UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: BME 2013
COURSE	: STATICS AND DYNAMICS
SEMESTER/SESSION	: 2-2024/2025
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 and direction measured counterclockwise from the positive x axis of the resultant force a\of the three forces acting on the ring A shown in Figure 1. Take $F_1 = 500\ N$ and direction $\theta = 20^0$. (8 marks)

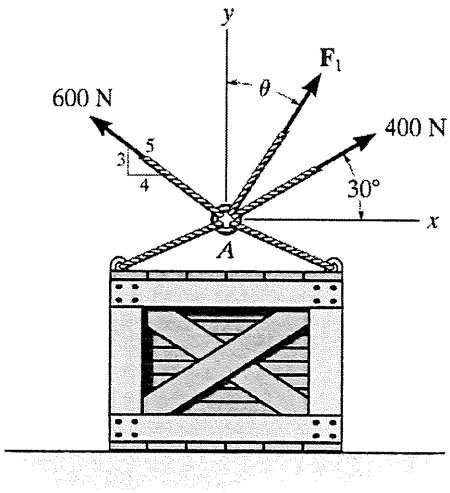


Figure 1

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 $F = 300\ N$ and $d = 1\ m$. (8 marks)

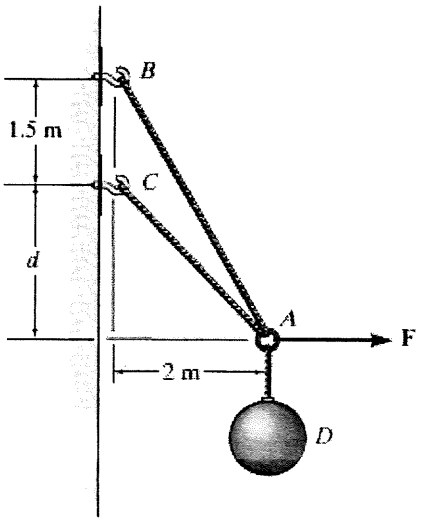


Figure 2

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)

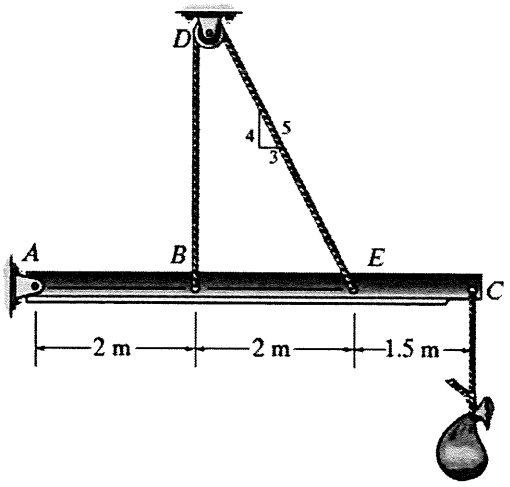


Figure 3

QUESTION 2

a) **Find** the resultant moment produced by the forces about point O shown in Figure 4. (5 marks)

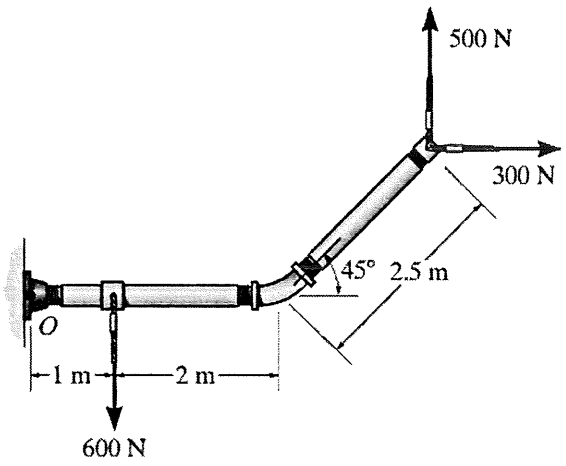


Figure 4

b) **Solve** the force in members *HD*, *CD*, and *GD* of the *Howe bridge truss* shown in Figure 5 below. Indicate if the members are in tension or compression. (12 marks)

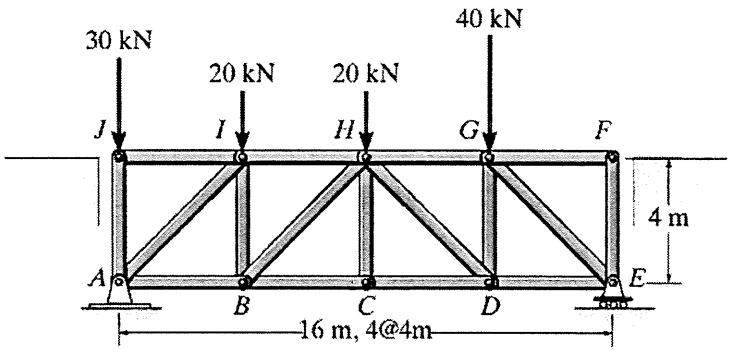
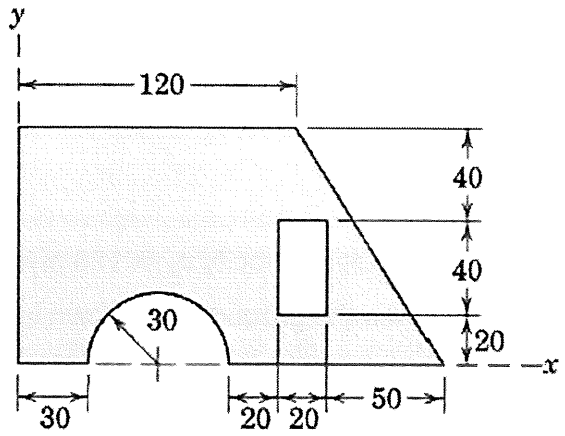


