Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER III
SESSION 2018/2019

COURSE NAME	:	MECHANIC OF MATERIAL
COURSE CODE	:	DAC 20703
PROGRAMME	:	DAA
EXAMINATION DATE	:	AUGUST 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY ALL CALCULATION STEPS AND FINAL ANSWERS SHOULD BE IN APPROPRIATE UNITS

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

Q1 (a) Define the Hooke's Law. Draw the graph to show the related relationship.
(5 marks)

(b) **Figure Q1(b)** shows one bar consists of steel, bronze and aluminum were welded to each others and have axial force. Determine force and normal stress in each bar segment if P = 100 N. Given A_{steel} = 500 mm^2, A_{bronze} = 1250 mm^2 and $A_{aluminum}$ = 2000 mm^2.
(10 marks)

(c) Based on data in plane stress elements shown in **Figure Q1(c)** draw Mohr Circle and calculate principal stress, maximun shear stress and its orientations.
(10 marks)

Q2 (a) Describe the procedures to draw shear force diagram (SFD) and bending moment diagram (BMD).
(2 Marks)

(b) Overhang beam was design to sustain few types of forces shown in **Figure Q2(b)**. Calculate unknown forces at these beam.
(5 Marks)

(c) Draw shear force diagram (SFD) for simply supported beam shown in **Figure Q2 (c)** and determine its maxsimum shear force.
(8 Marks)

(d) Simply supported beam has been imposed with different forces as shown in **Figure Q2(d)**. Draw shear force diagram (SFD and bending moment diagram (BMD) for these beam. Show importants values on the diagrams.
(10 Marks)

Q3 A torque T is applied, as shown in **Figure Q3**, to a solid shaft with built-in ends.

(a) Show that the resisting torques at the walls are $T_1 = T_b/L$.
(10 marks)

(b) Show that the resisting torques at the walls are $T_2 = T_a/L$.
10 marks)

(c) Briefly explain how would these values be changed if the shaft were hollow.
(5 marks)

Q4 (a) Define normal strain in beam.

(3 marks)

(b) **Figure Q4(b)** shows uniform distributed load 40 kN/m inserted to a beam with C cross section.

(i) Using **a-a** as reference, calculate value for **y**.

(5 marks)

(ii) Determine shear stress at point C located 2 m from support A and 100 mm from below of the beam.

(5marks)

(c) **Figure Q4(c)** shows uniform distributed load 20 kN/m inserted to a beam with T cross section.

(i) Using **a-a** as reference, calculate value for **y**.

(6 marks)

(ii) Determine shear stress at point C located 2 m from support A and 100 mm from below of the beam.

(6 marks)

Q5 (a) Explain in details the stress and strain relationship.

(4 marks)

(b) A square bar as shown in **Figure Q5(b)** has width and height of 40 mm. If an axial load force of 800 N is applied along the centroidal axis of the bar's cross sectional area, determine;

(i) The average normal stress and average shear stress acting along section plane a-a.

(5 marks)

(ii) The average normal stress and average shear stress acting along section plane b-b.

(5 marks)

(c) Two members are pinned together as shown in **Figure Q5(c)**. Top views of the pin connections at A and B are also given. If the pins have an allowable shear stress of 90 MPa and allowable tensile stress of rod CB is 115 MPa, determine;

(i) The smallest allowable diameter of pins A and B.

(6 marks)

(ii) The diameter of rod CB necessary to support the load.

(5 marks)

Q6 (a) Define the Torsion theory.

(2 marks)

(b) The solid steel shaft shown in **Figure Q6(b)** has a diameter of 20 mm. If it is subjected to the two torques, calculate the reactions at the fixed supports A and B.

(8 marks)

(c) Calculate the minimum diameter of a solid steel shaft that will not twist through more than 3° in a 6-m length when subjected to a torque of 12 kN·m and maximum shearing stress. Use G = 83 GPa.

(9 marks)

(d) A column has a length of 8 m having modulus of elasticity of 200 kN/mm^2, and a moment of inertia of 7519 x 10^4 mm^4. If the safety factor given is 2, determine the safe load of the column if;

(i) Both at the end of the column is pinned.

(3 marks)

(ii) Both at the end of the column is fixed.

