UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2016/2017

COURSE NAME	:	ADVANCED STRUCTURAL ANALYSIS
COURSE CODE	:	BFS40103
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JUNE 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) List **THREE (3)** advantages and **THREE (3)** disadvantages of statically indeterminate structure.

(6 marks)

(b) A continuous indeterminate beam shown in **FIGURE Q1** is supported by rollers at point A and B, and pinned at point C. A100 kN load is applied at 4 m from support A. Given E = 200 GPa and I= 500 x 10^6 mm^4. If support B is displaced 40 mm;

(i) Determine the compatibility equation

(2 marks)

(ii) Determine all reactions at supports

(13 marks)

(iii) Draw the shear force and bending moment diagram

(4 marks)

Q2 For the truss structure given in **FIGURE Q2**, use the stiffness method to determine;

(a) The local matrix for member 1 and 2.

(17 marks)

(b) The global matrix for the truss if local matrix for member 3 is given as;

$$[k_3] = AE \begin{bmatrix} 0.128 & 0.096 & -0.128 & -0.096 \\ 0.096 & 0.072 & -0.096 & -0.072 \\ -0.128 & -0.096 & 0.128 & 0.096 \\ -0.096 & -0.072 & 0.096 & 0.072 \end{bmatrix}$$

(8 marks)

Q3 The cross section of the structure is as shown in **FIGURE Q3.** The deck is supported by a row of steel pipe columns. The base of the columns are set in concrete pad footings

Q3 The cross section of the structure is as shown in **FIGURE Q3.** The deck is supported by a row of steel pipe columns. The base of the columns are set in concrete pad footings (restrained in X, Y and Z directions) while the top of the columns are supported laterally by the deck platform. The parameters are given as follows:

i) Height of column, H = 3.5 m

ii) Column is of tubular cross section shape with D = 100 mm and d = 105 mm

iii) Modulus of Elasticity = 70 GPa ; Ultimate Stress $\sigma_{ultimate}$ = 260 MPa

iv) Design compressive load of each column $P_{applied}$ = 80 kN

v) Factor of Safety, n = 3

With respect to Euler's column buckling :-

(a) Model the column support condition.

(3 marks)

(b) Conduct calculation checks on the actual load carrying capacity of the column and compare with $P_{applied}$. State your findings.

(10 marks)

(c) Provide solution of Q3(b) by showing relevant calculations and state your recommendation.

(12 marks)

Q4 (a) Discuss **TWO (2)** reasons why yield line theory is safe under reinforced concrete slab although it is based on upper bond limit.

(4 marks)

(b) Sketch the yield line pattern for the slabs shown in **FIGURE Q4(b).**

(4 marks)

(d) **FIGURE Q4(c)** shows an isotropic triangular slab subjected to a concentrated load, P of 50 kN and uniformly distributed load of 10 kN/m^2. Based on the yield line pattern shown in the figure, determine the ultimate resistance moment.

(17 marks)

Q5 (a) State the assumptions that an engineer need to consider in plastic bending.

(3 marks)

(b) Identify and sketch the possible collapse mechanisms for the structures shown in Figure **Q5(b)**.

(7 marks)

(c) **FIGURE Q5(c)** shows a portal frame which carries point load P at point B and C respectively. Determine the value of the collapse load, P of the frame.

(15 marks)

– END OF QUESTIONS –

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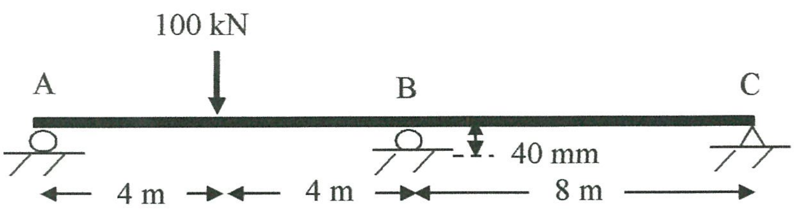

