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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	: ADVANCED STRUCTURAL ANALYSIS
COURSE CODE	: BFS 40103
PROGRAMME	: 4 BFF
EXAMINATION DATE	: JUNE 2013
DURATION	: 3 HOURS
INSTRUCTIONS	: ANSWER **FOUR** FROM **FIVE** QUESTIONS

THIS PAPER CONSISTS OF **NINE** (9) PAGES

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Q1 (a) State the major stages and steps in Finite Element Method.

(5 marks)

(b) For the given bar element in Figure **Q1(a)** with one Degree of freedom (D.O.F)/node, evaluate

(i) Shape functions

Using $U = a + bx + cx^2$

(10 marks)

(ii) Stiffness matrix

(10 marks)

Q2 (a) Determine the global stiffness matrix **[K]** for the frame given in Figure **Q2**. Assume node 3 is pinned and node 1 is fixed. Take $E = 300 \times 10^6$ mm^4, $A = 21 \times 10^3$ mm^2 for each member.

(10 marks)

(b) Determine the support reactions at node 1 and node 3 in Figure **Q2**. Take $E = 300 \times 10^6$ mm^4, $A = 21 \times 10^3$ mm^2 for each member.

(15 marks)

Q3 (a) Yield line theory was developed based on the upper bond limit which used to estimate the bending resistance of slab for reinforcement design. Discuss **Two (2)** reasons why yield line theory is safe to be used for under reinforced concrete slab.

(6 marks)

(b) Figure **Q3** 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.

(19 marks)

Q4 (a) List **Two (2)** advantages of using indeterminate structure

(4 marks)

(b) Determine all reaction forces at both support A and B of the beam shown in Figure **Q4**. *EI* is constant.

(21 marks)

Q5 (a) State **five (5)** assumptions in plastic analysis?

(5 marks)

(b) Figure **Q5** showed a rigid jointed frame that has uniform member with the value M_p. If a point load of 120 kN and 85 kN are applied on midspan BD and DG respectively and horizontal load at Point B of 30 kN, determine the following:

(i) Possible number of mechanisms occurred and name them,

(3 marks)

(ii) Plastic moment due to beam mechanism BCD

(4 marks)

(iii) Plastic moment due to beam mechanism DFG

(4 marks)

(iv) Plastic moment due to sway mechanism

(4 marks)

(v) Joint rotation at D

(3 marks)

(vi) Plastic moment due combined mechanism of mechanisms (ii), (iii), (iv) and (v) above.

(2 marks)

S1 (a) Nyatakan tahap dan langkah untuk setiap tahap dalam kaedah unsur terhingga

(5 markah)

(b) Untuk elemen bar yang diberi dalam Rajah **Q1** dengan satu darjah kebebasan/nod, tentukan

(i) Fungsi bentuk

(10 markah)

(ii) Matriks kekukuhan

(10 markah)

S2 (a) Tentukan matriks kekukuhan struktur [K] kerangka yang ditunjukkan dalam Rajah **Q2**. Anggap nod 3 adalah pin dan nod 1 adalah tetap. Ambil E = 300 x 10^6 mm^4, A = 21 x 10^3 mm^2 untuk setiap anggota.

(10 markah)

(b) Tentukan tindakbalas penyokong pada nod 1 dan nod 3 dalam Rajah **Q2**. Ambil E= 300 x 10^6 mm^4, A = 21 x 10^3 mm^2 untuk setiap anggota.

(15 markah)

S3 (a) Teori garis alah adalah berdasarkan kepada teori batasan atas dimana ia digunakan untuk menganggarkan rintangan lenturan untuk sesuatu papak bagi merekabentuk tetulang. Bincangkan **Dua (2)** sebab kenapa teori garis alah ini selamat untuk digunakan bagi lantai konkrit yang '*under reinforced*'.

(6 markah)

(b) Rajah **Q3** menunjukkan satu papak segitiga isotropik yang dikenakan yang dikenakan beban tumpu, P sebanyak 50 kN dan beban teragih seragam 10 kN/m^2. Berdasarkan corak garis alah yang diberikan dalam Rajah **Q3**, tentukan momen rintangan muktamad.