(3 marks)

- END OF QUESTION -

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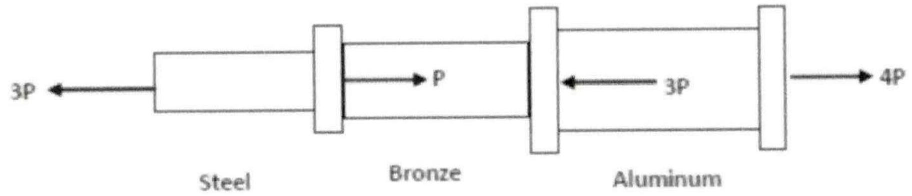

Figure Q1(b)

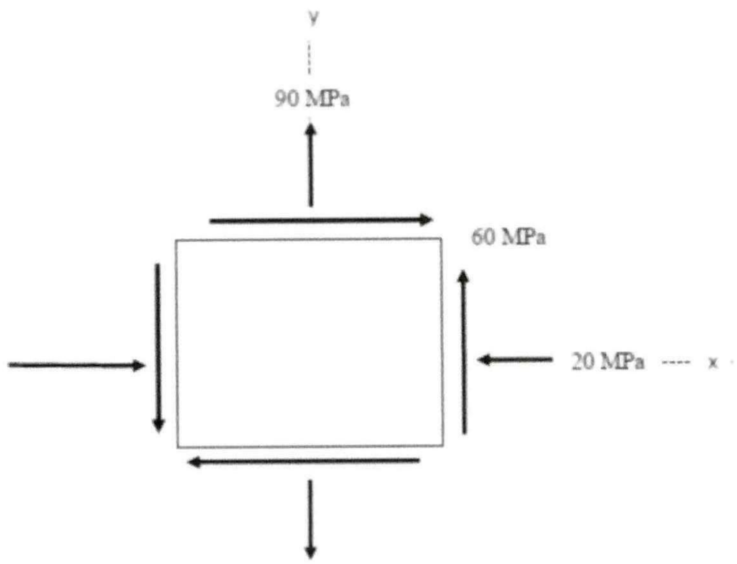

Figure Q1(c)

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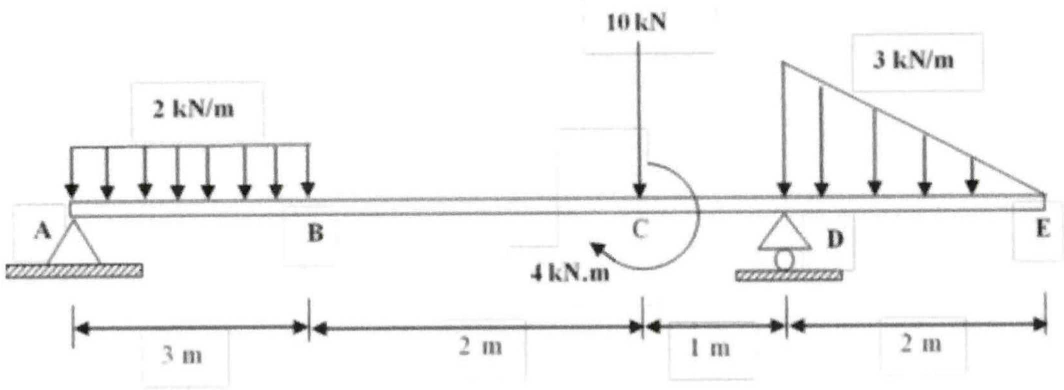

Figure Q2(b)

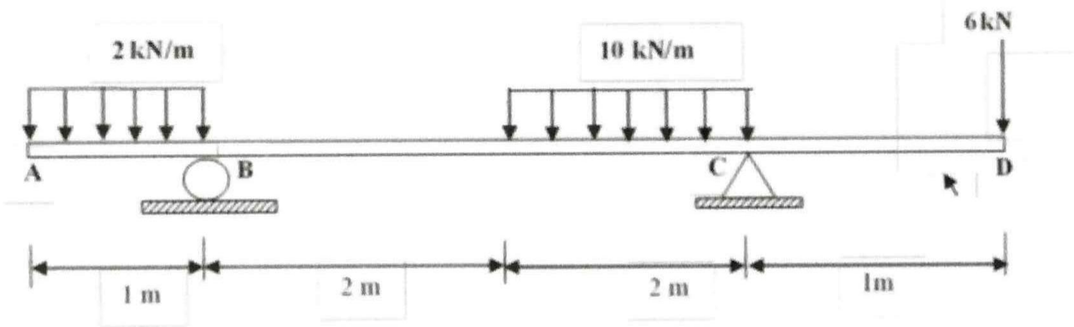

Figure Q2(c)

