AE01 MATHEMATICS—I

1 Multivariate Calculus 18 hours

1.1 Limit and continuity of functions of several variables, Partial derivatives of one and higher order.

1.2 Total differential and its application to approximations and errors, Implicit and homogeneous functions, Euler ‘s theorem.

1.3 Taylor ‘s theorem and series of function of several variables, Maxima and minima of functions of two variables, Method of Lagrange multipliers.

1.4 Double and triple integrals, Change of order of integration, Application to computation of volumes and surface areas of simple solids.

II [2]

2 Ordinary Differential Equations 16 hours

2.1 Separable, homogeneous, exact and linear first order differential equation, Bernoulli ‘s equation.

2.2 Homogeneous and non-homogeneous linear differential equation of second order, method of variation of parameters and method of undetermined coefficients, Euler - Cauchy equation, Higher order linear homogeneous differential equation with constant coefficients.

I [1, 2]; II [4, 5]

3. Matrices 16 hours

3.1 Addition, scalar multiplication and product of matrices, Elementary row operations.

3.2 Rank and inverse of a matrix, Consistency and solution of a system of linear equations.

3.3 Eigenvalues and eigenvectors, Hermitian, skew-Hermitian and unitary matrices, Diagonalization of matrices.

I [6, 7]; II [3]

4 Special Functions 10 hours

4.1 Power series solution of O.D.E., Series solution of Legendre and Bessel Equations.

4.2 Legendre polynomials and their properties, Bessel function of first kind and their properties, Recurrence relations for Bessel functions.

I [4]; II [6, 7]

Text Books

I. Erwin Kreyszig, "Advanced Engineering Mathematics" 8th edition, John Wiley and Sons (Asia) --- 2000

II. R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House --- 2002

Reference Books

1. Peter V. O'neil, "Advanced Engineering Mathematics" 4th edition Brooks / Cole Publishing Company ---1995

AE02 ENGINEERING GRAPHICS

1. Basic Concepts **2 hours**

1.1 Introduction
1.2 List of equipment and their use

I [1 (1.1-1.3, 1.5 to 1.26)]

2. Drawing Conventions : BIS Standard IS:SP–46–1988 **2 hours**

2.1 Types of conventional Lines.
2.2 Drawing sheet, sizes and layout of drawing sheet.
2.3 Technical writing : introduction, single stroke letters, capital and lower case letters, vertical and slant lettering and numerals
2.1 Norms of Dimensions and rules: Introduction, dimension terms and notations, theory of dimensions, placement of dimensions and rules, dimensioning of common features.

I [2 (2.1, 2.6, 2.7), 3(3.1-3.5, 3.7, 3.8), 18 (18.1-18.4, 18.6, 18.7)]

3. Projections **1 hour**

3.1 Orthographic Projections: Introduction, projection terms, coordinate planes of projection, first angle projection, third angle projection, methods of obtaining views.
3.2 Types of projections: Perspective and oblique.
3.3 Isometric projection and isometric drawing: Introduction, types, isometric projection, isometric scale, isometric drawing, methods of drawing.

I [17 (17.1, 17.4-17.7, 17.13, 17.18), 19 (19.1-19.5, 19.7, 19.10, 19.11, 19.16), 22]

4. Scales **2 hours**

4.1 Introduction, representative fraction, types of scales.
4.2 Plain scale

4.3 Diagonal scale

I [4 (4.1-4.6)]

5. Plane Geometry 10 hours

5.1 Construction of plane and geometric figures : triangle, square, rectangle, pentagon, hexagon and octagon
5.2 Construction of conics : parabola, ellipse, hyperbola.
5.3 Construction of curves of loci: cycloid, epicycloids, hypocycloid, involute of base circle, cylindrical helix.

I [6-8]

6. Solid Geometry 15 hours

6.1 Conventions used.
6.2 Projection of a point : Point lying in first, second, third and fourth quadrant and in any plane.
6.3 Projection of straight lines : Straight line kept perpendicular to H.P. and parallel to V.P.; parallel to H.P. and perpendicular to V.P.; parallel to both H.P. and V.P.; inclined to one plane and parallel to other plane; inclined to both H.P. and V.P.; one end of line in H.P. and other in V.P.;Trace of line.
6.4 Projection of plane. Plane with its surface perpendicular to H.P. and parallel to V.P.; its surface inclined to one plane and perpendicular to the other plane. Spatial relationship projections on primary and secondary auxiliary plane. Finding edge views; angles of planes with principal planes and true shape.
6.5 Projection of solids such as prisms and pyramids: triangular, square, and hexagonal; cylinders and cones and their section with axis parallel to V.P. and perpendicular to H.P., and axis parallel to H.P. and perpendicular to V.P. with axis parallel to both H.P. and V.P.; axis parallel to one and inclined to the other plane. Intersections of planes with solids such as cylinder and cone.
6.6 Development of surfaces: Drawing of the development curves for prisms; cylindrical, conical and spherical profiles using Zone and Lune method.
6.7 Intersections of surfaces: Introduction, methods, intersections of prisms, intersections of cylinders, intersection of cylinder and cone.

I [9-15, 16(16.1, 16.3, 16.5, 16.7, 16.10)]

7. Screw Threads and Threaded fasteners 4 hours

7.1 Thread terms and nomenclature
7.2 Drawing of different thread profiles of V, square, acme, buttress and knuckle threads.
7.3 Thread designations and conventional representation
7.4 Screwed fasteners : Drawing two views of hexagonal and square headed bolts and nuts, set screws, cap screws, locking devices, dimensioning.

II [18 (18.1-18.6, 18.8, 18.13, 18.15-18.19, 18.21)]

8. Keys, Cotters and Joints 3 hours

8.1 Classification of keys
8.2 Two views of parallel, taper, rectangular, jib head feather, peg, woodruff keys. Splined shaft and hub
8.3 Cotter joints: spigot and socket cotter joint, jib and cotter joint.

8.4 Knucklejoint.

II [19 (19.1-19.3, 19.6, 19.7)]

9. Rivets and Riveted Joints 3 hours

9.1 Rivets, shapes of rivet heads, rivet diameters, riveting, testing.
9.2 Drawing of snap head, pan head, flat countersunk head, rounded countersunk head.
9.3 Riveted Joints: sketching of two views of lap and butt joint for single and double riveted joints.

I [16]

10. Shaft Coupling 3 hours

10.1 Introduction, classification, rigid flange coupling, muffcoupling (two views)
10.2 Compression coupling, universal coupling.

II [20 (20.1, 20.2, 2.4, 20.5, 20.7, 20.10)]

11. Pipe Joint 2 hours

11.1 Introduction and standardization, types of pipes
11.2 Pipe Joints: Screwed joints, flanged joints, spigot and socket joints. Hydraulic pipe joint, expansion joint.

II [21 (21.1-21.6, 21.8-21.10, 21.12)]

12. Belts and Pulleys 3 hours

12.1 Introduction: Solid cast iron pulley, split pulley, built up pulley.
12.2 Fast and loose pulley.
12.3 Stepped pulley.

II [22 (22.1-22.6)]

13. Bearings 5 hours

13.1 Introduction, types of bearings.
13.2 Journal bearings, solid journal bearing, bushed bearing open bearing.
13.3 Plummer block.
13.4 Footstep bearing.
13.5 Wall bracket and bearing.
13.6 Ball and roller bearing (sketches)

II [23 (23.1-23.7, 23.9, 23.15, 23.17-23.19)]

14. I.C.E. Parts 2 hours

14.1 Introduction
14.2 I.C.E. Piston (one view sketch)
14.3 I.C.E. Connecting Rod (two views)

II [28 (28.1-28.3)]

15. Concept of Limits, Fits and Tolerances **2 hours**

15.1 Introduction
15.2 Conventional Fundamental Tolerancing.
15.3 Definitions and Schematic representations of : basic size, zeroline, maximum size, minimum size, upper deviation, lower deviation, tolerance, clearance fit, transition fit and interference fit.
15.4 Symbols for tolerances, deviations and fits.
15.5 Methods of giving tolerances and fits

II [13 (13.1, 13.2, 13.4, 13.6, 13.7)]

Text Books

I. P.S. Gill, 'Engineering Drawing', S.K. Kataria and Sons, Ludhiana (2003)
II. P.S. Gill, 'Machine Drawing', S..K. Kataria & Sons Ludhiana (2001)

Reference Books

1. S.C. Sharma and Naveen Kumar 'Engineering Graphics with Auto CAD' E.D. Galgotia and Sons, Delhi.(2002)
2. S.C. Sharma 'Machine Drawing' Galgotia Publication, Delhi. (2004)
3. R.B. Gupta, Fundamentals of Engineering Drawing, 'Satya Prakashan' Delhi (2001).
4. B.D. Bhatt, 'Machine Drawing'.
5. V. Lakshminarayanan and R.S. Vaishwnar, Engineering Graphics(1999)

AE03 APPLIED MECHANICS

1. Basic Concepts and Force Systems **3 hours**

1.1 Basic Concepts, Units, Scalars and Vectors, Laws of Mechanics.
1.2 Position Vector, Force, Moment and Couple.
1.3 Resultant of force systems, Distributed Forces, Centre of Gravity and Centre of Pressure.

I [1, 3, 4]

2. Equilibrium **6 hours**

2.1 Free body Diagrams, Equilibrium Conditions, Equilibrium Problems.
2.2 Plane Trusses, Method of Joints, Method of Sections.

2.3 Laws of Coulomb Friction, Equilibrium Problems with Friction Thrust Bearing, Belt, Screw etc.

I [5, 6A, 7]

3. Properties of Areas and Moments of Inertia 6 hours

3.1 Centroids of Lines, Areas, Volumes, Composite Figures, Centre of Mass.
3.2 Second Moments and Products of an Area, Transfer Theorems, Polar Moment of an Area.
3.3 Mass Moments and Product of Inertias of a Body, Translation of Coordinate Axes.

I [8, 9]

4. Kinematics and Dynamics of a Particle 6 hours

4.1 Velocity and Acceleration in Rectangular, Cylindrical and Polar Coordinates, Simple Relative Motion.
4.2 Application of Newton's Second Law.
4.3 Energy Method for a Particle, Conservative Forces Field, Conservation of Mechanical Energy, Systems of Particles.
4.4 Impulse and Momentum Relations for a Particle, Linear Momentum for a System of Particles, Impulsive Forces, Impact, Moment of Momentum Equations for a system of Particles.

I [11, 12, 13, 14]

5. Plane Motion of a Rigid Body 6 hours

5.1 Translation and Rotation of a Rigid Body, Chasles' Theorem, Time Derivatives of a Vector Fixed in a Moving References, Velocity and Acceleration of Points of a Rigid Body.
5.2 Moment of Momentum Equations, Rotation of a body of revolution about its Axis, General Plane Motion of a Slablike Body.
5.3 Kinetic Energy of a Rigid Body, Work Energy Relations.
5.4 Free Vibrations**,** Single Degree of Freedom, Energy Methods.

I [15, 16, 17, 19]

6. Stresses, Strains and Hooke's Law 6 hours

6.1 Definition of Stress, Stress Tensor, Stresses in Axially Loaded Bars, Analysis for Normal and Shear Stresses.
6.2 Normal Strain, Stress-Strain Diagrams, Hooke's Law, Poisson's Ratio, Thermal Strain, Simple Problems on Axially Loaded Bars.

6.3 Constitutive Relation for Shear, Generalized Hooke's Law, Relations between Elastic Constants, Thin walled Pressure vessels.

II [1, 2, 3]

7. Torsion **3 hours**

7.1 Torsion of Circular Elastic Bars, Shear Stresses and Angle of Twist.
7.2 Design of Circular Members in Torsion, Shaft Couplings.
7.3 Close Coiled Helical Springs, Stresses, Deflection.

II [4A, 10]

8. Beams **6 hours**

8.1 Shear Force and Bending Moment Diagrams, Differential Equations of Equilibrium.
8.2 Elastic Flexural Formula, Its Application, Composite Beams.
8.3 Deflection of Beams, Direct Integration, Moment Area Method.

