FACULTY OF SCIENCES

SYLLABUS FOR THE BATCH FROM THE YEAR 2023 TO YEAR 2026

Programme Code: BSCS

Programme Name: B.Sc. Computer Science

(Semester I-IV)

(PHYSICS SYLLABUS)

Examinations: 2024-25

Department of Physics

Khalsa College, Amritsar

(An Autonomous College)

S.No.	PROGRAMME OBJECTIVES
1.	To teach fundamental concepts of sciences and its societal applications through a 3-year program.
2.	To provide the key knowledge and laboratory resources to prepare students for careers as professionals in the field of science.
3.	To equip students with advanced knowledge, research training and experience in specific areas of science. These skills will prepare the successful graduate for careers in government, academia, or industry.

PROGRAMME SPECIFIC OUTCOMES (PSOs)	
PSO-1	To understand the fundamental concepts in physics, computer & mathematics and develop ideas based on them.
PSO-2	To possess knowledge on the topics in pure physics, computer & mathematics, empowering students to pursue higher degrees at reputed academic institutions.
PSO-3	To demonstrate problem-solving skills, innovative thinking and creativity.
PSO-4	To be motivated towards research in physics, computer, mathematics and related fields.
PSO-5	To enable students to become eligible to serve in DRDO, defense, public sector and private Sector.

ELIGIBILITY: A candidate who has passed 10+2 Non-medical examination from recognized board or any other examination considered equivalent there to be by the GNDU with 40% marks is eligible to apply (subject to change).

COURSE DURATION: 3 Years

COURSE SCHEME (Batch 2023-26)												
SEMESTER - I												
Course Code	**Course Name**	**Hours/ Week**	**Credits**			**Total Credits**	**Max. Marks**				**Page No.**	**Syllabus Changed/ Same as 2023-24**
			L	**T**	**P**		**Th**	**Pr**	**IA**	**Total**		
PHY111A	MECHANICS	3	2	1	0	3	56	-	50	200	4-5	Same **as 2023-24**
PHY111B	ELECTRICITY AND MAGNETISM	3	2	1	0	3	56	-			6-7	Same **as 2023-24**
PHY111P	PRACTICAL	4	0	0	2	2	-	38			8-9	Same **as 2023-24**

SEMESTER - II												
Course Code	**Course Name**	**Hours/ Week**	**Credits**			**Total Credits**	**Max. Marks**				**Page No.**	**Syllabus Changed/ Same as 2023-24**
			L	**T**	**P**		**Th**	**Pr**	**IA**	**Total**		
PHY121A	RELATIVITY AND ELECTROMAGNETISM	3	2	1	0	3	56	-	50	200	10-11	Same **as 2023-24**
PHY121B	VIBRATION AND WAVES	3	2	1	0	3	56	-			12-13	Same **as 2023-24**
PHY121P	PRACTICAL	4	0	0	2	2	-	38			14-15	Same **as 2023-24**

SEMESTER - III												
Course Code	**Course Name**	**Hours/ Week**	**Credits**			**Total Credits**	**Max. Marks**				**Page No.**	**Syllabus Changed/ Same as 2023-24**
			L	**T**	**P**		**Th**	**Pr**	**IA**	**Total**		
PHY231A	QUANTUM MECHANICS	3	2	1	0	3	56	-	50	200	16-18	Same **as 2023-24**
PHY231B	OPTICS AND LASERS	3	2	1	0	3	56	-			19-20	Same **as 2023-24**
PHY231P	PRACTICAL	4	0	0	2	2	-	38			21-22	Same **as 2023-24**

SEMESTER - IV												
Course Code	**Course Name**	**Hours/ Week**	**Credits**			**Total Credits**	**Max. Marks**				**Page No.**	**Syllabus Changed/ Same as 2023-24**
			L	**T**	**P**		**Th**	**Pr**	**IA**	**Total**		
PHY241A	STATISTICAL PHYSICS & THERMODYNAMICS	3	2	1	0	3	56	-	50	200	23-24	Same **as 2023-24**
PHY241B	ATOMIC AND MOLECULAR SPECTRA	3	2	1	0	3	56	-			25-26	Same **as 2023-24**
PHY241P	PRACTICAL	4	0	0	2	2	-	38			27-28	Same **as 2023-24**

B.Sc. SEMESTER–I
PHY111A
MECHANICS
(THEORY)

Teaching Hours (per week): 3
Total Credits: 3
Credits:LTP:210
Time: 3 Hours **Total Hours: 45**
Maximum Marks: 56
Pass Marks: 35%

Note for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 12 marks consisting of 8 short answer type questions carrying 2 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any 6 questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 11 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-programmable Scientific calculator is allowed.**

Course Objectives: The purpose of the course is to provide the basic information about co- ordinate system and motion of particles in it, to understand the conservation laws and also to determine the difference between elastic and inelastic collisions. It includes applications of central force to the stability of circular orbits, Kepler's laws of planetary motion, orbital precession and Rutherford scattering, dynamics of rotating objects i.e. rigid bodies, angular velocity, the moment of inertia, the motion of rigid bodies and Euler equations. It also helps to understand the differences between types of forces and the inverse square force field.

Course Contents:

UNIT–I

Cartesian, **Plane polar** and spherical polar co–ordinate systems, **Position vector,** area, volume, velocity and Acceleration in these systems. **unit vectors in plane polar and spherical polar coordinates**, Solid angle, Properties of space and time, conservative force, **Homogeneity of space and time, isotropy of space and related** conservation laws.