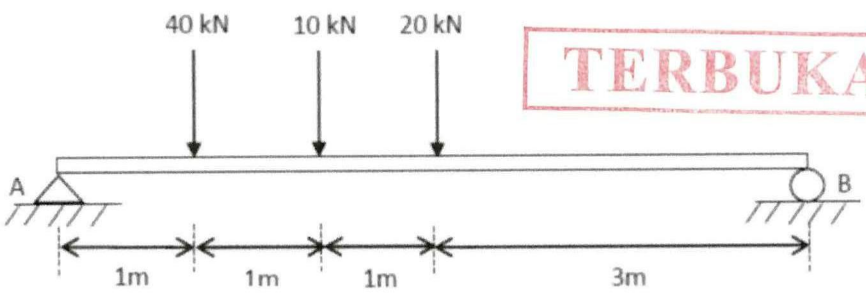

Figure Q2(d)

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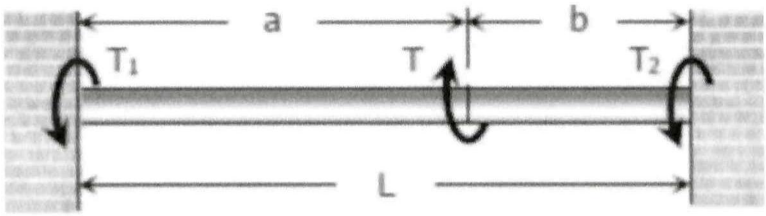

Figure Q3

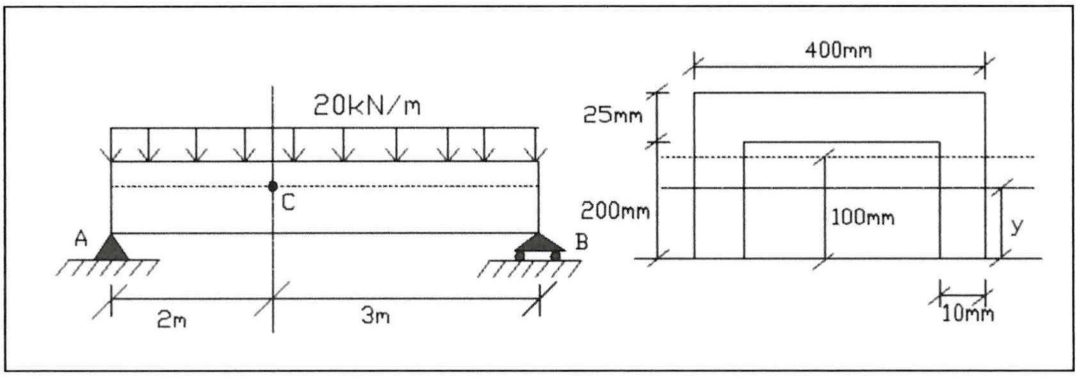

Figure Q4(b)

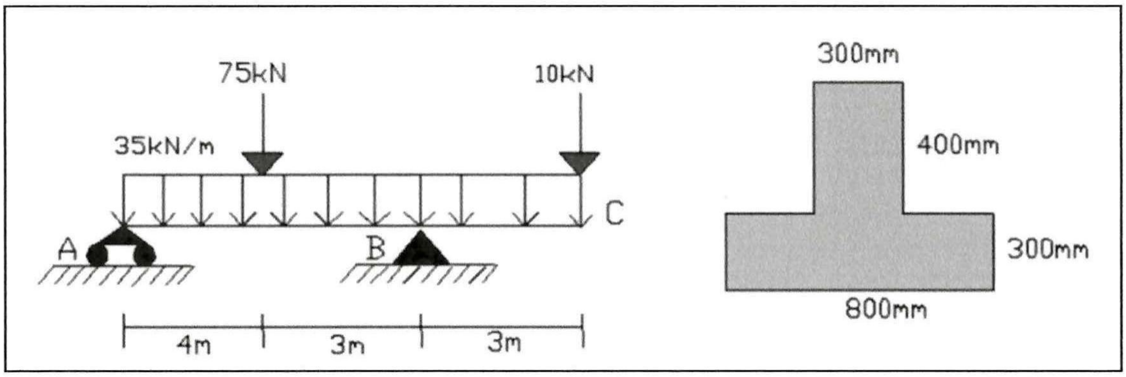

Figure Q4(b)

