

## **AM-P6201    ADVANCED MATHEMATICS**

**L T P**  
**3 0 0**

**Credits:3**

### **UNIT-I**

Review of analytic function and its properties, Line integral, Cauchy's theorem (proof using Green's Theorem) Cauchy's integral formula. Morera's theorem, Cauchy's inequality, Poisson's integral formulae. Power series. Taylor's and Laurent's series,

(10 Hrs)

### **UNIT-II**

Singularities. Zeros. Residues. Cauchy's residue theorem. Integration around unit circle. Integration over semi-circular contours (with and without real poles). Integration over rectangular contours. Engineering applications: analysing AC circuits and using Harmonic functions.

(12 Hrs)

### **UNIT-III**

Integral transforms. Fourier integral theorem. Fourier sine and cosine integrals. Fourier sine and cosine integrals. Fourier transforms. Properties of Fourier transforms. Convolution theorem for Fourier transforms. Applications of Fourier transforms to heat conduction, vibrations of a string, transmission lines etc.

12 Hrs)

### **UNIT-IV**

Z transforms and its properties. Z transform of polynomial functions, trigonometric functions and hyperbolic functions. Convolution theorem. Inverse Z-transform. Formation of difference equations and solution of first and second order difference equations with constant coefficients using Z-transform.

(12 Hrs)

### **RECOMMENDED BOOKS**

#### **Text Book**

R.K. Jain & S.R.K. Iyengar, Advanced Engg. Mathematics, Narosa  
Glyn James, Advanced Modern Engg. Mathematics, Pearson

#### **Reference Books**

H.S. Kasana, Complex Variables (Theory & Applications), PHI  
R.V. Churchill & I.W. Brown, Complex Variables and applications, McGraw  
Michael D Greenberg, Advanced Engg. Mathematics, Pearson

## **AM-P6202 STATISTICAL AND OPTIMIZATION TECHNIQUES**

**L T P**  
**3 0 0**

**Credits:3**

### **UNIT-I**

Axiomatic definition of probability. Baye's theorem, Random variables. Probability mass function and probability density function. Mathematical Expectation. Probability distributions-Binomial, Poisson and Normal distributions and their applications.

(12 Hrs)

### **UNIT-II**

Sampling distributions. Small and large sample tests (Z test, t test and F test). Chi-square test for independence and goodness of fit.

(11 Hrs.)

### **UNIT-III**

Introduction to Optimization Techniques. Basic concept and notations. Formulation of Linear Programming Problem (LPP). Graphical Solution. Standard Form of an LPP. Simplex method. Big M method. Two phase method. Duality Theory.

(14 Hrs.)

### **UNIT-IV**

Basic concept & notations. Balanced & unbalanced TP. Initial BFS of TP by using North-West corner rule, Matrix minima method & Vogel's Approximation Method. Improving an initial BFS to optimal solution. Introduction to Assignment Problem. Hungarian method to solve Assignment Problem.

(10 Hrs.)

### **RECOMMENDED BOOKS**

#### **Text Book**

S.P. Gupta, Statistical Method, Sultan Chand & co.

H.A. Taha, Operations Research

#### **Reference Books**

Hira & Gupta , Operations Research, S. Chand & co.

S.C. Gupta, Fundamentals of Mathematical Statistics, S. Chand & Co.

Snedecor & Cochran, Statistical Methods

## AM-P6203    FOURIER AND WAVELET METHODS

L T P  
3 0 0

Credits:3

### UNIT-I

$L^2(\mathbb{R})$  and approximate identities. Fourier transform, Basic properties. Fourier inversion.

(10)

### UNIT-II

Continuous wavelets. Examples of wavelets . Continuous wavelet transform (CWT) as a correlation. Constant Q- factor filtering interpretation and time frequency resolution. CWT as an operator. Inverse CWT. Discrete wavelet transform.

(12)

### UNIT-III

Multiresolution analysis(MRA). Construction of a general orthonormal MRA. Wavelet basis for MRA. Decomposition filters and reconstructing the signal. Continuous MRA interpretation for the discrete wavelet transform and discrete MRA.

(12)

### UNIT-IV

Condition number of a matrix. Wavelet-Galerkin methods for differential equations. Fourier and wavelet solutions of sideways heat equations.

(12)

## RECOMMENDED BOOKS

### Text Book

M.W. Frazier, An Introduction to Wavelets Through Linear Algebra, Springer.  
K.P. Soman and KI Ramachandran, Insight into Wavelets from Theory to Practice, PHI.

### Reference Books

R.M. Rao and A.S. Bopardikar, Wavelet Transforms: Introduction to Theory and Applications, Pearson Education  
Brani Vidakovic , Statistical Modeling by Wavelets, John Wiley & Sons.  
A.I. Zayed, Function and Generalized Function Transforms, CRS Press.

## AM-P6204 INDUSTRIAL MATHEMATICS

L T P  
3 0 0

Credits:3

### UNIT-I

Background about model and modeling methodology. Some basic facts about differential equations & Industry based simple differential-equation models. Industrial problems modelled with differential equations including, desalination, casting of sheet steel, and solar heating; problems include drug adoption and delivery.

### UNIT-II

Basic structure of queuing models, examples of queuing systems drawn from real life situations, role of exponential distribution.

### UNIT-III

Fuzzy Sets – Basic definitions.  $\alpha$ -level sets. Convex fuzzy sets, Basic operations on fuzzy sets. Types of fuzzy sets. Cartesian products. Algebraic products. Bounded sum and difference.  $t$  – conorms. The Extension Principle – The Zadeh's extension principle. Image and inverse image of fuzzy sets. Fuzzy numbers. Elements of fuzzy arithmetic.

### UNIT-IV

Introduction, modeling random variables, Generating random numbers, Simulations, using simulation models, data collection, empirical models, estimating parameters, Error and accuracy

### RECOMMENDED BOOKS

#### Text Book

J.N.Kapoor, Mathematical Modeling

H.A. Taha, Introduction to Operation Research, PHI.

#### Reference Books

H.J. Zimmermann, Fuzzy Set Theory and Its Applications, Allied Publishers Ltd., New Delhi,

G.J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic, Prentice-Hall of India, New Delhi.

Palgrave, Mathematical Modeling, Second Edition.

