Revised (Modified) Detailed Syllabus of I Semester Physics

Program Outcomes (PO):	
1.	Disciplinary knowledge
2.	Communication Skills
3.	Critical thinking, Reflective thinking, Analytical reasoning, Scientific reasoning
4.	Problem-solving
5.	Research-related skills
6.	Cooperation/ Teamwork/ Leadership readiness/Qualities
7.	Information/ Digital literacy/Modern Tool Usage
8.	Environment and Sustainability
9.	Multicultural competence
10.	Multi-Disciplinary
11.	Moral and ethical awareness/Reasoning
12.	Lifelong learning / Self Directed Learning

Course Content Semester – I

Mechanics and Properties of Matter

Course Title: Mechanics and Properties of Matter	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60
Model Syllabus Authors: PHYSICS BOS GCKA	

Prerequisites	
i.	Basic Knowledge of Classical Mechanics up to 12^{th} Standard

iii	Apply the concept of the relative frame of reference with appropriate postulates of the theory of relative motion to the measurement of length, time andvelocity.	X	X	X	X	X	X					X	X
iv	Apply the laws of Gravitation and Kepler laws to describe the working of satellites and other applications.	X	X	X	X	X	X					X	X
v	Determine theoretically and experimentally the relation between three elastic constants.	X	X	X	X	X	X					X	X
vi	Apply the concept of surface tension and viscosity offluids.	X	X	X	X	X	X					X	X

Unit1 (13 Hours)

Review of Units and measurements: System of units (CGS and SI), measurement of length, mass and time, dimensions of physical quantities, dimensional formulae. Minimum deviation, errors.

Vectors: Review of Vectors, Gradient, Divergence and Curls and their Physical significance.

Momentum and Energy: Work and energy, Conservation of linear momentum. Conservationof energy with examples. Collision: Two-dimensional elastic and inelastic collisions in centre of mass and laboratoryframes of reference. Single stage rocket (expression for velocity neglecting weight), Double stage rocket.

Topic Learning Outcomes

At the end of the topic, students should be able to:

SL No	TLO's	BL	CO	PO
i.	Define different systems of units in CGS and SI systems.	L1	1	1-6, 11-12
ii.	What is the dimension of physical quantity?	L1	1	1-6, 11-12
iii.	Write a dimension formula for coefficient of Viscosity of a liquid.	L2	1	1-6, 11-12
iv.	With example demonstrate how to calculate conversion of unit using a dimensional formula of a physical quantity.	L2	1	1-6, 11-12
v.	What is an error? Explain how it is calculated using minimum deviation.	L2	1	1-6, 11-12
vi.	What are scalar and vector? Explain with an example.	L1	1	1-6, 11-12
vii.	Explain gradient, divergence and curl in a physical phenomenon and write mathematical formula for the same.	L2	1	1-6, 11-12
viii.	Apply the work-energy theorem for constant forces acting on a particle.	L3	2	1-6, 11-12

Unit2 (13 Hours)
Laws of Motion: Newton's Laws of motion. Dynamics of single and a system of particles. Centre of mass. **Dynamics of Rigid bodies:** Rotational motion about an axis, Relation between torque and angular momentum, Rotational energy. moment of inertia: M I of a rectangular Lamina and solid cylinders. Flywheel, Theory of compound pendulum and determination of g. **Gravitation:** Law of Gravitation. The motion of a particle in a central force field (motion is in a plane.angularmomentumisconserved,arealvelocityisconstant).Kepler'slaws(statements).Satellite in a circular orbit.
Topic Learning Outcomes **At the end of the topic, students should be able to:**

SL No	TLO's	BL	CO	PO
i.	Apply laws of motion to various dynamical situations and the notion of inertial frames.	L2	3	1-6, 11-12
ii.	Explain what is force based on Newton's laws of motion.	L2	3	1-6, 11-12
iii.	Give the analogy between translational and rotational dynamics with an example of rolling with slipping.	L2	3	1-6, 11-12
iv.	Describe how fictitious forces arise in a non-inertial frame, using this explain why a person sitting in a merry-go-round experiences an outward pull.	L2	3	1-6, 11-12
v.	Apply Kepler's law to describe the motion of planets and satellites in circular orbit, through the study of law ofGravitation.	L3	3	1-6, 11-12
vi.	Apply Kepler's law for the orbital motion of natural or artificial satellite and obtain the relation between period, radius and the mass of the satellite.	L3	3	1-6, 11-12
vii.	Determine the location of the centre of mass, given the positions of several particles along an axis of a plane.	L2	3	1-6, 11-12
viii.	Locate the centre of mass of an extended, symmetric object by using symmetry.	L2	3	1-6, 11-12
ix.	Apply newton's laws of motion to moving particles under the gravitational force.	L3	4	1-6, 11-12
x.	Apply Newton's law of gravitation to relate the gravitational force between two particles to their masses and theirseparation.	L3	4	1-6, 11-12
xi.	Apply the conservation of mechanical energy (including gravitationalpotentialenergy)toaparticlemovingrelativetoanastronomical body (or some second body that is fixed in place).	L3	4	1-6, 11-12

Unit3 (13 Hours)
Elasticity: Hooke's law - Stress-strain diagram, elastic moduli-relation between elastic constants. Poisson's Ratio-expression for Poisson's ratio in terms of elastic constants. Work done in stretching and work done in twisting a wire-Twisting couple on a cylinder. Theory of Single Cantilever. **Torsional pendulum:** Determination of rigidity modulus and moment of inertia - q, η and σ bySearle's method.
Topic Learning Outcomes   **At the end of the topic, students should be able to:**

SL No	TLO's	BL	CO	PO
i.	State Hooke's law and obtain the equation for stress, strain and Young's modulus.	L2	5	1-6, 11-12
ii.	Differentiate between different types of elastic moduli.	L2	5	1-6, 11-12
iii.	For shearing strain, obtain the equation that relates stress to strain and their shear modulus.	L2	5	1-6, 11-12
iv.	Explain the advantages and disadvantages of a single cantilever.	L2	5	1-6, 11-12
v.	Define what is Poison's ratio and obtain the relation between Young's modulus, modulus of rigidity, bulk modulus and poisons ratio.	L2	5	1-6, 11-12
vi.	Higher order problems.	L3	5	1-6, 11-12

Teaching and Learning Methodology
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learningetc.

Formative Assessment Techniques
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Suggested Activities	
Activity No. 8	Draw Stress and Strain Curve for Steel, Rubber and Wood.
Activity No. 9	Calculate stored energy in a catapult in the form of elasticity.

