Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESI 2022/2023

COURSE NAME	:	MECHANICS OF MATERIALS
COURSE CODE	:	BFC 20903
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY/AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTION		1. ANSWER ALL QUESTION IN **PART A** AND THREE (3) QUESTION IN **PART B**. 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **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 ALL QUESTION

Q1 Figure **Q1** shows a concrete structure system. Beam AB support a uniform distribution load from the slab of 30 kN/m. The beam is 8 meter long with rectangular size of 200 mm x 350 mm.

(a) If the beam AB is pinned at A and roller at B, sketch a complete beam idealization.
(5 marks)

(b) Draw the shear and moment diagram for the beam and determine the maximum moment.
(10 marks)

(c) By ignoring bar reinforcement in beam AB, calculate maximum bending stress at tension and compression (in N/mm^2) of beam AB and draw the bending stress diagram. Then, determine bending stress at 100 mm below the neutral axis.
(10 marks)

(d) At support B, compute the shear stress at point P and maximum shear stress in N/mm^2.
(10 marks)

(e) Give your opinion on the significance to calculate shear, moment, bending stress and shear stress in design and analysis.
(5 marks)

PART B - ANSWER THREE (3) QUESTION ONLY

Q2 (a) List all the characteristics of stress-strain diagram of steel in Figure **Q2(a)**.
(5 marks)

(b) Two solid cylindrical rods are joined at B and loaded as shown in Figure **Q2(b)**. Rod AB is made of steel with E_s=200GPa and rod BC of brass with E_B=105GPa. Determine the total deformation of the composite rod ABC.
(5 marks)

(c) The given numbers of shearing stress, normal stress and orientation.

σ_x = 50MPa
σ_y = -20MPa
τ_{xy} = -10MPa
θ = 40°

(i) Sketch the plane stress transformation.
(2 marks)

(ii) Determine the normal stress due to x and y planes, (σ_x', σ_y') and shearing

stress subjected to the plane stress, $(\tau_{x'y'})$ using equation method.

(6 marks)

(iii) calculate the maximum shear stress, τ_{max} using equation method.

(2 marks)

Q3 A simply supported beam with length 6 m carries 3-point loads of 20 kN, 15 kN and 25 kN at distance of 2 m, 4 m and 5 m respectively as shown in Figure **Q3**.

(a) Calculate the reaction of each support.

(5 marks)

(b) Determine the deflection at $x = 3m$ from the support A and the slope at point A using MacCaulay Method.

(15 marks)

Q4 (a) Explain the condition of column design shown in Figure **Q4(a)** based on stability of structures.

(3 marks)

(b) A 2 m long pin ended column of square cross section is to be made of wood. Assuming E = 13 GPa, σ_{all} = 12 MPa and using a factor of safety of 2.5 in computing Euler's critical load for buckling, determine the size of the cross section if the column is to safely support 200 kN load.

(7 marks)

(c) The uniform column AB shown in Figure **Q4(c)(i)** consists of a 2.4 m section of structural tubing having the cross section shown in Figure **Q4(c)(ii)**,

(i) Using Euler's formula and a factor of safety of 2, determine the allowable centric load for the column and the corresponding normal stress.

(5 marks)

(ii) Using allowable centric load in Q4(c)(i), determine the maximum horizontal deflection and the maximum normal stress in the column when P is located 18 mm from the centroid using Secant equation. Use E=200GPa.

(5 marks)

Q5 (a) Define torsion and explain the fundamental equation to calculate torsion in a cylindrical shaft.

(6 marks)

(b) Figure **Q5(b)** shows a solid steel shaft with a diameter of 50 mm and a length of 1 meter is subjected to a torque of 1000 Nm.

(i) Calculate the polar second moment of inertia, J of the steel column with cross-section given.

(3 marks)

(ii) Determine the maximum shear stress and angle of twist in the shaft. Assume that the shear modulus of steel is 80 GPa

(8 marks)

(iii) Assume that the allowable shear stress of the steel is 125 MPa. Based on the calculated shear stress discuss whether the shaft safe for the given load

(3 marks)

– END OF QUESTIONS –

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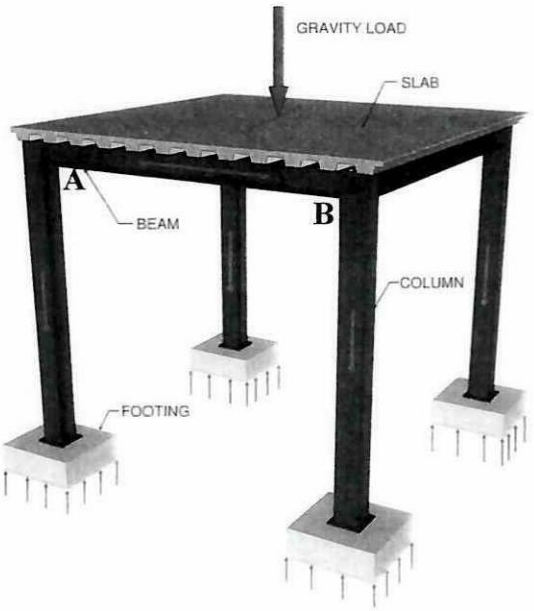

