

# Syllabus

## Physics Major and Minor for Associate Degree in Science



Effective for the Academic Session 2022 onward

## Physics Major Syllabus

<b>Course Code</b>	<b>Course Title</b>	<b>Credit Hours</b>
PHY-501	Mechanics	3(2 – 1)
PHY-502	Electricity & Magnetism	3(3 – 0)
PHY-503	Heat & Thermodynamics	3 (3 – 0)
PHY-504	Waves and Oscillation	3(3 – 0)
<b>Total</b>		<b>12</b>

## PHY-501 MECHANICS: Credit Hours: 3(2-1)

### Objectives:

The main objective of this course is to understand the different motions of objects on a macroscopic scale and to develop simple mathematical formalisms to analyze such motions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

**Basic Concepts:** Scalars and Vectors, Multiplication of Vectors: Dot and Cross Products. Vector triple product, scalar triple product, Del Operator, Divergence theorem, Stokes theorem, Coordinate systems: Cartesian system, spherical, cylindrical system of coordinates.

**Motion in One, Two and Three Dimensions:** Position & Displacement, Velocity and Acceleration, Motion under Constant Acceleration, Projectile Motion, Uniform Circular Motion, Relative Velocity and Acceleration in One and Two Dimensions, Inertial and Non-Inertial Reference Frames.

**Newton's Laws:** Newton's Laws of Motion and their Applications involving some particular forces including Weight, Normal Force, Tension, Friction, and Centripetal Force, Newton's Law of Gravitation, Gravitational Potential Energy, Escape Velocity, Kepler's Laws, Satellite Orbits & Energy.

**Work and Kinetic Energy:** Work done by Constant and Variable Forces: Gravitational and Spring Forces, Power, Conservative and Non-conservative Forces, Work and Potential Energy, Isolated Systems and Conservation of Mechanical Energy, Work Done by External Forces including Friction and Conservation of Energy.

**Angular Momentum:** Angular Velocity, Conservation of angular momentum, effects of Torque and its relation with angular momentum.

**Simple Harmonic Motion (SHM):** Amplitude, Phase, Angular Frequency, Velocity and Acceleration in SHM, Linear and Angular Simple Harmonic Oscillators, Energy in SHM, Simple Pendulum, Physical Pendulum, SHM and Uniform Circular Motion, Damped Harmonic Oscillator.

### PRACTICALS:

1. To determine the value of "g" by simple pendulum.
2. To determine the value of "g" by compound pendulum/ Kater's Pendulum.
3. To study the damping features of an oscillating system using simple pendulum of variable mass.
4. To study the dependence of Centripetal force on mass, radius, and angular velocity of a body in circular motion.
5. Determination of moment of inertia of a solid/hollow cylinder and a sphere etc

### Recommended Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed. 2010.
2. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed. 2010.
3. R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.
4. F. J Keller, W. E. Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill. 2nd ed. 1992.
5. D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed. 2008.

## PHY-502-ELECTRICITY AND MAGNETISM Credit Hours: 3(3-0)

### Objectives:

The main objective of this course is to understand the Physics of Electromagnetism and to develop simple mathematical formalisms to analyze the electromagnetic fields and interactions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

**Electrostatics:** Electric Charge, , Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge and an Electric Dipole, Electric Field due to different Charge Distribution (line, disc, ring), Electric Dipole in an Electric Field, Electric Flux, Gauss' Law and its Applications in Planar, Spherical and Cylindrical Symmetry.

**Electric Potential:** Electric potential, Electric potential energy, Equipotential Surfaces, Potential due to a Point Charge and a Group of Point Charges, Potential due to an Electric Dipole, Potential due to a Charge Distribution, Relation between Electric Field and Electric Potential.

**Magnetic Field and Magnetic Force:** Crossed Electric and Magnetic Fields and their Applications, Hall Effect, Magnetic Force on a Current Carrying Wire, Torque on a Current Loop, Magnetic Dipole Moment, Magnetic Field Due to a Current, Force between two Parallel Currents, Ampere's Law, Biot- Savart Law: Magnetic Field due to a Current, Long Straight Wire carrying Current, Solenoids and Toroids, A current-carrying Coil as a Magnetic Dipole,

**Electro Magnetic Induction:** Inductance, Faraday's Law of Induction, Lenz's Law, Induction and Energy Transfers, Induced Electric Fields, Inductors and Inductances, Self Inductance, RL Circuits, Energy Stored in a Magnetic Field, Energy Density, Mutual Induction.

