonic processes, AR, MA, ARMA processes

**Module 3**
Wiener filters and linear prediction, optimal linear filtering, forward and backward prediction, Levinson-Durbin algorithm, lattice predictors, joint-process estimation

**Module 4**
LMS adaptive filtering, method of steepest descent, LMS algorithm. Stability and performance analysis.

**Module 5**
Method of least squares, least-squares solution, properties, recursive least-squares method.

**TEXT BOOK/REFERENCES:**


1. S. Haykin, Adaptive Filter Theory, 5$^{th}$ edition, Prentice Hall, 2013
2. G. Strang, inear algebra and its applications.5$^{th}$ edition, Wellesley-Cambridge Press, 2016

# Advanced Semiconductor Devices

| Advanced Semiconductor Devices | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module- 1:**
Basic Introduction: Classification and properties of semiconductor devices. Binary and ternary semiconductors, dopants and impurities, temperature dependency, crystal structure of Si and GaAs. Growth techniques of GaAs and InP by LPE and MBE.

**Module- 2:**
Contact and MESFET:Metail-semiconductor contacts: ohmic and schottky contact, interface trap density issues, non-idealities (image force lowering and quantum mechanical tunnelling), Fermi level pinning, I-V characteristics. Motel semiconductor field effect transistor: operation and I-V characteristics, Shockley's model, velocity saturation effect, gradual channel approximation model. Velocity overshot effect.

**Module- 3:**
Hetero junction**:** different types of heterojunctions, band diagram. Importance of hetero junctions. High electron mobility transistors: AlGaAs/GaAs HEMT structure, band diagram, operation and I-V characteristics. Pseudomorphic (AlGaAs/InGaAs) and metamorphic (InAlAs/InGaAs) HEMT structures and their advantages.

**Module- 4:**
Heterojunction bipolar transistor: comparison between BJT and HBT, device structure and operation, current gain ($\beta$) calculation, effect of surface passivation in current gain.

**Module- 5:**
Solar cell: operations, I-V characteristics, maximum power transfer equation, fill factor, efficiency. Heterojunction solar cell (AlGaAs/GaAs), multi junction solar cell.

**Module- 6:**
Power devices: basic requirements of power semiconductor devices: on resistance, specific resistance, breakdown voltage. Power MOSFET, IGBT.

**TEXT/REFERENCES:**


1. VLSI fabrication principle, by Sorab K. Gandhi, Wiley India.
2. Physics of semiconductor devices, S.M. Sze, Wiley
3. Semiconductor optoelectronics devices, by Pallab Bhattacharya, PHI.
4. Fundamental of power semiconductor devices, by Jayant Baliga, Springer.

# Advanced Digital Systems

| Advanced Digital Systems | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module- 1**
Introduction to Digital IC design flow, Gate-Level, Dataflow & Behavioral Modeling of digital circuits.

**Module- 2**
Timing characteristics of combinational logic design and Sequential machines, system decomposition, arithmetic Module-s, ALU design.

**Module- 3**
Programming of complex digital logic circuits using HDL: Encoder/Decoder, Counters, shift registers, ADC, DAC, PLD etc.

**Module- 4**
Finite State Machines: Design and applications.

**Module- 5**
Programmable Memory elements: Structure and basic working principle of SRAM and DRAM, Scratchpads and cache memory, SOC memory systems, Board-based memory systems.

**Module- 6**
Design and operation of Field Programmable Gate Arrays (FPGA), CLB, Look up Table, routing architectures.

**Module- 7**
FPGA design flow based on HDL, FPGA system implementation, verification and testing.

**TEXT/REFERENCES:**


1. Verilog HDL, a Guide to Digital Design and Synthesis", Samir Palnitkar, 2003
2. HDL CHIP DESIGN", Douglas J. Smith, 2002
3. Verilog Designer's Library", Bob Zeidman, 2003
4. Computer system design: system-on-chip", M.J. Flynn & W. Luk, Wiley, 2011.
5. Digital Design, an Embedded Systems Approach Using VHDL", Peter J. Ashenden, Elsevier, 2008.

# Radar & Navigation Systems

| Radar & Navigation Systems | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module-1**
Introduction to Radar– concept, block diagram , operation , frequency ranges , applications , range equation. Radar performance factors – minimum detectable signal , receiver noise , Signal to Noise ratio ,Radar cross section of targets , transmitter power , pulse repetition frequency ,range ambiguities

**Module-2**
Types of Radar, Primary and secondary radar: SR/ASR/PSR/PAR/ARSR/ASMGCS.Doppler effect , FM - CW Radar , MTI Radar, MTI Signal Processor , Pulse Doppler Radar , Radar displays – A Scope – PPI Scope.

**Module-3**
Radio Navigation - methods of navigation , Radio direction finder , Radio Navigation systems - ADF / NDB , Radio compass ADF, VHF phase comparison using ADF , Hyperbolic navigation systems – basic principle , LORAN, Omega, DECCA , Radio ranges , VOR – ground equipment , VOR receiver , Doppler VOR /DME

**Module-4**
Approach and landing aids: Instrument Landing System (ILS) – elements, localizer, glide Path, marker beacons: OM, MM, IM, lighting systems, Co-located GP/DME, operation, limitation. Microwave Landing System (MLS) – operation, advantages & disadvantages. Navigation systems – INS and DNS.
Satellite Navigation systems – Concept of L1, L2 and L5, GPS: Constellation, Signal format, GPS signal scintillation, GPS errors, GPS segment (User, Control, and Ground), group velocity. DGPS , GNSS , COMPASS ,DORIS , GALILEO ,IRNSS , QZSS (concept only),SBAS,GAGAN.

**TEXT/REFERENCES:**


1. Introduction to Radar Systems – Merrill I. Skolnik , McGraw Hill
2. Radar Systems and Radio Aids to Navigation – Dr. A. K. Sen, Dr. A. B. Bhattacharya, Khanna Publishers
3. Elements of Electronic Navigation – N. S. Nagaraja , Tata McGraw Hill

# Advanced Control System

| Advanced Control System | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module-1**
State Variable Design: Effect of State Variable feedback on controllability and observability, Design of state feedback control through pole placement, Design of full order and reduced order observer.

**Module-2**
Non-linear System: Introduction, common physical nonlinearities, linearization of non-linear mathematical models.

