Syllabi of the Theory Courses Offered by Department of Physics

Course Description

Title of Course: Physics-I **Course Code: 18B11PH111**

L-T Scheme: 3-1 **Course Credits: 4**

Objectives: Broadly, the study of Physics improves one's ability to think logically about the problems of science and technology and obtain their solutions. The present course is aimed to offer a broad aspect of those areas of Physics which are specifically required as an essential background to all engineering students for their studies in higher semesters. The course intends to impart sufficient scientific understanding of different phenomena associated with Special relativity, Modern Physics, Statistical physics, atomic physics, and lasers.

Course Contents:

Unit-I (Theory of Special Relativity): Frames of reference, Galilean transformation, Michelson Morley Experiment, Postulates of special theory of relativity, time dilation and length contraction, twin paradox, Lorentz transformations, addition of velocities, Relativistic Doppler effect, Mass variation with velocity, Mass-energy relation. **[12]**

Unit-II (Introduction to Modern Physics):
Quantization of Radiation, Black body radiation, Rayleigh-Jeans law, Planck's law of radiation Wien's law, Stefan's law, Photoelectric effect Compton scattering, Atomic spectra, Bohr model of hydrogen atom, Frank hertz experiment, Matter waves, de Broglie hypothesis, Davisson Germer experiment **[12]**

Unit III Quantum Mechanics
Wave packets, phase and group velocity, Heisenberg's uncertainty principle, Schrödinger wave equation and its applications to the free particle in a box, potential barrier and Harmonic oscillator **[10]**

Unit-IV (Statistical Mechanics): Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distributions and their applications. **[06]**

Unit- V Laser Physics & Applications

Fundamental ideas of stimulated and spontaneous emission, Einstein's coefficients, Principle and working of laser, Different types of lasers (He-Ne Laser, Ruby Laser, Semiconductor Laser), Applications of Lasers. **[04]**

Text Books and References:

1. A. Beiser, Perspectives of Modern Physics, Tata McGraw Hill.
2. J R Taylor, C D Zafiratos, M A Dubson, Modern Physics for Scientist & Engineers, Pearson Education.
3. K Krane, Modern Physics, Wiley India.
4. J Bernstein, P M Fishbane, S. Gasiorowicz, Modern Physics, Pearson Education.
5. B. B. Laud, Laser and Non-Linear Optics, New Age International (P) Ltd.
6. R. Resnick, Relativity, New Age.

Course Outcomes:

Course Outcome	**Description**
CO1	Describes the limitations of Newton's laws and explain when special relativity become relevant, Learn to Apply the principles of Special Relativity to an extended range of problems involving particle kinematics
CO2	Demonstrates the ability to explain the concepts related to the consequences of Special Relativity, the nature of space-time and related dynamic observables
CO3	Acquired a profound understanding of inadequacy of classical mechanics regarding phenomena related to microscopic level, Become well versed with the experimental developments, historical account and importance of probabilistic interpretation
CO4	Understand the basic quantum mechanical ideas and relevant mathematical framework, approach the solution of one dimensional time independent Schrodinger equation
CO5	Appreciate the importance of applying statistical ideas to explore thermodynamic variables, Developed ability to identify and apply appropriate statistical method for describing the assembly of microscopic particles, comprehend basic properties and working of Laser systems

Course Description

Title of Course: Physics-II **Course Code: 18B11PH211**

L-T Scheme: 3-1 **Course Credits: 4**

Objectives: Broadly, the study of Physics improves one's ability to think logically about the problems of science and technology and obtain their solutions. The present course is aimed to offer a broad aspect of those areas of Physics which are specifically required as an essential background to all engineering students for their studies in higher semesters. At the end of the course, the students will have sufficient scientific understanding of basic vector calculus, electrostatics, magnetostatics, electromagnetic fields and waves, basic understanding of physics of semiconducting materials

Course Content:

Unit I (Electrostatics): Review of vector calculus, Cartesian, spherical polar and cylindrical coordinate systems, concept of gradient, divergence and curl, Coulomb's law, Gauss law and its applications, Boundary condition on electrostatic field, electric potential, Laplace equation, Poisson equation and related boundary value problems, capacitance, electrostatic fields in matter. . [**10**]

Unit II (Magnetostatics): Lorentz force, cyclotron formula, line, surface and volume currents, , Biot-Savart law and its applications, Ampere's law and its applications, equation of continuity, Faraday's law of electromagnetic induction, boundary conditions on magnetic field, Magnetic field in matter [**08]**

