JECRC™
UNIVERSITY
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School of Pure and Applied Sciences

Course Structure and Syllabi

B. Sc. (Physics Major)

Academic Programmes

July, 2014

Course Module-II

Semester I

S. No.	Subject	Lecture (Hr.)	Tutorials (Hrs.)	Practical (Hrs.)	Credits		Total Credits
					L	P	
	Major- 1(A)	**4**	**-**	**2**	**4**	**2**	**6**
	Major- 1(B)	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-1	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-2	**4**	**-**	**2**	**4**	**2**	**6**
BMC101A	General Studies	**3**			**3**		**3**
BMC001A	Computer Applications-I	**4**			**4**		**4**
BMC002A	Computer Lab-I						
BMC051A	Environmental Studies	**3**			**3**		**3**
	Total Credits						**34**

Semester II

Code	Subject	Lecture (Hr.)	Tutorials (Hrs.)	Practical (Hrs.)	Credits		Total Credits
					L	P	
	Major- 1(A)	**4**	**-**	**2**	**4**	**2**	**6**
	Major- 1(B)	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-1	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-2	**4**	**-**	**2**	**4**	**2**	**6**
BMC104A	General Studies	**3**			**3**		**3**
BMC003A	Computer Applications-II	**3**			**3**		**3**
BMC004A	Computer Lab-II						
BMC102A	Communication Skills-I	**3**			**3**		**3**
	Total Credits						**33**

Semester III

Code	Subject	Lecture (Hr.)	Tutorial (Hrs.)	Practical (Hrs.)	Credits		Total Credits
					L	P	
	Major- 1(A)	**4**	**-**	**2**	**4**	**2**	**6**
	Major- 1(B)	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-1	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-2	**4**	**-**	**2**	**4**	**2**	**6**
BMC107A	General Studies	**3**			**3**		**3**
BMC005A	Computer Applications-III	**1**			**1**		**1**
BMC006A	Computer Lab-III			**2**		**2**	**2**
BMC105A	Communication Skills-II	**2**	**1**		**3**		**3**
	Total Credits						**33**

Semester IV

Code	Subject	Lecture (Hr.)	Tutorial (Hrs.)	Practical (Hrs.)	Credits		Total Credits
					L	P	
	Major- 1(A)	**4**	**-**	**2**	**4**	**2**	**6**
	Major- 1(B)	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-1	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-2	**4**	**-**	**2**	**4**	**2**	**6**
BMC108A	General Studies	**3**			**3**		**3**
BMC007A	Computer Applications-IV	**4**			**4**		**4**
BMC008A	Computer Lab-IV						
BMC111A	Communication Skills-III	**3**			**3**		**3**
	Total Credits						**34**

Semester V

Code	Subject	Lecture (Hr.)	Tutorial (Hrs.)	Practical (Hrs.)	Credits		Total Credits
					L	P	
	Major- 1(A)	**4**	**-**	**2**	**4**	**2**	**6**
	Major- 1(B)	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-1	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-2	**4**	**-**	**2**	**4**	**2**	**6**
BMC110A	General Studies	**3**			**3**		**3**
BMC113A	Communication Skills-IV	**3**			**3**		**3**
BMC109A	Value Education	**3**			**3**		**3**
BMH026A	Seminar	**2**			**2**		**2**
							35

Semester VI

Code	Subject	Lecture (Hr.)	Tutorial (Hrs.)	Practical (Hrs.)	Credits		Total Credits
					L	P	
	Major- 1(A)	**4**	**-**	**2**	**4**	**2**	**6**
	Major- 1(B)	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-1	**4**	**-**	**2**	**4**	**2**	**6**
	Minor-2	**4**	**-**	**2**	**4**	**2**	**6**
BMC112A	General Studies	**3**			**3**		**3**
BPH027A	Project	**3**			**3**		**8**
	Total Credits						**35**

Physics Major

Course Code	Paper	Credits
	Semester-I	
BPH001A	Mathematical Physics	4
BPH002A	Waves and Oscillations	4
BPH003A	Mechanical Workshop-I	2
BES004A	Mechanical Workshop-II	2
	Total Credits	12
	Semester-II	
BPH005A	Thermodynamics	4
BPH006A	Optics	4
BPH007A	Thermodynamics Lab	2
BPH008A	Optics Lab	2
	Total Credits	12
	Semester-III	
BPH009A	Mechanics and Properties of Matter	4
BPH010A	Electricity and Magnetism	4
BPH011A	Mechanics Lab	2
BPH012A	Electricity and Magnetism Lab	2
	Total Credits	12
	Semester-IV	
BPH013A	Special Theory of Relativity	4
BPH014A	Quantum Mechanics	4
BPH015A	Computational Lab: Special Theory of Relativity	2

BPH016A	**Computational Lab: Quantum Mechanics**	**2**
	Total Credits	**12**
	Semester-V	
BPH017A	**Solid State Physics**	**4**
BPH018A	**Electronics (Solid State Electronic Devices)**	**4**
BPH019A	**Solid State Electronics Lab**	**2**
BPH020A	**Electronics and Optoelectronics Lab**	**2**
	Total Credits	**8**
	Semester-VI	
BPH021A	**Nuclear and Particle Physics**	**4**
	Elective Paper*	**4**
BPH030A	**Basic Electrical and Electronics Lab-I**	**2**
BPH031A	**Basic Electrical and Electronics Lab-II**	**2**
	Total Credits	**12**
	Elective Paper(s)	**4**
BPH022A	**Computational Physics**	**4**
BPH023A	**Digital Electronics**	**4**
BPH024A	**Statistical Mechanics**	**4**
BPH025A	**Atomic & Molecular Spectroscopy**	**4**
BPH026A	**Seminar**	**2**
BPH027A	**Project**	**8**

Semester I

BPH001A: Mathematical Physics **Credit(s): 4**

Unit-I

Dirac Delta Function: Definition. Representation and Properties of Dirac Delta Function.

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

Unit-II

Vector Calculus: Vector Differentiation. Scalar and Vector Fields. Ordinary and Partial Derivative of a Vector w.r.t. coordinates. Space Curves. Unit Tangent Vector and Unit Normal Vector (without Frenet- Serret Formulae). Directional Derivatives and Normal Derivative. Gradient of a Scalar Field and its Geometrical Interpretation. Divergence and Curl of a Vector Field. Del and Laplacian Operators. Vector Identities. Vector Integration**:** Ordinary Integral of Vectors. Line, Surface and Volume Integrals. Flux of a Vector Field. Gauss' Divergence Theorem, Green's Theorem and Stokes Theorem.

