Ref: Ex/Met/AM/ME/T/1A/114/2019(Old)

B.E. METALLURGICAL AND MATERIAL ENGINEERING

FIRST YEAR FIRST SEMESTER (Old) – 2019

Subject: ENGINEERING MECHANICS

Time: Three Hours **Full Marks : 100**

(Answer any five Questions)

1. (a) The 450kg uniform *I*-beam (**Fig. 1a**) supports the load shown. Determine the reactions at the supports. (10)

(b) The turn buckle (**Fig. 1b**) is tightened until the tension in cable *AB* is 1.2 kN. Calculate the magnitude of the moment about point *O* of the force acting on point *A*. (10)

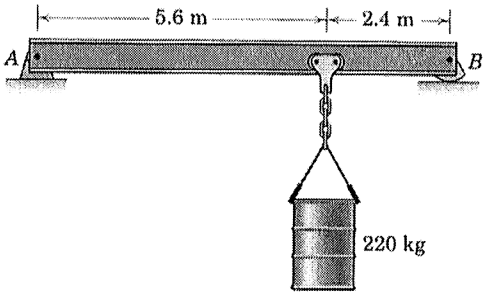

Fig. 1a

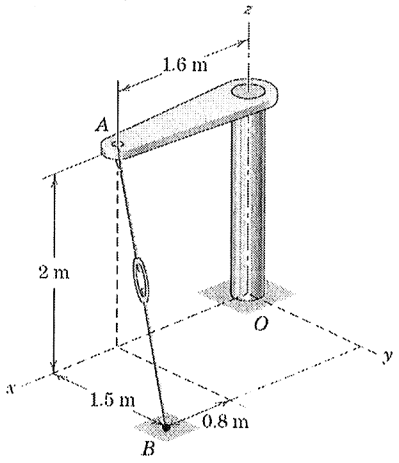

Fig. 1b

2. (a) The uniform 15 m pole (**Fig. 2a**) has a mass of 150 kg and is supported by its smooth ends against the vertical walls and by tension *T* in the vertical cable. Compute the reactions at *A* and *B*. (10)

(b) Determine the range of weights W for which the 100-lb block is in equilibrium (**Fig. 2b**). All wheels and pulleys have negligible friction. (10)

[Turn over

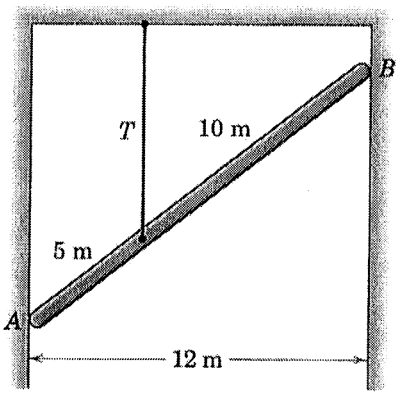

Fig. 2a

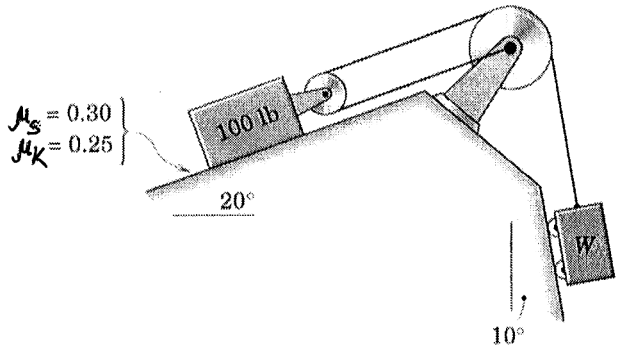

Fig. 2b

3. (a) Determine the magnitude of all pin reactions for the frame (**Fig. 3a**). (10)

(b) Replace the three forces acting on the bent pipe (**Fig. 3b**) by a single equivalent force **R**. Specify the distance x from point O to the point on the x-axis through which the line of action of **R** passes. (10)