**Module-3**
Describing function Analysis: Fundamentals, computation of Describing function, Describing function analysis of common nonlinearities, limit cycle ,Describing function method for stability analysis.

**Module-4**
Phase plane Analysis: Phase portraits, singular points, method of isoclines, delta method, phase portrait of second order non-linear systems, limit cycle.

**Module-5**
Lyapunov Stability method: Concept of asymptotic stability, Lyapunov functions, stability analysis by Lyapunov direct method, generation of Lyapunov function by Aizermen's method, Krasovskii method and variable gradient method

**Module-6**
Optimal Control: Introduction, formulation of optimal control problem, minimum time, minimum energy, minimum fuel problem, state regulator problem, output regulator problem, tracking problem, continuous time linear regulator.

**TEXT/REFERENCES:**


1. Norman S. Nise, Control System Engineering , Wiley Publishing Co.
2. Gopal: Modern Control System Theory, New Age International
3. Anand and Zmood, Introduction to Control Systems, 3rd edition, Butterworth-Heinemann Ltd., 1995.
4. John Doyle, Bruce Francis, and Allen Tannenbaum, Feedback Control Theory,Macmillan Publishing Co., 1990.
5. Stanislaw h. Zak, Systems and Control.
6. Hassan K. Khalil, Nonlinear systems, 3rd edition, Prentice Hall, 2002.
7. J. E. Slotine& W. Li, Applied Nonlinear Control, PH International.
8. Jean-Jacques E Slotine and Weiping Li, Applied Nonlinear Control, Prentice Hall,1991.
9. Jean-Jacques E Slotine and Weiping Li, Applied Nonlinear Control, Prentice Hall,1991.
10. Donald E. Kirk, Optimal Control theory – An Introduction.
11. Brian D. O. Anderson and John B. Moore, Optimal Control: Linear Quadratic Methods, PH.

# VLSI for Wireless Communication

| VLSI for Wireless Communication | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module 1**

Introduction: Overview of wireless channels and impairments, multipath fading, signaling over fading channel, Wireless Channel Description, Path Loss, Multipath Fading, Channel Model and Envelope Fading, Frequency Selective and Fast Fading

**Module 2**

Receiver Architectures: Receiver Front End, Filter Design, NF, IIP3 of receiver Front End,

**Module 3**

Low Noise Amplifier and mixer: Narrow Band and Wideband LNA Design: Active mixture, Banancing, conversion gain, distortion- low and high frequency. Passive mixture-switching mixture, distortion, conversion gain and noise in unbalanced switching mixture. Sampling mixture.

**Module 4**

Analog-to-Digital Converters: Demodulators, A/D converters Used in a Receiver, Low-Pass Sigma-Delta Modulators, Implementation of Low-Pass Sigma-Delta Modulators, Bandpass Sigma-Delta Modulators, Implementation of Bandpass Sigma-Delta Modulators.

**TEXT/REFERENCES:**


1. Bosco Leung, "VLSI for Wireless Communication, Second Edition, Springer

# Operating Systems

| Operating Systems | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module–1**
Introduction: Fundamentals of Operating System, The need for Operating System, Evolution of Operating System, Types of Operating System: batch, multi-programmed, time-sharing, real-time, distributed, parallel, Goals of an Operating System, Operating System Architecture.

**Module-2**
Processes management: Introduction of Process Management, Implicit/System and Non–implicit/User Process, Life cycle of a process, Process State and State Transitions, Suspended Process and Their State Transition, Process Control Block, Context Switching, Process Switching .Processes scheduling: Introduction, Scheduling types, Scheduling Levels, Pre-emptive & Non-preemptive Scheduling, Scheduling Algorithm-(FIFO, SJF, SRTN, SRRN, RR and Multilevel Queue).

**Module- 3**
Process communication and synchronization: Introduction, Concurrent Process, Critical section, Algorithm Approach to CS Implementation –Two Process Solution, Dekker's Solution, Peterson's Solution, Semaphore, Solution of Producer –Consumer, Solution of Reader –writer Problem, Monitor. Deadlocks: Introduction**,** Definition of Deadlock, Modelling Of Deadlock, Conditions for Deadlock, Dealing With Deadlock, Deadlock Prevention, Deadlock Avoidance- Dijkstra's Bankers Algorithm, Deadlock detection, Recovery from Deadlock, Starvation. Thread: Introduction, Threading issues, Thread Control Block, Types of Threads-User Threads, Kernel Threads, Hybrid Threads, Linux Threads, Java Threads.

**Module-4**
Memory management: Introduction, logical vs. physical address space, Swapping, Contiguous memory allocation, Non - Contiguous memory allocation, Paging Concept, Page Table Structure, Segmentation. Virtual memory: Introduction, Need for Virtual Memory, Demand Paging, Page Replacement Algorithm-FIFO Page-replacement Algorithm, Optimal Page-replacement Algorithm, Least Recently Page-replacement Algorithm, Thrashing.

**Module-5**
I/O and file systems: File concept, Access methods, Directory structure , File Attributes, File Operation, file system hierarchy**,** Types Of I/O , Input-Output Software, Kernel I/O Sub-Syatem**.** Disk management: Disk Structure, Disk Scheduling (FCFS, SSTF, SCAN, C-SCAN), RAID Structure. Security: Security Problem,User Authentication , Security Levels, Computer-Security Classifications

**TEXT/REFERENCES:**

1. Operating System Principles by Silberschatz A. and Peterson J. L., Wiley
2. Operating Systems by Dhamdhere, TMH
3. Operating Systems by NareshChauhan ,Oxford
4. Operating Systems by P.Balakrishna Prasad
5. Operating Systems by Deitel, &Choffnes.
6. Operating Systems by Stalling, Pearson

# Object Oriented Programming

| Object Oriented Programming | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module-1**

Object oriented programming concepts – objects – classes – methods and messages – abstraction and encapsulation – inheritance – abstract classes – polymorphism. Introduction to C++ – classes – access specifiers – function and data members – defaultarguments – function overloading – friend functions – const and volatile functions –staticmembers – Objects – pointers and objects – constant objects – nested classes – localclasses

**Module-2**

Constructors – default constructor – Parameterized constructors – Constructor with dynamic allocation – copy constructor – destructors – operator overloading – overloading through friend functions – overloading the assignment operator – type conversion – explicit constructor

**Module-3**

Function and class templates - Exception handling – try-catch-throw paradigm –exception specification – terminate and Unexpected functions – Uncaught exception.