Unit4 (13 Hours)
Surface tension: Definition of surface tension. Surface energy, relation between surface tension and surface energy, pressure difference across curved surface example. excess pressure inside spherical liquid drop, angle of contact. **Viscosity:** Streamline flow, turbulent flow, equation of continuity, determination of coefficient ofviscosity by Poisulle's method, Stoke's method. Problems.
Topic Learning Outcomes **At the end of the topic, students should be able to:**

SL No	TLO's	BL	CO	PO
i.	Define and explain the theory of surface tension of liquids.	L1	6	1-6, 11-12
ii.	Correlate between surface tension and surface energy.	L2	6	1-6, 11-12
iii.	Correlate the property of surface tension with different natural phenomena.	L2	6	1-6, 11-12
iv.	Explain the concept of capillarity in liquids and relate surface tension with capillarity.	L2	6	1-6, 11-12
v.	What is Angle of contact between different surfaces and explainhow pressure differs inside and outside the soap bubbles.	L2	6	1-6, 11-12
vi.	Explain how the coefficient of viscosity is calculated using by postulate method and strokes method.	L2	6	1-6, 11-12
vii.	Define viscosity and describe how viscosity can be measured.	L1	6	1-6, 11-12
viii.	Distinguish fluids from solids.	L2	6	1-6, 11-12
ix.	Classify fluids based on the law of viscosity.	L2	6	1-6, 11-12
x.	Explain the term streamline.	L1	6	1-6, 11-12
xi.	Describe steady flow, incompressible flow, non-viscous flow, andirrotational flow.	L2	6	1-6, 11-12
xii.	Explain fluid friction and the factors affecting it.	L1	6	1-6, 11-12
xiii.	Higher order problems.	L3	6	1-6, 11-12

Teaching and Learning Methodology
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion Collaborative Learning/ Experiential Learning / Self Directed Learningetc.

Revised (Modified) Detailed Syllabus of II Semester Physics

Program Outcomes (PO):	
1.	Disciplinary knowledge
2.	Communication Skills
3.	Critical thinking, Reflective thinking, Analytical reasoning, Scientific reasoning
4.	Problem-solving
5.	Research-related skills
6.	Cooperation/ Teamwork/ Leadership readiness/Qualities
7.	Information/ Digital literacy/Modern Tool Usage
8.	Environment and Sustainability
9.	Multicultural competence
10.	Multi-Disciplinary
11.	Moral and ethical awareness/Reasoning
12.	Lifelong learning / Self Directed Learning

Course Content Semester – II Electricity & Magnetism

Course Title: Electricity and Magnetism	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60
Model Syllabus Authors: PHYSICS BOS GCKA	

Prerequisites	
i.	Basic Knowledge of Electricity & Magnetism up to 12^{th} Standard

Unit 1 (13 Hours)

Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic Field. Potential and Electric Field of a dipole. Force and Torque on a dipole.

Electrostatic energy of a system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. The capacitance of a system of charged conductors. Parallel-plate capacitor. The capacitance of an isolated conductor. Method of Images and its application to (1) Plane Infinite Sheet and (2) Sphere.

Topic Learning Outcomes

At the end of the topic, students should be able to:

SL No	TLO's	BL	CO	PO
i.	Demonstrate Gauss law and Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges.	L2	1	1-6, 11-12
ii.	Explain and differentiate the vector (electric fields, Coulomb's law) and scalar(electric potential, electric potential energy) formalisms of electrostatics.	L1	1	1-6, 11-12
iii.	Apply Gauss's law of electrostatics to solve a defined problem.	L2	1	1-6, 11-12
iv.	Articulate knowledge of electric current, resistance and capacitance in terms of electric field and electric potential.	L2	1	1-6, 11-12
v.	Show that at every point in the space surrounding a charged particle the particle sets up an electric field, which is a vector quantity and thus has both magnitude and direction.	L2	1	1-6, 11-12
vi.	Explain electric field lines, including where they originate and terminate and what the spacing between them represents.	L2	1	1-6, 11-12
vii.	Define electric flux and calculate the electric flux due to arbitrary distribution of charges.	L2	1	1-6, 11-12
viii.	Determine the electric field due to a uniformly charged spherical shell, cylindrical area and planar surface using Gauss law	L2	1	1-6, 11-12
ix.	Establish the relation between electric potential and electric field;	L2	1	1-6, 11-12

Unit 2 (13 Hours)

Dielectric Properties of Matter: Electric Field in the matter. Polarization. Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.

Topic Learning Outcomes

At the end of the topic, students should be able to:

SL No	TLO's	BL	CO	PO
i.	Explain the electrical polarization and dielectrics of a material.	L1	2	1-6, 11-12
ii.	Define the electrical susceptibility, dielectric constant and electrical polarizability.	L1	2	1-6, 11-12
iii.	What is a capacitor and explain its working.	L1	2	1-6, 11-12
iv.	Obtain an expression for the capacitance of a parallel plate capacitor, spherical capacitor and a cylindrical capacitor which is filled with a dielectric constant □.	L2	2	1-6, 11-12
v.	Explain the displacement vector(D).	L1	2	1-6, 11-12
vi.	Obtain the relation between the electrical field, polarizability and displacement vector.	L2	2	1-6, 11-12
vii.	State and explain Gauss's law of dielectrics.	L1	2	1-6, 11-12
viii.	Obtain an expression for the magnetic force between two current elements and hence define a magnetic field B.	L2	3	1-6, 11-12
ix.	State Biot-Savart's Law.	L1	3	1-6, 11-12
x.	Obtain the magnetic field B around a straight wire and a circular loop.	L2	3	1-6, 11-12
xi.	What are the magnetic dipoles and their dipole moment?	L1	3	1-6, 11-12
xii.	Define and explain Ampere's circuit law.	L1	3	1-6, 11-12
xiii.	Give the applications of Ampere's circuit law to obtain the magnetic field for solenoid and toroid.	L1	3	1-6, 11-12
xiv.	Explain curl, divergence and vector potential associated with a magnetic field.	L1	3	1-6, 11-12

xv.	Obtain an expression for magnetic force on a point charge current carrying wire and between current elements.	L2	3	1-6, 11-12
xvi.	Obtain an expression for torque on the current loop in a uniform magnetic field.	L2	3	1-6, 11-12
xvii.	Higher order problems.	L3	2,3	1-6, 11-12

Teaching and Learning Methodology

Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Formative Assessment Techniques

One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Suggested Activities

Activity No. 4	Design a simple parallel plate capacitor. Using different oils in the gap between two parallel plates, obtain the dielectric constant of the oils used. Compare its value with the literature value at least in the case of three liquids.
Activity No. 5	List the real-time applications where capacitors are used.

