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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020**

COURSE NAME : MECHANICS OF MATERIAL
COURSE CODE : BFC20903
PROGRAMME CODE : BFF
EXAMINATION DATE : DECEMBER 2019/ JANUARY 2020
DURATION : 3 HOURS
INSTRUCTION : ANSWER ALL QUESTIONS

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THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

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- Q1** (a) Define with formulas and aid of sketches the following terms;
- (i) Normal stress (3 marks)
 - (ii) Shear stress (3 marks)
- (b) **Figure Q1** shows a state of plane stress. Using Mohr's circle method, plot and determine the following items:
- (i) Construct the Mohr's circle (3 marks)
 - (ii) Principal stresses and their orientations (6 marks)
 - (iii) Maximum shearing stress and its orientation (4 marks)
 - (iv) Normal and shearing stresses (σ_x , σ_y , τ_{xy}) after the element is rotated counter clockwise at 60° . (6 marks)
- Q2** (a) The simply supported beam AB in **Figure Q2(a)** is subjected to two static loads of P and 2P at C and D respectively.
- (i) Calculate the force reactions at A and B in terms of P (4 marks)
 - (ii) Draw the shear force diagram (2 marks)
 - (iii) Draw the bending moment diagram (2 marks)
- (b) If beam AB has a cross sectional size as shown in **Figure Q2(b)**, determine:
- (i) The location of the neutral axis (y') from the bottom of the beam (3 marks)
 - (ii) The moment of inertia, I in (m^4) (5 marks)
 - (iii) The value of load P in (kN) if the allowable shear stress $\tau_{allow} = 3$ MPa. (5 marks)

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- (c) Using the value of P from **Q2(b)**, calculate:
- (i) The maximum compressive stress (in MPa) (2 marks)
 - (ii) The maximum tensile stress (in MPa) (2 marks)

Q3 (a) (i) Calculate all reactions of simply supported beam in **Figure Q3(a)** (4 marks)

- (ii) By using the Double Integration Method and identifying all boundary condition, prove the maximum deflection occurred at $x = L/2$ for beam AB in **Figure Q3(a)** is given by

$$y_{max} = \frac{-PL^3}{48EI}$$

(6 marks)

- (iii) Determine the size of a solid rectangular sawn timber beam, if the maximum deflection is $y_{max} = 10$ mm. Given,

M_{max}	= 5 kNm
L	= 3 m
E_{timber}	= 13000 N/mm ²

(8 marks)

(b) **Figure Q3(b)** show a steel frame bus stop built in UTHM. The frame is made of a circular hollow section.

- (i) Determine the reaction torque at point A and D. (2 marks)
- (ii) Calculate the maximum and minimum shear stresses at segment AB. Given,

$d_{outside}, d_o$	= 88.9 mm
d_{inside}, d_i	= 82.55 mm.

(5 marks)

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- Q4** (a) From Euler's theory, derive the expression critical load $P_{cr} = \pi^2 EI/L^2$ for column with pin-pin supports. (10 marks)
- (b) **Figure Q4** shows a 12 m column built from S275 grade UC section ($I_y = I_z = 642 \times 10^6 \text{ mm}^4$). The column is pin ended and is laterally restrained against buckling in the minor axis at three points along the height of the column.
- (i) Calculate the critical load in both axes (x and y axis). (12 marks)
- (ii) Identify which axis is likely for the column to buckle. (3 marks)