Unit III (Electromagnetic Fields): Maxwell's equations in free space and matter, Maxwell correction to Ampere's law, Electromagnetic waves in free space and matter, Transverse nature of em waves and Polarisation, Propagation of electromagnetic field in free space and Poynting vector,Poynting theorem , Normal incidence of em waves. **[10]**

Unit IV (Elements of Solid State Physics): Basic ideas of bonding in solids, Crystal structure, X-ray diffraction, Band theory of solids, Distinction between metals, semiconductors and insulators **[04]**

Unit V (Physics of Semiconductors): Band theory of solids, Kronig Penney model, effective mass, Direct and indirect bandgap semiconductors, optical and thermal properties, Fermi-Dirac Distribution in semi-conductors, Equilibrium carrier concentrations in intrinsic and extrinsic semiconductors, Fermi energy variation with temperature and impurity concentration, Hall Effect in semiconductors, P-N junction characteristics **[10]**

Text/ Reference Books:

1. D.J. Griffiths, *Introduction to electrodynamics*, Prentice Hall of India Ltd.

2. B.G. Streetman, S. Banerjee, Solid State Electronic Devices

3. Semiconductor Physics and Devices, Donald A. Neamen

4. Boylstad and Nashelsky, *Electronic Devices and Circuits*, PHI, 6e, 2001.

5. J. Reitz, F. Milford and R. Christy, *Foundation of Electromagnetic Theory*,

Narosa Publishing.

6. J. Millman and C.C. Halkias, Electronic Devices and Circuits, Millman,

McGra-Hill

Course Outcomes:

Course Outcome	**Description**
CO1	Learn to apply the basic concepts of vector calculus and understanding of various coordinate systems and related properties, Demonstrate basic understanding of formulation and deduction of electric field produced by static charge distributions
CO2	Evaluate the electrostatic field due to symmetric charge distributions, Understand the utility of formulation of electric potential and solve related problems using special techniques and boundary conditions
CO3	Acquired understanding of electrostatic fields inside matter, Explain the magnetic field due to moving charge distribution, evaluate the magnetic field due to current distribution in space,
CO4	appreciate the importance of Maxwell's equations and understand the electromagnetic wave propagation in free space Categorisation of materials on the basis of band structure
CO5	Developed understanding of quantum mechanical origin of band formation in solids, describing the energy state of electrons in crystalline materials, comprehend basic carrier properties

Course Description

Title: Introduction to Quantum Computing **Course Code: 18B14PH541**

L-T Scheme: 3-0 Course **Credits: 3**

Objectives: The course *Introduction to Quantum Computing* is specifically designed to offer a pedagogical exposure for the students pursuing undergraduate level studies in computer science and electronics. This newly emerging discipline provides many exciting opportunities for the practitioners of physics and engineering. In the first half of the course we intend to cover some fundamental concepts of quantum computation and quantum information theory. In the second half of the course, we will touch upon advanced topics e.g., quantum algorithms and quantum communication.

Prerequisites: Students taking up this course are expected to be familiar with elementary calculus and matrix analysis. The necessary background in quantum mechanics and mathematical physics will be introduced as we go on in the course.

Course Contents:

Unit I: Introduction & Overview: A brief historical review of basic ideas of classical computation and its scope and limitations. Basic definitions of quantum logic and quantum information. Basic ideas of classical information theory; measures of information (information content and entropy); Maxwell's demon, classical theory of computation; universal computer; Turing machine; computational complexity; uncomputable functions; shortcomings of classical information theory and necessity of quantum information theory. Stern-Gerlach experiment for illustration and existence of electron spin, basic idea of superposition of states. **[10]**

Unit II: Theoretical Framework of Quantum Computation: Dirac notation and Hilbert spaces, dual vectors, linear operators. The spectral theorem, functions of operators. Tensor products, Schmidt decomposition theorem. State of a quantum system, time evolution of a closed quantum system, measurement in quantum mechanics. Pure and mixed states, density operator, partial trace, general quantum operators. Bloch Sphere representation of single qubit states, qubit rotations, single qubit gates. **[12]**

Unit III: Quantum Model of Computation: The quantum circuit model, single and multiqubit operations, universal sets of quantum gates. Efficiency of approximating unitary transformations, implementing measurements with quantum gates. **[10]**

