

CORE COURSES IN PHYSICS

SEMESTER-I
BPC-11

(MATHEMATICAL METHODS – I)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. **Vector Analysis:** Motivations, Definition of a vector, Dot and Cross Products; Scalar triple product; Vector triple product, Reciprocal vectors, Applications in Physical systems; Vector Differentiation and Integration; Line, surface and Volume Integrals; Gradient, Divergence and Curl; Gauss, Green's and Stokes' Theorems and Applications. (15)
2. **Coordinate Systems:** Curvilinear Coordinates, Differential Vector Operators; Orthogonal Coordinate Systems – Rectangular Cartesian Coordinates, Spherical Polar Coordinates, Cylindrical Coordinates, Jacobian of transformation, Gradient, Divergence, Curl and Laplacian in curvilinear coordinates (10)
3. **Fourier Series:** Real and complex expansions, Odd and even functions, half-range expansions, Dirichlet condition, Gibb's phenomenon, Parseval's theorem, Convergence of Fourier series, Fourier integrals. (8)
- 4.a. **Ordinary Differential Equations:** Basic Concepts and ideas, separable equations, equations reducible to separable form, exact differential equations, integrating factors, linear first-order differential equations, homogeneous linear equations of the second order, homogeneous second order equations with constant coefficients. Characteristic equations, SHM – free, forced and damped systems. Non-homogeneous equations. (10)
- b. **Elements of partial differential equations:** Separation of variables, Laplace equation, Fourier equations for Heat conduction, wave equation. (7)

Recommended References:

1. Mathematical methods for Physicists: Arfken and Weber. Elsevier
2. Mathematical methods of physics – J Mathews and R I Walker (Pearson)
3. Advanced Engineering Mathematics -- Erwin Kreyszig, Wiley Eastern University Edition
4. Mathematics for Physicists – Dennery and Krzywicki (Dover)
5. Introduction to mathematical physics: C. Harper. (Eastern Economic Ed. PHI)
6. Mathematical methods for physics and Engineering: Riley, Hobson, Bence (CUP, Indian ed)
7. Mathematical Methods in the Physical Sciences: Mary L. Boas, (Wiley)
8. Mathematical tools for Physics – J Nearing, downloadable from www.physics.miami.edu/nearing/mathmethods
9. Mathematical Physics – P K Chattopadhyay (New Age)
10. Vector and Tensor Analysis with applications – Borisenko and Tarapov (Dover)
11. Vector Analysis – MR Spiegel (Schaum series)
12. Fourier Transform – M. R. Spiegel (Schaum series)
13. Mathematical Physics – Ajoy Ghatak, Goyal and Chua (McMillan)
14. Differential equations – MR Spiegel (Schaum series)
15. Differential Equations – Simmons, Tata-McGrawHill
16. Differential Equations – Simmons and Kantz, Tata-McGrawHill

SEMESTER-I
BPC – 12

(MECHANICS & GENERAL PROPERTIES OF MATTER)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. Units and Dimensions, Dimensional analysis. (3)
2. **Reference frames:** Inertial and non-inertial frames of references, Galilean transformation equations, applications to rotating frames, centripetal and Coriolis accelerations. (5)
3. **Rigid Bodies:** System of particles, center of mass, angular momentum, equations of motion, conservation theorems for energy, momentum and angular momentum of rigid bodies, degrees of freedom, Euler's equations, Moments and products of inertia, parallel and perpendicular axes theorem, equation of motion for rotation, moment of inertia of regular rigid bodies about different axes. (9)
4. **Gravitation:** Inertial and Gravitational mass, Principle of equivalence and Einstein's thought experiments, Gravitational potential and intensity, Gauss's law, applications of Gauss's law, Poisson's equation, Laplace's equation, gravitational self energy, gravitational field and potential due to spherical bodies. (8)
5. **Elasticity:** Stress, strain and elastic constants for an isotropic solid, interrelationships between the various elastic constants, Torsion of a cylinder and torsional rigidity, Bending of beams and cantilevers, flexural rigidity, geometrical moment of inertia, strain-energy relations. (8)
6. **Viscosity and fluid dynamics:** Viscous fluids, definition of viscosity coefficient and Newton's law, streamline and turbulent flow, flow through a capillary tube and Poiseuille's equation, Reynold's number, Stoke's method and terminal velocity, Equation of continuity in differential form, Bernoulli's theorem and its applications, Toricelli's theorem, velocity of efflux. (9)
7. **Surface Tension:** Surface energy and surface tension, thermodynamic interpretation surface energy, molecular theory of surface tension, capillarity and rise of liquid in a tube of insufficient length, Jurin's law, excess pressure caused inside the curved surface of a liquid, work done for blowing of bubble, spreading and gathering of liquid. (8)

Recommended References:

1. Fundamentals of Physics, D. Halliday, R. Resnick and J. Walker 5th Ed, John Wiley & Sons.
2. Berkley Physics Vol. I.
3. Feynman Lectures in Physics Vol. I.
4. An Introduction to Mechanics, D. Kleppner and R.J. Kolenkov, Tata McGraw Hill Publication

SEMESTER-I
BPC-13

(THERMAL PHYSICS)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. **Kinetic theory of gases:** Ideal gas equation, Pressure of a gas, Kinetic interpretation of temperature, Concept of probability, Total and compound probability, Maxwell's law of distribution of velocities – its verification, Mean free path and its experimental determination, Degrees of freedom, equipartition of energy and its application to specific heat, experimental study of isotherms of real gases, van der Waal's equation of state, Virial coefficients. [12]

2. **Thermodynamics:** Thermodynamic equilibrium, work, indicator diagram, state function, exact and inexact differentials, First law of thermodynamics – its applications, Reversible and irreversible processes, Isothermal and adiabatic changes of ideal and real gases, Second law of thermodynamics, Carnot's theorem, Kelvin scale of temperature, Concept of entropy, principle of increase of entropy, Maxwell's thermodynamic relations, their applications and physical interpretation, Clausius-Clapeyron equation, Variation of latent heat with temperature, First-order phase transition, Triple point of water. [18]

3. **Transport properties:** Viscosity, conductivity and diffusion, Brownian motion. [5]

4. **Conduction of heat:** Conductivity and diffusivity, Fourier equation of propagation of heat in isotropic homogeneous medium, its solution for rectilinear and radial flow, periodic flow of heat, Weidemann-Franz law. [5]

5. **Radiation:** Emission and absorption, Kirchhoff's law, Black-body, Stefan-Boltzmann law, Wien's law, Rayleigh-Jeans law, Ultraviolet catastrophe, Planck's theory of black body radiation, solar radiation and temperature of the sun. [5]

6. **Low temperature phenomena:** Joule-Thomson effect, Principle of refrigeration, Principle of adiabatic cooling, Liquid helium and its properties, Second order phase transition, Nernst heat theorem and third law of thermodynamics. [5]

Recommended References:

1. Heat and Thermodynamics: Zeemansky and Dittman
2. Fundamentals of statistical and thermal physics: Frederick Reiff
3. Thermodynamics: H.B. Callen
4. A Treatise on Heat: Saha and Srivastava

SEMESTER-II
BPC-21

(ELECTRICITY & MAGNETISM-I)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. **Electrostatics in Vacuum:** Electric charge, conservation and quantization of charge, Coulomb's law, electric field, electric flux, Gauss's law and its application to field problems, mechanical force on a charged conductor. Electric Potential: Resume of vector algebra. Line integral of electric field, potential difference and the potential function, relation between field and potential, potential and field due to various charge distribution, electric dipole and quadrupole. (12)

2. **Electrostatics in dielectric media:** Dielectrics, polarization, bound charges, Gauss's law in dielectric, electric susceptibility and electric displacement, Linear dielectrics, boundary conditions at the dielectric surface, energy density in electrostatic field, microscopic theory of dielectric polarizability, Clausius-Mossotti relation, atomic radius from dielectric constant, polar molecules and Langevin-Debye formula. (8)

3. **Capacitance and Condensers:** Capacitance of parallel-plate, spherical and cylindrical capacitors with and without dielectrics, loss of energy in sharing charges. (3)

4. **Poisson's and Laplace's Equations:** Derivations, Earnshaw's Theorem, Application of Laplace's equation in spherical and cylindrically symmetric problem. Conducting sphere in uniform field. (5)

5. **Electrical Images:** Point charge near a conducting plane, point charge near a conducting Sphere, Induced surface charge, Force and energy. (4)

6. **Steady Current:** Current density, Electrical conduction in a metal, Ohm's law, Resistance and resistivity, Electromotive force, Kirchhoff's laws and their applications (4)

7. **Magnetic effect of steady current:** Force exerted by a magnetic field on a moving Charge, Ampere's law, Biot-Savart law, Calculations of Magnetic Inductions for a various current configurations, Helmholtz double coil galvanometer, Force between long parallel current carrying conductors, Torque on a current loop. (8)

8. **Electromagnetic Induction:** Faraday's law, Lenz's law, Self inductance and mutual inductance-calculations in simple cases, measurement of magnetic flux, energy stored in a magnetic field. (6)

Recommended References:

1. Electricity and Magnetism (vol-I) - Fewkes and Yarwood
2. Berkeley Physics Course (Vol-II)
3. Electricity and Magnetism- C.J Smith
4. Introduction to electrodynamics-David J. Griffiths.
5. Physics (Vol-II) - Halliday and Resnick

