

**UNIVERSITY COLLEGE TATI (UC TATI)****FINAL EXAMINATION QUESTION BOOKLET**

COURSE CODE	: BME 2013
COURSE	: STATICS & DYNAMICS
SEMESTER/SESSION	: 2-2023/2024
DURATION	: 3 HOURS

**Instructions:**

1. This booklet contains 4 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

**DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO**

**THIS BOOKLET CONTAINS 8 PRINTED PAGES INCLUDING COVER PAGE**

**QUESTION 1**

- a) **Find** the magnitude of the resultant force and its direction in Figure 1 so that the resultant force is directed vertically upward and has a magnitude of 800 N. (8 marks)

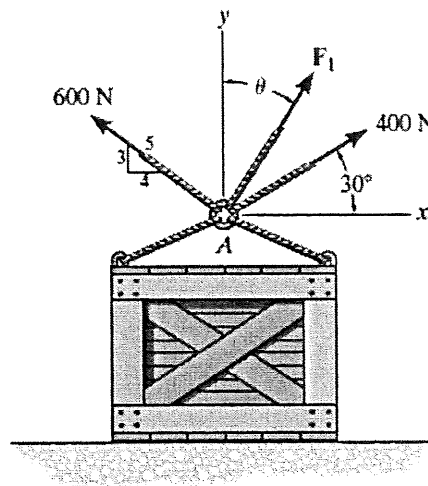


Figure 1

- b) **Solve** the force in cables AC and AB shown in Figure 2 needed to hold the 20 kg ball in equilibrium shown Figure 2. Take  $F = 300\text{ N}$  and  $d = 1\text{ m}$ . (8 marks)

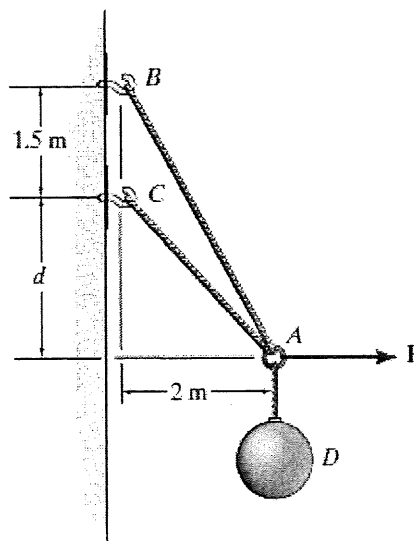


Figure 2

- c) i. **Sketch** the free-body diagram of the beam which supports the  $80\text{ kg}$  load and is supported by the pin  $A$  and cable which wraps around pulley at  $D$ . (See Figure 3). (2 marks)
- ii. **Solve** the tension in the cord (Figure 3) and the horizontal and vertical components of reaction at support  $A$  of the beam. (7 marks)

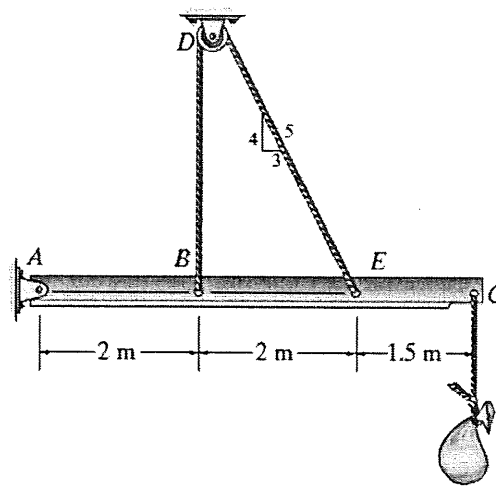


Figure 3

**QUESTION 2**

- a) **Find** the support reactions of the roller A and the smooth collar B on the rod shown in Figure 4. The collar is fixed to the rod AB, but is allowed to slide along rod CD.

(5 marks)

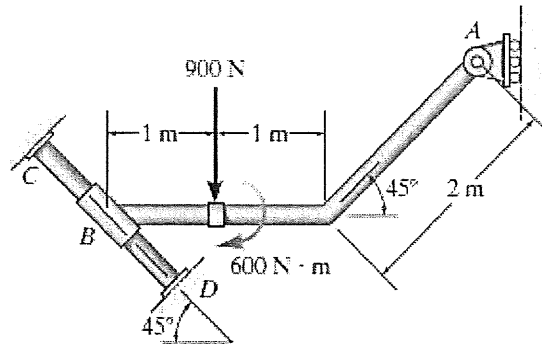


Figure 4

- b) **Solve** the force in members BC, CG, and GF of the Warren truss shown in Figure 5 below. Indicate if the members are in tension or compression.

(12 marks)

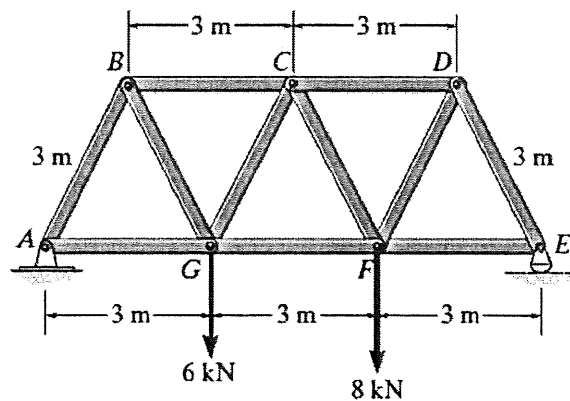
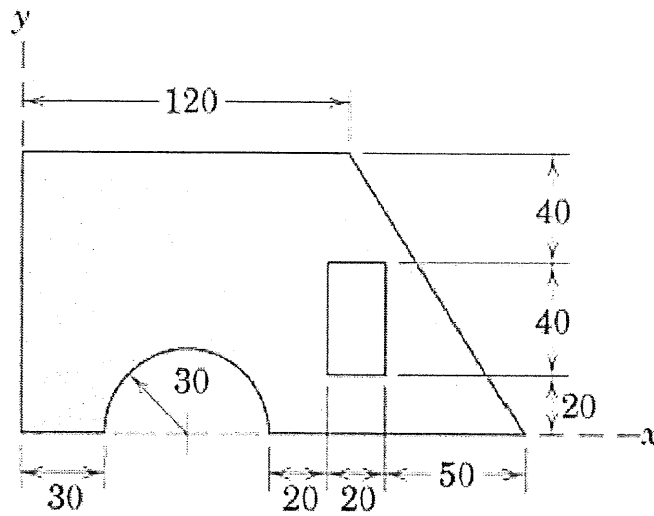