END OF QUESTIONS

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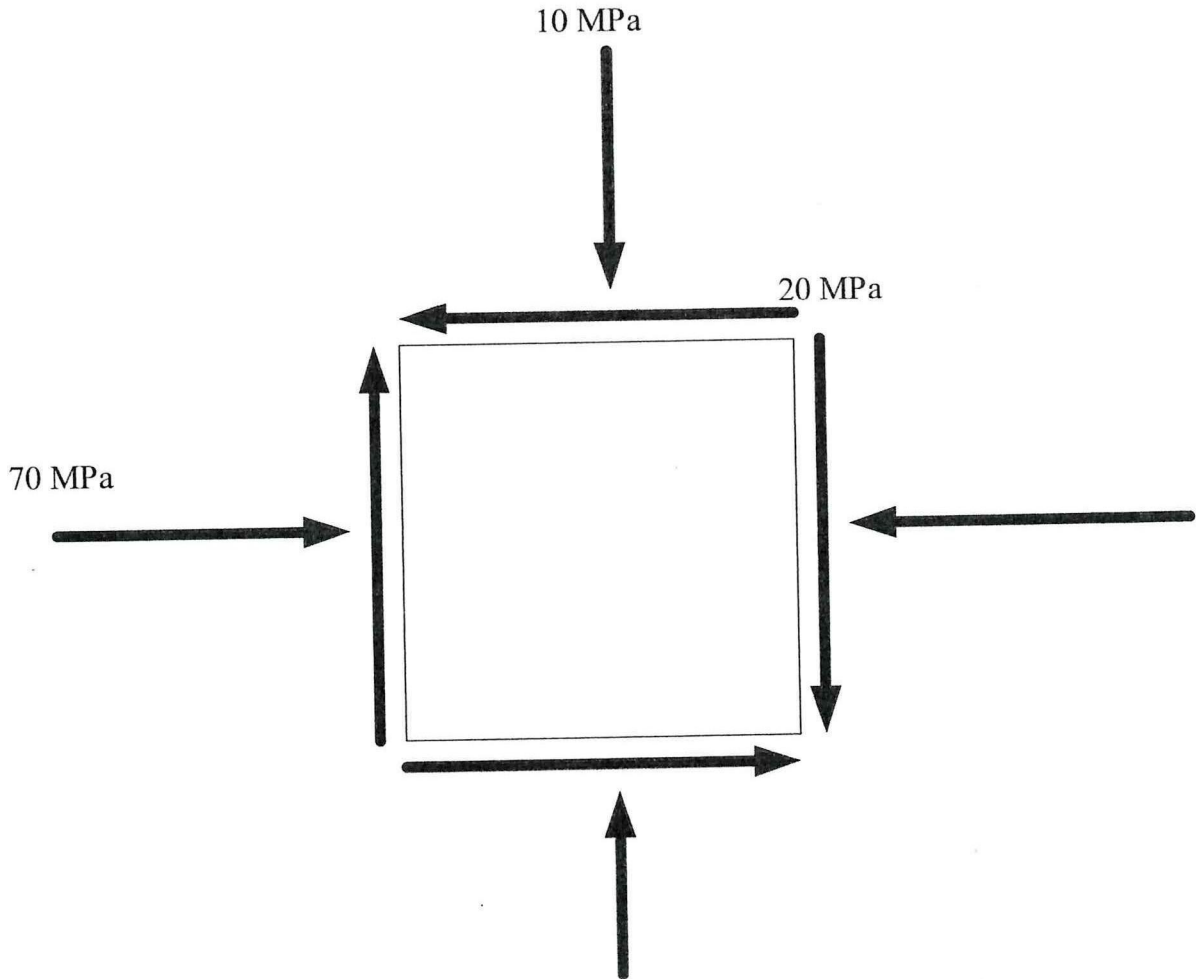


FIGURE Q1

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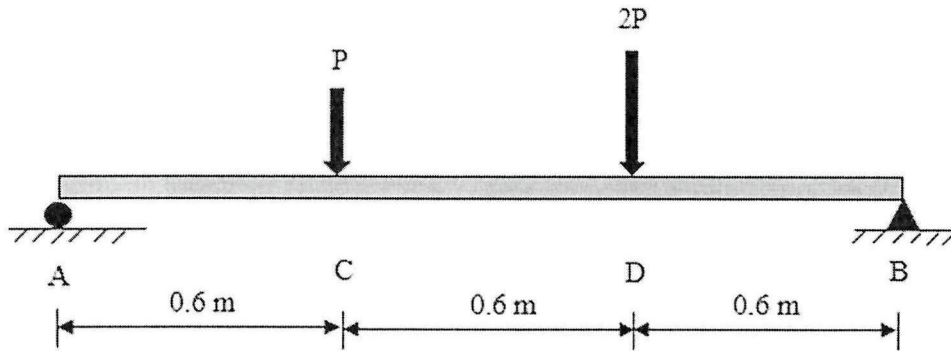
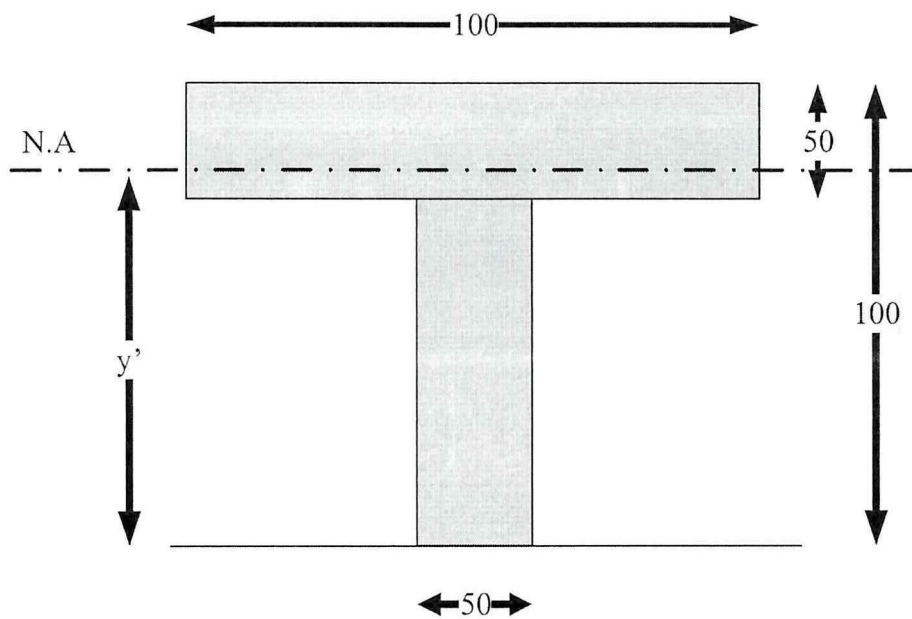