SEMESTER-II
BPC-22

(WAVES & GEOMETRICAL OPTICS)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

OSCILLATIONS & WAVES:

1. Free oscillation of simple system with one degree of freedom, general equation of motion, longitudinal and transverse oscillation of a mass between two springs, slinky approximation, small oscillations approximation. (5)
2. Composition of simple harmonic motion vibration, interference, beat, Linearity and superposition principles, Lissajous figures; Theory of free vibrations with damping, critical damping, Q of an oscillator, Forced oscillator with one degree of freedom, Transient and steady state oscillators, resonance, sharpness of resonance; Free oscillations of system with two degrees of freedom, coupled pendulum, Longitudinal and transverse oscillations of coupled masses. (15)
3. Fourier analysis, Fourier series and Fourier coefficients, Fourier transform, progressive and standing waves, phase and group velocity, Dispersive waves, energy and intensity of plane waves, relative and absolute intensity, Decibel and phon, classical wave equation, boundary conditions and normal modes vibration of stretched strings-plucked, struck and bowed strings, non-linear oscillations, combination tones. (10)
4. Shock waves, Doppler effect, Supersonic sound waves, Ultrasonics and application of ultrasonic waves, Acoustics of building, reverberations, Sabine's formula. (5)

GEOMETRICAL OPTICS:

1. Basic concept, Fermat's principle- proof of the laws of reflection, refraction and rectilinear propagation of light. (3)
2. Refraction at spherical surfaces, aplanatic surface, aplanatic foci, Helmholtz's relation of magnification, theory of thin lens, Two thin lenses separated by a distance, Matrix method in paraxial optics, Matrix description of image formation, thick lens, cardinal point, nodal slide. (6)
3. Aberration of light, spherical aberration and other monochromatic defects, causes and corrections, chromatic aberration, dispersive power, achromatic doublet, case of two separated lenses, Ramsden and Huygens eyepieces. (6)

Recommended References:

1. Berkeley Physics Course, Vol III (Waves).
2. The physics of waves and oscillation, N.K.Bajaj (Tata McGraw-Hill, New Delhi)
3. A text book on waves and acoustic, P.K.Chakrabarty and S.Choudhury (New Central Book Agency, Kolkata)
4. Optics, A.Ghatak (Tata McGraw-Hill, NewDelhi)
5. Geometrical and Physical Optics, R.S.Longhurst.
6. The Feynman Lectures on Physics, Vol.I

SEMESTER-II
BPC- 23

LABORATORY I

Full Marks: 50 (40 +10)

CP: 4

1. Determination of “g” by Kater's pendulum.
2. Determination of “g” by bar pendulum.
3. Determination of surface tension by capillary tube method and verification of Jurin's law.
4. Variation of surface tension with temperature by Jaeger's method.
5. Calibration of ammeter by potential drop method.
6. Determination of coefficient of viscosity Poiseuille's method.
7. Determination of coefficient of viscosity by Stoke's method
8. Comparison of two low resistances by potential drop method.
9. Determination of Young's Modulus (Y), Rigidity Modulus (n) & Poisson's ratio of a wire by Searle's method.
10. Determination of the Young's modulus of a beam by Flexure method.
11. Calibration of ammeter by copper deposition method.
12. Calibration of ammeter by potential drop method.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-III
BPC-31

(MATHEMATICAL METHODS – II)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. **Matrices:** Special types of Matrices – Unitary, Hermitean, orthogonal, symmetric and skew symmetric, matrices as operators – rotation matrix, Eigen values and eigenvectors of matrices. (5)

2. **Linear Vector Spaces:** Definitions, subspaces, Linear independence, bases of vector spaces, dimensions, linear transformations, the algebra of transformations, function space, space of infinite dimensionality. (10)

3. **Probability and Statistics:** Introduction, statistical distributions. Second moments and standard deviation, definitions of probability, fundamental laws of probability, discrete probability distributions, combinations and permutations, Stirling's approximations for the factorial, continuous distributions, expectation. The binomial distribution, the Poisson and Gaussian distribution. (10)

4. **Complex Analysis:** Complex Number System, Fundamental operations and the axiomatic foundations of complex algebra, graphical representation, polar form, De Moivre's theorem, roots of complex numbers, Euler's formula, n-th root of unity, polynomial equations, variables and functions, single and multiple valued functions, inverse functions, elementary functions. Functions of a complex variable, analytical functions, Cauchy-Riemann conditions, Taylor and Laurent Series, Singularities and zeros – pole, branch point, and branch cut. Calculus of residue and evaluation of integrals, Mapping, Conformal mapping (25)

Recommended References:

1. Matrices and Tensors in Physics – A W Joshi (New Age)
2. An introduction to Probability Theory & its Applications, William Feller, Volume I, Wiley Eastern Limited.
3. Theory and problem of probability and statistics – M R Spiegel (Schaum series)
4. The world is built on probability, Lev Tarasov, Mir Publishers, Moscow
5. Schaum's outline of theory and problems of complex variables with an introduction to conformal mapping and its applications, Murray R. Spiegel, McGraw-Hill
6. Complex Variables and Applications: R V Churchill and J W Brown, (McGraw-Hill)
7. Complex analysis for mathematics and Engineering , J. H. Mathews , R. W. Howell, Jones and Bartlett Publishers.
8. Complex analysis, L. V. Ahlfors, McGraw-Hill International Edition
9. Foundations of Complex Analysis S. Ponnusamy, Narosa Publishing House.
10. Complex Variables: Theory and Applications, H. S. Kasana, Prentice Hall of India Pvt Ltd.
11. Complex variables – Ablowitz and Fokas (CUP)
12. Also see the list of books recommended for course BPC- 11

SEMESTER-III
BPC-32

(ELECTRONICS I)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. **Network:** Definition, mesh and nodal methods, two port network, T and circuits and their transformations, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem. (7)

2. **Thermionic emission and vacuum tubes:** Electron emission from solid, Richardson-Dushman equation, Space charge effects and Child-Langmuir law, structure and characteristics of vacuum diode and triode (5)

3. **Semiconductor Physics:** Electrical conductivity of materials, metal, insulator and semiconductor, elemental and compound semiconductor, intrinsic and extrinsic semiconductor, concept of hole, law of mass action, density of majority and minority carriers, effective mass and mobility of holes and electrons, energy band concept, band diagram, direct and indirect band-gap semiconductor. (6)

4. **Semiconductor diodes:** Formation of p-n junction, electric field distribution at junctions, contact potential and depletion layer, Derivation of diode equation, forward and reverse biased junction, half wave, full-wave and bridge rectifiers, rectifier with filter (C, L and), diode characteristics and load line, diode clamping and clipping circuit. Zener diode, use of zener diode as a voltage regulator. (7)

5. **Transistors:** Bipolar Junction transistor: n-p-n and p-n-p transistors, Mechanism of current flow, current gains α and β and the relations, Characteristics in CE, CB and CC mode, Load line analysis of transistor, DC and AC load line, Q point, Active, cut-off and saturation region, amplifying action of a transistor. Junction field effect transistor: Structure of JFET and their characteristics, pinch-off, structure of MOSFET and their characteristics. (9)

6. **Special Purpose Devices:** P-N junction for optoelectronic devices (LED, photodiode, Solar cell) tunnel diode, SCR, Diac, Triac, metal-semiconductor junction. (4)

7. **Modulation and Demodulation:** Types of modulation, Amplitude modulation, modulation index, Analysis of amplitude modulated wave, idea of frequency and phase modulation, demodulation. (4)

8. **Radio Wave Propagation:** Elements of communication systems, Propagation of radio waves, Ionosphere influence on radio waves, radio transmitter and receiver, Antenna, Satellite communication. (5)

9. **Introduction to CRO:** Cathode ray tube, deflection system, Waveform tracing in CRO. (3)

Recommended References:

1. J. Millman and A. Grabel, 'Microelectronics', McGraw-Hill.
2. Streetman B.G., 'Solid State Electronic Devices' Prentice Hall.
3. Electronics fundamental and application, J. Ryder.
4. Malvino, 'Electronic Principles' Tata McGraw-Hill.
5. J. Nagrath, 'Electronics (Analog and Digital), Prentice Hall.
6. T. Chattopadhyay, 'Analog and Digital Electronics' CBS publishers, New Delhi.
7. R. K. Kar, 'Electronics (Classical & Modern), Books and Allied (P) Ltd.

SEMESTER-III
BPC-33

(COMPUTER APPLICATIONS IN PHYSICS)

FULL MARKS: 50 (40 + 10)

CP: 4

- 1. Introduction to Computers:** (4)
Brief History of modern computing: Mechanical and electronic computers; hand held devices – smart phones, PDA's, e-book readers, etc.; embedded computers.
Generic hardware components: CPU, RAM, hard drive; variety of I/O devices, peripherals.
Software structure: Operating Systems, daemons.
- 2. Data representation:** (4)
Number Systems – decimal, binary, octal and hexadecimal systems; conversion from one system to another.
Data representation – integer, float, ASCII, unicode.
- 3. Graphical Tools:** (4)
Graphical representation of data: Gnuplot
Drawing Tools: xfig
- 4. Introduction to programming in C:** (16)
Programming methodology: algorithms and flowcharts.
Elements of C through simple problems: data types, operators, control statements, functions, pointers:
a. Finding maximum, minimum, average, standard deviation and sorting of a set of numbers.
b. Series of numbers: Fibonacci series, exponential, sine and cosine;
c. Manipulation of matrices
d. Least Square Fit
- 5. Numerical Methods:** (16)
Integration: trapezoidal rule, Simpson's 1/3 rule.
Solution of differential equations: Euler's method, Runge-Kutta method (4th order)
Solution of transcendental equations: half-section method, Newton-Raphson method;
Interpolation: Newton's differential formulae.
- 6. Application to Problems in Physics:** (6)
Harmonic oscillator, planetary motion, projectile and scattering, LCR circuits, etc.

