



UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET

COURSE CODE	: BME 2013
COURSE	: STATICS AND DYNAMICS
SEMESTER/SESSION	: 1-2023/2024
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) If $F_1 = 150\text{ N}$ and $\theta = 30^\circ$, find the magnitude of the resultant force acting on the bracket and its direction measured clockwise from the positive x axis in Figure 1. (8 marks)

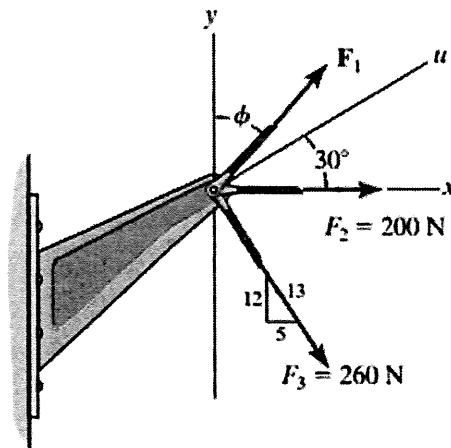


Figure 1

- 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)

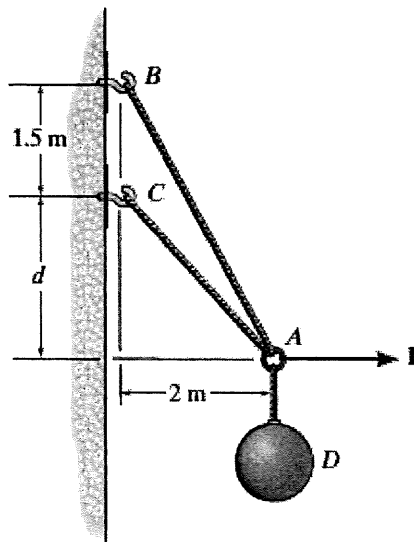


Figure 2

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- c) i. **Sketch** the free-body diagram of the beam which supports the 80 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)

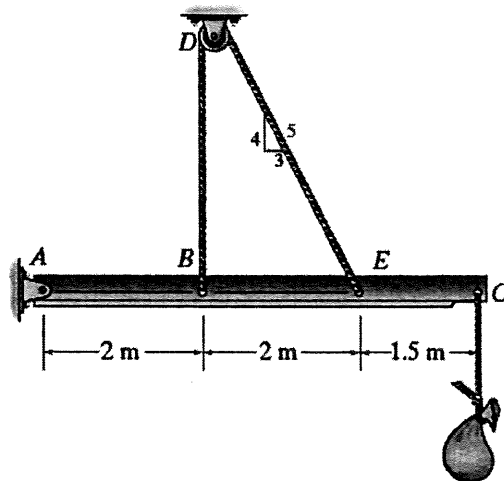


Figure 3

QUESTION 2

- a) **Find** the horizontal and vertical components of reaction at the pin A and the tension developed in cable BC used to support the steel frame in Figure 4. (5 marks)

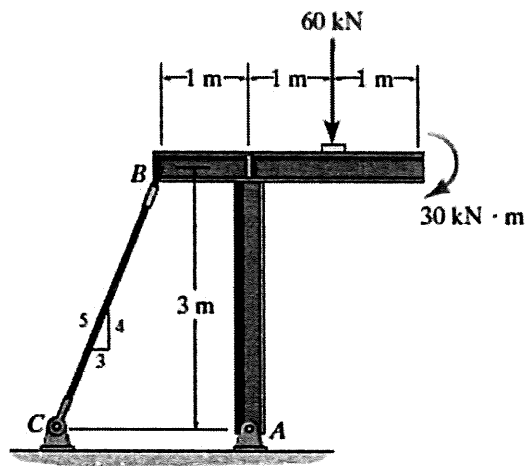


Figure 4

- 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)