Unit 3 (13 Hours)

Magnetic Properties of Matter: Magnetization vector **(M).** Magnetic Intensity **(H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Types of magnetic materials. B-H curves.

Electromagnetic Theory: Review of Faraday's and Lenz's Laws. Energy is stored in a Magnetic Field. Equation of continuity, displacement current, Maxwell's Equations, Differential and Integral
forms and their physical significance, Transverse nature of electromagnetic radiation, General plane wave equation in free space, Hertz's experiment, production of electromagnetic waves.

Topic Learning Outcomes

At the end of the topic, students should be able to:

SL No	TLO's	BL	CO	PO
i.	What is a magnetization vector, magnetic intensity, magnetic susceptibility and permeability?	L1	4	1-6, 11-12
ii.	Obtain relation between B, H and M.	L2	4	1-6, 11-12

Unit 4 (13 Hours)
Electrical Circuits: Kirchhoff's laws, charging and discharging of a capacitor. Complex Reactance and Impedance. RL and RC circuits and their time constants. LCR Circuits (series and parallel): (1) Resonance, (2) Power Dissipation (3) Quality Factor and (4) Band Width. **Ballistic Galvanometer:** Torque on a Current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping.
Topic Learning Outcomes **At the end of the topic, students should be able to:**

SL No	TLO's	BL	CO	PO
i.	State Kirchhoff's laws.	L1	6	1-6, 11-12
ii.	What is charging and discharging of capacitors? Explain how they are obtained.	L2	6	1-6, 11-12
iii.	Explain Complex reactance and impedance in a capacitor circuit.	L1	6	1-6, 11-12
iv.	With a schematic diagram, explain how time constant of RL and RC circuits are obtained.	L1	6	1-6, 11-12
v.	Give the circuit diagram of LCR circuits for both series and parallel circuits and explain how the resonance, power dissipation, quality factor and bandwidth are obtained for the same.	L2	6	1-6, 11-12
vi.	Give the construction and working of the Ballistic Galvanometer.	L2	7	1-6, 11-12
vii.	What is current and charge sensitivity of a Ballistic Galvanometer	? L2	7	1-6, 11-12
viii.	Higher order problems.	L3	6,7	1-6, 11-12

Course Title: PHYDSCCT II: Practical: Electricity and Magnetism

SECOND SEMESTER PHYSICS (PHYDSCCP-II) PRACTICALS

List of Experiments to be performed in the Laboratory

1.	Use of Multimeter for measuring a) Resistance b) AC & DC Voltages. C) DC Current and d) checking electrical fuses.
2.	Experiments on tracing of electric and magnetic flux lines for standard configuration.
3.	Determination of components of earth's magnetic field using a Ballistic galvanometer.
4.	Determination of capacitance of a condenser using B.G.
5.	Determination of high resistance by leakage using B.G.
6.	Determination of mutual inductance using BG.
7.	Charging and discharging of a capacitor (energy dissipated during charging and time constant measurements.
8.	Series and parallel resonance circuits (LCR circuits).
9.	Impedance of series RC circuits- determination of frequency of AC.
10.	Study the characteristics of a series RC and RL Circuit.
11.	Determination of self-inductance of a coil.
12.	Determination of unknown capacitance using de - Sauty bridge.
13	Determination of B_H using Helmholtz galvanometer.
14	Determination of unknown resistance using meter Bridge.
15	Determination of the cut-off frequency of high pass RC filter.
16	Determination of the cut-off frequency of low pass RC filter.
17	Determination of the frequency of an AC supply using Sonometer.
18	Study of the EMF induced as a function of velocity of magnet.
19	Study of the verification of magnetic field along the axis of Circular coil carrying current.
20	Determination of the time constant of RC circuit.

Note:

Physics as Discipline Specific CorenCourse (DSCCT)
B.Sc Semester – III
Title of the Course: PHY DSCCT III: Wave Motion and Optics

Unit – 1 -Waves and Superposition of Harmonic Waves (13 Hours)
The Portion to be Covered
Waves: Plane and Spherical Waves. Longitudinal and Transverse Waves. Characteristics of wave motion, Plane Progressive (Travelling) Wave and its equation, Wave Equation – Differential form. Particle and Wave Velocities: Relation between them. Energy Transport – Expression for intensity of progressive wave, Newton's Formula for Velocity of Sound. Laplace's Correction. Brief account of Ripple and Gravity Waves. **Superposition of Harmonic Waves: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats)–Analytical treatment. Superposition of two perpendicular Harmonic Oscillations: Lissajous Figures with equal and unequal frequency- Analytical treatment. Uses of Lissajous figures.**

Topic Learning Outcomes

At the end of the topic, students should be able to:

SL No	TLO's	BL	CO	PO
i.	Explain the difference between plane and spherical waves, longitudinal and transverse waves and give their characteristics.	**L2**	1	**1-6, 11-12**
ii.	Write down an equation for the progressive wave in its differential form.	**L2**	1	**1-6, 11-12**
iii.	Obtain the relation between particle and wave velocity.	**L2**	1	**1-6, 11-12**
iv.	Obtain an expression for intensity of progressive waves.	**L2**	1	**1-6, 11-12**

	teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take a stretched spring. Stretch it across two edges. Put a weight on the string, pluck it and measure the amplitude of the vibration. All group will measure the total damping time of oscillating spring. (Using mobile or scale) And plot a graph of the- 1. Varying load on the spring and amplitude at the centre. 2. Take another weight and put that in another place and measure the amplitude of vibration at the centre. 3. Vary the load in the centre of the spring and measure the amplitude at the centre.

Unit – 2 - Standing Waves and Acoustics (13 Hours)
The Portion to be Covered
Standing Waves: Velocity of transverse waves along a stretched string (derivation), Standing (Stationary) Waves in a String - Fixed and Free Ends (qualitative). Theory of Normal modes of vibration in a stretched string, Energy density and energy transport of a transverse wave along a stretched string. Vibrations in rods – longitudinal and transverse modes (qualitative). Velocity of Longitudinal Waves in gases (derivation). Normal Modes of vibrations in Open and Closed Pipes -- Analytical treatment. Concept of Resonance, Theory of Helmholtz resonator. **Acoustics: Absorption coefficient, Reverberation and Reverberation time, Sabine's Reverberation formula (derivation), Factors affecting acoustics in buildings, Requisites for good acoustics. Acoustic measurements – intensity and pressure levels.**
Topic Learning Outcomes **At the end of the topic, students should be able to:**

Unit – 3 - Nature of light and Interference (13 Hours)
The Portion to be Covered
Nature of light: Corpuscular model of light, wave model, Maxwells electromagnetic wave theory and Wave Particle Duality. **Interference of light by division of wave front:** Huygen's theory-Concept of wave-front-Interference pattern produced on the surface of water-Coherence-Interference of light waves by division of wave front- Young's double slit experiment- derivation of expression for fringe width-Fresnel Biprism- Interference with white light. **Interference of light by division of amplitude:** Interference by division of amplitude-Interference in thin film by reflected light-Interference wedge shaped thin film (air wedge)-color of thin films-Newton's rings (Reflected light) - Michelson Interferometer. Determination of wavelength of light, difference in wavelength and shapes of fringes.