FIGURE Q1

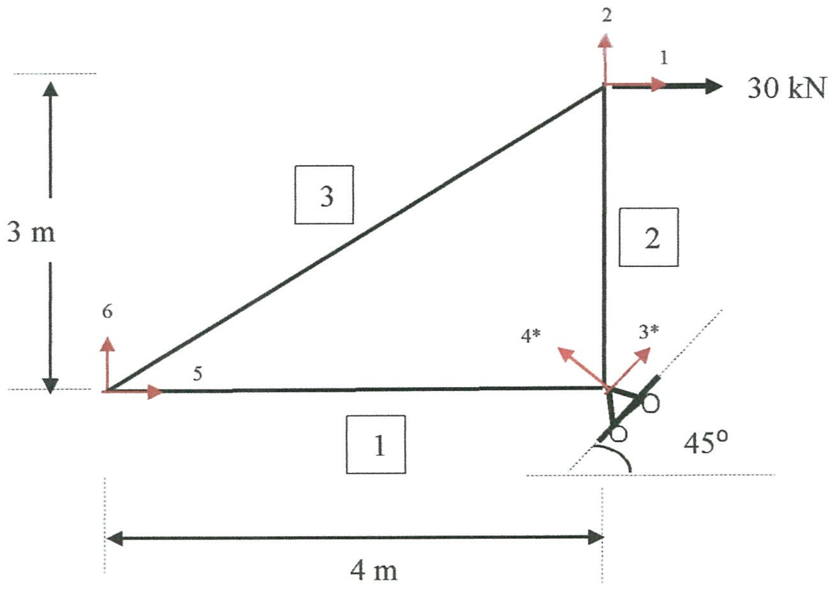

FIGURE Q2

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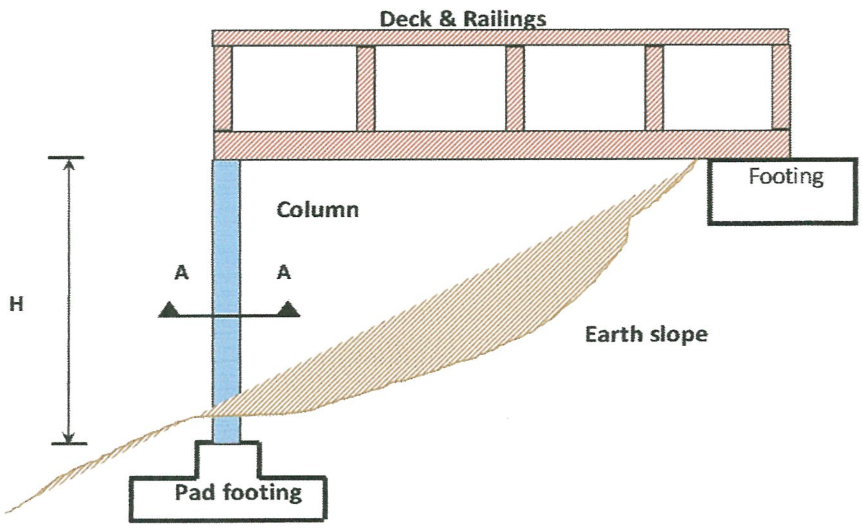