Recommended References:

Gottfried: Schaum's Outline Series – C
Computer Application Workbook

SEMESTER-IV
BPC-41

(CLASSICAL MECHANICS)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. Mechanics of a single particle and Mechanics of system of particles; Constraints of motion; Degrees of freedom; Generalized coordinate; some examples. (5)
2. Lagrangian formalism; Virtual displacement and virtual work done; D'Alembert's principle and derivation of Euler-Lagrange equations; Lagrange's equations for velocity-dependent potential; Application to Lagrange's equation to some simple cases. (10)
3. Cyclic coordinates Isotropy and Homogeneity of space, Lagrangian formulation of conservation laws of linear momentum, angular momentum and energy. (5)
4. Hamilton formalism; Variational principles; Hamilton's principle; Derivation of Lagrange's equation from Hamilton's principle. (6)
5. Hamilton's equation of motions; Hamiltonian; Applications of Hamilton's equation of motion to some simple cases. (6)
6. Two-body central force systems; reduction to the equivalent one body problem; The equation of motions and the first integrals; The equivalent one-dimensional problem and classification of orbits; The Kepler's Problem: Inverse-square law of force; Runge Lenz vector; The Virial theorem. (10)
7. Decay and scattering problems; Kinematics of decay of a particle; transformation between C and L frames of reference; elastic collisions; angle of scattering and recoil; scattering cross-section; Rutherford scattering; some problem. (8)

Recommended References:

1. Classical Mechanics: H. Goldstein, C. Poole, J. Stafko.
2. Mechanics: L. D. Landau and E. M. Lifshitz.
3. Classical Mechanics: N. C. Rana and P. S. Joag.
4. Theoretical mechanics: Murray R. Spiegel - Schaum's out line series

SEMESTER-IV
BPC-42

(ELECTRICITY & MAGNETISM II)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. Varying Currents & Alternating Currents:

Growth and decay of current in L-R circuit, Charging and discharging of capacitor in C-R and L-C-R circuits, Oscillating discharge, Moving coil ballistic galvanometer, damping, Measurement of high resistance by leakage, Mechanical analogues of LR, CR and LCR circuits. Resonance, Q-value, power factor, AC networks, AC generators and transformers. (12)

2. Thermoelectricity:

Thermoelectric effects, thermoelectric power and thermoelectric diagram, application of thermodynamics to thermoelectric circuits. (5)

3. Maxwell's equations:

Displacement current and equation of continuity, plane electromagnetic waves in free space, vector and scalar potentials, gauge transformation, energy and momentum conservation, Poynting's vector, propagation of electromagnetic waves in non-conductors, propagation in conducting media, reflection and refraction, Fresnel's equation. (13)

4. Special Theory of Relativity and electromagnetism

Galilean transformation, Lorentz transformation of space-time, length contraction and time dilation, Doppler effect for E.M waves, transformation of mass and energy, transformation of force, transformation of an element of volume, transformation of an electric charge density and current density. The electric and magnetic fields of moving electric charge: Magnetism as a relativistic effect from constant fields of a charge moving at a constant velocity, transformation of electric and magnetic fields. (20)

Recommended References:

1. Berkeley physics course, Vol. I & II.
2. Feynman Lectures in physics, Vol I & II
3. Introduction to electrodynamics- David J. Griffiths.
4. Electromagnetic Fields- Ritz, Milford, Christy
5. Introduction to special relativity-Robert Resnick.

SEMESTER-IV
BPC-43

(LABORATORY COURSE-II)

FULL MARKS: 50 (40 + 10)

CP: 4

1. Determination of thermal conductivity of a bad conductor
2. Determination of J by Callendar & Barnes method
3. Determination of melting point of a solid using thermocouple.
4. To study thermo e.m.f. vs. temperature diagram of a thermocouple and hence to find the thermoelectric power at a given temperature.
5. To draw μ - λ curve using spectrometer.
6. To draw i-H curve using a search coil and integrating measurement system
7. To draw B-H curve using search coil and integrating measurement system.
8. Determination of Self-inductance using Anderson's bridge.
9. To study static characteristics of a triode.
10. To study the characteristics of a junction diode.
11. To study the characteristics of a Zener diode.
12. To study the characteristics of a transistor (CE & CB modes) at different base currents, and calculation of transistor parameters.
13. Construction of a regulated power supply using discrete components on a breadboard.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-V
BPC-51

(MATHEMATICAL METHODS – III)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. Second order differential equations: – Singular points, series solutions, Frobenius method, Legendre, Bessel and Hermite equations (10)

2. Special Functions – Legendre, Bessel, Hermite and Laguerre functions – recurrence relations, orthogonality, generating functions, Rodrigues formula. Beta and Gamma functions, Dirac Delta function. Occurrence of special functions in physical problems. (15)

3. Non-linear differential equations – Non-linearity in some simple dynamical systems, fixed points and their classification, stability, linear stability analysis, Bifurcations. Examples, phase plane and phase portrait, limit cycle Lorenz equation, Chaos. (8)

4. Tensors: Introduction, coordinate transformation, scalars, covariant and contravariant tensors, ranks, Symmetric and Anti-symmetric tensors, Einstein summation rule, Kronecker delta, Levi-Civita tensor, and metric tensors, contraction, inner product and outer product. (12)

5. Integrals transforms: Fourier transforms, convolution theorems, short-comings of Fourier transforms, Wavelet transform. Applications. (5)

Recommended References:

1. Mathematical methods for Physicists: Arfken and Weber. Elsevier
2. Mathematical methods of physics – J Mathews and R I Walker (Pearson)
3. Advanced Engineering Mathematics -- Erwin Kreyszig, Wiley Eastern University Edition
4. Mathematics for Physicists – Dennery and Krzywicki (Dover)
5. Introduction to mathematical physics: C. Harper. (Eastern Economic Ed. PHI)
6. Mathematical methods for physics and Engineering: Riley, Hobson, Bence (CUP, Indian ed)
7. Mathematical Methods in the Physical Sciences: Mary L. Boas, (Wiley)
8. Mathematical tools for Physics – J Nearing, downloadable from www.physics.miami.edu/nearing/mathmethods
9. Mathematical Physics – P K Chattopadhyay (New Age)
10. Vector and Tensor Analysis with applications – Borisenko and Tarapov (Dover)
11. Vector Analysis – MR Spiegel (Schaum series)
12. Fourier Transform – M. R. Spiegel (Schaum series)
13. Mathematical Physics – Ajoy Ghatak, Goyal and Chua (McMillan)
14. Differential equations – MR Spiegel (Schaum series)
15. Differential Equations – Simmons and Kantz, Tata-McGraw-Hill.
16. Special Functions – N N Lebedev (Dover)
17. Mathematical Methods in classical and quantum physics – Tulsidass and S K Sharma
18. Tensor Analysis – Bary Spain (Radha Publishers)
19. Non-linear dynamics and Chaos – S H Strogatz (Levant)
20. Classical Mechanics – J C Upadhyay

SEMESTER-V
BPC-52

(ELECTRONICS II)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. Transistor amplifier: Transistor biasing and stabilization circuit, typical biasing circuit- fixed bias, collector to base bias, self bias, Graphical analysis of transistor amplifier for large signal, voltage and power amplifier, class-A, class-B, class-AB and class-C operation of amplifier. Small-signal analysis of transistor amplifier using hybrid model, current gain, voltage gain, input and output impedance. Multistage amplifiers- RC coupled amplifier, direct coupled amplifier and their frequency responses. (8)

2. Feedback in amplifier: Principal of feedback, negative and positive feedback, voltage and current feedback, advantages and disadvantages of feedback. (3)

3. Oscillator: Sinusoidal oscillator: Barkhausen's criterion for self sustained oscillation, tuned collector oscillator, Hartley, Colpitt's, phase-shift and Wien-bridge oscillators. Non-sinusoidal oscillator: Astable and Monostable multivibrator. (6)

4. Operational amplifier: Structure and characteristics, common mode gain and difference mode gain, CMRR, differential amplifier, active load, virtual ground, application of OP-AMP as inverting and non-inverting amplifier, unity gain buffer, adder, phase shifter, integrator, differentiator. (10)

5. Integrated circuits: Steps for the development of IC, fabrication of simple circuits, simple monolithic circuit layout. Scales of integration-SSI, MSI, LSI, VLSI (basic idea only) (4)

6. Power supply: Series voltage regulator using a zener diode and one transistor as pass element, using one transistor as comparator, three terminal IC regulators. (2)

7. Number systems and Boolean algebra: Decimal, binary, octal and hexadecimal number and conversion of one system to another, 1's and 2's complements of a binary number, Basic postulates and theorems of Boolean algebra, De-Morgan's theorem, binary addition, subtraction and multiplication. (5)