Unit IV: Quantum Algorithms: Probabilistic versus quantum algorithms. Phase kickback. The Deutsch and Deutsch-Jozsa algorithms. Quantum phase estimation and quantum Fourier transform, error analysis in arbitrary phase estimation. Finding orders, Shor's algorithm for order estimation. Quantum algorithms based on amplitude amplification, Grover's quantum search algorithm and related topics. **[8]**

Unit V: Quantum Entanglement & Teleportation: Mathematical and physical conceptions of quantum entanglement, entanglement distillation, entanglement of formation. Entanglement in pure and mixed states. No-Cloning theorem for quantum states. Quantum teleportation and quantum communication. **[5]**

Text Books & References:

1. Quantum computing explained, D.M. McMahon
2. Approaching Quantum Computing, D.C. Marinescu and G.M. Marinescu
3. Quantum Computation and Quantum Information, M.A. Nielsen and I.L. Chuang
4. An Introduction to Quantum Computing, P. Kaye, R. Laflamme and M. Mosca
5. Explorations in quantum computing, C.P. Williams and S.H. Clearwater
6. Introduction to quantum computers, G.P. Berman
7. The Physics of Information Technology, N. Gershenfeld
8. Quantum Computing, M. Hirvensalo
9. Quantum computing and communications: an engineering approach, S. Imre, F. Balazs
10. Quantum computing: a short course from theory to experiment, J. Stolze, D. Suter
11. The Principles of Quantum Mechanics, P.A.M. Dirac
12. Modern Quantum Mechanics, J.J. Sakurai
13. Problems and solutions in quantum computing and quantum information, W.H. Steeb, Y. Hardy
14. Mathematical Physics, S. Hassani, Springer Verlag

Course Outcomes:

Course Outcomes	Description
CO1	Provides basic ideas and limitations of classical computation. Introduces quantification of information in terms of Shannon's Entropy. Provides fundamental ideas of Quantum Physics and their applicability in computation and information processing.
CO2	Demonstrates theoretical framework of Quantum Computation, Linear Algebra, Dirac's notation, linear operators, tensor product, Hilbert spaces. Enables one to work with Gram- Schmidt orthogonalization process. Introduces ideas of quantum measurement, quantum states, their time-evolution and geometrical representation using Bloch-sphere. Provides examples of manipulation of single qubit states.
CO3	Establishes ideas of the Quantum Model of Computation, enabling one to work with simple quantum circuits and quantum logic gates; involving single and multi-qubit states.
CO4	Provides a comparison of probabilistic and quantum algorithms. Demonstrates quantum algorithms such as Deutsch, Deutsch-Jozsa algorithms, Shor's algorithm, Grover's search algorithm.
CO5	Establishes fundamental ideas of quantum entanglement, entanglement in pure and mixed states, No-Cloning theorem for quantum states. Quantum teleportation and Quantum communication.

Course Description

Title: Nanoscience **Course Code: 18B14PH542**

L-T Scheme: 3-0 **Credits: 3**

Objectives: The course aims to provide students an understanding of materials and their properties at the atomic level. The course is focused at imparting the effect of scale and size of materials on the properties of engineering materials. Modern development in the area of nanoscience and nanotechnology emphasises the manufacturing and processes for the synthesis of nanostructured materials, which are prime objectives to be addressed in this course.

Course Contents:

Unit I (Introduction and Classification of Nano-structured Materials): Nanoscience and Nanotechnology, Brief History and future scope, Gleiter's classification of nano-structured materials, Classification of nanostructures by dimensionality. Properties of Fullerene, Nanotubes, Graphene. **[10]**

Unit II (Conceptual Background): Concept of matter waves, Schrodinger wave equation, confinement, particle in a potential box, barrier penetration and tunnelling effects, concept of density of states. **[6]**

Unit III (Size Effects & Properties of Nano-structured Materials): Concept of characteristic time and length scales of physical phenomena, Definition and types of size effects, extended internal surface, increasing surface energy and tension, Grain boundaries, classical and quantum size effects, size dependent thermal, mechanical, electrical, magnetic and optical properties of nano-structured materials e.g. Reduction of lattice parameters, decrease in melting point, decreasing thermal conductivity, diffusion enhancement, increasing plastic yield strength and hardness, blue shift, broadening of energy bands, phase transitions in ferromagnetic and ferroelectric materials. **[14]**