SECTION A - A

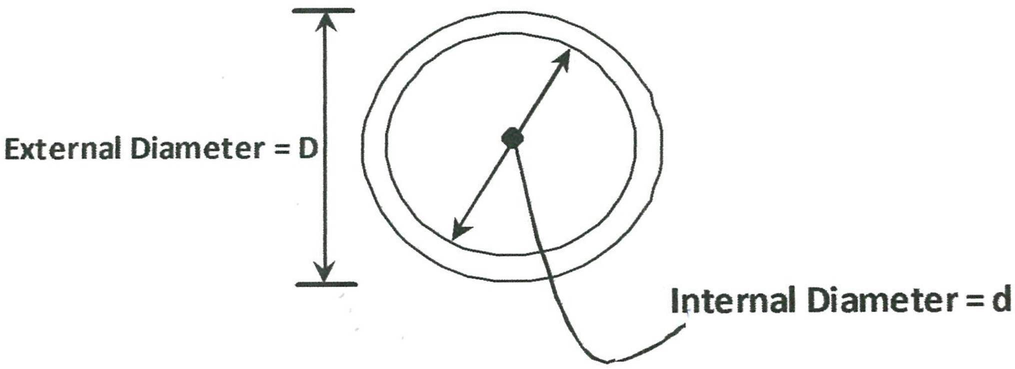

FIGURE Q3

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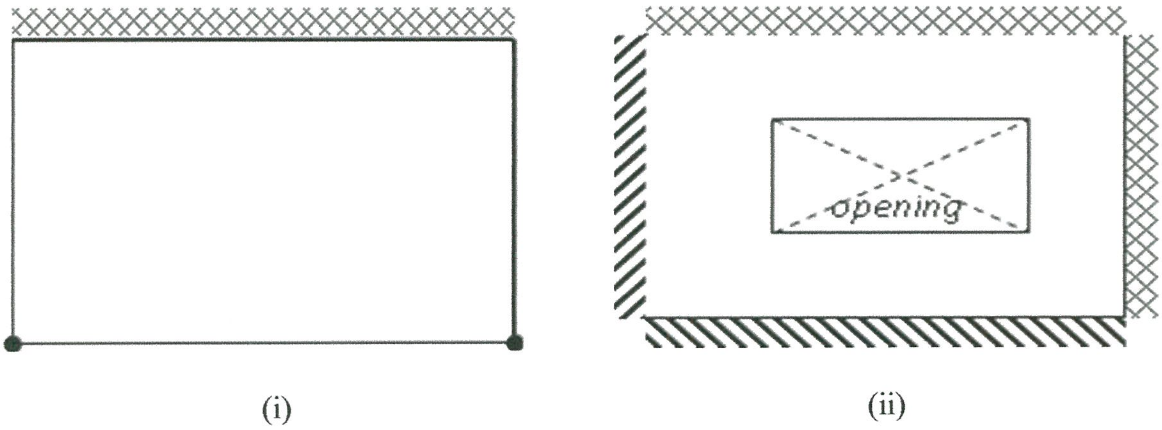

FIGURE Q4(b)

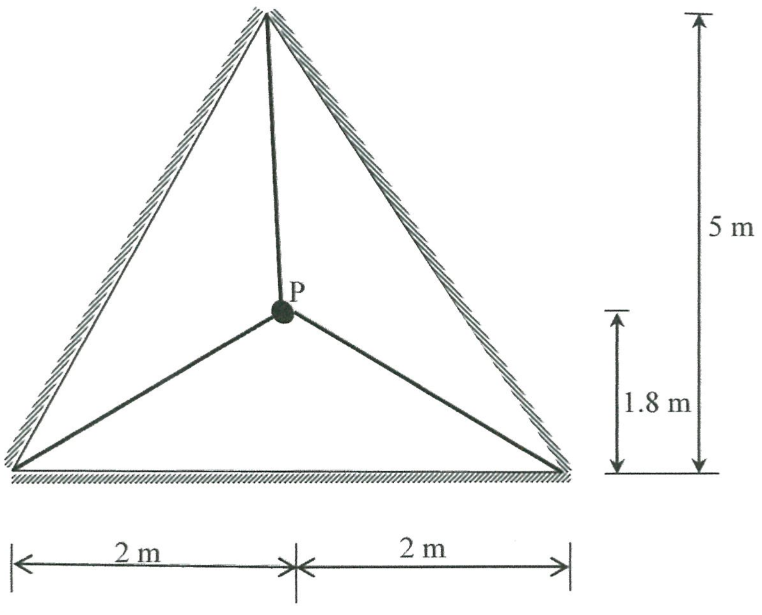

FIGURE Q4(c)

