JECRC™
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School of Pure and Applied Sciences

Course Structure and Syllabi

B. Sc. (Physics Minor)

Academic Programmes

July, 2014

Physics Minor Paper for B. Sc.

Course Code	Paper	Credits
	Semester-I	
BPH051A	**Mathematical Physics and Waves and Oscillations**	**4**
BPH052A	**Mechanical Workshop**	**2**
	Total Credits	**6**
	Semester-II	
BPH053A	**Thermodynamics and Optics**	**4**
BPH054A	**Thermodynamics and Optics Lab**	**2**
	Total Credits	**6**
	Semester-III	
BPH055A	**Mechanics and Electricity and Magnetism**	**4**
BPH056A	**Mechanics and Electricity Lab**	**2**
	Total Credits	**6**
	Semester-IV	
BPH057A	**Special Theory of Relativity and Quantum Mechanics**	**4**
BPH058A	**Computational Lab on Special Relativity and Quantum Mechanics**	**2**
	Total Credits	**6**
	Semester-V	
BPH059A	**Solid State Physics and Electronics**	**4**
BPH060A	Electronics and Opto-Electronics Lab	**2**
	Total Credits	**6**
	Semester-VI	

BPH061A	**Nuclear, Particle and Statistical Physics**	**4**
BPH062	**Basic Electrical and Electronics Lab**	**2**
	Total Credits	**6**

Semester I

BPH051: Mathematical Physics and Waves and Oscillations **Credit(s): 4**

Unit-I

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

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-II

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

Multiple Integrals: Double and Triple Integrals: Change of Order of Integration. Change of Variables and Jacobian. Applications of Multiple Integrals: (1) Area Enclosed by Plane Curves, (2) Area of a Curved Surface, (3) Volumes of Solids.

Unit-III

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-IV

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.

Unit-V

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:

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.

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

6. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Eastern Limited,1985.

BPH052A: Mechanical Workshop **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.

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.

***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

BPH053: Thermodynamics and Optics **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

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-V

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).

Fraunhofer 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.

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.

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.

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

4. Ajoy Ghatak, Optics, Tata McGraw Hill, 2008.

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

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

BPH054A: Thermodynamics and Optics Lab **Credit(s): 2**

Thermodynamics 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)

Optics experiments

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

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

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

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

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

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

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

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

Semester III

BPH055A: Mechanics and Electricity and Magnetism **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.

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-IV

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-IV

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-V

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.**

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.

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

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

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

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

BPH056A: Mechanics and Electricity Lab **Credit(s): 2**

Experiments on Mechanics

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 measure coefficient of Static Friction.

5. To Verify Lami's Theorem.

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

7. To verify the Bernoullis Theorem.

Experiments on Electricity and Magnetism

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

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

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

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

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

13. To study **LCR circuit** characteristics.

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

Semester IV

BPH057A: Special Theory of Relativity and Quantum Mechanics Credit(s): 4

Unit-I

Michelson-Morley Experiment and its Outcome.

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

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-II

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.

Bucherer's experiment. Segnac's experiment.

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

Unit-III

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-IV

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-V

Applications of Schrödinger Wave Equation:

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

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.

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).

Suggested Books

1. Arthur Beiser, Perspectives in Modern Physics, McGraw-Hill Book Company (1998).

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

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

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

5. A. Ghatak & S. Lokanathan, Quantum Mechanics: Theory and Applications, 5th Edition,

(Macmillan India , 2004)

BPH058A: Computational Lab: Special Theory of Relativity and Quantum Mechanics

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 programme to evaluate scalar potential due to electric charge.

6. To compute and plot electric potential due to two point charges.

7. To plot electric field vector due to electric charge(s).

8. To write programme to evaluate Schrödinger's equation of motion.

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

V11. Quantifying the Uncertainty

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

V12. For set of virtual experiments on electron diffraction

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

Semester V

BPH059A: Solid State Physics and Electronics **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. *T3* Law.

Unit-III

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Unit-IV

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, Star to Delta and Delta to Star Conversion. Wheatstone Bridge and its Applications to Wein Bridge and Anderson Bridge.

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.

Unit-V

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.

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

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

5. A. P. Malvino, Electronic Principals, Glencoe, 1993.

6. Allen Mottershead, Electronic Circuits and Devices, PHI, 1997.

BPH060A: Electronics and Opto-Electronics Lab **Credit(s): 2**

Experiments on Electronics

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

Experiments on Opto-electronics

6. To measure **Numerical Aperture of an Optical Fiber**.
7. To determine the Coherent Length and Coherent Time of **LASER** using Semiconductor **LASER**.
8. To determine the profile of **He-Ne LASER** beam.
9. To determine the value of Planck's Constant using a Photoelectric Cell.
10. To determine the Wavelength and the Angular Spread of a He-Ne Laser.
11. To study the variation in resistance of a semiconductor with temperature and determine **Band-Gap**.
12. To study **Logic Gates** and verify their **truth tables.**

Semester VI

BPH061A: Nuclear and Statistical Mechanics **Credit(s): 2**

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.

The basic idea of α-decay, **β-decay** and **γ-decay**,and **Nuclear Fission and Fusion**

Unit-II

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-III

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.

Unit-IV

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-V

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

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. Chandrashekhar Limit of mass and White Dwarfs.

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.

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

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

8. K. Huang, Statistical Mechanics, Wiley, 1987.

BPH062A: Basic Electrical and Electronics Lab **Credits: 2**

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.

ELECTRONICS LAB

6. 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).