UNIT-II

Various forces in Nature (Brief introduction), Centre of mass, **internal forces, central forces**, equation of motion under central force, reduction of two body problem to an equivalent one body problem, **Areal velocity, equation of motion of reduced mass in Plane polar coordinates, conservation of energy of particle in central force**, differential equation of the orbit and turning points.Kepler Laws of planetary motion.

UNIT–III

Inertial and Non-Inertial frame of reference. Non Inertial frames, rate of change of position vector in moving and rotating co-ordinate system, Coriolis force, **Horizontal and Vertical components of Coriolis force on the surface of earth, Effect of Coriolis force on a freely falling body**, **geographical consequences of coriolis force qualitative analysis of Foucault pendulum.**

UNIT–IV

Elastic collision in Lab and C.M. system, velocities, angles and energies, **concept of scattering, differential** cross section of elastic scattering, Rutherford scattering. Rigid Body, **centre of mass of continuous bodies, qualitative analysis of translational and rotational motion of rigid body with fixed axis; principal axis of a rigid body**, equation of motion for rotating rigid body, elementary gyroscope.

Books Prescribed:

1. Mechanics, Berkeley Vol.–I by C. Kittle.
2. Mechanics, H.S. Hans & S.P. Puri.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	derive the velocity and acceleration in different co-ordinates systems
CO2	have the knowledge about the various symmetries and associated conservation laws
CO3	Understand the application of central force, Kepler's laws of planetary motion,
CO4	have information about non-inertial frames: pseudo forces, examples involving the centrifugal force and Coriolis force
CO5	have information about the elastic and inelastic scattering along with Rutherford scattering and the motion of rigid bodies.

B.Sc. SEMESTER–I
PHY111B
ELECTRICITY AND MAGNETISM
(THEORY)

Teaching Hours (per week): 3
Total Credits: 3
Credits:LTP:210
Time: 3 Hours **Total Hours: 45**
Maximum Marks: 56
Pass Marks: 35%

Note for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 12 marks consisting of 8 short answer type questions carrying 2 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any 6 questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 11 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-programmable Scientific calculator is allowed.**

Course Objectives: The objective of this course is to apply knowledge of electricity and magnetism to explain natural physical processes and related technological advances and use of calculus along with physical principles to effectively solve problems encountered in everyday life.

Course Contents:

UNIT–I

Basic ideas of Vector Calculus Gradient, Divergence, curl and their physical significance. Laplacian and Poisson's Equations (Qualitative idea). Coulomb's Law for point charges and continuous distribution of charges. Electric field due to dipole and sheet of charge. Electric flux, Gauss's Law and its applications. Gauss's divergence theorem and differential form of Gauss's Law.

UNIT–II

Work and potential difference. Potential difference as line integral of field. Electric potential due to a point charge, a group of point charges, dipole, long uniformly charged wire and charged disc. Stoke's theorem, curl E=0, Electric fields as gradient of scalar potential. Calculation of E due to a point charge and dipole from potential. Concept of electrical images (Qualitative idea), Current and current density, equation of continuity. Microscopic form of Ohm's Law ($J=\sigma E$) and conductivity, Failure of Ohm's Law.

UNIT–III

Dielectrics, Polar and non-polar molecules, Polarization of Dielectric, Polarization vector, Atomic Polarizability, Dielectric Constant, Capacity of a capacitor with dielectric, Electric Susceptibility, Relation between Dielectric constant and Electric susceptibility, Gauss law in Dielectric, Displacement Vector, Relation between E, P and D. Energy stored in Capacitor having Dielectric Medium, Energy Density of a Dielectric Medium.

UNIT–IV

Field of a point charge moving with constant velocity. Interaction between moving charges and force between parallel currents. Behaviour of various substances in magnetic field. Definition of M and H and their relation to free and bound currents. Permeability and susceptibility and their interrelationship. Qualitative idea of diamagnetism, paramagnetism and ferromagnetism.

Books Prescribed:

1. Fundamentals of Electricity and Magnetism by Arthur F. Kipp.
2. Electricity and Magnetism, Berkeley Physics Course, Vol. II by E.M. Purcell.
3. Introduction to Classical Electrodynamics by David Griffith.
4. Electricity & Magnetism-T.S. Bhatia and Gurpreet Singh, Vishal Publications

Course Outcomes:

Sr. No.	**On completing the course, the students will be able to:**
CO1	Apply knowledge on electricity and magnetism to explain natural physical processes and related technological advances.
CO2	Understand the use of the Stoke's and Gauss Divergence theorems for solution of different physics problems.
CO3	Explain the concept of electric current and related concepts.
CO4	Understand about electric current and related concepts.
CO5	Explain the phenomenon of magnetism, types of magnetic materials and their properties.

B.Sc. SEMESTER–I
PHY111P
(PRACTICAL)

Teaching Hours (per week): 4
Total Credits: 2
Credits:LTP:002

Time: 3 Hours **Maximum Marks: 38**
Pass Marks: 35%

General Guidelines for Practical Examination:
I. The distribution of marks is as follows: **38 Marks**
i) One experiment: **15 Marks**
ii) Brief Theory : 8 **Marks**
iii) Viva–Voce: **10 Marks**
iv) Record (Practical file): **5Marks**
II. There will be one sessions of 3 hours duration. The paper will have one session.
Paper will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.
III. Number of candidates in a group for practical examination should not exceed 12.
IV. In a single group no experiment be allotted to more than three examinee in any group.

Course Objectives: Course objective of this subject is to follow the pragmatic way of learning and describe the basic experimental skills in the students. They will be able to demonstrate and able to evaluate the resistance, modulus of rigidity, torque and moment of inertia of body experimentally. They will also learn about the energy consumption by demonstrating the energy meter experiment.