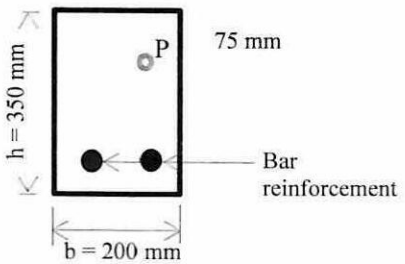

Cross-section for beam AB

FIGURE Q1

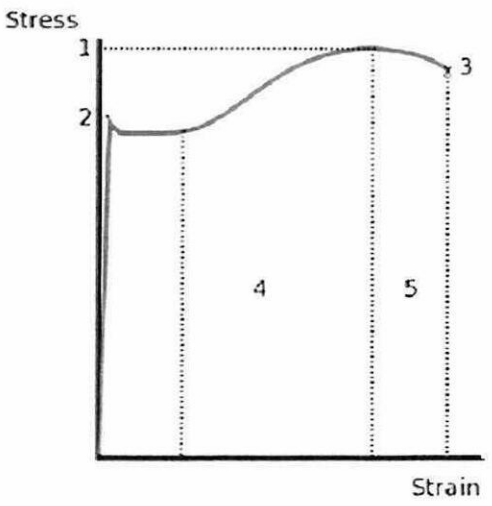

FIGURE Q2(a)

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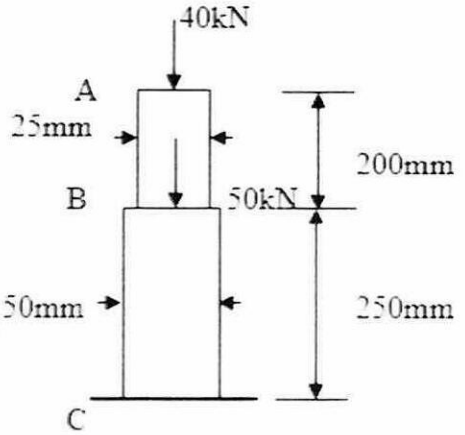

FIGURE Q2(b)

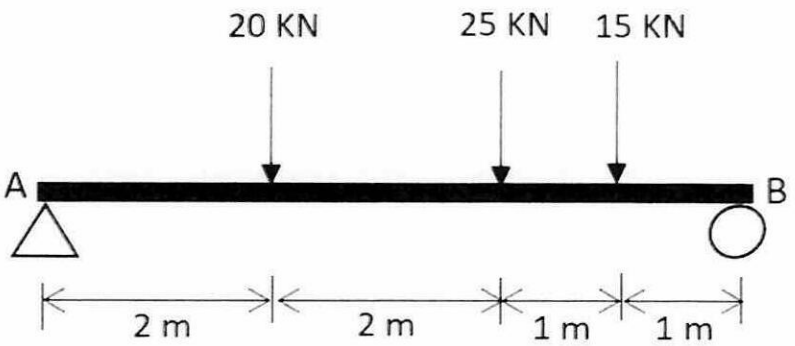

FIGURE Q3

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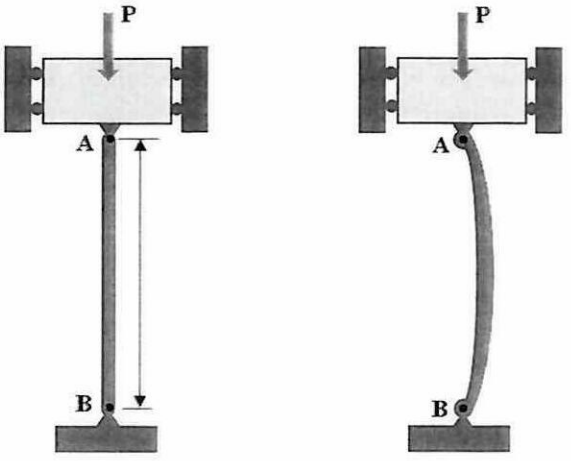

FIGURE Q4(a)

