Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	MECHANICS OF MATERIALS
COURSE CODE	:	BFC 20903
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	DECEMBER 2018 / JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) In mechanics, the materials are broadly divided into ductile and brittle materials. Briefly describe about these two types of material.

(6 marks)

(b) An aluminium rod ABC shown in **Figure Q1(a)** with Young's Modulus, E = 70 GPa consists of two cylindrical portion of AB and BC. The aluminium rod is to be replaced by a cylindrical steel rod DE with E of 200 GPA. Determine the minimum diameter, d, of the steel rod if its vertical deformation is not to exceed the deformation of the aluminium rod under the same load and the allowable stress in the steel rod is not to exceed 165 MPa.

(4 marks)

(c) **Figure Q1(b)** shows a plane stress rotated 25° counterclockwise. Using related equations, calculate the stress (σ_x, σ_y, τ_{xy}) before the plane is rotated.

(15 marks)

Q2 A simply supported beam shown in **Figure Q2(a)** is loaded with uniformly distributed load of 5 kN/m from A to B, concentrated load of 6 kN at C and moment of 2 kNm at D. The cross section of the beam is shown in **Figure Q2(b).**

(a) Draw the shear force diagram (SFD) and bending moment diagram (BMD) of the beam.

(10 marks)

(b) Calculate the minimum depth, d of the beam's cross sectional area if the beam has an allowable bending stress, σ_{allow} of 11.45 MPa.

(8 marks)

(c) Determine the shear flow at bolt **F** as indicated in **Figure Q2(b)**.

(7 marks)

Q3 (a) **Figure Q3(a)** shows a simply supported beam subjected to an applied bending moment M_o at B. By using the Double Integration method;

(i) Draw the free body diagram and calculate the reactions at supports A and B.

(2 marks)

(ii) Draw the elastic curve and derive the moment function M

(2 marks)

(iii) Derive the slope ($\frac{dv}{dx}$) and deflection (v) equations

(2 marks)

(iv) Determine the boundary conditions

(3 marks)

(v) Calculate the two constants C1, C2

(3 marks)

(vi) Compute the maximum slope and deflection of the beam

(3 marks)

(b) Prove that the torsion formula for a solid circular shaft shown in **Figure Q3(b)** is given by the torsion formula below:

$$\tau_{\max} = \frac{Tc}{J}$$

where T = internal torque, c = maximum radius of shaft and J = polar moment of inertia.

(5 marks)

(c) **Figure Q3(c)** is a circular hollow pipe with an outer diameter of 40 mm and inner diameter of 37 mm. The shaft is subjected to an external torsional force of 30 Nm, 20 Nm and 80 Nm at point B, C and D respectively. From the torsion formula, calculate the maximum shear stress of the hollow pipe.

(5 marks)

Q4 (a) Sketch and define the effective length of the column for the following support conditions:

i. Fixed and Free
ii. Fixed and Fixed
iii. Pinned and Fixed

(9 marks)

(b) A steel column with size of W200 × 46 of 4 m length are pin-connected at both ends. Given $E_s = 200$ GPa, $\sigma_y = 250$ MPa, area of cross section = 5890 mm^2, $I_x = 45.5 \times 10^6$ mm^4 and $I_y = 15.3 \times 10^6$ mm^4.

(i) Calculate the critical load, P_{cr}, buckling at the lowest moment of inertia.

(6 marks)

(ii) Check whether the Euler's equation is appropriate or not.

(4 marks)

(iii) Calculate the new axial load, P_{cr}, if the stress exceeds the yield stress.