(19 markah)

S4 (a) Senaraikan **dua (2)** kebaikan menggunakan struktur tak boleh tentu statik.

(6 markah)

(b) Tentukan semua daya tindakbalas penyokong A dan B untuk rasuk yang ditunjukkan dalam Rajah **Q4**. *EI* adalah malar.

(19 markah)

S5 (a) Nyatakan **lima (5)** anggapan dalam analisis plastik.

(5 markah)

(b) Rajah **Q5** menunjukkan satu kerangka bersambungan tegar yang mempunyai anggata seragam dengan nilai Mp. Jika satu beban tumpu 120 kN dan 85 kN dikenakan pada tengah rentang BD dan DG masing-masing dan beban mendatar pada titik B sebanyak 30 kN, tentukan:

(i) Bilangan mekanisme yang mungkin berlaku dan namakan

(3 markah)

(ii) Momen plastik disebabkan mekanisme rasuk BCD

(4 markah)

(iii) Momen plastik disebabkan oleh mekanisme rasuk DFG

(4 markah)

(iv) Momen plastik disebabkan oleh mekanisme huyung

(4 markah)

(v) Putaran sendi di D

(3 markah)

(vi) Momen plastik disebabkan mekansme gabungan (ii), (iii), (iv) dan (v) di atas.

(2 markah)

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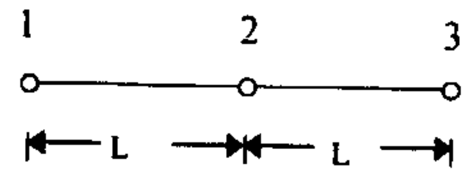

FIGURE Q1

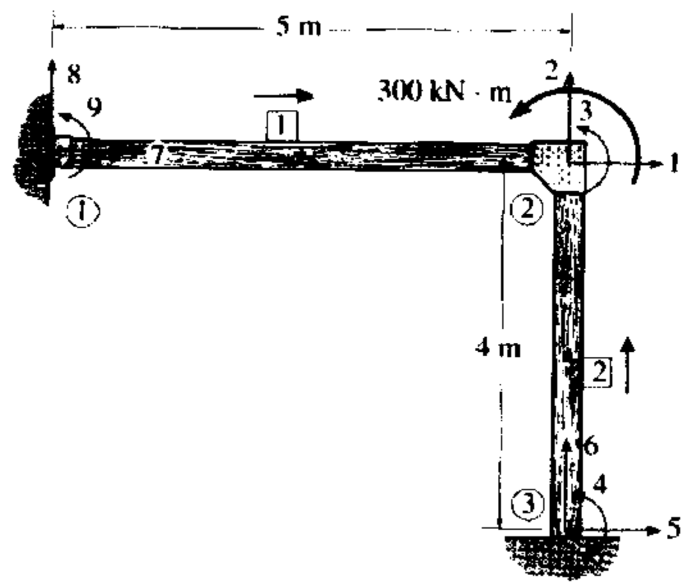

FIGURE Q2

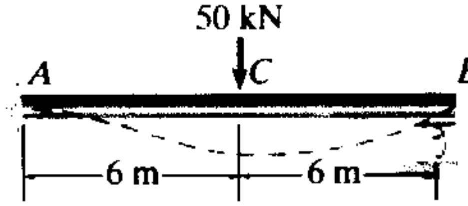

FIGURE Q3

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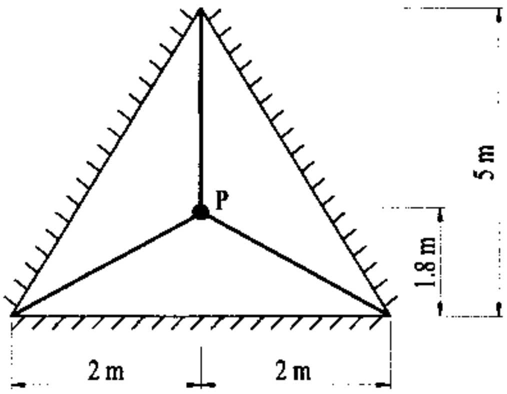

