Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	ADVANCED STRUCTURAL ANALYSIS
COURSE CODE	:	BFS 40103
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	DECEMBER 2018/ JANUARY 2019
DURATION	:	3 HOURS
INSTRUCTIONS	:	ANSWER **FOUR (4)** QUESTIONS ONLY

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

Q1 (a) A continuos beam as shown in **FIGURE Q1** is supported by pin at point A and roller at points B, C, and D. The beam is loaded with distributed load of 5 kN/m on its whole span. The load causes support B to settle 0.005 m and support C to settle 0.01 m. The modulus of elasticity, E, of the beam is 200 Gpa and the moment of inertia is 1.35 x 10^{-3} m^4. By using force-displacement method and taking B and C as redundants, determine:

i. Redundant forces R_1 and R_2

(10 marks)

ii. Reactions at supports A, B, C and D

(9 marks)

iii. Draw the bending moment diagram of the beam

(6 marks)

Q2 (a) List and draw **THREE (3)** common types of element used in finite element method.

(6 marks)

(b) A three member truss as shown in **FIGURE Q2(b)** is pinned supported at points A, B and D. Point load of 10 kN is acting downward at point C. Determine:

i. Horizontal and vertical deflections at point C

(12 marks)

ii. Reactions at each support

(7 marks)

Q3 (a) With aid of sketches, derive the Euler equation for:

i. Column with both ends pinned

(12 marks)

ii. Column with one end fixed and one end free

(4 marks)

(b) A column fabricated from aluminum is as shown in **FIGURE Q3(b)**. It is loaded with axial load of 800 N at a centroid of its cross section. Check the safety of the column if safety factor is 2.
Given: Modulus of elasticity, E = 72 GPa
Effective length, Le = 2.0 L

(9 marks)

Q4 (a) Explain briefly **THREE (3)** conditions which must be satisfied to ensure full collapse of a structure.

(6 marks)

(b) **FIGURE Q4(b)** shows the rigid jointed frame pinned at both its supports. The frame is loaded with 100 kN vertical loads at points D and E and 40 kN horizontal loads at points B and C. Determine the value of the collapse load factor when Mp is 120 kNm.

(19 marks)

Q5 (a) Explain the following terms;

i. Orthotropically reinforced slab

ii. Isotropically reinforced slab

(6 marks)

(b) A trapezoidal slab ABCD is simply supported along the two edges, AB and CD, and pinned along BC. The slab is subjected to a uniformly distributed load of 12 kN/m^2 as shown in **FIGURE Q5(b).** Determine the maximum resistance moment for the failure mechanism of the slab if edge EF displaced **ONE (1)** unit.
Given m' = 2m

(19 marks)

- **END OF QUESTIONS** -

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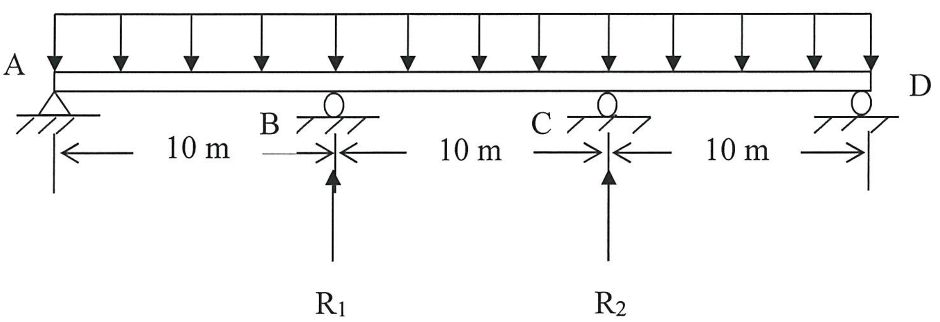

