CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	ADVANCED STRUCTURAL ANALYSIS
COURSE CODE	:	BFS40103
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE 2018 / JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) **Figure Q1(a)** shows a simply supported beam carrying three concentrated loads at points B, C, and D. Determine the displacement at point C due to all the concentrated loads.

(7 marks)

(b) An indeterminate frame shown in **Figure Q1(b)** is subjected to a horizontal force of 50 kN at point D and uniformly distributed load of 20 kN/m along member BC. EI for member AB is two times of member BC.

(i) Determine the reactions at supports A and C. Take support C as redundant.

(12 marks)

(ii) Sketch the shear force and bending moment diagrams.

(6 marks)

Q2 (a) For the two member truss shown in **Figure Q2(a)**, determine the reaction forces at node 1 and node 3. Given displacement at Joint 2 is:

$$\begin{Bmatrix} d_1 \\ d_2 \end{Bmatrix} = \begin{Bmatrix} 4.505/AE \\ -19.003/AE \end{Bmatrix}$$

(14 marks)

(b) Two connected steel bars as shown in **Figure Q2(b)** are axially loaded with 100 N at node 3. The cross section area for bar B is half of bar A. The horizontal displacement at node 2 is half of displacement at node 3. By using finite element method, determine the displacement at node 2 and node 3. The modulus of elasticity is constant.

(11 marks)

Q3 (a) What is the difference between short and slender column?

(5 marks)

(b) Derive the Euler equation for:

i. Column with one end fixed and one end free
ii. Column with both ends fixed.

Use sketches to support your answer.

(8 marks)

(c) A column pinned at both ends is as shown in **Figure Q3(c)**. Determine whether the column is slender or not. Assume L_e/r for slender column is > 30. Given E=23 GPa and safety factor is 2. Determine the safe load for the column.

(12 marks)

Q4 The rigid-jointed frame is loaded with working loads as shown in **Figure Q4**.

(a) List **THREE (3)** conditions that must be satisfied by a structure in its collapsed state.

(6 marks)

(b) Find the maximum plastic moment, M_p.

(19 marks)

Q5 (a) Explain the following terms;

(i) Orthotropically reinforced slab

(ii) Isotropically reinforced slab

(6 marks)

(b) A rectangular slab, simply supported along all four edges, is isotropically reinforced to give a yield moment of 27kN/m per metre width of slab. The slab measures 8 m by 6 m. By considering a reasonable collapse mode, as shown in **Figure Q5(b)**, calculate the value of the uniformly distributed load, q, that would just cause collapse.

(19 marks)

- END OF QUESTIONS -

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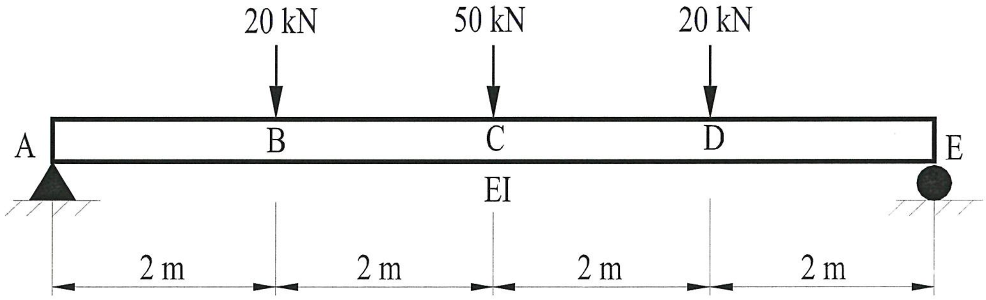

FIGURE Q1(a)

