Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	MECHANICS OF MATERIAL
COURSE CODE	:	DAC 12503
PROGRAMME CODE	:	DAA
EXAMINATION DATE	:	JULY 2024
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS

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 **SEVEN (7)** PAGES

Q1 The strength of material depends on its ability to sustain a load without undue deformation or failure.

a) **Figure Q1.1** shows the conventional stress-strain diagram. Label the important point on the diagram and briefly describe the behaviour for each segment on the diagram. *[Re-sketch the diagram into your answer booklet]*

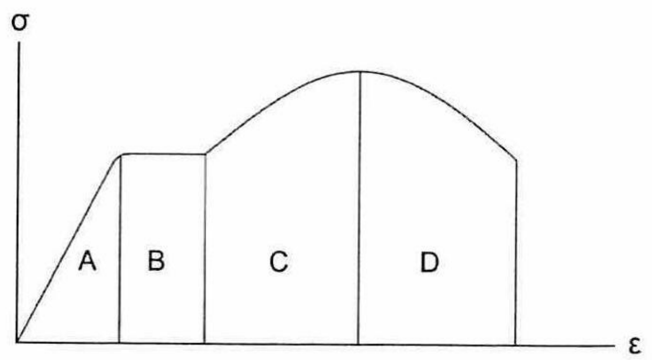


Figure Q1.1 Stress vs Strain

(4 marks)

b) A steel bar with E=200 GPa has dimension as shown in **Figure Q1.2**. If an axial force of 95 kN is applied to the bar,

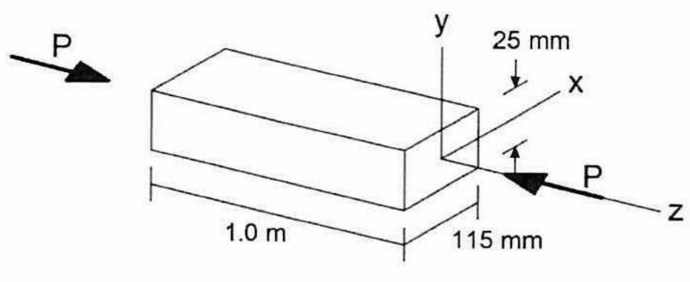


Figure Q1.2 Steel Bar

i) Calculate the normal stress in the bar.

(2 marks)

ii) Calculate the deformation in z-direction.

(4 marks)

iii) If the Poisson's ratio of the bar is 0.45, determine its strain at both x- and y-direction.

(1 mark)

iv) Determine the changes in the dimension of the cross section of the bar.

(4 marks)

c) Three different bars are stacked together as shown in **Figure Q1.3**.

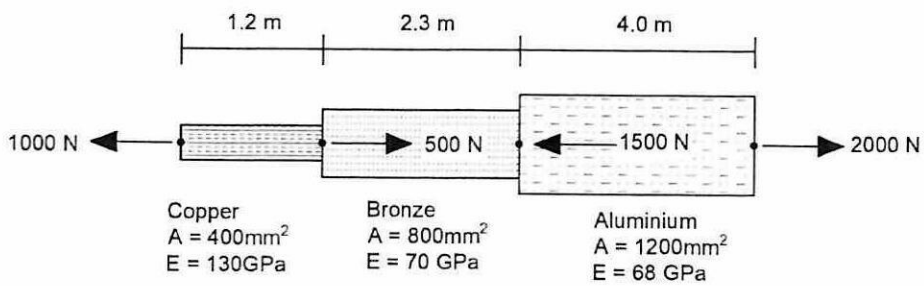


Figure Q1.3 Three Bars

i) Determine the internal forces for each bar.

(4 marks)

ii) Calculate the deformation for bronze bar ONLY.

(2 marks)

iii) Calculate the total deformation for the bars.

(4 marks)

Q2 A simply supported beam is subjected to loads as shown in **Figure Q2.1**. As future engineer, you need to;

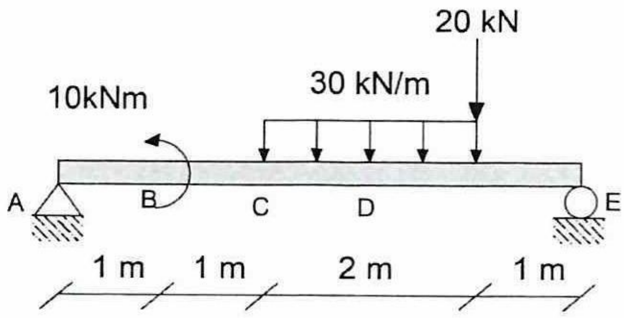


Figure Q2.1 Simply Supported Beam

a) Calculate the reaction supports.