8. Logic gates and digital circuits: Fundamental gates-OR, AND, NOT, Universal gates-NOR, NAND, Ex-OR and Ex-NOR gates, design of gates using discrete components like transistor, diode and resistances, simplification of Boolean expression, Karnaugh mapping, Representation of Boolean expression by SOP and POS methods, conversion of truth table into an equivalent circuit. Combinational logic gates-Half adder/subtractor, full adder, binary comparator, multiplexer, demultiplexer. Sequential logic gates-SR and JK Flip flops, application of flip flops (12)

Re commended References:

1. J. Millman and A. Grabel, 'Microelectronics', McGraw-Hill.
2. Streetman B.G., 'Solid State Electronic Devices' Prentice Hall.
3. Malvino, 'Electronic Principles' Tata McGraw-Hill.
4. Malvino and Leach, 'Digital principles and applications', Tata McGraw-Hill.
5. J. Nagrath, 'Electronics (Analog and Digital), Prentice Hall.
6. T. Chottopadhyay, 'Analog and Digital Electronics' CBS publishers, New Delhi.
7. R. K. Kar, 'Electronics (Classical & Modern), Books and Allied (P) Ltd

SEMESTER-V
BPC-53

(LABORATORY-III)

FULL MARKS: 50 (40 + 10)

CP: 4

1. Determination of radius of curvature of a plano-convex lens by Newton's ring method.
2. Determination of wavelength of a monochromatic source by Newton's ring method.
3. Determination of wavelength of a monochromatic source by Fresnel's bi-prism.
4. Determination of thickness of a film by Fresnel's bi-prism.
5. Determination of slit width by studying the single slit diffraction pattern.
6. Determination of slit width and width of obstacle by studying the double slit diffraction pattern.
7. Determination of grating constant using a standard source, and hence determination of unknown wavelength of a source.
8. Verification of Stefan's law by electrical method.
9. Determination of Planck's constant.
10. Determination of (a) specific rotation of a given substance, and hence (b) the unknown concentration of a solution.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-V
BPC-54

(PHYSICAL OPTICS)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. **Theories of Light:** Wave Theory, Huygens' Principle, laws of reflection and refraction. (3)

2. **Interference:** Coherent and incoherent sources, spatial and temporal coherence, constructive and destructive interference. Young's double-slit expt., Division of wave front-Lloyd's mirror, Fresnel bi-prism, Fresnel bi-mirror. Division of Amplitude-fringes with plane parallel plate, fringes with wedge shaped film. Fringes of equal inclination and fringes of equal thickness. Michelson interferometer, Rayleigh refractometer. Multiple beam interference, Newton's ring, Fabry Perot interferometer, Lummer Gehrcke interferometer. (15)

3. **Diffraction:** Huygens-Fresnel principle, rectilinear propagation of light. Fresnel diffraction-construction of zones, zone plate, Cornu's spiral, diffraction by straight edge, single slit, circular aperture and circular obstacle. Fraunhofer diffraction-single slit, double slit, rectangular aperture, circular aperture, plane transmission grating, concave grating, echelon grating. Resolving power of telescope and microscope. Babinet's principle. (15)

4. **Polarization:** Linear, circular and elliptic polarization, double refraction, Huygens' theory of double refraction through uniaxial crystal, Nicol prism, quarter and half wave plates, polaroids, optical activity and polarimeter, Interference of polarized light. (12)

5. **Electromagnetic Nature of Light:** Polarization, Dispersion (normal & anomalous), Rayleigh scattering, Kerr effect, Faraday effect. (5)

Recommended References:

1. Optics-Hecht & Zajac.
2. Physical and Geometrical optics-Longhurst.
3. Optics-B.K.Mathur.
4. Fundamentals of Optics - Jenkins & White.
5. Principles of Optics - Born & Woolf.
6. Physical Optics - Ghosh & Manna.

SEMESTER-VI
BPC-61

(ELEMENTARY QUANTUM MECHANICS)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

1. Role of experiment and theory in Physics. Quantum mechanics as paradigm shift from Classical Mechanics: determinism-equation of motion to probability density-expectation-uncertainty. (1)

2. **Failure of classical physics:** black body radiation, photo-electric effect; Planck's quantum hypothesis; Einstein's photo-electric equation; Bohr's atomic model and quantization of angular momentum and atomic spectra; Franck and Hertz's experiment; Stern and Gerlach's experiment; de Broglie's hypothesis, Davisson and Germer's experiment; Young's double slit experiment in the light of quantum hypothesis, wave-particle duality and complementarity. (8)

3. **Wave-function:** interpretation of wave function; Schrodinger Equation – time dependent and time independent forms; conditions to be satisfied by wave functions; observables, expectation value, operator representation, and measurements; stationary states; Ehrenfest's theorem; superposition of states and dynamism. (8)

4. **Wave functions and energies in one dimension with idea of barrier penetration:** infinite square well potential, delta function potential, finite square well potential, step function potential, free particle (illustrating uncertainty principle). (12)

5. **Formalism:** Operators, eigenvalues and eigenfunctions; linear operators, product of two operators, commutation relations, simultaneous eigenfunctions, orthogonal functions; Dirac notation, dual space, inner and outer products of wave functions, projection and identity operators; Hermitian adjoint of an operator, Hermitian operators, their eigenvalues, expectation values; generalized uncertainty principle. (5)

6. **Harmonic oscillator problem:** algebraic and analytic solutions and their correspondence; ground and excited states, zero point energy; comparison with classical oscillator. (4)

7. **Schrodinger equation in three dimensions:** Cartesian coordinates, particle in a rectangular box, degeneracy; spherical coordinates, angular and radial equations, spherical harmonics; hydrogen atom problem; Orbital angular momentum, Cartesian components, raising and lowering operators, commutation relations, eigenvalues; electron spin, explanation of observations from Stern and Gerlach's experiment, Pauli matrices. (12)

Recommended References:

1. Quantum Mechanics, D. Griffiths
2. Quantum Mechanics, Gasiorowich
3. Quantum Mechanics, Mathews & Venkatasnan
4. Quantum Mechanics, Ghatak & Loknathan

SEMESTER-VI
BPC -62

(STATISTICAL MECHANICS & SOLID STATE PHYSICS)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

(EACH GROUP HAS TO BE ANSWERED IN SEPARATE ANSWER SCRIPT)

GROUP – A: STATISTICAL MECHANICS:

Marks: 25

Lectures: 25

1. **Random walk and statistical basis of thermodynamics:** Basic concept of equilibrium theory, Macroscopic and microscopic states of system, Probability and thermodynamic probability, Principle of equal a priori probability, Probability distribution, its narrowing with increasing n , Average properties, Accessible and inaccessible states. (10)
2. **Elements of ensemble theory:** Phase space of classical system, Microcanonical ensemble, Quantum states and phase space, Canonical ensemble, Equipartition of energy, Partition function, Entropy of an ideal gas, Gibbs paradox, Sackur-Tetrode equation, A system of harmonic oscillators, Statistics of paramagnetism, Langevin-Brillouin theory, Grand canonical ensemble, fluctuations in different ensembles. (10)
3. **Introductory quantum statistics:** Limitations of Maxwell-Boltzmann statistics, Bose-Einstein and Fermi-Dirac statistics, statistics of occupation numbers, Thermodynamical behavior of an ideal Bose gas, Bose –Einstein condensation, Black-body radiation, Specific heat of solids at low temperature, Ideal Fermi system, Chandrasekhar limit (idea only), Fermi energy, Thermionic emission. (5)

Recommended References:

1. Fundamentals of statistics and thermal physics :Reif
2. A Treatise on Heat : Saha and Srivastava
3. Heat and thermodynamics : Zemansky and Dittman
4. Statistical Physics : Reif (Berkeley physics course-V)
5. Statistical thermodynamics : Lee, Sears and Turcotte
6. Thermal Physics : Gupta and Roy

GROUP – B: SOLID STATE PHYSICS

Lectures: 25

Marks: 25

1. Crystalline and Amorphous Solids, Lattice, Basis and Crystal, Miller Indices, Interatomic Forces, Types of Bonding of Solids, Cubic Structures (SC, FCC, BCC) of Crystals. (5)
2. Origin of X-Rays, Continuous and Characteristic Spectra, Mosley's law and Periodic Table, Explanation from Bohr's theory.
X-Ray Diffraction, Laue spots, Braggs Law, Reciprocal Lattice. (5)
3. Free Electron Theory of Metals, Bloch theorem, Energy Bands in Solids, Kronig-Penny model, Distinction between Metals, Insulators and Semiconductors, Fermi-Dirac Distribution and Energy Spectrum of Solids, Electron in Magnetic Field, Hall Effect. Lattice Vibrations, Specific Heats, Einstein and Debye Model. (10)
4. Basic idea of diamagnetism, paramagnetism, ferromagnetism and antiferromagnetism. (4)
5. Superconductivity, Meissner effect, Mössbauer effect (idea only) (1)

Recommended References:

1. Solid State Physics, Kittel
2. Elementary Solid State Physics, M. Ali Omar
3. Solid State Physics, Ashcroft & Mermin
4. Concepts of Modern Physics, Beiser

SEMESTER-VI
BPC-63
(LABORATORY-IV)

FULL MARKS: 50 (40 + 10)