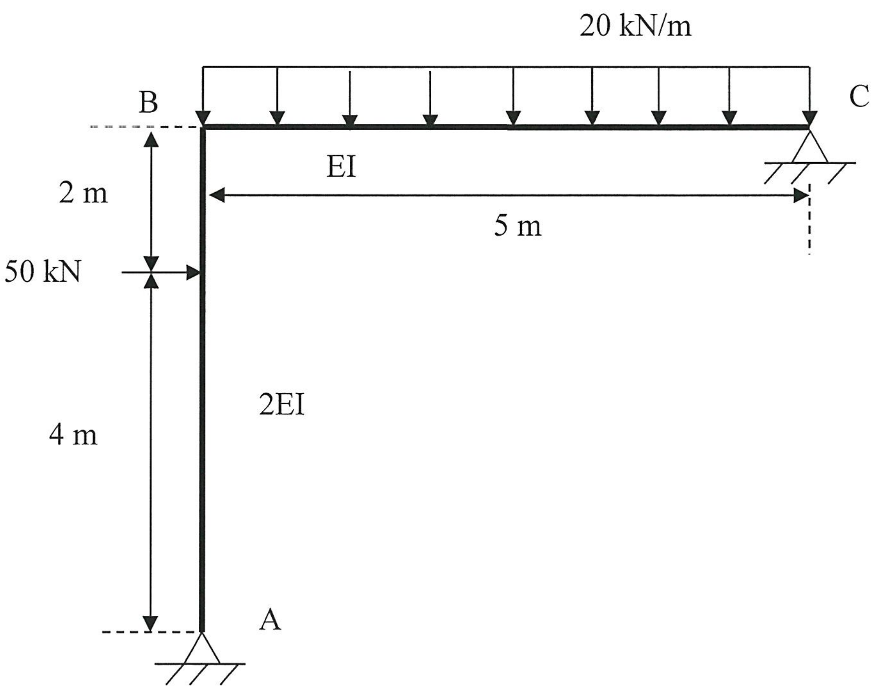

FIGURE Q1(b)

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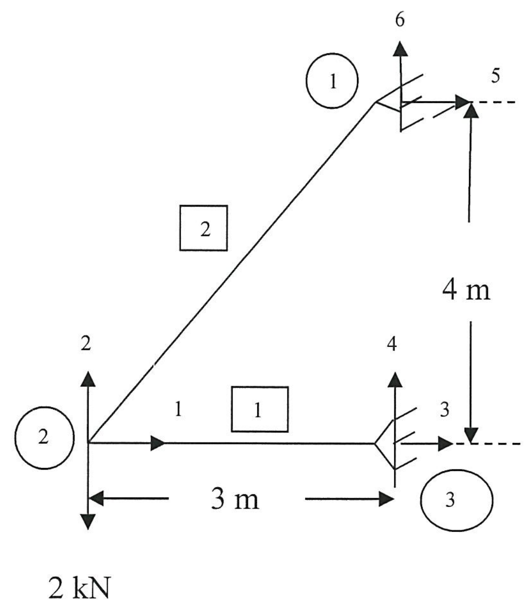

FIGURE Q2(a)

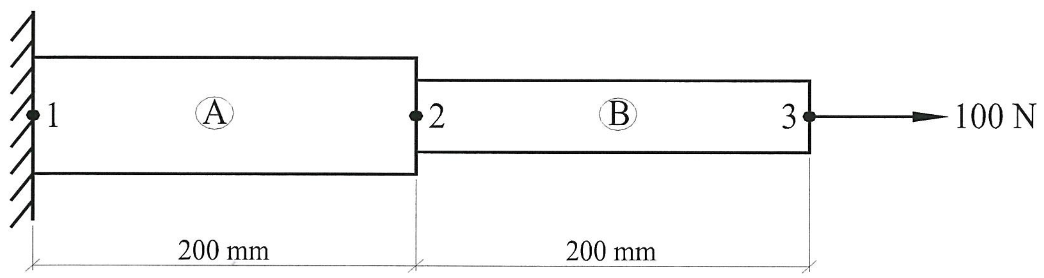

FIGURE Q2(b)

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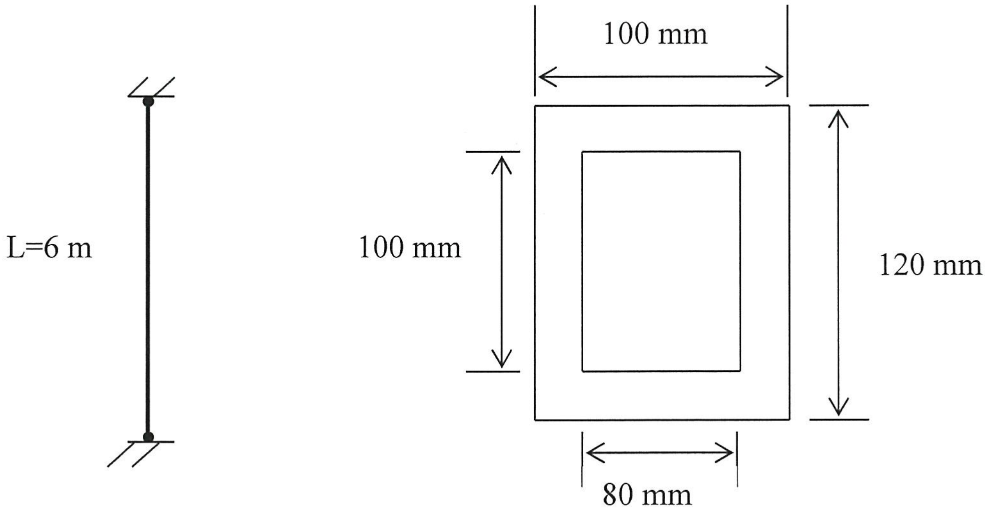