# AP-P6201 LASER AND ITS APPLICATIONS

L T P  
3 0 0

Credits:3

## UNIT- I

### LASER

Introduction, Einstein coefficient and light Applications, Laser rate equations, Optical resonators, The laser output, Q-switching, mode locking properties, Ruby, helium-neon, Solid state, carbon di-oxide, Dye and semiconductor lasers, free electron Lasers and cyclotron resonance masters. (10 hrs)

## UNIT- II

### HOLOGRAPHY

Introduction, Recording and reconstruction of Holograms, Type of Holograms, Holographic recording materials, holographic storage of information and Data processing, Holographic Interferometry and its application. (10hrs)

## UNIT-III

### OPTICAL FIBER COMMUNICATION

Introduction, Optical fibre Numerical Aperture, coherent bundle, fibre-optic communication system, Losses in optical fibres (Attenuation & Dispersion) Pulse dispersion in step index fibres, Graded index fibres, some general consideration: First and Second generation fibre optic communication system, Single mode fibres and the third Generation Optical communication system operation at 1.5 um wavelength, Fourth Generation optical fibres, applications fibre optic system, Advantage of fibre optic system. (12hrs)

## UNIT- IV

### APPLICATIONS OF LASERS & OPTICAL FIBRES

Introduction, Material processing, Welding, Cutting, Drilling, Hardening, Micro machining and other application, Metrology, Non-destructive testing, Pollution Detection, Laser tracking LIDAR, Precision length measurement, Velocity measurement, Recent advances, optical interconnections for integrated circuits, optical computing, Star war. (10hrs)

### RECOMMENDED BOOKS

Lasers – Theory & applications K Thyagarajan & A K Ghatak MacMillan India Ltd

# AP-P6202 SEMICONDUCTOR PHYSICS AND DEVICES

L T P  
3 0 0

Credit:3

## UNIT – I

### THE SEMICONDUCTOR

Introduction, Charge carrier in Semiconductor; Equilibrium distribution of electrons and holes, the  $n_0$  and  $p_0$  equations, intrinsic carrier concentration, intrinsic Fermi level; Dopant Atoms and energy Levels; qualitative description, ionization energy, Group III – IV semiconductors; The Extrinsic Semiconductor, Statistics of Donor and acceptors, Charge Neutrality, Position of Fermi Energy Level

4 Hrs

### CARRIER TRANSPORT PHENOMENA

Carrier Drift; Drift current density, mobility effects, conductivity, velocity saturation; Carrier Diffusion; Diffusion current density, total current density; Graded Impurity Distribution; Induced electric field, Einstein relation; Hall Effect

6 Hrs

## UNIT - II

### PN JUNCTION DIODE AND BIPOLAR TRANSISTOR

Introduction of PN junction, PN Junction current, Generation – Recombination currents, Junction breakdown, Charge storage and diode Transients, Tunnel Diode, Bipolar transistor action; Basic principle of operation, The modes of operation, amplification with Bipolar Transistors.

4 Hrs

### FUNDAMENTALS OF THE METAL-OXIDE- SEMICONDUCTOR FIELD EFFECT TRANSISTOR

Two Terminal MOS structure; Energy band diagrams, depletion layer thickness, work function differences, Flat band voltage, threshold voltage, charge distribution; Capacitance – voltage characteristics, Basic Operation of MOSFET, CMOS technology, radiation and Hot electron effects

6 Hrs

## UNIT - III

### JUNCTION FIELD – EFFECT TRANSISTOR

JFET concepts; Basic PN JFET and MESFET operations, Device Characteristics; Internal pinchoff voltage and Drain to source saturation voltage, Transconductance, MESFET, Nonideal effects, High electron mobility transistor

6 Hrs

### SEMICONDUCTOR POWER DEVICES

Power Bipolar Transistors; vertical power transistor structure, Power transistor characteristics, Darlington pair configuration, Power MOSFETs; Power transistor structure, power MOSFET characteristics, Parasitic BJT; Heat Sinks and Junction Temperature, Thyristors and varistors

6 Hrs

## UNIT - IV

### OPTICAL DEVICES

Optical Absorption; Photon absorption coefficient, electron hole pair generation rate Solar Cells; PN junction solar cell, hetero-junction solar cell, amorphous solar cell Photo-detectors; Photoconductor, photodiode, PIN photodiode, Avalanche photodiode, phototransistor; Photoluminescence and Electroluminescence: Basic transitions, luminescent efficiency, materials; Light Emitting Diodes: Generation of light, internal and external quantum efficiencies; LED devices; Laser Diodes; Stimulation emission and population inversion, optical cavity, threshold current, Device structure and characteristics

10 Hrs

### Recommended Book

Donald A. Neamen:	Semiconductor Physics and Devices,	Tata McGraw-Hill
S.M.Sze:	Physics of semiconductor Devices	(Wiley)

# AP-P6203 PLASMA AND ITS APPLICATIONS

L T P  
3 0 0

Credit:3

## UNIT-I

### Introduction to Plasma:

Excitation and ionization in a gas (different methods), Definition of plasma, Basic parameters of plasma, Bulk properties, Quasi-neutrality, Electrostatic Boltzman's equation, Plasma sheaths, The plasma frequency, Saha equation, Debye shielding and skin depth, Diffusive transport in plasma, Electron collision frequency, Cold and hot plasma, Magnetized plasmas, Plasma confinement, Radiation plasma, Arc Plasma, Fully ionized plasma

(12hrs)

## UNIT-II

### Charged particle motion:

Particle description of plasma, Motion of charged particles in electrostatic field, Motion of charged particles in uniform magnetic field, Motion of charged particles in electric and magnetic fields, Motion of charged particles in inhomogeneous magnetic field, Motion in a toroidal magnetic field, Magnetic mirror confinement, Motion of an electron in a time varying electric field, Motion in a crossed radio frequency and magnetic field, Theory of simple oscillations, Electron oscillations in a plasma, Electronic oscillation along with motion of ions, Derivation of plasma oscillations using Maxwell's equations, Ion oscillations and waves, Landau damping, Propagation of e.m. waves in plasma containing a magnetic field, Instabilities in plasma

(12hrs)

## UNIT-III

### Plasma Diagnostic Techniques:

Single probe method, Double probe method, Use of probe technique for measurement of plasma parameters, Microwave method, Spectroscopic method, Laser as a tool for plasma diagnostics, X-ray diagnostics, Acoustic method

(10hrs)

## UNIT-IV

### Plasma applications:

Source of power (MHD generator and Controlled thermonuclear fusion), Generation of microwaves utilizing high density plasma, plasma propulsion, materials processing with plasma arcs, plasma processing and fabrication (ion implantation in solids, plasma deposition and etching, paint spraying), Plasma diode and plasma lighting devices/torches, insulating dielectrics and breakdown, Plasma chemistry and Pollution control (thermal, non-thermal, electrostatic precipitation, corona)

(12hrs)

### Recommended Books:

1. F.F. Chen: *Introduction to Plasma Physics and Controlled Fusion*, Vol.1, Plasma Physics. 2<sup>nd</sup> Edition, Plenum Press 1984.
2. J. R. Roth : *Industrial Plasma Engineering*, Vol.1, Principles. IOP Publishing, Ltd 1995.
3. S.N.Sen: *Plasma Physics, Plasma state of matter*, Pragati Prakashan, Meerut, second edition, 1996.
4. Brian Chapman, *Glow Discharge Processes*, John Wiley & Sons, 1980.

