

Department of Physics, Amar Singh College, Srinagar

Semester 1

Course Title: Mechanics and Relativity

Course Objective:

The emphasis of course is to review the elementary concepts in a more advanced perspective and to build new concepts. It begins with the mathematics required in solving problems of interest which include Gravitation, translational and rotational dynamics of a system of particles, conservation of energy, Special theory of relativity, Simple Harmonic Motion and ends with elastic properties of solids. The Students will be able to apply the concepts learnt to several real world problems.

Learning Outcomes:

Upon completion of this course, the student will be able to:

- Understanding the motion of objects in different frame of references.
- Understand laws of motion, applications like projectile motion, simple harmonic oscillator, Rocket motion, elastic and inelastic collisions.
- Understanding the idea of conservation of angular momentum under central forces.
- Understand the application of central force to the stability of circular orbits, Kepler's laws of planetary motion.
- Understand the dynamics of rotating objects i.e. rigid bodies, angular velocity, the moment of inertia, parallel axis theorem, the inertia tensor, the motion of rigid bodies.
- Non-inertial frames: pseudo forces, examples involving the centrifugal force and coriolis force.
- Understand the elastic properties of material, elastic constants and their relation, torsion of a cylinder, bending of a beam.
- Understand the basics of motion of fluid which includes streamlined and turbulent flows, equation of continuity, critical velocity, flow of a liquid through a capillary tube, capillaries in series and parallel, Stokes' formula.
- Develop understanding of special theory of relativity and its applications to understand length contraction, time dilation and relativistic addition of velocities, conservation of momentum and variation of mass, relativistic momentum, relativistic energy, and mass energy relation.
- Work done in stretching and work done in twisting a wire – Twisting couple on a cylinder.
- Determination of rigidity modulus by static torsion-Torsional pendulum. Determination of elastic constants by Searle's method
- To determine the elastic constants of a wire by Searle's method.
- Moment of inertia of an irregular of an irregular body about an axis through its centre of gravity with a torsional pendulum.

Semester 2nd

Course Title: Electricity and Magnetism

Course Objectives

- To introduce basics of Vector Calculus: Gradient, divergence and curl
- To introduce of electrostatics and magneto statics in terms of new mathematical framework.
- Introduce electromagnetic induction, Maxwell's equations and electromagnetic waves.

Course Outcomes

Upon completion of this course, the student will be able to

- Apply concepts of vector calculus to solve problems related to gradient, divergence and curl.
- Apply principles of electrostatics and magneto statics to the solution of problems related to electric field, electric potential, boundary conditions
- Student is able to understand daily life phenomenon based on electromagnetic induction
- Student is able to understand nature of electromagnetic waves based on Maxwell's equation.
- Understand the basic concepts of electric and magnetic fields.
- Understand the concept of conductors, dielectrics, inductance and capacitance.
- Gain knowledge on the nature of magnetic materials.
- Understand the concept of static and time varying fields.
- Gain knowledge on electromagnetic induction and its applications
- Gain knowledge on EM waves, propagation and their properties.
- Ability to use Maxwell's equations in calculations featuring: both free and stationary electromagnetic waves.

Semester 3rd

Course Title: Thermal Physics and Statistical mechanics

Course Objective

- To understand the fundamental laws of thermodynamics and their application to various systems and processes.
- To understand basics of the kinetic theory of gases, transport phenomena in ideal gases, phase transition and behavior of real gases.
- To understand the relationship between the macroscopic properties of physical systems in equilibrium.
- To apply the principles of probability in distribution of particles in various systems and to calculate thermodynamic probability

Course outcomes:

Upon completion of this course, the student will be able to

- Explain the fundamentals of thermodynamics, Carnot cycle, statistics and distributions.
- Develop critical thinking and appropriate problem solving skills related to first and second law of thermodynamics
- Apply concepts learned in the course to real-life problems and situations
- Understand the process of thermal conductivity, viscosity and diffusion in gases.
- Understand the basic statistical methods and concepts like probability, random variables, expected value, variance, estimators and common probability distributions.
- Understand the relation between microscopic and macroscopic description through statistical mechanics; know and to apply the laws of thermodynamics and principles of free energy
- Describe thermodynamic processes and heat engines
- Understand the efficiency of Carnot's engine and its significance. The first and second of thermodynamics, the implications/limitation of the second law of thermodynamics on the performance of thermodynamic systems.
- Ability to evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.
- Understand the interrelationship between thermodynamic functions and ability to use such relationships to solve practical problems.