FIGURE Q3(c)

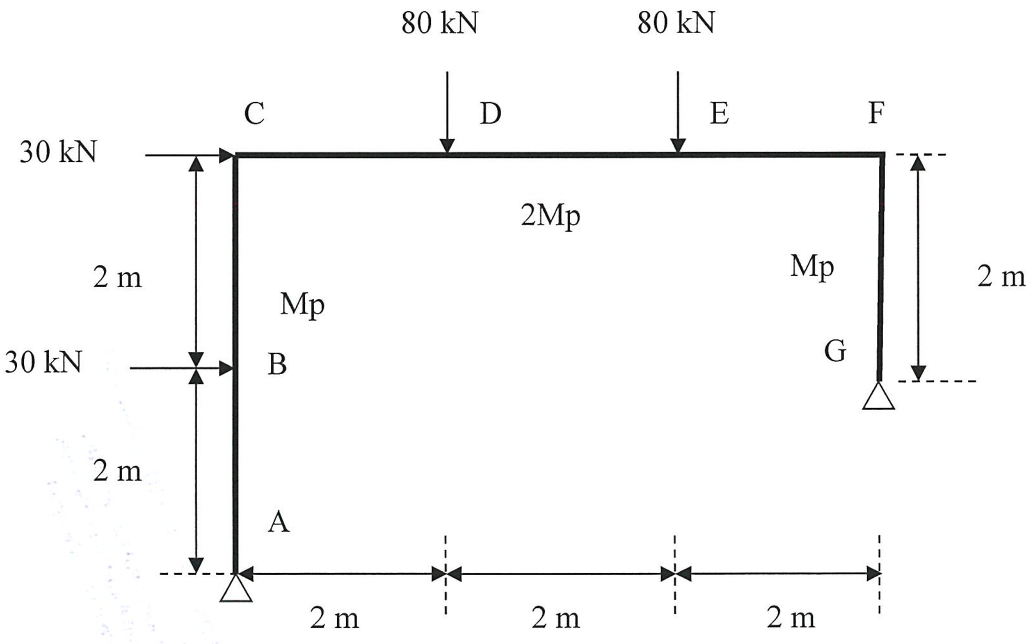

FIGURE Q4

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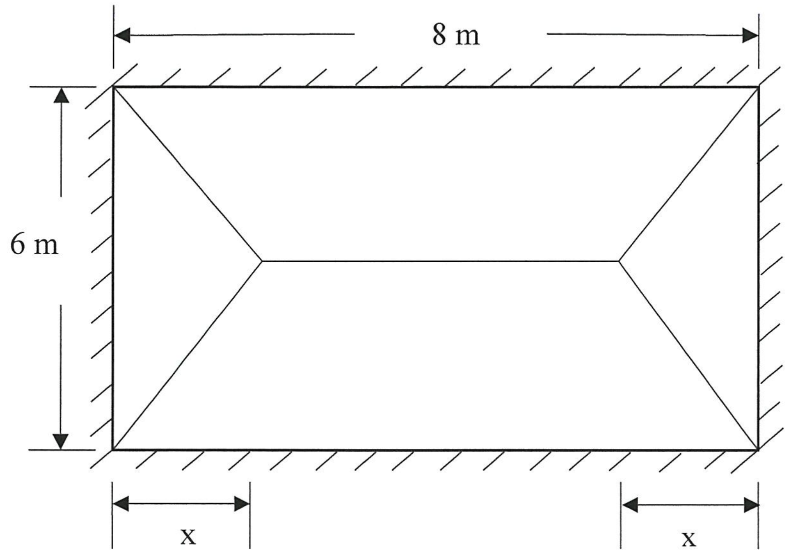