L T P  
3 0 0

Credits:3

**Unit-I**

**Scope and Significance:** Objective of EIA, comparative study of different assessment methodology, Adhoc procedures, overlay techniques, checklist, matrices and networks, Essential elements of an environmental impact analysis, Details content of EIA/Environmental Impact Assessment.

(13 Hrs)

**Unit-II**

**Impact Assessment for Air Environment:** Evaluation of the possible impacts of a proposed action on the air environment at meso scale and micro scale level, Methodological, adopted and step evolved.

(09 Hrs)

**Unit-III**

**Impact Assessment for Biological and Socio-cultural Environment:** Possible impact of a proposed action on specific diversity and functional balance of the ecosystem, Possible impact on the existing socio-cultural and economic patterns of the surrounding population, Assessment of noise pollution.

(07 Hrs)

**Unit-IV**

**Environmental Regulations and Standards:** Study of different Govt. regulations, Acts and specified emission standards, Constitution and working of Pollution Control Boards, International Treaties and Protocols.

(07 Hrs)

**RECOMMENDED BOOKS:**

<b>Author</b>	<b>Title</b>	<b>Publishers</b>
Harrison R.M. & Mora, S.J.	Introductory Chemistry for the Environmental Sciences	--
Rai, G.D.	Non-conventional Energy Sources	Khanna Publishers
Witte Schmidt & Brown	Industrial Energy Management & Utilization	Hemisphere Pub. Corp.
--	Energy Auditing Manuals	National Productivity Council, New Delhi.



**Unit-I**

**Introduction:** Introduction to Energy Science & Technology, Law of conservation of energy, Energy calculations, energy demand, various resources of non-conventional energy.

**Solar Energy:** Historical review and future prospects, fundamentals and applications, Solar thermal energy conversion systems: Solar Collectors, Solar thermal power plants, solar photovoltaic systems: Prospects of solar PV systems, principles of a photo voltaic cell, V-I characteristics of a solar cell, efficiency of a solar cell.

(13 Hrs)

**Unit-II**

**Geo-Thermal Energy:** History resources and applications, Hydrothermal (convective) resources, geo-thermal electric power plants, vapor dominated (steam) geothermal electrical power plant, liquid dominated (hot-water) geo-thermal electrical power plant, Liquid dominated flashed steam geothermal electric power plant, Binary cycle liquid dominated geothermal power plants, Comparison of various liquid dominated geo-thermal systems.

(09 Hrs)

**Unit-III**

**Liquid Energy:** Introduction, History and applications, Pipes of wind turbine generator units, Horizontal axis propeller type wind turbine generator units, Three blends, Horizontal axis wind turbine (WAWT), vertical axis wind turbines, introduction to wind energy forms and energy conversion systems.

(07 Hrs)

**Unit-IV**

**Bio-mass Energy:** Introduction, various resources and applications, processes, combustion, thermo-chemical, bio-chemical, hybrid bio-gas plants, Introduction and brief idea about ocean energy, tidal energy and nuclear energy systems etc.

(07 Hrs)

**RECOMMENDED BOOKS:****Author**Saha, S.N.  
Rao, G.D.**Title**Food Combustion Energy Technology  
Non-Conventional Energy Sources**Publishers**Dhanpat Rai Pub.  
Khanna Publications

# CS-P6201 Interactive Computer Graphics

L T P  
3 0 0

Credits:3

## UNIT I

### Overview of graphics systems

Display devices, physical input and output devices: storage tube graphic displays, Raster Refresh, Plasma Panel Displays, Liquid Crystals

### Output Primitives

Point plotting, Line Drawing algorithms – DDA algorithms, Bresenham's Line algorithm, Areafilling – Scan Line algorithm, flood-fill algorithm, Circle-Generating algorithms. (11 Hrs)

## UNIT II

### Two-dimensional Transformations

Basic transformations-translation, scaling, rotation, Matrix representation and homogenous coordinates, composite transformations-scaling relative to a fixed pivot, rotation about a pivot point, general transformation equations, other transformation-reflection, shear.

### Windowing and Clipping Techniques

Windowing concepts, Clipping algorithms-Line clipping – Cohen-Sutherland algorithm, Area clipping, Text clipping, Blanking, Windows-to-View port transformation. (13 Hrs)

## UNIT III

### Three Dimensional Graphics and Transformations

Coordinate systems and Display techniques, Representations-Polygon surfaces, Curved surfaces-Bezier and B-spline curves, Transformation – translation, scaling rotation, rotation about an arbitrary axis, other transformations-reflections, shear and 3-D viewing projections. (11 Hrs)

## UNIT IV

### Hidden-Surface and Hidden-Line Removal

Back-face removal, Depth-buffer method, Scan-line method, Depth-Sorting method i.e. Painter's algorithm, Hidden-Line elimination.

### Shading (Overview)

Modeling Light intesines diffuse reflections; diffuse reflectors, Specular reflectors, refracted light & reture surface patterns.

### Half toning, Surface Shading methods (overview)

Constant Intensity method, Gouraud Shading, Phong – Shading (13Hrs)

### Recommended books

Title	Author(s)	Publisher
	<b>Text</b>	
Computer Graphics	Hearn. D & MP Baker	Prentice Hall
Principle of Interactive Computer Graphics	Newman W.M	McGraw Hill
	<b>Reference</b>	
Computer Graphics - A Programming Approach	Harrington. S.	McGraw Hill
Fundamentals of Computer Graphics	Foley J.D et al.	Addison Wesley

# CS-P6202 COMPUTER NETWORKS

L T P  
3 0 0

Credits:3

## UNIT-I

### Basic & Computer Networks

12

Need & Evolution of Computer Networks, Description of LAN, MAN, WAN and wireless Networks, OSI and TCP/IP models with description of Data Encapsulation & peer to peer communication, Comparison of OSI and TCP/IP. Basic terminology of computer networks - bandwidth, physical and logical topologies, Media – 10 base Z, 10base S, 10base T, 100baseTX, 100base FX, 1000baseLX and wireless. LAN & WAN devices – Router, bridge, Ethernet switch HUB, Modem CSU/DSU etc.