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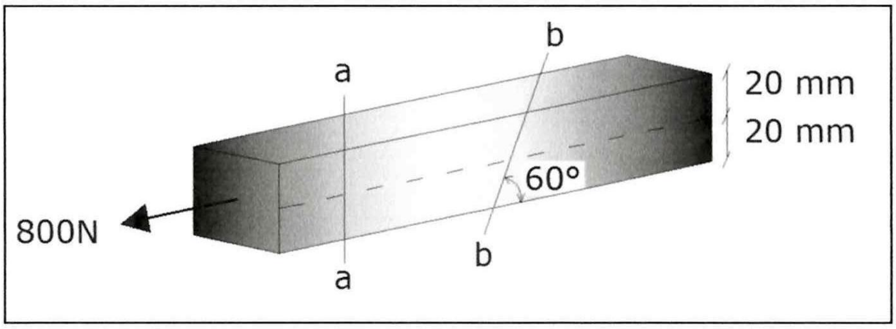

Figure Q5(b)

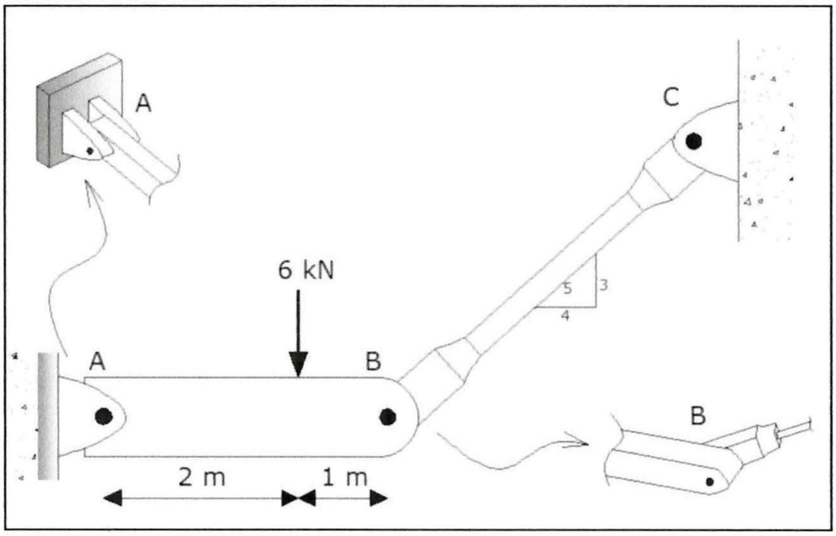

Figure Q5(c)

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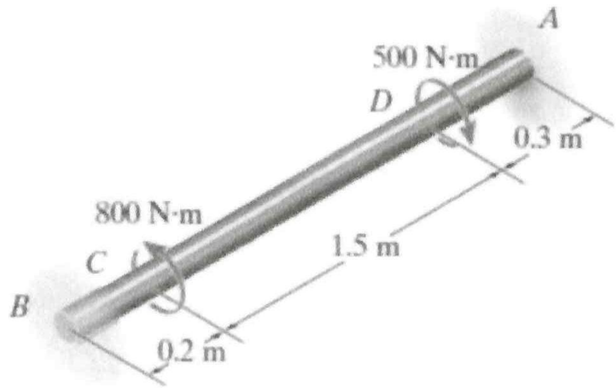

Figure Q6(b)

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FORMULA

Normal Stress

$$\sigma_{ave} = \frac{N}{A}$$

Normal Strain:

$$\varepsilon = \frac{\delta}{L}$$

Safety Factor

$$F.S. = \frac{\sigma_{fail}}{\sigma_{allow}}$$

Shear Stress

$$\tau_{ave} = \frac{V}{A}$$

Shear Strain

$$\gamma = \frac{\text{angular deformation}}{\text{(in radians)}}$$

Poisson's Ratio

$$v = \frac{-\varepsilon_{lateral}}{\varepsilon_{longitudinal}}$$

Hooke's Laws:

$$\sigma = E\varepsilon \qquad \tau = G\gamma$$

Generalized Hooke's Law

$$\varepsilon_x = \frac{\sigma_x}{E} - \frac{v\sigma_y}{E} - \frac{v\sigma_z}{E}$$

$$\varepsilon_y = \frac{\sigma_y}{E} - \frac{v\sigma_x}{E} - \frac{v\sigma_z}{E}$$

$$\varepsilon_z = \frac{\sigma_z}{E} - \frac{v\sigma_x}{E} - \frac{v\sigma_y}{E}$$

