25

Ex/MET/AM/ME/T/1A/114/2017(S)

BACHELOR OF METALLURGICAL ENGINEERING EXAMINATION, 2017
(First Year, First Semester, Supplementary)
ENGINEERING MECHANICS

Time: Three Hours **Full Marks: 100 (5×20)**

ANSWER ANY FIVE QUESTIONS

Any missing data may be assumed with suitable justification
Marks are indicated in the square brackets against each question
Different parts of the same question must be answered together

Q1. **[08+12]**

(a) A 400-N force is applied to the welded slender bar (Fig. Q1(a)) at an angle $\theta = 20^\circ$. Determine the equivalent force couple system acting on the weld at (a) point A and (b) point O. For what value of θ would the results of parts (a) and (b) be identical?

(b) The antenna tower is supported by three cables (Fig. Q1(b)). If the forces of these cables acting on the antenna are $F_B = 520$ N, $F_C = 680$ N and $F_D = 560$ N, determine the resultant force vector acting at A.

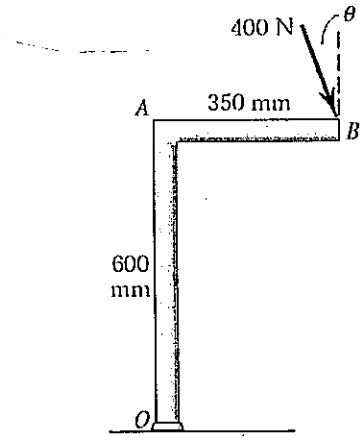

Fig. Q1(a)

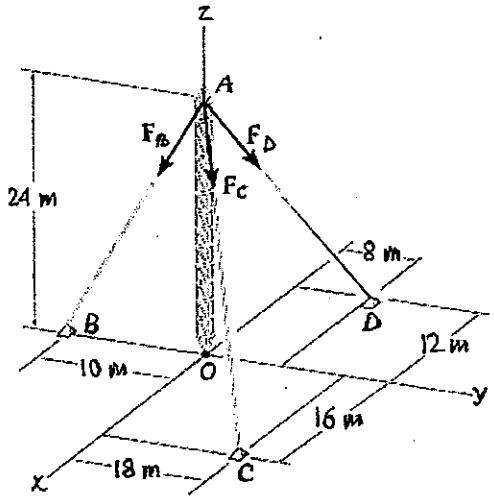

Fig. Q1(b)

Q2. **[10+10]**

(a) The 450 kg uniform I-beam supports the load shown in Fig. Q2(a). Determine the reactions at the supports.

(b) The spring (Fig. Q2(b)) of stiffness k=3.5 kN/m is stretched 10 mm when the disk center is in the leftmost position x=0. Determine the tension T required to position the disk center at x=150mm. At that position, what force N is exerted on the horizontal slotted guide? The mass of the disk is 3 kg.

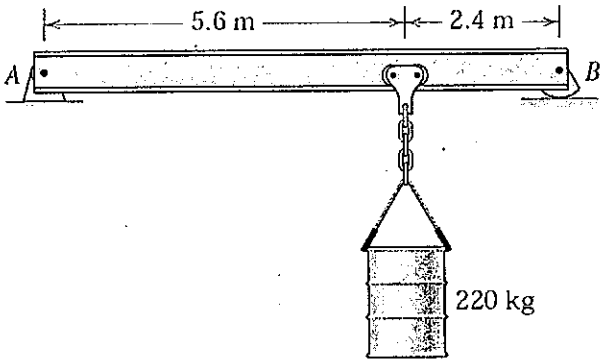

Fig. Q2(a)

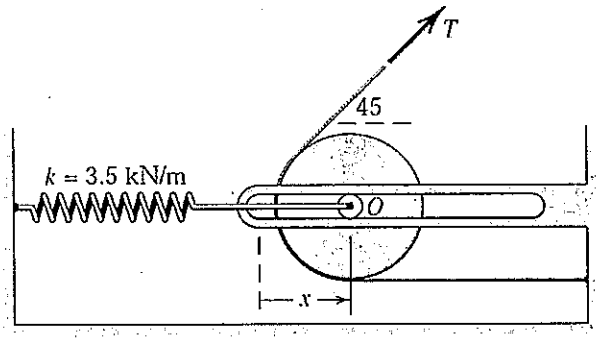

Fig. Q2(b)

Q3. **[10+10]**

(a) Determine the x- and y-coordinates of the centroid of the enclosed area shown in Fig. Q3(a).

(b) Determine the area moments of inertia of the Z-section about its centroidal x_0- and y_0- axes (Fig. Q3(b)).