II [5, 6, 10]

9. Fluid Statics **3 hours**

9.1 Fluids, System and Control Volume, Stress, Strain Rate, Properties of Fluids, Concept of Constitutive Relations.
9.2 Normal Forces of Fluids, Pressure Measurement, Force on Submerged Bodies, Manometers, Buoyancy, Stability, Liquids Subjected to Constant Linear Acceleration and Constant Rotation.

III [1, 2]

10. Analysis of Flow **6 hours**

10.1 Description of Fluid Flow, Acceleration, Continuity Equation, Stream Functions, Strain rates, Rotation, Circulation, Irrotational Flow, Potential Functions.
10.2 Basic Laws for a System, Reynold's Transport Theorem, Momentum Equations, Euler's Equation, Navier-Stokes Equation, Bernoulli's Equation.
10.3 Flow Measurement.
10.4 Dimensional Analysis and Similitude.

III [3, 4, 5, 13]

11. Ideal and Viscous Flow **6 hours**

11.1 Basic Ideal Flows and Superposition.
11.2 Simple Laminar Flows.

11.3 Introduction to Boundary Layer Theory, Drag, Turbulence, Flow around Immersed Bodies, Flow through Pipes.

III [6, 7, 8, 9, 10]

12. Fluid Machinery **3 hours**

12.1 Classification, Analysis of Turbo-machines, Performance.

III [14]

Text Books

I. I. H. Shames, "Engineering Mechanics: Statics and Dynamics" 4th Ed., Prentice Hall of India, N. Delhi (1996).
II. E.P. Popov, "Engineering Mechanics of Solids", Prentice Hall of India, N. Delhi (1993).
III. K.L. Kumar, "Engineering Fluid Mechanics", S. Chand and Co., N. Delhi (1997).

AE04 MATERIALS & PROCESSES

1. Crystal structures and Bondings
7 hours

1.1 Structure of the atom, ionization potential, electron affinity.
1.2 Bondings: Chemical, ionic and covalent bond energy and energy of cohesion.
1.3 Crystal geometry, Miller indices, inter planer separation, Bragg's Law.
1.4 Simple crystal structures (SC, BCC, FCC, & HCP): Covalent crystals (Ge, Si), ionic crystal (NaCl) and metallic crystals (Cu, Ag, Al, Fe, Mg & Zn).

I [3, 4, 5]; II [35]

2. Crystal imperfections
4 hours

2.1 Point, line, surface & volume imperfection, Frenkel and Schottky defects.
2.2 Geometry of edge and screw dislocations, Burgers vector.

I [6]; II [37]

3. Phase Diagrams
4 hours

3.1 The phase rule (Gibb's phase rule).
3.2 Single component system.
3.3 Binary phase diagram, Eutectic system.
3.4 The lever rule, Tie-line rule.
3.5 Zone refining.

I [7]; II [39]

4. Diffusion in solids
4 hours

4.1 Fick's Laws and its solutions, Doping applications.
4.2 Atomic model of diffusion.
4.3 The Einstein relation.

I [8]; II [47]

5. Conducting materials
7 hours

5.1 Free electron theory, Fermi function, energy states.
5.2 Metallic conduction: Conductivity, mobility and relaxation time.
5.3 Properties and uses of common conducting materials (e.g. maganine, nichrome, graphite, silicon carbide), filaments and contact materials.

I [14]

6. Semi-conducting materials and devices
7 hours

6.1 Energy bands in solids, energy gap.
6.2 Intrinsic and extrinsic (p-type and n-type) semiconductor.
6.3 Carrier concentration and conductivity.
6.4 Properties of common semi conducting materials.
6.5 Hall effect and its application.
6.6 p-n junction, junction diodes and junction transistors (pnp, npn) and their characteristics.

I [15]

7. Dielectric Materials
7 hours

7.1 Polarization and polarizability, local electric field.
7.2 Ionic, orientational and electronic polarization.
7.3 Temperature and frequency dependence, dielectric losses, dielectric strength.
7.4 Ferroelectricity & piezoelectricity and their application.

7.5 Properties and applications of common dielectric materials (e.g. glass, porcelain, PVC, bakelite, rubber, mica and transformer oil).

I [17]; II [25]

8. Magnetic Materials
7 hours

8.1 Ferromagnetism, domain structure, hysterises loop, eddy current losses.
8.2 Soft magnetic materials; Fe-Si alloys for power transformers, Ni-Fe alloys (permalloy) for pulse transformers, chokes and communication equipments.
8.3 Ferrimagnetism; Ferrites for high frequency transformers and computer memory cores.
8.4 Hard magnetic material; Carbon Steels, Alnico alloys and barium ferrite.

I [16]; II [12]

9. Processing of Electronic Materials
5 hours

9.1 Fabrication of integrated circuits.
9.2 Semiconductor grade silicon, single crystal growth.
9.3 Wafer manufacture, oxidation.
9.4 Photolithography, Doping.
9.5 Ion implantation, epitaxial growth (CVD) and Metallisation.

I [15]

10. Common fabrication processes
4 hours

10.1 Introduction to welding, soldering and brazing.
10.2 Casting, Forging & Rolling.
10.3 Extrusion and wire drawing.

II [50, 57]

11. Simple heat treatment processes
4 hours

[Definition, purpose, concept (Procedure in brief)]

11.1 Principles (Fundamentals) of heat treatment.
11.2 Annealing & Normalizing.
11.3 Hardening (by Quenching) and Tempering.

II [43]

Text Books

I. V. Raghavan, "Materials Science and Engineering" A first course, Prentice Hall of India, New Delhi, 4th Edition (2000)

II. O. P. Khanna, " A text book of Material Science and Metallurgy" Dhanpat Rai Publications, New Delhi, (1998)

Reference Books

1. C. S. Indulkar and S. Thiruvengadam, " An Introduction to Electrical Engineering Materials", S. Chand and Co., New Delhi (2003).
2. Mubeen and Mubeen, "Material Science", Khanna Publishers, Delhi, Second Edition.
3. Lawrence H. Van Vlack, " Elements of Materials Science and Engineering", Pearson Education, 6th Edition.

AE05 BASIC ELECTRONICS

1. Conduction in Semiconductors and Semiconductor Devices 5 hours

1.1 Intrinsic semiconductor, Donor and Acceptor impurities.
1.2 Fermi level, Hall effect, Avalanche and Zener effects.
1.3 P N Junction. Semiconductor diode and its characteristics.
1.4 Zener Diode, its characteristics and use in Voltage regulators.
1.5 Clipping and Clamping.
1.6 Transistor action (NPN and PNP). Characteristics of a Transistor. CB, CE and CC configurations and their characteristics.
1.7 Biasing of BJT.

I [1, 2, 3]; II [4, 5, 6, 8]

2. Small Signal BJT Amplifiers 8 hours

2.1 Basic signal amplifier and its parameters (A_v, A_i, R_{in}, R_{out}).
2.2 Hybird – model and pi-models of a BJT.
2.3 R-C coupled amplifiers and Cascaded amplifiers.
2.4 Darlington pair, Cascode and Difference Amplifiers.

I [10]; II [12,13]

3. Field-Effect Transistors (FET) 4 hours

2.5 J-FET and MOS-FET and their models
2.6 Small signal amplifiers using FETs.

I [4,10]; II [9]

4. Large Signal Amplifiers 3 hours

2.7 Class A, B, AB and C operation.
2.8 Transformer – coupled amplifiers, Push-pull amplifiers.
2.9 Calculation of efficiency, power dissipation, harmonic distortion.

I [17]; II [14]

5. Feed-Back Amplifiers 6 hours

2.10 Concept, classification and properties of negative feed back.
2.11 Effect on gain, input, output impedances, bandwidth, distortion and noise with negative feedback.
2.12 Analysis of negative feed-back amplifiers.

I [12]; II [15]

6. Oscillators 3 hours

2.13 Barkhausen criteria for oscillation.
2.14 R- C phase-shift and Wien-bridge oscillators.
2.15 General network and evolution of different oscillators viz Hartley, Colpitts, and Clapp oscillators.
2.16 Crystal oscillators, frequency stability.

I [15]; II [20]

7. Operational Amplifiers and Circuits 7 hours

2.17 OPAMP block diagram and its equivalent circuit.
2.18 Applications of OPAMP as a Summer, Differentiator, Integrator, Comparator, Sample and Hold circuit.
2.19 Offset currents, compensation, slew rate.

I [14]; II [25]

8. Waveform Generation and Shaping Circuits 8 hours

8.1. Multivibrators – monostable, bistable and astable types, their operation and design.
8.2. Sawtooth and Ramp generators.
8.3. Schmitt trigger.
8.4. Timer 555, its functioning and applications.

I [15]; II [21, 26, 27]

9. Rectifiers And Power Supplies **6 hours**

9.1. Half-wave and full-wave rectifiers.
9.2. Capacitor-input Filters.
9.3. Calculation of efficiency, dissipation and ripple factor in rectifiers.
9.4. Regulated power supplies.

I [17]; II [7, 30]

10. Digital Electronics **10 hours**

10.1. Basic gates, Boolean Algebra
10.2. De Morgan's theorem and Duality theorem
10.3. Karnaugh's map (for 2,3,4 variables)
10.4. Combinational circuits, standard representation for logical function (SOP and POS forms)
10.5. Flip-flops (D-type, S-R, J-K, Master-slave J-K, and T-type) their truth tables.
10.6. Shift Registers, Counters, Half and Full Adders.

I [6, 8]; II [32]

Text Books

I. J. Millman and A Grabel, "Microelectronics", Tata Mc Graw Hill, New Delhi, 2nd Edn. 1999.
II. J.B. Gupta, "Electronic Device and Circuits", S.K. Kataria & Sons, 2nd Edn. 2003.

Reference Books

1. A.S. Sedra and K.C. Smith, "Microelectronic Circuits", Saunders College Publishing International Edition, 3rd Edn., 1991.
2. R L Boylestad and L. Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education Asia, New Delhi, 8th Edn. 2002.

AE07 NUMERICAL ANALYSIS AND COMPUTER PROGRAMMING

1. Programming **3 hours**

1.1 Overview of programming.
1.2 Programming languages.
1.3 Programming techniques.

I [1]

2. Overview of C language **9 hours**

2.1 Data types, variables, constants, arithmetic expressions and assignment statements.
2.2 Program control statements, console I/O.
2.3 Arrays, functions and pointers. Structures, unions, enumerated data types.
2.4 File handling.
2.5 The C-preprocessor, C standard Lib and header files.

I [2-15]

3. Errors in Numerical Computation **3 hours**

3.1 Sources of errors in numerical computation.
3.2 Round-off error.
3.3 Truncation error.
3.4 Inherent error.
3.5 Stability of numerical algorithms.

II [1 (1.1, 1.3)]

4. Transcendental and Polynomial Equations **9 hours**

4.1 Bisection method.
4.2 Secant method.
4.3 Regula-Falsi method.
4.4 Newton-Raphson method.
4.5 Rate of convergence of iterative methods.
4.6 System of nonlinear equations.

II [2 (2.2, 2.3, 2.5, 2.7)]

5. Systems of Linear Equations and Inverse of a Matrix **9 hours**

5.1 Gauss-elimination method.
5.2 Gauss-Jordan method.
5.3 LU decomposition method.
5.4 Cholesky method for symmetric and positive definite systems.
5.5 Gauss-Jacobi iteration method.
5.6 Gauss-Seidel iteration method.
5.7 Rate of convergence of iterative methods.

II [3 (3.1, 3.2, 3.4)]

6. Interpolation and Approximation **9 hours**

6.1 Lagrange interpolation.
6.2 Errors of interpolation.
6.3 Divided differences.
6.4 Newton's divided difference interpolation.
6.5 Finite differences.
6.6 Newton's forward and backward differences interpolation.
6.7 Least squares approximation.