Topic Learning Outcomes

At the end of the topic, students should be able to:

SL No	TLO's	BL	CO	PO
i.	Explain using Michelson interferometer how to determine the wavelength of light.	L2	7	1-6, 11-12
ii.	Give an account of the different possible shapes that are obtained in Michelson interferometer experiment and their relevance.	L2	7	1-6, 11-12
iii.	Discuss the wave model and the Corpuscular model of light.	L2	7	1-6, 11-12
iv.	Explain Maxwells electromagnetic waves.	L2	7	1-6, 11-12
v.	Give an account of the phenomenon of wave-particle duality.	L1	7	1-6, 11-12
vi.	Give the Huygen theory of wave-front.	L1	7	1-6, 11-12
vii.	Define Interference. Give some examples of Interference.	L1	7	1-6, 11-12

Activity No. 13	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate (KMNO4) solution. Place a small non oily floating material (ex: thin plastic) on the surface of the liquid. Drop two marbles of same weight (mass) from the same height on to the surface of the water but at the different time intervals. Plot graph for the different observations. **For teachers:** Demonstrate the formation of Lissajous Figure using a CRO. Give different shapes of Lissajous Figure with varying frequency and amplitude. Ask the students to comment on the observations.

Unit – 4 - Diffraction and Polarisation (13 Hours)

The Portion to be Covered

Fraunhofer Diffraction: Introduction- Fraunhofer diffraction- Single slit diffraction pattern-position of Maxima and Minima (Qualitative arguments) - double slit diffraction pattern-position of Maxima and minima-Theory of plane diffraction Grating-Grating spectrum- normal and oblique incidence- Resolving power and dispersive power of a grating.

Fresnel Diffraction- Fresnel half period zones-Diffraction by a circular aperture-Diffraction by an opaque disc-The Zone plate -Comparison between zone plate and convex lens.

Polarisation: Introduction-Production of polarized light, Huygens theory of double refraction, positive and negative Crystals, production of Circular and Elliptical polarized light - Quarter wave plates and half wave plates- Analysis of polarized light-optical activity and applications.

Textbooks

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1.	The Physics of Waves and Oscillations,	N K Bajaj	Tata McGraw-Hill Publishing Company Ltd., Second Edition,	1984
2.	Waves and Oscillations	N Subramanyam and Brij Lal	Vikas Publishing House Pvt. Ltd., Second Revised Edition	2010
3.	A Text Book of Sound	D R Khanna and R S Bedi	Atma Ram & Sons, Third Edition	1952
4.	Oscillations and Waves	Satya Prakash	Pragathi Prakashan, Meerut, Second Edition	2003
5.	Optics	Ajoy Ghatak	McGraw Hill Education (India) Pvt Ltd	2017
6.	A text Book of Optics	Brij Lal, M N Avadhanulu & N Subrahmanyam	S. Chand Publishing	2012

References Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1.	Berkeley Physics Course – Waves,	Frank S Crawford Jr.	Tata Mc Graw-Hill Publishing Company Ltd., Special Indian Edition,	2011
2.	Optics	Eugene *Hecht*	Pearson Paperback	2019
3.	Introduction To Optics	Pedrotti and Frank L ,	Pearson India	3rd Edition
4.	Fundamentals of Optics	Francis Jenkins Harvey White	McGraw Hill Education	2017

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Detailed Syllabus of IV Semester Physics

Program Outcomes:	
1.	Disciplinary knowledge
2.	Communication Skills
3.	Critical thinking, Reflective thinking, Analytical reasoning, Scientific reasoning
4.	Problem-solving
5.	Research-related skills
6.	Cooperation/ Teamwork/ Leadership readiness/Qualities
7.	Information/ Digital literacy/Modern Tool Usage
8.	Environment and Sustainability
9.	Multicultural competence
10.	Multi-Disciplinary
11.	Moral and ethical awareness/Reasoning
12.	Lifelong learning / Self Directed Learning

Course Content Semester – IV
Thermal Physics and Electronics

Course Title: Thermal Physics and Electronics	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60
Model Syllabus Authors: PHYSICS BOS GCKA	

Prerequisites	
i.	Study of Pre-University

Course Learning Outcomes	
At the end of the course students will be able to:	
i.	Apply the laws of thermodynamics and analyze the thermal system.

Physics as Discipline Specific CorenCourse (DSCCT)
B.Sc Semester – IV
Title of the Course: PHY DSCCT IV: Thermal Physics and Electronics

Unit – 1	
The Portion to be Covered	(13 Hours)

Thermodynamics:
Review of the concepts of Heat and Temperature.
First Law of Thermodynamics: Differential form. Internal Energy. Equation of state for an adiabatic process. Work Done during Isothermal and Adiabatic Processes.
Second Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Reversible and Irreversible processes with examples. Heat Engines: Carnot engine & efficiency. Refrigeration & coefficient of performance. Applications of Carnot engine in locomotion. Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. Concept of Entropy. Second Law of Thermodynamics in terms of Entropy.
Third Law of Thermodynamics: Statement. Significance and Unattainability of Absolute Zero.

Topic Learning Outcomes
At the end of the topic, students should be able to:

SL No	TLO's	BL	CO	PO
i.	Explain the first law of thermodynamics.	L1	1	1-6,11-12
ii.	Give the differential form of the first law of thermodynamics and define what the internal energy is.	L2	1	1-6,11-12
iii.	Obtain an expression for work done in isothermal and adiabatic processes.	L2	1	1-6,11-12

Activity No. 3	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. **(i)** The first slide will explain the process of doing the experiment. **(ii)** In the second slide. Students will show the graph of measurement. **(iii)**In the third slide, they will list three observations from that study. **Activity:** Take ice cubes of different size and immerse in water and measure the temperature change with time and repeat the experiment. Graph the observations.

Unit – 2

The Portion to be Covered (13 Hours)

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Properties and Applications.

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations (1) First order Phase Transitions with examples, Clausius - Clapeyron Equation (2) Values of Cp-Cv (3) JouleThomson Effect and Joule-Thomson coefficient and Derive an equation for Vander Walls gas. Attainment of low temperature by liquefaction of gases and adiabatic demagnetization.

