UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2007/2008

April 2008

EAS 254/3 – Structural Analysis
[Analisis Struktur]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **NINE (9)** printed pages including appendices before you begin the examination.
*[Sila pastikan kertas peperiksaan ini mengandungi **SEMBILAN (9)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions: This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions only. All questions carry the same marks.

*[**Arahan**: Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan sahaja. Semua soalan membawa jumlah markah yang sama.]*

You may answer the question either in Bahasa Malaysia or English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

All questions **MUST BE** answered on a new page.
*[Semua soalan **MESTILAH** dijawab pada muka surat baru.]*

Write the answered question numbers on the cover sheet of the answer script.
[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]

1. (a) Define the Principle of Virtual Forces for Deformable Bodies.

Berikan definasi Prinsip Daya Maya bagi Ubahbentuk Anggota.

(3 marks / *3 markah*)

(b) Figure 1 shows a simply supported beam carrying uniformly distributed load of 10kN/m from A to D and a concentrated load of 15kN at D. The moment of inertia of the center portion BD of the beam is 1.5I, whereas the end segments AB and DE have a moment of inertia I. Determine the slope and displacement at point B using **method of virtual work**. Given I = 90 x 10^6mm^4 and E = 200GPa.

*Rajah 1 menunjukkan satu rasuk disokong mudah yang menanggung beban teragih seragam 10kN/m dari A ke D dan satu beban tumpu 15kN di D. Momen inersia bagi rasuk di bahagian BD ialah 1.5I, manakala di bahagian AB dan DE ialah I. Tentukan cerun dan anjakan pada titik B menggunakan **kaedah kerja maya**. Diberi nilai I = 90 x 10^6 mm^4 dan E = 200GPa.*

(17 marks / *17 markah*)

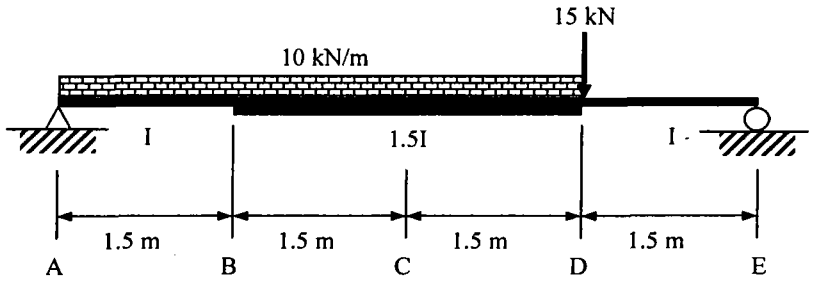


Figure 1 / Rajah 1

2. (a) For the structures shown in Figure 2(a) to (d), check their external and internal stability of the structures and specify the degree of determinacy if any.

Untuk struktur-struktur kekuda dalam Rajah 2(a) hingga (d), semak kestabilan dalaman dan luaran struktur tersebut dan nyatakan darjah kebolehtentuan sekiranya ada.

(8 marks / *8 markah*)