Unit-III

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

Unit-IV

Fourier Series: Fourier Series. Dirichlet Conditions (Statement only). Kronecker's Method for Computation of Fourier Coefficients. Even and Odd Functions. Orthogonality of Sine and Cosine

functions. Sine and Cosine Series. Applications: Square Wave, Triangular Wave, Output of Full Wave Rectifier and other Simple Functions. Summing of Infinite Series Term-by-Term Differentiation and Integration of a Fourier Series.

Unit-V

Calculus of Variations

Variational Calculus: Variational Principle. Euler's Equation and its Application to Simple Problems. Geodesics. Concept of Lagrangian. Generalized Coordinates. Definition of Canonical Momenta. Euler-Lagrange's Equations of Motion and its Applications to Simple Problems: (e.g., simple pendulum and one dimensional harmonic oscillator). Definition of Canonical Momenta.

Canonical Pair of Variables. Definition of Generalized Force: Definition of Hamiltonian (Legendre Transformation). . Hamilton's Principle. Poisson Brackets and their Properties. Lagrange Brackets and their Properties.

Suggested Books

1. George Arfken: Mathematical Methods for Physicists, Academic Press.
2. L. A. Pipes: Applied Mathematics for Engineers & Physicists, McGraw Hill.
3. Merle C. Potter and Jack Goldberg: Mathematical Methods, PHI.
4. Fredrick W. Byron and Robert W. Fuller: Mathematics of Classical and Quantum Physics, Dover Publications.

5. M. R. Spiegel: Vectors Analysis, Schaum's Outline Series.

BPH002A: Waves and Oscillations **Credit(s): 4**

Unit-I

Oscillations in Arbitrary Potential Well: Simple Harmonic Oscillations. Differential Equation of SHM and its Solution. Amplitude, Frequency, Time Period and Phase. Velocity and Acceleration. Kinetic, Potential and Total Energy and their Time Average Values. Reference Circle. Rotating Vector Representation of SHM.

Free Oscillations of Systems with One Degree of Freedom: (1) Mass-Spring system, (2) Simple Pendulum, (3) Torsional Pendulum, (4) Oscillations in a U-Tube, (5) Compound pendulum: Centres of Percussion and Oscillation, and (6) Bar Pendulum.

Unit-II

Driven Oscillations: Damped Oscillations: Damping Coefficient, Log Decrement. Forced Oscillations: Transient and Steady States, Amplitude, Phase, Resonance, Sharpness of Resonance, Power Dissipation and Quality Factor. Helmholtz Resonator.

Coupled Oscillators: Normal Coordinates and Normal Modes. Energy Relation and Energy Transfer. Normal Modes of N Coupled Oscillators.

Unit-III

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves:

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Unit-IV

Elastic Waves in Solid Rod. Pressure Waves in Glass Columns. Transverse Waves in Strings. Waves in Three Dimensions. Spherical Waves. Fourier Series and Fourier Analysis of Wave Motion. Plane Electromagnetic Waves. Energy and Momentum of Plane EM Waves. Radiation Pressure. Radiation Resistance of free space. EM Waves in dispersive Media. Spectrum of EM Waves.

Unit-V

Ultrasonics: Production of ultrasonic waves. Echo; Reverberation, reverberation time, Sabine‟s formula, remedies over reverberation; Absorption of sound, absorbent materials; Conditions for good acoustics of a building; Noise, its effects and remedies. **Piezoelectric effect**. Detection of ultrasonic waves: Piezoelectric detector. Kundt's tube method. Sensitive flame method. Thermal detector method. Properties of ultrasonic waves. Cavitation. Acoustic grating. Velocity measurements.

Industrial Applications of Ultrasonics: Drilling. Welding. Soldering. Ultrasonic cleaning. **SONAR**: Non-destructive testing. Pulse echo technique. Transmission technique. Resonance. Medical Applications: Echocardiograms/Sonogram. Ultrasonic Imaging (Scandisplay).

Suggested Books

1. A. P. French: Vibrations and Waves, CBS Pub. & Dist., 1987.

2. K. Uno Ingard: Fundamentals of Waves & Oscillations, Cambridge University Press, 1988.

3. Daniel Kleppner and Robert J. Kolenkow: An Introduction to Mechanics, McGraw-Hill, 1973.

4. Franks Crawford, Waves: BERKELEY PHYSICS COURSE (SIE), Tata McGrawHill, 2007.

1. M. S. Seymour Lipschutz: Schaum's Outline of Vector Analysis, McGraw-Hill, 2009.

2. D. E. Bourne, P C Kendall: Vector Analysis and Cartesian Tensors, Chapman & Hall,

BPH003A: MECHANICAL WORKSHOP-I **Credit(s): 2**

BPH003A: MECHANICAL WORKSHOP-I **Credit(s): 2**

List of Exercises

Machine Shop Study of lathe machine, drilling machine and shaper, their parts and demonstration of operations performed on them.

1. Prepare a job on lathe machine by performing turning, facing and

chamfering as per given drawing.

2. Prepare a job on shaper as per given drawing.

Fitting Shop Study of fitting tools, their uses and demonstration of operations by using different tools.

3. Prepare a job including finishing of all four sides by filing and make a square notch.

4. Prepare a job by finishing its two sides and perform drilling and taping on it.

Carpentry Shop Study of wood and wood working, tools used in carpentry shop and their applications.

5. Prepare a T-lap/Cross lap joint.

6. Prepare a bridle joint.

Welding Shop Definition of welding and brazing process and their applications. Study of tools used in arc and gas welding shop.

7. Prepare a lap/butt joint in arc welding shop.

8. Demonstration of different types of flames in gas welding shop.

9. Study of common welding defects.

Foundry Shop Study of moulding and casting process, moulding sand, foundry tools and patterns used for moulding.

