Question Bank
for
1st Semister - major - C-II
Physics :— minor - 3rd Semister -

PHYSICS-C — II: MECHANICS

Question Set based on Unit–I

PHYSICS-C — II: MECHANICS
Unit–I: Rotational Dynamics and Non-Inertial Systems
Full Marks: 100

Group–A

Answer all questions.
1 × 10 = 10 marks

1. Define angular momentum.
2. What is torque?
3. Define moment of inertia.
4. State the principle of conservation of angular momentum.
5. Write the expression for rotational kinetic energy.
6. What is meant by a non-inertial frame of reference?
7. Define a uniformly rotating frame.
8. What is centrifugal force?
9. What is Coriolis force?
10. Write the expression for Coriolis force.

Group–B

Answer any nine questions.
2 × 9 = 18 marks

1. Distinguish between mass and moment of inertia.
2. Write the relation between torque and angular momentum.
3. Explain the theorem of perpendicular axes.
4. Explain the theorem of parallel axes.
5. Write the moment of inertia of a uniform rod about an axis through its centre and perpendicular to its length.
6. Write the moment of inertia of a solid cylinder about its symmetry axis.
7. State the relation between angular velocity and linear velocity.
8. What are fictitious forces? Give two examples.
9. Explain the centrifugal force in a rotating frame.
10. Write the expression for Coriolis force and explain its terms.

Group–C

Answer any eight questions.
5 × 8 = 40 marks

1. Derive the expression for the angular momentum of a particle about a fixed axis.
2. Derive the equation of rotational motion, (\tau = I\alpha).
3. Derive the expression for the rotational kinetic energy of a rigid body.
4. Derive the moment of inertia of a uniform rod about an axis passing through its centre and perpendicular to its length.
5. Derive the moment of inertia of a solid cylinder about its symmetry axis.
6. Explain the motion of a rigid body involving both translation and rotation.
7. Explain the concept of a non-inertial frame and derive the expression for a fictitious force.
8. Explain centrifugal force in a uniformly rotating frame.
9. Derive the expression for Coriolis force.
10. Discuss the physical effects and applications of Coriolis force.

Group–D

Answer any four questions.
8 × 4 = 32 marks

1. State and prove the principle of conservation of angular momentum. Discuss its applications.
2. Derive the expressions for the moment of inertia of rectangular, cylindrical and spherical bodies.
3. Explain in detail the kinetic energy of a rigid body undergoing both translational and rotational motion.
4. Explain the motion of a particle as observed from a uniformly rotating frame. Derive the expressions for centrifugal and Coriolis forces.
5. Discuss non-inertial frames and fictitious forces. Explain the laws of physics in rotating coordinate systems.
6. Derive the expression for Coriolis force and discuss its important applications.
7. Explain the relation between torque, angular momentum and rotational kinetic energy with suitable derivations.
8. Derive the moment of inertia of a sphere and discuss the role of moment of inertia in rotational motion.

PHYSICS-C II: MECHANICS

UNIT–II QUESTION SET

Topics: Elasticity, Fluid Motion, Gravitation and Central Force Motion

GROUP–A

Answer all questions.
$1 \times 10 = 10$ marks

1. Define elastic constant.
2. What is twisting couple?
3. Define viscosity.
4. State Poiseuille's equation.
5. State Newton's law of gravitation.
6. Define gravitational potential.
7. What is gravitational mass?
8. Define central force.
9. State Kepler's first law.
10. What is a geosynchronous orbit?

GROUP–B

Answer any nine questions.
$2 \times 9 = 18$ marks

1. Distinguish between stress and strain.
2. Write the relation between Young's modulus, bulk modulus and rigidity modulus.
3. Explain the twisting of a cylinder or wire.
4. Write Poiseuille's equation and explain the symbols used.
5. Distinguish between inertial mass and gravitational mass.
6. Define gravitational potential energy and write its expression.
7. What is the difference between gravitational potential and gravitational field?
8. Define central force and give two examples.
9. State Kepler's three laws of planetary motion.
10. What is a geosynchronous orbit? Mention one application.

GROUP–C

Answer any eight questions.
$5 \times 8 = 40$ marks

1. Derive the relation between the elastic constants of an isotropic material.

2. Derive the expression for the twisting couple of a cylindrical wire.
3. Explain the kinematics of moving fluids and derive the equation of continuity.
4. Derive Poiseuille's equation for the flow of a liquid through a capillary tube.
5. Derive the expression for gravitational potential energy due to a spherical shell.
6. Explain the motion of a particle under a central force field.
7. Derive the energy equation for a particle moving under a central force.
8. Explain the reduction of the two-body problem into an equivalent one-body problem.
9. Derive the equation of motion for a satellite in a circular orbit.
10. Explain geosynchronous orbits and their applications.

GROUP–D

Answer any four questions.
$8 \times 4 = 32$ marks

1. Explain the elastic constants and derive the relation between Young's modulus, bulk modulus and rigidity modulus.
2. Derive the expression for the twisting couple acting on a cylindrical wire and discuss its applications.
3. Derive Poiseuille's equation for the flow of a liquid through a capillary tube. State the assumptions involved.
4. State Newton's law of gravitation and derive the expressions for gravitational potential and gravitational potential energy due to a spherical shell and a solid sphere.
5. Discuss the motion of a particle under a central force field. Derive the conservation of angular momentum and the energy equation.
6. Explain the two-body problem and show how it can be reduced to an equivalent one-body problem.
7. Derive the equation of motion for a particle in a circular orbit under a central force. Discuss the energy of the orbiting particle.
8. State and explain Kepler's laws of planetary motion. Discuss circular satellite orbits, geosynchronous orbits and their applications.