CP: 4

1. To determine the mutual inductance by Carey Foster's method using dc source and ballistic galvanometer.
2. Measurement of high resistance by the method of leakage of charge of a charged condenser.
3. To find mutual conductance (M) between two coils by direct method.
4. Construction of basic logic gates (OR, AND, NOT, NAND and NOR) using discrete components on a bread board, and hence verification of (i) the truth tables by measuring the voltages, (ii) Demorgan's theorem and (iii) universal nature of NAND and NOR gates.
5. Study the characteristics of a CE amplifier.
6. Study of an OPAMP and its application as a Non-Inverting Amplifier and as a Unity gain buffer.
7. Study of an OPAMP and its application as an Inverting Amplifier.
8. Study of an OPAMP and its application as an Inverting Adder.
9. Study of the performance of a simple voltage comparator using OPAMP.
10. Construction of a Phase-shift oscillator on a breadboard using transistor. Study of the waveform of the oscillator and calibrate it using a CRO.
11. Study the characteristics of a feedback amplifier.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-VI
BPC-64

(ATOMIC, MOLECULAR, NUCLEAR & PARTICLE PHYSICS)

FULL MARKS: 50 (40 + 10)

CP: 4

LECTURES: 50

(EACH GROUP HAS TO BE ANSWERED IN SEPARATE SCRIPTS)

GROUP A: ATOMIC & MOLECULAR PHYSICS

LECTURES: 22

MARKS: 25

1. Atomic Spectra:

Bohr atom model, Sommerfeld's elliptical orbits and space quantization, spin quantization, Larmours theorem, magnetic moment, Bohr magneton. (3)

Alkali spectra, Explanation of the doublet nature from vector atom model, selection rules for transition, Pauli's exclusion principle and periodic table. Effect of magnetic field on the spectral lines-Zeeman effect (normal and anomalous), Lande g-factor, Paschen Bach effect, effect of electric field on the spectral lines-Stark effect, L-S coupling, Lande interval rule, J-J coupling. (10)

2. Molecular Spectra:

Classification of molecular spectra - electronic, vibrational and rotational spectra of diatomic molecules, fluorescence, phosphorescence, Raman spectra, optical pumping, Masers and Lasers, Einstein A and B coefficients. (9)

Recommended References:

1. Introduction to Atomic Spectra, White
2. Structure of Atoms and Molecules, Kondratiev
3. Atomic Spectra and Atomic Structure, Herzberg.
4. Spectra of Diatomic Molecules, Herzberg.
5. Introduction to Molecular Spectroscopy, Barrow.
6. Molecular Spectroscopy, Banwell

Group B: Nuclear Physics

Lectures: 14

Full Marks: 15

1. **Introduction to Nuclear Physics:** Composition of nucleus, nuclear size, nuclear force and other forces of nature, binding energy curve.; properties of nuclear force, range and depth of potential: deuteron problem, n-p, p-p scattering at low-energies, non-central forces, quadrupole moment of deuteron, saturation of nuclear force, meson theory of nuclear force, Yukawa theory.

2. **Radioactivity:** α , β , γ decay and internal conversion

3. **Models of the nucleus:** liquid drop model, semi-empirical mass formula, Fermi gas model, shell model and magic numbers.

4. **Nuclear reactions:** conservation laws, direct and compound reactions – Ghoshal's experiment, fission and fusion reaction, nuclear reactor.

5. **Detectors:** Basics of interaction of charged and neutral particles in matter, Geiger-Muller counter, photo-multiplier tube, scintillators, crystals

6. **Accelerators:** basic ideas of pelletron, cyclotron, Betatron, synchrotron

Group C: Particle Physics

Lectures: 14

Full Marks: 15

1. **Introduction to particles and interactions:** source of 'elementary' particles: cosmic ray, nuclear reactors, particle accelerators; discovery of neutron, positron, neutrinos, anti-proton and anti-neutron, baryons, mesons, leptons and 'strange' particles; fundamental forces of nature; quarks, leptons and mediators

2. **Quantum numbers:** quantum numbers associated with 'elementary' particles, their conservation and violation

3. **Quark Model:** The Eightfold Way, quark model, multiplets

4. **Relativistic Kinematics:** collisions & decays - examples and applications

5. **Standard Model and beyond:** unification of forces, Standard Model, Higgs boson; Supersymmetry; antimatter, dark matter, matter anti-matter asymmetry; Supersymmetry.

6. **Particle Physics experiments:** Tevatron, LHC, INO, Kamiokande, etc.

References:

1. Nuclear Theory (Vol.-I), Eisenberg & Greiner, North-Holland.
2. Concepts of Nuclear Physics, B. Cohen, North-Holland.
3. Theory of Nuclear Physics, Bohr & Mottelson.
4. Nuclear Physics (Theory and Experiment), Roy & Nigam, Wiley & Sons.
5. Theoretical Nuclear Physics, Blatt & Weisskopf, John Wiley & Sons.
6. The Atomic Nucleus, Evans, McGraw-Hill.
7. Introduction to Elementary Particles, David Griffiths, John Wiley & Sons.
8. Introduction to Particle Physics, M. P. Khanna, Prentice-Hall of India Private Limited.
9. Concepts of Modern Physics, A. Beiser, McGraw-Hill Education
10. <http://public.web.cern.ch/public/en/Science/Science-en.html>
11. <http://ed.fnal.gov/home/students.shtml>.

ELECTIVE COURSES IN PHYSICS

SEVERAL ELECTIVE COURSES WILL BE OFFERED FOR SEM V & SEM VI. HOWEVER, THE NUMBER OF COURSES OFFERED IN EACH SEMESTER WILL BE DECIDED BY THE DEPARTMENT. OUT OF THE OFFERED COURSES STUDENTS HAVE TO SELECT ONE COURSE FOR SEM-V AND ANOTHER FOR SEM-VI. HOWEVER, FINAL DECISION WILL BE MADE BY A COMMITTEE WITH H.O.D. AS THE CONVENER.

PRESENTLY, THERE ARE SEVEN ELECTIVE COURSES IN THE SYLLABUS. SOME NEW COURSES MAY BE ADDED IN PHASES. HOWEVER, THE NAMES OF THE ELECTIVE COURSES TO BE OFFERED FOR SEM V AND SEM VI FOR A PARTICULAR YEAR WILL BE ANOUNCED BEFORE THE COMMENCEMENT OF SEM V AND SEM VI.

THESE ELECTIVE COURSES ARE, IN PRINCIPLE, OPEN TO ALL IIIRD YEAR STUDENTS OF SIKSHA-BHAVAN, VISVA-BHARATI.

SEMESTER-V/VI
BPE-1

GROUP THEORY & TENSOR ANALYSIS

Full Marks: 50 (40+10), CP: 4, Lectures: 50

1. **Group Theory:** Symmetries in nature; Definition of group; Explanation of abstract ideas related to group theory using simple examples. Continuous group: $O(2)$ and $O(3)$ Rotation in two and three dimensions; Generators of rotation group angular momentum; Representation of $O(3)$ and the spherical harmonics; $SU(2)$ and spin; Lorentz group in 3+1 dimensions; Generators and their algebra; Origin of Thomas Precession; Solving quantum Coulomb and/or the oscillator problem using group theory. Discrete group: Parity and time reversal symmetry in physics and the consequences (parity selection rule, Kramer's degeneracy etc.); Permutation symmetry of identical objects; Symmetry of a regular configuration like a square and/or triangular sheet; Symmetry of different types of lattices; Symmetry of molecules; Normal mode calculations using group theory.

(30)

2. **Tensor Analysis and differential geometry:** Scalar, vector, pseudo scalar and pseudo vector; Outer product of two vectors as a tensor; Pseudo tensor; A few examples; General definition of a tensor; Rank of a tensor; Brief overview of dual vector space; Covariant, Contra variant and mixed tensors; Kronecker delta as a tensor; Levi Civita tensor in 3 and higher dimensions; Contraction of tensors by using Kronecker delta and Levi Civita tensors; Maxwell's equations and tensor; Metric on a space as a rank two tensor; Derivative of tensors; Christoffel symbol; Riemann curvature tensor; Elements of GTR.

(20)

SEMESTER-V/VI
BPE-2

THE PHYSICS OF ENERGY

Full Marks 50,

CP: 4

Lectures 50

Energy and its Uses (10 Lectures)

- Units and scales of energy use
- Mechanical energy and transport
- Heat energy: Conversion between heat and mechanical energy
- Electromagnetic energy: Storage, conversion, transmission and radiation
- Intro to the quantum, energy quantization
- Energy in chemical systems and processes, flow of CO₂
- Entropy and temperature
- Heat engines, efficiency
- Conversion: Phase change energy conversion, refrigeration and heat pumps
- Internal combustion engines
- Sterling engine
- Conversion: Steam and gas power cycles, the physics of power plants

Sources of Energy (30 Lectures)

- Fundamental forces in the universe
- Quantum mechanics relevant for nuclear physics
- Nuclear forces, energy scales and structure
- Nuclear binding energy systematics, reactions and decays
- Nuclear fusion
- Nuclear fission and fission reactor physics
- Nuclear fission reactor design, safety, operation and fuel cycles
- The flow of energy in the universe
- Solar : Solar radiation
- Solar: Absorption and thermal utilization
- Solar: Solar-thermal electricity
- Solar: Photovoltaics
- Solar: Advanced PV, overview
- Biological energy sources and fossil fuels
- Wind: Fluid dynamics and power in the wind, available resources
- Wind: More about fluids, viscosity, types of fluid flow, lift
- Wind: Wind turbine dynamics and design, wind farms
- Geothermal power and ocean thermal energy conversion
- Tidal/wave/hydro power

Systems and Synthesis (10 Lectures)

- Nuclear radiation, waste and proliferation
- Climate change
- Energy storage
- Energy conservation

References:

1. 'Sustainable Energy - Without the Hot Air' by David J. C. MacKay (Available online)
2. 'Power with nature: solar and wind energy Demystified' by Rex A. Ewing (available online)

3. 'Wind Energy Explained: Theory, Design and Application', by J. F. Manwell, J. G. McGowan and A. L. Rogers; John Wiley & Sons Ltd., UK (2004).
4. 'The Solar Economy: Renewable energy for sustainable global future' by Hermann Scheer; Earthscan, London, UK (2004).
5. 'Introductory Nuclear Physics' by Kenneth S. Krane; John Wiley & Sons Ltd. (1988).

