Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2016/2017

| | | |
|---|---|---|
| COURSE NAME | : | MECHANIC OF MATERIALS |
| COURSE CODE | : | BNP 20203 |
| PROGRAMME | : | BNA/BNB/BNC |
| EXAMINATION DATE | : | DECEMBER 2016/ JANUARY 2017 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER **FOUR (4)** QUESTIONS ONLY |



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

**Q1** (a) With the aid of suitable diagrams, explain the following term:

(i) normal stress

(2 marks)

(ii) shear stress

(3 marks)

(b) A plane element is subjected to a set of stresses as shown in **Figure Q1(b)** .

(i) Determine the principal stresses and the locations of the planes where they occur.

(5 marks)

(ii) Determine the maximum shearing stresses and the locations of the planes where they occur.

(5 marks)

(iii) Determine the normal and shearing stresses at a plane making an angle of $45^{0}$ measured from the x-plane.

(5 marks)

(iv) Prove the answers from (a)-(c) by using Mohr circle.

(5 marks)

**Q2** Uniformly distributed load of 30 kN/m are applied to a beam of the cross section as shown in **Figure Q2(a)**. The cross section of the beam is shown in **Figure Q2(b)**.

(i) Determine the maximum bending stress in the beam.

(10 marks)

(ii) Calculate the moment resistance of the beam at a bending stress of 165 $N/mm^2$.

(10 marks)

(iii) Determine the radius of curvature at the point of maximum bending moment.

(5 marks)

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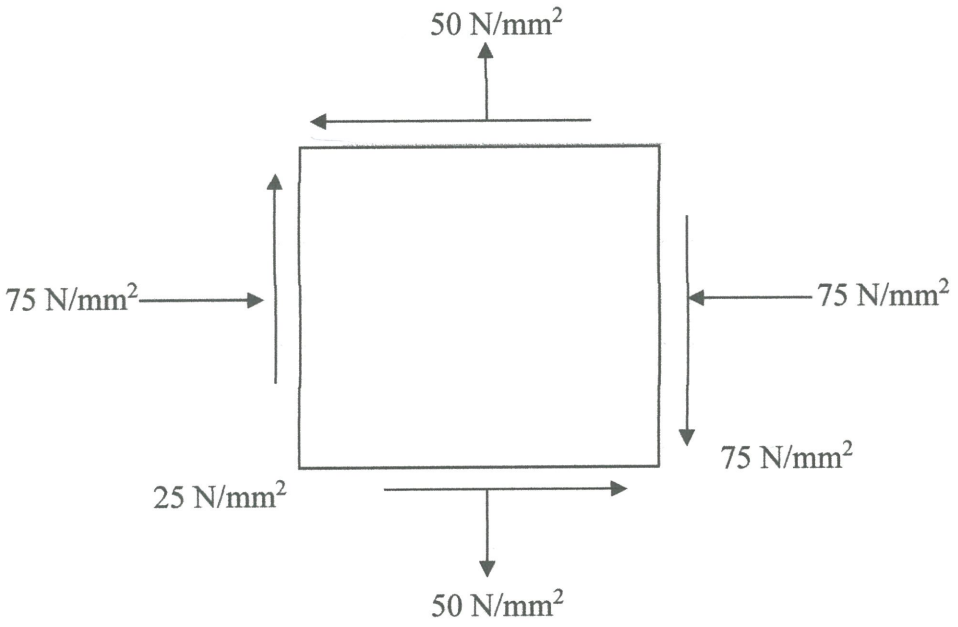