Kinetic Theory of Gases: Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of
Velocities in an Ideal Gas: Mean, RMS and Most Probable Speeds. Degrees of Freedom, Law of
Equipartition of Energy. Specific heats of Gases.

Radiation: Blackbody radiation, spectral distribution, the concept of energy density and pressure of radiation, Wien's law, Wien's displacement law, Stefan-Boltzmann law, Rayleigh-Jeans law, Ultraviolet Radiation catastrophe and Planck's law of radiation.

Topic Learning Outcomes

At the end of the topic, students should be able to:

SL No	TLO's	BL	CO	PO
i.	State Maxwell relations.	L1	2	1-6, 11-12
ii.	Give examples where Maxwells relations are used.	L1	2	1-6, 11-12

Unit – 3
The Portion to be Covered (13 Hours)
Semiconductor devices: Review of Intrinsic and Extrinsic semiconductors, p-n junction and its Characteristics and Parameters, Diode approximations, Half-wave rectifier, Full-wave rectifier, Zener diode voltage regulators: Regulator circuit with no load, Loaded Regulator. **Junction Transistors**: Basics of Bipolar Junction Transistors (BJT), BJT operation, Common Base, Common Emitter and Common Collector Characteristics. Field Effect Transistor (FET) and its characteristics. Transistor as an Amplifier and Oscillator.
Topic Learning Outcomes **At the end of the topic, students should be able to:**

SL No	TLO's	BL	CO	PO
i.	Define Semiconductors and Band Gap. Explain on what basis they are classified as intrinsic and extrinsic.	L2	3	1-6, 11-12
ii.	Define PN junction. Explain it's functioning in forward and reverse bias.	L1	3	1-6, 11-12
iii.	Explain the approximation used in a real diode with respect to an ideal PN Junction?	L2	3	1-6, 11-12
iv.	With a schematic diagram, explain half wave and full wave rectifiers.	L1	3	1-6, 11-12
v.	Define a Zener diode and explain how it is different from an ordinary diode using V-I curves?	L2	3	1-6, 11-12
vi.	With the schematic diagram, explain the working of voltage regulators of different types using a Zener diode.	L1	3	1-6, 11-12
vii.	Give the basic concepts used in the instruction of bipolar junction transistor and its operation.	L1	3	1-6, 11-12

Unit – 4
The Portion to be Covered (13 Hours)
Electronics: Integrated Circuits (Analog and Digital), Operational Amplifier, Ideal characteristics of Op-Amp, Inverting and Non-Inverting Configurations. Applications- Voltage Follower, Addition and Subtraction. **Digital:** Switching and Logic Levels, Digital Waveform. Number Systems: Decimal Number System, Binary Number System, Converting Decimal to Binary, Hexadecimal Number System: Converting Binary to Hexadecimal, Hexadecimal to Binary. **Boolean Algebra Theorems:** De Morgan's theorem. Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, NAND Gate, NOR Gate, Algebraic Simplification, Implementation of NAND and NOR functions.
Topic Learning Outcomes **At the end of the topic, students should be able to:**

SL No	TLO's	BL	CO	PO
i.	Define op-amps and give the characteristics of an ideal opamp.	L1	4	1-6, 11-12
ii.	Explains an inverting and non-inverting configuration of typical op-amps, with a schematic diagram.	L2	4	1-6, 11-12
iii.	Explain how op-amps can be used as a voltage follower, with a schematic diagram and with relevant expressions.	L2	4	1-6, 11-12
iv.	Explain how op-amps can be used as a voltage follower, adder and subtractor, with a schematic diagram and with relevant expressions.	L2	4	1-6, 11-12
v.	Give different digital wave forms and explain how one can visualize the switching and logic levels.	L1	5	1-6, 11-12
vi.	Write any four-digit numbers other than zero in the decimal number system and convert that into binary and hexadecimal.	L2	5	1-6, 11-12

List of Experiments to be performed in the Laboratory	
1.	Mechanical Equivalent of Heat by Callender and Barne's method
2.	Coefficient of thermal conductivity of Copper by Searle's apparatus
3.	Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method
4.	Determination of Stefan's constant/ Verification of Stefan's law
5.	Variation of thermo-emf across two junctions of a thermocouple with temperature
6.	Determination of Temperature coefficient of resistance of thermistor using Meterbridge.
7.	Newtons Law of cooling.
8.	Emissivity of Surface.
9.	Verification of Clausius –Clapeyron equation and determination of specific enthalpy
10.	V-I Characteristics of PN Junction diodes (FB & RB) V-I and Zener Diode.
11.	Characteristics of BJT in Common Emitter Configuration
12	Half Wave and Full Wave Rectifier Without Filter/ Half Wave and Full Wave Rectifier with Filter
13.	Non-inverting and Inverting op-amp circuits Voltage follower, Adder and Subtractor circuits
14.	Adder and Subtractor circuits.
15.	Logic Gates: Truth table verification of logic gates using TTL 74 series ICs.
16	Assignment - I
17	Assignment -II

DEPARTMENT of PHYSICS

Government College (Autonomous)

Sedam Road Kalaburagi-585105

Program Name	**B.Sc in Physics**	Semester	V
Course Title	Classical Mechanics and Quantum Mechanics- I **(Theory)**		
Course Code:	PHY C9-T	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s): Basics of Mechanics, Newtonian Mechanics, modern physics

Course Outcomes (COs): After the successful completion of the course, the student will be able to

- Identify the failure of classical physics at the microscopic level.
- Find the relationship between the normalization of a wave function and the ability to correctlycalculate expectation values or probability densities.
- Explain the minimum uncertainty of measuring both observables on any quantum state.
- Describe the time-dependent and time-independent Schrödinger equation for simple potentials likefor instance one-dimensional potential well and Harmonic oscillator.

Apply Hermitian operators, their eigenvalues and eigenvectors to find various commutation anduncertainty relations.

UNIT-1

Introduction to Newtonian Mechanics: Frames of references, Newton's laws of motion, inertial and non-inertial frames. Mechanics of a particle, Conservation of linear momentum, Angular momentum and torque, conservation of angular momentum, work done by a force, conservative force and conservative energy.

Lagrangian formulation: Constraints, Holonomic constraints, non-holonomic constraints, Scleronomic and Rheonomic constraints. Generalized coordinates, degrees of freedom, Principle of virtual work, D'Alembert's principle, Lagrange equations. Newton's equation of motion from Lagrange equations, simple pendulum, Atwood's machine and linear harmonic oscillator.