Course Contents:

1. To determine low resistance with Carey Fosters Bridge.
2. To determine the resistance and specific resistance of copper with the help of Kelvin's double bridge.
3. To study the variation of resistance of a filament of a bulb with its temperature.
4. Capacitance by flashing and quenching of a neon lamp.
5. Measurement of Capacitance, determination of permittivity of a medium air and relative permitivity by de–Sauty's bridge.
6. To determined I using Anderson Bridge.
7. Exercise on fitting of given data to straight line and calculation of probable error.
8. To study the dependence of moment of inertia on distribution of mass (by noting time periods of oscillations using objects of various geometrical shapes but of same mass).
9. To establish relationship between torque and angular acceleration using fly wheel.
10. To find the moment of inertia of a flywheel.
11. Study of bending of beams and determination of young's Modulus.
12. Determination of Poissons or rubber plastic.
13. To find young's modulus, modulus of rigidity & Poisson ratio by Searle's method.
14. To study flow of water through capillary tubes of different length and area of cross section of (at least two each) and calculate coefficient of viscosity.
15. To determine energy transfer, coefficient of restitution and verify laws of conservation of linear momentum and kinetic energy in elastic collisions using one dimensional collisions of hanging spheres.
16. **To study the RL and RC circuits.**

17. Energy meter.
18. **To study the charging and discharging of capacitor.**

Books Prescribed:

1. Practical Physics Vol. I, T.S. Bhatia, Gursharan Kaur, Iqbal Singh, Vishal Publications.
2. Practical Physics, C.L. Arora, S. Chand & Co.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Determine low resistance with Carey Fosters Bridge.
CO2	Study the dependence of moment of inertia on distribution of mass (by noting time periods of oscillations using objects of various geometrical shapes but of same mass).
CO3	Find Moment of Inertia and establish relationship between torque and angular acceleration using fly wheel.
CO4	Determine the resistance and specific resistance of copper with the help of Kelvin's double bridge.
CO5	Understand the measure of Capacitance, determination of permittivity of a medium air and relative permitivity by de–Sauty's bridge.

B.Sc. SEMESTER–II
PHY121A
RELATIVITY AND ELECTROMAGNETISM
(THEORY)

Teaching Hours (per week): 3
Total Credits: 3
Credits:LTP:210
Time: 3 Hours **Total Hours: 45**
Maximum Marks: 56
Pass Marks: 35%

Note for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 12 marks consisting of 8 short answer type questions carrying 2 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any 6 questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 11 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-programmable Scientific calculator is allowed.**

Course Objectives: The aim of course is to understand the key observations and events that led to the development of Einstein's theory of special theory of relativity, Minkowski space; to understand the basics and applications of electromagnetism, LCR Circuits, Maxwell's equations, E.M. Waves; to understand the fundamental principles of special theory relativity, applications and possibilities; to understand the experimental basis of these fundamental principles and how this contributed to the subsequent development of fundamental physics.

Course Contents:

UNIT–I

Galilean transformations; Applications of Galilean transformations to mechanics and electromagnetism; Postulates of special theory of relatively; Lorentz transformations; observer and viewer in relativity; Relativity of simultaneity; Length **Contraction**; Time **dilation**; **Experimental evidence of time dilation; Velocity addition theorem**; Relativistic Doppler effect; Variation of mass with velocity; Mass–energy equivalence; Relativistic momentum & energy, their transformations; E in different frames of reference; Transformation equation of E and B from one frame to another.

UNIT–II

Space-time continuum; Concepts of Minkowski space; **Events, Interval between events: Space-like interval, Time-like interval, Light-like interval; Light cone; Concept of world line;** Four vector formulation; **Some important four vectors: Position four-vector, velocity four-vector, Four force (Minkowski force) etc.**

UNIT–III

Lorentz's force; Definition of Bio-Savart's Law and its application to long straight wire, circular current loop and solenoid; Ampere's Circuital law and its applications; Divergence and curl of B; Vector potential–definition; current density–definition; Faraday's Law of EM induction; Displacement current; Mutual inductance; Reciprocity theorem; Self-inductance; L for solenoid; Coupling of Electrical circuits; LCR series and parallel circuit; Q–factor, Power consumed; Power factor.

UNIT–IV

Maxwell's equations their derivation and characterizations; E.M. waves; Wave equation in a medium having finite permeability and permittivity but with conductivity $\sigma=0$; Poynting vector; Impedance of a dielectric to EM waves; EM waves in a conducting medium and Skin depth; EM wave velocity in a conductor and anomalous dispersion; Response of a conducting medium to EM waves; Reflection and transmission of EM waves at a boundary of two dielectric media for normal and oblique incidence.

Books Prescribed:

1. A Primer of Special Theory of Relativity by P. L. Sardesai; New Age International Publisher.
2. EM Waves and Radiating Systems by Edward C. Jordan and K.G. Balmain.
3. Fields and Waves Electromagnetic by David K. Cheng.
4. Electricity & Magnetism-T.S. Bhatia and Gurpreet Singh, Vishal Publishing Co.

Relativity and Electromagnetism, T.S. Bhatia, Vishal Publishing Co.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Discuss the key observations and events that led to the development of Einstein's theory of special relativity.
CO2	Explain the fundamental principles of special relativity and electromagnetism and the far-reaching connections between them.
CO3	Describe Maxwell equations and its physical consequences.
CO4	Describe the nature of electromagnetic wave and its propagation through different media and interfaces.
CO5	Discuss the experimental basis of these fundamental principles and how this contributed to the subsequent development of fundamental physics.