II [4 (4.2-4.4, 4.9)]

7. Numerical Differentiation 6 hours

7.1 Methods based on interpolation.
7.2 Methods based on finite differences.
7.3 Methods based on undetermined coefficients.
7.4 Choice of optimal step size.
7.5 Richardson extrapolation methods.

II [5 (5.2-5.4)]

8. Numerical Integration 9 hours

8.1 Newton Cotes methods (Trapezoidal rule, Simpson's rule).
8.2 Composite integration methods.
8.3 Derivation of methods using the method of undetermined parameters.
8.4 Romberg integration.
8.5 Gaussian methods (Gauss-Legendre methods, Gauss-Chebyshev methods, Gauss-Laguerre methods, Gauss-Hermite methods).

II [5 (5.7 - 5.10)]

9. Numerical Solution of First Order Ordinary Differential Equations 3 hours

9.1 Taylor's series method.
9.2 Euler method.
9.3 Runge-Kutta methods (Second and fourth order).

II [6 (6.4)]

Text Books

I. E.Balagurusamy, "Programming in ANSI C", Tata Mc Graw Hill, 1992.

II. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering Computation", Fourth Edition, New Age International Publishers, 2003.

Reference Books

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods : Problems and Solutions", New Age International Publishers, 1994.
2. A. Ralston and P. Rabinowitz "A First Course in Numerical Analysis", McGraw-Hill, 2nd edition, 1978.

AE08 CIRCUIT THEORY AND DESIGN

1. Network Elements and their Characterization
3 hours

1.1 Resistance, capacitance and inductance parameters and their terminal properties.
1.2 Voltage and current sources – dependent and independent.
1.3 Coupled coils.

I [1, 2]; II [5]

2. Foundations of Network Analysis
6 hours

2.1 Topological descriptions of networks.
2.2 KCL, KVL.
2.3 Number of network equations.
2.4 Source transformations.
2.5 Examples of formulation of network equations.
2.6 Loop and node variable analysis and their solutions.
2.7 Duality.

I [2, 3]

3. Transient Response
6 hours

3.1 RL and RC networks – free and forced responses , initial conditions.
3.2 RLC networks – free and forced responses, initial conditions.
3.3 Transient response and s-plane roots.
3.4 Continuity of current in coupled coils on switching.

I [4, 5], II [5]

4. Transform Methods, Network Functions, Network Theorems
6 Hours

4.1 Concept of complex frequency.
4.2 Transform impedance and transformed circuits.
4.3 Superposition and reciprocity.

4.4 Thevenin's and Norton's theorems.
4.5 Network functions for one and two-ports.
4.6 Calculation of network functions.
4.7 Poles and zeros.
4.8 Time domain behaviour from pole zero plots.

I [9, 10]; II [7]

5. Sinusoidal Steady State Analysis
3 hours

5.1 Meaning of the term.
5.2 Sinusoidal analysis using exp(jwt) excitation.
5.3 Phasors and phasor diagrams.

I [12]

6. Energy and Power
3 hours

6.1 Energy and power in L, C and R elements.
6.2 Effective and RMS values.
6.3 Average and complex power.
6.4 Maximum power transfer theorem and its applications.
6.5 Tellegen's theorem.

I [14]

7. Resonance
6 hours

7.1 Amplitude and phase response, minimum phase functions.
7.2 Single tuned circuits.
7.3 Double tuned circuits.
7.4 Poles, zeros and time delay.

II [8]

8. Two-port Networks
9 hours

8.1 Two-port parameters (z, y, h, ABCD) and their interrelationships.
8.2 Transfer functions using two-port parameters.
8.3 Interconnection of two-ports.
8.4 Analysis of ladder networks.

II [9]

9. Elements of Realizability Theory
3 hours

9.1 Causality and stability.
9.2 Hurwitz polynomials.
9.3 Positive real functions.

9.4 Elementary synthesis procedures.

II [10]

10. Synthesis of Two Element Kind One ports 6 hours

10.1 Properties of LC immittance functions.
10.2 Synthesis of LC Driving Point Immittances (DPI).
10.3 Properties of RC DPI's .
10.4 Synthesis of RC DPI's.
10.5 Properties and synthesis of RL DPI's.
10.6 Synthesis of certain RLC DPI's.

II [11]

11. Elements of Transfer Function Synthesis
6 hours

11.1 Properties of transfer functions.
11.2 Zeros of transmission.
11.3 Synthesis of transfer immittances with resistive termination.
11.4 Constant resistance networks.

II[12]

12. Approximation Theory
3 hours

12.1 Maximally flat low pass filter approximation.
12.2 Chebyshev approximation.
12.3 Synthesis of low-pass filters.
12.4 Magnitude and frequency scaling.
12.5 Frequency transformations (13.10).

II [13]

Text Books

I. M E Van Valkenburg, "Network Analysis", Prentice Hall of India, 1997.

II. F F Kuo, "Network Analysis and Synthesis", Wiley, 1990.

AE09 ANALOG AND DIGITAL ELECTRONICS

1. Operational Amplifiers — 9 hours

1.1 Example of Biasing an Op Amp.
1.2 Internal Structure of 741 Op Amp.
1.3 DC analysis of 741 Op Amp.
1.4 Small Signal Analysis of 741 Op Amp.
1.5 DC Level Shifting (V_{BE} multiplier).
1.6 Offset Voltages and Currents.
1.7 Measurement of Op-Amp Parameters.
1.8 Frequency Response and Gain.
1.9 Frequency Compensation .
1.10 Instrumentation Amplifiers.
1.11 MOS Operational Amplifiers.
1.12 CMOS Operational Amplifiers.

I [2 (2.4, 2.7), 7 (7.7), 8 (8.11), 9 (9.2-9.6)]; II [10 (10.4), 14 (14.7, 14.12, 14.13)]

2. Active Filters — 8 hours

2.1 Butterworth Filter: pole location, finding transfer function.
2.2 Chebyshev Filter: equiripple property, finding transfer function.
2.3 Second Order Resonator.
2.4 Single Amplifier Biquad Sections for all Types including Allpass.
2.5 Multiple Op-Amp Biquad.
2.6 Sensitivity Considerations.
2.7 Introduction to Switched Capacitor Filters.

I [12 (12.3, 12.5, 12.7-12.10)]

3. Other Analog Ics — 6 hours

3.1 The Counting Type A/D Converter.
3.2 Successive Approximation Type A/D Converter.
3.3 Flash Type A/D Converter.
3.4 Dual Slope Type A/D Converter.
3.5 Comparator Circuits and Their Applications.
3.6 Sample and Hold Circuits.
3.7 IC Power Amplifiers.
3.8 Analog Multipliers (Logarithmic multipliers).
3.9 Log and Antilog Amplifiers.

I [9 (9.9), 14 (14.8)]; II [15 (15.7-15.9), 16 (16.2, 16.5, 16.13, 16.14)]

4. Transistor as a Switch — 4 hours

4.1 Switching Characteristics of Diodes.

4.2 Switching Characteristics of BJTs.
4.3 Switching Characteristics of FETs.
4.4 Use of Schottky Diodes in Switching.

II [2 (2.9, 2.10, 2.12), 3 (3.2), 4(4.12), 5(5.3)]

5. MOS Digital Circuits **5 hours**

5.1 Basic Concepts of Logic Circuits.
5.2 NMOS Logic Circuits.
5.3 CMOS Logic Circuits.
5.4 Transmission Gates.
I [10 (10.1-10.5)]

6. Bipolar Logic Circuits **8 hours**

6.1 The BJT Inverter.
6.2 TTL Family.
6.3 TTL Families with Improved Performance.
6.4 Other TTL Logic Circuits.
6.5 ECL Family.
6.6 Interfacing Between TTL and ECL Family.

I [11 (11.7)]; II [6 (6.10, 6.11)]; III [7]

7. Combinational Digital Systems **6 hours**

7.1 Standard Gates.
7.2 Exclusive-OR, Nand and NOR gates.
7.3 Binary Adders.
7.4 Arithmetic Operations: binary subtraction.
7.5 Digital Comparators.
7.6 Parity Check Generators.
7.7 Decoder/ Demultiplexer.
7.8 Data Selector, Multiplexer.
7.9 Encoder.
7.10 ROM and its Applications.

II [6 (6.2, 6.3), 7 (7.2-7.11)]

8. Sequential Digital Systems **7 hours**

8.1 Various Types of Flip Flops.
8.2 Clocked SR flipflop.
8.3 JK, T and D flipflops.
8.4 Shift Registers and Sequence Generators.

8.5 Counters.
8.6 Applications of Counters

II [8 (8.1-8.8)]

9. LSI Systems **7 hours**

9.1 Dynamic MOS.
9.2 Programmable ROM.
9.3 Erasable PROM and EEPROM.
9.4 RAM.
9.5 Memory Cells.
9.6 Bipolar Memory Cells.
9.7 Programmable Array Logic.
9.8 PLA and Programming a PLA.
9.9 CCD.
9.10 Seven-segment Display System.

II [7(7.11, 7.12, 7.14, 7.15), 9 (9.1, 9.2, 9.4-9.8)]

Text Books

I. S.Sedra and K.C.Smith, "Microelectronic Circuits", Saunders College Publishing, Third Edition, 1991.
II. J.Millman and A.Grabel, "Microelectronics", McGraw-Hill International Edition, Second Edition, 1991.
III. H.Taub and D.Schilling,"Digital Integrated Electronics". McGraw-Hill1977.

AE10 ELECTRICAL ENGINEEING

1. Transformers **8 hours**

1.1 Construction and working principles.
1.2 Equivalent circuit.
1.3 Regulation and efficiency.
1.4 Parallel operation.
1.5 Three-phase connections.
1.6 Variable frequency operation.
1.7 Pulse transformers.
1.8 Applications.

I [3]

2. Synchronous Machines — 6 hours

2.1 Construction and working principles of generators.

2.2 Steady state characteristics.

2.3 Effect of saliency.

2.4 Synchronous motors.

2.5 Application of Synchronous machines.

I [8]

3. DC Machines — 6 hours

3.1 Construction and working principles.
3.2 Characteristics of different types of generators and motors.
3.3 Armature reaction and commutation.
3.4 Starting.
3.5 Speed control.
3.6 Application of dc motors.

I [7]

4. Induction Machines — 8 hours

4.1 Construction and working principle of three phase induction motors.
4.2 Rotating magnetic field.
4.3 Equivalent circuit.
4.4 Torque-speed characteristics.
4.5 Starting.
4.6 Speed control.
4.7 Generator operation.
4.8 Single phase induction motors.
4.9 Applications.

I [9]

5. Special Machines — 8 hours

5.1 Machines in control systems.
5.2 Synchros and servomotors.
5.3 AC tachometers.
5.4 Stepper motors.
5.5 Hysterisis motors.
5.6 Switched reluctance motors.

5.7 Universal motors.
5.8 Applications.

I [10]

6. Generation **8 hours**

6.1 Different types of generating stations- Thermal, Hydro and Nuclear, choice of system.
6.2 Cogeneration.
6.3 Gas turbines and diesel generators.
6.4 Renewable sources- solar and wind.
6.5 Energy conservation.

II [1]

7. Transmission and Distribution **8 hours**

7.1 Choice of voltage for transmission and distribution.
7.2 Characteristics of overhead lines and cables.
7.3 Voltage regulation.
7.4 HVDC transmission.
7.5 Protection system.
7.6 Switch gear and relays.
7.7 Carrier current protection and communication.
7.8 Inductive interference.

II [5, 14, 15, Appendix F]

8. Energy Storage Systems and Utilisation **8 hours**

8.1 Accumulators.
8.2 Lead acid and nickel cadmium cells.
8.3 Button cells for low power applications.
8.4 Electric heating and welding processes and their control.
8.5 Industrial drives and their control (including solid state controllers).