## UNIT-II

### Physical Layer

12

Representation, one bit on physical modem i.e. in wired network, optical Network and wireless N/W, Encoding / Modulation – Manchester Encoding, AM, FM and PM. Dispersion, Jitter, Latency and collision. Different types of Media – Shielded twisted pair, Unshielded twisted pair, Coaxial cable, Optical Fiber cable and wireless.

## UNIT-III

### Data Link Layer

12

LLC and MAC sub layer, MAC addressing Layer 2 devices, Framing Error control and flow control. Error detection & correction CRC code block parity & checksum. Elementary data link protocol sliding window protocol, Channel allocation problem – static and dynamic. Multiple Access protocol – ALOHA, CSMA/CD Token bus Token ring, FDDI.

## UNIT-IV

### Network Layer

12

Segmentation and autonomous system path determination, Network layer addressing, Network-layer data gram, IP addressed classes. Subnetting – Sub network, Subnet mark. Routing algorithm – optimality Principle, Shortest path routing, Hierarchical routing, Broadcast routing, Multicast routing, Routing for mobile host – Concatenated Visual circuits, tunneling Fragmentation and DHCP. Routing Protocol – RIP, IGRP, OSPF and EIGRP. Network layer in ATM Networks.

### Transport Layer

Layer 4 Protocol TCP & UDP. Three-way hand shakes open connection. ATM AAL Layer protocol, Session Layer design issue, Presentation layer design issue, and Application layer design issue. Application layer Protocol, TELNET, FTP, HTTP, SNMP.

## Recommended Books

Title	Author(s)	Publisher
<b>Text</b>		
Computer Networks	Tanenbaum	PHI
Computer Networks and Their Protocols	Darix	DLA Labs
<b>Reference</b>		
Comp. Communication & Networks	Freer	East-West-Press
Data Communication and Networking	Forouzen	Tata McGraw Hill

# CS-P6203 Simulation & Modelling

L T P  
3 0 0

Credits:3

## UNIT-I

### System Models

12

Introduction to systems; scientific and nonscientific systems; discrete & continuous systems; characteristics of systems; different views of systems; modeling of systems; physical and symbolic models; examples of models from various disciplines. Computer systems; electrical systems, economic system & inventory system.

## UNIT-II

### System Simulation

12

Continuous system simulation; analog versus digital simulation; basic operation & notation for analog simulation; linear systems & simultaneous equation representation; digital computer simulation; simulation of a real life time-dependent system via a programming language such as Fortran/Pascal.

## UNIT-III

Discrete system simulation-event, activity & process; representation of time; fixed step vs. event-to-event model; analysis of a discrete system; generation of random number generation for microcomputers; testing of pseudo-random numbers; monte-carlo computation; simulation of a real life discrete system.

12

## UNIT-IV

Computer language for simulation of continuous & discrete systems; characteristics of a simulation language; introductory discussion of CSMP, GPSS and SIMSCRIPT

12

### Recommended Books

Title	Author(s)	Publisher
	<b>Text</b>	
Simulation and Modeling	Liffick	TMH
System Simulation with Digital Computer	Deo	PHI
	<b>Reference</b>	
Computer Simulation and Modeling	Neelamkavil, John-Wiley	
System Simulation	Gorden	PHI

# CS-P6204 SOFTWARE ENGINEERING

L T P  
3 0 0

Credits:3

## UNIT-I

### **Evolving role of Software** 12

characteristics, components, applications of S/W. A layered technology, S/W process Linear Sequential, Prototyping, RAD, Incremental, Spiral, Component assembly & S/W process & Project metrics.

## UNIT-II

### **S/W scope** 12

resources, estimation, decomposition techniques, empirical estimation models. Project scheduling, refinement of major tasks, scheduling project plan, Software reliability, S/W equality assurance plan, software quality standards (ISO/CMM). The system engineering hierarchy information engineering, information strategy planning, requirement analysis, analysis principles, Data modeling information flow structured analysis

## UNIT-III

### **Data Dictionary** 12

Software testing Fundamentals, Test Case design, White box testing, Basis path testing, Control structure testing, Black box testing. Activity network for conversion. Combating resistance to change.

## UNIT-IV

### **Post implementation review** 12

review plan. S/W maintenance and enhancement procedure. System security, Threats & control measures, disaster/recovery planning, ethics in system development, ethics codes & standard of behavior

### **Recommended Books**

Title	Author(s)	Publisher
<b>Text</b>		
Software Engineering	Ian Somer Ville	Addison Wesley
Software Engineering	ROGER S.PRESSM	TMH
<b>Reference</b>		
An Integrated Approach to Software Engineering	Pankaj Jalote	
System Analysis & Design Software Engineering Principles	ELIAS M AWAD, Richard Fairley	

# EC-P6201 INTRODUCTION TO DIGITAL SIGNAL ROCESSING

L T P  
3 0 0

Credits:3

## Unit I

**Introduction:** Limitations of analog signal processing, Advantages of digital signal processing. Discrete time characteristics of Signals & Systems Some elementary discrete time sequences and systems; Concepts of stability, causality, linearity, time invariance and memory; Linear time invariant systems and their properties; Linear constant coefficient difference equations.

(12 Hrs)

## Unit II

**Z-Transform:** The Z Transform Z-Transform, Region of convergence; Properties of the Z-transform; Convolution theorem; Parseval's relation; Unilatera; Z-transform and its application to difference equations with non-zero initial conditions.

(12 Hrs)

## Unit III

**DFT:** Discrete Fourier Transform DFT and its properties; Linear, Periodic and Circular convolution; Fast Fourier Transform algorithm using decimation in time and decimation in frequency techniques; Linear filtering approaches to computation of DFT. Structure for Discrete Time Systems Signal flow graph representation, Transposed forms, Lattice structures.

(12 Hrs)

## Unit IV

**Filter design:** Design of Digital Filters Linear Phase FIR filters; Design methods for FIR filters; IIR filter design by impulse Invariance, Bilinear Transformation, Matched Z-Transformation, Frequency Transformation in the Analog and Digital Domain.

