B.E. Chemical Engineering Examination, 2019 (Old)
(Ist Year, 1st Semester)

Engineering Mechanics

Time: - Three hours Full Marks – 100

Answer any FIVE questions

Q1. (a) Determine a vector of magnitude 18 units which is perpendicular to both the vectors $\vec{A} = (4i - j + 3k)$ units and $\vec{B} = (-2i + j - 2k)$ units.

(10)

(b) Refer to Fig. A. Calculate the magnitude F_{AB} of the projection of the force F = 100 kN on the diagonal AB of the upper face of the rectangular parallelepiped.

(10)

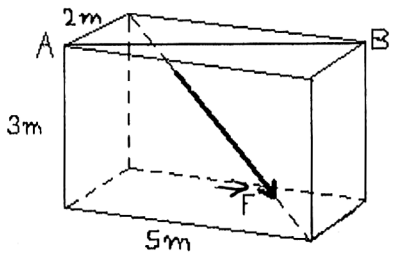

Fig. A

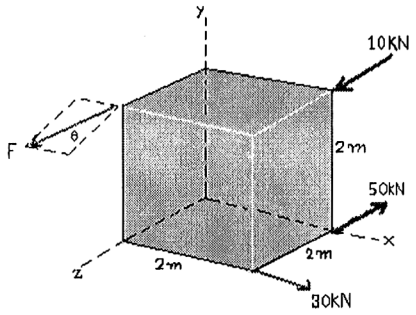

Fig. B

Q2. (a) Refer to Fig. B. If the resultant of the four forces is a couple **M**, find **F**, θ, and **M**.

(10)

(b) A block having a mass of 500 kg is held by five cables as shown in Fig. C. What are the tensions in these cables? Lower cables are identical and are identically connected at ends.

(10)

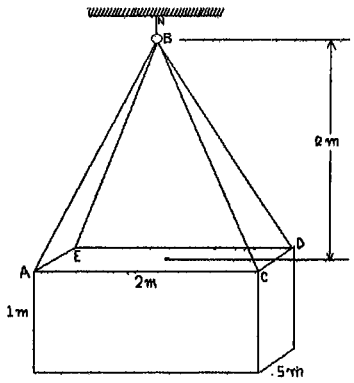

Fig. C

Q3. (a) Refer to Fig. D. What force F is needed to get the 300 kg block moving to the right? The coefficient of static friction for contact surfaces is 0.3. (10)

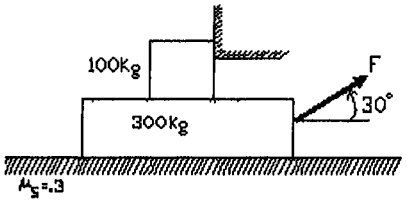

Fig. D

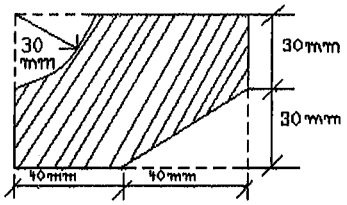

Fig. E

(b) Calculate the moment of inertia about x- axis for the shaded area as shown in Fig. E. (10)

Q4. (a) A body moves in a straight line with a velocity whose square (v^2) decreases linearly with its displacement (s) as shown in Fig. F. Determine the time required for the body to travel the 200 m distance and find the distance traveled during the last 3 seconds before it comes to rest. (8)

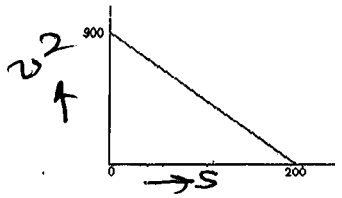

Fig. F

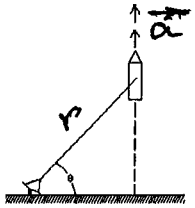

Fig. G

(b) A particle P moves along a plane curve with a speed v, measured in metres per second, given by $v = 2 + 0.3t^2$ where t is the time in seconds after P passes a certain fixed point on the curve. If the total acceleration of P is 2.4 m/s^2 when t = 2 s, compute the radius of curvature of the curve for the position of the particle at this instant.

(6)

(c) A rocket is fired vertically and tracked by the radar antenna as shown in Fig. G. At the instant when $\theta = 60^0$, measurements give $\dot{\theta} = 0.03$ rad/s and r = 7500 m, and the vertical acceleration of the rocket is found to be a = 20 m/s^2. For this instant determine the values of r and θ.

(6)

Q5. (a) A constant force $\vec{F} = 0.3j$ N acts for 2 seconds on a 0.2 kg particle which has an initial velocity $\vec{V} = (1.0i + 4.5k)$ m/s at time t = 0. Compute the magnitude of the velocity of the particle for the instant when t = 2s.

(8)

(b) An object of mass m is given an initial velocity u up the inclined plane at point A as shown in Fig. H. An instant it passes point B, the normal force of the contact between it and the supporting surface drops to one-half the value it had when the object was approaching B. The coefficient of friction between the object and the incline is 0.30. Calculate the initial velocity u.

(12)

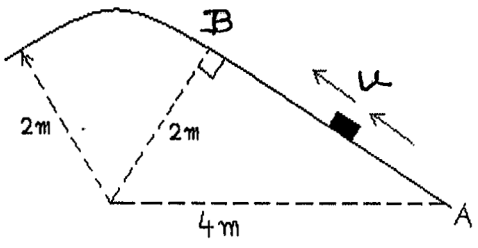

Fig. H

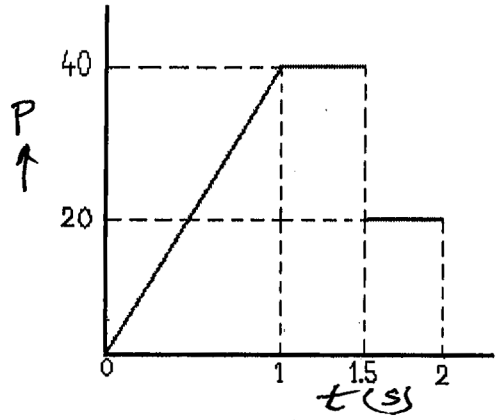

Fig. I

Q6. (a) A 5-kg body is moving in a horizontal straight line with a velocity of 8 m/s when a horizontal force P is applied to it at right angle to the initial direction of motion. The force P varies according to the graph as shown in Fig. I. If P remains constant in direction and is the only force acting on the body in its plane of motion, find the magnitude of the velocity of the body when t = 2 s and the angle θ it makes with the direction of P.

(10)

(b) The 7-kg collar A slides with negligible friction on the fixed vertical shaft as shown in Fig. J. When the collar is released from rest at the bottom position shown, it moves up the shaft under the action of the constant force F = 200 N applied to the cable. Calculate the stiffness of the spring if its maximum compression is to be limited to 75 mm. The position of the small pulley at B is fixed.

(10)

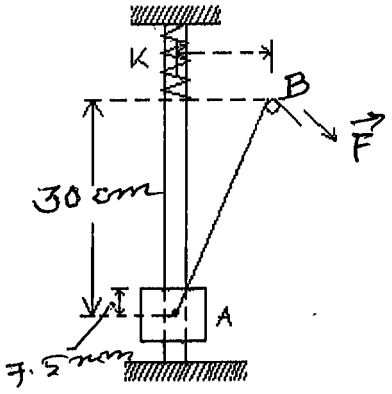

Fig. J