**Module-4**

Inheritance – public, private, and protected derivations – multiple inheritance–virtualbase class – abstract class – composite objects Runtime polymorphism – virtualfunctions – pure virtual functions.

**Module-5**

Streams and formatted I/O – I/O manipulators - file handling – random access – object serialization – namespaces - std namespace – ANSI String Objects – standard template library.

**TEXT/REFERENCES:**


1. Object Oriented Programming with C++ by E Balaguruswamy
2. The Complete Reference C++ by Herbert Schildt

# Nano-Technology

| Nano-Technology | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module 1**

Introduction: Introduction to nanomaterials, Properties of materials & nanomaterials, role of size in nanomaterials, nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters. Zero-, One-, Two- and Three- dimensional structure, Size control of metal Nanoparticles and their properties: Optical, Electronic, Magnetic properties; Surface Plasmon, Resonance, Change of bandgap.

**Module 2**

Physics of material: Schrodinger equation, Solutions of the Schrodinger equation for free particle, particle in a box, particle in a finite well, Reflection and transmission by a potential step and by a rectangular barrier. Electronic Properties: Free electron theory, Band theory of solids, Bloch theorem, Kroning-Penne model, Metals and Insulators, Semiconductors: Classification, Transport properties, Size and Dimensionality effects, Band structures, Brillouin zones, Mobility, Resistivity, Relaxation time, Recombination centers, Hall effects.

**Module 3**

Synthesis process: top-down and bottom-up approach, Chemical process: Sol-gel synthesis; Microemulsions or reverse micelles, myle formation; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Electrochemical synthesis. Physics process: RF plasma, MW plasma, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition method and Electro deposition.

**Module 4**

Characterization process structural characterization: X-Ray diffraction, scanning electron microscopy (SEM), scanning probe microscopy (SPM), TEM, EDAX analysis, scanning tunnelling microscopy (STM), atomic force microscopy (AFM).Spectroscopic characterization: operation and principle, UV-VIS-IR spectrophotometer, raman spectroscopy. Surface characterization: x-ray photoelectron spectroscopy (xps), Auger electron spectroscopy, Low Energy Ion Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), and Rutherford Backscattering Spectroscopy (RBS).

**Module 5**

Nanodevices : spin gate transistor, electron wave transistor, quantum dot array, quantum computer, bit and qubit. Resonance tunnelling devices (RTD), single electron transistors (SET), Super conducting switching Devices: Cryotron, Josephson Tunneling Devices. Nanosensors: fundamental of sensors, sensor for aerospace and defence: Accelerometer, Pressure Sensor, Night Vision System, Nano tweezers. MEMS and NEMS.

**TEXT/REFERENCES:**


1. Quantum Mechanisc: theory and application. By AjoyGhatak and S. Lokanathan, Macmillan India.
2. Chemistry of nanomaterials : Synthesis, properties and applications. By C.N.R. Rao. wiley
3. Microfabrication and Nanomanufacturing. By Mark James Jackson, CRC press.
4. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, by Ray F. Egerton, springer.
5. Thermal Analysis of Materials, by Robert F Speyer, New York.

# Machine learning &Artificial Intelligence

| Machine learning &Artificial Intelligence | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module 1**
Introduction: The foundations of AI. Importance of AI and related fields.

**Module 2**
Rules: Working memory, Rule base, Conflict set, Conflict resolution strategies, backward and forward chaining, meta rules.

**Module 3**
Logic: Propositional and Predicate logic, Representation atoms, connectives, literals, CNF, DNF and casual form, interpretation and model, satisfiability, resolution principle and unification.

**Module 4**
Structure Representation: Semantic networks, frames, conceptual dependency, scripts, inheritance, default values.

**Module 5**
Reasoning under Uncertainty: Basic probability notation, probabilistic reasoning, Bayesian networks, certainty factor methods.

**Module 6**
Introduction to fuzzy set: Introduction to fuzzy set, Fuzy membership functions, T-Norm, S-Norm, Complement in fuzzy sets, Fuzzy Relations, Linguistic Hedges

**Module 7**
Reasining with Fuzzy logic:Introduction to Fuzzy Implication rules and Fuzzy logic.

**Module 8**
General issues in knowledge representation and interference: logical agents, reasoning and resolution, adequacy, richness, granularity, ease of representation and use, modeling uncertainty, the fame problem, declarative and procedural representation.

**Module 9**
Problem solving by Searching: State space representation, heuristics, heuristic evolution function, and problem reduction. Searching for solutions. Informed and uninformed search strategies.

**Module 10**
Search Methods: generate and test, hill climbing, means ends analysis, depth first, breath-first, best -first, exploiting domain constraints, dependency directed back tracking, minimax, alpha-beta pruning, and iterative deepening.

**Module 11**
Learning: Introduction to Supervised and Unsupervised Learning, Fuzzy C-means clustering, Linear Classification using neural net.
**Module 12**
Introduction to Evolutionary computing: Basic Introduction to genetic algorithm.

**TEXT/REFERENCES:**


1. S. Russell and P. Norvig, "Artificial Intelligence: a modern approach", Prentice Hall,
2. Amit Konar,"Artificial intelligence and soft computing: behavioral and cognitive modeling of the human brain." CRC press

# Laser and Nonlinear Optics

| Laser and Nonlinear Optics | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module 1**
Introduction to Lasers, Properties of Lasers, Solid state lasers, Linear Optics in Homogeneous and Isotropic Media, Optical wave in anisotropic media.

**Module 2**
Optical Response of an Harmonic Oscillator, Nonlinear Susceptibility Tensors, Nonlinear Wave Propagation, Second Harmonic Generation, Three Wave Mixing, Phase Matching, Frequency Conversion Devices.

**Module 3**
Optical Response Of An Atomic System, Nonlinear Optical Susceptibilities, Nonlinear Optical Materials, Organic Nonlinear Optical Materials.

**Module 4**
General Theory Of Four-Ware-Mixing, Nonlinear Refraction And Absorption, Self Focusing, Saturation Of Absorption, Two-Photon Absorption, Kerr Lens Modelocking, Optical Phase Conjugation And Degenerate Four-Wave-Mixing, Inelastic Scattering Processes, Stimulated Raman Scattering(SRS), Stimulated Brillouin Scattering Consequences Of The Stimulated Scattering In Optical Communication

**Module 5**
Propagation In Fibers, Pulse Propagation In A Linear Dispersive Medium, Optical Pulse Propagation In Nonlinear Medium, Solitons In Optical Fibers, Long Distance Soliton Transmission System.