[12 Hrs]

Activities Annexure-I: [3 Hrs]

UNIT-2

Variational principle: Hamilton's principle, Deduction of Hamilton's principle, Lagrange's equation of motion from Hamilton's principle, Hamilton's principle for non-holonomic systems.

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Hamiltonian Mechanics: The Hamiltonian of a system, Hamilton's equations of motion, Hamilton's equations from variational principle, Integrals of Hamilton's equations, energy integrals,

[12 Hrs]

Activities Annexure-I: [3 Hrs]

UNIT-3

Introduction to Quantum Mechanics

Brief discussion on failure of classical physics to explain black body radiation, Photoelectric effect, Compton effect, stability of atoms and spectra of atoms.

Compton scattering: Expression for Compton shift (With derivation).

Matter waves: de Broglie hypothesis of matter waves, Electron microscope, Wave description o particles by wave packets, Group and Phase velocities and relation between them, Experimenta evidence for matter waves: Davisson- Germer experiment, G.P Thomson's experiment and its significance.

Heisenberg uncertainty principle: Elementary proof of Heisenberg's relation between momentum and position, energy and time, angular momentum and angular position, illustration of uncertainty principle by Gamma ray microscope thought experiment. Consequences of the uncertainty relations: Diffraction of electrons at a single slit, why electron cannot exist in nucleus?.

[12 Hrs]

Activities Annexure-I: [3 Hrs]

UNIT-4

Foundation of Quantum Mechanics

Probabilistic interpretation of the wave function - normalization and orthogonality of wav functions, Admissibility conditions on a wave function, Schrödinger equation: equation o motion of matter waves - Schrodinger wave equation for a free particle in one and thre dimension, time-dependent and time-independent wave equations, Probability current densit equation of continuity and its physical significance, Postulates of Quantum mechanics:States a normalized wave functions. Dynamical variables as linear Hermitian operators, (positio momentum, angular momentum, and energy as examples). Expectation values of operators ar their time evolution. Ehrenfest theorem (no derivation), Commutator brackets- Simultaneo Eigen functions, Commutator bracket using position, momentum and angular momentu operators.

[12 Hrs]

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Activities Annexure-I: **[3 Hrs]**

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1. Physics for Degree Students B.Sc., Third Year, C.L.Arora and P.S.Hemne, 1st edition, S.Chand &Company Pvt. Ltd., 2014.
2. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
3. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer
4. Classical Mechanics, G. Aruldhas, 2008, Prentice-Hall of India Private limited, New Delhi.
5. Classical Mechanics, Takwale and Puranik-1989, Tata Mcgraw Hill, new Delhi
6. Concepts of Modern Physics, Arthur Beiser, McGraw-Hill, 2009.
7. Physics for Scientists and Engineers with Modern Physics, Serway and Jewett, 9th edition, CengageLearning, 2014.
8. Quantum Physics, Berkeley Physics Course Vol. 4. E.H. Wichman, Tata McGraw-Hill Co., 2008.
9. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, McGraw Hill, 2003.
10. P M Mathews and K Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill publication, ISBN: 9780070146174.
11. Ajoy Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer Publication,ISBN 978-1-4020-2130-5.
12. Modern Physics; R.Murugeshan & K.Sivaprasath; S. Chand Publishing.
13. G Aruldhas, Quantum Mechanics, Phi Learning Private Ltd., ISBN: 97881203363.
14. Gupta, Kumar & Sharma, Quantum Mechanics, Jai Prakash Nath Publications.

PRACTICALS: List of Experiments

1. To determine 'g', the acceleration due to gravity, at a given place, from the L – T graph, for a simple pendulum.
2. Studying the effect of mass of the bob on the time period of the simple pendulum
3. Studying the effect of amplitude of oscillation on the time period of the simple pendulum
4. Determine the acceleration of gravity is to use an Atwood's machine.
5. Study the conservation of energy and momentum using projectile motion.
6. Verification of the Principle of Conservation of Linear Momentum
7. Determination of Planck constant and work function of the material of the

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Program Name	**BSc in Physics**	Semester	**V**
Course Title	Elements of Atomic, Molecular & Laser Physics **(Theory)**		
Course Code:	PHY C11-T	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite (s): PUC Science Knowledge

Course Outcomes (COs): After the completion of the course, the student will be able to

Describe atomic properties using basic atomic models.

Interpret atomic spectra of elements using vector atom model.

Interpret molecular spectra of compounds using basics of molecular physics.

Explain laser systems and their applications in various fields.

Unit 1: Basic Atomic models

Thomson's atomic model; Rutherford atomic model – Model, Theory of alpha particle scattering. Rutherford scattering formula; Bohr atomic model – postulates, Derivation of expression ~~for~~ radius, total energy of electron; Origin of the spectral lines; Spectral series of hydrogen atom; Effect of nuclear motion on atomic spectra - derivation; Ritz combination principle; Correspondence principle; Critical potentials – critical potential, excitation potential and ionisation potential; Atomic excitation and its types, Franck-Hertz experiment Sommerfeld's atomic model – model, Derivation of condition for allowed elliptical orbits.

[12 Hrs]

Activities: **[3 Hrs]**

1. Students to estimate radii of orbits and energies of electron in case of hydrogen atom in different orbits and plot the graph of radii / energy versus principal quantum number 'n'. Analyse the nature of the graph and draw the inferences.
2. Students to search critical, excitation and ionisation potentials of different elements and plot the graph of critical /excitation / ionisation potentials versus atomic number/mass number/neutron number of element. Analyse the nature of the graph and draw the inferences.

Unit 2: Vector atomic model and optical spectra

Vector atom model – model fundamentals, spatial quantisation, spinning electron; Quantum

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numbers associated with vector atomic model; Coupling schemes – L-S and j-j schemes; Pauli's exclusion principle; Magnetic dipole moment due to orbital motion of electron – derivation; Magnetic dipole moment due to spin motion of electron; Lande g-factor and its calculation for different states; Stern-Gerlach experiment – Experimental arrangement and Principle; Fine structure of spectral lines with examples; Spin-orbit coupling/Spin-Orbit Interaction – qualitative; Optical spectra – spectral terms, spectral notations, selection rules, intensity rules; Fine structure of the sodium D-line; Zeeman effect: Types, Experimental study and classical theory of normal Zeeman effect, Zeeman shift expression (no derivation), examples; Stark effect: Experimental study, Types and examples.

[12 Hrs]
[3 Hrs]

Activities:

1. Students to couple a p-state and s-state electron via L-S and j-j coupling schemes for a system with two electrons and construct vector diagrams for each resultant. Analyse the coupling results and draw the inferences.
2. Students to estimate magnetic dipole moment due to orbital motion of electron for different states $^2P_{1/2}$, $^2P_{3/2}$, $^2P_{5/2}$, $^2P_{7/2}$, $^2P_{9/2}$ and $^2P_{11/2}$ and plot the graph of dipole moment versus total orbital angular momentum "J". Analyse the nature of the graph and draw the inferences.

