UNIVERSITI SAINS MALAYSIA

KSCP EXAMINATION
Academic Session 2007/2008

June 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 appendix 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 consists of **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.]

.../2-

1. (a) Define the Principle of Virtual Forces for Deformable Bodies.
Berikan definasi Prinsip Daya Maya bagi Ubahbentuk Anggota.

[3 marks / *markah*]

(b) Figure 1 shows a simply supported beam carrying uniformly distributed load of 10kN/m along segment AD and a concentrated load of 15kN at B. The moment of inertia of segment AB of the beam is I, whereas the segment BD has a moment of inertia 2I. Determine the slope and vertical 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 di sepanjang AD dan satu beban tumpu 15kN di B. Momen inersia bagi rasuk di bahagian AB adalah I, manakala di bahagian BD adalah 2I. Tentukan cerun dan anjakan pugak pada titik B menggunakan ***kaedah kerja maya****. Diberi nilai I = 90 x 10^6 mm^4 dan E = 200GPa.*

[17 marks / *markah*]

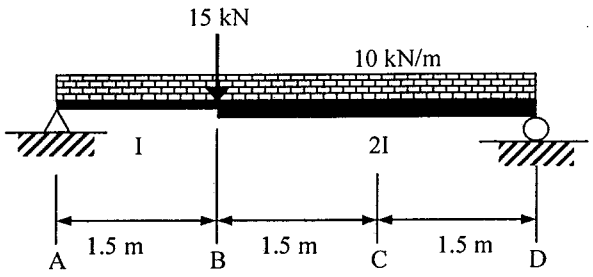
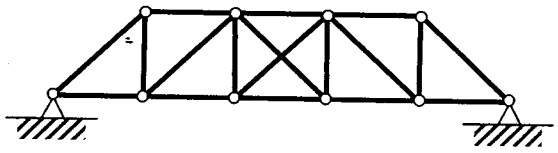


Figure 1 / *Rajah 1*

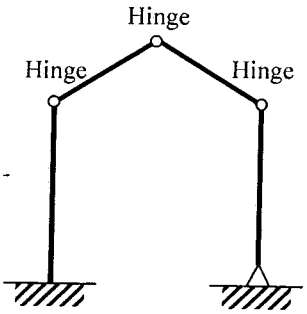
2. (a) For the structures shown in Figure 2(a) to (c), check their external and internal stability of the structures and specify the degree of determinacy if any.

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

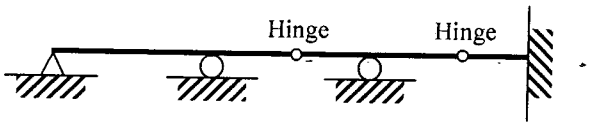
[6 marks / *markah*]



(a)



(b)



(c)

Figure / *Rajah 2*

2. (b) The beam shown in Figure 3 carrying uniformly distributed load of 10KN/m along segment AC and 40KN of concentrated load at B support A is fixed and additionally supported at C using tie rod CD which pinned at D. Determine the force in member CD using **method of least work** and calculate all the reaction forces at A. The cross sectional area of tie rod is 200mm^2 while the moment of inertia of the beam is 140 x 10^{6}mm^4. Neglect axial compression and shear in the beam. Assume the modulus of elasticity for both beam and rod are 200GPa.

Satu rasuk yang ditunjukkan dalam Rajah 3 menganggung beban teragih seragam 10KN/m di sepanjang AC dan satu beban tumpu 40KN di B sambungan A diikat tegar dan disokong tambah dengan rod CD di titik C yang disokong pin di D. Tentukan daya dalam anggota CD menggunakan ***kaedah kerja terkecil*** *dan kira semua daya tindakbalas di A. Luas keratan rentas rod adalah 200mm^2 manakala momen inersia rasuk adalah 140x10^{6}mm^4. Abaikan mampatan paksi dan ricih dalam rasuk. Anggap modulus keanjalan bagi rasuk dan rod adalah 200 GPa.*

[14 marks / *markah*]

