Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	MECHANICS OF MATERIAL
COURSE CODE	:	BFC 20903
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JULY 2022
DURATION	:	3 HOURS
INSTRUCTION	1.	ANSWER ALL QUESTIONS
	2.	THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND 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 **SEVEN (7)** PAGES

Q1 (a) Necking is a common phenomenon of ductile materials. It can be observed through the negative gradient of stress-strain curve at the plastic region when the applied force exceeding the ultimate stress. Discuss the relationship of necking with Poisson's ratio.

(4 marks)

(b) **Figure Q1** shows ceramic specimens subjected to the pure uniaxial force. Specimen A is compressed until failure at the maximum compressive force, Fc = 31.12 kN. Meanwhile, specimen B experiences tension that reached the maximum tensile force, Ft = 4.98 kN. The surface area perpendicular to the force has the size of 8.5 mm width and 100 mm length.

(i) Determine the important parameters of σ_{avg}, R, σ_{min} and σ_{max}. Then, plot Mohr's circle for specimens A and B at the same τ-σ plane.

(11 marks)

(ii) Describe **THREE (3)** observation on Mohr's circle for specimens A and B.

(6 marks)

(iii) If the orientation of element is set at $\theta_p = 15°$ and $\theta_p = 30°$, discuss the changes that may occur to Mohr's circle.

(4 marks)

Q2 (a) As shown in **Figure Q2(a)**, a 700 mm long, 18 mm diameter rod made of a homogeneous, isotropic material is observed to increase in length by 500 μm, and to decrease in diameter by 3.2 μm when subjected to an axial 18 kN load. Determine the modulus of elasticity and Poisson's ratio of the material.

(5 marks)

(b) As shown in **Figure Q2(b)**, a concrete floor slab is reinforced by 16 mm diameter steel rods placed 38 mm above the lower face of the slab and spaced 150 mm on centres. The modulus of elasticities are 25 GPa and 200 GPa for concrete and steel, respectively. Knowing that a bending moment of 4.5 kNm is applied to each 0.3 m width of the slab, determine:

(i) The maximum stress in the concrete.

(5 marks)

(ii) The stress in the steel.

(5 marks)

(c) The thin-walled extruded beam shown in **Figure Q2(c)** is made of aluminium and has a uniform 3 mm wall thickness. Knowing that the shear in the beam is 5 kN, determine:

(i) The shearing stress at point A.

(5 marks)

(ii) The maximum shearing stress in the beam.

(5 marks)

Q3 (a) Briefly explain, what is the difference between the double integration and Macaulay's method for determining deflection and slope in beam structures?

(3 marks)

(b) As shown in **Figure Q3(a)**, a uniform distributed load of 20 kN/m is applied to the centre of the beam. The cross section of the beam is shown in **Figure Q3(b)**. The beam has the modulus of elasticity of E = 200 GPa. By using the Macaulay's method,

(i) Determine the equations of slope and deflection.

(10 marks)

(ii) Determine the maximum deflection in the beam.

(3 marks)

(iii) Determine the slope at point A.

(2 marks)

(c) A cantilever beam with the length of 4 m is shown in **Figure Q3(c)**. In this beam, a uniform distributed load of 10 kN/m in the length of BC is applied. Use the moment-area theorem to determine the slope at point B. Take EI as constant.

(7 marks)

Q4 (a) **Figure Q4(a)** shows a steel column with the length of 3.5 m and pin-ended supported at both sides. The steel column has a rectangular cross section (100 mm× 200 mm).

(i) Check whether the Eurler's formula is appropriate or not by using condition $\sigma_{cr} \leq \sigma_y$. The yield stress of steel is σ_y = 250 MPa and the Modulus Elasticity of the steel is 200 GPa. Use factor of safety of 3.5 for buckling.

(10 marks)

(ii) Determine the largest allowable load (P_{allaw}) and critical load that can be applied.

(3 marks)

(b) A compound steel column consists of two square concrete segments is shown in **Figure Q4(b)**. Segment 1 has 100 mm edges and segment 2 has 150 mm edges. The column is subjected to torques of T_B = 8 kNm and T_C = 12 kNm to act in the direction given in **Figure Q4(b).** Take G_{steel} = 81GPa.

(i) Determine maximum shear stress and angle of twist at point C.

(7 marks)

(ii) In your opinion, what shapes of cross section that prone to torsional bucking. Provide your judgements.