B.Sc. SEMESTER–II
PHY121B
VIBRATION AND WAVES
(THEORY)

Teaching Hours (per week): 3
Total Credits: 3
Credits:LTP:210
Time: 3 Hours **Total Hours: 45**
Maximum Marks: 56
Pass Marks: 35%

Note for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 12 marks consisting of 8 short answer type questions carrying 2 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any 6 questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 11 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-programmable Scientific calculator is allowed.**

Course Objectives: The purpose of the course is to understand the physical characteristics of SHM and obtaining solution of the oscillator using differential equations, to calculate logarithmic decrement relaxation time and quality factor of a harmonic oscillator. This course provides information to understand the difference between simple harmonic vibrations of same frequencies and different frequencies, wave equation and to understand the significance of transverse waves and longitudinal waves, coupled mechanical as well as electrical oscillators.

Course Contents:

UNIT–I

Simply harmonic motion, energy of a SHO, **Variation of Kinetic energy and potential energy**, Compound pendulum. Torsional pendulum Electrical Oscillations, Vibrations of a mass on string, superposition of two perpendicular SHM of same period and of period in ratio 1:2 **(Graphical and Analytical Method)**.

UNIT–II

Damped and undamped oscillations, Decay of free Vibrations due to damping. Differential equation of motion, types of motion, types of damping. Determination of damping co–efficient– Logarithmic decrement, relaxation time and Q-Factor. Electromagnetic damping (Electrical oscillator).

UNIT–III

Differential equation for forced mechanical and electrical oscillators. Transient and steady state behavior, Displacement and velocity variation with driving force frequency, variation of phase with frequency, resonance. Power supplied to an oscillator and its variation with frequency,Q-value and band width, **Q-value as an amplification factor**. Stiffness coupled oscillators, Normal co–ordinates and normal modes of vibration. Inductance coupling of electrical oscillators.

UNIT–IV

Types of waves, wave equation (transverse) and its solution characteristic impedance of a string. Impedance matching. Reflection and Transmission of waves at boundary. Reflection and transmission of energy. Reflected and transmitted energy coefficients. Standing waves on astring of fixed length, **Progressive and Stationary waves**, Energy of vibration string, Wave and group velocity.

Books Prescribed:

1. Fundamentals of Vibrations and Waves by S.P. Puri.
2. Physics of Vibrations and Waves by H.J. Pain.
3. EM Waves and Radiating Systems by Edward C. Jordan and K.G. Balmain.
4. Fields and Waves Electromagnetic by David K. Cheng.
5. Waves and Vibrations, T.S. Bhatia, Vishal Publishing Co.
6. Vibrations and Waves, Modern Publishers, Jalandhar.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Understand simple harmonic motion and will be able to solve the equations of motions for physical systems that undergo simple harmonic motion.
CO2	Understand the damped oscillator in the over damped, critically damped and under damped regimes.
CO3	Understand, derive and solve the equations for a forced oscillator, the concept of resonance and variation of displacement and velocity with driving force frequency.
CO4	Understand the concept of coupled oscillators will be able to derive and solve the equation of motion for simple systems and describe the motion of coupled oscillators in terms of normal mode solutions.
CO5	Understand about wave, differences between longitudinal and transverse waves, the concepts of phase and group velocities and be able to calculate these quantities.

B.Sc. SEMESTER–II
PHY121P
(PRACTICAL)

Teaching Hours (per week): 4
Total Credits: 2
Credits: LTP: 002

Time: 3 Hours **Maximum Marks: 38**
Pass Marks: 35%

General Guidelines for Practical Examination:

I. The distribution of marks is as follows: **38 Marks**
i) One experiment: **15 Marks**
ii) Brief Theory : 8 **Marks**
iii) Viva–Voce: **10 Marks**
iv) Record (Practical file): **5Marks**

II. There will be one sessions of 3 hours duration. The paper will have one session. Paper will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.

III. Number of candidates in a group for practical examination should not exceed 12.

IV. In a single group no experiment be allotted to more than three examinee in any group.

Course Objectives: The Course objective of this subject is to follow the pragmatic way of learning and describe the basic experimental skills in the students. They will be able to demonstrate and able to evaluate the value of acceleration due to gravity g by using Cater's pendulum, Bar pendulum, experimentally and theoretically compare the results of Resonance in a series and parallel LCR circuit. They will also learn about the induced e.m.f. as function of the velocity of the magnet by demonstrating the Faraday's experiment.

Course Contents:

1. To study the magnetic field produced by a current carrying solenoid using a search coil and calculate permeability of air.
2. To study the induced e.m.f. as function of the velocity of the magnet.
3. Study of phase relationships using impedance triangle for LCR circuit and calculate Impedance.
4. Resonance in a series and parallel LCR circuits for different R–value and calculate Q–value.
5. To find the coefficient of self-inductance by Ray Leigh's Method.
6. To measure the charge sensitivity of a moving coil Ballistic galvanometer using a known capacitor.
7. To find the angle of dip in the lab using an earth inductor.
8. To find the value of B_H the horizontal component of earth's magnetic field in the lab using a deflection & vibration magnetometer.
9. To study the variation of magnetic field with distance along the axis of coil carrying current by plotting a graph.
10. Measure time period as a function of distance of centre of suspension (oscillation) from centre of mass, plot relevant graphs, determine radius of gyration and acceleration due togravity.
11. Melde's experiment.
12. Find the value of g by Kater's pendulum.