Unit 3: Molecular Physics

Types of molecules based on their moment of inertia; Types of molecular motions and energies; Born-Oppenheimer approximation; Origin of molecular spectra; Nature of molecular spectra; Theory of rigid rotator – energy levels and spectrum, Qualitative discussion on Non- rigid rotator and centrifugal distortion; Theory of vibrating molecule as a simple harmonic oscillator – energy levels and spectrum; Electronic spectra of molecules – fluorescence and phosphorescence; Raman effect – Stoke's and anti-Stoke's lines, characteristics of Raman spectra, classical and quantum approaches, Experimental study of Raman effect; Applicationsof Raman effect.

[12 Hrs]
[3 Hrs]

Activities :

1. Students to estimate energy of rigid diatomic molecules CO, HCl and plot the graph of rotational energy versus rotational quantum number 'J'. Analyse the nature of the graph and draw the inferences. Also students study the effect of isotopes on rotationalenergies.
2. Students to estimate energy of harmonic vibrating molecules CO, HCl and plot the graph of vibrational energy versus vibrational quantum number 'v'. Analyse the nature of the graph

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and draw the inferences.

Unit 4: Laser Physics

Ordinary light versus laser light; Characteristics of laser light; Interaction of radiation with matter - Induced absorption, spontaneous emission and stimulated emission with mention ofrate equations; Einstein's A and B coefficients – Derivation of relation between Einstein's coefficients and radiation energy density; Possibility of amplification of light; Population inversion; Methods of pumping; Metastable states; Requisites of laser – energy source, active medium and laser cavity; Difference between Three level and four level lasers with examples;Types of lasers with examples; Construction and Working principle of Ruby Laser and He-Ne Laser; Application of lasers (qualitative) in science & research, isotope separation, communication, fusion, medicine, industry, war and space

[12 Hrs]

Activities: [3 Hrs]

1. Students to search different lasers used in medical field (ex: eye surgery, endoscopy, dentistry etc.), list their parameters and analyse the need of these parameters for specific application, and draw the inferences. Students also make the presentation of the study.
2. Students to search different lasers used in defence field (ex: range finding, laser weapon, etc.), list their parameters and analyse the need of these parameters for specific application, and draw the inferences. Students also make the presentation of the study.

REFERENCES

1. Modern Physics, R. Murugeshan, Kiruthiga Sivaprakash, Revised Edition, 2009, S. Chand & Company Ltd.
2. Atomic & Molecular spectra: Laser, Raj Kumar, Revised Edition, 2008, Kedar Nath Ram Nath Publishers, Meerut.
3. Atomic Physics, S.N. Ghoshal, Revised Edition, 2013, S. Chand & Company Ltd.,
4. Concepts of Atomic Physics, S.P. Kuila, First Edition, 2018, New Central Book Agency (P) Ltd.
5. Concepts of Modern Physics, Arthur Beiser, Seventh Edition, 2015, Shobhit Mahajan, S. Rai Choudhury, 2002, McGraw-Hill.
6. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash, Fourth Edition

2008,Tata McGraw-Hill Publishers.

7. Elements of Spectroscopy – Atomic, Molecular and Laser Physics, Gupta, Kumar a Sharma, 2016, Pragati Publications.

PRACTICALS: List of Experiments.

1. To determine Planck's constant using Photocell.
2. To determine Planck's constant using LED.
3. To determine wavelength of spectral lines of mercury source using spectrometer.
4. To determine the value of Rydberg's constant using diffraction grating and hydrogen discharge tube.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine fine structure constant using fine structure separation of sodium D-lines using a plane diffraction grating.
7. To determine the value of e/m by Magnetic focusing or Bar magnet.
8. To determine the ionization potential of mercury.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To determine the absorption lines in the rotational spectrum of Iodine vapour.
11. To determine the force constant and vibrational constant for the iodine molecule from its absorption spectrum.
12. To determine the wavelength of laser using diffraction by single slit/double slits.
13. To determine wavelength of He-Ne laser using plane diffraction grating.
14. To determine angular spread of He-Ne laser using plane diffraction grating.
15. Study of Raman scattering by CCl_4 using laser and spectrometer/CDS

Note: Students have to perform at least EIGHT(8) experiments from above list

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Program Name	**B. Sc**	Semester	VI
Course Title	Elements of Condensed Matter & Nuclear Physics (Theory)		
Course Code:	PHY C14 - T	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**3 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s):

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

- Explain the basic properties of nucleus and get the idea of its inner information.
- Understand the concepts of binding energy and binding energy per nucleon v/s mass number graph.
- Describe the processes of alpha, beta and gamma decays based on well-established theories.
- Explain the basic aspects of interaction of gamma radiation with matter by photoelectric effect,Compton scattering and pair production.
- Explain the different nuclear radiation detectors such as ionization chamber, Geiger-Mueller counteretc.
- Explain the basic concept of scintillation detectors, photo-multiplier tube and semiconductor

  Detectors

UNIT-1

Crystal systems and X-rays: Crystal structure: Space Lattice, Lattice translational vectors, Basis of crystal structure, Types of unit cells, primitive, non-primitive cells.. Seven crystal system, Coordination numbers, Miller Indices, Expression for inter planner spacing. **X Rays:** Production and properties of X rays, Coolidge tube, Continuous and characteristic X-ray spectra; Moseley's law. **X-Ray diffraction**, Scattering of X-rays, Bragg's law. **Crystal diffraction:** Bragg's X-ray spectrometer- powder diffraction method, Intensity vs 2θ plot (qualitative).

Free electron theory of metals: Classical free electron model (Drude-Lorentz model), expression for electrical and thermal conductivity, Weidman-Franz law, Failure of classical free electron theory; Quantum free electron theory, Fermi level and Fermi energy, Fermi-Dirac distribution function (expression for probability distribution F(E), statement only); Fermi Dirac distribution at T=0 and $E<E_f$, at $T\neq 0$ and $E>E_f$, F(E) vs E plot at T = 0 and $T\neq0$. Density of states for free electrons (statement only, no derivation).