(12 Hrs)

## RECOMMENDED BOOKS:

### Text Books

#### Title

#### Author

#### Publisher

Digital Signal Processing -

J. G. Proakis & D.G. Manolakis,

Prentice Hall, 1992

### Reference Books

#### Title

#### Author

#### Publisher

Discrete Time Signal  
Processing

- A. V. Oppenheim & R W.  
Schafer,

Prentice Hall

# EC-P6202 PRINCIPLES OF DIGITAL COMMUNICATIONS

L T P  
3 0 0

Credits:3

## Unit I

**Review to Random Variables and processes:** Random variables: commutative distribution function, probability density function (pdf), average value and variance of random variables. Tchebycheff's inequality, Gaussian pdf, Rayleigh pdf of sum of random variables, Correlation between two random variables. Random processes: Introduction classification, correlation, auto correlation, Power spectral density (PSD) of a sequence of random pulses, PSD of digital data.

(12 Hrs)

## Unit II

**Formatting and source coding:** Introduction, concept of amount of information, entropy and information rate. Shannon's theorem, channel capacity, capacity of a Gaussian channel, BW-S/N trade off, sampling, quantization, quantization error, quantization noise, companding, PCM, delta modulation, adaptive delta modulation.

(12 Hrs)

## Unit III

**Line coding schemes:** Introduction, properties, general method for derivation of power spectral density of a broad class of digital signals, ON-OFF signaling, polar signaling, bipolar and split phase (or Manchester) signaling and comparison among them pulse shaping: Nyquist's first, second and third criteria for zero ISI, introduction to equalizer and eye diagram, Derivation of error probability for signaling in AWGN.

(12 Hrs)

## Unit IV

**Modulation schemes:** Introduction, generation, reception, spectrum and geometrical representation and error probability (in AWGN) of BPSK, binary differential phase shift keying (BDPSK), QPSK, MPSK, QAM, BFSK, and MSK.

(12 Hrs)

## RECOMMENDED BOOKS

### Text Books

#### Title

Modern analog and digital business and promotion communication beauro

#### Author

B.P Lathi

#### Publisher

Wiley

### Reference Books

#### Title

Communication systems  
Digital Communications

#### Author

Bruce Carlson  
S .Haykins

#### Publisher

Mc Graw Hill  
Wiley

# EC-P6203 ANALOG AND DIGITAL ELECTRONICS

L T P  
3 0 0

Credits:3

## Unit I

**Semiconductor Diodes:** PN junction Diode - VI characteristics, qualitative analysis of its behavior, Rectifiers-half wave and full wave, clippers, clampers, clamping circuit theorem, Voltage multipliers, Special purpose diodes - Zener diode, Tunnel diode, Varactor diode.

**Bipolar Junction Transistor:** Transistors-construction, operation, characteristics, parameters, Transistor as an amplifier at low frequency Amplifier types-CE, CB, CC.

(12 Hrs)

## Unit II

**Transistor Biasing and Stabilization:** DC operating point, DC Biasing circuits-fixed bias, emitter bias, voltage divider bias, voltage feedback, Bias stability, Stabilization against variation in  $I_{CO}$ ,  $V_{BE}$  and  $\beta$ , Bias compensation.

**Field-Effect Transistor:** The junction FET - construction, operation, characteristics, parameters, Biasing of JFET, Small signal analysis of JFET as an amplifier.

(12 Hrs)

## Unit III

Number Systems And Boolean Algebra: Review of Number systems, Radix conversion, Complements 9's & 10's, Subtraction using 1's & 2's complements, Binary codes, Error detecting and Correcting codes, Theorems of Boolean algebra, Canonical forms, Logic gates.

(12 Hrs)

## Unit IV

**Combinational Logic:** Representation of logic functions, Simplification using Karnaugh map, Tabulation method, Implementation of combinational logic using standard logic gates, Multiplexers and Demultiplexers, Encoders and Decoders, Code Converters, Adders, Subtractors, Parity Checker and Magnitude Comparator.

**Sequential Logic Concepts And Components:** Flip flops: SR, JK, D and T flip flops - Level triggering and edge triggering, Excitation tables - Counters - Asynchronous and synchronous type, Shift registers.

(12 Hrs)

## RECOMMENDED BOOKS:

### Text Books

#### Title

Electronics Circuits and devices

Modern Digital Electronics

#### Author

JB Gupta

R P Jain

#### Publisher

Dhanpat Rai

Tata McGraw-Hill,

### Reference Books

#### Title

Electronic Devices and Circuit Theory

#### Author

Boylestad Nashelsky,

#### Publisher

8<sup>th</sup> Ed., Pearson Education,



# EC-P6204 MICROPROCESSORS PRINCIPLES

L T P  
3 0 0

Credits:3

## Unit I

**Introduction:** Microprocessors, its evolution, function and impact on modern society, Microcomputer systems, Microprocessor architecture and its operations, Memory, Inputs and output devices.

**Architecture of a microprocessor (with reference to 8085 microprocessor):** Concept of Bus, Bus organization of 8085, Functional block diagram of 8085, and function of each block, Pin details of 8085 and related signals, Demultiplexing of address/data bus (A<sub>0</sub>-A<sub>7</sub>), Generation of read write control signals.

(12 Hrs)

## Unit II

**Memories and I/O Interfacing:** Memory organization, memory map, portioning of total memory space, address decoding, and concept of I/O mapped I/O and memory mapped I/O. Interfacing of memory and I/O devices.

(12 Hrs)

## Unit III

**Programming using 8085 microprocessors:** The 8085 programming model, instruction classification, instruction format, how to write assemble and execute a simple program introduction to 8085 instruction data transfer (copy) operations, Arithmetic operations, Logic operations Branch operations Writing assembly language programs, programming techniques with additional instruction programming techniques: looping counting and indexing additional data transfer and 16 bit arithmetic instruction arithmetic and logical operations related to memory, Stack and Sub Routines, Stack, Subroutine, Conditional call and return instructions.

(12 Hrs)

## Unit IV

**Programming:** Counters and time delays, Illustrative program hexa decimal counter, Illustrative program: zero to nine (Modulo 10) counter, Illustrative program: Generating pulse waveform.

Comparative study of 8 bit microprocessors i.e. 8085, Z80, 6800.