**Figure Q1(b)**

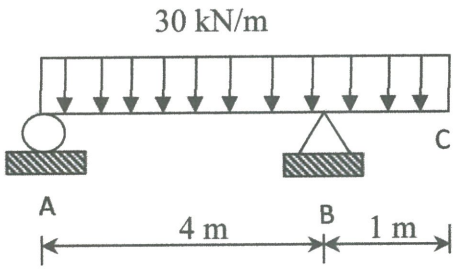


**Figure Q2(a)**

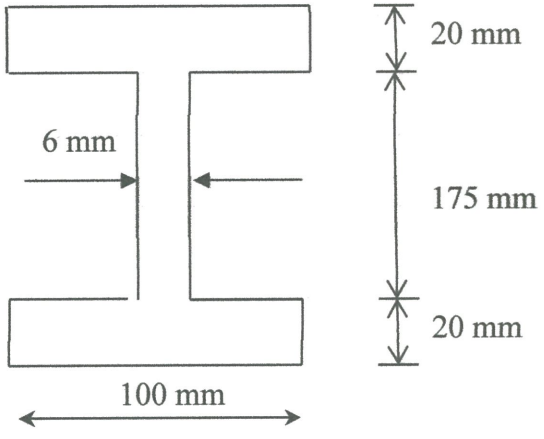


**Figure Q2(b)**

**Q3** A simply supported beam with 10 m span length subjected to a distribution load 2 kN/m and two points loads of 5 kN and 4 kN shown in **Figure Q3(a)**. Point A and B can be denoted as pinned and roller support of beam, respectively. Assume the Young's Modulus, E is 200 x $10^6$ kN/m$^2$. Solve the problems by using Macaulay's method.

(i) Define reaction force and moment function of beam.

(4 marks)

(ii) Determine the boundary condition at point A and B.

(2marks)

(iii) Derive the general equation of bending moment, slope-deflection and deflection-equation of the beam.

(8 marks)

(iv) Given moment inertia of beam cross-section Ixx is 16.9 x $10^6$ mm$^4$ and Iyy is 2.7x $10^6$ mm$^4$ . Determine the slope point A and deflection at x=6 from support A.

(11 marks)

**Q4** (a) A Steel with length of 8 m has a cross-sectional dimension as shown in **Figure Q4 (a)**. Given the modulus of elasticity for steel is Est= 200 GPa and yield limit stress, $\sigma_y$ = 250 MPa

(i) Calculate moment of inertia for both x and y axis, of the cross section of column

(8 marks)

(ii) Calculate critical load, Pcr if it is fixed at both ends and check whether the Euler's formula is appropriate or not by using the condition $\sigma_{cr} < \sigma_y$ .

(7 marks)

(b) **Figure Q4 (b)** shows the composite bars with the different material is subjected to the torque. The length of AB is 3 m and the diameter is 100 mm, while the length of BC is 0.4 m with the diameter of 50 mm. By given shear modulus of material AB is 30 GPa and material BC is 80 Gpa. Determine the maximum shear stress and the position. Determine the angle of twist at C.

(10 marks)

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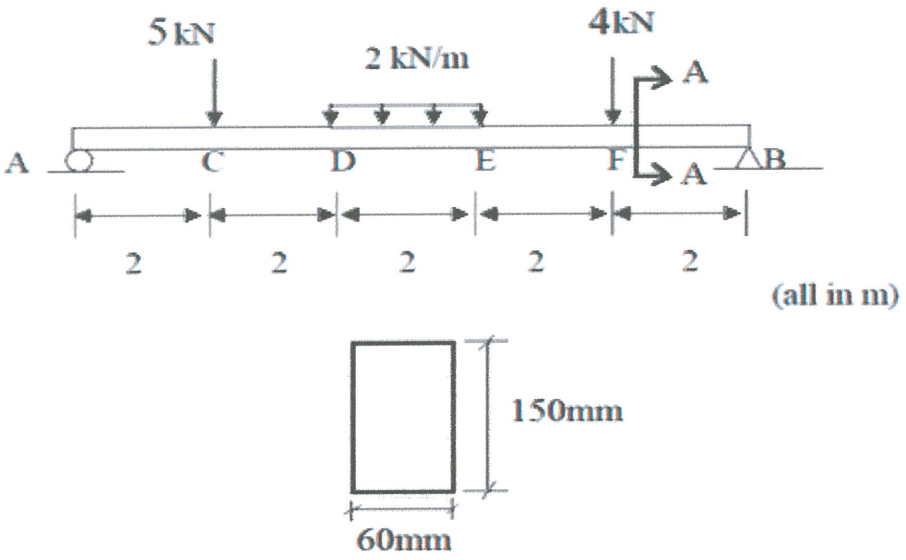