Unit IV (Synthesis & Characterisation of Nanostructures): Top-down and Bottom approaches, Vapor – phase synthesis, Liquid phase synthesis, Sol-gel technique, Solid – state phase synthesis, consolidation of nano-powders. X-ray diffraction (XRD), UV- visible, FTIR, TGA, Scanning Electron microscopy (SEM), Transmission electron Microscopy (TEM), Scanning probe microscopy, Scanning tunnelling Microscopy (STM) and Atomic Force microscopy (AFM). **[10]**

Unit V (Application of Nanotechnology): Applications of Nanostructures for diversified fields of Engineering. **[5]**

Text Books:

1. Nano Structures & Nano Materials, Synthesis, Properties & Applications by Guozhong Cao, Imperial College Press.
2. Concept of modern Physics by Arthur Beiser, 6 th Edison, McGraw-Hill.

Reference Books:

1. Introduction to Solid State Physics by C.Kittel 7th ed. Wiley
2. Nanoscale Energy Transport and Conversion: A Parallel Treatment of Electrons, Molecules, Phonons, and Photons by Gang Chen, Oxford University Press
3. Nano/Micro scale heat transfer by Zhuomin M. Zhang, Mc Graw-Hill Nanoscience and Technology series
4. Nanoscale materials in chemistry, 2 nd edition, by Kenneth J. Klabunde and Ryan M. Richards, John Wiley & Sons.

Course Outcomes

Course Outcome	Description
CO1	Introduction to the concept of Nanoscience and classification of nanostructured materials
CO2	Basic concept of crystal structure and quantum mechanics
CO3	Size effect and its effect on structural properties of materials.
CO4	Introducing basic concepts of defects, crystal structures, band theory of solids in 1D, 2D and 3D.
CO5	Synthesis and characterization of nanostructured materials.

Course Description

Title: Material Science & Applications **Course Code: 18B14PH543**

L-T Scheme: 3-0 **Credits: 3**

Objectives: Materials are the building blocks for almost all the technologies associated with electronic gadgets, electrical components, communication systems, signal processing, storing of information, hardware components and their related accessories. Therefore, search for new materials and study of their properties, useful for electronics, electrical and computer technology has become an area of current interest to the scientists and technologists. The present course aims at giving the students a basic knowledge necessary for understanding electric, magnetic, semiconducting, polymeric, solar and superconducting materials used in engineering applications.

Course Contents:

Unit I (Elementary Crystallography): Introduction to crystallography, Lattice translation vectors, Basis and Crystal structure, Symmetry operations, Primitive Lattice cell, Two-dimensional lattice types, systems, Number of lattices, Point groups, Three-dimensional lattice types, Systems, Number of Lattices, Points groups and space groups. Indexing system for crystal planes, Miller indices, Simple crystal structures, NaCl, hcp, diamond structure.

X-ray diffraction and Bragg’s law; Determination of Crystal structure using Bragg’s diffractometer. **[10]**

Unit II (Dielectric Materials): Polarisation mechanism & Dielectric Constant, Sources of polarizability, Behaviour of polarisation under alternating field, Applications of Dielectric Materials in capacitor, Different types of capacitor, Charging-discharging mechanism of capacitor, Energy stored in capacitor, Design of capacitor banks for specific requirements, Piezo motor and transformer, ferro memory cell. **[10]**

Unit III (Magnetic Materials): Concept of magnetism, Classification – dia-, para-, ferro-, antiferro- and ferri-magnetic materials, Concepts of electromagnetic induction, application of magnetic materials for motors, transformers, generators and magnetic storage devices. **[10]**

Unit IV (Materials for Energy Storage & Conversion Devices): Different types of energy storage devices, concept of battery, choice of electrode and electrolyte material for rechargeable battery. Concepts of p-n junction, Solar cell, Applications of solar cells in making solar panels. **[10]**

Unit V (**Superconducting Materials:**): Meissner effect, Critical field, type-I and type-II superconductors; Field penetration and London equation; BCS Theory, High temperature Superconductors and their Applications. **[5]**

Text Books & References:

1. Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
2. Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
3. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
4. Solid State Physics by S. O. Pillai.