**TEXT/REFERENCES:**


1. Laser and Fundamentals by W.T. Silvast
2. Laser: theory and Applications, K. Thyagarajan and A. K. Ghatak
3. Laser and Nonlinear Optics, B.B. Laud
4. Nonlinear Fiber Optics, Govind Agrawal(5$^{th}$Edn)

# Fuzzy Logic and Neural Network

| Fuzzy Logic and Neural Network | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module 1**
Introduction to Neural Networks: Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN.

**Module 2**
Essentials of Artificial Neural Networks**:** Artificial Neuron Model, Operations of Artificial Neuron, ANN Architectures, Classification Taxonomy of ANN – Connectivity, Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules.

**Module 3**
Single Layer Feed Forward Neural Networks: Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Limitations of the Perceptron Model.

**Module 4**
Multilayer Feed forward Neural Networks : Credit Assignment Problem, Generalized Delta Rule, Derivation of Backpropagation (BP) Training, Summary of Back propagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.

**Module 5**
Associative Memories: Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory, Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function. Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis.

**Module 6**
Fuzzy Set and Fuzzy Logic: Introduction to fuzzy set, System Components Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

**Module7**
RecentAdvances: Fundamentals Of Genetic Algorithms – Genetic Modeling – Hybrid Systems – Integration Of Fuzzy Logic, Neural Networks And Genetic Algorithms – Non Traditional Optimization Techniques Like Ant Colony Optimization – Particle Swarm Optimization And Artificial Immune Systems – Applications In Design And Manufacturing.

**TEXT/REFERENCES:**


1. Russell Eberhart and Yuhui Shi, “Computational Intelligence: Concepts to Implementations”, Elsevier
2. Amit Konar, “Computational intelligence: principles, techniques and applications”, Springer Science & Business Media.
3. John Fulcher, " Computational intelligence: a compendium”, Springer.

# Digital Speech Processing

| Digital Speech Processing | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module 1**

Digital models for the speech signal - mechanism of speech production – acoustic theory – Portnoff's equations-lossless tube models – complete speech production model- digital models

**Module 2**

Speech analysis:-linear prediction of speech - auto correlation - formulation of LPC equation - Solution of LPC equations - Levinson Durbin algorithm - Levinson recursion - Schur algorithm - lattice formulations and solutions – PARCOR coefficients

**Module 3**

Speech synthesis - pitch extraction algorithms - Gold Rabiner pitch trackers –autocorrelation pitch trackers - voice/unvoiced detection - homomorphic speech processing – homomorphic systems for convolution - complex Cepstrums – pitch extraction using homomorphic speech processing.Spectral analysis of speech - short time Fourier analysis – STFT interpretations-filter
bank summation method of short time synthesis

**Module-4**

Automatic speech recognition systems - isolated word recognition - connected word recognition -large vocabulary word recognition systems - pattern classification - DTW,HMM - speaker recognition systems - speaker verification systems – speaker identification Systems.

**TEXTREFERENCES:**


1. Rabiner L.R. & Schafer R.W., "Digital Processing of Speech Signals", Prentice Hall Inc., 1978.
2. Thomas F. Quatieri, "Discrete-time Speech Signal Processing: Principles and Practice" Prentice Hall, Signal Processing Series, 1st Edn., 2001.
3. O'Shaughnessy, D. "Speech Communication, Human and Machine". John Wiley & Sons; 2nd Edn,1999.
4. Deller, J., J. Proakis, and J. Hansen. "Discrete-Time Processing of Speech Signals." Wiley-IEEE Press, Reprint edition, 1999.
5. Owens F.J., "Signal Processing of Speech", Macmillan New Electronics, 1993.
6. Saito S. & Nakata K., "Fundamentals of Speech Signal Processing", Academic Press, Inc., 1985.
7. Papamichalis P.E., "Practical Approaches to Speech Coding", Texas Instruments, Prentice Hall,1987.
8. Rabiner L.R. & Gold, "Theory and Applications of Digital Signal Processing", Prentice Hall of

*1.* India*,1975.*

9. Jayant, N. S. and P. Noll. "Digital Coding of Waveforms: Principles and Applications to Speech and Video. Signal Processing Series", Englewood Cliffs: Prentice-Hall, 2004.
10. Thomas Parsons, "Voice and Speech Processing", McGraw Hill Series, 1986.
11. Chris Rowden, "Speech Processing", McGraw-Hill International Limited, 1992.

# Digital Image Processing

| Digital Image Processing | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**<u>COURSE CONTENT:</u>**

**Module 1:**
Concept of analog and digital images and two dimensional signal processing. Processing levels of digital images. Utilization of radio frequency spectrum for DIP: basic idea about BioMedical, Seismic, Astronomical, Remote sensing, earth resource exploration related images. Fundamental processes of DIP such as enhancement, restoration, segmentation, compression, object classification, detection and recognition.

**Module 2:**
Basic mathematical transformations related to DIP : continuous and discrete Fourier transform, Matrix manipulation to achieve image processing, Slant, Hadamard, Haar transformation etc. Geometrical Spatial transform, concept of linearity in images, concept of image registration, fusion of more than one images, concept of optical flow between two images, application of fuzzy logic in image processing, Image interpolation, zooming, shrinking, replication and reduction, false contouring and chess boars appearance in images.

**Module 3:**
Fundamental concept of image formation and digitization, memory space required for image storage and transmission, gray level and colour images, gray level discrimination, Weber ratio, relative intensity.

**Module 4:**
Various neighborhood concept between image pixels, digital path and distance, image graphics fundamentals. Histogram of images, local and global histogram techniques, histogram specification and equalization, histogram of orientation gradient.

**Module 5:**
Image enhancement in space domain, gray level adjustment, various transformation of gray levels, Spatial domain filtering by spatial masks, two dimensional spatial convolution between imageand filtering mask, high pass and low pass spatial filtering of images, standard low pass filter masks. Unsharpmasking and high boost filter in space domain.