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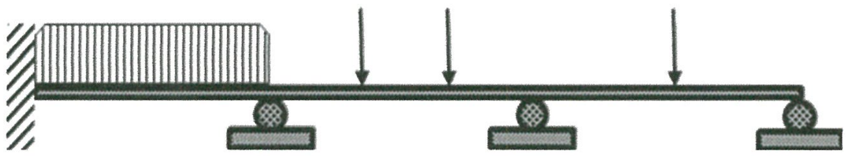
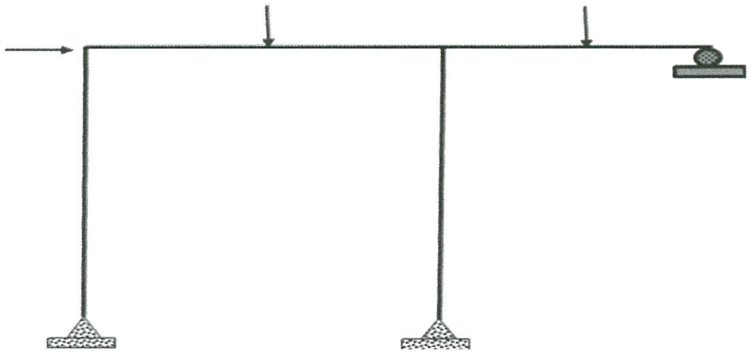


(i)



(ii)

FIGURE Q5(b)

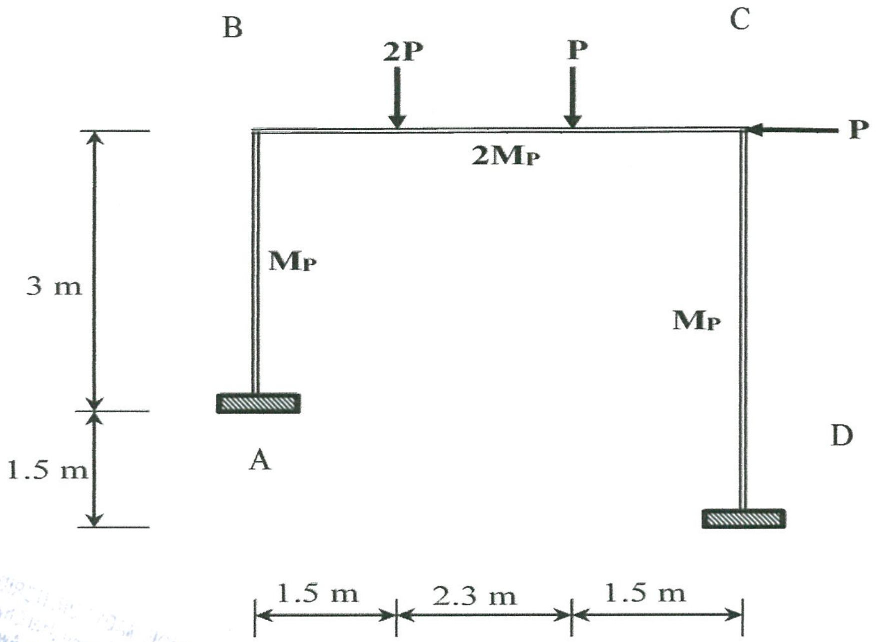


FIGURE Q5(c)

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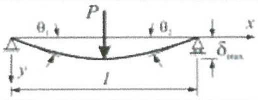
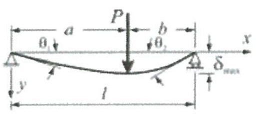
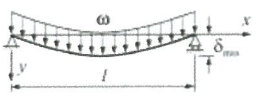
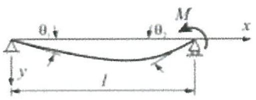
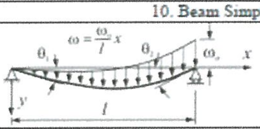
The following information may be useful. The symbols have their usual meaning.