Semester 4th**Course Title: Waves and Optics****Course Objective**

The course aims to introduce the basic concepts required for a mathematical description of oscillations and waves, and to provide expertise for solving the differential equations which arise in simple mathematical models for oscillations and waves

It begins with explaining ideas of superposition of harmonic oscillations leading the physics of travelling and standing waves. The course also provides an in depth understanding of light as electromagnetic wave for various phenomena namely, interference and diffraction with emphasis on practical applications of the same.

Course Outcomes

Upon completion of this course, the student will be able to

- Understand physical characteristics of SHM and obtaining solution of the oscillator using differential equations
- Calculate logarithmic decrement relaxation factor and quality factor of a harmonic oscillator
- Use Lissajous figures to understand simple harmonic vibrations of same frequency /different frequencies
- Solve wave equation and understand significance of transverse/Longitudinal waves
- Solve wave equation of a longitudinal vibration in bars free at one end / fixed at both the ends.
- Obtain boundary conditions of a longitudinal vibration in bars free at one end and also fixed at both the ends
- Gain knowledge on applications of transverse and longitudinal waves.
- Understand the properties of light like reflection, refraction, interference, diffraction etc
- Understand the applications of diffraction and polarization.
- Understand the applications of interference in design and working of interferometers.

Semester 5th

Course Title: Modern Physics

Course Objective

The objective of this course is to teach main aspects of inadequacy of Classical Mechanics as well as understanding of historical development of Quantum mechanics. It also imparts the understanding of the sub atomic particles and their properties. It will emphasize to gain knowledge about the different nuclear techniques and their applications in different branches of physics and societal applications.

Course Outcomes

Upon completion of this course, the student will be able to

- Understand the origins of quantum mechanics
- Understand and explain the differences between classical and quantum mechanics
- Understand the idea of wave function
- To interpret the wave function and apply operators to it to obtain information about a particle's physical properties such as position, momentum and energy
- Understand the uncertainty relations
- Understand the Schrodinger wave mechanics
- Solve the Schrodinger equation for simple 1D time-independent potentials
- Appreciate the importance and develop an understanding of angular momentum
- Identify and relate the eigen value problems for energy, momentum, angular momentum and central potentials
- Develop the idea of spin
- Understand many electron atoms and interaction of spins i.e. LS and JJ coupling.
- Understand the change in behavior of atoms in external applied electric and magnetic field
- Understand rotational, vibrational, electronic and Raman spectra of molecules and their applications.
- Able to describe electron spin and nuclear magnetic resonance spectroscopy and their applications.
- Understand properties of the nuclear force and the exchange force model.
- Understand the procedures for nuclear fission and fusion. A basic understanding of nuclear properties and popular nuclear models that describe the quantum structure, decay, and reactions of nuclei.
- Understand basic knowledge about the Standard Model of elementary particles and interactions.

Semester 6th

Course Title: Solid State Physics and Devices

Course Objective:

The course will provide a valuable theoretical introduction and an overview of the fundamental applications of the physics of solids. This course introduces the basic concepts and principles required for understanding the properties exhibited by condensed matter, especially crystalline solids. It enables the students to appreciate how the interesting and wonderful properties exhibited by matter depend upon its atomic and molecular constituents. The gained knowledge helps to solve problems in solids state physics using relevant mathematics. It also communicates the importance of solid state physics in modern society. This course includes knowledge of semiconductor physics, working and applications of devices, including p-n junctions, BJTs and FET etc.