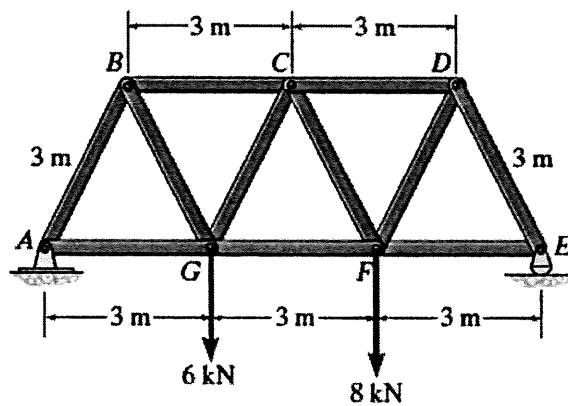


Figure 5

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

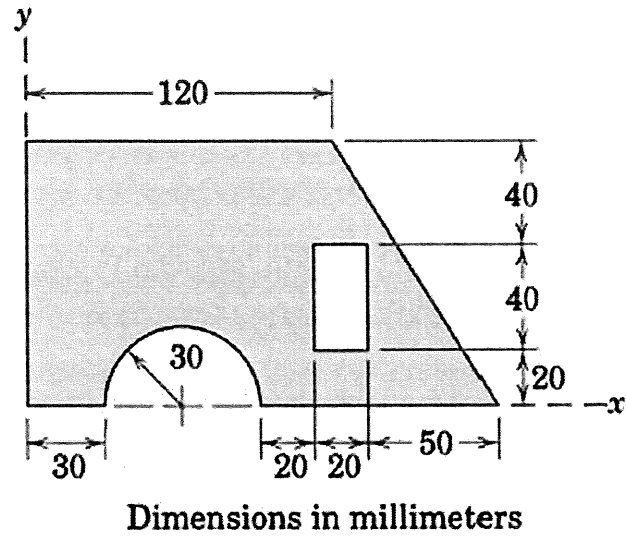


Figure 6

QUESTION 3

- a) A motorist enters a freeway at 36 km/h and accelerates uniformly to 90 km/h . From the odometer in the car; the motorist knows that she traveled 0.2 km while accelerating. **Find** the acceleration of the car and the time required to reach 90 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)

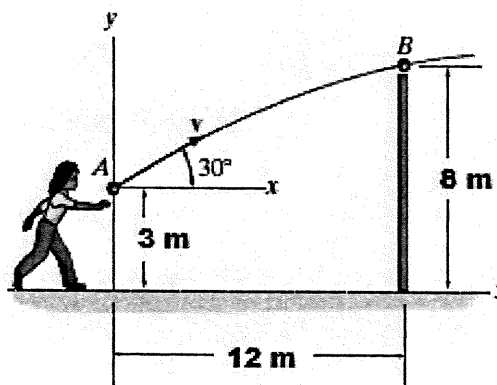


Figure 7

- c) The angular acceleration of the disk is defined by $\alpha = 3t^2 + 12 \text{ rad/s}$, where t is in seconds. If the disk is originally rotating at $\omega_0 = 12 \text{ rad/s}$ in Figure 8, **determine**
- the velocity (4 marks)
 - the normal, n and tangential, t components of acceleration of point A on the disk when $t = 2 \text{ s}$ (5 marks)

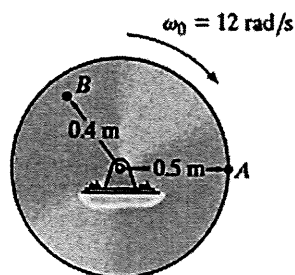


Figure 8

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 kg moves distance $s = 6\text{ m}$ in 3 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)

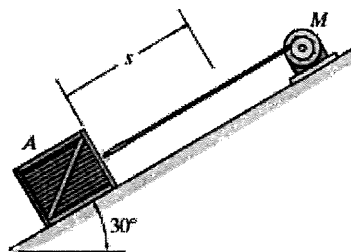


Figure 9

- 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)

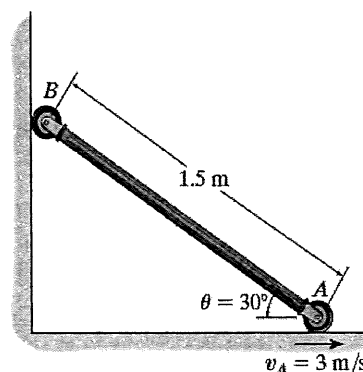


Figure 10

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

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FORMULA**Static Equilibrium:**

$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum M = 0$$

Newton's 2nd 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

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

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