SEMESTER-V/VI
BPE-3

MATERIAL SCIENCE: EVOLUTION AND APPLICATIONS

Full Marks: 50 (40 + 10)

CP: 4

Lectures: 50

Preamble: The Department of physics understands that Material science not only surrounds us in our everyday life but critically helps the development in areas such as economy, health care, environment, sport, defense and much more. Materials science course teaches about the processes required to change the atomic structures of materials in order to engineer new and different materials. Studying materials science is really an exploration of a hugely progressive field and enrolled students will have the chance to generate own ideas and research during a degree in India or abroad. It is a highly intensive and specialized course, offered by Physics Department of Visva-Bharati among very few institutions in India. The Department will arrange 50 lectures in one semester of six months duration.

Course Goals

- 1.) A general understanding of different types of materials and their structure
- 2.) A general understanding of the role of new materials on advances in technology, society and civilizations

Course description:

The discovery of new materials has shaped history and built civilizations. Materials have played such an important role that scholars have named periods of history after them like the Stone Age, the Bronze Age and the Iron Age. The study of the world history generally focuses on wars, the rulers who governed and the formation and (subsequent) downfall of empires. Little if anything is said about the materials that have often led to the success (and sometimes failure) of these empires. This trend continues in modern civilization with the advances in materials preceding many of the leaps in technology that we took for granted as part of our society. The computer and the electronic revolution are completely built upon silicon and our ability to change the electrical properties of this most unusual material. Rapid, reliable, modern air transportation is completely dependent on the use of aluminum and other lightweight and strong materials. What are the future changes in materials that will lead to revolutions in our society? Advances in health care, the promise of nanotechnology, the colonization of space all are exciting ideas with tremendous potential that will be taken care of in some part of the advances in the materials which may make these things possible. This course will trace the utilization, properties and production techniques of materials from the Bronze Age up through modern times and into the future. It will start with a description of properties of the first materials utilized by man such as stone, fiber and copper. These materials are explained by considering their atomic structure, the binding forces between atoms and their arrangement. The properties of iron and steel are explained along with the history of iron and steel making. The properties of materials are also covered from a historical as well as from a scientific point of view.

- I. Introduction (May consult referred book 3): Classification of Materials, Metals, Polymers, Semiconductor materials and other modern materials
- II. Historical Development of Materials: The first materials: Stone and Clay, The first metals: Copper and Bronze, Gold and Silver and the basis of wealth, Mechanisms and Properties of Metals, The basics of structure, the basics of mechanical properties, The Discovery of Iron, A New Material: Glass, Steel: The Modern Metal (For I-II, 5 Lectures)
- III. Polymers: A Modern Class of Materials

The Discovery of Polymerization, Mechanisms and Properties: What are Polymers? The Unique Properties of Polymers, The Growth of a Science and an Industry

- IV. Polymer Structures
Polymer molecules -mers, chemistry, common polymers, molecular structure and configuration, Crystallinity
- V. The Semiconductor Revolution: The Information Age
- VI. Other Modern Materials (Nano Materials etc):
Nanostructural Characterization Techniques, Nanosystems. (For III-IV-V-VI, 15 Lectures)
- VII. Atomic Structure and Interatomic Bonding, Atomic Structure and the Periodic Table, Atomic Bonding in Solids, its effects
- VIII. Structure of Crystalline Solids (metals and semiconductors)
Crystal Structures: Unit cells, common structures, lattice parameters, density calculations, crystal systems (For VII-VIII, 10 Lectures)
- IX. Defects and imperfections in solids, Point Defects, Dislocations.
- X. Diffusion: Diffusion mechanisms, Steady-State diffusion, Factors that influence diffusion
- XI. Mechanical Properties: Concepts of stress and strain, Elastic Deformations, Plastic Deformations, Hardness
- XII. Deformation & strengthening: Dislocations and Plastic Deformations, Deformation and Strengthening of polymers
- XIII. Failure: Fracture, Fatigue: the S-N curve, Creep (For IX-X-XI-XII-XIII, 10 Lectures)
- XIV. Phase Diagrams and Phase Transformations: Basic Concepts, Equilibrium Phase diagrams & Phase transformations- basic concepts, Glass transition and crystallization of polymer
- XV. Electrical Behavior: Basic Concepts, Band Structure and Material Behavior: Conductors, Semiconductors, ionic conductors, passive and active dielectrics
- XVI. Applications of Materials: Traditional metal, semiconductors and polymer applications, Nano composites (For XIV-XV-XVI, 10 Lectures)

Resource materials:

1. "The Substance of Civilization", Stephen, L. Sass, Arcade Publishing, 1999
2. "Materials Science and Engineering: An Introduction", Callister, William D., 4th or 5th Edition, John Wiley & Sons, New York, 1999.
3. Fundamentals of Materials Science and Engineering: An Integrated Approach, Callister, William D. Jr., 2nd Ed., John Wiley and Sons, 2003, ISBN 0-471-47014-7
4. <http://ojps.aip.org/> Online search of AIP science articles

In addition: Faculty may post study materials on web or may use E-mail ID of enrolled students to post Knowledge materials

SEMESTER-V/VI
BPE-4

PHYSICS IN EVERYDAY LIFE

Full Marks: 50

CP: 4

Lectures: 50

Basics: Units and dimensions; Dimensional analysis and estimation of energy scales for different physical processes; Order of magnitude calculations; The Fermi problem. (2)

Physics of Earth: Estimating the radius and mass of earth by elementary methods; Age of the earth; Other Physical parameters of the earth; Earth's interior; Thermal structure of Earth; Gravity and magnetic fields of the earth; Plate tectonics & Geodynamics; Seismology & Tomography; Gravity & magnetic methods; Electrical & Electromagnetic methods; Seismic Methods; Well logging and other methods. (8)

Atmospheric Physics: Composition and structure of the atmosphere; Radiation scattering of radiation by atmosphere; Emission & absorption of terrestrial radiation; Greenhouse effect; global warming and climate change; Atmospheric thermodynamics and role of water vapour; Atmospheric electricity; Physics of clouds; Cloud Seeding; Air and the atmospheric dynamics; Weather prediction. (8)

Human body and medical physics: Eye and the vision; working principles of spectacles, contact lenses, binoculars, telescopes, microscopes etc.; Ear and sound; working principles of hearing aid device; How the lungs and the heart work? Physics of rotator cuff and the skeleton; Noninvasive probe inside the body: Sound waves and working principles of stethoscope, ultrasonography; Blood circulation, blood pressure & sphygmomanometer; Electrical activity of heart & ECG(Electrocardiography); Electromagnetic radiation, interaction of matter with radiation and working principles of X-ray; Nuclear magnetic resonance and MRI; electron positron annihilation & the PET scan. Working principles of LASER and its use in surgery; Nanoscience and future promises in medical physics. The structure of a human cell; DNA, RNA; Protein and Enzymes. (12)

Physics of cooking: Controlled use of fire for cooking: from clay oven to electric heaters; Conduction, convection and radiation; Interaction of microwaves with matter & microwave ovens; Heat pumps and domestic refrigerator; the Mpemba effect: can hot water freeze faster than cold water? Physics behind the working principles of a few kitchen appliances: bottle opener as a lever, electric chimney, nanotechnology based auto-cleaning utensils. (5)

Communication Physics: Use of electromagnetic waves for telecommunication; from J. C. Bose to present day technology; Working principles of cell phone, GPS, internet etc.; physics of fiber optics based communication; difficulty with faster signal transmissions and possible remedies; elementary ideas on possible next generation telecommunication modes and devices. (5)

DATA Storage devices: Different forms of energy used in storing data; Working principles of magnetic storage devices; Magnetic tapes, Floppy disk and HDD; Working principles of optical storage devices; CD, DVD etc.; Electrical storage devices; semiconductors; DATA storage in RNA & DNA; elementary ideas about future generation storage devices based on spintronics, ion trap technologies. (5)

Physics & Sports: Throwing Javelin, shot-put etc.; Swimming & diving; Other field & track events. Aerodynamics of a flying ball; Spin and Swing bowling; Instantaneous measurement of the speed of the cricket ball; how accurate these measurements are? Heavy Vs. light bat; the swing mass of the bat; the sweet spot of a bat; Physics of base ball and other soft balls. (5)

References:

