Bihar Engineering University, Patna

B.Tech 1st Semester Exam-2022

Course: B.Tech. *Time: 03 Hours*

Code: 101101 *Subject: Physics (Mechanics)* *Full Marks: 70*

Instructions:-

(i) The marks are indicated in the right-hand margin.

*(ii) There are **NINE** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

(iv) Question No. 1 is compulsory.

(v) Symbols used (if any) have their usual meanings.

Q.1 Choose the correct option of the following (any seven): **[2 x 7 = 14]**

(a) The angular velocity of rotating body is expressed in terms of

(i) revolution per minute (ii) radians per second

(iii) metre per second (iv) None of these

(b) Which of the following statements is wrong?

(i) The matter contained in a body is called mass

(ii) The force with which a body is attracted towards the centre of the earth is called weight

(iii) The total motion possessed by a moving body is called impulsive force

(iv) None of the above

(c) Which type of vibration is also known as transient vibrations?

(i) Undamped vibration (ii) Damped vibration

(iii) Torsional vibration (iv) Transverse vibration

(d) Transmissibility is the ratio of

(i) force transmitted to the supporting structure and force impressed upon the system

(ii) displacement amplitude of mass and displacement amplitude of supporting structure

(iii) Both (i) and (ii)

(iv) None of the above

(e) A non-inertial reference frame is a frame of reference that is undergoing _____ with respect to an inertial frame.

(i) velocity (ii) acceleration

(iii) Both (i) and (ii) (iv) None of these

(f) A turning car with constant speed is the example of

(i) inertial reference frame (ii) non-inertial reference frame

(iii) Both (i) and (ii) (iv) None of these

(g) When a particle moves with a uniform velocity along a circular path, then the particle has

(i) tangential acceleration only (ii) centripetal acceleration only

(iii) both tangential and centripetal acceleration (iv) None of these

(h) Gradient of scalar field is _____ to the equipotential surface.

(i) parallel (ii) perpendicular

(iii) inclined (iv) None of these

(i) Example of non-conservative force is

(i) gravity (ii) ideal spring (Hooke's law)

(iii) electrostatic force (iv) human pushes and pulls

(j) Pooja spins a ball of mass m attached to a string of length r around her head with a velocity v_i. If the ball splits in half, losing exactly one-half of its mass instantaneously, what is its new velocity, v_f?

(i) v_i (ii) $v_i/4$

(iii) $2v_i$ (iv) $4v_i$

Q.2 (a) A particle moves in a circle of radius b with angular velocity $\theta = \alpha t$, where $\alpha(rad/sec^2)$ is a constant. Describe the particle's velocity in polar coordinates. **[8]**

(b) Three freight cars of mass M are pulled with force F by a locomotive. Friction is negligible. Find the forces on each car. **[6]**

Q.3 Write short notes on the following: **[14]**

(a) Harmonic oscillator

(b) Motion of a rod executing canonical motion with centre of mass fixed

Q.4 (a) Discuss three-dimensional rigid body motion describing angular velocity and moment of inertia tensor. **[10]**

(b) The position of a particle of mass m under the influence of a free particle is given by $\vec{r} = A\sin\omega t\hat{i} + B\cos\omega t\hat{j}$. Find the expression for its force. **[2]**

(c) Express $\vec{s}$ of cylindrical coordinate system into unit vectors of Cartesian coordinate system. **[2]**

Q.5 (a) Explain Euler's law of motion and derive an expression for the Euler's equation of motion for rigid body. **[9]**

(b) Prove that curl of a conservative force is equal to zero. **[5]**

Q.6 Write and solve equation of motion of a mass executing simple harmonic oscillation in the presence of a damping force. Also discuss the cases of over damping, critical damping and undamping oscillations. **[14]**

Q.7 (a) Show that if the total linear momentum of a system of particles is zero, the angular momentum of the system is the same around all origins. **[5]**

(b) A particle with a mass of 4kg has a position vector in metre given by $r = 3t^2\hat{i} - 2t\hat{j} - 3t\hat{k}$, where t is the time in seconds. For $t = 3$ seconds, determine the magnitude of the angular momentum of the particle and the magnitude of the moment of all forces on the particle, both about the origin of coordinates. **[9]**

Q.8 Write short notes on the following: **[7x2=14]**

(a) Critically damped oscillator

(b) Satellite maneuver

Q.9 Write short notes on any two of the following: **[7x2=14]**

(a) Angular velocity vector and its rate of change

(b) Moment of inertia tensor

(c) Foucault pendulum