(5 marks)

– END OF QUESTIONS –

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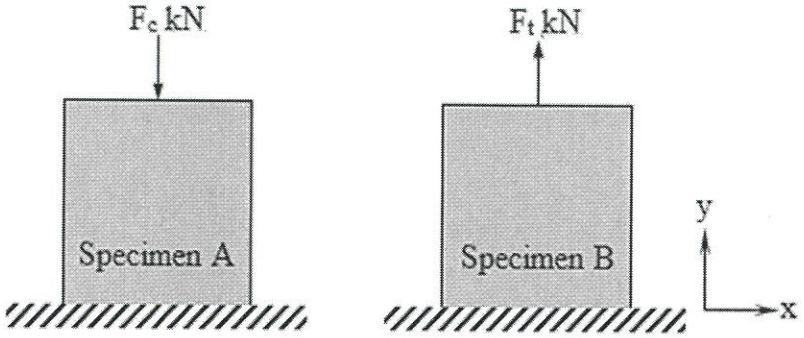

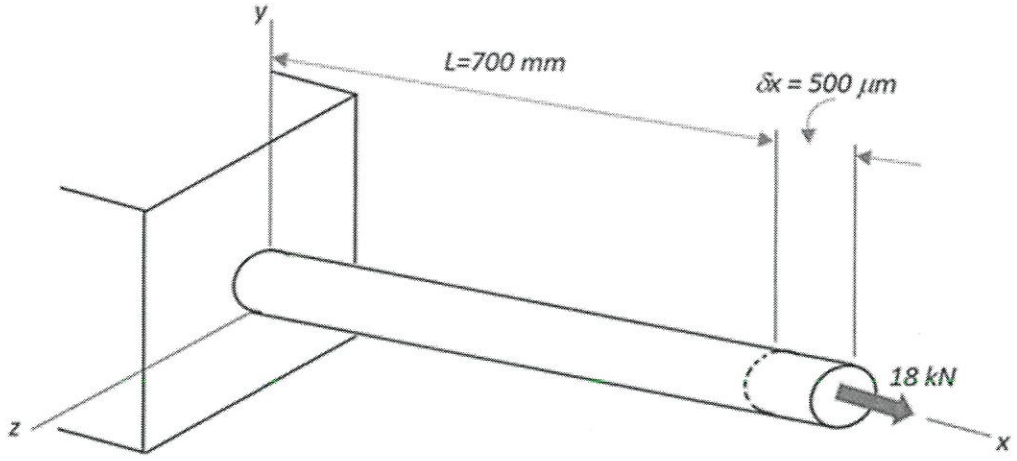

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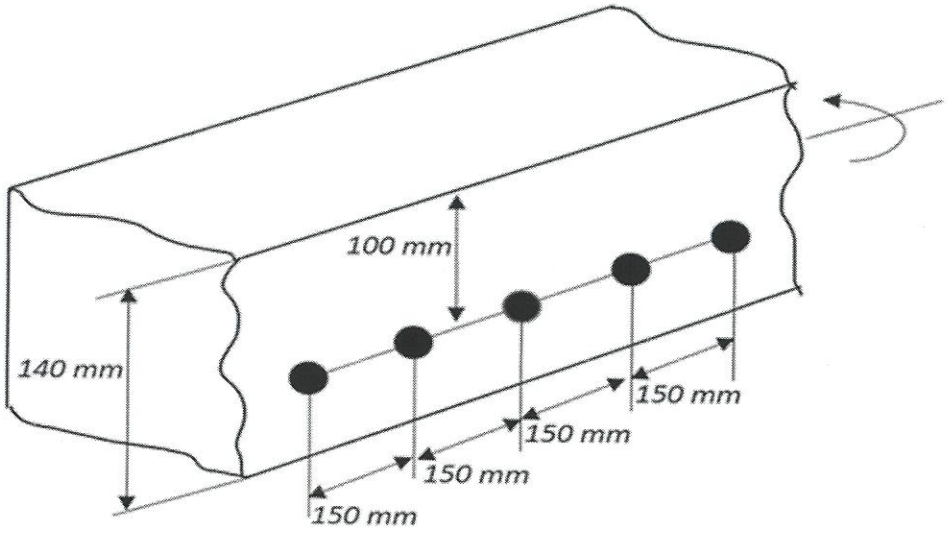

FIGURE Q2(b)

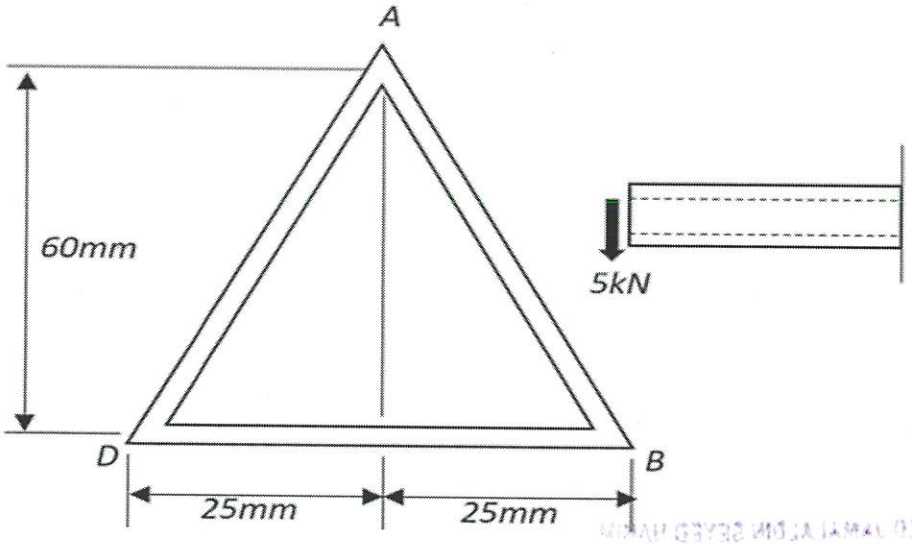

FIGURE Q2(c)