III

Text Books

I. I.J.Nagrath and Kothari, 'Electric Machines', Tata Mc Graw Hill, 2nd Edition, New Delhi (1999)

II. I.J.Nagrath and Kothari, 'Power System Engineering', Tata Mc Graw Hill, New Delhi (1994)

III. E.O.Taylor, 'Utilisation of Electric Energy', Orient Longmans, Bombay(1989).

Reference Books

1. H.Cotton, 'Advanced Electrical Technology', Sir Isaac Pitman and Sons, London (1974).
2. H.Cotton, 'Transmission and Distribution of Electric Energy', B. I. Publishers, New Delhi(1998)
3. P.C.Sen, 'Principles of Electric Machines and Power Electronics', Wiley Eastern (1987).

AE11 CONTROL ENGINEERING

1. Mathematical Models 6 hours

1.1 Terminology and basic structure of feedback control systems.
1.2 Concepts of state variable models, impulse response models, and transfer function (TF) models.
1.3 TF models of mechanical, electrical, thermal, and hydraulic systems.
1.4 Systems with dead-time elements.
1.5 Models of disturbances and standard test signals.
1.6 Dynamic system response to standard test signals.

I [1 (1.1-1.2), 2)]

2. Block Diagram and Signal Graph Models of Feedback Systems 9 hours

2.1 Block diagram manipulations.

2.2 Mason's gain rule.

2.3 Models of industrial control devices: DC and AC motors, techogenerators, synchros, LVDT, electrohydraulic valves, hydraulic actuators, elecropneumatic transducers, Flow control valves.

2.4 Application examples of motion control (position, and speed), and process control (temperature, and liquid-level).

I [3]

3. Basic Characteristics of Feedback Control Systems 7 hours

3.1 Stability.
3.2 Steady-state accuracy, transient accuracy.
3.3 Disturbance rejection.
3.4 Insensitivity and robustness.
3.5 Basic modes of feedback control: proportional, integral, and derivative (PID).

I [4 (4.1-4.6)]

4. Stability and Performance (Time Domain) 8 hours

4.1 Concepts of stability.
4.2 Routh stability criterion.
4.3 Performance specifications.
4.4 Steady-state error constants and system types.

I [5, 6 (6.1-6.6)]

5. Compensator Design using Root Locus Plots 6 hours

5.1 The root locus concepts.

5.2 Construction of root loci.

5.3 Phase-lag, phase-lead and lag-lead compensation.

I [7 (7.1-7.8, 7.11)]

6. Stability and Performance (Frequency Domain) 12 hours

6.1 The Nyquist stability criterion.
6.2 Stability margins.
6.3 The Bode plots.
6.4 Stability margins on the Bode plots.
6.5 Performance specifications.
6.6 Evaluating the closed-loop frequency response.
6.7 Constant-*M* circles.
6.8 Nichols chart.

I [8, 9 (9.1-9.5)]

7. Compensator Design using Frequency Response Plots 6 hours

7.1 Phase-lag, phase-lead, and lag-lead compensation.
7.2 Robust control systems.

I [10]

8. Implementation of Common Compensators 6 hours

8.1 Passive electric networks.

8.2 Op-Amp usage.

8.3 Use of digital computer as compensator device.

8.4 Tuning of PID controllers.

I [11]

Text Books

I. M.Gopal, *Control Systems: Principles and Design*, 2nd edition, New Delhi : Tata McGraw-Hill, 2002.

Reference Books

1. B.C. Kuo and F. Golnaraghi, *Automatic Control Systems*, 8th edition, John Wiley, 2003
2. K. Ogata, *Modern Control Engineering*, 4th edition, Pearson Education, 2002

AE12 INSTRUMENTATION AND MEASUREMENT

1. Measurement Fundamentals — 6 hours

1.1 Definition of measurement and instrumentation, classification of transducers.

1.2 Static Performance Characteristics: Accuracy, Static Error, Uncertainty, Precision, Repeatability, Resolution, Linearity, Span, Range, Threshold, Input and Output impedances.

1.3 Dynamic Performance Characteristics: Dynamic Error, Fidelity, Bandwidth, Speed of Response, Time Constant and Settling Time.

1.4 Error in measurement: Gross errors, Systematic errors and Random errors.

1.5 Calibration and Standards: Definition and Process of Calibration, Classification of Standards, Primary, Secondary and working standards.

I [1 (1.1-1.7)]

2. Electronic Multimeters — 4 hours

2.1 Multimeter or VOM.

2.2 Amplified DC Meter, Chopper-stabilized amplifier, series-shunt chopper using two MOSFETs.

2.3 Electronic Multimeter.

2.4 Digital Voltmeters.

II [4 (4.10), 6(6.1, 6.4, 6.7)]

3. Resistance and Impedance Bridges — 4 hours

3.1 Wheatstone bridge, Kelvin double bridge.
3.2 Capacitance comparison bridges: Schering Bridge for measurement of capacitors.
3.3 Inductance comparison bridges: Maxell, Hay and Wien bridges.
3.4 Q-Meter.

II [5 (5.1-5.11), 6(6.9)]

4. Signal Generation 5 hours

4.1 The Sine-wave generator, Frequency Synthesized Signal Generator, Frequency Divider generator.
4.2 Signal Generator Modulation.
4.3 Sweep-frequency Generator.
4.4 Pulse and Square-wave Generators, Function Generator.
4.5 Audio Frequency Signal Generation.

II [8 (8.1-8.8)]

5. Oscilloscopes 8 hours

5.1 Oscilloscope Block diagram.
5.2 Cathode Ray tube, CRT circuits.
5.3 Vertical Deflection System, Delay line, Multiple trace, Horizontal Deflection System.
5.4 Oscilloscope Probes and Transducers.
5.5 Oscilloscope techniques, Phase Angle and Time Delay Measurement, Determining Modulation Characteristics.
5.6 Special Oscilloscopes: Storage and Sampling Oscilloscopes.

II [7 (7.1-7.11)]

6. Time and Frequency Measurement 3 hours

6.1 Simple Frequency counter: Display counting, Time base, Input signal processing, Period measurement.
6.2 Measurement Errors: Gating Error, Time-base Error, Trigger level Error.
6.3 Extending the Frequency range of the Counter.

II [10 (10.1-10.3)]

7. Magnetic Measurements 4 hours

7.1 Quantities measured in Magnetism.
7.2 Measurement of Flux by Induced EMF.
7.3 Testing properties of Ferromagnetic materials: Permeability, Methods for obtaining B-H curves by DC and AC testing methods.
7.4 Obtaining Hysteresis loop of a material under AC operating conditions.

2. [9]

8. Radio Frequency Power Measurement 4 hours

8.1 Measurement of RF power: with a Thermocouple RF Ammeter, with an RF Voltmeter and by using a Toroidal core Current Transformer.
8.2 RF Power measurement using a Thermal Sensor.
8.3 Thruline RF Wattmeter.
8.4 Bolometer method of Power Measurement.

III [22 (22.4-22.6)]; 1. [20 (20.3-20.9)]

9. Receiver Measurements 5 hours

9.1 Receiver Basics, Receiver Parameters.
9.2 Measuring Sensitivity; The Quieting Method, Selectivity Measurement.
9.3 Sweep Method, Image Response.
9.4 AM Alignment.
9.5 FM Receiver Alignment.
9.6 Sweep Alignment, Nonswept Alignment, Dual sweep Alignment.

III [21(21.3-21.15)]

10. Signal Analysis Instruments 4 hours

10.1 Wave Analyzers.
10.2 Harmonic Distortion Analyzers.
10.3 Spectrum Analysis.

II [9 (9.1-9.3)]

11. Transducers 8 hours

11.1 Classification of Transducers: Input and output Transducers, Primary sensors vs. Transducers. Active and passive Transducers, Transponders.
11.2 Resistive (Strain gauge) Transducer, Inductive and Capacitive Transducers.
11.3 Thermoelectric, Piezoelectric, Photoelectric, Hall Effect and Electromechanical Transducers.

I [1 (1.4-1.5), 6(6.1-6.3), 7(7.1-7.6)]

12. Digital Data Acquisition Systems 5 hours

12.1 Digital-to-Analog Conversion.
12.2 Analog-to-Digital Conversion: Counter-type A/D Converter, Successive approximation A/D converter, Sample-and-hold circuit.
12.3 Multiplexing: Digital-to-analog Multiplexing, Analog-to digital Multiplexing.
12.4 Spatial Encoders: Encoder using a Binary Counting System, Binary-coded-decimal Disk Converter, V-brush Binary Encoder

II [12 (12.4-12.7)]

Text Books

I. D.V.S. Murty 'Transducers and Instrumentation' Prentice Hall of India Pvt. Ltd., New Delhi (2003)
II. W.D. Cooper and A.D. Helfrick ' Electronic Instrumentation and Measurement Techniques' Prentice – Hall of India Pvt. Ltd., New Delhi (1988)
III. Joseph J. Carr 'Elements of Electronic Instrumentation and Measurement", –Prentice Hall, Englewood Cliffs, New Jersey (1986)

Reference Books

1. H S Kalsi, 'Electronic Instrumentation', Tata McGraw Hill Publishing Company Ltd, New Delhi (1995)
2. I F Kinnard "Applied Electrical Measurements", John Wiley & Sons, Inc, New York(1956)

AE13 COMPUTER ENGINEERING

1. Introduction

6 hours

1. **Microcomputers and Microprocessors.**
2. **Definitions of Hardware, Software, Firmware, Batch Processing, Multiprogramming, Multiuser Systems; Difference between Dumb, Intelligent and Smart Systems.**
3. **Definitions of Distributed Processing, Parallel Processing, Flynn's Classification of Computers, Control and Data Flow Computers, RISC and CISC Computers, Some Applications of Computers.**

I [1]; III [1 (1.11-1.13, 1.15, 1.17-1.23)]

2. Computer Codes, Programming and Operating Systems

10 hours

1. Binary and Hexadecimal Number System.
2. Computer Codes.
3. Computer Programming.
4. Computer Operating Systems.
5. Some basic Commands (general, Disk and File Management) of DOS, UNIX, LINUX, WINDOWS (Basics and USER Interface), Novell NETWARE, BIOS.

I [2 (2.1-2.4), 8 (8.17, 8.20)]

3. Central Processing Unit (CPU)

12 hours

3.1 The programming model of CPU- Intel 8085, Its Pin Configuration, Instruction Cycle, Timing diagrams of fetch, read and write cycles, Its Instruction Set, Addressing Modes, Programming in Assembly Language.

3.2 Interrupts structure of 8085.

3.3 The programming model of CPU- Intel 8086/8088, Concept of Segmented Memory.

3.4 8086- Addressing Modes, Its Pin Configuration, Interrupts, Minimum mode vs. Maximum mode.

I [3 (3.1, 3.2)]; II [3 (3.1-3.3), 5, 7, 12)]; III [5 (5.13)]

4. Memory Chips and Memory Interfacing

8 hours

1. Main Memory Technologies such as ROM, EPROM, EEPROM, Flash Memory, SRAM, DRAM, memory Modules such as SIMMs, DIMMs and RIMMs.
2. Interfacing Memories to Processor such as 8085.
3. Concept of Cache memory, Associative Memory, Virtual Memory.
4. Magnetic Memories such as Hard Disk (also concept of RAID System), Floppy Disk (also concept of Soft and Hard Sectored floppies), RAM Disks.
5. Optical Disks such ad CD-ROM, CD-RAM, DVD.

I [7 (7.1)]; II [3 (3.3)] ; III [6 (6.2, 6.3, 6.6, 6.8)]

5. I/O Units

12 hours

1. Introduction to Input Devices such as keyboards Mouse, Joy Stick, Track Ball, Optical and Magnetic Scanners.

2. Introduction to Output Devices such as CRT Terminals, keyboards (also concept of Raster, Vector and Bit Mapped Scan), LED and LCD Displays, Printers: Dot Matrix, Ink Jet, Laser Line, Plotters.
3. Introduction to The Programmable Peripheral Interface- 8255.
4. Introduction to The Programmable Interval Timer/Counter -8253/8254.
5. Introduction to Programmable Interrupt Controller –8259.
6. Introduction to DMA and DMA Controller-8237

Basic Concepts in Serial Data Transfer, 8085 serial I/O lines, Introduction to USART-8251 and RS-232C standard.