1. Physics of the Earth, 4th edition, F. D. Stacy, and P. M. Davis, Cambridge University Press

SEMESTER-V/VI
BPE-5

THEORETICAL AND OBSERVATIONAL ASPECTS OF ASTRONOMY

Full Marks: 50 (40+10), CP: 4, Lectures: 50

Preamble: *This course is one of the elective papers offered by the Department of Physics, Visva-Bharati. Students of Siksha-Bhavana having Physics and Mathematics as main subject (not fourth subject) in the +2 level may opt for this course. To have clear sky condition, the paper should be introduced in even semester.*

1. (a) What is astronomy?- An introduction the prospects of astronomy.
(b) An overview on spherical trigonometry.
(c) Geodesics, small circles and great circles. (5)
2. (a) Earth and the related terrestrial astronomy.
(b) Celestial Sphere and related topics.
(c) Three systems of celestial coordinates and their transformations. (15)
3. (a) Time associated with astronomy.
(b) Astronomical refraction, parallax, aberration, precession and nutation. (5)
4. General description of
(a) sun and solar system,
(b) comets,
(c) meteors,
(d) moon and
(e) eclipses. (10)
5. Stellar Astronomy:
(a) star: formation, evolution and death (b) constellations, (c) Stellar magnitudes, (d) variable stars, (e) double stars and (f) Cepheid variables. (10)
6. Observational astronomy. (5)

References:

1. Text book of astronomy and astrophysics with elements of cosmology, V.B. Bhatia, Narosa publishing house, 2001.
3. Astrophysics- stars and galaxies, K.D. Abhyankar, Universities press, 2001
4. Astronomy, K,K, Dey

(TO BE OFFERRED ONLY IN SEM VI)

SEMESTER-V/VI
BPE-6

INTRODUCTION TO NANOSCIENCE

Full Marks : 50 (40 + 10)

CP: 4

Lectures: 50

- **Introduction:** (5 lectures)

What is nanoscience? Why is nanoscience interesting and important? Fundamental phenomena as a function of size and reduced dimensionality; the role of surfaces; Emphasis on uses of new materials.

- **Theoretical basis** (15 Lectures)

The uncertainty principle, Probability amplitudes and the rules of quantum Mechanics, Many particle wave functions and identical Particles, The Pauli exclusion principle, Multielectron atom Electrons in nanostructures and quantum effects, Fermi liquids and the free electron model, Transport in free electron metals, Crystal structure, X-Ray diffraction, Bloch's theorem, band structure, Brillouin zones and Fermi surfaces.

Hartree, Hatree-Fock Approximation for many electron systems, Introduction to density function theory, modeling of nanotubes and nanowires.

- **Generic methodologies:** (5 lectures) The principles of nanostructure production, laboratory preparation and the limitations of materials including nanoscale fabrication and characterization technologies.

- **Tools:** (5 Lectures)

X-ray Diffractometer, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Atomic force microscope (AFM), Scanning tunneling microscope (STM) (idea only).

- **Nanomaterials and Nanocomposites:** (20 Lectures)

- Metal nanoparticles, nano-rod and nano-tube: Preparation and characterization, Electronic properties, metal-non-metal transition, Quantum size effect, core-shell structure, quantum conductance in metal nanowires.

- Nanocomposites: Synthesize of nanoclusters (metal/semiconductor) inside a medium, such as glass, and ceramic media, Important nanoscale systems and their novel properties (clusters, dots, films).

- Oxide nanostructures (semiconductor, Ferroelectric, ferrites etc.) created by various Physical and chemical routes. Explore the physical properties of oxides that make them important to optical, electronic and magnetic applications. Mechanical properties (Individual nanostructures, Bulk nanostructured materials).

- Carbon nano-tube: Fabrication and characterization aligned CNT, Emission devices using CNT.

References:

S. M. Lindsay, '*Introduction to nano-science*', Oxford University Press, 2010.

Richard Martin, *Electronic Structure: Basic theory and practical methods*, Cambridge University Press, 2004.
A.A.Balandin & K.L.Wong, Eds Handbook of semiconductor nanostructures and nanodevices
H.S.Nalwa, Handbook of nanostructured biomaterials and their application in nanobiotechnology
H.S.Nalwa, Nanoclusters and nanocrystals

SEMESTER-V/VI
BPE-7

ELECTRICAL & ELECTRONIC INSTRUMENTS

Full Marks: 50, CP: 4 Lectures: 50

1. Voltmeters and Ammeters: Analog Voltmeters: DC Voltmeter, AC Voltmeter, Vacuum Tube Voltmeter (VTVM), Field Effect Transistor Voltmeter (FET-VM); Analog Ammeters.

Digital Voltmeters: General Characteristics, Ramp Type, Integrating Type, Continuous Balance, Digital Multimeters (6)

2. Power Supply : Rectifiers with / without Filter, Principle of Regulation, Regulated Power Supply using Zener, Transistor and ICs, Fixed and Variable Voltage Source(s) using ICs, Constant current supplies, Power Supply using SCRs, Fabrication of Regulated Power Supply, Switched Mode Power Supply (SMPS),

DC – DC Converters: Buck Converters, Boost Converters, Buck – Boost Converters. (10)

3. Uninterrupted Power Supply (UPS) : Technologies, Offline / Standby, Line-interactive, Double-conversion / Online, Double Conversion On Demand, Ferro-resonant, DC Power, Rotary DRUPS (Diesel Rotary UPS), Air- DRUPS. (5)

4. Inverters: Brief History, Basic Designs, Advanced Designs, Three Phase Inverters. (4)

5. Signal Generators: Basic Oscillator circuits, Pulse and Square wave generators, Standard Signal Generators – Description with Block diagrams, Signal Generators with different frequency ranges, Function Generators. (5)

6. Cathode Ray Oscilloscope: Basic CRO operation, Block diagram, Cathode Ray Tube (CRT), Principle of Focusing and Deflection of Electron Beam, Vertical and Horizontal Deflecting Systems, Sweep generators, Synchronization of sweep, Dual Trace CRO, Dual Beam CRO. (5)

7. LCR Bridges : General Form of AC Bridges, Measurement of Inductance and Capacitance, Maxwell Bridge, Hay Bridge, Schering Bridge. (5)

8. Three Phase Transformer: Transformer – Review, Three Phase Transformer – Theory and mode of operation, Voltage Stabilizer. (5)

9. Electric Motor: Principle of DC motor, Theory of Rotating Magnetic field – Induction Motors, Three Phase AC Motor, Stepper Motor, Servo Motor. (5)

Recommended References:

1. Modern Electronic Instrumentation & Measurement Techniques, Helfrick & Cooper, Prentice- Hall.
2. Electronic Measurement, Terman & Petit, McGraw Hill
3. Electricity & Magnetism, Sterling.

ALLIED COURSES IN PHYSICS

SEMESTER-I
BPA-11

(MECHANICS & THERMAL PHYSICS)

Full Marks: 50 (40+10), CP = 4 Lectures: 50
(EACH GROUP HAS TO BE ANSWERED IN SEPARATE SCRIPT)

Group A (Mechanics)

Marks: 20

Lectures: 20

1. **Vectors:** Axial and polar vectors, dot and cross product, scalar triple product and vector triple product. Gradient, divergence and curl, statement of divergence theorem and Stokes' theorem. [4]
2. **Rotational motion:** Angular velocity, angular acceleration, angular momentum, torque, fundamental equations of rotational motion, principle of conservation of angular momentum. [5]
3. **Dynamics of rigid bodies:** Moment of inertia and radius of gyration, their physical significance, theorem of parallel and perpendicular axes. Rotational kinetic energy, calculation of moment of inertia of some simple systems. [6]
4. **Gravitation:** Law of universal gravitation, gravitational potential and intensity, calculation of potential and intensity of thin uniform spherical shell and solid sphere, escape velocity. [5]

Group B (Thermal Physics)

Marks: 30

Lectures: 30

1. **Kinetic theory of gases:** Perfect gas, pressure exerted by gas, Maxwell's law of distribution of molecular velocities (statement only) – r.m.s., mean and most probable velocities, degrees of freedom, principle of equipartition of energy – application in simple cases. Mean free path, Brownian motion (qualitative). Equation of state – defects of ideal gas equation, Van der Waal's equation, and critical constants. [10]
2. **Thermal conductivity of solids:** Different processes of transmission of heat, thermal conductivity and diffusivity, Fourier equation in 1-Dimension for heat flow, Ingen-Hausz's experiment, conductivity of composite slabs, conductivity of poor conductors, Searle's experiment. [5]
3. **Thermodynamics:** Specific heat, Internal energy, Isothermal and adiabatic processes, first law of thermodynamics; Indicator diagram, reversible and irreversible processes, cyclic process; Second law of thermodynamics, Carnot cycle, Carnot theorem, absolute scale of temperature, entropy. [10]
4. **Radiation:** Radiation of heat, emissive and absorptive power, Kirchhoff's law, black body Radiation, Stefan's law, Planck's law (statement only), Wien's displacement law, Rayleigh-Jean's law. [5]

SEMESTER-I
BPA-12

(LABORATORY COURSE)

Full Marks – 25 (20 + 5), CP = 2

1. Determination of specific gravity of granular solid insoluble in water.
2. Determination of specific gravity of granular solid soluble in water.
3. Determination of moment of inertia of metallic cylinder/ rectangular bar.
4. Verification of Boyle's law.
5. $n - L$ curve using sonometer.
6. $m - l^2$ curve using sonometer.
7. Determination of velocity of sound by air column method.
8. Determination the Young's modulus of a material taken in the form of a wire by Vernier method (stretching).