10 Prepare a mould by using a given pattern.

11 Making and baking of dry sand cores for placing in horizontal, vertical and hanging positions in the mould cavity.

Tin Smithy Shop Study of sheet metal workshop, tools used in smithy shop and soldering

12 Prepare a mechanical joint and perform soldering on it.

13 Prepare a funnel as per given drawing.

***Suggested Books*:**

1. Hajra Choudhury Workshop Technology Vol 1 & 2, Media Promoters & Publishers P. Ltd,Bombay.
2. Chapman W. A. J., *Workshop* Technology Parts 1 & 2, Viva Books P. Ltd., New Delhi.

Semester II

BPH005A: Thermodynamics **Total Credit(s): 4**

Unit-I

Second Law of Thermodynamics: Reversible and Irreversible Changes. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot Cycle. Carnot Engine and its Efficiency. Refrigerator and its Efficiency. Second Law of Thermodynamics : Kelvin-Planck and Clausius

Statements and their Equivalence. Carnot Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Unit-II

Entropy: Change in Entropy. Entropy of a State. Clausius Theorem. Clausius Inequality. Second Law of Thermodynamics in terms of Entropy. Entropy of a Perfect Gas. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Impossibility of Attainability of Absolute Zero: Third Law of Thermodynamics. Temperature-Entropy Diagrams. First and second order Phase Transitions.

Unit-III

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials U, H, F and G: Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work. Cooling due to Adiabatic Memagnetization. Approach to Absolute Zero.

Unit-IV

Kinetic Theory of Gases: Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific Heats of Gases.

Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

Unit-V

Real gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

Phase Thransitions. Thermodynamic Potentials.

Suggested Books

1. Enrico Fermi: Thermodynamics, Courier Dover Publications, 1956.

2. Meghnad Saha, B. N. Srivastava: A Treatise on Heat: Including Kinetic Theory of Gases,

Thermodynamics and Recent Advances in Statistical Thermodynamics, Indian Press, 1958.

BPH006A: Optics **Total Credit(s): 4**

Unit-I

Classical Photometry: Introduction.

Geometrical Optics
Fermat's Principle: Optical Path. Fermat's Principle of Least Time or Extremum Path. Examples of Fermat's Principle: (1) Reflection and (2) Refraction.

Wave Optics
Nature of Light :- Theories of Light. Electromagnetic Nature of Light Definition of a Wave Front. Propagation of a Wave Front. Huygens Principle of Secondary Wavelets.

Unit-II

Interference: Interference: Division of Amplitude and Division of Wavefront. Young's Double Slit Experiment. Lloyd's Mirror and Fresnel's Biprism. Phase Change on Reflection: Stoke's treatment. Interference in Thin Films: Parallel and Wedge-shaped Films. Fringes of Equal Inclination (Haidinger Fringes) and Fringes of Equal Thickness (Fizeau Fringes). Newton's Rings: Measurement of Wavelength and Refractive Index.

Michelson's Interferometer: (1) Idea of form of fringes (No Theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, (5) Standardization of Meter and (6) Visibility of Fringes.

Unit-III
Diffraction: Fresnel diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Comparison of a Zone plate with a Convex lens. Diffraction due to (1) a Straight Edge and (2) a Rectangular Aperture (Slit), (3) a Small Circular Aperture and (4) an Opaque Circular Disc. Fresnel's Integrals, Cornu's Spiral: Fresnel Diffraction Pattern due to a Straight Edge.

Fraunhoffer diffraction: Diffraction due to (1) a Single Slit, (2) a Double Slit and (3) a Plane

Transmission Grating. Rayleigh's criterion of resolution. Resolving Power and Dispersive Power of a Plane Diffraction Grating.

Unit-IV
Coherence: Spatial and temporal coherence, Coherence length, Coherence time. Q- factor for

LASER. Visibility as a Measure of Coherence. Spatial Coherence and Size of the Source. Temporal Coherence and Spectral Purity.

LASER: Theory of LASER action: Einstein's coefficients, Threshold conditions for LASER Action. Method and Mechanism of production of He-Ne LASER. Semiconductor LASER. Elementary ideas of Q-switching and Mode Locking.

Unit-V

Holography: Holography versus photography. Basic theory of Holography. Applications of Holography in Microscopy and Interferometry.

Optical Communication: Optical fiber as optical wave-guide. Numerical Aperture and Maximum Angle of Acceptance.

Suggested Books

1. F. A. Jenkins and Harvey Elliott White: Fundamentals of Optics, McGraw-Hill, 1976.

2. Ajoy Ghatak: Optics, Tata McGraw Hill, 2008.

3. Eugene Hecht and A R Ganesan: Optics, Pearson Education, 2002.

4. A. K. Ghatak & K. Thyagarajan: Contemporary Optics, Plenum Press, 1978.

BPH007A: Thermodynamics Lab **Credit(s): 2**

N.B.: Students are required to perform at least 12 experiments

List of Experiments

1. To determine **thermal conductivity** of a given material by **Lee's apparatus**.

2. To determine specific heat of the given material.

3. To verify Stefan's law of radiations by using an incandescent lamp.

4. To study Adiabatic changes using Clement and de Sorme experiment.

5. To determine Callendar and Barne's constant flow method.

6. To determine the mechanical equivalent of heat (J) by Electrical method (Joule's Calorimeter)

7. To study conduction: Composite wall experiment

8. To study convection: Pool Boiling experiment

9. To study convection: Experiment on heat transfer from tube-natural convection.

10. To study convection: Heat Pipe experiment.

11. To study convection: Heat transfer through fin-natural convection .

12. To study convection: Heat transfer through tube/fin-forced convection.

13. Study of any experiment on Stefan's Law, on radiation determination of emissivity, etc.

14. To study heat exchange: Parallel flow experiment.

15. To study heat exchange: Counter flow experiment.

BPH008A: Optics Lab **Credit(s): 2**

N.B.: Students are required to perform at least 12 experiments from the following list:

1. To determine the Height of a Building using a Sextant.

2. To determine **Resolving power** of **Telescope**.

3. To determine the wavelength of prominent lines of Mercury by using plane **Diffraction Grating**.

4. To determine **Dispersive Power** of a Prism using Mercury light source and **Spectrometer**.

5. To determine the **Specific Rotation** of **Glucose/Sugar Solution** by **Polarimeter**.

6. To determine the **wavelength of Sodium light using diffraction grating** and spectrometer.

7. To determine **wavelength of sodium light using Fresnel Biprism**.

8. To determine **wavelength of Sodium light by Newton's Rings' experiment**.

9. To determine the **Dispersive Power of a Plane Diffraction Grating**.

10. To determine **transmission coefficient** of a semi-transparent glass plate using **LB Photometer**.

11. To determine the **wavelength of LASER using Diffraction** of Single Slit.

12. To determine Young's Modulus of glass-plate by Cornu's experiment.

Semester III

BPH009A: Mechanics and Properties of Matter **Credit(s): 4**

Unit-I

Work and Energy Theorem: Work and Kinetic Energy Theorem. Conservative and Non-Conservative Forces. Potential Energy. Energy Diagram. Stable and Unstable Equilibrium. Gravitational Potential Energy. Elastic Potential Energy. Force as Gradient of Potential Energy. Work and Potential energy. Work done by Non-conservative Forces. Law of Conservation of Energy. Elastic and Inelastic Collisions between particles. Centre of Mass and Laboratory Frames.