(12 Hrs)

## **RECOMMENDED BOOKS:**

### **Text Books**

#### **Title**

Microprocessor and micro controllers

#### **Author**

Dr B P Singh

#### **Publisher**

Galgria Publications

Microprocessor Architecture ,programming and application with 8080/8085

Ramesh S Gaonker

Willey Eastern Ltd New Delhi

### **Reference Books**

An introduction to microprocessors

A P Mathur

Tata McGraw hill, new Delhi

Microprocessor and microcomputer

Refiqzaman

Universal Book

**UNIT-I**

**Introduction to various separation processes:** Gas-Liquid, Gas–Solid, Liquid-Liquid, Liquid-Solid separation; Concept of phase equilibrium, Stage equilibrium, Stage efficiency, Equilibrium concentration; Single stage contact equilibrium, counter-current multiple contact stages, Concept of equilibrium line and operating line, Determination of optimum number of contact stages by analytical and graphical method; Rate of extraction, Rate of gas absorption, Individual and over all mass transfer coefficient; Calculation of tower height for gas absorption for both dilute and concentrated solution. Construction and working mechanism of different extraction equipments like single stage extraction, Multiple stage static bed system, Bollmann extractor, Hildebrandt extractor, Rotocell extractor.

(12 Hrs)

**UNIT-II**

**Solid Separation Process:** Introduction, Concept of size, Shape, Cut-size, Sieving, Magnetic separation, Eddy-current separation, Wet separation, Ballistic separation, Color separation.

(03 Hrs)

**Wet separation process:** Liquid-solid and liquid- liquid separation by hydroclones, Surface velocity classifier, Elutriators, Impingement separator, Electrostatic precipitation.

(04 Hrs)

**Distillation:** Introduction, boiling point diagram, differential or simple distillation, Flash or equilibrium distillation, Continuous rectification with and without reflux, Reflux ratio, Optimum reflux ratio, Batch distillation, Application of distillation in food processing.

(05 Hrs)

**UNIT-III**

**Membrane Separation Technology:** Introduction to microfiltration, Ultrafiltration, Reverse osmosis, Electro dialyses, dialyses, physical characteristics of membrane separation, Factors affecting reverse osmosis process, Concentration polarization, Design of reverse osmosis and ultra filtration systems, Operation layout of the modules, Electrodialysis, pervaporisation, Fabrication of membranes, Application of membrane technology in food industry.

(12 Hrs)

**UNIT-IV**

**Powder Technology:** Classification off powder, Separation of powder, Sieving, Air classification, Factors affecting air classification, Cyclone application, Air separation, Particle size distribution.

(06 Hrs)

**Super Critical Fluid Extraction:** Introduction, Properties of SCF, Food application, Application of SCFE in analytical technique, Pharmaceutical application.

(06 Hrs)

**Recommended Books:**

	<b>Author</b>	<b>Title</b>	<b>Publisher</b>
1	Grandison A S & Lewis M J	Separation Process in The Food & Biotechnology Industries	Woodhead Pub Ltd
2	Narayanan CM & Bhattacharyya BC	Mechanical Operations For Chemical Engineers	Khanna Pub
3	Dutta B K	Mass Transfer & Separation Process	PHI
4	Anantharaman N & Begum KMMS	Elements of Mass Transfer	PHI

**INTRODUCTION:**

Sensors, biological materials in sensors, difficulties in ordinary chemical sensors, problems associated with sensors and different transducers used in instrumentation.

**BIOSENSORS:**

Basic principle of operation types of biosensors accuracy and precision, industrial application and future trends.

**BIOINSTRUMENTS:**

Principles, functions and application of bioinstruments i.e. Gene gun, ELISA probe, Biochips, molecular switches, PCR  
Bioprocess control  
Control algorithm, types working principles and their applications

**Author****References Books  
Title**

Mittal, G.S

Computerized control system in Food Engg.

Gabriele Wagner  
and J.G. Guilbault

Food Biosensor analysis

Mukhopadhyay, S.N.

Process Biotechnology Fundamentals

# IE-P6201- Fundamentals of Measurement and Instrumentation

L T P  
3 0 0

Credits: 3

## Unit-I

- 1. Measurement System** **6 hrs**  
Necessity & scope of instrumentation, important process variables & their Units, applications of measurement system, elements of generalized measurement system, input-output configuration, methods for correction for interfering & modifying inputs
- 2. Errors** **6 hrs**  
Error Sources, types of errors, statistical treatment of data, analysis, Probability of errors, rejection of data based upon confidence level, method of least squares, graphical presentation of data

## Unit-II

- 3. Static Characteristics** **12 hrs**  
Various static characteristics, static calibration, calibration curve, static correction, scale range, scale span, reproducibility, drift, repeatability, hysteresis; accuracy & precision, significant figures, static sensitivity, threshold, dead time, dead zone, input & output impedances, loading effects due to shunt series connected instruments, generalized impedance & stiffness concepts, impedance matching & maximum power transfer

## Unit-III

- 4. Dynamic Characteristics** **12 hrs**  
Dynamic response, measuring lag, fidelity, dynamic error, transfer function, order of the system, types of test inputs, step response of 1<sup>st</sup> & 2<sup>nd</sup> order systems & study of characteristic indices

## Unit-IV

- 5. Display & Recording Methods** **6 hrs**  
Indicating methods, analogue & digital comparison, LED, LCD as display units, 7 segment, 14 segment & dot matrix display, Nixie tube display, difference between integrating & recording methods, recording requirements, various methods of strip chart recording, potentiometer & null balance type of recorders
- 6. Cathode Ray Oscilloscope** **6 hrs**  
CRT, its main parts, electrostatic focusing & deflection, deflection sensitivity, post deflection acceleration, types of screens for CRT, aquadag color, CRTs, various time base & amplifiers oscilloscope circuits, method of synchronization, various controls on CRO.

## RECOMMENDED BOOKS

Title	Author	Publisher
1. Electrical & Electronic Measurement and Instt.	A K Sawhney	Dhanpat Rai
2. Measurement Systems Applications & Design	EO Doebelin	TMH
3. Mechanical Measurements	T G Beckwith	PHI
4. Transducers and instrumentation	DVS Murthy	Dhanpat Rai

# IE – P6202 Sensors & Signal Processing

L T P  
3 0 0

Credits: 3

## Unit I

1. **Introduction** **12hrs**  
General Concept of Measurement: Basic block diagram stages of generalized measurement system state characteristics; accuracy, precision, resolution, reproducibility, sensitivity, zero drift, linearity, Dynamic characteristics, zero order instrument first order instrument, time delay.

## Unit II

2. **Sensors** **12 hrs**  
Sensors and Principles: Resistive sensors, Potentiometer and strain gauges, Inductive sensors: Self inductance type, mutual inductance type, LVDT, Capacitive sensors, piezoelectric sensors thermocouples, thermistors, radiation pyrometry, Fibre optic sensors, temperature sensor, photo electric sensors, pressure and flow sensors.