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Activities: Annexure-II [12 Hrs]
[3 Hrs]

UNIT-2

Magnetic Properties of Matter, Dielectrics and Superconductivity

Magnetic Properties of Matter

Review of basic formulae: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility, magnetization (M), Classification of Dia, Para, and ferro magnetic materials; Langevin Classical Theory of dia – and Paramagnetism. Curie's law, Ferromagnetism and Ferromagnetic Domains (qualitative). Discussion of B-H Curve. Hysteresis and Energy Loss, Hard and Soft magnetic materials

Dielectrics: Static dielectric constant, polarizability (electronic, ionic and orientation),calculation of Lorentz field (derivation), Clausius-Mosotti equation (derivation), dielectric loss.

Superconductivity: Definition, Experimental results – Zero resistivity and Critical temperature– The critical magnetic field – Meissner effect, Type I and type II superconductors.

Activities: Annexure-II [12 Hrs]
[3 Hrs]

UNIT-3

General Properties of Nuclei: Constituents of nucleus and their intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy ,main features of binding energy versus mass number curve, angular momentum, parity, magnetic moment, electric moments

Radioactivity decay: Radioactivity : definition of radioactivity, half life, mean life, radioactivity equilibrium (a) Alpha decay: basics of α-decay processes, theory of α emission (brief), Gamow factor, Geiger-Nuttall law. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion (Definition).

Activities: Annexure-II [12 Hrs]
[3 Hrs]

UNIT-4

Interaction of Nuclear Radiation with matter: Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, Energy loss due to ionization (quantitative description of Bethe Block formula), energy loss of electrons.

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Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Accelerators : Cyclotrons and Synchrotrons.

[12 Hrs]

Activities: Annexure-II [3 Hrs]

REFERENCES

Text Books

1. Solid State Physics-R. K. Puri and V.K. Babber., S.Chand publications, 1st Edition(2004).
2. Fundamentals of Solid State Physics-B.S.Saxena,P.N. Saxena,Pragati prakashan Meerut(2017).
3. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008). Nuclear Physics, Irving Kaplan, Narosa Publishing House

Reference Books

1. Introduction to solid State Physics, ***Charles Kittel***, VII edition, **(1996)**
5. Solid State Physics- **A J Dekker**, MacMillan India Ltd, **(2000)**
6. Essential of crystallography, **M A Wahab**, Narosa Publications **(2009)**
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8. Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw Hill, 1998).
9. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
10. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
11. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (Institute ofPhysics (IOP) Publishing, 2004).
12. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
13. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier,2007).

PRACTICALS: List of Experiments

CONDENSED MATTER PHYSICS

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1. Determination of Plank's constant by Photo Cell
2. Hall Effect in semiconductor: determination of mobility, hall coefficient.
3. Energy gap of semiconductor (diode/transistor) by reverse saturation method
4. Thermistor energy gap
5. Fermi Energy of Copper
6. Analysis of X-ray diffraction spectra and calculation of lattice parameter.
7. Plank's constant by LED
8. Spectral Response of Photo Diode and its I-V Characteristics.
9. Determination of particle size from XRD pattern using Debye-Scherrer formula.
10. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method).
11. Measurement of susceptibility of paramagnetic solid (Gouy's Method)

NUCLEAR PHYSICS

1. Study the characteristics of Geiger-Mùller Tube. Determine the threshold voltage, plateau regionand operating voltage.
2. Study the absorption of beta particles in aluminium foils using GM counter. Determine mass attenuation coefficient of Aluminium foils.
3. Study the absorption of beta particles in thin copper foils using G M counter and determine massattenuation coefficient.
4. Study the attenuation of gamma rays in lead foils using Cs-137 source and G M counter. Calculatemass attenuation coefficient of Lead for Gamma.
5. Determine the end point energy of Tl-204 source by studying the absorption of beta particles in aluminium foils.
6. Study the attenuation of absorption of gamma rays in polymeric materials using Cs-137 source andG M counter

Note: Students have to perform at least EIGHT(8) experiments from above list

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Program Name	**B. Sc in Physics**	Semester	**VI**
Course Title	Electrodynamics and Statistical Physics **(Theory)**		
Course Code:	PHY C18 - T	No. of Credits	**04**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite (s): PUC Science Knowledge

Course Outcomes (COs): After the completion of the course, the student will be able to

- Describe basics of electrodynamics.
- Explain EM wave propagation in unbounded media.
- Apply classical statistics to physical situations.
- Apply quantum statistics to physical problems.

Unit 1: Basics of Electrodynamics

Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.

[12 Hrs]

Activities: **[3 Hrs]**

1. Students to study the physical meaning of divergence and curl operators and apply the knowledge to understand Maxwell's equations. Present the study by PPT presentation.
2. Students to identify different wave equations in physics and learn to solve the equations by different techniques

Unit 2: EM Wave Propagation in Unbounded Media

Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagationthrough conducting media, relaxation time, skin depth. Wave propagation through diluteplasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere. EM wave propagation in optical fibers.

[12 Hrs]

Activities: **[3 Hrs]**

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1. Students to identify optical fibers used in different applications and record their characteristics.
2. Students to identify radiation sources used in mobile communication and list their characteristics (2G/3G/4G/5G).

Unit 3: Classical Statistics

Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) –Applications to Specific Heat and its Limitations.

[12 Hrs.]

[3 Hrs.]

Activities:

1. Students to learn Binomial distribution using coins and plot the distribution curve.
2. Students to learn Normal distribution using nails and plot the distribution curve.

Unit 4: Quantum Statistics

Bose-Einstein distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

[12 Hrs.]

[03 Hrs.]

Activities:

1. Students to list particles belonging to Bosons and Fermions, and understand their characteristics . Students also make the presentation of the study.
2. Students to search the contribution of Indian scientist J.C. Bose in Bose-Einstein condensation. Students also make the presentation of the study.

REFERENCES

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
3. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

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4. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
5. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
6. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, OxfordUniversity Press.

PRACTICALS: List of Experiments

1. Specific Heat of Solid by Electrical Method
2. Determination of Dielectric Constant of polar liquid.
3. B-H Curve Using CRO.
4. Spectral Response of Photo Diode and its I-V Characteristics
5. Design and construct a Wien bridge oscillator (sine wave oscillator) using op-amp
6. Study the characteristics of a thermistor (temperature coefficient of resistance).
7. Study of V-I characteristics of LED.
8. Binomial distribution using coins and plot the distribution curve.
9. Normal distribution using nails and plot the distribution curve.
10. To find the width of the wire or width of the slit using diffraction pattern by a He-Ne or solid state laser.
11. Optical image addition/subtraction.
12. Optical image differentiation.
13. Assignment-1
14. Assignment-2
15. Assignment-3

Note: 1.As and when new experiments available & set upped will be introduced time-to- time.

Note: 2.Students have to perform at least EIGHT(8) experiments from above list

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Pedagogy: Demonstration/Experiential Learning / Self Directed Learning etc.

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