Unit-II

Rotational Dynamics: Angular Momentum of a Particle and System of Particles. Torque. Conservation of Angular Momentum. Rotation about a Fixed Axis. Moment of Inertia. Calculation of Moment of Inertia for Rectangular, Cylindrical, and Spherical Bodies. Kinetic Energy of Rotation. Motion involving both Translation and Rotation.

Unit-III

Elasticity: Relation Between Elastic Coefficients. Twisting Torque on a Cylinder or Wire.

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Unit-IV

Gravitation and Central Force Motion: Law of gravitation. Inertial and Gravitational Mass. Potential and Field due to Spherical Shell and Solid Sphere.

Motion of a Particle under Central Force Field. Two Body Problem and its Reduction to One Body Problem and its Solution. The Energy Equation and Energy Diagram. Kepler's Laws (Ideas Only). Orbits of Artificial Satellites.

Unit-V

Inertial and Non- Inertial Systems: Reference Frames: Inertial Frames and Galilean Transformations. Galilean Invariance and Conservation Laws. Non-inertial Frames and Fictitious Forces. Uniformly Rotating Frame. Physics Laws in Rotating Coordinate Systems. Centrifugal forces: Coriolis Force and its Applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Suggested Books

1. Daniel Kleppner, Robert J. Kolenkow: An introduction to mechanics, McGraw-Hill, 1973.

2. Charles Kittel,Walter Knight: Malvin Ruderman,Carl Helmholz,Burton Moyer,Mechanics Berkeley physics course.

3. D. S. Mathur: Mechanics, S. Chand & Company Limited, 2000.

BPH010A: **Electricity and Magnetism** **Credit(s): 4**

Unit-I

Electric Field and Electric Potential: Electric Field: Electric Field and Lines. Electric Field **E** due to a Ring of Charge. Electric Flux. Gauss's law. Gauss's law in Differential form. Applications of Gauss's Law: **E** due to (1) an Infinite Line of Charge, (2) a Charged Cylindrical Conductor, (3) an Infinite Sheet of Charge and Two Parallel Charged Sheets, (4) a Charged Spherical Shell, (5) a Charged Conducting Sphere, (6) a Uniformly Charged Sphere, (7) Two Charged Concentric Spherical Shells and (8) a Charged Conductor. Force on the Surface of a Charged Conductor and Electrostatic Energy in the Medium surrounding a Charged Conductor.

Unit-II

Electric Potential: Line Integral of Electric Field. Electric Potential Difference and Electric Potential V (Line integral). Conservative Nature of Electrostatic Field. Relation between **E** and V. Electrostatic Potential Energy of a System of Charges. Potential and Electric Field of (1) a Dipole, (2) A Charged Wire and (3) A Charged Disc. Force and Torque on a Dipole. Conductors in an Electrostatic Field. Description of a System of Charged Conductors. An Isolated Conductor and Capacitance. Method of Images and its Application to: (1) Plane Infinite Sheet and (2) Sphere. **Electrostatic Energy** of (1) A Point Charge; (2) A System of Point Charges; (3) A Uniform Sphere; and (4) A Capacitor.

Unit-III

Dielectric Properties of Matter: Dielectrics: Electric Field in Matter. Dielectric Constant. Parallel Plate Capacitor with a Dielectric. Polarization, Polarization Charges and Polarization Vector. Electric Susceptibility. Gauss's law in Dielectrics. Displacement vector **D**. Relations between the three Electric Vectors. Capacitors filled with Dielectrics.

Unit-IV

Magnetic Field: Magnetic Effect of Currents: Magnetic Field **B**. Magnetic Force between Current Elements and Definition of **B.** Magnetic Flux. Biot-Savart's Law: **B** due to (1) a Straight Current Carrying Conductor and (2) Current Loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital law (Integral and Differential Forms): B due to (1) a Solenoid and (2) a Toroid. Properties of **B.**

Forces on an Isolated Moving Charge. Magnetic Force on a Current Carrying Wire. Torque on a Current Loop in a Uniform Magnetic Field.

Unit-V

Electromagnetic induction: Faraday's law (Differential and Integral forms). Lenz's Law. Self and Mutual Induction. Energy stored in a Magnetic Field. Maxwell's equations.

Suggested Books

1. Edward M. Purcell: Electricity and Magnetism, McGraw-Hill Education, 1986.

2. Arthur F. Kip: Fundamentals of Electricity and Magnetism, McGraw-Hill, 1968.

3. J. H. Fewkes & John Yarwood: Electricity & Magnetism, Oxford Univ. Press, 1991.

4. David J. Griffiths: Introduction to Electrodynamics, Benjamin Cummings, 1998 (Also, PHI).

BPH011A: Mechanics Lab **Credit(s): 2**

N.B.: Students are required to perform at least 12 experiments

1. To determine the Young's Modulus.

2. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.

3. To determine the Elastic Constants of a Wire by Searle's method.

4. To verify Law of Parallelogram of Forces.

5. To verify Polygon law of forces.

6. To determine Support Reactions of a Simply Supported Beam.

7. To measure coefficient of Static Friction.

8. To Verify Lami's Theorem.

9. To determine moment of inertia of a flywheel about its own axis of rotation.

10. To determine the coefficient of discharge of venturimeter.

11. To determine the coefficient of discharge, contraction & velocity of an orifice.

12. To verify the Bernoullis Theorem.

13. Determination of velocity of sound in air by observing standing waves using speaker, microphone and CRO.

14. Study of the random decay and determination of decay constant using statistical board.

BPH012A: Electricity and Magnetism Lab **Credit(s): 2**

N.B.: Students are required to perform at least 12 experiments

1. To use a Multimeter for measuring (a) Resistances, (b) A/C and DC Voltages, (c) AC and DC Currents, (d) Capacitances, and (e) Frequencies.