5.7 Introduction to Programmable Keyboard and Display Interface –8279.

II [14 (14.3), 15 (15.1, 15.2, 15.4 -15.6), 16 (16.1, 16.3, 16.4)]; III [7 (7.1 – 7.4)]

6. Advanced Processors
6 hours

6.1 Introduction of advanced Intel Microprocessors - 80386, 80486, Pentium and P6 processors with focus on their block diagrams, programming models and different modes (real, protected and virtual 8086).

1. Brief Introduction to Other Processors such as Power PC, MIPS, CYRIX, AMD's, SUN's Ultra SPARC, Motorola series.

I [3]; III [5 (5.22-5.32)]

7. Personal Computer Architecture and Bus Systems
6 hours

7.1 Familiarization with PC/XT architecture based on 8088 processor.

7.2 Introduction to ISA, EISA and PCI bus structure.

I [11 (11.1-11.3)]

Text Books

1. The 80x86 family: Design, Programming and Interfacing, Third Edition (2002), John Uffenbeck Pearson Education.
2. Microprocessor Architecture, Programming and Applications with the 8085, Fourth Edition (2000), R. S. Gaonkar, Penram International Publishing (India).
3. Computer Fundamentals: Architecture and Organization, Third Edition (2000), B. Ram, New Age International (P) Ltd.

Reference Books

1. The Intel Microprocessors: Architecture, Programming and Interfacing, sixth edition, Barry B. Brey, Pearson Education.

AE14 ELECTROMAGNETICS AND RADIATION

1. Electrostatics **9 hours**

1.1 Coulomb's law and Gauss's law and their applications (line charge, surface charge and volume charge).
1.2 Energy in electrostatic fields.
1.3 Capacitance of parallel plate and coaxial cables.
1.4 Fields in dielectrics.
1.5 Boundary conditions.
1.6 Laplace and Poisson's equations and their applications.

I [2, 3, 4, 6]; II [4, 5]

2. Magnetostatics **6 hours**

2.1 Ampere's law and Biot-Savart's law and their applications.
2.2 Energy in magnetic field.
2.3 Boundary conditions.

I [2, 3, 4]; II [6, 7]

3. Maxwell's Equations **9 hours**

3.1 Maxwell's equations in integral form and differential form, (Gauss's law in electric and magnetic field, Ampere's circuital law, Faraday's law).

I [3, 4]; II [9]

4. Uniform Plane Waves **6 hours**

4.1 Wave equations and its solutions for free space and conducting media, surface impedance.
4.2 Power flow in an electromagnetic field , Poynting vector.
4.3 Reflection and refraction of uniform waves in conductors and dielectrics with normal and oblique incidence.

I [5, 9]; II [9, 10, 11]

5. Transmission Lines **12 hours**

5.1 Distributed parameters (R, L, C, G) for open wire and coaxial cable.
5.2 Transmission line theory : line equation and solution , lossless lines.
5.3 Voltage Standing wave ratio (VSWR), Reflection coefficient.
5.4 Transmission lines as tunned circuit elements (short circuited and open circuited line).
5.5 Matching (quarter wave transformer, single stub).

I [6, 7]

6. Rectangular Waves Guides **6 hours**

6.1 Transverse electric (TE) and Transverse magnetic (TM) waves for rectangular wave Guide.
6.2 Dominant mode, cut off frequency, guide wavelength, wave impedance, Wave guide Measurements.
6.3 Rectangular cavity resonator.

I [10]; II [13]

7. Elements of Antennas **9 hours**

7.1 Hertizian Dipole.
7.2 Radiation resistance and directivity.
7.3 Linear Antennas (half wave dipole and its radiation field and radiation resistance, linear antenna of arbitrary length).
7.4 Antenna arrays (array of two Hertizian dipoles, uniform linear array of n antennas).

I [11]; II [18, 21]

8. Elements of Wave Propagation **3 hours**

8.1 Elementary idea of ground wave, Space wave (direct wave) and Sky wave (ionospheric) propagation and their characteristics (skip distance, MUF or critical frequency, Reflection and refraction of waves by ionosphere).

II [19]

Text Books:

I. N. N. Rao, "Elements of Engineering Electromagnetics " 5th edition (2002) Prentice Hall of India. .

II. K. A. Gangadhar and P. M. Ramanathan, "Field Theory" 15th edition , 2002, Khanna Publishers.

Reference Books:

1. Dr. J. P. Tewari, " Engineering Electromagnetics (Theory, Problems and Applications)" 2nd edition, 1999, Khanna Publishers.
2. Kraus / Fleisch, " Electromagnetics with Applications", 5th edition (International) , 1999, Mc Graw Hill.
3. Jordan and Balmain, " Electromagnetic waves and Radiating Systems" 2nd edition, Prentice Hall of India.

AE15 COMMUNICATION ENGINEERING

1. Introduction to Communication Engineering **2 hours**

1.1 Information signals.
1.2 Block diagram of a communication system.
1.3 Need for modulation.
1.4 Transmitters and Receivers.
1.5 Channel noise.

II [1]

2. Noise **6 hours**

2.1 Types of noise.
2.2 Description of shot noise and thermal noise.
2.3 Available noise power.
2.4 White noise.
2.5 Noise temperature and Noise Figure.
2.6 Noise calculations.

2.7 Mathematical representation of narrowband noise.
2.8 Probability density function of the envelope of narrowband noise.

I [14]; II [2]

3. Modulated Signals — 20 hours

3.1 Need for modulation.
3.2 Types of modulation of a sinusoidal carrier.
3.3 Amplitude modulation, definition, waveform, mathematical expression.
3.4 Power relations and spectrum.
(sinusoidal carrier with a sinusoidal modulating signal)
3.5 Generation and detection of AM signals.
3.6 AM Broadcasting.
3.7 Double sideband (DSB-SC) signals.
3.8 Single sideband (SSB) signals.
3.9 Vestigial sideband (VSB) signals.
3.10 Mathematical expressions of DSB-SC, SSB and VSB signals.
(sinusoidal and arbitrary modulating signals)
3.11 Spectra.
3.12 Power and bandwidth savings.
3.13 Generation and detection methods and their complexities.
3.14 Typical applications.
3.15 Performance of AM signals in the presence of noise.
3.16 Frequency and phase modulation.
(sinusoidal carrier with sinusoidal modulating signal)
3.17 Mathematical expressions, waveforms, Power.
3.18 Spectra and bandwidth.
3.19 Narrowband and wideband FM signals.
3.20 Direct and indirect methods of generation of FM signals.
3.21 Discriminators.
3.22 Performance of WBFM signals in the presence of noise.
3.23 Pre-emphasis and de-emphasis.
3.24 FM stereophonic broadcasting.
3.25 Comparison of AM and FM signals.
3.26 Frequency division multiplexing.

I [3, 4, 8, 9]; II [3-6]

4. Pulse Modulation — 15 hours

4.1 Sampling theorem for low pass signals, its statement and proof.
4.2 Recovery of original signal from the samples.
4.3 Natural and flat top sampling.
4.4 Pulse amplitude modulated (PAM) signals.
4.5 Pulse width modulated (PWM) signals.
4.6 Pulse position modulated (PPM) signals.
4.7 Generation and detection of pulse modulation signals.
4.8 Pulse code modulation (PCM) signals.
4.9 Quantisation noise, bandwidth, trade-off, nonlinear quantisation, companding.

4.10 Delta modulation (DM) signals, slope overload, noise, bandwidth.
4.11 Adaptive delta modulation (ADM).
4.12 Baseband and modulated data signals.
4.13 Noise performance.
4.14 Optimum receiver for baseband binary data signals.

I [5, 6, 11]; II [13]

5. Information Theory and Coding 12 hours

5.1 Concept and measure of information, entropy, information rate.
5.2 Source coding (Shannon-Fano and Huffman).
5.3 Shannon's coding theorem.
5.4 Channel capacity of a Gaussian channel.
5.5 Basic error control coding.]
5.6 Block codes – Coding and decoding.
5.7 Examples of Algebraic codes.

I [13]

6. Practical Communication Systems 5 hours

6.1 Radar principle.
6.2 Range equation, Performance factors.
6.3 Pulsed radars.
6.4 Moving target indicator.
6.5 CW Doppler radar.
6.6 Phased array radar.
6.7 Television fundamentals: scanning, idea of bandwidth.
6.8 Synchronization and blanking pulses, composite video signal.
6.9 Monochrome television transmission and reception.
6.10 Colour transmission and reception.

II [16-17]

Text Books

I. Taub & Schilling: Principles of Communication Systems; McGraw Hill International 2nd Edition, 1986.
II. Kennedy: Electronic Communication Systems; Tata-McGraw Hill; 3rd Edition. 1985.

Reference Books

1. Lathi: Modern Analog and Digital Communication Systems; Holt, Rinehart and Winston, 2nd edn., 1993.
2. Skolnik: Introduction to Radar Systems; McGraw Hill. 2nd edn.,1980.
3. Gulati: Monochrome and Colour Television; Wiley Eastern, 1990.
4. Das, Mallick and Chatterjee: Principles of Digital Communications; Wiley Eastern, 1991.

AE16 INDUSTRIAL MANAGEMENT

1. Management Concept and Functions — 5 hours

1.1 Management Concept
- 1.1.1 Evolution and Development of Management Thought
- 1.1.2 Principles of Management
- 1.1.3 Levels of Management
- 1.1.4 Industrial Management

1.2 Functions of Management
- 1.2.1 Planning – types of plans, objectives of planning
- 1.2.2 Organizing
- 1.2.3 Staffing – role and definition
- 1.2.4 Directing – Concept, salient features, principles of directing
- 1.2.5 Control – Managerial control, techniques of Managerial Control

I [15]; II [3]

2. Organisation — 6 hours

2.1 Importance of Organisation
2.2 Characteristics of Organisation
2.3 Process of Organisation
2.4 Principles of Organisation
- 2.4.1 Span of Control
- 2.4.2 Delegation of Authority – Principles and Problems
- 2.4.3 Authority and Responsibility

2.5 Organisation – Structure and Need

2.6 Types of Organisation
- 2.6.1. Line Organisation
- 2.6.2 Functional Organisation
- 2.6.3 Line & Staff Organisation
- 2.6.4 Project Organisation
- 2.6.5 Matrix Organisation

I [3]; II [9, 10]

3. Organisational Behaviour — 9 hours

3.1 Group Dynamics – Concepts, Characteristics of Group, types of Groups, advantages and disadvantages of groups
3.2 Organisational Change – Causes, response and resistance to change
3.3 Organisational Development - Concept, objectives and characteristics

3.4 Organisational Conflict – Stages of conflict, causes of conflict, sources of conflict and conflict resolution

3.5 Managerial Leadership – Concept, styles of managerial leadership

3.6 Motivation – Definition, Need, factors affecting motivation, otivational techniques

3.7 Morale – Concept, high & low morale, factors affecting morale

3.8 Communication – formal & informal communication, communication channel & structure, communication process & systems, barriers to successful communication

I [3,19, 20]; II [11]

4. Personnel Management 7 hours

4.1 Principles of a good personnel policy
4.2 Recruitment and Selection
4.3 Education and Training
4.4 Labour Turnover
4.5 Wages and Salary Administration
4.6 Discipline – Causes, disciplinary action & punishment, disciplinary procedure
4.7 Grievances Handling

I [20]; II [54, 62, 63]

5. Industrial Relations and Labour Laws 8 hours

5.1 Industrial Relations

5.1.1 Trade Unions
5.1.2 Industrial Dispute
5.1.3 Strikes, lockout, Picketing & Gherao
5.1.4 Collective Bargaining
5.1.5 Workers Participation in Management
5.1.6 Union – Management Relations