**Module 6:**
Image enhancement in frequency domain, basic process steps for frequency domain filtering, ideal, Butterworth and Gaussian low pass and high pass filters. Notch filters. Unsharpmasking and high boost filter in frequency domain, adaptive filters.

**Module 7:**
Image degradation and restoration, basic model, various types of additive and non-additive noises and their statistical nature, linear space domain filters, order statistic filters. Homo-morphic filters. Image reconstruction by parallel beam and fan beam back projection method, Filtered back projection method, Lucy Richardson algorithm.

**Module 8:**
Fundamental of color image processing. Various color spaces and their significances and applications.

**Module 9:**
Discrete Wavelet transform and multi resolution theory. Implementation of image processing steps by wavelet transform.

**Module 10:**
Lossless and lossy Image compression techniques and different coding methods. Discrete cosine transform and Fractal compression of images.

**Module 11:**
Morphological image processing methods. Erosion, dilation, opening, closing formulas for binary and gray scale images. Filtering by morphological processing method.

**Module 12:**
Image segmentation : dis-similarity and similarity based segmentation, morphological based segmentation. Various edge detectors, thresholding, region growing, merge and split methods.

**Module 13:**
Image representation and description. Various coding and algorithms. Detection of image features.

**Module 14:**
Object detection and recognition. Principal component analysis, neural network, morphological based recognition process. Support vector machine and Laplacian Support vector machine as classifiers.

**TEXT/REFERENCES:**


1. Fundamental of Digital Image Processing- Gonzalez and Woods (Pearson)
2. Digital image Processing using Matlab- Gonzalez, Woods and Eddins (TMH)
3. Fundamental of Digital Image Processing- A.K. Jain (PHI)
4. Digital Image Processing – Jay Raman (TMH)
5. Digital Image processing – Sreedhar (Oxford University Press)Digital Image Processing – Madhuri Joshi (PHI)

# Cryptography & network security

| Cryptography & network security | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module-1**
Introduction: Security Policies, Model of network security, Security attacks, services and mechanisms, OSI security architecture, Classical encryption techniques.

**Module-2**
Symmetric Key Cryptography: Mathematics of symmetric key cryptography: Modular arithmetic, Euclid's algorithm, Linear Congruence, Matrices, Block ciphers and Stream ciphers, Symmetric key ciphers: DES, Differential and linear cryptanalysis, AES, RC4.

**Module-3**
Public Key Cryptography: Mathematics of asymmetric key cryptography: Primes, Primality Testing, Factorization, Euler's totient function, Fermat's and Euler's Theorem, Chinese Remainder Theorem, Exponentiation and logarithm, Asymmetric Key Ciphers: RSA cryptosystem, Key distribution, Key management, Diffie- Hellman key exchange , ElGamal cryptosystem, Elliptic curve arithmetic, Elliptic curve cryptography.

**Module-4**
Message Authentication And Integrity: Authentication function, MAC, Hash function, Security of hash function and MAC, SHA, Digital signature and authentication protocols, DSS, Entity Authentication: Biometrics, Passwords, Challenge Response protocols- Authentication applications – Kerberos.

**Module-5**
Security Practice And System Security: PGP, S/MIME, IP security, Web Security, System Security: Intruders – Malicious software – viruses – Firewalls, SSL and TSL.

**TEXT/REFERENCE:**


1. William Stallings, Cryptography and Network Security: Principles and Practice, PHI
2. Forouzan and Mukhopadhyay, , Cryptography and Network Security, Mc Graw Hill.

# Biomedical signal Processing

| Biomedical signal Processing | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module 1:**
Introduction: Preliminaries, Different biomedical signals: ECG, EEG, EMG etc. necessity of special attention in biomedical signal processing.

**Module 2:**
Filtering: Statistical preliminaries, Time Domain Filtering: Synchronized Average, Moving Average, Moving Average Filter to Integration, Derivative-based operator. Frequency Domain Filtering: Notch Filter, the Weiner Filter. Adaptive Filtering

**Module 3:**
Event Detection: Example of events: P, QRS and T wave in ECG, Derivative based Approaches for QRS Detection, Pan Tompkins Algorithm for QRS Detection. Dicrotic Notch Detection, Correlation Analysis of EEG Signal

**Module 4:**
Waveform Analysis: Illustrations of problem with case studies Morphological Analysis of ECG Correlation coefficient The Minimum phase correspondent and Signal Length, Envelop Extraction Amplitude demodulation The Envelogram

**Module 5:**
Analysis of activity: Root Mean Square value Zero-crossing rate Turns Count, Form factor, Frequency-domain Analysis Periodogram

**TEXT/REFERENCE:**


1. Eugene N. Bruce, Biomedical Signal Processing and Signal Modeling, John Wiley & Sons
2. Steven Kay, Fundamentals of Statistical Signal Processing, Prentice Hall

# Robotics

| Robotics | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module 1:**
Introduction: Science and Technology of robots.

**Module 2:**
Fundamentals of Robotic System , Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors.

**Module 3:**
Kinematics of serial robots:Fundamentals, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution techniques using theory of elimination, Inverse kinematics solution for the general 6R serial manipulator.

**Module 4:**
Kinematics of parallel robots: Degrees-of-freedom of parallel mechanisms and manipulators, Active and passive joints, Constraint and loop-closure equations, Direct kinematics problem, Mobility of parallel manipulators, Closed-from and numerical solution, Inverse kinematics of parallel manipulators and mechanisms, Direct kinematics of Gough-Stewart platform.

**Module 5:**
Velocity and statics of robot manipulating systems: Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Loss and gain of degrees of freedom, Statics of serial and parallel manipulators, Statics and force transformation matrix of a Gough-Stewart platform, Singularity analysis and statics.

**Module 6:**
Dynamics of serial and parallel robots :Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators, Generation of symbolic equations of motion using a computer, Simulation (direct and inverse) of dynamic equations of motion, Examples of a planar 2R and four-bar mechanism, Recursive dynamics, Commercially available multi-body simulation software (ADAMS) and Computer algebra software Maple.

**Module 7:**
Motion planning and control : Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non-linear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, force control and hybrid position and force control, Advanced topics in non-linear control of manipulators.

