Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2023/2024

COURSE NAME	:	STATICS
COURSE CODE	:	BDA 10203
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	JANUARY / FEBRUARY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER **THREE (3)** QUESTIONS IN PART A AND **ALL** QUESTIONS IN PART B 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **NINE (9)** PAGES

PART A: ANSWER THREE (3) QUESTIONS ONLY

Q1 (a) The beam is to be hoisted using two chains as shown in **Figure Q1.1**. Determine the magnitudes of forces F_A and F_B acting on each chain in order to develop a resultant force of 600 N directed along the positive y axis, given $\theta = 45°$.

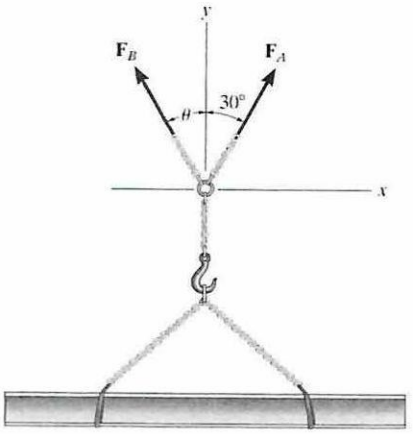


Figure Q1.1 Hoisted beam.

(6 marks)

(b) A cord is mounted at point A and B on a concrete wall. Dimensions are shown in **Figure Q1.2** with z = 4 m length.

(i) Determine the position vector **r** directed from point A to point B.

(4 marks)

(ii) Calculate the length of cord AB.

(2 marks)

(iii) If the cord AB were replaced with new 7.5 m length of cord, determine the new position of +z of point B. Other dimensions are remained unchanged.

(8 marks)

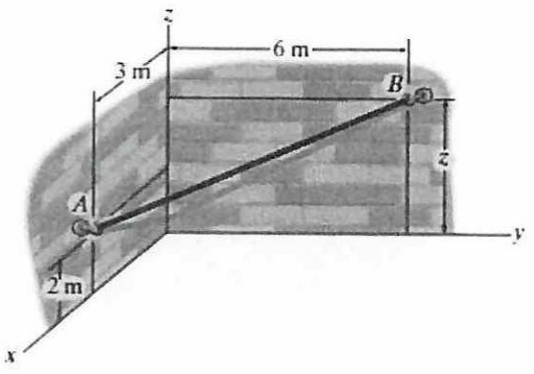


Figure Q1.2 A cord mounted on a concrete wall.

Q2 (a) The x and y coordinates of points *A*, *B* and *C* of the sailboat are shown in **Figure Q2.1**.

(i) Determine the components of unit vector that is parallel to the cable *AB* and points from *A* toward *B*.

(3 marks)

(ii) Determine the components of unit vector that is parallel to cable *BC* and points from *C* toward *B*.

(3 marks)

(iii) Use the dot product to determine the angle between the cable *AB* and the cable *BC*.

(4 marks)