Figure 5

- c) **Compute** the centroid of the plate area shown in Figure 6 below. (8 marks)



Dimensions in millimeters

Figure 6

**QUESTION 3**

- a) A motorist enters a freeway at  $36 \text{ km/h}$  and accelerates uniformly to  $90 \text{ km/h}$ . From the odometer in the car; the motorist knows that she traveled  $0.2 \text{ km}$  while accelerating. **Find** the acceleration of the car and the time required to reach  $90 \text{ km/h}$ . (8 marks)
- b) A ball is thrown from A. If it is required to clear the wall at B, **compute** the minimum magnitude of its initial velocity  $V_A$  in Figure 7. (8 marks)

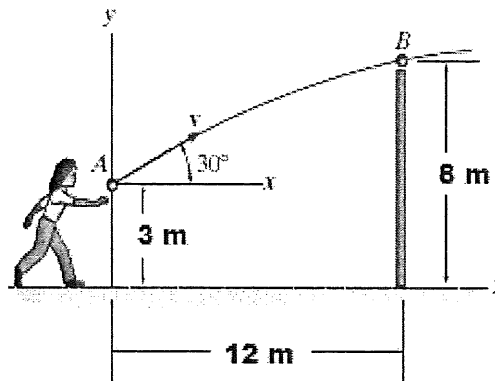


Figure 7

- c) The bucket is hoisted by the rope that wraps around a drum wheel shown in Figure 8. If the angular displacement of the wheel is  $\theta = (0.5t^3 + 15t) \text{ rad}$ , where  $t$  is in second, **determine** the velocity and acceleration of the bucket when  $t = 3 \text{ s}$ . (9 marks)

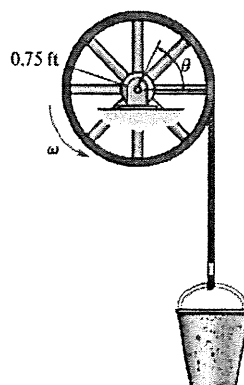


Figure 8

**QUESTION 4**

- a) The motion of a particle is defined by the relation  $x = 12t^3 - 18t^2 + 2t + 5$ , where  $x$  and  $t$  are expressed in meters and seconds, respectively. **Find** the position, the velocity, when the acceleration of the particle is equal to zero.

(8 marks)

- b) Figure 9 shows the motor winds in the cable with a constant acceleration, such that the  $20\text{ kg}$  moves distance  $s = 6\text{ m}$  in  $3\text{ s}$  starting from the rest. **Compute** the tension developed in the cable. The coefficient of kinetic friction between the crate and the plane is  $\mu_k = 0.3$ .

(8 marks)

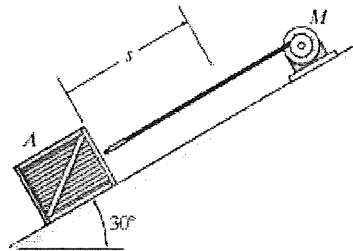


Figure 9

- c) If roller A moves to the right with a constant velocity of  $v_A = 3\text{ m/s}$ , **determine** the angular velocity of the link and the velocity of roller B at the instant  $\theta = 30^\circ$  shown in Figure 10.

(9 marks)

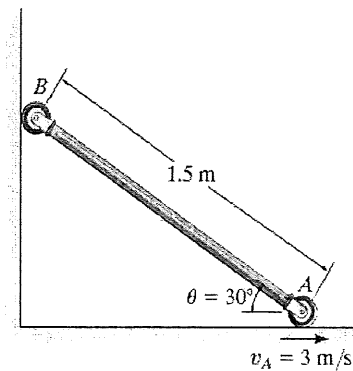


Figure 10

-----End of question-----

FORMULA

**Static Equilibrium:**

$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum M = 0$$

**Newton's 2<sup>nd</sup> Law:**

$$\sum F = ma$$

**Friction Force:**

$$F_f = \mu F_N$$

**Equation of Linear Motion:**

$$v = v_0 + a_c t$$

$$s = s_0 + v_0 t + \frac{1}{2} a_c t^2$$

$$v^2 = v_0^2 + 2a_c (s - s_0)$$

**Circular Motion:**

$$\theta = \text{rad}$$

$$\omega = \frac{d\theta}{dt}, \text{rad/s}$$

$$\alpha = \frac{d\omega}{dt}, \text{rad/s}^2$$

**Acceleration constant:**

$$\omega = \omega_0 + \alpha_c t$$

$$\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha_c t^2$$

$$\omega^2 = \omega_0^2 + 2\alpha_c (\theta - \theta_0)$$

**Motion at Point P:**

$$v = \omega r$$

$$a_t = \alpha r$$

$$a_n = \omega^2 r$$

**Relative Motion Analysis: Velocity**

$$v_B = v_A + v_{B/A}$$

$$v_B = v_A + \omega \times r_{B/A}$$

