Code : 101101

B.Tech 1st Semester Exam., 2018 (New)

PHYSICS (Mechanics)

Time : 3 hours *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.

1. Choose the correct option of the following (any *seven*) : 2×7=14

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

(i) revolution per minute

(ii) radians per second

(iii) Any one of the two

(iv) None of the two

(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 the above

(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 the above

(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 the above

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

(i) parallel

(ii) perpendicular

(iii) Both (i) and (ii)

(iv) None of the above

(i) Example(s) of non-conservative forces is/are

(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) $4v_i$

2. (a) Define the law of parallelogram of forces. What is the use of this law? 4

(b) At a certain instant, a body of mass 10 kg, falling freely under the force of gravity, was found to be falling at the rate of 20 m/s. What force will stop the body in (i) 2 seconds and (ii) 2 metres? 5

(c) The right-angle bar shown in Fig. 1 rotates clockwise with an angular velocity which is decreasing at the rate of 4 rad/s^2. Write the vector expressions for the velocity and acceleration of point A when $\omega = 2$ rad/s. 5

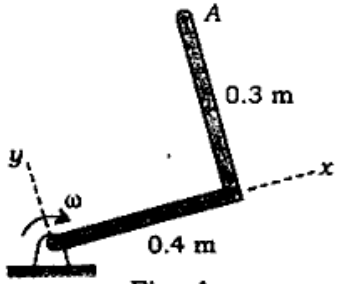

Fig. 1

5. (a) A particle of mass m is released from rest in position A and then slides down the smooth vertical plane track as shown in Fig. 4. Determine its angular momentum about both points A and D (i) as it passes position B and (ii) as it passes position C. 9

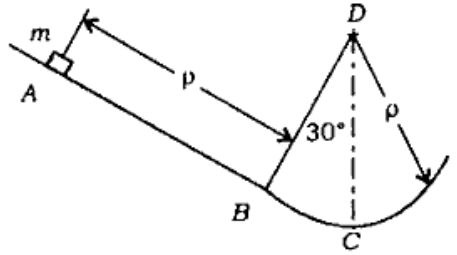

Fig. 4

(b) Explain the inertial and non-inertial frame of references with examples. 5

6. (a) The piston of a steam engine moves with simple harmonic motion. The crank rotates at 120 r.p.m. and the stroke length is 2 metres. Find the velocity and acceleration of the piston, when it is at a distance of 0·75 metre from the centre. 5

(b) The 8 kg body shown in Fig. 5 is moved 0·2 m to the right of the equilibrium position and released from rest at time $t = 0$. Determine its displacement at time $t = 2$ seconds. The viscous damping

coefficient c is 20 N-s/m, and the spring stiffness k is 32 N/m. 9

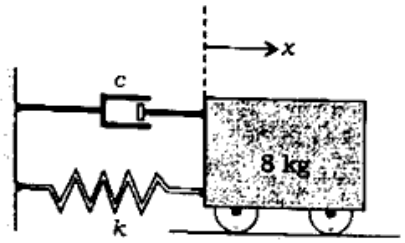

Fig. 5

7. *(a)* Describe the Euler's equations of motion for a rigid body. 5

(b) The 3 kg sphere shown in Fig. 6 moves in the x-y plane and has the indicated velocity at a particular instant. Determine its *(i)* linear momentum, *(ii)* angular momentum about point O, and *(iii)* kinetic energy. 9

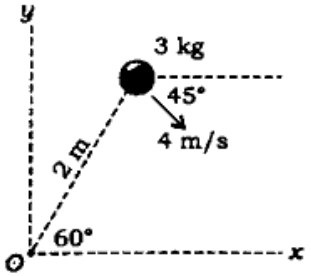

Fig. 6

8. *(a)* How would you locate the instantaneous centre of a rigid link moving with combined motion of rotation and translation? 7

(b) In a crank and connecting rod mechanism, the radius of crank and length of the connecting rod are 300 mm and 1200 mm respectively. The crank is rotating at 180 r.p.m. Find the velocity of the piston, when the crank is at an angle of 45° with the horizontal. 7

9. *(a)* A circular wheel of mass 50 kg and radius 200 mm is rotating at 300 r.p.m. Find its kinetic energy. 4

(b) The 0·8 m arm OA shown in Fig. 7 for a remote-control mechanism is pivoted about the horizontal x-axis of the clevis, and the entire assembly rotates about the z-axis with a constant speed $N = 60$ r.p.m. Simultaneously, the arm is being raised

at the constant rate $\dot{\beta} = 4$ rad/s. For the position where $\beta = 30°$, determine—*(i)* the angular velocity of *OA*, *(ii)* the angular acceleration of *OA*, *(iii)* the velocity of point *A*, and *(iv)* the acceleration of point *A*. 10

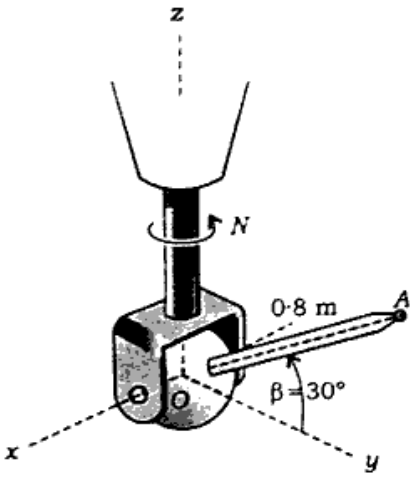

Fig. 5

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