Stress Concentration:

$$\sigma_{max} = K\sigma_{ave}$$

Axial Deformation:

$$\delta = \int_0^L \frac{P_x}{E_x A_x} dx$$

Due to Force

$$\delta = \frac{F\,L}{E\,A}$$

Due to Temperature Change

$$\delta_{Temp} = \alpha\, L\, \Delta T$$

Torsion:

Circular or Round Tube section:

$$\tau = \frac{T\rho}{J} \quad \text{and} \quad \phi = \frac{TL}{GJ}$$

Bending Stress:

for Horizontal moment

$$\sigma = -\frac{Mc}{I}, \quad \tau = VQ/Ib$$

Moments of inertia:

for circle:

$$J_{circle} = \frac{\pi D^4}{32} \qquad I_{circle} = \frac{\pi D^4}{64}$$

for rectangle:

$$I_{rectangle} = \frac{1}{12} bh^3$$

Column

$P_{cr} = \pi^2 EI/L_e^2$

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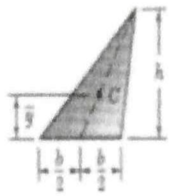
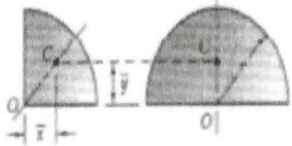
FORMULA

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	$\frac{4r}{3\pi}$	$\frac{\pi r^2}{2}$

Due to Force: $\delta = \frac{FL}{EA}$

Due to Temperature Change: $\delta_{Temp} = \alpha L \Delta T$

$$\tau = \frac{T\rho}{J} \quad \text{and} \quad \phi = \frac{TL}{GJ}$$

$$\sigma = -\frac{Mc}{I}$$

$$J_{circle} = \frac{\pi D^4}{32} \qquad I_{circle} = \frac{\pi D^4}{64} \qquad I_{rectangle} = \frac{1}{12} bh^3$$

Normal Stress: $\sigma_{ave} = \frac{N}{A}$

Normal Strain: $\varepsilon = \frac{\delta}{L}$

Safety Factor: $F.S. = \frac{\sigma_{fail}}{\sigma_{allow}}$

Shear Stress: $\tau_{ave} = \frac{V}{A}$

Shear Strain: $\gamma = \frac{\text{angular deformation}}{\text{(in radians)}}$

Poisson's Ratio: $\nu = \frac{-\varepsilon_{lateral}}{\varepsilon_{longitudinal}}$

Hooke's Laws: $\sigma = E\varepsilon \qquad \tau = G\gamma$

Generalized Hooke's Law:

$$\varepsilon_x = \frac{\sigma_x}{E} - \frac{\nu\sigma_y}{E} - \frac{\nu\sigma_z}{E}$$

$$\varepsilon_y = \frac{\sigma_y}{E} - \frac{\nu\sigma_x}{E} - \frac{\nu\sigma_z}{E}$$

$$\varepsilon_z = \frac{\sigma_z}{E} - \frac{\nu\sigma_x}{E} - \frac{\nu\sigma_y}{E}$$

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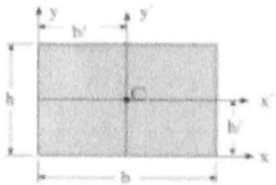
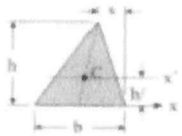
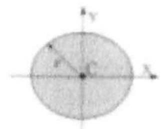
FORMULA

Rectangle: $\bar{I}_x = \frac{1}{12}bh^3$ $\bar{I}_y = \frac{1}{12}b^3h$	
Triangle: $\bar{I}_x = \frac{1}{36}bh^3$	
Circle: $\bar{I}_x = \bar{I}_y = \frac{1}{4}\pi r^4$	
Semi-circle: $I_x = I_y = \frac{1}{8}\pi r^4$ $\bar{I}_x = \left(\frac{\pi}{8} - \frac{8}{9\pi}\right)r^4$	
Parallel axis theorem $I_x = \bar{I}_x + Ad^2$ $I_y = \bar{I}_y + Ad^2$	

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