

Mechanics and Relativity

Assam University

FYUG · Semester 1 · Credits 3

Unit 1: Fundamentals of Dynamics

- Force and linear momentum
- Principle of conservation of momentum
- Momentum of variable-mass system: motion of rocket
- Motion of a projectile in uniform gravitational field
- Dynamics of a system of particles
- Centre of mass
- Impulse
- Work–Energy theorem
- Conservative and non-conservative forces
- Elastic potential energy
- Force as a gradient of potential energy
- Law of conservation of mechanical energy
- Elastic and inelastic collisions in one and two dimensions
- Collisions in centre of mass and laboratory frames

Unit 2: Rotational Dynamics

- Angular momentum of a particle and system of particles
- Torque
- Principle of conservation of angular momentum
- Moment of inertia
- Calculation of moment of inertia for rectangular, cylindrical and spherical bodies
- Elasticity
- Hooke's law
- Poisson's ratio and its limiting values
- Relation connecting elastic constants
- Twisting torque on a cylinder or wire

Unit 3: Gravitation and Central Force Motion

- Law of gravitation
- Gravitational potential and potential energy
- Potential and field due to spherical shell and solid sphere
- Central force: definition and characteristics
- Kepler's laws with derivation
- Deduction of Newton's law of gravitation from Kepler's law
- Satellite in circular orbit
- Orbital velocity
- Escape velocity
- Time period of satellite
- Geosynchronous orbits
- Weightlessness
- Basic idea of global positioning system (GPS)

Unit 4: Oscillations and Non-Inertial Systems

- Simple harmonic oscillations
- Differential equation of SHM and its solution
- Kinetic energy, potential energy and total energy in SHM
- Time-average values
- Damped oscillations
- Forced oscillations
- Resonance and sharpness of resonance
- Power dissipation
- Quality factor
- Inertial and non-inertial frames
- Fictitious forces
- Uniformly rotating frame
- Laws of physics in rotating coordinate systems
- Coriolis theorem
- Centrifugal force
- Coriolis force and its applications

Unit 5: Relativity

- Galilean transformations
- Galilean invariance
- Michelson–Morley experiment and its outcome
- Postulates of Special Theory of Relativity
- Lorentz transformations
- Simultaneity and order of events
- Lorentz contraction
- Time dilation and its experimental verification
- Twin paradox
- Relativistic addition of velocities
- Variation of mass with velocity
- Massless particles
- Mass–energy equivalence