## Unit III

3. **Signal Conditioning** **12 hrs**  
Signal conditioning: Amplification, Filtering, Level conversion, Linearisation, Buffering, sample and hold circuit, quantization, multiplexer/ demultiplexer, analog to digital converters, digital to analog converters.

## Unit IV

4. **Data Acquisition** **06 hrs**  
Data acquisition and conversion: General configuration, single channel and multichannel data acquisition system, Digital Filtering, data logging data conversion, introduction to digital transmission systems, PC based data acquisition system.
5. **Interfacing** **06 hrs**  
Interface systems and standards: Block diagram of a typical interface IEE 488 standard bus British Standard interface (BS 4421) CAMAC Interface MEDIA interface RS232C standard.

### RECOMMENDED BOOKS

	<b>Title</b>	<b>Author</b>	<b>Publisher</b>
1.	Instrumentation -Devices and Systems	Rangam, Sarma & Mani	TMH
2.	A Course in Electrical and Electronic Measurements and Instrumentation	A.K. Sawhney	Dhanpat Rai & Sons
3.	Measurement Systems	E.O. Doebelin	McGraw Hill
4.	Instrument Measurement & Analysis	Nakara	PHI

# IE-P6203- Elements of Power Systems

L T P  
3 0 0

Credits: 3

## Unit-I

1. **Supply System** **06 Hrs**  
Introduction to Transmission and Distribution systems, Comparison between DC and AC systems for Transmission and Distribution, comparison of cost of conductors, choice of working voltage for transmission & distribution, economic size of conductors - Kelvin's law, Radial & mesh distribution networks, Voltage regulation
2. **General** **06 Hrs**  
Conductor materials; solid, stranded, ACSR, hollow and bundle conductors. Different types of supporting structures for overhead lines. Elementary ideas about transmission line construction and erection. Stringing of conductors, spacing, sag and clearance from ground, overhead line insulators, concept of string efficiency

## Unit-II

3. **Transmission Line Parameters** **05 Hrs**  
Introduction to line parameters, Resistance of transmission line, inductance of single phase two wire line, concept of G.M.D., Inductance of three phase line, Use of bundled conductor, transposition of power lines, capacitance of 1-phase and 3-phase lines. effect of earth on capacitance of conductors
4. **Performance Of Transmission Lines** **07 Hrs**  
Representation of short transmission line, medium length line (nominal T & II circuits). long length line by hyperbolic equations and equivalent T & II circuits. Power flow through transmission lines, ABCD constants, Voltage regulation

## Unit-III

5. **Circle Diagram And Line Compensation** **12 Hrs**  
Receiving end circle diagram for long transmission lines based on ABCD constants, equivalent T circuits, power loss, surge impedance loading, reactive power requirement of system series and shunt compensation, Synchronous phase modifiers, rating of phase modifiers

## Unit-IV

6. **Underground Cables** **12 Hrs**  
Classification of cables based upon voltage and dielectric material, insulation resistance and capacitance of single core cable, dielectric stress, Capacitance of 3 core cables, methods of laying, heating effect, Maximum current carrying capacity, cause of failure, comparison with overhead transmission lines

### RECOMMENDED BOOKS

Title	Author	Publisher
<b>Text books</b>		
1. Course in Electrical Power	C.L. Wadhwa	New Age
2. Power System Analysis	Nagrath and Kothari	TMH
<b>Reference Books</b>		
3. Electrical Energy System Theory- An introduction	O.L. Elgerd	TMH
4. Elements of Power System Analysis	W.D. Stevenson Jr	TMH
5. Power System Analysis & Design	B.R. Gupta	Wheeler

# IE-P6204- Bio-Sensors & MEMS

L T P  
3 0 0

Credits: 3

## **Unit-I**

### 1. **Overview**

**12 hrs**

Overview of biosensors and their electrochemistry: Molecular reorganization: enzymes, Antibodies and DNA, Modification of bio recognition molecules for Selectivity and sensitivity Fundamentals of surfaces and interfaces

## **Unit-II**

### 2. **Bioinstrumentation**

**12 hrs**

Bioinstrumentation and bioelectronics devices: Principles of potentiometry and potentiometric biosensors, principles of amperometry and amperometric biosensors, Optical Biosensors based on Fiber optics, FETs and Bio-MEMS, Introduction to Chemometrics, biosensor arrays; electronic nose and electronic tongue

## **Unit-III**

### 3. **MEMS Technology**

**12 hrs**

MEMS Technology: Introduction Nanotechnology and MEMS, MEMS design, and fabrication technology, Lithography, Etching, MEMS material, bulk micromachining, Surface micromachining, Microactuator, electrostatic actuation , Micro-fluidics

## **Unit-IV**

### 4. **Applications**

**12 hrs**

MEMS types and their applications : Mechanical MEMS □ strain and pressure sensors, accelerometers etc., Electromagnetic MEMS, micromotors, wireless and GPS MEMS etc Magnetic MEMS, all effect sensors, SQUID magnetometers, Optical MEMS, micromachined fiber optic component, optical sensors, Thermal MEMS, thermo-mechanical and thermo-electrical actuators, Peltier heat pumps

## **RECOMMENDED BOOKS**

	<b>Title</b>	<b>Author</b>	<b>Publisher</b>
1.	Foundation of MEMS	Chang	Illinois Ece Series
2.	Microsensors, MEMS and Smart Devices	Julian W. Gardner, Vijay Varadan & Osama O. Awadelkarim	Wiley
3.	Biosensors: Theory and Applications	Donald G. Buerk	CRC
4.	Electrochemical Sensors, Biosensors and their Biomedical Applications	Xueji Zhang, Huangxian Ju & Joseph Wang	Academic Press

# ME-P6201 INDUSTRIAL ENGINEERING

L T P  
3 0 0

Credits:3

## Unit - I

**Introduction:** Industrial Engineering. Definition and Evolution, Understanding Industrial System Focus: Production/Service System. Performance measures of a Production System -Production, Productivity, Efficiency, Effectiveness, Quality, Flexibility, Agility etc.

**Classical Industrial Engineering:** Classical Industrial Engineering -Work Study: Method Study and Time Study, Human Factors, Ergonomics, Motivation Recent and Emerging Applications of IE –Role of IT in Systems– MIS, FMS etc.

(12 Hrs)

## Unit - II

**Value Engineering:** Concept of value analysis, Aim and objectives, Phases in value analysis, Test for value analysis advantages.