FIGURE Q1

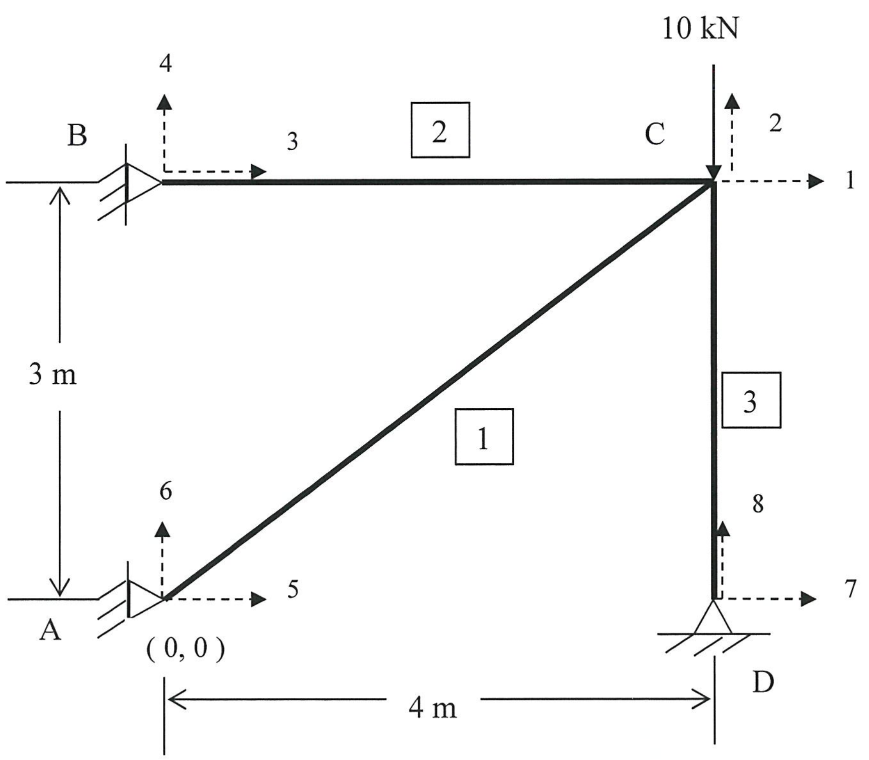

FIGURE Q2(b)

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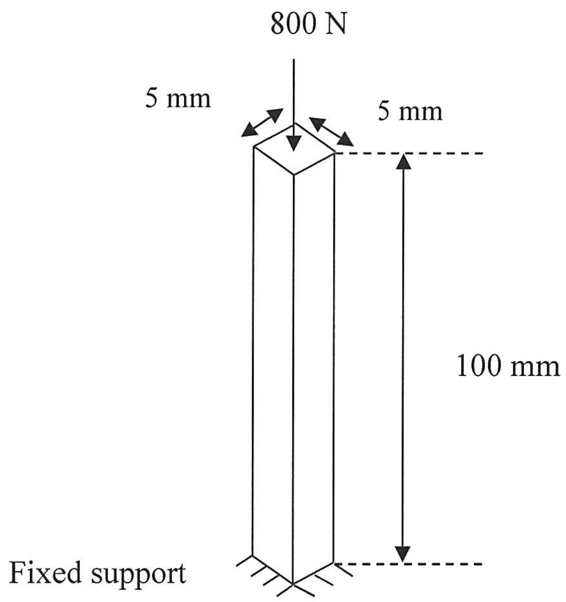

FIGURE Q3(b)