FIGURE Q5(b)

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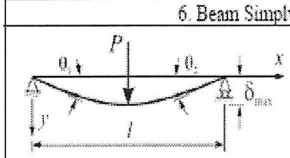
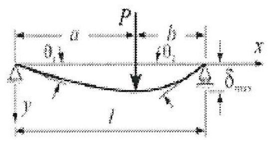
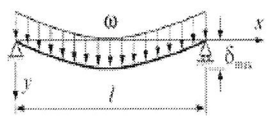
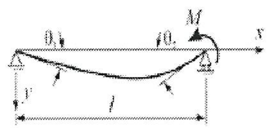
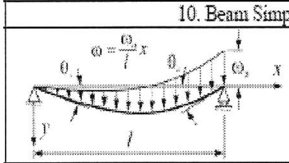
FORMULA

1) Beam Deflection Formulae

BEAM TYPE	SLOPE AT ENDS	DEFLECTION AT ANY SECTION IN TERMS OF x	MAXIMUM AND CENTER DEFLECTION
6. Beam Simply Supported at Ends – Concentrated load P at the center			
	$\theta_1 = \theta_2 = \frac{Pl^2}{16EI}$	$y = \frac{Px}{12EI}\left(\frac{3l^2}{4} - x^2\right)$ for $0 < x < \frac{l}{2}$	$\delta_{max} = \frac{Pl^3}{48EI}$
7. Beam Simply Supported at Ends – Concentrated load P at any point			
	$\theta_1 = \frac{Pb(l^2 - b^2)}{6lEI}$ $\theta_2 = \frac{Pab(2l - b)}{6lEI}$	$y = \frac{Pbx}{6lEI}\left(l^2 - x^2 - b^2\right)$ for $0 < x < a$ $y = \frac{Pb}{6lEI}\left[\frac{l}{b}(x-a)^3 + \left(l^2 - b^2\right)x - x^3\right]$ for $a < x < l$	$\delta_{max} = \frac{Pb\left(l^2 - b^2\right)^{3/2}}{9\sqrt{3}\,lEI}$ at $x = \sqrt{\left(l^2 - b^2\right)/3}$ $\delta = \frac{Pb}{48EI}\left(3l^2 - 4b^2\right)$ at the center, if $a > b$
8. Beam Simply Supported at Ends – Uniformly distributed load ω (N/m)			
	$\theta_1 = \theta_2 = \frac{\omega l^3}{24EI}$	$y = \frac{\omega x}{24EI}\left(l^3 - 2lx^2 + x^3\right)$	$\delta_{max} = \frac{5\omega l^4}{384EI}$
9. Beam Simply Supported at Ends – Couple moment M at the right end			
	$\theta_1 = \frac{Ml}{6EI}$ $\theta_2 = \frac{Ml}{3EI}$	$y = \frac{Mlx}{6EI}\left(1 - \frac{x^2}{l^2}\right)$	$\delta_{max} = \frac{Ml^2}{9\sqrt{3}\,EI}$ at $x = \frac{l}{\sqrt{3}}$ $\delta = \frac{Ml^2}{16EI}$ at the center
10. Beam Simply Supported at Ends – Uniformly varying load: Maximum intensity ω_o (N/m)			
	$\theta_1 = \frac{7\omega_o l^3}{360EI}$ $\theta_2 = \frac{\omega_o l^3}{45EI}$	$y = \frac{\omega_o x}{360lEI}\left(7l^4 - 10l^2x^2 + 3x^4\right)$	$\delta_{max} = 0.00652\frac{\omega_o l^4}{EI}$ at $x = 0.519l$ $\delta = 0.00651\frac{\omega_o l^4}{EI}$ at the center

FORMULA

$$k = \frac{EA}{L}\begin{bmatrix} \lambda_x^2 & \lambda_x\lambda_y & -\lambda_x^2 & -\lambda_x\lambda_y \\ \lambda_x\lambda_y & \lambda_y^2 & -\lambda_x\lambda_y & -\lambda_y^2 \\ -\lambda_x^2 & -\lambda_x\lambda_y & \lambda_x^2 & \lambda_x\lambda_y \\ -\lambda_x\lambda_y & -\lambda_y^2 & \lambda_x\lambda_y & \lambda_y^2 \end{bmatrix}$$