2022
B.A./B.Sc.
First Semester
GENERIC ELECTIVE – 1
PHYSICS
Course Code: PHG 1.11
(Mechanics)

Total Mark: 70   *Pass Mark: 28*
Time: 3 hours

Answer <u>five</u> *questions, taking* <u>one</u> *from each unit.*

UNIT–I

1. (a) What is an inertial frame of reference? Prove that vector sum of mass moments of all the particles forming a system about the centre of mass is zero.   1+4=5

   (b) If the two vectors are given by $\vec{A} = 3\hat{i} - 4\hat{j} - \hat{k}$ and $\vec{B} = 2\hat{i} + 3\hat{j} + 2\hat{k}$. Find $\vec{A} \times \vec{B}$ and $\vec{A}.\vec{B}$.   3+3=6

   (c) A particle moves from position $3\hat{i} + 2\hat{j} - 6\hat{k}$ to $14\hat{i} - 13\hat{j} + \hat{k}$ in metre units and a constant force $4\hat{i} + 2\hat{j} + 3\hat{k}$ Newton acts on it, calculate the work done by the force.   3

2. (a) What is centre of mass of a system of particles? If no external force acts on a system of particles, prove that centre of mass is either at rest or moving with uniform velocity.   1+5=6

   (b) Show that Newton's first law of motion is simply a special case of the second law. Discuss the limitations of Newton's laws of motion.   3+2=5

   (c) If $\vec{A} = 2\hat{i} + 2\hat{j} + 3\hat{k}$ and $\vec{B} = 6\hat{i} - 3\hat{j} + 2\hat{k}$ are two vectors, find the angle between them.   3

UNIT–II

3. (a) Solve the differential equation $x\dfrac{d^2 y}{dx^2} - \dfrac{dy}{dx} = 3x^2$.   3

(b) Discuss light and critical damping.   3+3=6

(c) Describe bar pendulum for the determination of acceleration due to gravity.   5

4. (a) Derive the general expression of velocity and acceleration of a particle undergoing SHM.   3+3=6

(b) For a SHM, derive the expression of the average K.E. and P.E. of a particle. Show that the total energy of a particle executing SHM remain constant.   2+2+2=6

(c) What do you mean by compound pendulum?   2

UNIT–III

5. (a) Obtain the equation of motion for equivalent one body problem for the two masses.   6

(b) Derive the expression of K.E. for a body in motion.   3

(c) The position of a particle is given by $r = \hat{i} + 2\hat{j} - \hat{k}$ and linear momentum $p = 3\hat{i} + 4\hat{j} - 2\hat{k}$. Find the angular momentum of the particle.   3

(d) State the law of conservation of angular momentum. Express it mathematically.   2

6. (a) Discuss the motion of a rocket and find its velocity when its weight is taken into account.   6

(b) Find the relation between torque and angular momentum and show that in absence of torque the angular velocity remains constant.   3

(c) The moon is revolving around the earth along a circular orbit of radius r. Calculate the magnitude of orbital angular momentum of the moon.   3

(d) State the law of conservation of energy.   2

UNIT–IV

7. (a) Derive an expression for the intensity of the gravitational field due to spherical shell at a point outside the shell and on the surface of the shell.   3+3=6

(b) Prove that the areal velocity of the radius vector for a particle under a central force is constant. 4

(c) Obtain the expression for radius of the orbit of the artificial satellite. 4

8. (a) Establish the expression of relativistic addition of velocities. 5

(b) Discuss the physiological effect on astronauts. 5

(c) The average lifetime of a π-meson is 2×10^{-8} second. Calculate the average life while it moves with a velocity $0.8\,c$. 4

UNIT–V

9. (a) Prove that $Y = 2\eta(1+\sigma)$, where the symbols have their usual meaning. 5

(b) Derive the expression for twisting couple per unit twist of a solid cylinder. 5

(d) State Hooke's law. A cube of aluminium of side 10 cm is subjected to a shearing force of 10 N. The top surface of the cube is displaced by 0.01 cm with respect to the bottom. Calculate shearing stress, shearing strain and modulus of rigidity. 4

10. (a) Describe the determination of Young's modulus of elasticity for a wire by Searle's method. 5

(b) What is surface energy in a state of tension? Derive the relation between surface tension and surface energy. 4

(c) Explain Newton's law of viscosity. 3

(d) A soap bubble is slowly enlarged from a radius of 0.01 m to 0.1 m. Calculate the work done in the process. Surface tension of water is given as $73\times10^{-3}\,N/m$. 2

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