5.2 Labour Laws – Essential Provisions

5.2.1 Factories Act 1948
5.2.2 Payment Of Wages Act 1943
5.2.3 Workmen Compensation Act 1943
5.2.4 Industrial Disputes Act 1947
5.2.5 Minimum Wages Act 1948

I [21, 22]; II [61, 64 – 66, 68]

6. Productivity and Quality 8 hours

6.1 Productivity - Factors affecting productivity, Increasing productivity, Productivity measures, Productivity & Quality

6.2 Production, Planning & Control – Forecasting, scheduling, control of production and process control

6.3 Quality Control – Definition, Concepts & basic fundamentals of SQC, Objectives, elements tools & implementation of TQM

6.4 Work Study – objectives, procedures, time study and work measurement

6.5 Inventory Control – Objectives, material requirement planning, ABC Analysis, EOQ and simple inventory models

I [2, 7, 8, 9, 24]; II [79, 25, 27, 34]

7. Decision Making — 7 hours

7.1 Definitions and Importance of Decision Making

7.2 Types of Decisions

7.3 Decision Making Process

7.4 Guidelines for effective decision-making

7.5 Quantitative Techniques in Decision Making

- 7.5.1 OR
- 7.5.2 Cost-Benefit Analysis
- 7.5.3 Linear Programming
- 7.5.4 Network Analysis – CPM/PERT

7.6 Decision Making under Certainty, Uncertainty and Risk

I [18]; II [81]

8. Finance and Accounting Fundamentals — 7 hours

8.1 Finance Management

- 8.1.1 Finance Management Concepts
- 8.1.2 Working Capital
- 8.1.3 Factors affecting working capital
- 8.1.4 Financial Statement and Financial Ratios

8.2 Cost Accounting

- 8.2.1 Elements of Cost
- 8.2.2 Types of Cost
- 8.2.3 Cost Control and Accounting
- 8.2.4 Break-even Analysis

8.3 Budget

- 8.3.1 Budget and Budgetary Control
- 8.3.2 Types of Budget
- 8.3.3 Preparation of Budget
- 8.3.4 Budget as a process of planning, coordination and control

I [26, 27, 28]

9. Marketing Fundamentals **3 hours**

9.1 Marketing – definition, principles and functions
9.2 Market Management and functions
9.3 Market Research
9.4 Product Packaging
9.5 Product Mix

I [31]; II [82]

Text Books

I. O.P.Khanna , ' Industrial Engineering and Management,' Dhanpat Rai and Sons, Delhi (2003).
II. K.K. Ahuja, ' Industrial Management,' Khanna Publishers, Delhi (2003).

Reference Books

1. Ravi Shankar, "Industrial Engineering and Management', Galgotia Publications Pvt Ltd, New Delhi (2003).
2. "Management Guide Series" (14 Booklets), National Productivity Council, New Delhi (1990).
3. R.S. Davar, " Personnel Management", Vikas Publshing House, Delhi (1997).

AE17 TELECOMMUNICATION SYSTEMS

1. **Introduction** **1 hour**

1.1 Evolution of Telecommunication.

I [1 (1.1)]

2. Telecommunication Switching **10 hours**

2.1 Switching Functions.

2.2 Space Division Switching.

2.3 Time Division Switching.

2.4 Two – Dimensional Switching: TS, ST, TST, STS Switches.

I [4 (4.7-4.9), 6 (6.1-6.6)]; II [5 (5.1,5.4,5.4.1,5.4.2)]

3. Subscriber Loop 6 hours

3.1 Transmission Systems: Two-wire and Four-wire transmission, Pair gain systems.

3.2 Transmission Impairments: Attenuation, interference, noise, cross-talk, distortion, Echoes.

3.3 Analog Subscriber Loop Interface, BORSCHT.

II [1 (1.2.4,1.2.5,1.2.8), 5 (5.6.2)]

4. Telecommunication Traffic 8 hours

4.1 Traffic Characterization.

4.2 Loss Systems.

4.3 Delay Systems.

I [8 (8.1, 8.2, 8.5, 8.6)]; II [12 (12.1, 12.2, 12.4,12.4.1-12.4.3)]

5. Mobile Communication 7 hours

5.1 Cell Concept.

5.2 Global System for Mobile Communication (GSM).

5.3 Code Division Multiple Access(CDMA) Cellular Systems : Channel establishment, Multipath,
Power control, Handoff.

I [9 (9.10)]; II [1 (1.2.14), 9 (9.2, 9.3)]

6. Fiber Optic Systems 10 hours

6.2 Transmission: Multimode and Single Mode fibers, Attenuation, Chromatic dispersion, Channel bandwidth

6.3 Line codes for fiber optic transmission

6.4 Wavelength division multiplexing (WDM)

6.5 Fiber System Design

6.6 Introduction to SONET / SDH

II [8 (8.1-8.5,8.5.1,8.5.2)]

7. Digital Subscriber Access 8 hours

7.1 Integrated Services Digital Network (ISDN) : Basic and primary rates, access architecture; S,T and U interfaces, D- channel

7.2 ISDN Services

7.3 Digital Subscriber Loop (DSL)

I [11 (11.3-11.6, 11.8)]; II [11 (11.1, 11.2.1)]

8. Data Networks 10 hours

8.1 WAN, MAN, LAN

8.2 PSTN

8.3 Circuit Switching, Packet Switching

8.4 Data Communication Architecture

8.5 Asynchronous Transfer Mode (ATM) networks : ATM cells, service categories, ATM connections-virtual channel and virtual path

I [10 (10.1, 10.2.1,10.2.2,10.3)]; II [10 (10.1,10.3.1-10.3.3)]

Text Books

I. T. Vishwanathan, “Telecommunication Switiching Systems and Newtorks”, Prentice-Hall of India,1992

II. J. C. Bellamy, “Digital Telephony”, John Wiley (International Student Edition), Third Edition, 2002

AE18 PROJECT

The Project will consist of hardware/software, design/development, experimental/theoretical work or a critical in-depth literature survey of a contemporary topic or a combination of these. A

student is expected to put in about six hours/week spread over a period of three to four months. There will be no joint project work.

The students may work for their project in any industry, in an educational institution, in R&D Laboratory or in a library depending upon the nature of the project. The student will be required to have a supervisor from one of these places who can supervise and guide the project work. In case of difficulties, the students may contact the Local centre.

The project work can be taken only after clearing **14 compulsory papers** of Section A & B. Such eligible students are required to submit their project applications to their Local centre with brief write up of the intended project, bio-data of their guide, guide's willingness letter to super wise the project along with a draft of Rs 1000/- as project fee. The Project applications should be submitted so as to reach their Local centre by 20 Oct/20 April. On approval of their application, Local centres will issue the approval letters to the individual students.

On completion of the project, the student will submit two bound copies of the Project Report to IETE Local Centre as per the dates intimated by the Centre. The project work will be assessed by an Assessment Board. The students will be intimated by the local centres of the venue, date & time for presentation of their project report & appearing before the Assessment Board. The result of the project will be finalized at IETE HQ and declared along with the main IETE examination result. Pass marks for the project will be 50%. Students not getting 50% marks will be required to re-register for the project following the usual procedure. The students will have the option of taking up a new project or continue with the earlier project.

AE20 MICROWAVE THEORY AND TECHNIQUES

1. Introduction **2 hours**

1.1. Introduction to Microwaves.
1.2. Microwave region and band designations.
1.3. Advantages and application of Microwaves.
1.4. Review of Electromagnetics-Maxwells Equations, Wave equations, TE and TM modes.

I [1, 2]

2. Transmission Lines **8 hours**

2.1 Review of transmission line theory.
2.2 Two wire parallel transmission lines: voltage and current relationships in a transmission line, characteristic impedance, reflection coefficient, input impedance.
2.3 Standing waves: VSWR.
2.4 Impedance matching.
2.5 Stub matching.

2.6 Smith Chart.

I [3]; II [3 (3.5, 3.6)]

3. Microwave Transmission Lines 14 hours

3.1 Multiconductor Transmission lines: Coaxial, Strip lines, micro strip lines.

3.2 Parallel striplines.

3.3 Coplanar striplines.

3.4 Shielded strip lines.

3.5 Wave guides: Rectangular, Circular wave guides, Solution of wave equations, TE, TM modes, Dominant mode, Field patterns, cut-off frequencies, wave impedance, attenuation, power handling capacities.

3.6 Open wave guide structures.

3.7 Microwave integrated circuits.

3.8 Cavity resonators: rectangular and circular cavity resonators, resonant frequency, field expressions, field patterns, quality factor, re-entrant cavity, coupling to cavities.

I [4 (4.1, 4.2 (4.2.1-4.2.5), 4.3, 4.4, 4.5), 5]; II [11 (11.1-11.4)]

4. Microwave Components 8 hours

4.1 Wave guide junctions.
4.2 Scattering parameters.
4.3 Microwave T-junctions: E, H, Magic Tees and their scattering matrices, Rat-race junction.
4.4 Directional couplers.
4.5 Wave guide joints.
4.6 Wave guide bends, corners, transitions.
4.7 Other components: twists, irises, posts and tuning screws, coupling probes and loops.
4.8 Ferrite devices: isolators, circulators, phase shifters and attenuators.

I [6]

5. Microwave Measurements 8 hours

5.1 Typical microwave bench set up.
5.2 Measurement of frequency.
5.3 Measurement of power.
5.4 Attenuation.
5.5 Phase shifter.
5.6 VSWR.
5.7 Impedance.
5.8 Insertion loss.

5.9 Dielectric constant.
5.10 Noise factor.
5.11 Q of a cavity resonator.

I [7]

6. Microwave Tubes and Semiconductor Devices — 12 hours

6.1 High frequency limitations.
6.2 Klystron amplifier.
6.3 Klystron oscillator.
6.4 TWT.
6.5 Magnetron.
6.6 Microwave transistors.
6.7 MESFETs.
6.8 Varactor diodes.
6.9 Parametric amplifiers.
6.10 PIN.
6.11 SBD.
6.12 Transferred Electron devices: Gunn diode.
6.13 Avalanche Transit Time devices: IMPATT, TRAPATT, BANTT.
6.14 MASERS.

I [8, 9]

7. Microwave Communication Systems — 8 hours

7.1 Propagation modes.
7.2 Analog microwave communications: LOS, OTH, LOS range calculation, repeaters, tropospheric wave field strength calculation.
7.3 Fading.
7.4 Duct propagation.
7.5 Digital microwave communications.
7.6 Microwave antennas.
7.7 Typical applications-satellite communications and radars as typical applications.

I [10, 11(11.1-11.7, 11.9, 11.11-11.15)]

Text Books:

I. M.Kulkarni "Microwave and Radar Engineering" Third Edition, Umesh Publications (2003)
II. S. Y. Liao "Microwave Devices and Circuits" Third Edition, PHI (1990)

Reference Books:

1. R.E.Collin "Foundations of Microwave Engineering, McGraw Hill (1992)

2. Om.P.Gandhi "Microwave Engineering and Applications" Maxwell Macmillan International Ed. (1989)

AE21 DIGITAL COMMUNICATIONS

1. Baseband Modulation **12 hours**

1.1 Sampling theorem for LP singal and BP signals. Aliasing.
1.2 Quantisation, SNR-bandwidth trade off, Compression Laws.
1.3 Pulse Code modulation (PCM).
1.4 DPCM, ADPCM, DM & ADM, Prediction filter.
1.5 M-aray Pulse modulation wave forms.
1.6 Correlative coding.

I [2]

2. Baseband Demodulation **8 hours**

2.1 Detection of binary signals in presence of Gaussian noise. Maximum likelihood.receiver. Matched filter, Realization of matched filter, Error probability.