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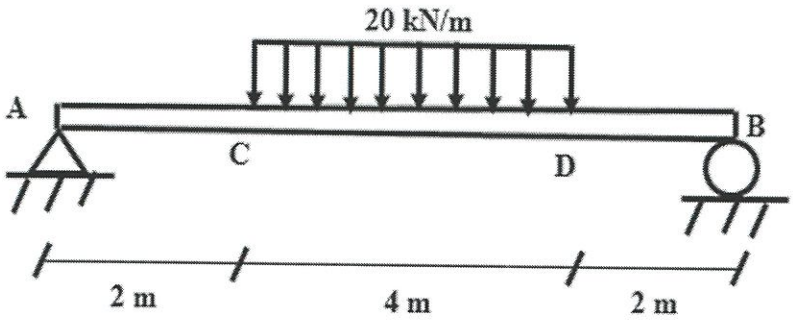

FIGURE Q3(a)

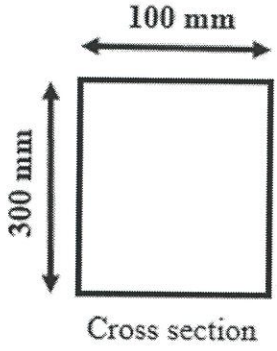

FIGURE Q3(b)

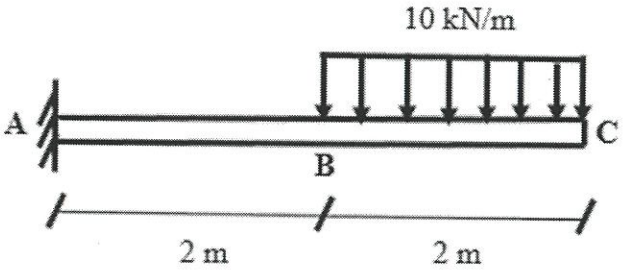

FIGURE Q3(c)

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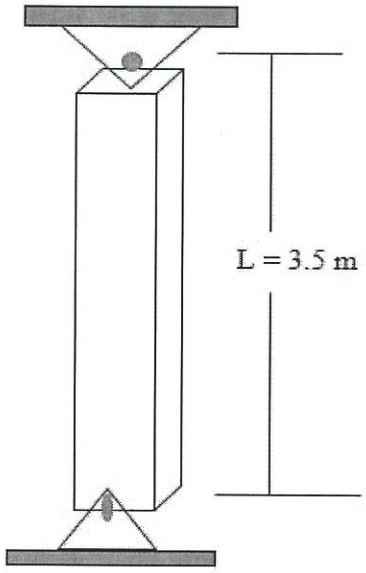

FIGURE Q4(a)

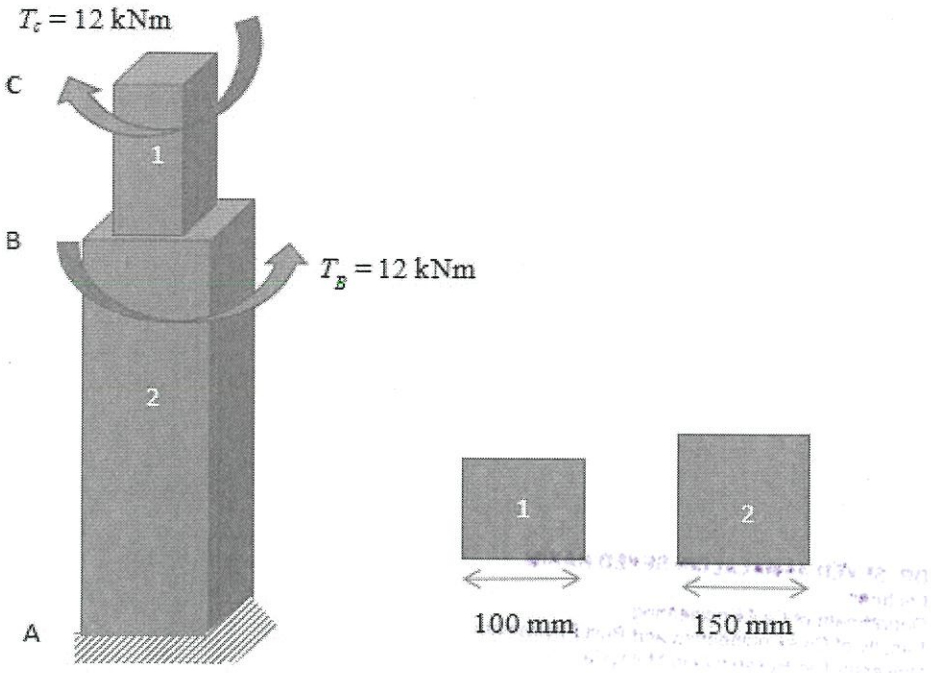

FIGURE Q4(b)