Course Outcomes:

Course Outcomes	**Description**
CO1	Provides basic ideas about the crystal structure, lattice planes and unit cells for the understanding of various physical, electrical and optical properties of solids. Also, to analyse the different crystal structure using the X-ray diffraction technique.
CO2	To understand different polarisation mechanisms related to dielectric materials, which is useful for understanding the mechanism of capacitors and their applications in devices.
CO3	Establishes ideas of magnetic hysteresis in different ferromagnetic materials for their application in magnetic memories, hard drives etc. The topics are significant to understand their soft and hard magnetic behaviour on basis of their magnetic structure and type of materials.
CO4	Provides basic knowledge about the components and working of the battery and other storage devices. Also, these topics explain the basics of solar cells to be used in solar panels and other device applications.
CO5	It gives understanding about the critical temperature and critical magnetic field of the superconductors. Provides explanation of superconductors and HTSC using the BCS theory. It explains how these materials are applicable in Maglev and Squid devices.

Course Description

Title: Mechanics and Relativity **Course Code: BS1PH101**

L-T Scheme: 3+0 **Credits: 3**

Objectives: : To introduce basic concepts and the analytical framework of Newtonian Mechanics and Relativity. The course emphasises on understanding the theoretical framework of classical mechanics and its applications in analysing problems involving inverse square law of force, effect of centrifugal and Coriolis forces due to earth's rotation, mechanics of rigid bodies, classical Rutherford scattering, elementary concepts of special relativity to name a few.

Course Contents:

Unit I (Preliminary Concepts): Vector Algebra, dimensional analysis, unit systems, concept of frame of references etc. Laws of Motion: Newton's first law of motion and concept of inertia, Second law of Motion concept of force. Newton's third law. Gravity, Weight, and the Gravitational Field, Contact Forces, Force of a String, The Normal Force, Friction, the Linear Restoring Force, Simple Harmonic Motion etc. **[12]**

Unit II (Conservation Principles): Introduction to Momentum, Angular Momentum, Work and Energy, Conservation laws. Inverse square law of force, Effect of centrifugal and Coriolis forces due to earth's rotation, Center of mass (C.M), Lab and C.M frame of reference, motion of CM of system of particles subject to external forces, elastic, and inelastic collisions in one and two dimensions. **[12]**

Unit III (Scattering Problems in Classical Mechanics): Scattering angle in, the laboratory frame of reference, Impact parameter, Scattering cross section. **[7]**

Unit IV (Rigid Bodies): Elementary dynamics of rigid bodies. **[7]**

Unit V (Special Relativity): Frames of reference, Inertial and non-inertial frames of reference Postulates of special theory of relativity, Derivation of Lorentz transformation and physical significance of Lorentz invariance, Length contraction and time dilation, Concept of simultaneity, Relativistic velocity transformation relations, mass energy relation, Concept of zero rest mass of photon, Relativistic relation between energy and momentum. **[7]**

Text Books:

1. An Introduction to Mechanics, D. Kleppner and R.J. Kolenkow
2. Mechanics (Berkeley Physics Course, Vol. 1), C. Kittle et.al.
3. Introduction to Special Relativity, R. Resnick

Reference Books:

1. Fundamentals of Physics, R. Resnick, D. Halliday
2. Concept in Physics Vol.: I, H.C.Verma

Course Outcomes:

Course Outcome	Description
CO1	Explains concepts of motion and Newton’s law of motions, and frames of references.
CO2	Enables one to understand motion in 1D and 2D Cartesian and Polar coordinate systems, to apply Newton's laws of motion to various physical problems. Delineates the principles of conservation of energy, momentum and angular momentum.
CO3	Enables one to apply laws of mechanics to understand dynamics of rigid bodies and mechanics of fluids.
CO4	Offers an explanation to scattering problems with the help of laws of mechanics.
CO5	Convinces the learner that Newtonian Mechanics has limitations, typically when the speed of a particle is comparable to the speed of light. Delineates postulates of Special Theory of Relativity. Offers elementary knowledge to work with Lorentz’s transformation and its consequences e.g., Length Contraction and Time Dilation. Briefly introduces Relativistic Dynamics and results like the redefinition of momentum, mass-energy equivalence, concept of rest mass to name a few.

Course Description

Title: Electricity & Magnetism **Course Code: BS1PH201**

L-T Scheme: 3-0 **Credits: 3**

Objectives: Among four fundamental forces, electromagnetic force is not only the best understood force, it is also overwhelmingly in everyday life. Ranging from chemical reactions, to modern telecommunication, electromagnetic fields play a central role. This course intends to build conceptual foundations of the subject with the help of elementary vector algebra and calculus.