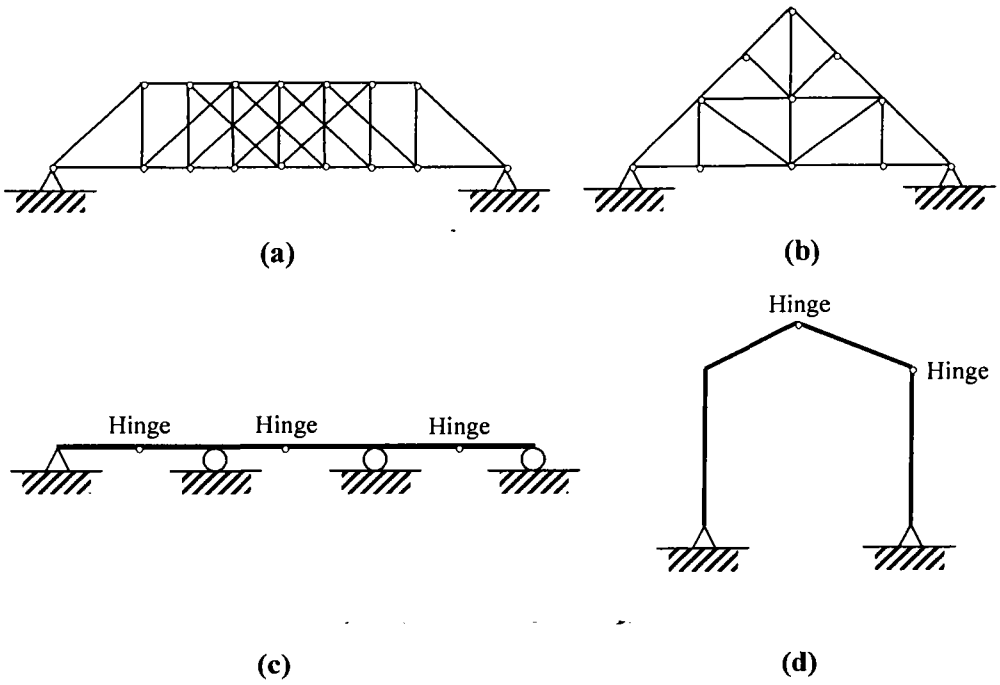


Figure 2 / Rajah 2

2. (b) The beam shown in Figure 3 is fixed at A and additionally supported at B using tie rod BC. Determine the force in member BC using **method of least work** and calculate all reaction forces at A. The cross sectional area for tie rod is $150mm^2$ and point C is pinned. Given I = 140 x 10^6mm^4 for the beam and E = 200GPa. Neglect axial compression and shear in the beam.

Satu rasuk yang ditunjukkan dalam Rajah 3 diikat tegar di sambungan A dan disokong dengan rod tambahan BC di titik B. Tentukan daya dalam anggota BC menggunakan ***kaedah kerja terkecil*** *dan kira semua daya tindakbalas di A. Luas keratan rentas rod ialah $150mm^2$ dan ia bersambung di C. Diberi nilai I = 140 x 10^6mm^4 untuk rasuk dan nilai E = 200GPa. Abaikan mampatan paksi dan ricih dalam rasuk*

(12 marks / *12 markah*)

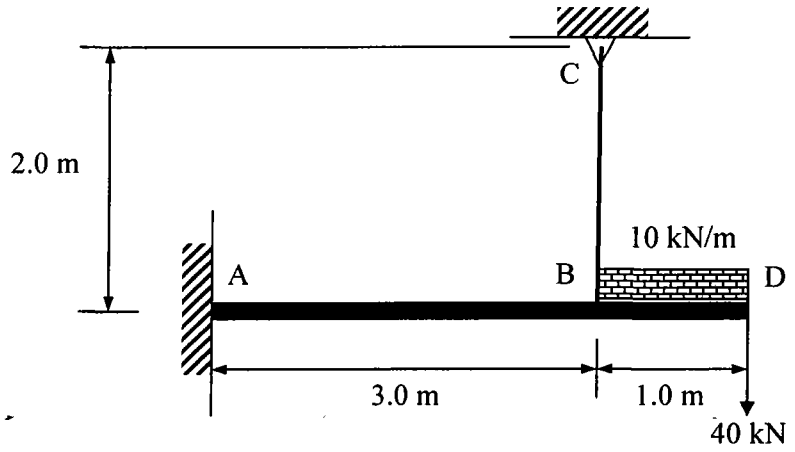


Figure 3 / Rajah 3

3. (a) Figure 4 shows a beam carrying a triangular load of 6kN/m and a uniformly distributed load of 8kN/m on span AB and BC, respectively. Support A is fixed and support B, C and D are rollers. Using **moment distribution method**, calculate internal moments at all supports of the beam. Assume value of EI is constant and neglect axial deformation. Hence, sketch the deflected shape and bending moment diagram of the beam.

*Rajah 4 menunjukkan satu rasuk yang membawa beban segitiga 6kN/m dan beban teragih seragam 8kN/m bertindak masing-masing di sepanjang rentang AB dan BC. Penyokong A adalah jenis tegar dan penyokong B, C dan D ialah rola. Dengan menggunakan **kaedah agihan momen**, kira nilai momen dalaman di setiap penyokong rasuk tersebut. Anggap nilai EI adalah malar dan abaikan pesongan paksi. Seterusnya, lakarkan bentuk terpesong dan gambarajah momen lentur rasuk tersebut.*

(18 marks / *18 markah*)

(b) If point E for the continuous beam in Figure 4 is fixed, sketch new bending moment diagram and deflected shape of the beam.

Sekiranya titik E bagi rasuk selanjar dalam Rajah 4 diikat tegar, lakarkan gambarajah momen lentur dan bentuk terpesong baru rasuk tersebut.