2.2 Intersymbol interference equilization.

I [3]

3. Bandpass Modulation & Demodulation **12 hours**

3.1 Digital Bandpass modulation Technique.ASK, FSK, PSK, DPSK, MSK, QPSK,QAM.

3.2 Coherent and non coherent detection.

3.3 Error performance analysis.

I [4]

4. Channel Coding **16 hours**

4.1 Types of error control, Structured sequences.
4.2 Linear block codes.
4.3 Error detecting & correcting capability.
4.4 Cyclic codes.
4.5 Hamming Code, Extended Golay Code, BCH Code.
4.6 Convolution Code and its properties, Turbo Codes.
4.7 Decoding algorithms.
4.8 Coding for bandwidth- Constrained channels.

I [5] II [9(9.9)]

5. Spread Spectrum Technique **12 hours**

5.1 Spread spectrum overview.
5.2 Pseudonoise sequences.
5.3 DS-Spread Spectrum.
5.4 Frequency hopping.
5.5 Synchronization.
5.6 Jamming consideration.

I [12]

Text Books

I Bernard Sklar, "Digital Communication", Pearson Education, Asia

II "Communication System Engineering", John G. Proakis & Masoud Salehi, Pearson Education, Asia.

Reference Books

1. Simon Hykin, "Digital Communication", John Wiley & Sons.

AE22 SATELLITE AND SPACE COMMUNICATIONS

1. **Introduction, Brief History, Overview** **1 hour**

I [1]

2. Satellite Orbits **6 hours**

2.1 Orbital mechanics.
2.2 Look Angle determination.
2.3 Launch Vehicles: Placing satellite in geostationary orbit, geostationary transfer orbit.
2.4 Orbital effects in communications.

I [2 (2.1, 2.2, 2.5, 2.6)]

3. Propagation Effects **5 hours**

3.1 Atmospheric losses.
3.2 Ionospheric effects.
3.3 Rain attenuation.

II [4 (4.2-4.4)]

4. Satellite Link **11 hours**

4.1 Basic transmission theory : EIRP, free-space transmission.
4.2 System Noise : Noise figure, noise temperature, G/T ratio of earth station.
4.3 Downlink design, uplink design, combined uplink- down link C/N.

I [4 (4.2-4.4, 4.6-4.8)]; II [12 (12.1-12.8, 12.10)]

5. Modulation and Multiplexing **8 hours**

5.1 FM links, SCPC, FDM/FM.
5.2 Digital modulation : Baseband signals, digital carrier systems- OOK, FSK, BPSK, QPSK modulations and detection.
5.3 Carrier and bit timing recovery.
5.4 Time division multiplexing.

I [5 (5.1, 5.2, 5.6)]; II [9 (9.6), 10 (10.2-10.6)]

6. Space Segment **6 hours**

6.1 Power supply, attitude control, satellite stabilization.
6.2 Station keeping.
6.3 Transponders: Wideband receiver, demultiplexer, power amplifier, antenna subsystem.

II [7 (7.1-7.4, 7.7, 7.8)]

7. Multiple Access **10 hours**

7.1 Basic concepts.
7.2 FDMA.
7.3 TDMA.
7.4 DAMA, SPADE.
7.5 CDMA.

I [6 (6.1-6.5, 6.8)]; II [14 (14.5, 14.7, 14.9)]

8. Error Control **7 hours**

8.1 Error detection and correction.
8.2 Channel capacity.
8.3 Error control coding: Linear and cyclic block codes, Convolution codes.

I [7 (7.1-7.5)]; II [11.1-11.4)]

9. VSAT Systems **6 hours**

9.1 Overview.
9.2 Network architectures.
9.3 Access control and multiple access.

I [9 (9.2-9.5)]

Text Books

I. T. Pratt, C. Bostian, J. Allnutt, "Satellite Communications", 2nd Edition, Wiley (International Student Edition), 2003

II. D.Roddy, "Satellite Communications", 3rd Edition, McGraw-Hill

(International Student Edition), 2001

AE24 OPTOELECTRONICS & OPTICAL COMMUNICATIONS

1. Introduction **5 hours**

1.1 Advantages of Optical Fiber Communication.
1.2 Elements of Optical Fiber Communication Link.

I [1]

2. Optical Fibers **16 hours**

2.1 Ray Theory.
2.2 Step Index and Graded Index Fibers.
2.3 Propagation in Dielectric wave guides, Modes and Rays.
2.4 Slab Wave guide.
2.5 Numerical Aperture.
2.6 Attenuation.
2.7 Dispersion.
2.8 Modal Noise.
2.9 Polarization.
2.10 Fiber Cables.
2.11 Fiber Splices and Joint losses.
2.12 Connectors.

I [2 (2.1, 2.2, 2.3, 2.10), 3 (3.1, 3.2)]; II [3, 4, 5]

3. Optical Sources **12 hours**

3.1 Basic Concepts.
3.2 Optical Emission from Semiconductor Injection Lasers.
3.3 Multimode and Single Mode Injection Lasers.
3.4 Laser Characteristics.
3.5 LED's-Structures and Characteristics.
3.6 Coupling.
3.7 Modulation of Lasers and LED's.

I [4]; II [6, 7]

4. Receiver Noise **12 hours**

4.1 Photo Detector Noise.
4.2 p–i-n photodiode.
4.3 Avalanche photo diode.
4.4 Thermal Noise.
4.5 Receiver structures.
4.6 Preamplifiers.
4.7 Receiver Performance calculation.

I [6, 7(7.1, 7.2, 7.3)]; II [8]

5. Fiber Communication Systems **15 hours**

5.1 System consideration.
5.2 Link Power budget.
5.3 Rise Time budget.
5.4 Range.
5.5 System Design.
5.6 Line Coding.
5.7 LED and Laser Drive Circuits.
5.8 AGC and Equalization.
5.9 Sub carrier Modulation.
5.10 Coherent Systems.
5.11 Optical TDM.
5.12 Sub Carrier Multiplexing (SCM).
5.13 WDM Network Architectures.
5.14 SONNET/SDH.

I [8 (8.1, 8.2, 9 (9.3), 12 (12.1, 12.2, 12.3)]; II [11 (11.3, 11.9)

Text Books:

I G. Keiser, "Optical Fiber Communications", McGraw Hill Inc., 2000, 3rd edition.

II J. Senior, "Optical Fiber Communications", Prentice-Hall International, 1991

AE25 PHYSICAL ELECTRONICS AND SOLID STATE DEVICES

1. Electronics in Solids **12 hours**

1.1 Energy Bands: Insulator, Metal, Semiconductor, Intrinsic and Extrinsic Semiconductor, Direct and Indirect Semiconductor, Fermi level variation in semiconductor, Temperature dependence of carrier concentration.

1.2 Carrier Dynamics in semiconductors: Carrier Transport by drift and diffusion, Scattering, low field response, high field transport, impact ionization, band to band tunneling, charge injection and quasi Fermi levels, generation and recombination.

1.3 Carriers in electric and magnetic field: Hall Effect, Hall Coefficient, low temperature and high temperature effects.

I [3 (3.1, 3.3, 3.4)]; II [3 (3.2-3.4, 3.6, 3.7)]

2. P-N Junction Diodes 10 hours

2.1 Junction characteristics: current-voltage characteristics, capacitance-voltage characteristics, effect of temperature on characteristics, Zener and Avalanche breakdown, forward and reverse biased junctions, space charge at junction.

2.2 Transient and A-C conditions: Time variation of stored charge, reverse recovery transient, small signal equivalent circuit of diode, large signal switching of diode.

2.3 Metal-Semiconductor junctions: Schottky barriers, Schottky effect, rectifying and ohmic contacts, heterojunctions.

I [5 (5.2-5.5, 5.7, 5.8)]; II [5(5.6)]

3. Bipolar Transistors 10 hours

3.1 BJT static performance parameters: Emitter injection efficiency, base transport factor, collector efficiency and current gain.

3.2 Transient response: Cutoff, saturation, the switching cycle, frequency limitations of transistors.

3.3 Secondary effects in real devices: Early effect and punch through, thermal effects, current crowding effect, high injection and Kirk effect.

I [7 (7.6, 7.7)]; II [7 (7.4, 7.5)]

4. Field Effect Transistors 10 hours

4.1 MOS Device: MOS as capacitor, oxide and interface trapped charge, I-V characteristics, depletion and enhancement MOSFET, complementary MOSFET.

4.2 Important issues in real devices: Short channel effects, substrate bias effects, latch-up, subthreshold characteristics, leakage currents.

4.3 Charge transfer Device: The basic principle, applications.

I [6 (6.5), 9 (9.4)]; II [9 (9.3, 9.5)]

5. Microwave and Photonic Devices 10 hours

5.1 Tunnel doide, IMPATT, and Gunn diode, Varactor diode, characteristics of microwave transistor, tunnel transistor.
5.2 LED and LCD, Photodetectors, solar cells, Semiconductor Lasers.

I [5 (5.5), 7(7.8), 8, 10)]; III [3 (3.3)]

6. Integrated Circuits 8 hours

6.1 Evolution of ICs: SSI, MSI, LSI, VLSI, Monolithic and Hybrid circuits.

6.2 Monolothic IC Process: Crystal growth, wafer preparation, metallization testing, bonding, packaging.

I [1 (1.1, 1.3), 9(9.1, 9.2, 9.6)]

Text Books

I. Ben G. Streetman and Sanjay Banerjee, "Solid State Electronic Devices", Prentice-Hall of India Private Limited (2001)

II. Jasprit Singh, "Semiconductor Devices - Basic Principles", John Wiley & Sons,Inc.(2002)

III. S M Sze, "Physics of Semiconductor Devices", John Wiley &Sons (1999)

AE26 POWER ELECTRONICS

1. Thyristor and other Power Semiconductor Devices 8 hours

1.1 Devices belonging to the thyristor family: Thyristor, Triac, GTO thyristor, MOS-controlled thyristor, Static Induction Thyristor.
1.2 Two-transistor model of a Thyristor, Thyristor Characteristics, Gating Requirements, Thyristor Firing Circuits and their Control Features, UJT, PUT.
1.3 Thyristor turn-on and turn-off Mechanisms, Ratings, Losses and Cooling.
1.4 Series and Parallel operation of Thyristors, Overcurrent and Overvoltage Protection; di/dt and dv/dt Protection.
1.5 Other Power Electronic Devices: Power transistor, Power MOSFET, IGBT.

I [1 (1.2-1.11), 10 (10.1, 10.2)]; II [4(4.2-4.13)]

2. Controlled Rectifier Circuits and Converter operation 8 hours

2.1 Single-phase Half-wave, Bi-phase Half-wave and Single-phase Bridge (or full-wave) configurations.
2.2 Three-phase Half-wave, Six-phase Half-wave and Three phase Bridge (or full wave) Configurations, twelve-pulse circuits.
2.3 Transformer Ratings for Rectifying circuits.
2.4 Inverting mode of a Converter, Regulation.
2.5 Three-phase Dual converters; Power Factor Improvement techniques: Extinction angle control, Symmetrical angle control, Pulse Width Modulation (PWM), Sinusoidal PWM.
2.6 Design of converter circuits, effect of load and source impedances (overlap), Gating Circuits.

I [2 (2.1-2.11), 3 (3.1-3.4)], II [5(5.1-5.4)]

3. D C Choppers 8 hours

3.1 Principles of Step-down Choppers and their operation with RL load, Step-up choppers.
3.2 Chopper classification, class A, B, C, D and E Choppers.
3.3 Switching mode Regulators: Buck, Boost, Buck-boost and Cu'k Regulators.
3.4 Thyristor Chopper circuits: Impulse-commutated choppers, Effects of source and load inductance, Resonant Pulse Choppers.
3.5 Chopper circuit design.

II [9 (9.1-9.9)]

4. Thyristor Commutation Techniques 6 hours

4.1 Natural commutation techniques.
4.2 Forced-commutation techniques: Self, Impulse, Resonant pulse, Complementary, External pulse, Load side and Line side Commutation circuits.
4.3 Commutation circuit design.