2. To convert a **Galvanometer into an Ammeter** of given range and calibrate it.

3. To convert a **Galvanometer into a Voltmeter** of given range and calibrate it.

4. To determine **specific Resistance** of a wire by **Carrey-Foster's Bridge**.

5. To determine radius of a current carrying coil using **Tangent Galvanometer**.

6. To study **LCR circuit** characteristics.

7. To study **L-C transmission Line** and determine **attenuation coefficient**.

8. To study **R-C transmission Line** and determine **attenuation coefficient**.

9. To determine an unknown resistance using ***de-Sauty Bridge***.

10. To determine an unknown resistance using ***Anderson Bridge***.

11. To study charging and discharging of a capacitor and determine time constant.

12. To determine characteristics of **Solar Cell**. (Complete Kit)

13. Determination of value of Earth's magnetic field (B-H) using Tangent Galvanometer.

14. To determine the magnetic field along an axis passing through the centre of current carrying coil using Tangent Galvanometer.

Suggested Books

1. Geeta Sanon: B. Sc. Practical Physics, 1st Edn. (2007), R. Chand & Co.

2. B. L. Worsnop and H. T. Flint: Advanced Practical Physics, Asia Publishing House, New Delhi.

3. Indu Prakash and Ramakrishna: A Text Book of Practical Physics, Kitab Mahal, New Delhi.

4. D. P. Khandelwal: A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.

Semester IV

BPH013A: Special Theory of Relativity **Credit(s): 4**

Unit-I

Tensors: Transformation of co-ordinates. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Pseudotensors. Invariant Tensors: Kronecker Delta. Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors: Scalar and Vector Products, Scalar and Vector Triple Products.

Unit-II

Michelson-Morley Experiment and its Outcome.

Transformations: Galilean Transformations. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and Order of Events.

Unit-III

Proper Time. Length Contraction. Time Dilation. Relativistic Transformation of Velocity, Relativistic Addition of Velocities. Frequency and Wave Number.

Mass-Energy equivalence principle. Variation of Mass with Velocity. Relativistic relation between energy and momentum. Relativistic Doppler effect. Relativistic Kinematics.

Unit-IV

The idea of Space-Time and Minkowski Space. Null-Cone representation. Metric Tensor.

Four Vector Formalism: Four Velocities, Four Momenta. Transformation of Energy and Momentum.

Unit-V

Bucherer's experiment. Segnac's experiment.

Equivalence Principle. Mach's Principle. Einstein's Box Experiments.

Suggested Books

1. David J. Griffiths: Introduction to Electrodynamics, Benjamin Cummings, 1998 (Also, PHI).

2. Arthur Beiser: Prospects in Modern Physics, McGraw-Hill Book Company (1998).

3. M. R. Spiegel: Vector Analysis, Schaum's Outline Series.

BPH014A: Quantum Mechanics **Credit(s): 4**

Unit-I

Particles and Waves: Inadequacies in Classical Physics. Blackbody Radiation: Quantum Theory of Light. Photoelectric Effect. Compton Effect. Franck-Hertz experiment. Wave Nature of Matter: De Broglie Hypothesis. Wave-Particle Duality. Davisson-Germer Experiment. Wave description of Particles by Wave Packets. Group and Phase Velocities and Relation between them. Two- Slit Experiment with Electrons. Probability. Wave Amplitude and Wave Functions. Heisenberg's Uncertainty Principle (Uncertainty Relations involving Canonical Pair of Variables): Derivation from Wave Packets. γ-ray Microscope.

Unit-II

Basic Postulates and Formalism: Energy, Momentum and Hamiltonian Operators. Time-independent Schrodinger Wave Equation for Stationary States. Properties of Wave Function. Interpretation of Wave Function. Probability Density and Probability. Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Expectation Values. Wave Function of a Free Particle.

Unit-III

Applications of Schrödinger Wave Equation

Eigen Functions and Eigenvalues for a Particle in a One Dimensional Box.

Problems in One Dimension: (1) Finite Potential Step: Reflection and Transmission. Stationary Solutions. Probability Current. Attractive and Repulsive Potential Barriers. (2) Quantum Phenomenon of Tunneling: Tunnel Effect. Tunnel Diode (Qualitative Description). (3) Finite Potential Well (Square Well).

Unit-IV

Bound State Problems: General Features of a Bound Particle System, (1) One Dimensional Simple Harmonic Oscillator: Energy Levels and Wave Functions. Zero Point Energy, (2) Quantum Theory of Hydrogen Atom: Particle in a Spherically Symmetric Potential. Schrodinger Equation. Separation of Variables. Radial Solutions and Principal Quantum. Number, Orbital and Magnetic Quantum Numbers.

Unit-V

Sommerfeld's Free Electron Gas Model and its Applications: Density of energy states, Fermi energy levels. Determination of Specific Heats of solids. Band Theory of solids: Understanding Semiconductors. Band Gap in solids. Conductivity and Mobility due to electrons and Holes. Solar Cells.