**Module 8:**
Modeling and control of flexible robots : Few Models of flexible links and joints, Kinematic modeling of multi-link flexible robots, Dynamics and control of flexible link manipulators, Numerical simulation results,

## TEXT/REFERENCE:


1. Murray, R.M., Li, Z., and Sastry,S.S.,A Mathematical Introduction to Robotic Manipulator, CRC Press, 1994.
2. Merlet, J.-P.,ParallelRobots,Kluwer Academic, Dordrecht, 2001.
3. Featherstone, R.S., Robot Dynamics Algorithms,Kluwer Academic Publishers, 1987.
4. Haug,E.J., Computer-Aided Kinematics and Dynamics of Mechanical Systems: Basic Methods,Vol. 1,Allyn and Bacon, 1989.
5. Siciliano,B., and Khatib, O.(Editors), Handbook of Robotics, Springer, 2008.
6. Craig, J. J., Introduction to Robotics: Mechanics and Control, 2nd Edition, Addison-Wesley, 1989.
7. Robotics: Fundamental Concepts and Analysis, Oxford University Press, Second reprint, May 2008.

# Smart Antenna

| Smart Antenna | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module-1**

Introduction, Need of Smart Antenna Systems, Overview of smart antenna systems, The Vector Channel Impulse Response and the Spatial Signature, Spatial Processing Receivers, Fixed Beam forming Networks, Switched Beam Systems, Hybrid Beamformer, Overview of distributed beamforming, interference rejection using adaptive antennas.

**Module-2**

Adaptive Antenna Systems, Wideband Smart Antennas, Diversity Techniques, Multiple Input - Multiple Output (MIMO) Communications Systems, MIMO for frequency selective scenarios. SDMA using smart antennas.

**Module-3**

Sample matrix inversion algorithm, unconstrained LMS algorithm, normalized LMS algorithm, Constrained LMS algorithm, Perturbation algorithms, Neural network approach, Adaptive beam space processing, Implementation issues.

**Module-4**

Direction of Arrival (DOA) Estimation for smart antennas: Spectral estimation methods, linear prediction method, Maximum entropy method, Maximum likelihood method, Eigen structure methods, MUSIC algorithm – root music and cyclic music algorithm, the ESPRIT algorithm.

**TEXT/REFERENCE:**


1. R.A. Monzingo, R.A. Haupt, W.H. Miller, "Introduction to Adaptive Arrays", SciTech Publishing Inc.
2. Frank Gross, "Smart Antennas for Wireless Communications", Mc Graw Hill.
3. Ahmed El-Zooghby, "Smart Antenna Engineering", Artech House Publishers.
4. Constantine Balanis, "Introduction to Smart Antennas", Morgan and Claypool Publishers.
5. J. Liberti, T.S. Rappaport, "Smart Antennas for Wireless Communications-IS-95 and Third Generation CDMA Applications", Prentice Hall

# Wireless Network

| Wireless Network | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module-1**
Wireless Networking: Primer on wireless communications and networking A. Physical layer, OFDM and 802.11 (WiFi) PH, Multi-antenna systems and MIMO, Overview of 802.11n/ac PHY including beam forming MAC layer -CSMA/CA and WiFi MAC overview, Wide bandwidth channel access techniques (802.11n/ac), Energy efficiency and rate control.

**Module-2**
Multi-Gigabit Wireless Networks: Next generation (5G) wireless technologies Upper Gigahertz and Terahertz wireless communications A. Millimeter wave networking, Directionality and beamforming, Mobility and signal blockage, IEEE 802.11ad (60 GHz WLAN) MAC and PHY overview. B. Visible light communication, High-speed networking using LEDs, IEEE 802.15.7 PHY and MAC overview, C. Sensing through visible light, visible light indoor localization and positioning

**Module-3**
Indoor Localization and RF Sensing: A.Smartphone localization, WiFi fingerprinting, protocols and challenges, Non-WiFi localization, B.Device-free sensing with radio frequency, Mining wireless PHY channel state information, Device-free localization and indoor human tracking, Activity and gesture recognition through RF.

**Module-4**
Low-Power Networking: A.Backscatter communication, Radio Frequency Identification (RFID) technology overview, Energy harvesting tags and applications, B. Internet-of-Things (IoT), IoT protocol overview - CoAP and MQTT, IPv6 networking in low-power PANs (6LoWPAN).

**Module-5**
Quality of service, quality of user experience, Cross layer design concept.

**Module-6**
Future Mobile Networks: A.Drone networking - Multi-UAV networks, architectures and civilian applications -Communication challenges and protocols for micro UAVs B. Connected and autonomous cars -Wireless technologies for Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) communications -Automotive surrounding sensing with GHz and THz signals

**TEXT/REFERENCE:**


1. Wireless Communications: Principles and Practice, by Theodore S. Rappaport, Prentice Hall.
2. Stallings, Wireless Communications & Networks, 2nd edition.
3. Molisch, Wireless Communications, 2005.
4. Wireless Networking Complete, by Pei Zheng et al., Morgan Kaufmann.
5. Wireless Communications, Andrea Goldsmith, Stanford University.

# RF Circuits & Systems

| RF Circuits & Systems | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module-1**

Introduction: Importance of RF and Microwave Concepts and Applications. Frequency Spectrum, RF and Microwave. Circuit Design, Dimensions - RF Behavior of Passive Components: High Frequency Resistors, High Frequency Capacitors, High Frequency Inductors, General Introduction, Types of Transmission ines-Equivalent Circuit representation.

**Module-2**

The Smith Chart: Introduction, Derivation of Smith Chart, Description of two types of smith chart, Z-Y Smith chart, Distributed Circuit Applications, Lumped Element Circuit Applications. SINGLE AND MULTIPORT NETWORKS: Basic Definitions, Interconnecting Networks.

**Module-3**

Network Parameters: ABCD, Z, Y and Scattering Parameters, Conversion between network parameters, Signal Flow Chart Modelling.

**Module-4**

Stability and Gain Considerations – RF Design RF Source, Transducer Power Gain, Additional Power Relations-Stability Considerations: Stability Circles, Unconditional Stability, and Stabilization Methods-Unilateral and Bilateral Design for Constant Gain- Noise Figure Circles- Constant VSWR Circles.

**Module-5**

Rf Filters, Amplifiers and Oscillators. Design Generalization-Basic Resonator and Filter Configurations: Low Pass, High Pass, Band Pass and Band Stop type Filters-Filter Implementation using Module- Element and Kuroda's Identities Transformations. Introduction, Types and Characteristics of Amplifiers, Small Signal Amplifiers, Design of different types of amplifiers (NBA, HGA, MGA, LNA, MNA, BBA), Design of Large Signal Amplifiers, Oscillator vs Amplifier design, Design procedure of Transistor oscillators.

