

PHYSICS

MODULE I – HEAT

1. **Units and physical quantities.** Measurement of physical quantities. Systems of units (base units, derived units, multiples and submultiples). The International System of Units (SI). Rules and style conventions. Unit conversions. Dimensional analysis.
2. **Temperature and thermal expansion.** Temperature measurement. Thermal equilibrium. Thermal expansion.
3. **Calorimetry.** Phase changes. Phase equilibrium. Heat capacity. Latent heat of fusion and of vaporization.
4. **Heat transfer.** Thermal conduction. Free and forced convection. Radiation. Stefan-Boltzmann law. Spectral distribution of the radiation emitted by a black body: the Planck radiation formula. Wien's law.
5. **Thermal properties of matter.** State equations. Surface pVT for an ideal gas and for a real substance. Phase diagrams. Points of fusion, boiling and sublimation versus pressure. Vapour pressure. Saturated vapour pressure. Atmospheric humidity.

MODULE II - MECHANICS

1. **Vectorial operations.** Vector components. Vector addition; product with a scalar; scalar product; vector product.
2. **Equilibrium of a particle and of a rigid body.** Newton's laws. Translation equilibrium. Friction; coefficients of friction. Rotation equilibrium. Torque.
3. **Kinematics.** Straight line motion equations. Position, velocity, acceleration. Motion with constant velocity and constant acceleration. Free fall; reference frames.
4. **Dynamics.** Newton's second law. Gravitation. Inertial reference frames; non-inertial forces.
5. **Two-dimensional motion.** Projectiles. Circular motion. Tangential acceleration and centripetal acceleration. Centripetal force. Vertical and horizontal circular motion. Angular velocity and angular acceleration.
6. **Work and Energy.** Work in straight line motion. Kinetic energy and gravitational potential energy. Principle of conservation of energy. Conservative and dissipative forces. Power.
7. **Impulse and momentum.** Conservation of momentum. Collisions. Restitution coefficient. Inelastic collisions; elastic collisions.

MODULE III – ELASTICITY, FLUID MECHANICS AND THERMODYNAMICS

1. **Elasticity.** Traction and compression stress. Shearing stress. Hydrostatic pressure and deformation in fluids. Hooke's law. Bulk modulus. Elastic and plastic behaviour.

2. **Hydrostatics.** Fundamental principle of hydrostatics. Pascal's principle. Pressure measurement. Buoyancy. Arquimedes principle. Forces on vertical walls. Surface tension. Capillarity
3. **Hydrodynamics.** Movement of newtonian fluids. The continuity equation. Bernoulli equation. Viscosity. Poiseuille's law. Reynolds number. Viscous resistance. Stokes' law.
4. **Thermodynamics.** Heat and mechanical energy. Internal energy. First Law of Thermodynamics. Work. Adiabatic, constant pressure, isothermal and constant volume processes. Work and heat in a cycle. Efficiency of a cycle. Heat capacities of an ideal gas. Adiabatic state equations. Carnot cycle. Second Law of Thermodynamics. Reversibility and entropy.

MODULE IV

1. **Transport equations.** Fick's law. Analogies between diffusion transport for mass, heat and momentum. Resistances and conductances. Water potential. Resistant analogues. Introduction to transport in porous media.
2. **Energy and mass balances.** Control volume and fluxes across boundaries. Boundary conditions. Storage and variation of a property.
3. **Applied mechanics** or presentation of equipments for flux measurements and discussion of energy and mass balances in simple case-studies adapted to specific curricula.