13. To compare the M.I. of solid & hollow sphere of same mass using tensional pendulum.
14. Measure time period of oscillation of a Maxwell needle and determine modulus of rigidity of the material of a given wire.
15. To measure obtain logarithmic decrement, coefficient of damping, relaxation time, and quality factor of a damped simple pendulum.
16. **Computer based simulations of the formation of standing waves.**
17. **Computer based simulations of the formation of concept of phase.**

Books Prescribed:

1. Practical Physics Vol. I, T.S. Bhatia, Gursharan Kaur, Iqbal Singh, Vishal Publications.
2. Practical Physics, C.L. Arora, S. Chand & Co.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Study the induced e.m.f. as function of the velocity of the magnet.
CO2	Compare the results of Resonance in a series and parallel LCR circuits for different R–value and calculate Q–value experimentally as well as theoretically.
CO3	Plot the graph of variation of magnetic field with distance along the axis of current carrying coil carrying.
CO4	Verify the laws of vibrating strings and compare the mass per unit length of string using Melde's experiment.
CO5	Find the value of acceleration due to gravity (g) by Kater's pendulum.

B.Sc. SEMESTER–III
PHY231A

QUANTUM MECHANICS

(THEORY) **Teaching Hours (per week): 3**
Total Credits: 3
Credits:LTP:210
Time: 3 Hours **Total Hours: 45**
Maximum Marks: 56
Pass Marks: 35%

Note for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 12 marks consisting of 8 short answer type questions carrying 2 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any 6 questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 11 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-programmable Scientific calculator is allowed.**

Course Objectives: The main objective of this course is to make students aware about the basic formulations in quantum mechanics. To acquire mathematical skills require to develop theory of quantum mechanics. To develop understanding of postulates of quantum mechanics and to learn to apply them to solve some quantum mechanical systems. To offer systematic methodology for the application of Schrodinger equation to solve quantum mechanical systems. There are many different types of representations of state and operators that are very useful in studying the subject deeply. It teaches about various commutation and uncertainty relations. Students will be given insight to solve Schrodinger wave equation in three dimensions.

UNIT–I

Formalism of Wave Mechanics:

Brief introduction to need and development of quantum mechanics, photoelectric effect, **Laws of Photoelectric emission, classical and Einstein explanation of photoelectric effect, concept of photon,** Compton effect, **classical and quantum explanation of Compton effect**, **Dual nature of electromagnetic waves and matter:** Wave particle duality, De broglie hypothesis, Davisson and Germer experiment, Free particles, **Wave Function, Limitation of free particle wave function, localized particle, wave packet, phase velocity, group velocity, Born's interpretation of the wave function,** derivation of Uncertainity principle, **application of Uncertainty principle**.

UNIT–II

Time dependent and Time independent Schrodinger wave equation, General solution and stationary state, normalization, **properties of eigen function**, conservation of probability density, **orthogonal wave function**, **expectation value of position and momentum, condition for**

Linearly independent and dependent functions, linear operators, commutator, Hermition operator, observables, **angular momentum operator in Cartesian and spherical polar co-ordinates,** operator for energy, scalar product of states, **Schwartz inequality, uncertainty in measurement of observables**, Guassian wave packet. motion of the wavepacket: Ehrenfest theorem,

UNIT–III

Application of Schrodinger wave equation to one dimensional problems: Schrodinger's wave equation for a particle in one dimensional infinite potential well (closed box). One dimensional step potential for $E>V_0$, one dimensional step potential for $0<E<V_0$, one dimensional potential barrier of finite height and width $E<V_0$, Quantum mechanical tunnelling effect, one dimensional square well of finite depth, **Harmonic oscillator**, **Parity.**

UNIT–IV

Application of Schrodinger equation to three dimensional problems: **Schrodinger's wave equation in spherical polar co-ordinates, separation of Schrodinger equation for spherical symmetric potential,** Hydrogen atom, solution of $R(r)$, $\Theta(\theta)$,$\Phi(\varphi)$ equations, spherical Harmonics**,** Eigen wave function, **physical interpretation of quantum number**s, **vector model of the atom** degeneracy, three dimensional harmonic oscillator (Cartesian coordinates).

Books Prescribed:

1. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan,

(Tata McGraw Hill Pub., Co., Delhi) 2002.

2. Quantum Mechanics J.L. Powell and B. Craseman (Narosa Pub. House, New Delhi) 1997.

3. Concepts of Modern Physics, Arthur Beiser (McGraw Hill Pub. Co., New Delhi, 9th Ed.)

1995.

4. Elements of Modern Physics, S.H. Patil (McGraw Hill), 1998.

5. Quantum Mechanics, E. Merzbacher (John Wiley, 2nd Edition)

6. Fundamentals of Molecular Spectroscopy, C.N. Banwell (Tata McGraw Hill Pub. Co.,

Delhi), 2001.

7. Atomic Spectra, H.G. Kuhn (Longmans), 2nd Ed., 1969.

8. Introduction to Quantum Mechanics, L. Pauling and E.B. Wilson (Tata McGraw Hill Pub.

Co., Delhi), 2002.

9. Quantum Mechanics, W. Greiner (Springer Verlag), 1994.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Learn the basic formulation of Quantum mechanics developed by de Broglie and Schrodinger.
CO2	Understand various operators and Schrodinger equation.

CO3	Understand detailed quantum mechanical analysis of few one dimensional potential systems.
CO4	Learn the detailed quantum mechanical analysis of few three dimensional potential systems.
CO5	Analyze Hydrogen atom and Harmonic oscillator.