(6 marks)

- END OF QUESTIONS -

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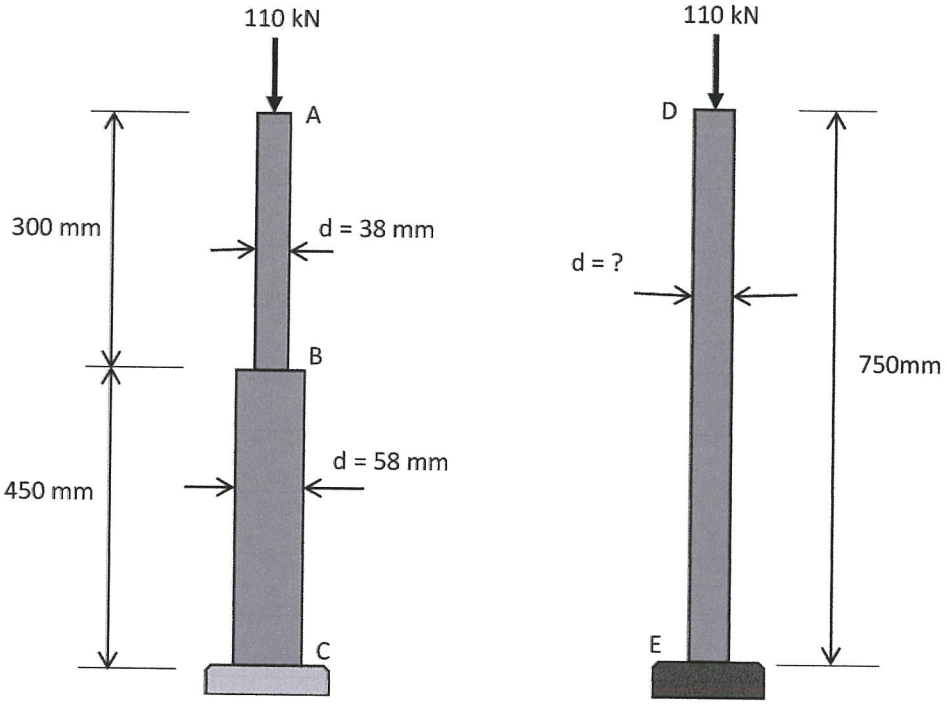

Figure Q1(a)

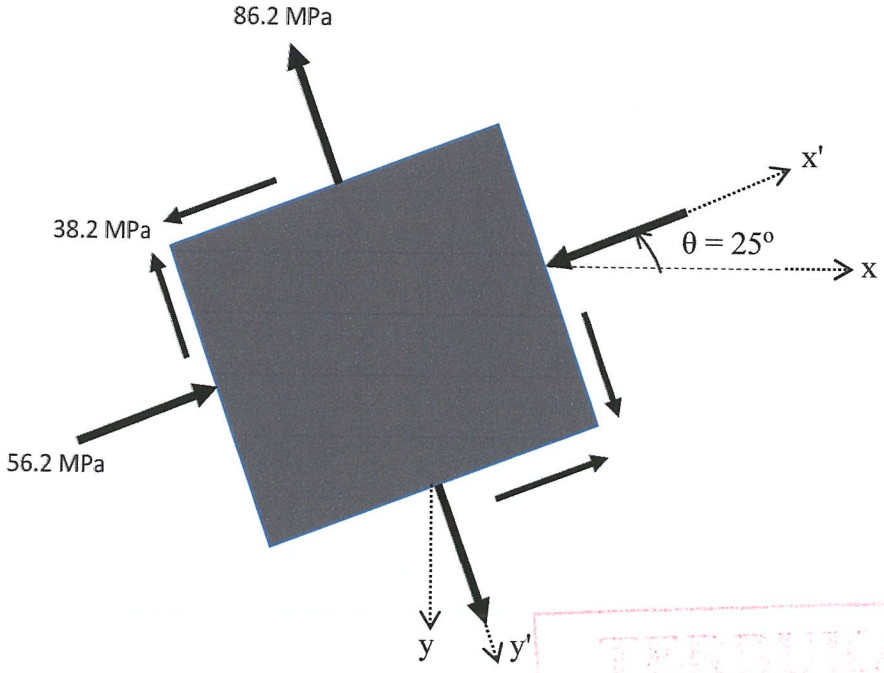

Figure Q1(b)

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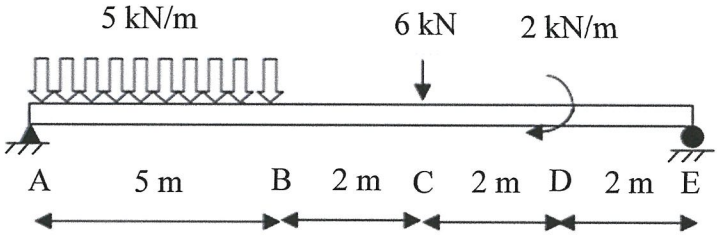