**TEXT/REFERENCE:**


1. Mathew M. Radmanesh, “Radio Frequency & Microwave Electronics”, Pearson Education Asia, Second Edition,
2. Reinhold Ludwig and Powel Bretchko,” RF Circuit Design – Theory and Applications”, Pearson Education Asia, First Edition.
3. Ulrich L. Rohde and David P. New Kirk, “RF / Microwave Circuit Design”, John Wiley & Sons USA, 2000.
4. DevendraK.Misra ,”Radio Frequency and Microwave Communication Circuits – Analysis and Design “John Wiley & Sons, Inc.

# Low Power VLSI Circuits

| Low Power VLSI Circuits | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**MODULE- 1:**
Low-Power Design Methodologies: an Overview: Why Low-Power? Basics of MOS circuits: MOS Transistor structure and device modeling, MOS inverters characteristics, delay and power estimation. Static and Dynamic CMOS circuits, Pass-transistor circuits.

**MODULE- 2:**
Sources of power dissipation: Dynamic Power Dissipation, Static Power Dissipation and Degrees of Freedom, Parameters involved in power dissipation, switching activity and power estimation techniques.

**MODULE- 3:**
Supply Voltage Scaling Approaches: Device feature size scaling, Multi-VDD Circuits, Architectural level approaches, High-level transformations, Dynamic voltage scaling and Power Management, Switched Capacitance Minimization Approaches: Hw/ Sw Tradeoff, Bus Encoding, 2's complement Vs Sign Magnitude Architectural optimization, Clock Gating, low power logic styles like adiabatic logic circuit, Low power BICMOS circuit design.

**MODULE- 4:**
Short Channel effects, Leakage Power minimization Approaches such as VTCMOS, MTCMOS, DTCMOS, Transistor stacking, Power Gating and others.

**MODULE- 5:**
Binary Decision Diagram representation of Boolean function, Low Power logic synthesis and optimization. Low power physical design, Low power gate level design and synthesis.

**MODULE- 6:**
Introduction of low power circuit testing and Battery-aware System design, Variation tolerant design.

**TEXT/REFERENCE:**


1. K.Roy and S.C. Prasad , LOW POWER CMOS VLSI circuit design, Wiley,2000
2. DimitriosSoudris, ChirstianPignet, Costas Goutis, DESIGNING CMOS CIRCUITS FOR LOW POWER, Kluwer, 2002
3. J.B. Kuo and J.H Lou, Low voltage CMOS VLSI Circuits,Wiley 1999.
4. A.P.Chandrakasan and R.W. Broadersen, Low power digital CMOS design, Kluwer, 1995.
5. Gary Yeap, Practical low power digital VLSI design, Kluwer, 1998.
6. Abdellatif Bellaouar, Mohamed.I. Elmasry, Low power digital VLSI design, S.Kluwer, 1995.
7. James B. Kuo, Shin – chia Lin, Low voltage SOI CMOS VLSI Devices and Circuits. JohnWiley and sons, inc 2001

# Internet of Things

| Internet of Things | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module-1:**
Introduction: IoT-introduction, Characteristics. Design of IoT-Physical and logical, Building blocks of IoT, Communication models & APIs

**Module-2:**
Machine2Machine (M2M): Machine to Machine-Introduction, Difference between M2M and IoT, Software define Network.

**Module-3:**
Energy efficiency, sustainable communication techniques

**Module-4:**
Challenges in IoT: Challenges in IoT: Design, localisation techniques, Development and Security challenges.

**Module-5:**
Real life applications of IoT: Industry automation, Monitoring applications, Survelliance, and Other IoT applications, pollution monitoring, agricultural monitoring, smart city application.

**Module 6:**
Hands-on IoT: Introduction to various IoTtools,Application development using IoT tools, Introduction to different embedded system platform like rashberry pie, adrinoetc, sensor based application with embedded system platform.

**Module 7:**
IoT and Python: Introduction to Python, Implementing IoT concepts with python.

**TEXT/REFERENCE:**


1. Vijay Madisetti, ArshdeepBahga, “Internet of Things: A Hands-On Approach”
2. WaltenegusDargie,ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice".

# Industrial Electronics

| Industrial Electronics | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module- 1**
Thyristors : Thyristor family, Two transistor analogy of SCR, construction, Turn on and Turn Off characteristics, specifications and parameters, Turn On methods, S.C.R. firing and synchronizing circuits, U.J.T. related firing circuits, SCR Protection, Commutation circuits.

**Module- 2**
Phase Controlled Rectifier: Principle of Phase Control, Single-Phase Mid-Point Converter, Bridge Converter, Full Converter, Semi converter, Dual converter.

**Module- 3**
DC to DC converters: Basic principle of chopper circuit, various chopper circuits and their working, step up chopper, Line Regulators.

**Module- 4**
Inverters: Pulse width modulated Inverters, Single Phase Series and Parallel inverter, Force Commutated Thyristor Inverters, Current Source Inverter, and Three Phase Bridge Inverter.

**Module- 5**
AC Voltage Controllers: Types, Single Phase Voltage Controller with RL Load, Sequence Control of AC Voltage Controllers, Cycloconverters.

**Module- 6**
Industrial application of ultrasonic and its basic principle, optical devices, S.M.P.S., U.P.S., Advanced control of power electronic circuits using microprocessors, isolation and amplifier circuits, synchronization circuits.

**TEXT/REFERENCE:**


1. Rehg, James, A., Sartori, Glenn. Industrial Electronics. 5th ed. Upper Saddle River: Prentice Hall. 2006
2. Dubey, G.K., Power Semiconductor Controlled Drives, Prentice Hall inc. (1989).
3. Sen, P.C., Thyristor DC Drives, John Wiley and Sons (1981).
4. J.M.D. Murphy, F.G. Turnbull, Power Electronic Control of Ac Motors, Pergamon (1990).
5. Paul, B., Industrial Electronic and Control, Prentice Hall of India Private Limited (2004).