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-II
BPA -21

(GENERAL PROPERTIES OF MATTER & OPTICS)

Full Marks-50 (40 + 10), CP: 4

(EACH GROUP HAS TO BE ANSWERED IN SEPARATE SCRIPT)

Group-A: General Properties of Matter Marks: 25 Lectures: 25

1. **Elasticity:** Stress and strain, Hook's law, elastic constant and their interrelations, work done in stretching a wire, torsion of a cylinder, determination of Y , determination of η (static and dynamical method) (5)

2. **Surface Tension:** Surface tension and surface energy, molecular theory of surface tension, angle of contact, capillary, excess pressure of a curved liquid surface, factors affecting Surface Tension. (5)

3. **Viscosity:** Coefficient of viscosity, streamline and turbulent motion, Reynolds number, Bernoulli's equation, flow of liquid through a capillary tube, Poiseuille's equation and determination of viscosity of a liquid, Stokes' law, factors affecting viscosity, application to blood flow. (5)

4. **Wave Motion:** Different types of waves, Longitudinal/Transverse waves and progressive/stationary waves, Period, Amplitude, Frequency, Wavelength, Velocity, Phase etc., Forced Vibrations and Resonance, Resonance column method of finding velocity of sound waves, Transverse waves in a string, Laws of vibration of strings, Characteristics of musical sound, Doppler effect, Ultrasonics, Ultrasonography, Intensity, decibel. (10)

Group-B: Optics Marks: 25 Lectures: 25

1. **Fermat's Principle:** Fermat's principle, Laws of reflection and refraction from Fermat's principle. (2)

2. **Prism:** Dispersion, Dispersive power, Deviation, dispersion by raindrop, rainbow. (2)

3. **Thin Lenses:** Equivalent focal length of two lenses in contact, Equivalent focal length of two lenses separated by a distance, chromatic aberration in lens, achromatic combination of lenses, spherical aberration in a lens and its remedy. (5)

4. **Velocity of Light:** Introduction, Determination of velocity of light: Fizeau (Terrestrial), Foucault's and Michelson's method, Constancy of velocity of light in all frames of references. (1)

5. **Wave Theory of Light:** Huygen's principle, the laws of reflection and refraction. (2)

6. **Interference:** Young's Experiment, Coherence, Theory of interference by division of Wave front, Biprism Experiment, Interference by division of amplitude, Interference from thin films, Newton's ring. (5)

7. **Diffraction:** Introduction, Fraunhofer diffraction, single slit, circular aperture, double slit, plane diffraction gratings, Fresnel diffraction, Zone plate. (5)

8. **Polarization:** Introduction to polarization, polarization by reflection; Nicol Prism, Double refraction, optical activity, polarimeter, Faraday effect (3)

SEMESTER-II
BPA -22

(LABORATORY COURSE)

Full marks: 25 (20 + 5). CP = 2

1. Determination the rigidity modulus of a material taken in the form of wire by statical method.
2. Determination the rigidity modulus of a material taken in the form of wire by dynamical method.
3. Determination of the focal length of a convex mirror with the help of an auxiliary lens.
4. Determination of the focal length of a convex lens by combination method.
5. Determination of the focal length of a convex lens by displacement method.
6. Determination of the refractive index of the material of a prism by spectrometer.
7. Determination of the refractive index of a liquid by lens and mirror.
8. Determination of the refractive index of a liquid by travelling microscope.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

SEMESTER-III
BPA -31

(ELECTRICITY & MAGNETISM)
Full Marks: 50 (40+10), CP = 4, Lectures: 50

1. **Electrostatics** : Electric charge, Coulomb's law, electrostatic potential and intensity, intensity and potential due to a point charge,; Induction, lines of force, Gauss' theorem and its application, capacity of condenser, parallel-plate, spherical and cylindrical condensers; Loss of energy due to charge sharing,; Dielectrics, electric polarization. [10]
2. **Magnetostatics** : Magnetic pole, pole strength, magnetic potential and intensity, potential due to a bar magnet and magnetic shell, moment of a magnet, forces between two magnets, couple on a magnet, work done in deflecting a magnet, magnetometers – deflection and vibration; Terrestrial magnetism, magnetic elements of earth, determination of H. [5]
3. **D. C. Circuit**: Kirchhoff's law and its application, potentiometer and its application, measurement of e.m.f., current and resistance by potentiometer, Wheatstone's bridge and its sensitivity. [6]
4. **Electro-magnetic induction**: Self and mutual inductances, calculation of inductance in solenoid. [2]
5. **Varying current** : Growth and decay of current in L-R and C-R circuits, time constant and log decrement; Induction coil. [3]
6. **Alternating current** : R.M.S. and mean value of current, e.m.f., reactance and impedance phase and vector diagram, choke, power factor in A.C. circuits, L-R, C-R and L-C-R circuits – series and parallel resonance, applications to radio and TV; Transformers. [8]
7. **Electrolysis**: Faraday's law of electrolysis and their experimental verification, chemical equivalent, electro-chemical equivalent, determination of reduction factor of a tangent galvanometer, dissociation, ionic mobility. [2]
8. **Thermo-electricity** :
Thermo-electric effect, Seebeck, Peltier and Thomson effect, laws of thermo-electricity, thermo-electric curves and thermo-electric inversion, thermo-electric power, thermo-electric series, thermo-couple. [4]
9. **Electromagnetism** : Magnetic effect of electric current, Laplace's equation, Ampere's theorem, calculation of magnetic field at a point on the axis of a circular coil; Solenoid, Helmholtz galvanometer, field due to a current in an infinitely long wire, effect of magnetic field on current carrying conductor, ammeter, voltmeter, shunt [10]

SEMESTER-III
BPA -32

(LABORATORY COURSE)
Full marks: 25 (20+5), CP = 2

1. Determination of the resistance per unit length of a meter bridge wire by Carey Foster's method.
2. Determination of the value of low resistance by drop of potential method.
3. To measure the e. m. f. of a cell by a potentiometer using a milli-ammeter.
4. Determination of specific resistance by meter bridge with end correction.
5. Determination of the electrochemical equivalence of copper using an ammeter (single deposit necessary).
6. Determination of the moment of a bar magnet and the horizontal component of earth's magnetic field by magnetometer.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)

**SEMESTER-IV
BPA -41**

(MODERN PHYSICS & ELECTRONICS)

Full marks: 50 (40 + 10), CP = 4, Lectures: 50

(EACH GROUP HAS TO BE ANSWERED IN SEPARATE SCRIPT)

Group A: Modern Physics

Marks: 35

Lecture: 35

1. Atomic Physics: Discharge of electricity through rarefied gas, cathode ray and their properties; Ionization of gases by radiation, measurement of e/m (specific charge) by Thomson's method, determination of 'e' (electronic charge) by Millikan's oil drop experiment; Aston's mass spectrograph, Frank-Hertz expt. (8)
2. Quantum theory of radiation: Planck's concept --- radiation formula (statement only) --- qualitative discussion of photo-electric effect and Compton effect in support of quantum theory; Raman effect. (5)
3. Basic Quantum Mechanics: Wave nature of material particles, wave-particle duality, wavelength of de Broglie waves, Heisenberg uncertainty principle, Bohr's theory of hydrogen spectra --- concept of quantum number, Schrödinger equation, particle in a one dimensional infinite well -- - energy Eigen values, wave function and its probabilistic interpretation. Pauli exclusion principle. (10)
4. Solid State Physics: Crystalline nature of solid, diffraction of X-ray, Bragg's law; Moseley's law - explanation from Bohr's theory. (4)
5. Nuclear Physics: Binding energy of nucleus, binding energy curve and stability; Radioactivity, successive disintegration, radioactive equilibrium, radioactive dating, radioisotopes and their uses, nuclear transmutation, fission and fusion, nuclear reactor. (5)
6. Special Theory of Relativity: Postulates of STR, formulae of (i) Length contraction; (ii) Time dilation; (iii) Velocity addition; (iv) Mass variation, and (v) Mass-energy equivalence. (3)

Group B: Electronics

Marks: 15

Lectures: 15

1. Diodes and Transistors : Introduction to semiconductors, P-N junction diode, bridge rectifier, capacitance input filter, Zener diode, voltage regulator, Transistors --- α and β and their interrelations; output characteristics in CE mode, single stage CE amplifier --- approximate expressions of current and voltage gain with the help of 'Load Line'. (10)
2. Digital electronics: binary systems, binary numbers. Decimal to binary and reverse conversions; binary addition and subtraction.
Logic gates : OR, AND, NOT gates --- truth tables. Statement of de Morgan's theorem, NOR and NAND universal gates. (5)

SEMESTER-IV
BPA -42

(LABORATORY COURSE)

Full marks: 25 (20 +5),

CP: 2

1. To draw the characteristic curve of a p-n junction diode and hence to determine its ac resistance from the characteristic curve.
2. To study the performance of a p-n junction diode as a half-wave and a full-wave rectifier and hence to find out the percentage regulation.
3. To draw the forward and reverse characteristic curves of a Zener diode.
4. To draw the static output characteristic curve of a transistor in common emitter configuration for different base currents and hence to find out the forward current gain parameter.
5. To construct OR, AND, NOT and NAND gates using discrete circuit components and to verify their truth table.
6. To verify the truth tables of OR, AND and NOT gates and to verify De Morgan's theorem by using NAND gates.

(NEW EXPERIMENTS MAY BE ADDED IN PHASES)