Suggested Books

1. L. I. Schiff: Quantum Mechanics, 3rd edition, (McGraw Hill Book Co., New York 1968).

2. E. Merzbacher: Quantum Mechanics, 3rd edition, (John Wiley & Sons, Inc1997)

3. J. L. Powell & B. Crasemann: Quantum Mechanics, (Addison-Wesley Pubs.Co.,1965)

4. A. Ghatak & S. Lokanathan: Quantum Mechanics: Theory and Applications, 5th Edition, (Macmillan India , 2004)

BPH015A: Computational Lab-I: Special Theory of Relativity **Credit(s): 2**

1. To write programme to simulate motion of a projectile.

2. To write programme on length contraction formula and plot this expression.

3. To write programme on time-dialation formula and plot it geometrically.

4. To write programme on mass variation formula and plot this expression.

5. To write a program to simulate Doppler effect

6. To write the program to evaluate the expression for velocity addition theorem

7. To write programme to evaluate light-cone representation.

In addition, students are advised to undergo the following virtual experience on Internet:

V1-V11. Set of virtual experiments on 'Special Theory of Relativity':

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/SpecRel.html

V1. **The Constancy of the Speed of Light**

The Michelson-Morley Experiment

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/Flash/MichelsonMorley/MichelsonMorley.html

Einstein "Explains" the Michelson-Morley Experiment

V2. **Exploring the Consequences of Einstein's "Explanation"**

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/Flash/Flatland/Flatland.html

V3. Spacetime: Spacetime Diagrams, and The Dimensions of Spacetime

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/SpecRel.html#Surveyors

Further Consequences of Einstein's Explanation

V4. Time Dilation

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/Flash/TimeDilation.html

V5. Length Contraction

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/Flash/LengthContract.html

V6. Simultaneity

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/Flash/Simultaneity.html

V7. Relative Speeds

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/SpecRel.html#RelSpeeds

V8. Mass-Energy Equivalence

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/MassEnergy.html

V9. The "Speed" of Objects

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/SpecRel.html#RelSpeeds

V10. The Lorentz Contraction is Invisible

http://www.upscale.utoronto.ca/GeneralInterest/Harrison/SpecRel/Flash/ContractInvisible.html

BPH016A: **Computational Lab-II: Quantum Mechanics** **Credit(s): 2**

1. To write programme to evaluate scalar potential due to electric charge.
2. To compute and plot electric potential due to two point charges.
3. To plot electric field vector due to electric charge(s).
4. To write programme to evaluate Schrödinger's equation of motion.
5. To write a program to calculate the energy eigen values for harmonic oscillator (first 3energies)
6. To write programme to evaluate Heisenberg's equation of motion.

7. To write a program to calculate probability of quantum mechanical tunneling.

In addition, students are advised to undergo the following virtual experience on Internet:

V1. Quantifying the Uncertainty

http://www.saburchill.com/physics/chapters/0068.html

V2. For set of virtual experiments on electron diffraction

http://www.uv.es/inecfis/QPhVL/index.html

Semester V

BPH017A: Solid State Physics **Credit(s): 4**

Unit-I

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Types of Bonds. Ionic Bond. Covalent Bond. Van der Waals Bond. Diffraction of x-rays by Crystals. Bragg's Law.

Unit-II

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Einstein and Debye Theories of Specific Heat of Solids. T^3 Law.

Unit-III

Dielectric Properties of Materials: Dielectric Polarization. Local Electric Field at an Atom. Depolarization Field. Dielectric Constant. Electric Susceptibility. Polarizability. Classical Theory of Electric Polarizability. Clausius- Mosotti Equation. Normal and Anomalous Dispersion. Complex Dielectric Constant.

Unit-IV

Electrical Properties of Materials: Elementary Band Theory of Solids. Bloch Theorm. Kronig-Penney Model. Effective Mass of Electron. Concept of Holes. Band Gaps. Energy Band Diagram and Classification of Solids. Law of Mass Action. Insulators, and Semiconductors. Direct and Indirect Band Gap. Intrinsic and Extrinsic Semiconductors. p- and n- Type Semiconductors. Conductivity in Semiconductors. Hall Effect in Semiconductors (Qualitative Discussion Only).

Unit-V

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth.

Isotope effect. Idea of BCS theory (No derivation): Cooper Pair and Coherence length. Variation of Superconducting Energy Gap with Temperature. Experimental Evidence of Phonons. Josephson Effect.

Suggested Books

1. Charles Kittel: Introduction to Solid State Physics, 7th Edition, John Wiley and Sons, Inc.

2. A. J. Dekkar: Solid State Physics, Macmillan India Limited, 2000.

3. J. S. Blackmore: Solid State Physics, Cambridge University Press, Cambridge.

4. N. W. Ascroft and N. D. Mermin: Solid State Physics, (Harcourt Asia, Singapore 2003).

BPH018A: Electronics (Solid State Electronic Devices) Credit(s): 4

Unit-I

Circuit Analysis: Kirchhoff's Laws, Mesh and Node Analysis of dc and ac Circuits, Duality in Networks. Network Theorems. Norton's Theorem. Thevenin's Theorem. Equivalent Star (T) and delta (π) Networks of a Given Network. Wheatstone Bridge and its Applications to Wien Bridge and Anderson Bridge.

Unit-II

Semiconductor Diodes: p and n Type Semiconductors. Energy Level Diagram. Conductivity and Mobility. pn Junction Fabrication (Simple Idea). Barrier Formation in pn Junction Diode. Current Flow Mechanism in Forward and Reverse Biased Diode (Recombination, Drift and Saturation of Drift Velocity). Derivation of Mathematical Equations for Barrier Potential, Barrier Width and Current for Step Junction. pn junction and its characteristics. Static and Dynamic Resistance. Diode Equivalent Circuit. Ideal Diode. Load Line Analysis of Diodes. Load Line and Q-point.

Unit-III

Two-terminal Devices and their Applications: (1) Rectifier Diode. Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency. Qualitative idea of C, L and π - Filters. (2) Zener Diode and Voltage Regulation. (3) Photo Diode, (4) Tunnel Diode, (5) LED (6) Varactor Diode.

Bipolar Junction transistors: NPN and PNP Transistors. Characteristics of CB, CE and CC Configurations. Current gains α, β and γ and Relations between them. Load Line Analysis of

Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff, and Saturation Regions. Transistor in Active Region and Equivalent Circuit.

Unit-IV

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Resistance, Voltage and Power Gains. Class A, B, and C Amplifiers.

Coupled Amplifiers: RC-Coupled Amplifier and its Frequency Response of Voltage Gain.

Feedback in Amplifiers, Effects of Positive and Negative Feedback on Input Impedance, Output Impedance and Gain, Stability, Distortion and Noise.

Unit-V

Sinusoidal Oscillators: Barkhauson's Criterion for Self-sustained Oscillations. RC Phase Shift Oscillator, Determination of Frequency. Hartley Oscillator. Colpitts Oscillator.

Suggested Books

1. Robert Boylestad and Louis Nashelsky: Electronic Devices and Circuit Theory, 8Th Edition, Pearson Education, India, 2004.
2. A. P. Malvino: Electronic Principals, Glencoe, 1993.
3. Allen Motorshead: Electronic Circuits and Devices, PHI, 1997.