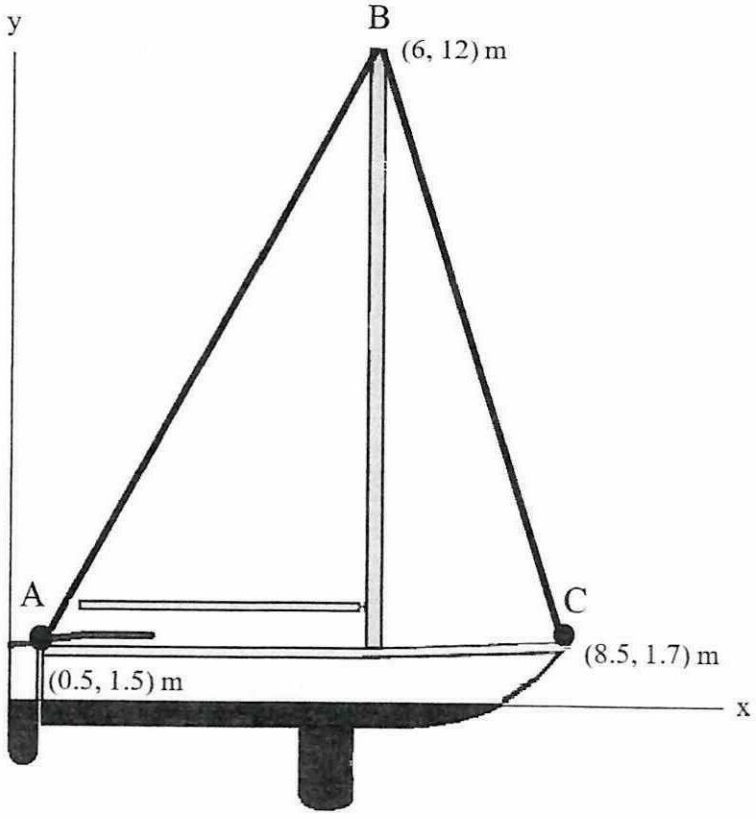


Figure Q2.1 The sailboat.

(b) A surveyor measures the location of point A shown in **Figure Q2.2** and determines that $\boldsymbol{r_{OA}} = \{400\,\boldsymbol{i} + 300\,\boldsymbol{j}\}\,m$. He wants to determine the location of point B so that and $|r_{AB}| = 600\,m$ and $|r_{OA} + r_{AB}| = 1000\,m$. Please help this surveyor complete his task by solving the following questions:

(i) The distance of point A from point O.

(1 mark)

(ii) The angle of point A from the positive x-axis.

(1 mark)

(iii) The angle of point B from the positive x -axis using the cosine law.

(4 marks)

(iv) The cartesian coordinates of point B.

(4 marks)

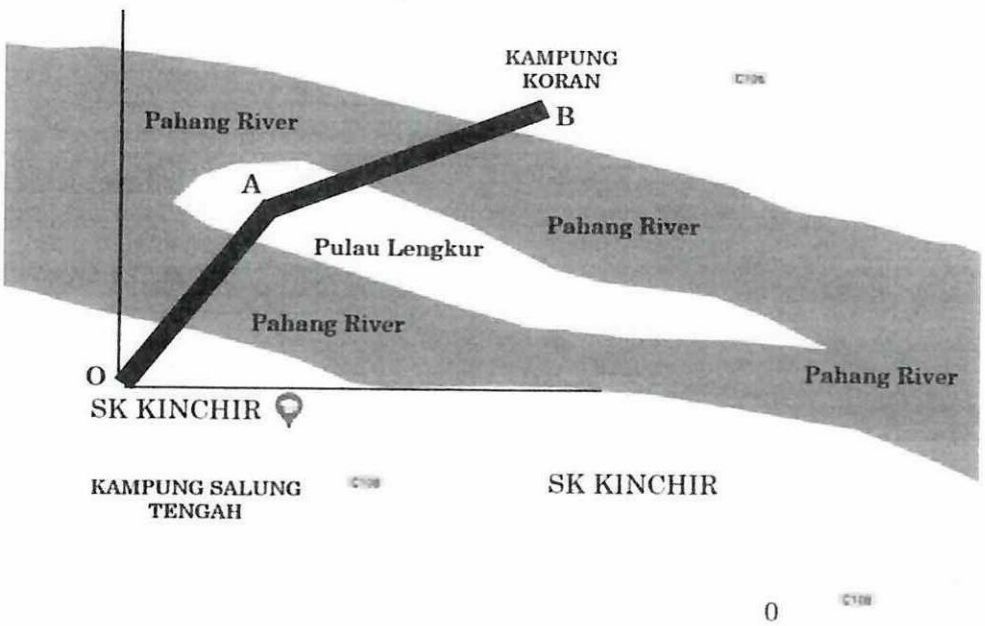


Figure Q2.2 Proposed bridge across the Pahang River.

Q3 (a) Explain how moments contribute to the effectiveness of a wrench in the process of tightening and loosening a bolt.

(4 marks)

(b) **Figure Q3.1** shows a frame exerted to a system of forces and moment.

(i) Determine the equivalent resultant force and couple moment acting at point *A*.

(12 marks)

(ii) Specify the location of the equivalent single force along member *AB* measured from point *B*.