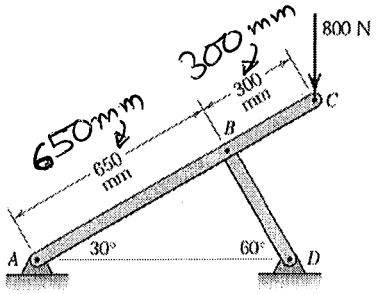

Fig. 3a

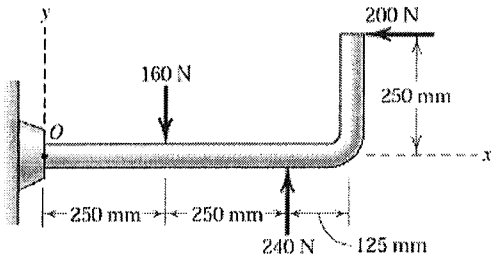

Fig. 3b

4. (a) Locate the centroid of the area of a circular sector (**Fig. 4**) with respect to its vertex. (10)

(b) Derive the distance from the base of a triangle of altitude h to the centroid of its area. (10)

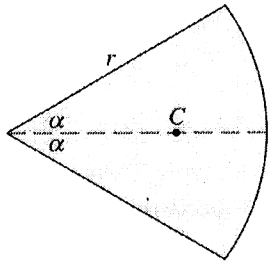

Fig. 4

5. (a) A projectile is launched with an initial speed of 200 m/s at an angle of 60° with respect to the horizontal (**Fig. 5**). Compute the range R as measured up the incline. (10)

(b) A car starts from rest and moves along a straight line with an acceleration given by $a = 3s^{-1/3}\text{m/s}^2$, where s is in meters. Determine the car's acceleration and position when t=4s. Consider, s=0 when t=0. (10)

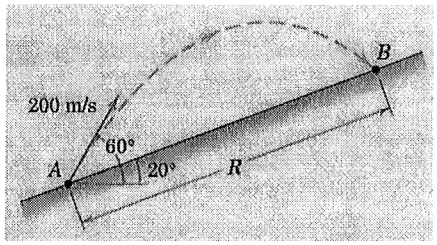

Fig. 5

6. (a) Derive the components of both velocity and acceleration of a particle executing plane curvilinear motion in polar coordinates $(r-\theta)$. (10)

(b) A jet plane (**Fig. 6**) flying at a constant speed v at an altitude h=10km is being tracked by radar located at O directly below the line of flight. If the angle θ is decreasing at the rate of 0.020 rad/s when $\theta=60^0$, determine the value of $\ddot{r}$ at this instant and the magnitude of the velocity of the plane. (10)

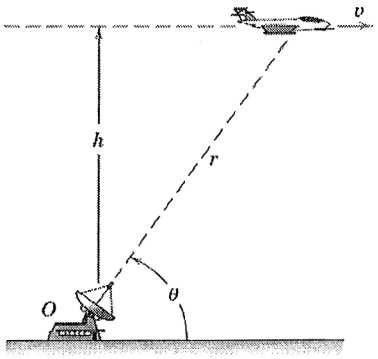

Fig. 6

7. (a) Determine the cross product of the vectors F_1=4i-5j-3k and F_2=4i+5j-6k and the angle between them. (5)

(b) A point is acted upon by a set of forces F_1=(3i-5j-2k), F_2 =(2i+7j+3k) and F_3=(-i+2j+5k). Determine the magnitude of the resultant force and its direction cosines. (5)

(c) Determine the force P required to begin rolling the uniform cylinder (**Fig.** 7) of mass ***m*** over the obstruction of height h. (10)

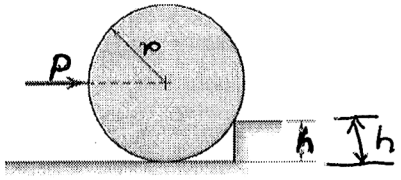

Fig. 7

8. Write short notes on **any four** of the following (***any four***): (5X4=20)

(a) Parallelogram law of forces.
(b) Dot product of vectors.
(c) Cross product of vectors.
(d) Pappus-Guldinus Theorem.
(e) Moment of a couple is a free vector.
(f) Parallel axis theorem for area moment of inertia.
(g) Equilibrium of rigid bodies.