BPH019A: Solid State Electronics Devices Lab **Credit(s): 2**

N.B.: Students are required to perform at least 12 experiments from the following list:

1. To test a Diode and Transistor using (a) a Multimeter and (b) a CRO.
2. To measure (a) Voltage, (b) Frequency and (c) Phase Difference using a CRO.
3. To study **Diode/Zener Diode** characteristics.
4. To study **Transistor** characteristics.
5. Determine static resistance and dynamic resistance of p-n junction diode and plot the V-I characteristics
6. Plot the V-I characteristics of zener diode and hence determine the dynamic resistance from

the characteristics.

7. Observe output waveform of half wave rectifier with and without filter capacitor and measure DC voltage, DC current, ripple factor with and without filter capacitor.
8. Observe output waveform of full wave rectifier with and without filter capacitor and measure DC voltage, DC current, ripple factor with and without filter capacitor.
9. Observe waveform at the output of Bridge rectifier with and without filter capacitor and measure DC voltage, DC current, ripple factor with and without filter capacitor.
10. Design a full wave rectifier using discrete components on a breadboard and measure DC voltage, DC current, ripple factor with and without filter capacitor.
11. Obtain the input and output characteristics of common emitter transistor
12. Obtain the input and output characteristics of common base transistor.
13. Draw DC load line of transistor working as a switch.
14. Obtain V-I characteristics of field effect transistor (FET).

BPH020A: Electronics and Opto-Electronics Lab **Credit(s): 2**

1. To measure **Numerical Aperture of an Optical Fiber**.
2. To determine the Coherent Length and Coherent Time of **LASER** using Semiconductor **LASER**.
3. To determine the profile of **He-Ne LASER** beam.
4. To determine the value of Planck's Constant using a Photoelectric Cell.
5. To determine the value of e/m by using Bar Magnet method.
6. To determine the Wavelength and the Angular Spread of a He-Ne Laser.
7. To determine resistance of the given material by **Four Probe method**.
8. To study the variation in resistance of semiconductor with temperature and determine **Band-Gap**.
9. To study **Logic Gates** and verify their **truth tables.**
10. To determine the value of Planck's Constant using LEDs of at least 4 different wavelengths.

Semester VI

BPH021A: Nuclear and Particle Physics **Credit(s): 4**

Unit-I

Structure of nuclei: Basic Properties of Nuclei: (1) Mass, (2) Radii, (3) Charge, (4) Angular Momentum, (5) Spin, (5) Magnetic Moment (μ), (6) Stability and (7) Binding Energy.

Radioactivity: Law of Radioactive Decay. Half-life, Theory of Successive Radioactive Transformations. Radioactive Series, Binding Energy, Mass Formula.

Unit-II

α-decay: Range of α-particles, Geiger-Nuttal law and α-particle Spectra. Gamow Theory of Alpha Decay.

β-decay: Energy Spectra and Neutrino Hypothesis.

γ-decay: Origin of γ-rays, Nuclear Isomerism and Internal Conversion.

Nuclear Models: Liquid Drop Model. Mass formula. Shell Model. Meson Theory of Nuclear Forces and Discovery of Pion.

Unit-III

Nuclear Reactions: Types of Reactions and Conservation Laws. Concept of Compound and Direct Reaction. Compound Nucleus. Scattering Problem in One Dimension: Reflection and Transmission by a Finite Potential Step. Stationary Solutions, Attractive and Repulsive Potential Barriers. Scattering Cross-section. Reaction Rate. Q-value of Reaction. Fission and Fusion.

Accelerators: Van de Graff Generator, Linear Accelerator, Cyclotron, Betatron and Light and Heavy Ion Synchro-Cyclotron. Idea of Large Hadron Collider.

Unit-IV

Detectors of Nuclear Radiations: Interaction of Energetic particles with matter. Ionization chamber. GM Counter. Cloud Chambers. Wilson Cloud Chamber. Bubble Chamber. Scintillation Detectors. Semiconductor Detectors (Qualitative Discussion Only). An Idea about Detectors used in Large Hadron Collider.

Unit-V

Elementary Particles (Qualitative Discussion Only): Fundamental Interactions. Classification of Elementary Particles. Particles and Antiparticles. Baryons, Hyperons, Leptons, and Mesons. Elementary Particle Quantum Numbers : Baryon Number, Lepton Number, Strangeness, Electric Charge, Hypercharge and Isospin.

Suggested Books

1. Arthur Beiser: Concepts of Modern Physics, McGraw-Hill Book Company, 1987.

2. Bernard L. Cohen: Concepts of Nuclear Physics, Tata Mcgraw Hill (1998).

3. R.A. Dunlap: Introduction to the Physics of Nuclei and Particles, Singapore: Thomson Asia (2004).

4. Irving Kaplan: Nuclear physics, Oxford & IBH, 1962.

5. Kenneth S. Krane: Introductory Nuclear Physics, John Wiley & Sons, 1988.

Elective Papers

One has to choose one of the following four elective papers

BPH022A: (Elective 1) Computational Physics **Credit(s): 4**

Exercises to understand any five of the following problems:

(i) Solving differential equations
(ii) Evaluating integrals
(iii) Stochastic methods, especially Monte Carlo methods
(iv) Specialized partial differential equation methods, for example the finite difference method and the finite element method
(v) The matrix eigen value problem – the problem of finding eigen values of very large matrices, and their corresponding eigenvectors (eigen states in quantum physics).
(vi) Understanding Molecular dynamics by computational means.
(vii) Understanding Computational fluid dynamics
(viii) Understanding Computational Magneto-hydrodynamics

Suggested Books

1. Andi Klein and Alexander Godunov, Introductory Computational Physics **(2006)**

2. Rubin H. Landau, José Páez and Cristian C. Bordeianu and A Survey of Computational Physics: Introductory Computational Science.

BPH023A: (Elective 2) Digital Electronics **Credit(s): 4**

Unit-I

Analog Circuits: Integrated Circuits (Qualitative Treatment only): Active and Passive components. Discrete Circuit Component. Wafer. Chip. Advantages and Drawbacks of ICs.

Scale of integration: SSI, MSI, LSI and VLSI (Basic Idea and Definitions Only). Classification of ICs. Fabrication of Components on Monolithic ICs. Examples of Linear and Digital ICs.