FIGURE Q2(a)



Alls unit in (mm)

FIGURE Q2(b)

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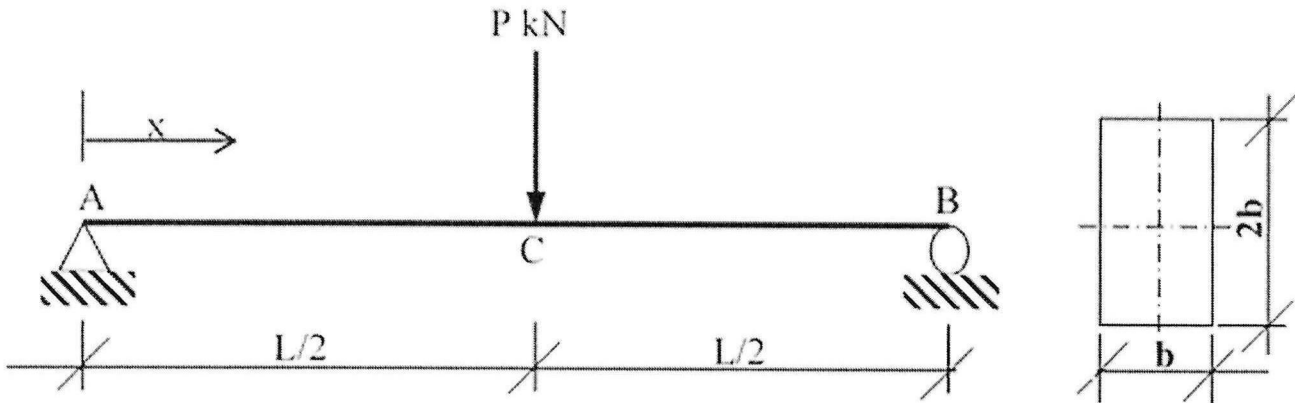


FIGURE Q3 (a)

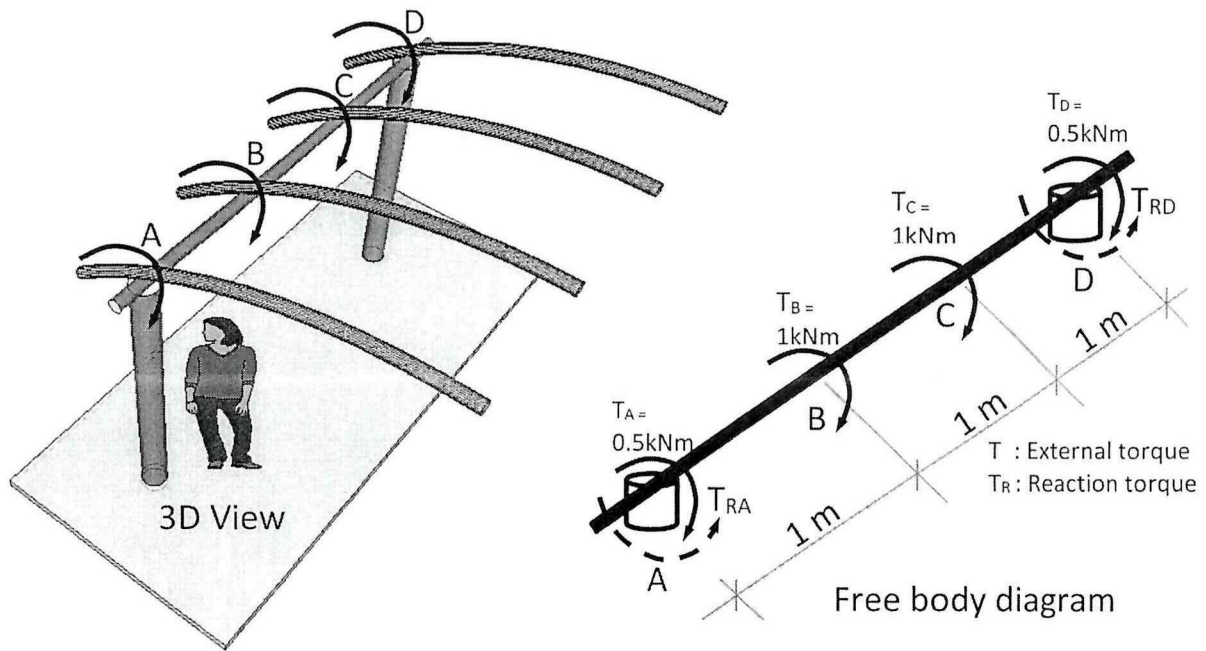


FIGURE Q3(b)