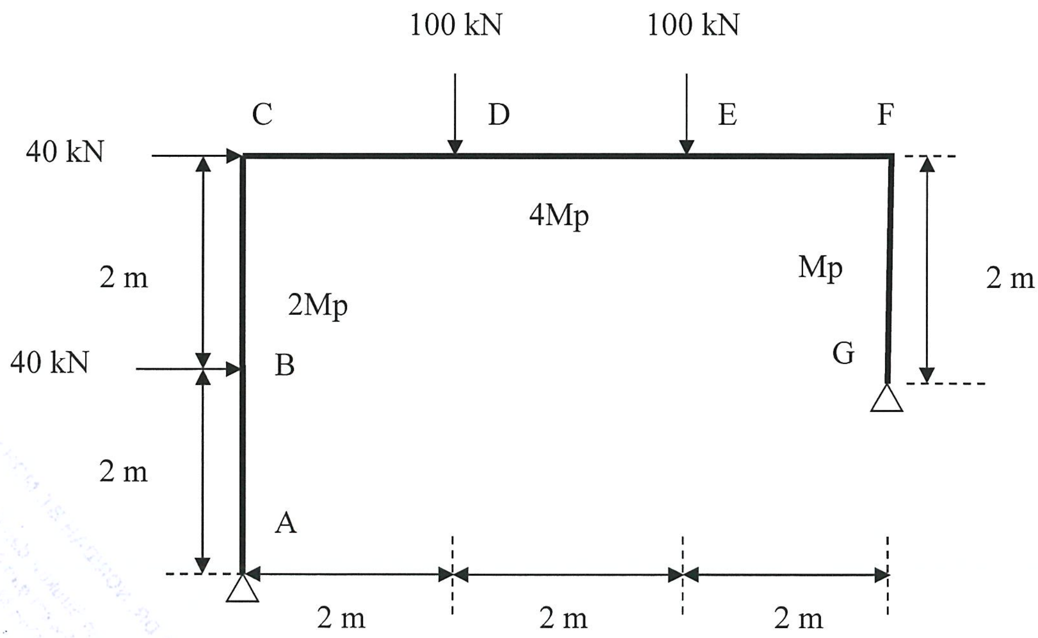

FIGURE Q4(b)

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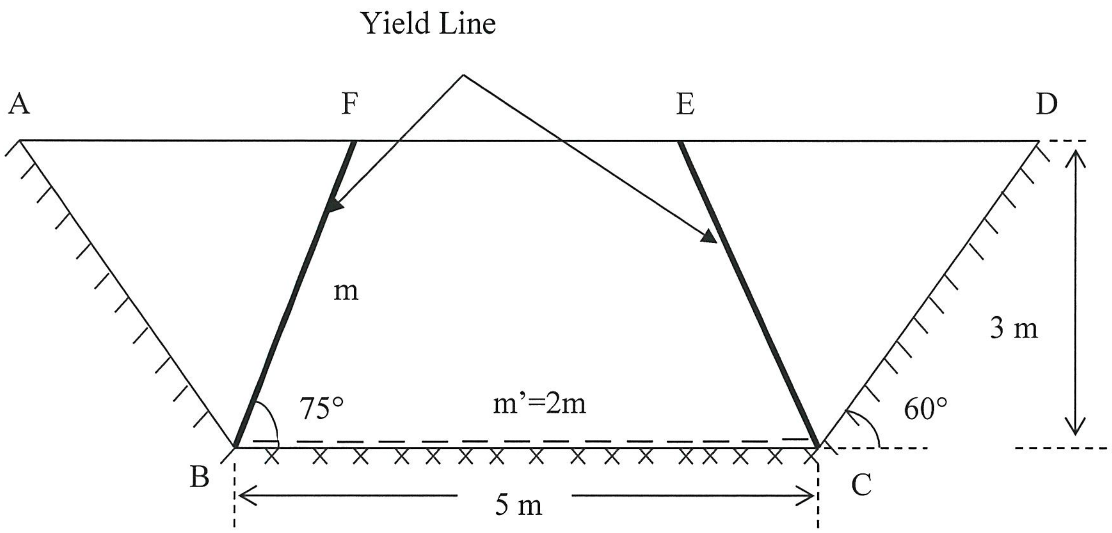

FIGURE Q5(b)

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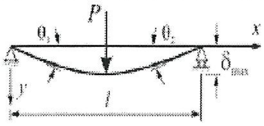
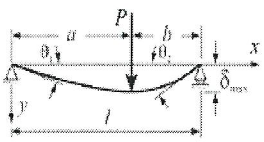
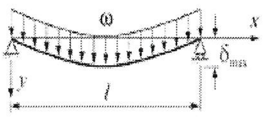
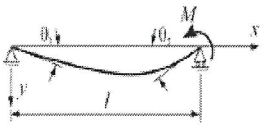
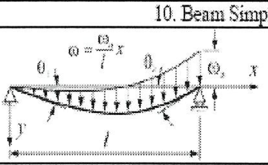
FORMULA

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

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