**Product Design & Development:** Product Development life cycle, Product standardization, simplification, specialization, Diversification, Break-even analysis, BEP.

**Production and Process Planning:** Objectives of PPC, Component of PPC, Phases of PPC, Process planning, steps in process planning for flow shop scheduling, types of scheduling systems, master scheduling, order scheduling.

(12 Hrs)

## Unit - III

**Sales Forecasting Techniques:** Types of forecasting, importance of demand planning, methods of sales forecasting, Qualitative and Quantitative methods of demand planning.

**Inventory Control & Management :** Introduction, Inventory, Deterministic model of EOQ, EOQ, Selective Inventory Control, Japanese Influences: Just in Time (JIT), Kanban etc.; Increasing Integration in Industrial Enterprises: From MRP to ERP to Supply Chain Management.

(12 Hrs)

## Unit – IV

**Recent Development in Manufacturing Systems:** Performance improvement by IT skills - Decision Support System (DSS), Intelligent Systems. Engineering Managers, System and Process (ERP) Specialists, Change Managers, study the concept of SCM, TQM, TPM, CRM, and QFD etc.

(12 Hrs)

### Recommended Books:

Title	Author(s)	Publisher
Industrial Engineering	Ravi Shankar	Galgotia
Industrial Engineering & Management	O.P.Khanna	Khanna
Production Management	Ronald Mayer	TMH
Industrial Engineering & Management	Telesang	S.Chand



**Unit – I**

**Introduction and Planning Phase of PPC:** Components of PPC, Planning, routing, loading, scheduling and despatching, objectives and principles of PPC, Phases of PPC, factors affecting PPC, organization set up of PPC, types of production, Job Production, Batch production and Continuous production, Introduction to value analysis.

(12 Hrs)

**Unit - II**

**Planning Phase of PPC:** Definition and concept of forecasting, objectives and types of forecasting, Routing, function of routing, routing procedure, documents of routing, factors affecting routing procedure, its advantages and limitations.

(12 Hrs)

**Unit - III**

**Process Planning:** Sequencing: Johnson' rule for sequencing, types of sequencing, Scheduling, objectives of scheduling, functions, types of scheduling: Master scheduling, order scheduling, Index method of scheduling, Gantt chart.

(12 Hrs)

**Unit - IV**

**Action Phase of PPC and Control Phase of PPC:** Despatching, duties of despatcher, despatch procedure, centralized and decentralized despatching, Inventory control, objectives of inventory control, Economic Order Quantity, Progress reporting, Corrective action, Expediting and Replanning.

(12 Hrs)

**Recommended Books**

<b>Title</b>	<b>Author(s)</b>	<b>Publisher</b>
Industrial Engineering and Management	M. S Mahajan	Dhanpat Rai
Industrial Engineering and Management	O. P Khanna	Dhanpat Rai
Production Planning & inventory Control	Narisimtan Mcleavy Billington	PHI
Production and Operation Management	B.S. Goel	Pragati Prakashan
Production Planning & Inventory Control	P. S. Eilon	Rivermead Books.

**Unit - I**

**PLANT LAYOUT:** Definition, Principle of plant layout, objectives, Classification of layout-static & mixed layout,

**Advantages & limitations of layout:** Analytical tools/procedures of layout ie operation process charts, flow process charts, flow diagrams, templates, scale model.

(12 Hrs)

**Unit - II**

**Facility Location:** Introduction, importance of plant location, factors affecting plant layout & location ,break even analysis, single & multi facility location problem, model for multifacility location problem, Minimax location problem

(12 Hrs)

**Unit – III**

**Layout design:** Production line techniques, prerequisites factors influencing layout design, storage space requirement, flow pattern, layout design procedure, SLP, ALDEP,CORELAP, CRAFT, Line balancing, assembly operations, numerical problems.

(12 Hrs)

**Unit – IV**

**Material handling:** Introduction, functions of material handling, engineering & economic considerations, principle of material handling, selection of material handling devices, classification of material handling equipments, material handling in process layout, & line layout.

(12 Hrs)

**Recommended Books:**

<b>Title</b>	<b>Author(s)</b>	<b>Publisher</b>
Facility Layout & Location	Francis, R.L	Prentice hall Inc
Plant layout & material handling	Moore	John Wiley
Industrial Engineering Handbook	H.B Maynard	Mc Graw Hill
Industrial Engineering & production Management	M. Mahajan	Dhanpat Rai
Industrial Engineering & management	S. Dalela	Standard Publisher

**ME-P6204**

**NON DESTRUCTIVE TESTING & FAILURE ANALYSIS**

**L T P**  
**3 0 0**

**Credits:3**

**Unit - I**

**Introduction:** Weld quality, Introduction to NDT, industrial importance of NDT, comparison between destructive and non-destructive testing.

**Quality Concept and NDT:** NDT as a quality tool, benefits from NDT, visual examination, liquid penetration and magnetic particle tests

(12 Hrs)

**Unit - II**

**Ultrasonic Examination:** Principles of wave propagation, ultrasonic fields and their characteristics, generation of US waves, piezoelectric and magnetostrictive effects, calibration and control of ultrasonic testing equipment, ultrasonic testing of materials, pulse echoes, through-transmission and resonance methods of testing.

**Radiography:** X-ray and Gamma ray sources, equipments and accessories, radiography techniques, image quality indicators and screens, X-ray films, film processing and interpretation, radiation safety, fluoroscopy, Xero-radiography.

(12 Hrs)

**Unit – III**

**Recent Methods used in the NDT:** Principles of acoustics emission, instrumentation and application, optical and acoustical holography, neutron radiography, thermography, and real time imaging.

(12 Hrs)

**Unit - IV**

**Failure Analysis:** Material failure and failure due to the environmental effects, common causes of failure in metals and alloys, failure due to the improper heat treatment (e.g. overheating, burning, improper quenching, decarburizing etc.), embrittlement of metals, residual stresses in metals and their effects, defects in production/manufacturing e.g. segregation, blow holes etc., fundamentals of crack propagation.

(12 Hrs)

**Recommended Books:**

<b>Title</b>	<b>Author(s)</b>	<b>Publisher</b>
Metallurgy of Failure Analysis'	Das A.K	Tata Mc Graw Hill
Analysis of Metallurgical Failures'	Colangelo V.A. Heisler F.A.	John Wiley and Sons
Practical Non Destructive Testing'	Baldev Raj Jayakumar T	Narosa Publishing House