$$J = \frac{\pi}{32} (d_o^4 - d_i^4)$$

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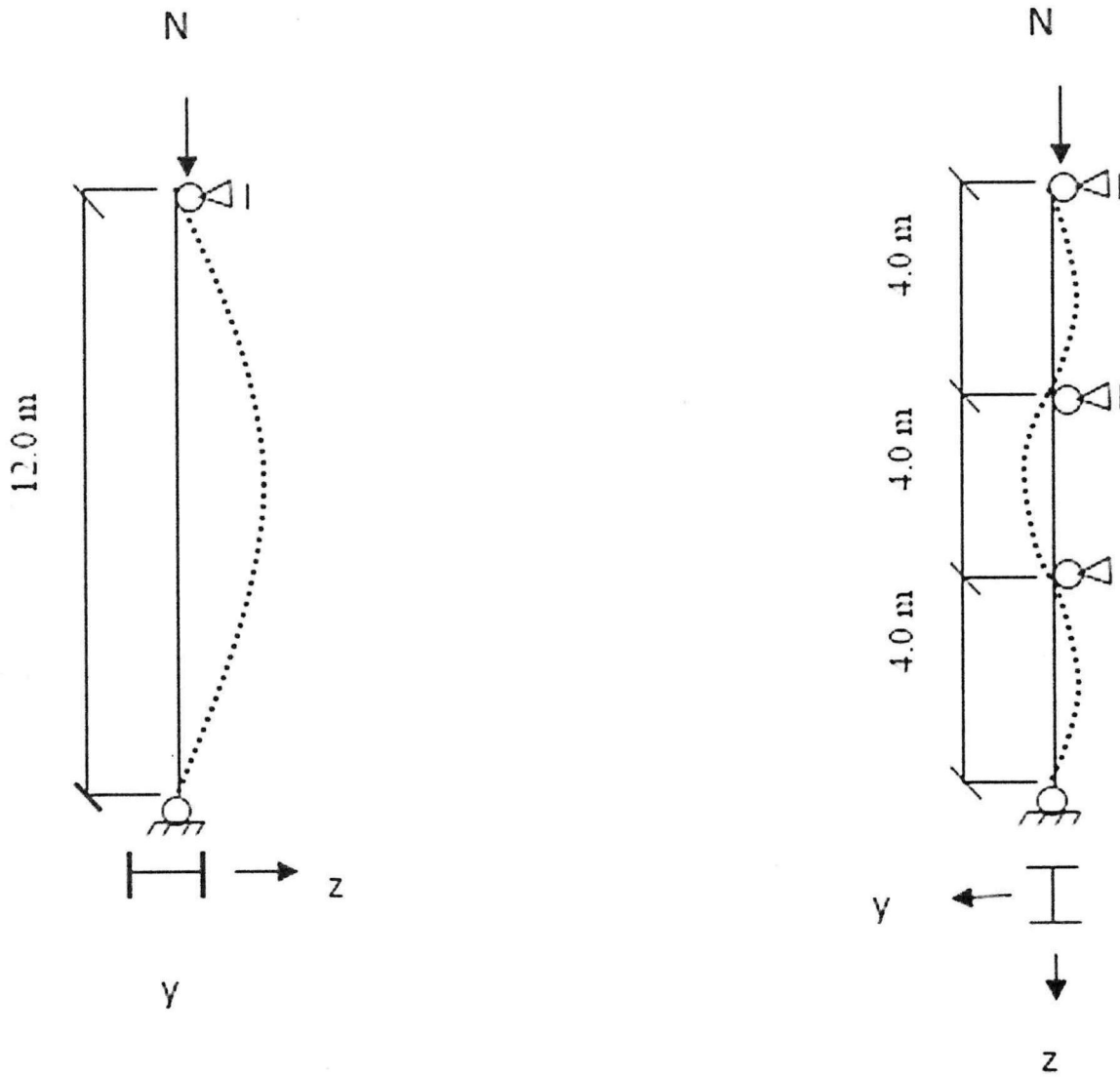


FIGURE Q4

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