(2 marks / *2 markah*)

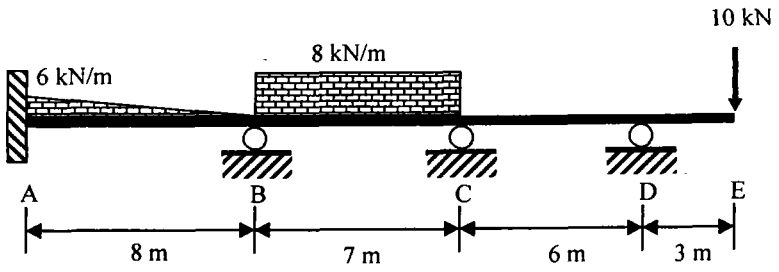


Figure 4 / Rajah 4

4. (a) Figure 5 shows a frame carrying a uniformly distributed load of 24kN/m on span AB. Support A, C and D are fixed. Each member is assigned value of I as shown in Figure 5. Determine the internal moments at the joints of the frame using the **slope deflection method**. Hence sketch the deflected shape and bending moment diagram of the frame.

*Rajah 5 menunjukkan satu kerangka yang membawa beban teragih seragam 24kN/m direntang AB. Penyokong A, C dan D adalah tegar. Nilai I setiap anggota kerangka ditunjukkan dalam Rajah 5. Tentukan nilai momen dalaman di setiap sambungan kerangka tersebut menggunakan **kaedah cerun pesongan**. Seterusnya lakarkan bentuk terpesong dan gambarajah momen lentur kerangka tersebut.*

(16 marks / *16 markah*)

(b) If support C is replaced with pinned support, sketch new bending moment diagram and deflected shape of the frame.

Sekiranya penyokong C digantikan dengan penyokong pin, lakarkan gambarajah momen lentur dan bentuk terpesong baru kerangka tersebut.

(4 marks / *4 markah*)

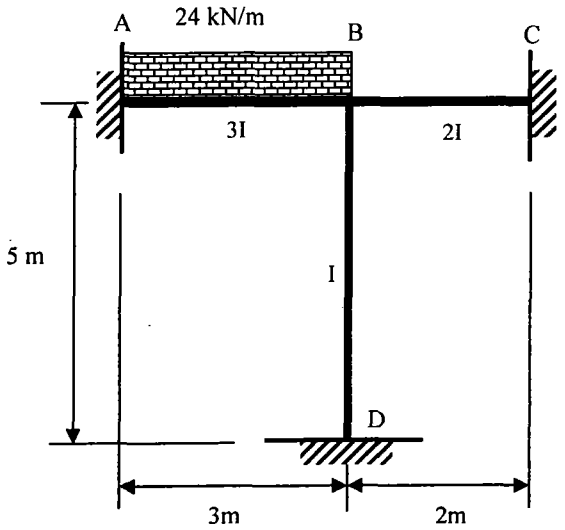


Figure 5 / Rajah 5

5. (a) Sketch and name **THREE (3)** types of independent plastic mechanisms of frame structure.

*Lakar dan namakan **TIGA (3)** jenis mekanisma plastik tidak bersandar pada struktur kerangka.*

(3 marks / *3 markah*)

(b) Determine the plastic moment of rectangular hollow section shown in Figure 6(a). The yield stress of the section is 275N/mm^2.

Tentukan momen plastik bagi keratan segiempat tepat bergeronggang dalam Rajah 6(a). Tegasan alah keratan tersebut ialah 275N/mm^2.

(3 marks / *3 markah*)

(c) Draw **THREE (3)** collapse mechanisms of the frame shown in Figure 6(b) and determine the plastic moment of the frame for each mechanism. Assume load factor is 1.0. If the column and beam of the frame are constructed using the section as shown in Figure 6(a), check whether the frame will undergo plastic collapse.