Course Contents:

Unit I (Introduction to Vector Calculus): Basic concepts of Vector calculus: Cartesian, Spherical polar and Cylindrical Coordinate systems, concept of Gradient, divergence, curl and fundamental theorems. **[10]**

Unit II (Electrostatics): Electric charge, conservation of charge, quantization of charge, Coulomb's force law, Electric field, charge distributions, flux, Gauss's law and its applications, energy associated with electric field. Electric potential, potential due to various charge distribution, Method of images, Laplace's and Poisson's equations, Energy of system of charges, Electric field inside matter, linear dielectric materials, polarisation, capacitance, energy stored in a capacitor, Electric displacement, Electric currents. **[15]**

Unit III (Magnetostatics): Electric currents, generation of Magnetic field due to electric currents, Biot-Savart law, Ampere's law, magnetic field inside matter, forces and torques in magnetic field, electromagnetic induction, Faraday's law, lenz law, Inductance and magnetic circuits. **[10]**

Unit IV (Electromagnetism): Maxwell's equations in free space and matter, Maxwell correction to Ampere's law, electromagnetic waves in free space, Transverse nature of electromagnetic waves and polarisation, propagation of electromagnetic field in free space. **[10]**

Text Books & References:

1. Physics: Resnick and Halliday
2. Electricity and Magnetism: Berkeley Physics Course vol. 2
3. Electromagnetics, Schaum's Outline Series.
4. Introduction to electrodynamics, D. J. Griffiths , Prentice Hall of India Ltd.

Course Outcomes:

Course Outcomes	Description
CO1	Offers basic working knowledge of coordinate systems in a generalised way and vector differential operators.
CO2	Offers understanding of electric fields produced by static charges, Coulomb's law and charge of conservation. Introduces Gauss's law of electrostatics and enables one to use the same in calculation of electric fields in a variety of static charge configurations. Introduces the notion of electric potential and establishes its relation with electrostatic fields.
CO3	Offers a basic understanding of electrostatic fields inside the matter. Introduces concepts of Electric Flux Density Vector (Electric Displacement Vector), Dielectric Polarisation. Also offers working knowledge of calculation of capacitance, energy stored in a capacitor.
CO4	Builds conceptual foundation of Magnetostatics. Offers working knowledge of calculation of magnetic fields using Biot-Savart law and Ampere's law. Convinces about the limitation of Ampere's law, introduces Maxwell's correction and establishes the concept of Displacement current.
CO5	Summarises fundamental laws of electricity and magnetism in terms of Maxwell's Equations. Establishes electromagnetic nature of light and proves transverse nature of Electromagnetic waves in free space.

COURSE DESCRIPTION

Title of Course: Quantum Mechanics **Course Code: BS1PH402**

L-T Scheme: 3-0 **Credit: 3**

Objectives: This course is focused on detailed elucidation of basic principles of quantum mechanics. Meticulous introduction and discussion of various experimental results is going to be presented. This is to understand and appreciate the general physical implications of basic quantum ideas

Course Description:

Unit I (Historical Background & Origin of Quantum Ideas): Failures of classical physics in microscopic domain, Black body radiations, Photoelectric effect, x-ray diffraction, Atomic spectra and Bohr model of hydrogen atom. **[8]**

Unit II (Wave-Particle Dualism & Uncertainty Principle): Compton effect, Davisson & Germer experiment, De Broglie hypothesis, Wave packets, concept of phase velocity and group velocity, Heisenberg uncertainty principle and its applications, Angular momentum and spin, Stern-Gerlach experiment. **[12]**

Unit III (Wave Function & Schrödinger Equation): Statistical interpretation of wave function, Wave function and its properties, free particle wave function, Probability and Expectation values, Operators for dynamical variables, time-dependent Schrödinger equation, steady state Schrödinger equation, equation of continuity, Ehrenfest theorem. **[10]**

Unit IV (Schrödinger Equation & One Dimensional Application): olution of time dependent Schrödinger equation for a free particle, Stationary states, energy Eigenvalues and Eigenfunctions in case of a particle trapped in an infinite square well, bound states and scattering states for delta function potential, finite square well, reflection and transmission coefficients, tunnelling, Potential step, rectangular potential barrier, linear harmonic oscillator. **[08]**