(3 marks)

b) Construct the shear force and bending moment expression for each section by using cut section method.

(8 marks)

c) Draw the shear force diagram.

(5 marks)

d) Identify the contra point on your SFD and calculate its distance from point A.

(4 marks)

e) Draw the bending moment diagram.

(5 marks)

Q3 Your senior engineer has done the first part of the calculation for deflection of simply supported statically determinate beam. The FBD and cross section of the beam is illustrated as in **Figure Q3.1**. The reaction support at roller is 66.7 kN (↑) and at pin is 53.3 kN (↑). You need to continue the calculation by;

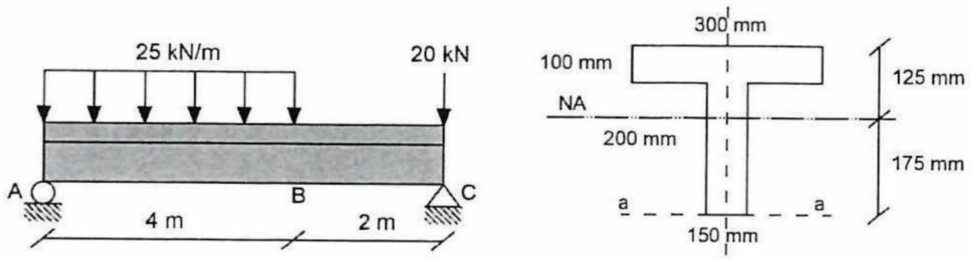


Figure Q3.1 Beam and its Cross Section

a) Sketch the shear force and bending moment diagram and identify the maximum bending moment.

(6 marks)

b) Construct the slope and deflection expression for the beam by using Macaulay method.

(4 marks)

c) State the boundary condition.

(2 marks)

d) Determine the coefficient of the slope and deflection expression.

(6 marks)

e) Calculate the second moment of inertia, I for the beam.

(3 marks)

f) Determine the slope and deflection located 3.0m to the left from point C. Given $E=5x10^6$ N/mm^2.

(4 marks)

Q4 An element is subjected to stresses, σ_x = -46 kN/mm^2, σ_y = 0 kN/mm^2 and τ_{xy} = -19 kN/mm^2. Analyse the Plane Transformation problem by using equation method.

a) Sketch the stresses on the element.

(3 marks)

b) Determine the stress on x-axis and y-axis if the element is rotated 15° clockwise from positive x-axis by using equation method.

(7 marks)

c) Sketch the transformed stresses.

(4 marks)

d) Calculate the orientation and the principle stresses of the element by using equation method.

(6 marks)

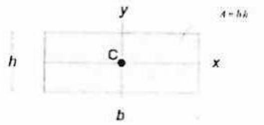
e) Calculate the maximum in-plane shear stress of the element by using equation method.

(5 marks)

-END OF QUESTIONS-

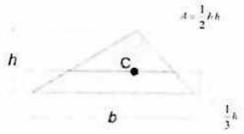
Appendix A

$$\bar{I} = \frac{bh^3}{12} + Ad_y^2$$



$$I_x = \frac{1}{12} b h^3$$

$$I_y = \frac{1}{12} b^3 h$$



$$I_x = \frac{1}{36} b h^3$$

$$I_y = \frac{1}{36} b^3 h$$

$$EI \frac{d^2 y}{dx^2} = M$$

$$EI \frac{dy}{dx} = Mx + C_1$$

$$EIy = \frac{Mx^2}{2} + C_1 x + C_2$$

$$\sigma_{x'} = \left(\frac{\sigma_x + \sigma_y}{2}\right) + \left(\frac{\sigma_x - \sigma_y}{2}\right)\cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\sigma_{y'} = \left(\frac{\sigma_x + \sigma_y}{2}\right) - \left(\frac{\sigma_x - \sigma_y}{2}\right)\cos 2\theta - \tau_{xy} \sin 2\theta$$

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

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

$$\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$$

$$\sigma = \frac{P}{A} \quad ; \quad \tau = \frac{V}{A} \quad ; \quad \varepsilon = \frac{\delta}{L} \quad ; \quad \sigma = E\varepsilon$$

$$\delta = \frac{PL}{AE} \quad ; \quad \nu = -\frac{\varepsilon_{lat}}{\varepsilon_{long}}$$