*Lukiskan **TIGA (3)** mekanisma runtuh bagi struktur kerangka dalam Rajah 6(b) dan tentukan momen plastik bagi setiap mekanisma runtuh struktur kerangka tersebut. Anggap faktor daya sebagai 1.0. Sekiranya tiang dan rasuk kerangka tersebut dibina menggunakan keratan dalam Rajah 6(a), semak samada struktur kerangka tersebut akan mengalami kegagalan plastik.*

(14 marks / *14 markah*)

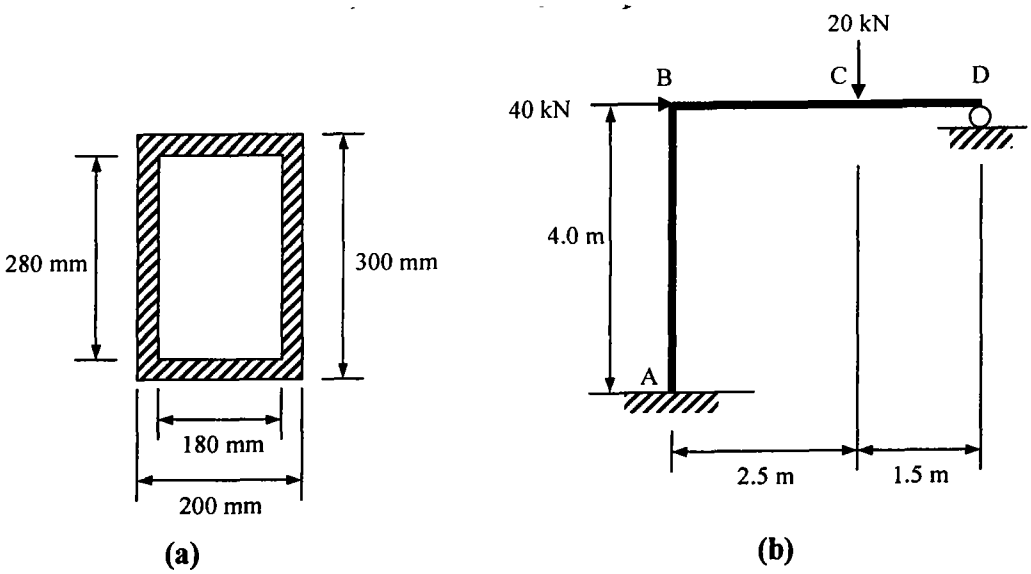


Figure 6 / Rajah 6

6. Figure 7 shows a continuous beam with pinned support at A while roller support at C and D. Assume EI is constant.

Rajah 7 menunjukkan satu rasuk selanjar disokong dengan pin di A dan disokong rola di C dan D. Anggap EI ialah malar.

(a) Draw the influence line diagram for the vertical reaction at support D. Plot numerical values at every 1.0m interval.

Lukiskan gambarajah garis imbas bagi tindak balas di D. Plotkan nilai berangka pada setiap 1.0m selaan.

(6 marks / *6 markah*)

(b) Draw the influence line diagram for the shear force at B. Plot numerical values at every 1.0m interval.

Lukiskan gambarajah garis imbas bagi daya ricih di B. Plotkan nilai berangka pada setiap 1.0m selaan.

(7 marks / *7 markah*)

(c) Draw the influence line diagram for the moment at B. Plot numerical values at every 1.0m interval.

Lukiskan gambarajah garis imbas bagi momen di B. Plotkan nilai berangka pada setiap 1.0m selaan.

(7 marks / *7 markah*)

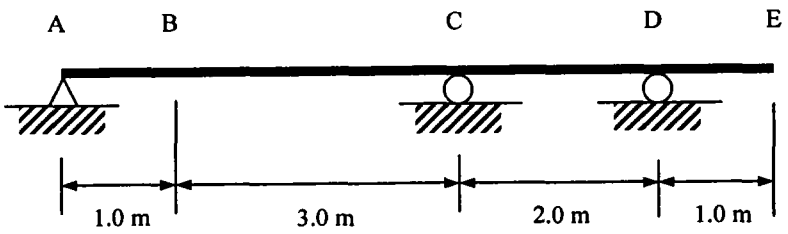
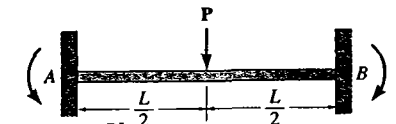


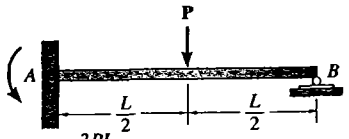
Figure 7 / Rajah 7

- ooo O ooo -

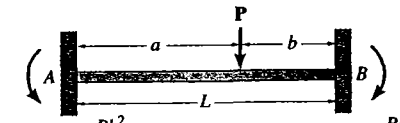
Fixed End Moments



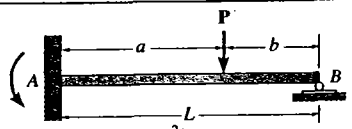
$(FEM)_{AB} = \frac{PL}{8}$ $(FEM)_{BA} = \frac{PL}{8}$