II [7 (7.1-7.4)]

5. A C Voltage Controllers 8 hours

5.1 On-off and Phase control principles.
5.2 Single-phase AC controllers with Resistive and Inductive loads.
5.3 Three-phase AC controllers: Half-wave, Full-wave and Bidirectional delta connection configurations.
5.4 Single-phase Transformer-tap changers.
5.5 Design of AC Voltage-controller circuits.
5.6 Effects of Source and Load Inductances.

II [6 (6.1-6.9, 6.11-6.13)]

6. Cycloconverters **8 hours**

6.1 Principle of a Single-phase Cycloconverter.
6.2 Blocked Group Operation.
6.3 Circulating current mode.
6.4 Control of a cycloconverter.
6.5 Three-phase cycloconverters, Reduction of output harmonics.

I [5 (5.1)]; II [6 (6.10)]

7. Inverter Circuits **8 hours**

7.1 Single-phase Center-tapped Inverter.
7.2 Single-phase Half-bridge and bridge configurations.
7.3 Three-phase Inverters: 180-degree and 120-degree conduction.
7.4 Voltage control of Single-phase Inverters: Single PWM, Multiple PWM and Sinusoidal PWM.
7.5 Voltage control of Three-phase Inverters.

I [5 (5.3)]; II [10 (10.1-10.7)]

8. D C and A C Drives **6 hours**

8.1 Basic Characteristics and Operating modes of D C Motors.
8.2 Single-phase and three-phase Converter Drives.
8.3 Chopper Drives, principles of Regenerative Braking and Rheostatic Braking controls.
8.4 Induction Motor Drives and their Performance Characteristics.
8.5 Speed and Torque variation using the various controls: Stator voltage, Rotor-voltage, Frequency and Stator Current controls.
8.6 Industrial Applications of DC and AC Drives.
8.7 Microprocessors in the control of Electrical Drives.

I [8 (8.6), 9(9.12)]; II [14 (14.1-14.6), 15 (15.1-15.2)]; III [7 (7.1-7.6)]

Text Books

I. Cyril W Lander, "Power Electronics", McGraw Hill Book company, Singapore (1993).

II. Muhammad H Rashid, "Power Electronics-Circuits, Devices and Applications", New Delhi, 2001.

III. Vedam Subrahmanyam, "Thyristor Control of Electric Drives", New Delhi,1998

AE27 DIGITAL HARDWARE DESIGN

1. Introduction **3 hours**

1.1 Digital System : Definition of combinational and sequential system from the behavioral and structural point of view.

1.1.1 Analog & Digital signals.

1.1.2 Pulse and Level signals.

1.2 Introduction to specification and implementation of Digital system; structured analysis and design.

1.3 Computer-Aided Design Tools.

I [1]

2. Combinational System **15 hours**

2.1 Introduction to combinational system and specification levels, High level specification of combinational system.

2.2 Data representation and coding.

2.3 Switching algebra and switching functions.

2.4 Cannonical forms and functional properties.

2.5 Minimal functions and their properties.

2.6 Karnaugh's map method and tabulation technique.

2.6.1 Involvement of don't care terms.

2.7 Multiple output switching functions and their minimization

2.8 Gated implementations of various combinational circuits.

2.9 Functional decomposition.

2.10 Symmetric functions and their identification.

2.11 Introduction to threshold logic and unate functions.

2.11.1 Identification and realization of threshold functions.

I [2]; II [4, 6, 7] & 1, 2

3. Introduction to VHDL (VHSIC Hardware Description Language) **9 hours**

3.1 Basic Terminology.

3.1.1 Entity Declaration.

3.1.2 Architecture Body.

3.2 Behavioral style of modeling.
3.3 Data flow style of modeling.
3.4 Structural style of modeling.
3.5 Mixed style of modeling.
3.6 Specification using VHDL.

III [2]; I[2]

4. Modular Design Concept — 12 hours

4.1 Standard combinational modules and their high level descriptions.
- 4.1.1 Binary Decoders.
- 4.1.2 Binary Encoders.
- 4.1.3 Priority Encoders.
- 4.1.4 Multiplexers.
- 4.1.5 Demultiplexers.

4.2 Decoder Networks.
4.3 Multiplexer as universal module.
4.4 Standard sequential modules and their high level descriptions.
- 4.4.1 Registers.
- 4.4.2 Shift Registers.
- 4.4.3 Counters.

4.5 Studies on programmable modules.
- 4.5.1 Read only memories (ROM).
- 4.5.2 Implementation of Digital system with ROMs.

4.6 Programmable sequential arrays.
4.7 Studies on PLDs.
- 4.7.1 Introduction to PAL and GAL devices.
- 4.7.2 FPGA (Field Programmable Gate Arrays).

I [9, 11, 12]; 2(12)

5. Sequential Machines — 12 hours

5.1 Finite State Machine.
- 5.1.1 Definitions, Pulse mode and Fundamental mode of operation, deterministic machines.
- 5.1.2 Flow table and transition diagrams, Mealy and Moore model machines.

5.2 Realization of Flow table/ Transition Diagram from verbal descriptions.
5.3 Minimization of flow tables for completely specified and incompletely specified synchronous sequential machines.
5.4 Simple state assignment techniques.
5.5 Introduction to Asynchronous Sequential Machines, Hazard & Races.

II [9, 10, 12]; 1 [5]

6. Introduction of Algorithm State Machines — 9 hours

6.1 ASM Charts and ASM Blocks.
6.2 Data Subsystem.
6.3 Control Subsystem.
6.4 Design examples.
6.5 Microprogrammed controller.
6.5.1 Structure of Microprogrammed controller.
6.5.2 Micro instruction format.
6.5.3 Micro instruction sequencing and timing.

I [14]; 3[8]

Text Books

I. M.D. Ereegovac, T Lang, J H Moreno, 'Introduction to Digital Systems' John Wiley and Sons (Asia) Pte, Ltd,
II. Z. Kohavi, ' Switching and Finite Automata Theory' Tata McGraw Hill,1994.
III. J. Bhaskar, 'A VHDL Primer' Pearson Education Asia Pte Ltd., Indian Branch)/(Addison Wesley Longman Singapore Pte.Ltd.,)

Reference Books

1. S.C. Lee, 'Digital Circuits and Logic Design, Prentice Hall of India.
2. R.J. Tocci and Neal S. Widmer, 'Digital Systems Principles and Applications' Pearson Edu. Asia.
3. R.K. Dueck, 'Digital Design with CPLD Applications and VHDL' Delmar Thomson Learning.

AE28 COMPUTER NETWORKS

1 Introduction **4 hours**

1.1 Evolution of Network Architecture and Services
1.2 Future Network Architectures and Their Services
1.3 Examples of Protocols, Services, and Layering
1.4 The OSI Reference Model
1.5 Overview of TCP/IP Architecture
1.6 Application Layer protocols and TCP/IP Utilities

I [1 (1.1,1.2), 2]

2 Switching and Multiplexing **6 hours**

2.1 Circuit, switching

2.2 Packet switching
2.3 Multiplexing (FDM, Synchronous TDM, Statistical muxing, Asymmetrical Digital Subscriber Line-ADSL, xDSL)

II [8, 9, 10]

3 Peer to peer protocols and Data Link Layer 8 hours

3.1 Peer-to-Peer Protocols and Service Models
3.2 ARQ Protocols and Reliable Data Transfer Service
3.3 Other Peer-to-Peer Protocols
3.4 Data Link Controls (Framing, Point-to-Point Protocol, HDLC Data Link Control)

I [4 (4.1-4.3)]

4 LANs and MAC protocols 6 hours

4.1 Multiple Access Communications
4.2 Local Area Networks
4.3 Random Access,
4.4 Scheduling Approaches to Medium Access Control,
4.5 LAN Protocols (Ethernet and IEEE 802.3 LAN Standard, Token-Ring and IEEE 802.4 LAN Standard)
4.6 FDDI
4.7 Wireless LANs (IEEE 802.11 Standard)
4.8 LAN Bridges.

I [6 (6.1-6.3, 6.6, 6.7)]

5 Packet Switching Networks 8 hours

5.1 Network Services and Internal Network Operation
5.2 M/M/1 Queues(Little's Formula)
5.3 Packet Network Topology
5.4 Data grams and Virtual Circuits,
5.5 Routing in Packet Networks
5.6 Shortest-Path Routing Algorithms

I [7 (7.1 – 7.4) & Appendix A]

6 TCP/IP Networks 8 hours

6.1 The TCP/IP Architecture
6.2 The Internet Protocol
6.3 IPv6
6.4 User Data gram Protocol
6.5 Transmission Control Protocol
6.6 Internet Routing Protocols

6.7 Multicast Routing
6.8 DHCP and Mobile IP
6.9 Internet Routing protocols
6.10 Multicast Routing

I [8]

7 ISDN and ATM Networks 6 hours

7.1 Overview of ISDN (ISDN Channels, User Access, ISDN protocols, Broadband ISDN)
7.2 BISDN Reference Model
7.3 ATM Layer
7.4 ATM adaptation Layer
7.5 ATM Signaling
7.6 PNNI Routing

I [9]; II [Appendix A]

8 Network Security and distributed applications 8 hours

8.1 Security requirements and attacks
8.2 Encryption, authentication, digital signatures
8.3 Ipv4 and Ipv6 security
8.4 ASN.1, SNMP, SMTP, MIME, HTTP

II [18, 19]

9 Advanced Network Architectures/Protocols 6 hours

9.1 IP forwarding Architectures
9.2 Overlay Model
9.3 MPLS
9.4 Integrated services in the Internet
9.5 RSVP
9.6 Differentiated Services
9.7 Real-Time Transport Protocol
9.8 Session Control Protocols

I [10, 12(12.3,12.4)]

Text Books

I. Leon Garcia and Widjaja., Communication Networks,2/e, Tata McGraw-Hill,2003

II. Stallings W. Data and Computer Communications. PHI Ltd Sixth Edition, 2003

5 Reference Books

1. Behrouz, Forouzan, Data Communication and Networking TMH 1999
2. W.L.Scheweber "Data Communications" McGraw-Hill International Student Edition, 1999
3. U. Black, "Data Communications" PHI 1999

AE35 MATHEMATICS—II

1. Complex Analysis **22 hours**

1.1 Analytic function, Cauchy- Riemann equations, Elementary functions of complex variable, Harmonic functions.
1.2 Conformal mapping, Linear fractional transformations.
1.3 Complex line integral, Cauchy integral theorem,Cauchy integral formula, Cauchy inequality, Lioville and Morera theorems.
1.4 Taylor and Laurent series, Singularities and zeros, Poles, Residues and Residue theorem.
1.5 Evaluation of real integrals by contour integration.

I [12, 13, 14, 15]; II [10, 11, 12, 13, 14]

2. Vector Analysis **20 hours**

2.1 Vector and scalar function and fields, Differentiation of vector function, Tangent vector to a curve in space.
2.2 Gradient, Divergence, Curl.
2.3 Line integral of vector functions, Independence of path, Green's theorem.
2.4 Surface integrals, Divergence theorem, Stoke's theorem.

I [8, 9]; II [15]

3. Partial Differential Equations **8 hours**

3.1 Solution of Partial Differential Equations by method of separation of variables.
3.2 One dimensional wave and heat conduction equation, Laplace equation in two variables.

I [11]; II [9]

4. Probability Concepts **10 hours**

4.1 Random variable, Probability mass function and density function.

4.2 Expectation, Mean and variance of a random variable.
4.3 Binomial, Poisson and Normal distributions.

I [22]

Text Books

I. Erwin Kreyszig, "Advanced Engineering Mathematics" 8th edition, John Wiley and Sons (Asia) --- 2000

II. R. K. Jain and S. R. K. Iyengar, "Advanced Engineering Mathematics", Narosa Publishing House --- 2002

Reference Books

1. Peter V. O'neil, "Advanced Engineering Mathematics" 4th edition Brooks / Cole Publishing Company ---1995