B.Sc. SEMESTER–III
PHY231B

OPTICS AND LASERS

(THEORY)

Teeaching Hours (per week): 3
Total Credits: 3
Credits:LTP:210
Time: 3 Hours **Total Hours: 45**
Maximum Marks: 56
Pass Marks: 35%

Note for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 12 marks consisting of 8 short answer type questions carrying 2 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any 6 questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 11 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-programmable Scientific calculator is allowed.**

Course Objectives: Learnt the natural phenomenon of wave nature of light and its experimental proof and Understand the effect of interference of light during reflection, transmission and Michelson interferometer, diffraction and polarization of light and their types, laser physics with its applications in different fields, stimulated and spontaneous emission studied by Einstein equations.

Course Contents:

UNIT–I

Interference of Light:

Superposition of light waves and interference, **concept of coherence, spatial and temporal coherence, coherence length, coherence time ,**Young's double slit experiment, Conditions for observing interference fringes, Interference pattern by division of wavefront and **division of amplitude,** Fresnel Biprism, Displacement of fringes, Change of phase on reflection, Interference in thin films due to reflected and transmitted light, **Role of interference in antireflection and high reflection dielectric coatings.** Newton's Rings, Michelson Interferometer.

UNIT–II

Diffraction:

Huygen's fresnel theory, half-period zones, Zone plate, Distinction between fresnel and fraunhoffer diffraction. Fraunhoffer diffraction: single slit , rectangular and circular apertures, Effect of diffraction in optical imaging, Resolving power of diffraction grating , telescope and microscope.

UNIT–III

Polarization:

Plane Polarized light, Elliptically polarized light, wire grid polarizer, Sheet polarizer, Applications of polaroids, Double reflection, Calcite crystals, Nicol prism, Negative and positive crystals ,Quarter and half wave plates, Polarization by reflection Malus's Law, Brewester's Law, , Scattering, , , Retardation plates, Production Analysis of polarized light,.

UNIT–IV

Laser Fundamentals:

Derivation of Einstein relations, Concept of stimulated emission and population inversion, **Line width , line profile, Optical absorption: Fuchbauer Ladenberg formula and schawlow Townes condition,** Components of laser devices, Classification of pumping schemes: three level and four level lasers. Types of lasers: Ruby and Nd:YAG lasers, He-Ne lasers construction, mode of creating population inversion and output characteristics, application of lasers –a general outline.

Books Prescribed:

1. Fundamentals of Optics, F.A. Jenkins and Harvey E White,(Mcgraw Hill) 4th edition,2001
2. Optics, Ajoy Ghatak,(McMillan Indian) 2nd edition, 7th reprint, 1997
3. Introduction to Atomic Spectra, H.E. White (Mcgraw Hill, Book Co., Inc., New York)
4. Laser Fundamentals, W.T. Silfvast (Foundation Books), New Delhi, 1996
5. Laser and Non-Liner Optics, B.B. Laud (New Age Pub.) 2002
6. Optics, Born and Wolf, (Pergamon Press) 3rd edition, 1965
7. Laser, Svelto, (Plenum Pres) 3rd edition, New York

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Learn the natural phenomenon of wave nature of light and its experimental proof.
CO2	Understand the effect of interference of light during reflection, transmission and Michelson interferometer.
CO3	Understand the concepts and complete explanation of diffraction and polarization of light and their types.
CO4	Explain the basic theories of laser physics with its applications in different fields.
CO5	Explain the stimulated and spontaneous emission studied by Einstein equations.

B.Sc. SEMESTER–III
PHY231P

(PRACTICAL)

Teaching Hours (per week): 4
Total Credits: 2
Credits:LTP:002

Time: 3 Hours **Maximum Marks: 38**

Pass Marks: 35%

General Guidelines for Practical Examination:

I. The distribution of marks is as follows: **38 Marks**
i) One experiment: **15 Marks**
ii) Brief Theory : 8 **Marks**
iii) Viva–Voce: **10 Marks**
iv) Record (Practical file): **5Marks**
II. There will be one sessions of 3 hours duration. The paper will have one session. Paper will consist of 8 experiments out of which an examinee will mark 6 experiments and one of these is to be allotted by the external examiner.
III. Number of candidates in a group for practical examination should not exceed 12.
IV. In a single group no experiment be allotted to more than three examinee in any group.

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Course Objectives: Main objective of this course is to acquire the appropriate data accurately form spectrometer measurements, sextant, laser diffraction, polarimeter and keep systematic record of laboratory activities. Interpret findings using the correct physical scientific framework and tools. Prepare professional quality textual and graphical presentations of laboratory data and spectral results. Evaluate possible causes of discrepancy in practical experimental observations, results in comparison to theory.

Course Contents:

1. To determine refractive index of glass and liquid using spectrometer.
2. To determine the Cauchy's constants.
3. To study the refractive index of a doubly refracting prism.
4. To set up Newton's rings to determine wavelength of sodium light.
5. To determine the wavelength by using plane diffraction grating (Use Hg source)
6. To determine dispersive power of plane diffraction grating.
7. To determine resolving power of a telescope.
8. To determine resolving power of a grating.
9. To measure an accessible (Horizontal and vertical) height using sextant.
10. To measure inaccessible height by using sextant.
11. To study the rotation of plane of polarization by using polarimeter.

12. Determination of wavelength of He-Ne laser using single slit /N slit diffraction pattern.

13. **To study the spectral characteristics of a photocell.**

14. To compare the illuminating power of two light sources using photo-cell.

15. To determine the resolving power of a prism.

Books Prescribed:

1. Practical Physics Vol. II, T.S. Bhatia, Gursharan Kaur, Iqbal Singh, Vishal Publications.
2. Practical Physics, C.L. Arora, S. Chand & Co.