Unit V (Quantum Mechanics in Three Dimensions): Separation of Schrödinger equation in Cartesian coordinates, Separation of Schrödinger equation in spherical polar coordinates, The hydrogen atom, Quantum mechanical treatment of orbital angular momentum, spin and Concept of degeneracy. **[07]**

Text Books & References:

1. Introduction to Quantum Mechanics, D.J. Griffiths, Pearson Publication
2. Quantum Physics: Berkeley Physics Course Vol. 4, E.H. Wichman, McGraw Hill
3. Quantum Mechanics, B.H. Bransden and C.J. Joachain, Pearson Publications
4. Quantum Mechanics, L.I. Schiff, Tata McGraw Hill
5. Introduction to Mathematical Physics, C. Harper, Prentice-Hall Publications

Course Outcomes	**Description**
CO1	Comprehending the historical developments, important benchmark experiment, conclusions and understand the inadequacy of classical ideas in explanation of phenomena at the microscopic level
CO2	Acquired a profound understanding of requirement of introducing quantum ideas on the basis various experimental results, developed importance of probabilistic interpretation and description of physical phenomena based on heuristic arguments based on Uncertainty principle, Develop the ability to discuss wave particle duality and associated concepts
CO3	Understand the basic quantum mechanical description and statistical interpretation of wave function and relevant mathematical formulation in terms of Schrödinger equation
CO4	Approach the solution of time dependent and time independent Schrodinger equation in case of variety of one dimensional potential field
CO5	Understanding the Eigenvalue problems for energy, momentum, angular momentum and central potentials by recognizing boundary conditions, setting up and solving differential equations based on separation of variables, power series solution, explain the idea of spin and concept of degeneracy

COURSE DESCRIPTION

Title: Wave & Optics **Course Code:** BS1PH403

L-T Scheme: 3-0 **Credits: 3**

Objectives: This course aims at a detailed introduction of basic principles of superposition of waves and consequences. Various theoretical and experimental aspects related to Interference, diffraction and polarisation are to be presented. Also included are the basic principles and working of Laser systems.

Course Description:

Unit I (Introduction to Superposition of Waves): Fermat's principle, Simple harmonic motion, forced vibrations and origin of refractive index, wave propagation, wave equation, Huygen's principle, rectilinear propagation, Superposition of waves, Coherence, Spatial Coherence, Temporal coherence **[09]**

Unit II (Interference): Two beam interference by division of wave front, intensity distribution, Fresnel's two mirror arrangement, Fresnel's biprism, Interference with white light, displacement of fringes, Lloyd's mirror arrangement, Phase change on reflection, Interference by division of amplitude, Interference by a plane parallel film illuminated by plane wave, Cosine law, Non-reflecting films, high reflectivity by thin film deposition, reflection by periodic structure, Interference by a film with two non parallel reflecting surfaces, Colours of thin films, Newton's rings, The Michelson interferometer, Multiple beam interferometry, Multiple reflections from a plane parallel film, Fabry-Perot interferometer. **[15]**

Unit III (Diffraction): Fraunhofer diffraction, Single slit diffraction, Diffraction by a circular aperture, Double slit diffraction, N-slit diffraction, Diffraction Grating, Missing orders, Fresnel diffraction and half period zones **[09]**

Unit IV (Polarisation): Proof of Light as transverse electromagnetic wave, Polarisation, Polarised light, Malus's law, anisotropic media, Double refraction, analysis of polarised light, optical activity. **[6]**

Unit V (Basic Principle of Laser system): Lasers as a source of coherent light, Einstein coefficients, Population inversion, Optical resonator, Basic properties and applications of Laser, Ruby laser, He-Ne laser **[06]**

Text Books & References:

1. Optics by Ajoy Ghatak
2. Optics by Eugene Hecht
3. Fundamentals of Optics by Jenkins and White
4. Lasers-Principles and Applications by Ghatak and Thyagrajan

Course Outcomes:

Course Outcomes	**Description**
CO1	Understand the rectilinear propagation of light, difference between a ray and a wave Explain the principle of superposition and redistribution of intensity of light in a given region of space
CO2	Acquired knowledge of the phenomenon of interference by division of wave front and division of amplitude through important standard experiments & their results
CO3	Understand and interpret the basic aspect related to diffraction of light through various apertures and practical implications
CO4	Acquired the knowledge of polarisation on the basis of transverse nature of light and related applications
CO5	Developed a basic comprehension of basic properties and working of Laser systems and applications