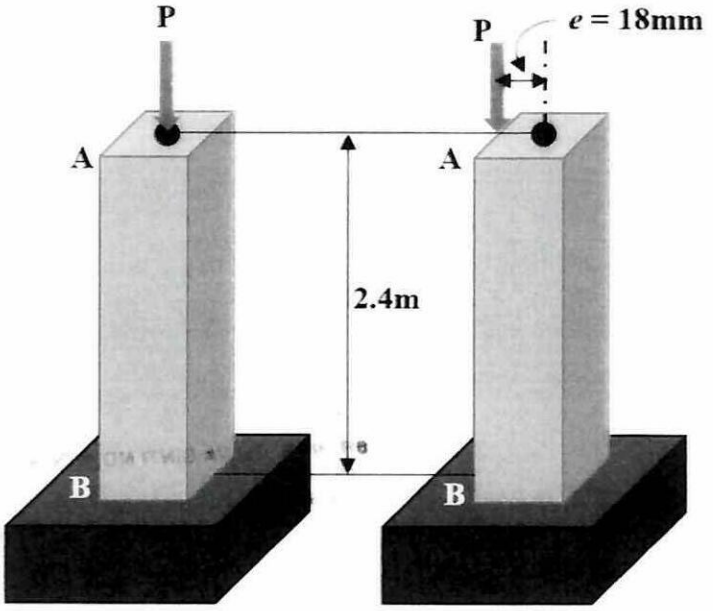

FIGURE Q4(c)(i)

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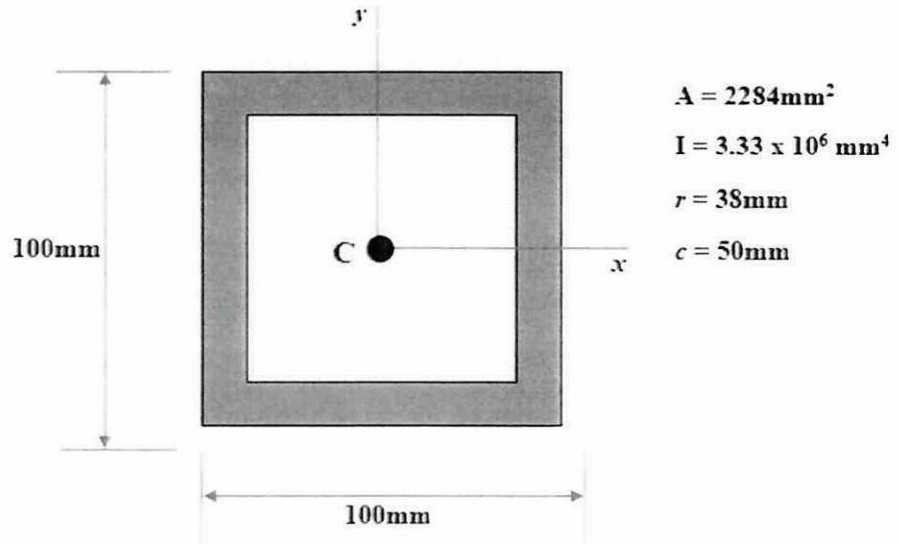

FIGURE Q4(c)(ii)

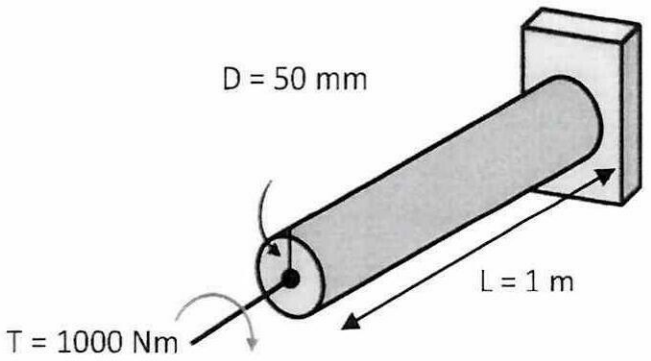

FIGURE Q5(b)

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Formulae

$$\sigma = \frac{My}{I}$$

$$\tau = \frac{VA\bar{y}}{I_b}$$

$$\delta = \frac{PL}{AE}$$

$$\tau_{\substack{max \\ min}} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy^2}}$$

$$P_{cr} = \frac{\pi^2 EI}{L^2}$$

$$y_m = e\left[sec\left(\frac{\pi}{2}\sqrt{\frac{P}{P_{cr}}}\right) - 1\right]$$

$$\sigma_m = \frac{P}{A}\left[1 + \frac{ec}{r^2} sec\left(\frac{\pi}{2}\sqrt{\frac{P}{P_{cr}}}\right)\right]$$

$$\boldsymbol{\tau} = \frac{TR}{J}$$

$$\theta = \frac{TL}{GJ}$$