9. A block of weight 5 N rests on a block of weight 6 N which again rests on a smooth plane. If a force of 3 N is applied to the lower block, the two blocks just slip. Determine the maximum possible force which can be applied to the upper block such that the two blocks will move together.

10. A gun is so designed that, on firing, the barrel recoils against a spring. A dashpot, at the end of the recoil, allows the barrel to come back to its initial position within the minimum time without any oscillation. The gun barrel has a mass of 500 kg and a recoil spring of 300 N/mm. The barrel recoils 1m on firing. Determine:
(i) the initial recoil velocity of the gun barrel, and
(ii) the critical damping coefficient of the dashpot engaged at the end of the recoil stroke.

11. A body having a mass of 15 kg is suspended from a spring which deflects 12 mm under the weight of the mass.
(i) Determine the frequency of the free vibrations,
(ii) What is the viscous damping force needed to make the motion aperiodic at a speed of 1 mm/s?
(iii) Determine the amplitude of the ultimate motion if, when damped to this extent, a disturbing force having a maximum value of 100 N and vibrating at 6 Hz is made to act on the body,.

Ex/CON/PE/T/122/2017

JADAVPUR UNIVERSITY

Bachelor in Construction Engineering Examination - 2017

First Year – 2nd Semester

Engineering Mechanics II

Time : 3 Hours | Full Marks : 100

Answer **Group – A (Compulsory),** ***any three*** *from* **Group – *B* & *any two*** *from* **Group – *C*** *[40+(3x12)+(2x12)=100]*

Group – A (Compulsory) [(10x2) + (5x4) =40]

1. (i) The position vector of a point at time 't' is $r = a\cos\omega t\,\hat{i} + b\sin\omega t\,\hat{j}$
Find out the equation of its path. (10x2=20)

(ii) A particle attached to one end of an inextensible string is described a vertical circle of radius r. What will be its minimum velocity?

(iii) The velocity of a particle of mass 4 kg is $(5\,\hat{i} + 3\,\hat{j})$ m/s when it is at the point (2,1)m. Find out its angular momentum.

(iv) With usual notation, for a single degree of freedom system, the equation of motion is $4\ddot{x} + 9\dot{x} + 16x = 0$. Find the damping ratio of the system.

(v) What will be the units in SI system: Moment of momentum, Moment of inertia.

(vi) A particle moves from t =0 to t = 3.5 sec along a straight line such that its velocity is given by $v = (3t^2 - 6t)$ m/sec. Find the average velocity of the particle.

(vii) Two balls of equal mass and of perfectly plastic material are lying on the floor. One of the balls with velocity v is made to strike the second ball. What will be velocity of both the balls after impact?

(viii) A rotor of 0.2 m diameter is rotating at a constant speed. It is braked by applying a torque of 1.744 N.m to attain angular retardation of 0.8722 rad/s^2. Determine the moment of inertia of the rotor.

(ix) A man can throw a ball upto a maximum distance of 30 m on a horizontal plane. Find out the maximum height he can throw the ball?

(x) Define the equations of static equilibrium and dynamic equilibrium.

2. a) A drum of 20 N weight is lying on a horizontal plane with its axis parallel to the plane. If the diameter of the drum is 1 meter and if the length of the drum is 2 meters determine the work to be expended to erect the drum with its axis vertical. (5x4=20)

b) Check whether the following force field is conservative or non-conservative.
$F = (z \sin x + y)\ \bar{i} + (4yz + x)\ \bar{j} + (2y^2 - 5\cos x)\ \bar{k}$ N.

c) A man weighing 80 N stands in a boat so that he is 5 m from a pier on the shore. He walks 4 m in the boat toward the pier and then stops. How far from the pier will he be at end of this time? The boat weighs 200 N and there is assumed to be no friction between it and the water.

d) Determine the natural frequency of the vibrating system as shown in **Fig.1**

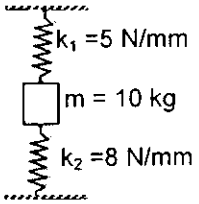


Fig.1

e) The bob of a conical pendulum of length 'L' and weight w describes a horizontal circle defined by the equations x = a Cosωt, y = a Sinωt. Find the tension T in the string during the motion.

Group – B (Answer any **Three**) [3x12=36]

3. A boy standing on the ground throws a stone which crosses a building as shown in **Fig. 2.** It is found that the time taken to pass the floor AB in both directions is 2 sec, whereas that taken to cross the floor CD in both directions is 1 sec. Determine the height of the building.

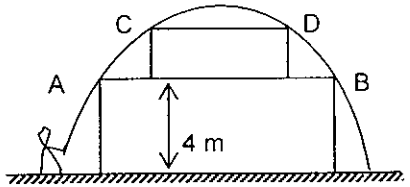


Fig. 2

4. Determine the banking angle θ of the circular track so that the wheels of the sports car shown in **Fig. 3** will not have to depend upon friction to prevent the car from sliding up or down the curve. The car travels at a constant speed of 30 m/s. The radius of the track is 200 m.

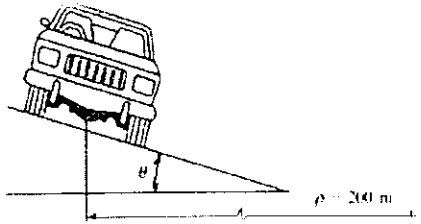
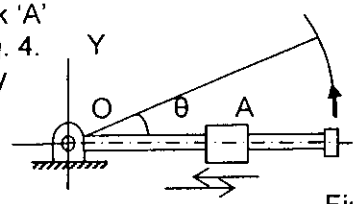


Fig. 3

5. A link OM starts rotating anticlockwise from a horizontal position with a block 'A' sliding on it from rest as shown in Fig. 4. The angular position of the link at any instant is given by θ = 0.5t and the position of the block as measured from O along the link is given by $r = 2 - 0.3\ t^2$, θ being in radians, t being in sec and r being in meters. Determine the velocity and acceleration of the block when θ = 60°



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6. A ball of mass 0.15 kg strikes an inclined wall horizontally and gets deflected as shown in **Fig.5**. The initial and final velocities of the ball are 30 m/sec and 45 m/sec respectively. The ball remains in contact with the wall for a period of 0.01 second. Determine the average force exerted on the ball due to impact.

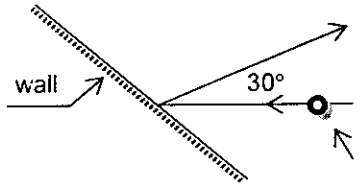
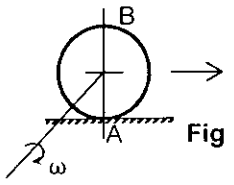


Fig.5

7. An artificial satellite is launched from the earth by its carrier rocket and i into an elliptical orbit with a perigee altitude of 2000 km. If the apogee al is to be 4000 km, compute the necessary perigee velocity and the corresponding apogee velocity. Find also the minimum velocity required into a parabolic orbit. Mean diameter of earth = 12742 km.

Group – C (Answer any **Two**) [2x12=24]

8. A wheel of diameter 1m is rolling without slip on a horizontal surface as shown in **Fig.6**. At the instant under consideration the centre of the wheel has a velocity of 1m/sec and the rotation is 2 rad/sec. Determine the velocity and acceleration of the points A and B on the rim of the wheel.



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