(4 marks)

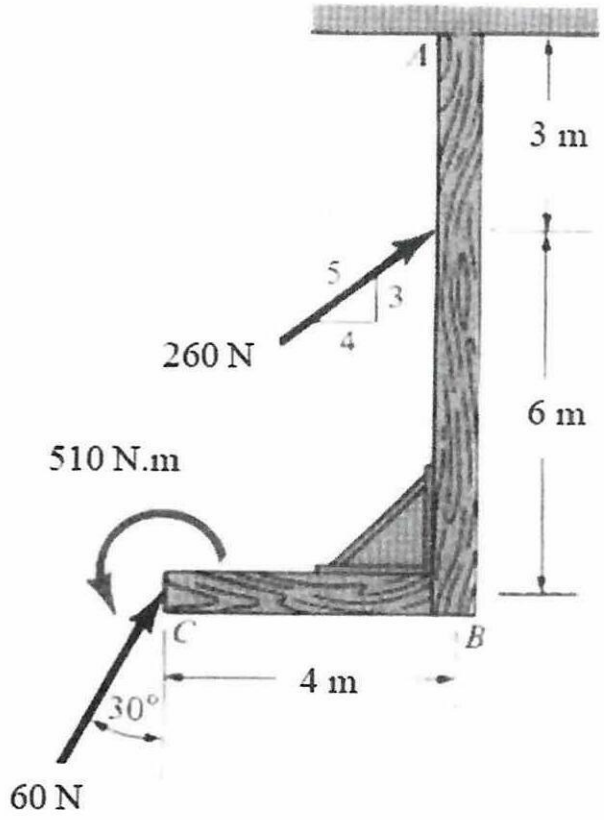


Figure Q3.1 Frame exerted to a system of forces and moment.

Q4 (a) Briefly define;

(i) Frame

(2 marks)

(ii) Machine

(2 marks)

(b) The frame shown in **Figure Q4.1** is supported by a pin joint at *C* and a roller support at *E*. A concentrated force acts at joint *A* and a couple acts at end of member *BDH*.

(i) Sketch the free body diagram of the overall structure and determine the reactions at supports *C* and *E*.

(9 marks)

(ii) Sketch individual free body diagrams of members *ABC*, *BDH* and *ADE*.

(3 marks)

(iii) Determine the reactions on member *ABC* at joints *B* and *C*.

(4 marks)

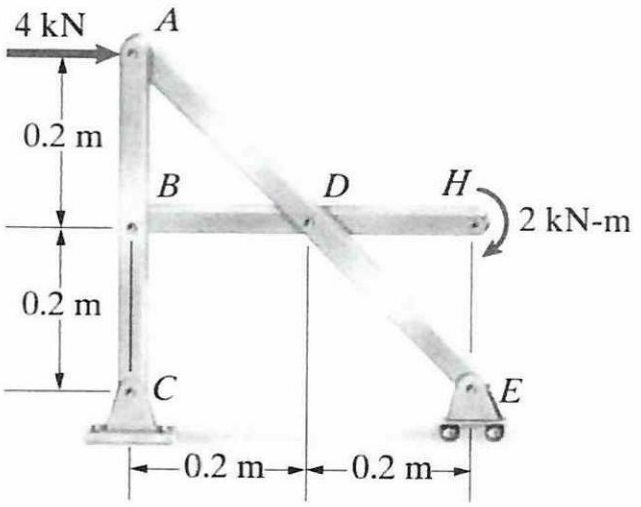


Figure Q4.1 A frame supporting concentrated force and couple.

PART B: ANSWER ALL QUESTIONS

Q5 Locate the center of mass of the bracket-and-shaft combination shown in **Figure Q5.1**. The vertical face is made from sheet metal which has a mass of 25 kg/m^2. The material of the horizontal base has a mass of 40 kg/m^2, and the steel shaft has a density of 7830 kg/m^3. (All dimensions in the figure are in millimetres).

(20 marks)

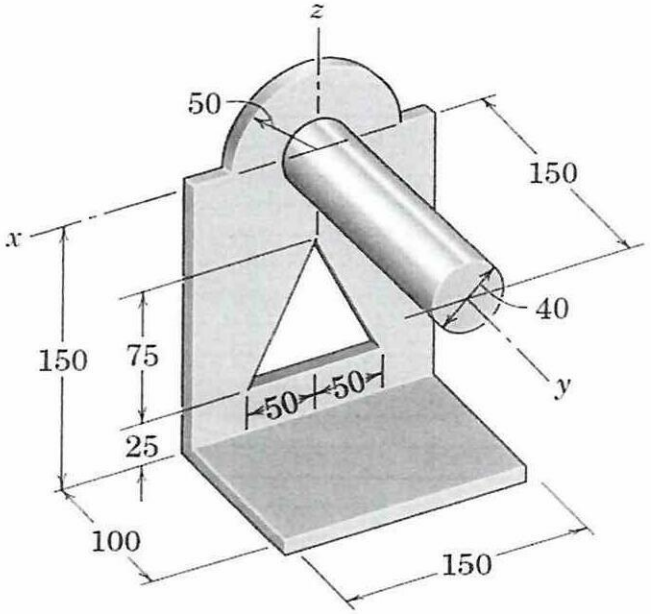


Figure Q5.1 Bracket-and-shaft sheet metal combination.