Course Outcomes:

Sr. No.	**On completing the course, the students will be able to:**
CO1	Use the spectrometer to study various spectra.
CO2	Understand the concept of sextant to measure accessible and inaccessible lengths.
CO3	Verify the law of probability distribution using coins.
CO4	Explain Diffraction through grating using He-Ne laser and sodium light.
CO5	Understand the concept of polarimeter.

B.Sc. SEMESTER–IV
PHY241A

STATISTICAL PHYSICS & THERMODYNAMICS

(THEORY)

Teaching Hours (per week): 3
Total Credits: 3
Credits:LTP:210
Time: 3 Hours **Total Hours: 45**
Maximum Marks: 56
Pass Marks: 35%

Note for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 12 marks consisting of 8 short answer type questions carrying 2 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any 6 questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 11 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-programmable Scientific calculator is allowed.**

Course Objectives: This course provides an introduction to the basic idea of statistical physics, from which emerges an understanding of the microstate, macrostate, particle distribution in static and dynamic systems. It includes the detailed theory of classical and quantum statistics of various physical systems. Students will be able to link the statistical aspect of entropy and thermodynamical probability. It gives an insight into the derivation of various thermodynamical relations and their applications

UNIT–I

Basic ideas of Statistical Physics, Scope of Statistical Physics, Basic ideas about probability, **Examples of independent events, Principle of equal priori Probability**, **permutations, combinations,** Distribution of four distinguishable particles into compartments of equal size. Concept of macrostates, microstates, Thermodynamic Probability, Effects of constraints on the system. Distribution of *n* particles in two compartments. Deviation from the state of maximum probability, Equilibrium state of dynamic system. Distribution of distinguishable n particles in k Compartments of unequal sizes.

UNIT–II

Phase space and division into elementary cells. Three kinds of statistics. The basic approach in three statistics. Maxwell Boltzmann (MB) statistics applied to an ideal gas in equilibrium. Experimental verification of law of distribution of molecular speeds, **most probable speed, average speed and root mean square speed of particles,** Need for Quantum Statistics – Bose-Einstein (B.E.) statistics, **application of BE statistics to photon gas** (Statement of Planck's law of **Black body** Radiation), Wien's Displacement and Stefan's Boltzmann's law of radiations.

Radiation pressure and stability of massive stars, Fermi Dirac (FD) statistics, **application of FD statiscs to free electron inside conductors, degenerate Fermi gas, stability of white dwarfs** Comparison of M.B, B.E and F.D statistics.

UNIT–III

Statistical definition of entropy, Change of entropy of system, **third law of thermodynamics**, **additive** nature of entropy, Law of increase of entropy, Reversible and irreversible processes, and their examples, work done in reversible process, examples of increase in entropy in natural processes, entropy and disorder, Brief review of Terms used in thermodynamics, Laws of Thermodynamics, **The Heat Engine, Carnot reversible Heat Engine**, Entropy changes in Carnot cycle, **Carnot's Theorem**, **Unattainability of absolute zero**, **Ideal refrigerator**, **Seebeck, Peltier and Thomson effect,** Applications of thermodynamics to thermoelectric effect, change of entropy along reversible path in P-V diagram. **Cosmic background radiations** and Heat death of universe.

UNIT–IV

Perfect differentials, derivation of Stefan's law using thermodynamics, Derivation of Maxwell Thermodynamics relations, Cooling produced by adiabatic expansion, Adiabatic Compression, change of internal energy with volume, Specific heat and constant pressure and constant volume. Expression for C_P-C_v, Change of state and Claypron equation, **Production of very low temperatures by adiabatic demagnetization**, **concept of negative temperature.**

Books Prescribed:

1. Statistical Physics and Thermodynamics, V.S. Bhatia, T. S. Bhatia, (Vishal Publications, Jalandhar).
2. A Treatise on Heat, M.N. Saha & b.N. Srivastava (The Indian Press Pvt. Ltd., Allhabad),1965.
3. Statistical Mechanics: An Introductory Text, Bhattacharjee, J.K. (Allied Pub., Delhi), 2000.
4. Statistical Physics, Bhattacharjee, J.K. (Allied Pub., Delhi) 2000.
5. Statistical Mechanics, B.B. Laud, (Macmillan India Ltd.) 1981.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Understand the concept of thermo dynamical probability and energy wise distribution of particles in various compartments
CO2	Learn the concept of phase space, classical and quantum statistics.
CO3	Analyze the statistical concept of entropy.
CO4	Analyze the application of thermodynamics, heat death of universe.
CO5	Derive and understand application of Maxwell thermodynamical relations.

B.Sc. SEMESTER–IV
PHY241B

ATOMIC AND MOLECULAR SPECTRA

(THEORY)

Teaching Hours (per week): 3
Total Credits: 3
Credits:LTP:210
Time: 3 Hours **Total Hours: 45**
Maximum Marks: 56
Pass Marks: 35%

Note for paper setter and students:

1. **There will be five sections.**
2. **Section A is compulsory and will be of 12 marks consisting of 8 short answer type questions carrying 2 mark each covering the whole syllabus. The answer should not exceed 50 words. The candidate will have to attempt any 6 questions in this section.**
3. **Sections B, C, D and E will be set from units I, II, III & IV respectively and will consist of two questions of 11 marks each from the respective unit. The candidates are required to attempt one question from each of these sections. Each question in these sections should not have more than two subparts.**
4. **Non-programmable Scientific calculator is allowed.**

Course Objectives: The main course objective of this subject to understand the main catastrophe of different theories for explaining the structure of atom and origin of the observed spectra, Bohr's theory and Zeeman effect, one electron atomic spectra and different quantum numbers required for complete explanation, Interpret the many electron atomic spectra of alkali and alkaline earth atoms with LS couplings. To give basic information about X-ray spectra, molecular spectra and Raman effect.