Unit-II

Operational Amplifiers (Use Black Box approach): Basic Characteristics of Op-Amps. Characteristics of an Ideal Op-Amp. Feedback in Amplifiers . Open-loop and Closed-loop Gain. Frequency Response. CMRR. Virtual ground.

Unit-III

Applications of Op-Amps: (1) Inverting and Non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Unity follower, (5) Differentiator, (6) Integrator, (7) Zero Crossing Detector.

Unit-IV

Digital Circuits: Difference Between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND AND NOR Gates. Exclusive OR and Exclusive NOR Gates.

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Unit-V

Data processing circuits: Basic Idea of Multiplexers, De-multiplexers, Decoders, Encoders, Parity Checkers.

Memories: Read-only memories (ROM), PROM, EPROM.

Suggested Books

1. D. P. Leach & A. P. Malvino: Digital principles and applications, Glencoe, 1995.

2. Thomas L. Floyd, Digital Fundamentals: 3rd Edition, Universal Book Stall, India, 1998.

3. Robert F Coughlin and Frederick F Driscoll: Operational Amplifiers and Linear Integrated Circuits, 4th Edition, PHI, 1992.

4. R. A. Gayakwad: Op-Amps and Linear Integrated Circuits, Pearson, 2000.

BPH024A: (Elective 3) Statistical Mechanics **Credit(s): 4**

Unit-I

Classical Statistics: Entropy and Thermodynamic Probability. Maxwell-Boltzmann Distribution Law. Ensemble Concept. Partition Function. Thermodynamic Functions of Finite Number of

Energy Levels. Negative Temperature. Thermodynamic Functions of an Ideal Gas. Classical Entropy Expression, Gibbs Paradox. Law of Equipartition of Energy – Applications to Specific Heat and its Limitations.

Unit-II

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure Temperature Dependence. Kirchhoff's Law. Stefan-Boltzmann Law and Wien's Displacement law. Saha's Ionization Formula.

Unit-III

Quantum Theory of Radiation: Radiation: Stefan-Boltzmann Law: Thermodynamic Proof. Radiation Pressure. Spectral Distribution of Black Body Radiation. Wien's Distribution Law and Displacement Law. Rayleigh-Jean's Law. Ultraviolet Catastrophe. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation : Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law and (4) Wien's Displacement Law from Planck's Law.

Unit-IV

Bose-Einstein Statistics: B-E distribution law. Thermodynamic functions of a Completely Degenerate Bose Gas. Properties of liquid He (qualitative description). Radiation as photon gas. Bose's derivation of Planck's law.

Unit-V

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law. Thermodynamic functions of an ideal Completely Degenerate Fermi Gas. Fermi Energy. Electron gas in a Metal. Specific Heat of Metals.

Suggested Books

1. F. Reif, Statistical Physics: Berkeley Physics Course, McGraw-Hill, Company Ltd, 2008.

2. S. Lokanathan and R. S. Gambhir: Statistical and Thermal Physics: An introduction PHI.

3. K. Huang: Statistical Mechanics, Wiley, 1987.

BPH025A: (Elective 4) Atomic and Molecular Spectroscopy Credit(s): 4

Unit-I

Determination of e/m of the Electron. Thermionic Emission. Isotopes and Isobars.

Introduction to Spectroscopy: X-rays: Ionizing Power, X-ray Diffraction, Bragg's Law. Bohr Atomic Model, Critical Potentials, X-rays-Spectra: Continuous and Characteristic X-rays, Moseley Law.

Unit-II

Atoms in Electric and Magnetic Fields: Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

Unit-III

Many electron atoms: Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

Unit-IV

Molecular Spectra: Rotational Energy levels, Selection Rules and Pure Rotational Spectra of a Molecule. Vibrational Energy Levels, Selection Rules and Vibration Spectra. Rotation-Vibration Energy Levels, Selection Rules and Rotation-Vibration Spectra. Determination of Internuclear Distance.

Raman Effect: Quantum Theory of Raman Effect. Characteristics of Raman Lines. Stoke's and Anti-Stoke's Lines. Complimentary Character of Raman and infrared Spectra.

Unit-V

LASER: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

Suggested Books

1. Arthur Beiser: Concepts of Modern Physics, McGraw-Hill Book Company, 1987.

2. J. B. Rajam: (with foreword by Louis de Broglie) Atomic physics, S. Chand & Co., 2007.

3. Ghatak and Thyagarajan: Optoelectronics, Oxford University Press.

BPH030A: Basic Electrical and Electronics Lab-I **Credits: 2**
BPH031A: Basic Electrical and Electronics Lab-I **Credits: 2**

List of Exercises

A. ELECTRICAL LAB

1. To study Graphical Symbols used to indicate electrical equipment and components. Single line diagram of an Electrical power distribution system.

2(i) To study the functions of components used in house wiring. Connections of house wiring including earthing with 1-phase energy meter, MCB, ceiling fan, tube light, three pin socket and a lamp operated from two different positions.

(ii) To study the construction, working of the different types of lamps.

3(i) To study the construction and working of ceiling fan, single phase induction motor and three phase squirrel cage induction motor.

(ii) To connect ceiling fan along with regulator. To also connect a single phase induction motor through an auto-transformer and to run it at varying speeds.

4(i) To study moving coil & moving iron ammeters and voltmeters, wattmeters and energy meters.

(ii) To run a 3-phase squirrel cage induction motor on no load and measure its voltage, current, power and power factor. Reverse the direction of rotation.

5(i) To study the construction and connect single phase transformer and auto-transformer. Measure input and output voltage and find turn ratio of transformer.

(ii) To study the construction of a core type three phase transformer. Connect star and delta connection of a 3-phase transformer and find relation between line and phase voltage.

ELECTRONICS LAB

6(i) Identification, testing of resistors, inductors, capacitors, PN-diode, Zener diode, LED, LCD, BJT, FET, UJT, SCR, Photo diode and Photo transistor.

(ii) Introduction to Printed Circuit Boards (PCBs) and mount components on PCB.

7. To study the functions of CRO, analog & digital multi-meters and function / signal generator.

8. To observe output waveform of half wave and full wave rectifier (centre tap and bridge).

9. To design circuits using *Bread Board* (introductory lessons).