Q6 The coefficient of static friction is between the 100 N body and the 15° wedge shown in **Figure Q6.1** is 0.20. Determine the magnitude of the force P required to begin raising the 100 N body if;

(a) rollers of negligible friction are present under the wedge, as illustrated in **Figure Q6.1**.

(10 marks)

(b) the rollers are removed and the coefficient of static friction $\mu_s = 0.20$ applies at this surface as well.

(10 marks)

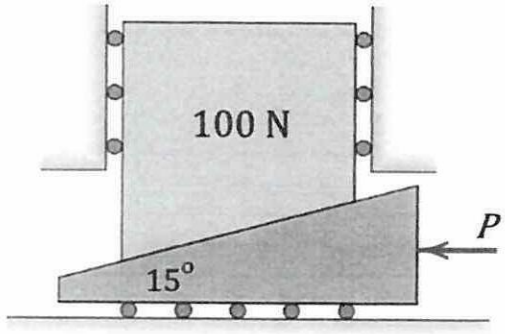
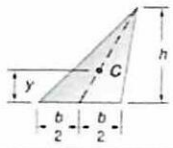
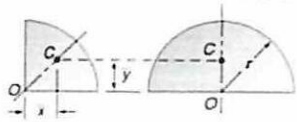
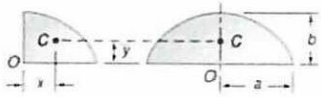
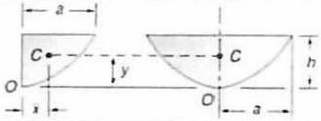
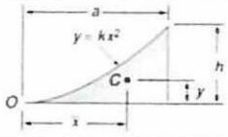
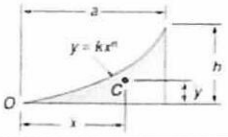
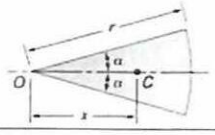
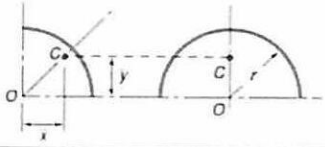
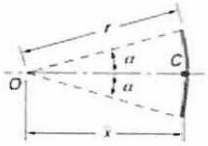


Figure Q6.1 The wedge and 100 N block.

- END OF QUESTIONS -

APPENDIX A

CENTROIDS OF COMMON AREAS & VOLUMES

Shape		$\bar{x}$	$\bar{y}$	Area
Triangular area			$\frac{h}{3}$	$\frac{bh}{2}$
Quarter-circular area		$\frac{4r}{3\pi}$	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{4}$
Semicircular area		0	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{2}$
Quarter-elliptical area		$\frac{4a}{3\pi}$	$\frac{4b}{3\pi}$	$\frac{\pi ab}{4}$
Semielliptical area		0	$\frac{4b}{3\pi}$	$\frac{\pi ab}{2}$
Semiparabolic area		$\frac{3a}{8}$	$\frac{3h}{5}$	$\frac{2ah}{3}$
Parabolic area		0	$\frac{3h}{5}$	$\frac{4ah}{3}$
Parabolic spandrel		$\frac{3a}{4}$	$\frac{3h}{10}$	$\frac{ah}{3}$
General spandrel		$\frac{n+1}{n+2}a$	$\frac{n+1}{4n+2}h$	$\frac{ah}{n+1}$
Circular sector		$\frac{2r\sin\alpha}{3\alpha}$	0	αr^2
Quarter-circular arc		$\frac{2r}{\pi}$	$\frac{2r}{\pi}$	$\frac{\pi r}{2}$
Semicircular arc		0	$\frac{2r}{\pi}$	πr
Arc of circle		$\frac{r\sin\alpha}{\alpha}$	0	$2\alpha r$