**Alternating Fields and Currents:** LC Oscillations, Damped Oscillations in an RLC circuit, Alternating Currents, Forced Oscillations, Resistive, Capacitive, and Inductive Loads, RLC series Circuit, Power in AC Circuits, Transformers, Gauss' Law for Magnetism, Induced Magnetic Fields, Displacement Current, Spin & Orbital Magnetic Dipole Moment, Diamagnetism, Paramagnetism, Ferromagnetism, Hysteresis.

### Recommended Text Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed. 2010.
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## **PHY-503-HEAT AND THERMODYNAMICS Credit Hours : 3(3-0)**

**Objectives:** To understand the fundamentals of heat and thermodynamics.

**Basic Concepts and Definitions in Thermodynamics:** Thermodynamic system, Surrounding and Boundaries. Type of systems. Macroscopic and microscopic description of system. Properties and state of the substance: Extensive and Intensive properties, Equilibrium, Mechanical and Thermal Equilibrium. Processes and Cycles: Isothermal, Isobaric and Isochoric. Zeroth Law of Thermodynamics, Consequence of Zeroth law of Thermodynamics. The state of the system at Equilibrium.

**Heat and Temperature:** Temperature, Kinetic theory of ideal gas, Work done on an ideal gas, Review of previous concepts. Internal energy of an ideal gas: Equipartition of Energy, Intermolecular forces, Qualitative discussion, The Virial expansion, The Van der Waals equation of state.

**Thermodynamics:** First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion. Reversible and irreversible processes. Second law of thermodynamics, Carnot theorem and Carnot engine. Heat engine, Refrigerators. Calculation of efficiency of heat engines. Thermodynamic temperature scale: Absolute zero, Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy and Second law of thermodynamics, Entropy and Probability. Thermodynamic Functions: Thermodynamic functions (Internal energy, Enthalpy, Gibb's functions, Entropy, Helmholtz functions), Maxwell's relations, TdS equations, Energy equations and their applications. Low Temperature Physics, Joule-Thomson effect and its equations. Thermoelectricity: Thermocouple, Sebeck's effect, Peltier's effect.

### **Recommended Books:**

1. D. Halliday, R. Resnick and K. Krane, "Physics", John Wiley, 5th ed.2002.
2. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley, 9th ed. 2010.
3. M. W. Zemansky, "Heat and Thermodynamics", Mc Graw Hill, 7th ed.1997.
4. M. Sprackling, "Thermal Physics" McMillan 1991.
5. B. N. Roy, "Principle of Modern Thermodynamics", Institute of Physics,London 1995.

**PHY-504 WAVES AND OSCILLATIONS Credit Hours: : 3(3-0)**

**Objective(s):**

To develop a unified mathematical theory of oscillations and waves in physical systems.

**Simple and Damped Simple Harmonic Oscillation:** Mass-Spring System, Simple Harmonic Oscillator Equation, Complex Number Notation, LC Circuit, Simple Pendulum, Quality Factor, LCR Circuit.

**Forced Damped Harmonic Oscillation:** Steady-State Behavior, Driven LCR Circuit, Transient Oscillator Response, Resonance.

**Coupled Oscillations:** Two Spring-Coupled Masses, Two Coupled LC Circuits, Three Spring Coupled Masses, Normal Modes, Atomic and Lattice Vibrations.

**Transverse Waves:** Transverse Standing Waves, Normal Modes, General Time Evolution of a Uniform String, Phase velocity, Group Velocity, Pulse wave form.

**Longitudinal Waves:** Spring Coupled Masses, Sound Waves in an Elastic Solid, Sound Waves in an Ideal Gas.

**Traveling Waves:**, Traveling Waves in an Infinite Continuous Medium, Energy Conservation, Reflection and Transmission at Boundaries, Electromagnetic Waves. Standing Waves in a Finite Continuous Medium

**Multi-Dimensional Waves:** Plane Waves, Three-Dimensional Wave Equation, Laws of Geometric Optics, Waveguides, Cylindrical Waves.

**Interference and Diffraction of Waves:** Double-Slit Interference, Single-Slit Diffraction.

**Recommended Books:**

1. J. Pain, "The Physics of Vibrations and Waves", John Wiley, 6th ed. 2005.
2. P. French, "Vibrations and Waves", CBS Publishers (2003).
3. F. S. Crawford, Jr., "Waves and Oscillations", Berkeley Physics Course,
4. Vol. 3, McGraw-Hill, 1968.
5. A. Hirose, and K. E. Lonngren, "Introduction to Wave Phenomena", Krieger Publications, 2003.

## Physics Minor Syllabus

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PHY-502	Electricity & Magnetism	3(3 – 0)
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