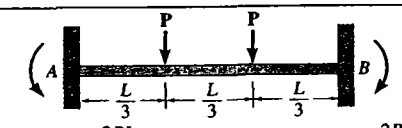
$(FEM)'_{AB} = \frac{3PL}{16}$



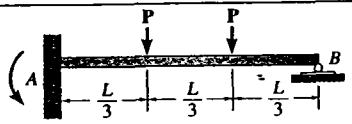
$(FEM)_{AB} = \frac{Pb^2a}{L^2}$ $(FEM)_{BA} = \frac{Pa^2b}{L^2}$



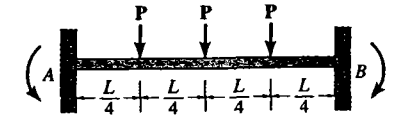
$(FEM)'_{AB} = (\frac{P}{L^2})(b^2a + \frac{a^2b}{2})$



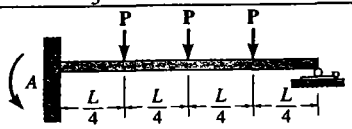
$(FEM)_{AB} = \frac{2PL}{9}$ $(FEM)_{BA} = \frac{2PL}{9}$



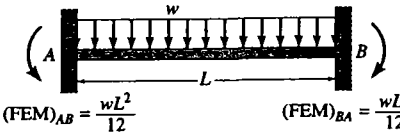
$(FEM)'_{AB} = \frac{PL}{3}$



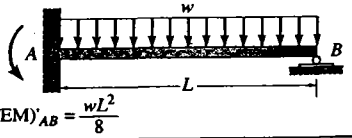
$(FEM)_{AB} = \frac{15PL}{48}$ $(FEM)_{BA} = \frac{15PL}{48}$



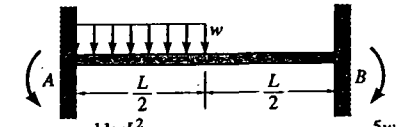
$(FEM)'_{AB} = \frac{45PL}{96}$



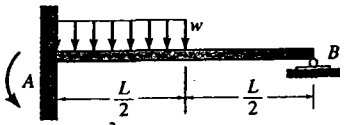
$(FEM)_{AB} = \frac{wL^2}{12}$ $(FEM)_{BA} = \frac{wL^2}{12}$



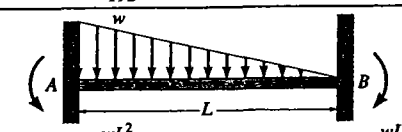
$(FEM)'_{AB} = \frac{wL^2}{8}$



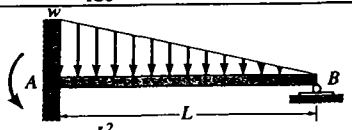
$(FEM)_{AB} = \frac{11wL^2}{192}$ $(FEM)_{BA} = \frac{5wL^2}{192}$



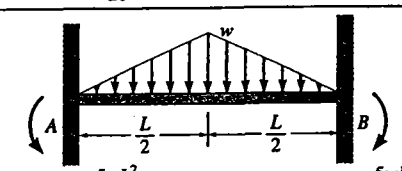
$(FEM)'_{AB} = \frac{9wL^2}{128}$



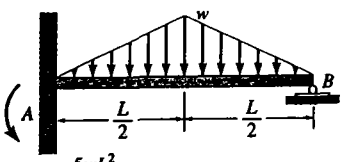
$(FEM)_{AB} = \frac{wL^2}{20}$ $(FEM)_{BA} = \frac{wL^2}{30}$



$(FEM)'_{AB} = \frac{wL^2}{15}$

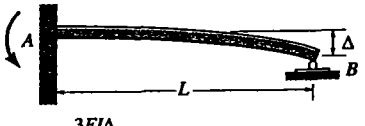


$(FEM)_{AB} = \frac{5wL^2}{96}$ $(FEM)_{BA} = \frac{5wL^2}{96}$



$(FEM)'_{AB} = \frac{5wL^2}{64}$

$(FEM)_{AB} = \frac{6EI\Delta}{L^2}$ $(FEM)_{BA} = \frac{6EI\Delta}{L^2}$



$(FEM)'_{AB} = \frac{3EI\Delta}{L^2}$