Figure Q2(a)

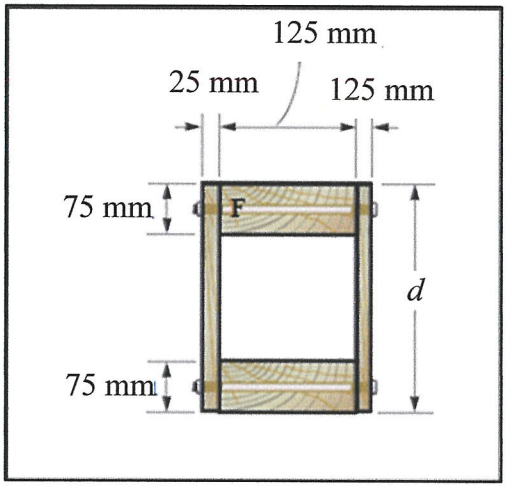

Figure Q2(b)

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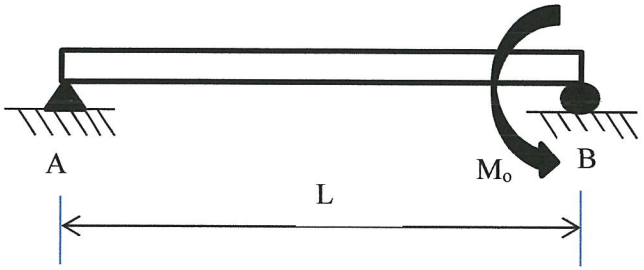

Figure Q3(a)

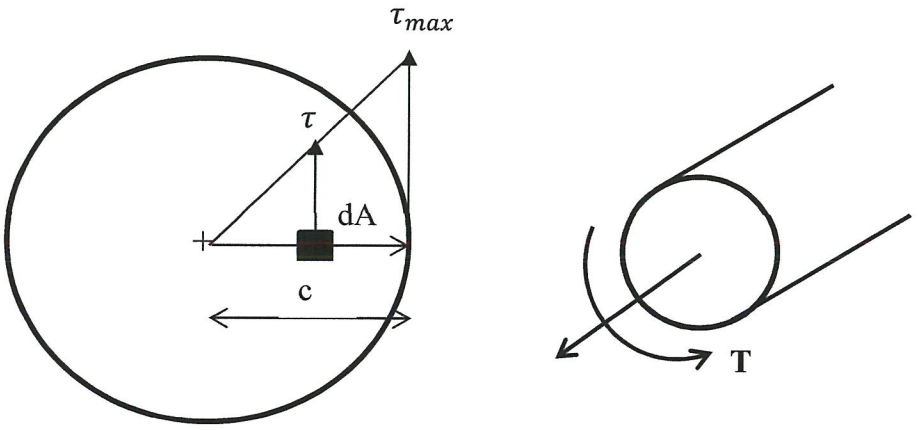

Figure Q3(b)

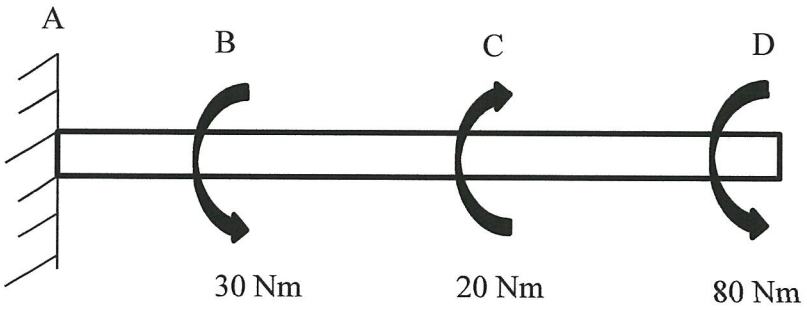

Figure Q3(c)