PHYSICS-C II: MECHANICS

UNIT–III: OSCILLATIONS

Topics: Simple Harmonic Motion, Damped Oscillations and Forced Oscillations

GROUP–A

Answer all questions.
$1 \times 10 = 10$ marks

1. Define simple harmonic motion.
2. Write the differential equation of SHM.
3. Define amplitude and angular frequency.
4. Write the expression for the velocity of a particle executing SHM.
5. Write the expression for the kinetic energy in SHM.
6. What is damped oscillation?
7. What is meant by forced oscillation?
8. Define resonance.
9. What is quality factor?
10. Define sharpness of resonance.

GROUP–B

Answer any nine questions.
$2 \times 9 = 18$ marks

1. State the characteristics of simple harmonic motion.
2. Derive the differential equation of SHM.
3. Write the solution of the differential equation of SHM.
4. Obtain the expressions for velocity and acceleration in SHM.
5. Write the expressions for kinetic, potential and total energy of SHM.
6. What is damping? Mention the effect of damping on oscillation.
7. Distinguish between transient and steady-state oscillations.
8. Explain resonance in forced oscillations.
9. Define power dissipation and quality factor.
10. What is meant by sharpness of resonance?

GROUP–C

Answer any eight questions.
$5 \times 8 = 40$ marks

1. Derive the differential equation of simple harmonic motion and obtain its solution.

2. Derive the expressions for velocity and acceleration of a particle executing SHM.
3. Derive the expressions for kinetic energy, potential energy and total energy in SHM.
4. Show that the total energy of a particle executing SHM remains constant.
5. Derive the equation of motion for a damped oscillator and discuss its solution.
6. Explain forced oscillations and distinguish between transient and steady-state solutions.
7. Derive the amplitude of a forced oscillator in the steady state.
8. Explain resonance and derive the condition for resonance.
9. Explain power dissipation in forced oscillations and define the quality factor.
10. Discuss the sharpness of resonance and its relation with quality factor.

GROUP–D

Answer any four questions.
$8 \times 4 = 32$ marks

1. Derive the differential equation of SHM and obtain its complete solution. Discuss the displacement, velocity and acceleration of the oscillator.
2. Derive the expressions for kinetic energy, potential energy and total energy of a particle executing SHM. Also obtain their time-average values.
3. Derive the equation of a damped harmonic oscillator and discuss the nature of its motion for different damping conditions.
4. Explain forced oscillations. Derive the steady-state solution and obtain the expression for amplitude and phase difference.
5. Explain resonance in forced oscillations. Derive the condition for resonance and discuss the sharpness of resonance.
6. Derive the expression for average power dissipation in a forced oscillator and explain the significance of quality factor.
7. Discuss transient and steady-state responses of a forced oscillator with suitable equations.
8. Explain the complete theory of forced oscillations, including resonance, power dissipation, sharpness of resonance and quality factor.

PHYSICS-C II: MECHANICS

SPECIAL THEORY OF RELATIVITY — QUESTION SET

GROUP–A

Answer all questions.
$1 \times 10 = 10$ marks

1. What is meant by the Special Theory of Relativity?
2. State the two postulates of Special Relativity.
3. What is Lorentz contraction?
4. Define time dilation.
5. What is relativistic mass?
6. Write the relativistic expression for momentum.
7. What is mass-energy equivalence?
8. Define relativistic Doppler effect.
9. What is a four-vector?
10. Write Einstein's energy-momentum relation.

GROUP–B

Answer any nine questions.
$2 \times 9 = 18$ marks

1. State the Michelson–Morley experiment and its significance.
2. Explain the postulates of Special Theory of Relativity.
3. Distinguish between Galilean and Lorentz transformations.
4. Explain Lorentz contraction and write its mathematical expression.
5. Explain time dilation with a suitable equation.
6. Derive the relativistic addition law of velocities.
7. Explain the variation of mass with velocity.
8. Establish the mass-energy equivalence relation.
9. Explain the relativistic Doppler effect.
10. Define four-vector and give examples of four-vectors.

GROUP–C

Answer any eight questions.
$5 \times 8 = 40$ marks

1. Describe the Michelson–Morley experiment and explain its null result.

2. Derive the Lorentz transformation equations.
3. Derive the expression for length contraction.
4. Derive the expression for time dilation.
5. Derive the relativistic transformation law for velocities.
6. Derive the expression for relativistic mass and momentum.
7. Derive Einstein's mass-energy equivalence relation.
8. Derive the relativistic energy-momentum relation.
9. Explain the relativistic Doppler effect and obtain its expression.
10. Explain four-vectors and discuss energy-momentum four-vector.

GROUP–D

Answer any four questions.
$8 \times 4 = 32$ marks

1. Describe the Michelson–Morley experiment in detail. Explain its result and discuss how it led to the development of Special Theory of Relativity.
2. State the postulates of Special Relativity and derive the Lorentz transformation equations.
3. Derive Lorentz contraction and time dilation. Explain their physical significance.
4. Derive the relativistic transformation law for velocity and discuss the relativistic addition of velocities.
5. Derive the expressions for relativistic momentum and relativistic mass. Show how mass varies with velocity.
6. Derive Einstein's mass-energy equivalence relation and obtain the energy-momentum relation.
7. Explain the relativistic Doppler effect and derive the expression for the change in observed frequency.
8. Explain the concept of four-vectors. Discuss the energy-momentum four-vector and its significance in Special Relativity.