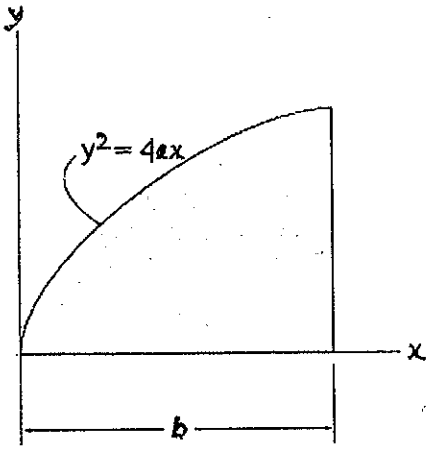

Fig. Q3(a)

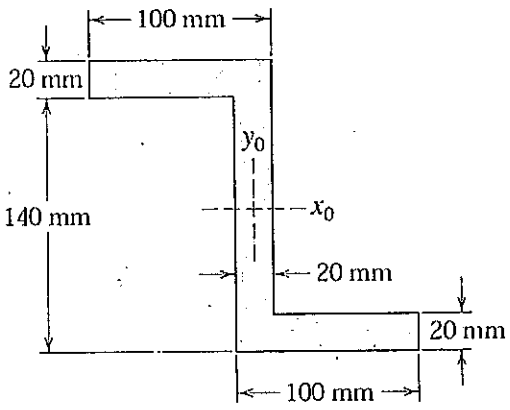

Fig. Q3(b)

Q4. The uniform 7 m steel shaft has a mass of 200 kg and is supported by a ball-and-socket joint at A in the horizontal floor. The ball end B rests against the smooth vertical walls as shown in Fig. Q4. Compute the forces exerted by the walls and the floor on the ends of the shaft. **[20]**

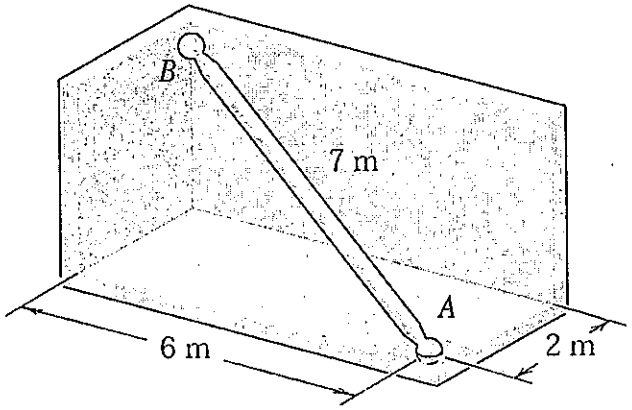

Fig. Q4

Q5. **[10+10]**

(a) When the engine of a land vehicle moving with velocity v is shut off, the aerodynamic and other resistances to its motion may be represented in terms of its acceleration as $a = -0.03 - 0.2v^2$. If the vehicle was moving at 6 m/s when the engine was disengaged, find the distance in which it will come to rest.

(b) A broadjumper (Fig. Q5(b)) approaches his takeoff board A with a horizontal velocity of 10 m/s. Determine the vertical component v_y of the velocity of his center of gravity at takeoff for him to make the jump shown. What is the vertical rise h of his center of gravity?

Q6. **[10+10]**

(a) Deduce the normal and tangential components of both velocity and acceleration of a particle executing plane curvilinear motion.

(b) As the hydraulic cylinder (Fig. Q6(b)) rotates around O, the exposed length l of the piston rod P is controlled by the action of oil pressure in the cylinder. If the cylinder rotates at the constant rate $\dot{\theta}$=60 deg/s and l is decreasing at the constant rate of 150 mm/s, calculate the magnitudes of the velocity and acceleration of the end B when l=125 mm.

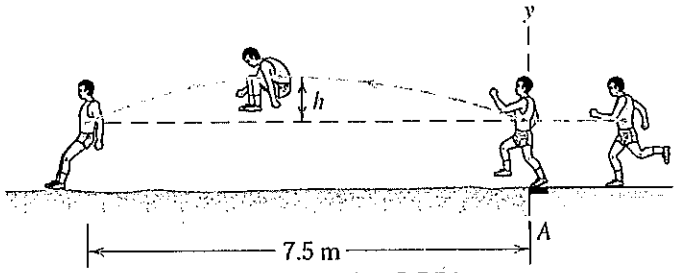

Fig. Q5(b)

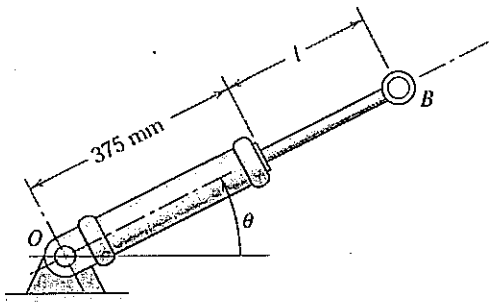

Fig. Q6(b)

Q7. **5×4=20**

(a) What is a sliding vector? Explain with an example.

(b) State and explain Lami's theorem.

(c) Write and explain the theorems of Pappus.

(d) Explain D'Alembert's principle.

---------- X ----------