Figure 5

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 $36\ km/h$ 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 projectile is fired with an initial velocity $v_A = 150\ m/s$ off the roof of the building. **Compute** the range *R* where it strikes the ground at B shown in Figure 7. (8 marks)

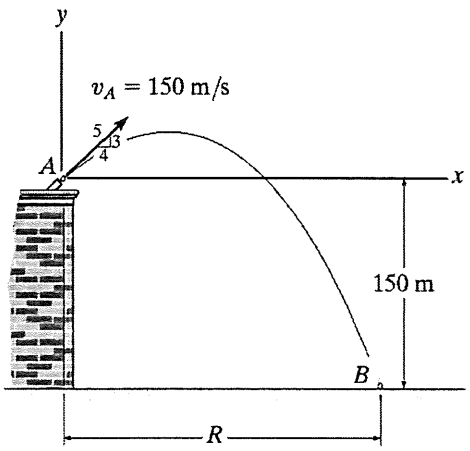


Figure 7

c) The angular acceleration of the disk is defined by $\alpha = 3t^2 + 12$ rad/s, where t is in seconds. If the disk is originally rotating at ω_0= 12 rad/s in Figure 8, **determine**

i. the velocity (4 marks)

ii. the normal,n and tangential,t components of acceleration of point A on the disk when t = 2 s (5 marks)

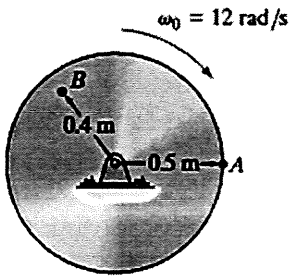


Figure 8

QUESTION 4

a) The motion of a particle is defined by the relation $x = 6t^4 - 2t^3 - 12t^2 + 3t + 3$, where x and t are expressed in meters and seconds, respectively. **Find** the position, the velocity, when $a = 0$ (8 marks)

b) Figure 9 shows the motor winds in the cable with a constant acceleration, such that the $20\ kg$ moves distance $s = 6m$ 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)

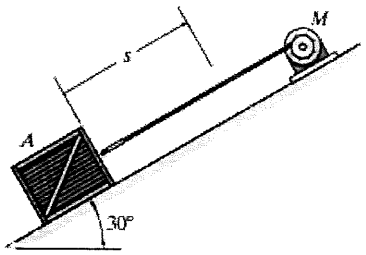


Figure 9

c) If roller A moves to the right with a constant velocity of v_A= 3 m/s, **determine** the angular velocity of the link and the velocity of roller B at the instant θ = 30° shown in Figure 10. (9 marks)

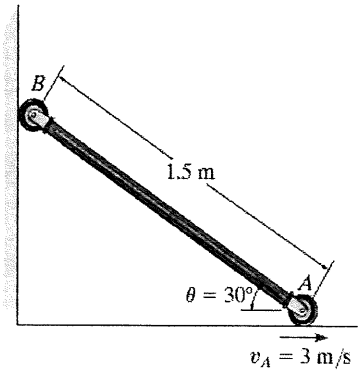


Figure 10

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

FORMULA

Static Equilibrium:

$$\sum F_X = 0$$
$$\sum F_Y = 0$$
$$\sum M = 0$$

Newton's 2nd Law:

$$\sum F = ma$$

Friction Force:

$$F_f = \mu F_N$$

Equation of Linear Motion:

$$v = v_O + a_C t$$

$$s = s_O + v_O t + \tfrac{1}{2} a_C t^2$$

$$v^2 = v_O{}^2 + 2a_C (s - s_O)$$

Circular Motion:

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

$$\alpha = \frac{d\omega}{dt}, rad/s2$$

Acceleration constant:

$$\omega = \omega_0 + \alpha_c t$$
$$\theta = \theta_0 + \omega_0 t + \tfrac{1}{2}\alpha_c t^2$$
$$\omega^2 = \omega_0^2 + 2\alpha_c(\theta - \theta_0)$$

Motion at Point P:

$$v = \omega r$$
$$a_t = \alpha r$$
$$a_n = \omega^2 r$$

Relative Motion Analysis: Velocity

$$\mathbf{v}_B = \mathbf{v}_A + \mathbf{v}_{B/A}$$

$$\mathbf{v}_B = \mathbf{v}_A + \boldsymbol{\omega} \times \mathbf{r}_{B/A}$$