Beam Deflection Equation

BEAM DEFLECTION FORMULAS

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 $0 < x < a$ $y = \frac{Pb}{6lEI}\left[\frac{l}{b}(x-a)^3 + (l^2-b^2)x - x^3\right]$ for $a < x < l$	$\delta_{max} = \frac{Pb(l^2-b^2)^{3/2}}{9\sqrt{3}\,lEI}$ at $x = \sqrt{(l^2-b^2)/3}$ $\delta = \frac{Pb}{48EI}(3l^2 - 4b^2)$ 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

Member Stiffness Matrix for Truss

$$\mathbf{k} = \frac{AE}{L}\begin{array}{c} \begin{array}{cccc} N_x & N_y & F_x & F_y \end{array} \\ \begin{bmatrix} \lambda_x^2 & \lambda_x\lambda_y & -\lambda_x^2 & -\lambda_x\lambda_y \\ \lambda_x\lambda_y & \lambda_y^2 & -\lambda_x\lambda_y & -\lambda_y^2 \\ -\lambda_x^2 & -\lambda_x\lambda_y & \lambda_x^2 & \lambda_x\lambda_y \\ -\lambda_x\lambda_y & -\lambda_y^2 & \lambda_x\lambda_y & \lambda_y^2 \end{bmatrix} \end{array} \begin{array}{c} N_x \\ N_y \\ F_x \\ F_y \end{array}$$

Where ➔ $\lambda_x = \frac{x_F - x_N}{L}$; $\lambda_y = \frac{y_F - y_N}{L}$

$$[k^*] = [T^T]\ AE/L \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} [T]$$

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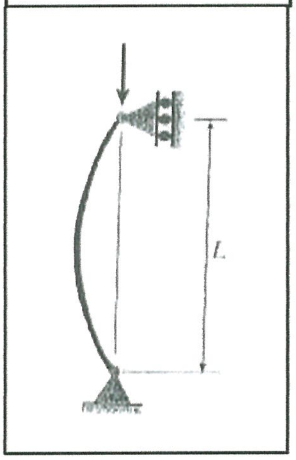
The following information may be useful. The symbols have their usual meaning.

Table of Column Support Conditions and its corresponding Critical Load

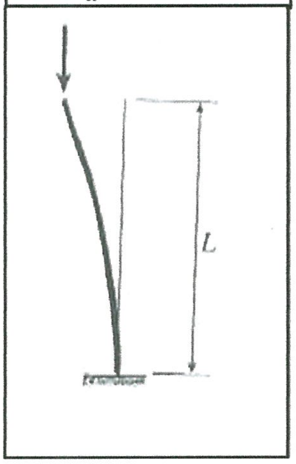
(a) Pinned - Pinned Column

$P_{cr} = \pi^2 EI / L^2$



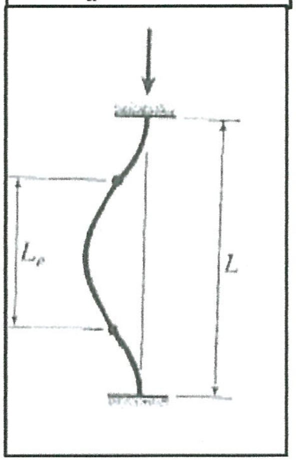
(b) Fixed - Free Column

$P_{cr} = \pi^2 EI / 4L^2$



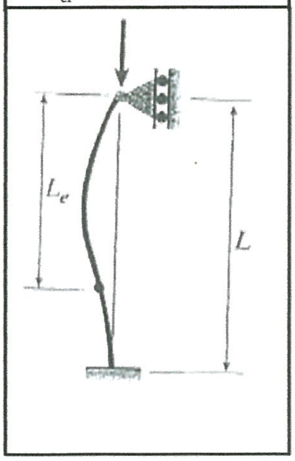
(c) Fixed - Fixed Column

$P_{cr} = 4\pi^2 EI / L^2$



(d) Fixed - Pinned Column

$P_{cr} = 2.046\, \pi^2 EI / L^2$



Other Equations

Moment of inertia for tabular section = $(\pi / 64) [D^4 - (D - 2t)^4]$ where $t = D - d$

$P_{cr} = c\, \pi EI / L^2$; $\sigma = F / A$

Internal Work = $\int M d\Theta = \Sigma M\Theta$

External Work = $\Sigma\, q\, A_i\, \Delta_i$