# JADAVPUR UNIVERSITY

B. E. Construction Engineering Examination – 2019(Old)

First Year – 2nd Semester

## Engineering Mechanics II

Time : 3 Hours     Full Marks : 100

Answer Group – A (Compulsory) and any Five from Group – B & Group – C taking at least two from each Group.     [10+5 x18=100]

### Group – A (Compulsory)     (10x1=10)

1. Answer as per instruction / choose the most appropriate option as the case may be:     (10x1=10)

(a) The unit of work or energy in S.I units is :
(i) Newton, (ii) Pascal, (iii) Watt, (iv) Joule.

(b) State Kepler's second law of planetary motion.

(c) If a momentum of a body is doubled, its K.E will:
(i) Increase by two times, (ii) Increase by four times, (iii) Remains same, (iv) Get halved, (v) Reduce to four times.

(d) Two non-collinear parallel equal forces in opposite direction
(i) balance each other, (ii) constitute a moment, (iii) constitute a moment of couple, (iv) constitute a resultant couple.

(e) State the condition of equilibrium for co-planar non-concurrent forces.

(f) A projectile is fired at an angle θ to the vertical. Its horizontal range will be minimum when θ is :     (i) 0°, (ii) 30°, (iii) 45°, (iv) 60°, (v) 90°.

(g) Work done by all the forces is equal to change in:
(i) Potential Energy, (ii) Kinetic Energy, (iii) Power, (iv) Total mechanical energy, (v) None of these.

(h) 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.

(i) With usual notation, for a single degree of freedom system, the equation of motion is $m\ddot{x} + 36\pi^2 x = 0$. Find the natural frequency of the system.

(j) 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.

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:4:

9. (a) A machine weighing 3.5 kg vibrates in a viscous medium. A harmonic exciting force of 40 N acts on the machine and produces resonant amplitude of 18 mm with a period of 0.2 second. Determine the damping coefficient.     (10+5+3=18)

(b) Determine the equation of motion of an elastic body under a harmonic forced damped vibration system.

(c) Calculate the critical damping coefficient of a system with a mass of 1 kg attached to the end of a spring with a stiffness 0.9 N/mm.

## Group – B

2. (a) From the system of pulley shown in the **Fig. 1** find the tension in the rope. Assume the pulley is frictionless and mass less and $W_1 > W_2$ (8+10=18)
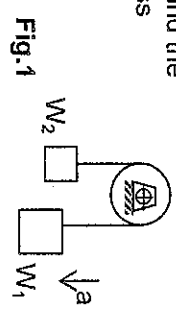
**Fig.1**
$W_2$ $\qquad$ $\downarrow a$ $\quad$ $W_1$

(b) 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 4 sec, whereas that taken to cross the floor CD in both directions is 2 sec. Determine the height of the building.
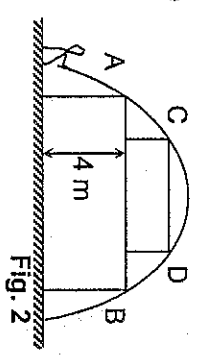
A $\quad$ C $\qquad$ D $\quad$ B
$\leftarrow$ 4 m $\rightarrow$

**Fig. 2**

3. (a) Determine the natural frequency of the vibrating system as shown in **Fig.3** (8+10=18)

**Fig.3**
$k_1 = 5$ N/mm
$k_2 = 8$ N/mm
m = 10 kg
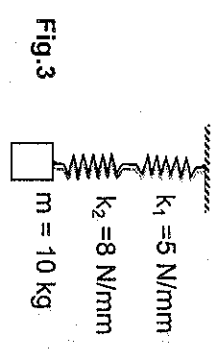
(b) A locomotive weighing 800 kN has a velocity of 25 km/h and backs into freight car weighing 200 kN which is rest on a level track. After coupling is made, with what velocity will the entire system continue to move? Neglect all the frictions.

4. (a) A cyclist is taking a curve of radius 30 m with a speed of 6 m/s along a rough pavement. Determine the angle of heel he must make with the vertical so that overturning of the cycle is avoided. When vertical, the c.g. of the bicycle together with its rider is at a height of 1 m from the ground. (8+10=18)

(b) A train enters bend of radius 500 m with a speed of 30 kmph and leaves the bend with a speed of 40 kmph during which it covers a distance of 200 m. Determine the total acceleration when it leaves the bend.

5. (a) 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. Find the velocity of both the balls after impact. (8+10=18)

(b) A nail is driven into a block of wood by allowing a hammer of weight 2 Kgf to fall upon the nail from a height of 1 m. The weight of the nail is 1 Kgf and the coefficient of restitution for the pair is 0.5. If the resistance of the wood to penetration is 2000 Kgf and remains constant, find the depth of penetration of the nail per blow.

## Group – C

6. (a) An artificial satellite is launched from the earth by its carrier rocket and inserted into an elliptical orbit with a perigee altitude of 2000 km. If the apogee altitude is to be 4000 km, compute the necessary perigee velocity and the corresponding apogee velocity. Mean diameter of the earth is $12.742 \times 10^3$ km and surface gravitational acceleration 9.81 m/sec². (10+8=18)

(b) A steam turbine is rotating at 3000 rpm. Due to maintenance trouble the steam is shut off and the turbine rotor decelerates at 10 rad/sec² assumed constant. Determine how long the turbine will take to come to a stop.

7. (a) The driver of car running at a speed of 30 km/hour sees a boy in front of him at a distance of 25 m. He thinks for a while and applies brakes. If the boy is thus just saved and if the coefficient of friction between the tyre and the pavement is 0.5, find the reaction time taken by the driver. (10+8=18)

(b) 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.

8. (a) The small 2-kg block A slides down the curved path and passes the lowest point B with a speed of 4 m/s as shown in **Fig 4**. If the radius of curvature of the path at B is 1.5 m, determine the normal force N exerted on the block by the path at this point. (10+8=18)
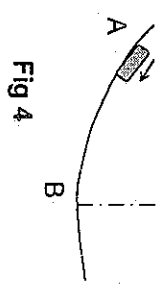
A $\qquad$ B
**Fig 4**

(b) A tennis ball is dropped vertically from rest in a height of 20 m on a horizontal floor. It rebounds to a height of 12 m. The ball falls down and rises again to an unknown height. What is the height of this second rebound?

Turn Over