**Figure Q3 (a)**

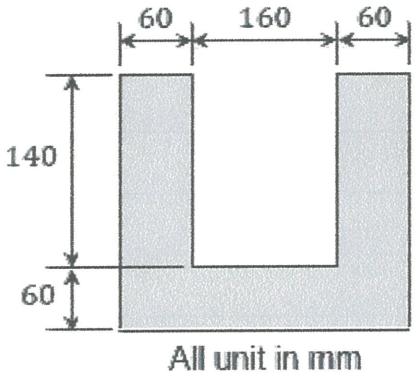


**Figure Q4 (a)**

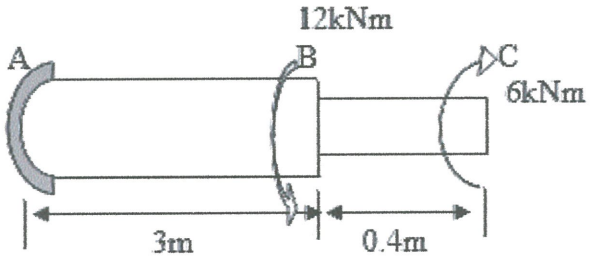


**Figure Q4 (b)**

**Q5** (a) Define the following statement;

(i) Truss Structure

(3 marks)

(ii) Stability and Determinacy

(3 marks)

(b) List **TWO (2)** assumptions of analysis to determine the member's force of the truss.

(2 marks)

(c) **Figure Q5 (c)** shows a truss structure which supported by a pin at joint A and a roller at joint B. Vertical load of 10 kN and horizontal load 8kN are applied at joint F and C respectively. Using Method of Joints, determine the following statement;

(i) Determine the stability and determinacy of the truss structure.

(2 marks)

(ii) Calculate the reaction force at Joint A and joint B.

(2 marks)

(iii) The wooden headframe is subjected to the loading shown in **Figure Q5 (c)**. Determine the force in member ED, ID and DC only. State if the members are in tension or compression.

(13 marks)



**- END OF QUESTIONS -**

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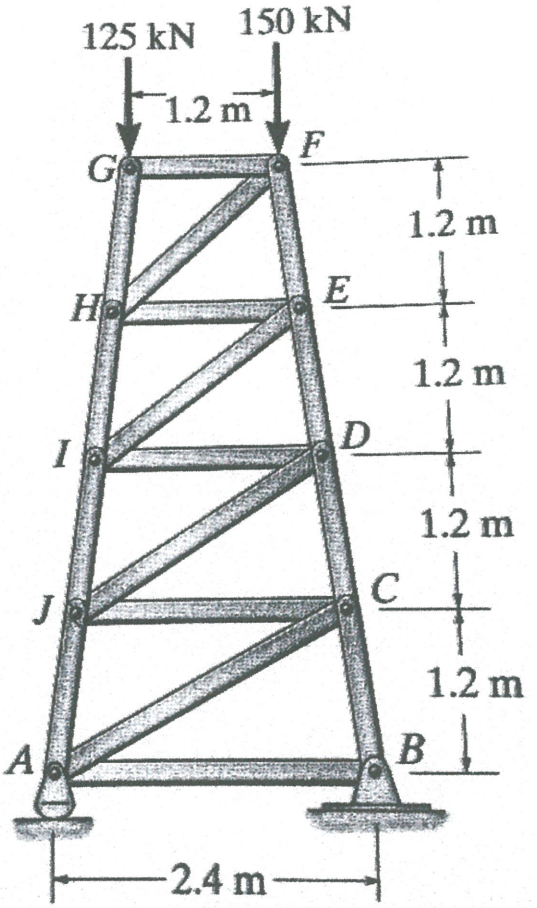


**Figure Q5 (c)**





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## LIST OF EQUATIONS

1. $\sigma = \frac{P}{A}$
2. $\tau = \frac{P}{A}$
3. $\varepsilon = \frac{\delta}{L}$
4. $\sigma = E\varepsilon$
5. $\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$
6. $\sigma_{y'} = \frac{\sigma_x + \sigma_y}{2} - \frac{\sigma_x - \sigma_y}{2} \cos 2\theta - \tau_{xy} \sin 2\theta$
7. $\tau_{x'y'} = -\frac{\sigma_x - \sigma_y}{2} \sin 2\theta + \tau_{xy} \cos 2\theta$
8. $I_x = \frac{bh^3}{12}$ ; $I_y = \frac{b^3h}{12}$ ; $I_{circle} = \frac{\pi d^4}{64}$
9. $\sigma = \frac{My}{I}$
10. $Pcr = \frac{\pi^2 EI}{(2L)^2}$