FIGURE Q4

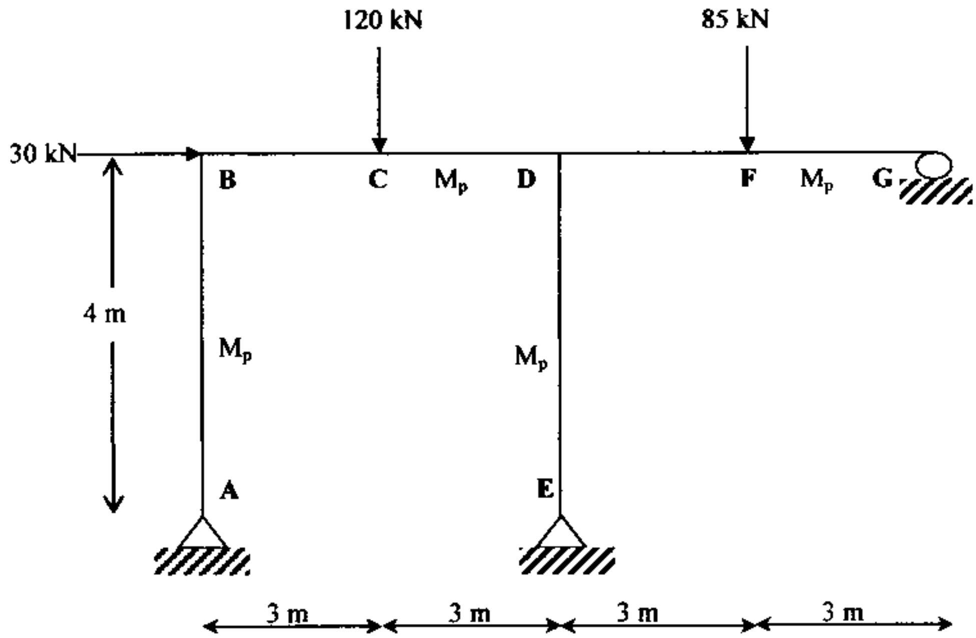

FIGURE Q5

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FORMULA

$$\begin{array}{c} \\ \end{array}\begin{matrix} N_{x'} & N_{y'} & N_{z'} & F_{x'} & F_{y'} & F_{z'} \end{matrix}$$

$$\begin{bmatrix} q_{Nx'} \\ q_{Ny'} \\ q_{Nz'} \\ q_{Fx'} \\ q_{Fy'} \\ q_{Fz'} \end{bmatrix} = \begin{bmatrix} \frac{AE}{L} & 0 & 0 & -\frac{AE}{L} & 0 & 0 \\ 0 & \frac{12EI}{L^3} & \frac{6EI}{L^2} & 0 & -\frac{12EI}{L^3} & \frac{6EI}{L^2} \\ 0 & \frac{6EI}{L^2} & \frac{4EI}{L} & 0 & -\frac{6EI}{L^2} & \frac{2EI}{L} \\ -\frac{AE}{L} & 0 & 0 & \frac{AE}{L} & 0 & 0 \\ 0 & -\frac{12EI}{L^3} & -\frac{6EI}{L^2} & 0 & \frac{12EI}{L^3} & -\frac{6EI}{L^2} \\ 0 & \frac{6EI}{L^2} & \frac{2EI}{L} & 0 & -\frac{6EI}{L^2} & \frac{4EI}{L} \end{bmatrix} \begin{bmatrix} d_{Nx'} \\ d_{Ny'} \\ d_{Nz'} \\ d_{Fx'} \\ d_{Fy'} \\ d_{Fz'} \end{bmatrix}$$