UNIT–I

Introduction to Atomic Spectra: Observation of spectra, Types of spectra, Light sources, Spectral analysis, Units in spectroscopy, Bohr's Theory, Spectral series, Representation of spectral lines by terms, **Correction for finite nuclear mass** , Bohr's correspondence Principle, Ritz combination Rule, Continuum at series limit, Evidences in favour of Bohr's Theory, **Limitations of Bohr's Theory**, Frank-Hertz Experiment.

UNIT–II

One Electron Atomic Spectra: Spectrum of Hydrogen atom, **Quantum numbers, Space quantization** ,**Vector model of the atom, Orbital magnetic dipole moment :Bohr magneton ,** electron spin, Stern Gerlach experiment, Total angular momentum, **Spectroscopic terms**, spin orbit interaction , **Fine structure of Hydrogen ,** Hyperfine structure Normal Zeeman effect, ,anomalous Zeeman effect, Lande g **factor .**

UNIT–III

Many Electron System Spectra: Exchange symmetry of wave function, exclusion principle, shells, subshells in atoms, LS and **JJ coupling**, **spectra of alkali atoms**, fine structure in alkali spectra, Alkaline earth spectra.

UNIT–IV

X-ray spectra: **Production of X-rays, Continuous and Characteristic X-ray Spectra, Soft and Hard X-rays**, Mosley law, X-ray Absorption spectra, Auger effect. Molecular spectra: Rotational and Vibrational Spectra, **Raman Effect: Classical and Quantum theory of Raman Effect,** Introduction to Raman spectra.

Books Prescribed:

1. Introduction to Atomic Spectra: H.E. White-Auckland McGraw Hill, 1934.
2. Fundamentals of Molecular Spectroscopy: C.B. Banwell-Tata McGraw Hill, 1986.
3. Spectroscopy Vol. I, II & III: Walker & Straughen
4. Introduction to Molecular Spectroscopy: G.M. Barrow-Tokyo McGraw Hill, 1962.
5. Spectra of Diatomic Molecules: Herzberg-New York, 1944.
6. Molecular Spectroscopy: Jeanne L McHale.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Describe the theories explaining the structure of atom and origin of the observed spectra.
CO2	Explain the experimental proof of different effects like Bohr's theory and Zeeman effect.
CO3	Identify the one electron atomic spectra effects and different quantum numbers required for complete explanation
CO4	Interpret the many electron atomic spectra of helium, alkaline atoms with LS couplings and selection rules.
CO5	Describe the X-ray and molecules spectra and understand the complete Raman effect.

B.Sc. SEMESTER–IV
PHY241P

(PRACTICAL)

Teaching Hours (per week): 4
Total Credits: 2
Credits:LTP:002

Time: 3 Hours **Maximum Marks: 38**
Pass Marks: 35%

General Guidelines for Practical Examination:
I. The distribution of marks is as follows: **38 Marks**
i) One experiment: **15 Marks**
ii) Brief Theory : 8 **Marks**
iii) Viva–Voce: **10 Marks**
iv) Record (Practical file): **5Marks**
II. There will be one sessions of 3 hours duration. The paper will have one session.

Paper will consist of 8 experiments out of which an examinee will mark 6 experiments and

one of these is to be allotted by the external examiner.

III. Number of candidates in a group for practical examination should not exceed 12.

IV. In a single group no experiment be allotted to more than three examinee in any group.

Course Objectives: The main course objective of this subject to understand the main catastrophe of different theories for explaining the structure of atom and origin of the observed spectra, Bohr's theory and Zeeman effect, electron atomic spectra effects and different quantum numbers required for complete explanation, Interpret the many electron atomic spectra of helium, alkaline atoms with LS couplings and selection rules, X-ray and molecules spectra and Raman effect.
Course Contents:

1. To study adiabatic expansion of gas and hence to calculate value of γ.
2. To find the coefficient of Thermal Conductivity of a bad conductor by Lee's method.
3. **To plot a graph between the themo emf and temperature for a given thermocouple.**
4. Study the Hydrogen gas discharge tube spectra and obtain the value of Rydberg constant.
5. To study the photoelectric effect using photocell and determine the value of Planck's constant.
6. To determine the ionization potential of mercury.
7. Study of variation of light intensity with distance using photovoltaic cell (Inverse Square Law)
8. To determine the heating efficiency of an electric kettle with varying voltage.
9. To study the absorption spectra of iodine vapours.
10. Verify Laws of probability distribution by throwing of similar coins.
11. **Obtain the value of the Stefan's Constant.**
12. **Obtain the value of e/m using Thomson's method.**

Books Prescribed:

1. Practical Physics Vol. II, T.S. Bhatia, Gursharan Kaur, Iqbal Singh, Vishal Publications.
2. Practical Physics, C.L. Arora, S. Chand & Co.

Course Outcomes:

Sr. No.	On completing the course, the students will be able to:
CO1	Use the spectrometer to study Hydrogen and iodine absorption spectra.
CO2	Explain the heating efficiency of electric kettle with varying voltage.
CO3	Demonstrate the photoelectric effect, determination of Planck's constant and inverse square law
CO4	Determine Ionization potential of mercury.
CO5	Find the Thermo emf and its variation with temperature.