# Embedded System Design

| Embedded System Design | L-3 T-0 P-0 | 3 credits |
|---|---|---|

## COURSE CONTENT:

**Module-1:**
Introduction to Embedded Systems: Introduction to embedded systems with examples, classification, desirable features and history. General aspects of Embedded System hardware MCU internals - Reset types, Timers, Stacks, Interrupts, DMA, Serial Communication, interfacing ADC & DAC, keyboards, displays and touch screens, sensors and actuators with micro-controller. Memory: SRAM, DRAM and Flash. Buses and protocols: Bus Arbitration, On Board Buses- I2C and SPI, Off Board buses – USB,CAN, AMBA, Ethernet, Wi-Fi, Zigbee and Bluetooth,

**Module-2:**
The ARM Processor: ARM processor fundamentals: Introduction to microprocessors and microcontrollers, 8-bit and 16- bit, von Neumann and Harvard architectures, CISC and RISC architectures, ARM versions. Arithmetic and logic instructions and programs. Branch, call, and looping in ARM, Macros. ARM memory map, memory access, and stack. ARM pipeline and CPU evolution. ARM instruction set: programming model, assembly language, Thumb instruction set. Input/output mechanisms, isolated and memory mapped IO. interrupts and real time operations, ARM interrupts vectors, priorities and latency. supervisor modes, exceptions, traps, co-processors. Programming the peripherals of ARM using Assembly and C and KeilMicrovision IDE.

**Module-3:**
Embedded controllers design using verilog HDL and FPGA: Finite state machine concepts, Verilog HDL, design examples like – stepper motor controller, Traffic signal controller, Vending machine controller, Elevator and Seat belt controller etc, Design implementation in FPGA.

## TEXTS/REFERENCES:


1. A. N. Sloss, D. Symes, and C. Wright, "ARM system developer's guide: Designing and optimizing system software", Elsevier, 2008.
2. M.A. Mazidi, S.Naimi, J.Mazidi, “ARM Assembly Langusge Programming and Architecture”, Pearson.
3. Michael Barr, “Programming Embedded Systems in C and C++”, O'Really, 1999.
4. Kirk Zurell, “C Programming for Embedded Systems”, CMP Books, 2000.
5. Samir Palnitkar“Verilog HDL: A Guide to Digital Design and Synthesis”, Pearson.

# ELECTRONIC SYSTEM DESIGN

| Electronic System Design | L-3 T-0 P-0 | 3 credits |
|---|---|---|

**COURSE CONTENT:**

**Module-1**

Op amps: DC performance of op amps: Bias, offset and drift. AC Performance of operational amplifiers: band width, slew rate and noise. Signal conditioning, Instrumentation & Isolation amplifiers. A/D and D/A conversion: sampling and quantization, antialiasing and smoothening filters, Data converters, interfacing with DSP blocks. Power supplies: Characteristics and design of regulated power supply.

**Module-2**

Cabling of Electronic Systems: Capacitive coupling, effect of shield on capacitive coupling, inductive coupling, effect of shield on inductive coupling, effect of shield on magnetic coupling, magnetic coupling between shield and inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, coaxial cable versus shielded twisted pair, ribbon cables.
Grounding of Electronic Systems: Safety grounds, signal grounds, single-point ground systems, multipoint-point ground systems, hybrid grounds, functional ground layout, practical low frequency grounding, hardware grounds, grounding of cable shields, ground loops, shield grounding at high frequencies.

**Module-3**

Signal measurement in the presence of noise: synchronous detection, signal averaging. Noise in electronic systems, design of low noise circuits. Balancing & Filtering in Electronic Systems: Balancing, power line filtering, power supply decoupling, decoupling filters, high frequency filtering, and system bandwidth. Protection Against Electrostatic Discharges (ESD): Static generation, human body model, static discharge, ESD protection in equipment design, software and ESD protection, ESD versus EMC. Interfacing of analog and digital systems. PCB design and layout, System assembly considerations.

**TEXT/REFERENCES:**


1. Electronics of measuring systems - practical implementation by: T. T. Lang ; Wiley, 1987.
2. Electronic Instrument Design, 1st edition; by: Kim R.Fowler ; Oxford University Press.
3. Applications of analog integrated circuits by: S. Soclof ; Prentice Hall1990.
4. Intuitive Analog circuit design by: Mark.TThompson ; Published by Elsevier.
5. Noise Reduction Techniques in Electronic Systems, 2nd edition; by: Henry W.Ott ;JohnWiley& Sons.
6. Digital Design Principles& Practices, 3rd edition by: John F. Wakerly ; Prentice Hall International, Inc.
7. Operational Amplifiers and linear integrated circuits, 3rd edition by: Robert F. Coughlin ; Prentice Hall International, Inc.
8. Printed Circuit Boards: Design and Technology by: W.C. Bosshart ; Tata McGraw Hill, 1983.

# Computer Architecture

| Computer Architecture | L-3 T-0 P-0 | 3 credits |
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**COURSE CONTENT:**

**Module- 1**
Instruction Set Architecture (ISA): ISA Principles and Trade-offs, RISC and CISC, Instruction Classes, Semantic Gap, Translation, MIPS and X86 ISA.

**Module- 2**
Micro architecture: Single Cycle and Multi Cycle Micro architecture, Control and Data path.

**Module- 3**
Pipelining: Pipelining basics, Ideal Pipeline, Pipeline Stalls, Data and Control Dependencies, Resource Contention, Data Dependence and Control Dependence handling,

**Module- 4**
Branch Prediction: Misprediction penalty, BTB, Branch prediction techniques (Static and Dynamic).

**Module- 5**
Out of Order Execution: OoO Execution basics, Tomasulo's Algorithm.

**Module- 6**
Vector and Array Processors.

**Module- 7**
The Memory Hierarchy: Memory System, DRAM and SRAM, Cache Memories, Direct mapped cache, Set associative cache, Fully associative cache, Cache replacement policies, Cache Write Handling.

**Module- 8**
Virtual Addressing: Basic Mechanism, Paging, Page Fault, Address translation, Page Replacement algorithms, Access Control, Privilege Levels.

**Module- 9**
Multiprocessors: Parallel Speed-up, Amdahl's Law.

**Module- 10**
Interconnects: Topology, Routing, Flow Control.

**TEXT/REFERENCES:**


1. Hennessy and Patterson, Computer Architecture: A Quantitative Approach, Elsevier.
2. Morris Mano, Computer System Architecture, Pearson.
3. Dally and Towels, Principal and Practices of Interconnection Networks, Elsevier