$$\begin{matrix} N_x & N_y & N_z & F_x & F_y & F_z \end{matrix}$$

$$\mathbf{k} = \begin{bmatrix} \left(\frac{AE}{L}\lambda_x^2 + \frac{12EI}{L^3}\lambda_y^2\right) & \left(\frac{AE}{L} - \frac{12EI}{L^3}\right)\lambda_x\lambda_y & -\frac{6EI}{L^2}\lambda_y & -\left(\frac{AE}{L}\lambda_x^2 + \frac{12EI}{L^3}\lambda_y^2\right) & -\left(\frac{AE}{L} - \frac{12EI}{L^3}\right)\lambda_x\lambda_y & -\frac{6EI}{L^2}\lambda_y \\ \left(\frac{AE}{L} - \frac{12EI}{L^3}\right)\lambda_x\lambda_y & \left(\frac{AE}{L}\lambda_y^2 + \frac{12EI}{L^3}\lambda_x^2\right) & \frac{6EI}{L^2}\lambda_x & -\left(\frac{AE}{L} - \frac{12EI}{L^3}\right)\lambda_x\lambda_y & -\left(\frac{AE}{L}\lambda_y^2 + \frac{12EI}{L^3}\lambda_x^2\right) & \frac{6EI}{L^2}\lambda_x \\ -\frac{6EI}{L^2}\lambda_y & \frac{6EI}{L^2}\lambda_x & \frac{4EI}{L} & \frac{6EI}{L^2}\lambda_y & -\frac{6EI}{L^2}\lambda_x & \frac{2EI}{L} \\ -\left(\frac{AE}{L}\lambda_x^2 + \frac{12EI}{L^3}\lambda_y^2\right) & -\left(\frac{AE}{L} - \frac{12EI}{L^3}\right)\lambda_x\lambda_y & \frac{6EI}{L^2}\lambda_y & \left(\frac{AE}{L}\lambda_x^2 + \frac{12EI}{L^3}\lambda_y^2\right) & \left(\frac{AE}{L} - \frac{12EI}{L^3}\right)\lambda_x\lambda_y & \frac{6EI}{L^2}\lambda_y \\ -\left(\frac{AE}{L} - \frac{12EI}{L^3}\right)\lambda_x\lambda_y & -\left(\frac{AE}{L}\lambda_y^2 + \frac{12EI}{L^3}\lambda_x^2\right) & -\frac{6EI}{L^2}\lambda_x & \left(\frac{AE}{L} - \frac{12EI}{L^3}\right)\lambda_x\lambda_y & \left(\frac{AE}{L}\lambda_y^2 + \frac{12EI}{L^3}\lambda_x^2\right) & -\frac{6EI}{L^2}\lambda_x \\ -\frac{6EI}{L^2}\lambda_y & \frac{6EI}{L^2}\lambda_x & \frac{2EI}{L} & \frac{6EI}{L^2}\lambda_y & -\frac{6EI}{L^2}\lambda_x & \frac{4EI}{L} \end{bmatrix} \begin{matrix} N_x \\ N_y \\ N_z \\ F_x \\ F_y \\ F_z \end{matrix}$$

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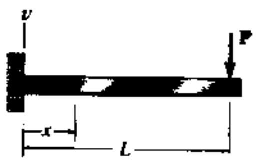
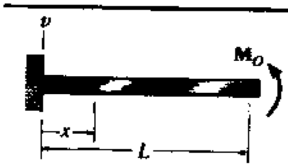
FORMULA

Beam Deflections and Slopes

Loading	v + ↑	θ + ↺	Equation + ↑ + ↺
	$v_{max} = -\frac{PL^3}{3EI}$ at $x = L$	$\theta_{max} = -\frac{PL^2}{2EI}$ at $x = L$	$v = \frac{P}{6EI}(x^3 - 3Lx^2)$
	$v_{max} = \frac{M_O L^2}{2EI}$ at $x = L$	$\theta_{max} = \frac{M_O L}{EI}$ at $x = L$	$v = \frac{M_O}{2EI}x^2$