Course Outcomes:

Upon completion of this course, the student will be able to

- Understand the basic concepts of force between atoms and bonding between molecules. Understanding of diffraction experiment and reciprocal lattice
- Understand crystal vibrations: phonon heat capacity and thermal conductivity
- Understand free electron Fermi gas: density of states, Fermi level, and electrical conductivity
- Understand electrons in periodic potential: energy bands theory classification of metals, semiconductors and insulators
- Understand semiconductors: band gap, effective masses, charge carrier distributions, doping, pn junctions
- Understand metals: Fermi surfaces, temperature dependence of electrical conductivity
- Understand the properties of semi conductors
- Understand the applications of semiconductor devices
- Understand the basics of diode and working of rectifier circuits and characteristics.
- Understanding and ability to analyze the characteristics of transistor and transistor biasing circuits.
- Understanding and ability to analyze the characteristics of FET, JFET, MOSFET and biasing circuits

Semester: IV (Skill Enhancement Course)

Renewable Energy & Energy Harvesting

Course objectives: The aim of this course is to impart the students a thorough understanding of various energy resources. Explaining the difference between renewable and Non-renewable energy sources. To demonstrate understanding of different types of renewable energy technologies that are currently available, and how they are used to provide energy. To demonstrate harness the eco-friendly & non-depleting energy resources. The course also introduces the modern energy trends like piezoelectric & electromagnetic energy harvesting.

Learning outcome

- To understand the importance of sustainable energy
- Understand the advantages/disadvantages the use of Renewable and Non-renewable resources
- Need for alternate sources of energy.
- Advantages of Wind Energy harvesting.
- Structure and Components of Wind Turbines.
- Basics of energy from Ocean
- Harnessing of Ocean Thermal Energy/Tidal Energy
- Understanding of Geothermal Energy
- Introduction to Hydro Energy as resource of Renewable energy
- Understanding of various aspects of solar energy harvesting /solar cooking and solar electric power generation.
- Introduction of photo voltaic (PV) systems.
- Understanding Piezoelectricity.

Course objective/ learning outcome:

This course aims to impart the basic understanding of conductors, semiconductor and components like diode, transistor. Moreover, it will build the conceptual understanding of theoretical communication system.

- Understanding basic concepts of Voltage, Current, Resistance, and Power.
- Ohm's law, Series, parallel and series-parallel resistance combinations.
- Understanding difference between AC and DC electricity.
- Applying Kirchhoff's law.
- Use of Voltmeter and ammeter.
- Basic electric circuit elements and their combination.
- Understanding and measuring Current and voltage drop across the DC circuit elements.
- Understanding principle of Electromagnetic induction
- Applications of Eddy Currents
- Understanding of Power in an AC circuit containing resistance, inductance and capacitance, Power factor
- Understanding the function of AC generator
- Understanding of DC Motors
- Basic understanding of a Transformer.
- Safety consideration in electricity.
- Distinguishing between conductors, insulators and semiconductors.
- Intrinsic and Extrinsic semiconductors.
- Use of semiconductor, N-Type Semiconductor. P-type semiconductor
- Use of Diode as rectifier.
- Basic idea about filter circuits.
- Understanding of Zener diode as voltage regulator.
- Basic understanding of Analog and digital instruments.
- Functions of Multimeter.
- Understanding the working principle of cathode ray oscilloscope (CRO)
- Applications of CRO (1) study of wave form (2) Measurement of Voltage, Current, Frequency and phase difference

Introduction to Communication Systems and Instrumentation**Course objective/ learning outcome:**

This course aims to impart the basic understanding of conductors, semiconductor and components like diode, transistor. Further, students will be introduced to various optical phenomena for understanding of optical communications and applications in medical diagnosis.

- Understanding basic concepts of Voltage, Current, Resistance, and Power.
- Ohm's law, Series, parallel and series-parallel resistance combinations.
- Understanding difference between AC and DC electricity.
- Applying Kirchhoff's law to determine the values of unknown currents, Voltage in the circuits
- Use of Voltmeter and ammeter.
- Basic electric circuit elements and their combination.
- Understanding and measuring Current and voltage drop across the DC circuit elements.
- Understanding the concept of Reflection of light.
- Use of Optical fibre
- Uses of optical fibre in communications/ Medical applications.
- Understanding the function of Modulation'
- Use of Diode as detector.
- Distinguishing between conductors, insulators and semiconductors.
- Intrinsic and Extrinsic semiconductors.
- Use of semiconductor, N- Type Semiconductor. P-type semiconductor
- Use of Diode as rectifier.
- Basic idea about filter circuits.
- Understanding of Zener diode as voltage regulator.
- Basic understanding of Analog and digital instruments.
- Functions of Multimeter.
- Understanding the working principle of cathode ray oscilloscope (CRO)
- Applications of CRO (1) study of wave form (2) Measurement of Voltage, Current, Frequency and phase difference.