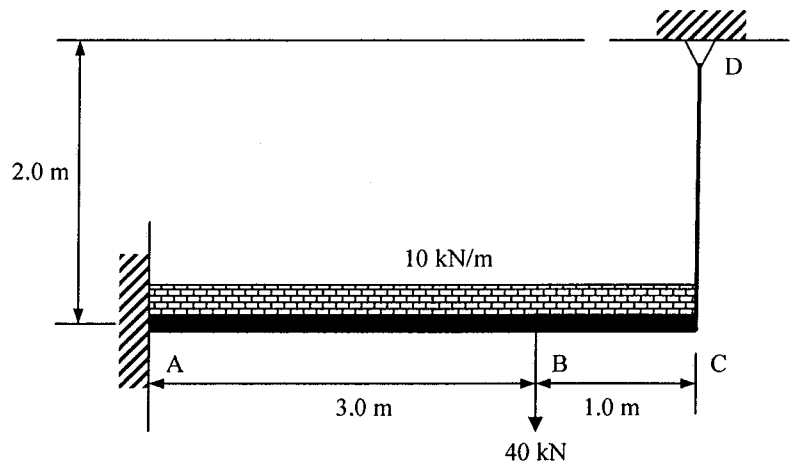


Figure ***/ Rajah 3***

3. (a) Figure 4 shows a beam carrying a uniformly distributed load of 3kN/m on span AB and a point load of 200kN on span BC. An additional point load of 50kN is applied at support D. Support A and D are fixed while support B and C 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 teragih seragam 3kN/m bertindak di sepanjang rentang AB dan beban tumpu sebanyak 200kN di atas rentang BC. Satu beban tumpu tambahan sebanyak 50kN dikenakan di penyokong D. Penyokong A dan D adalah jenis tegar manakala penyokong B dan C 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 / *markah*]

(b) If loading of 50kN at point D is removed, for the continuous beam in Figure 4, sketch new bending moment diagram and deflected shape of the beam.

Sekiranya beban 50 kN di titik D disingkirkan, bagi rasuk selanjar dalam Rajah 4 diikat tegar, lakarkan gambarajah momen lentur dan bentuk terpesong baru rasuk tersebut.

[2 marks / *markah*]

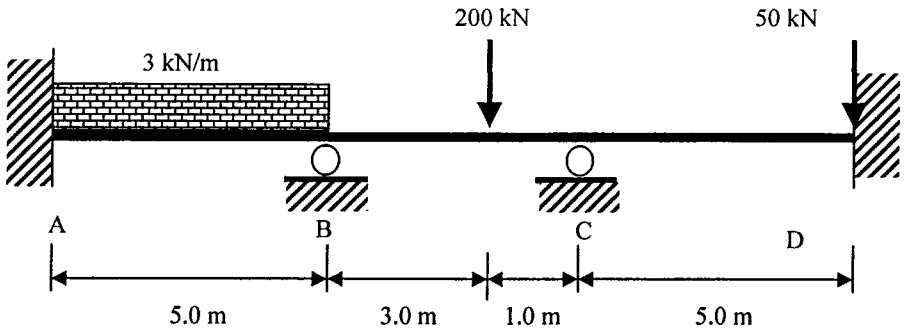


Figure / *Rajah 4*

4. (a) Figure 5 shows a frame carrying a uniformly distributed load of 20kN/m on span BC. 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 20kN/m direntang BC. 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 / *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 / *markah*]

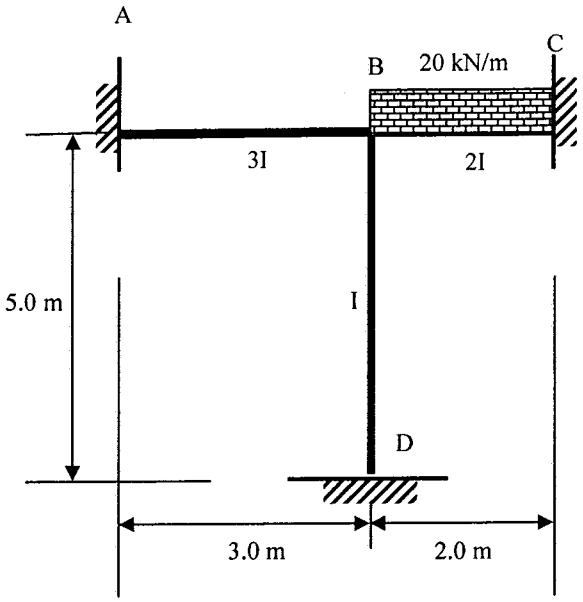


Figure / *Rajah 5*

5. (a) 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.

[6 marks / *markah*]

(c) Draw **THREE (3)** collapse mechanisms of the frame shown in Figure 6(b) and determine the plastic moment for each of the mechanism. Assume load factor is 1.7. 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 1.7. Sekiranya tiang dan rasuk kerangka tersebut dibina menggunakan keratan dalam Rajah 6(a), semak samada struktur kerangka tersebut akan mengalami kegagalan plastik.*

[14 marks / *markah*]

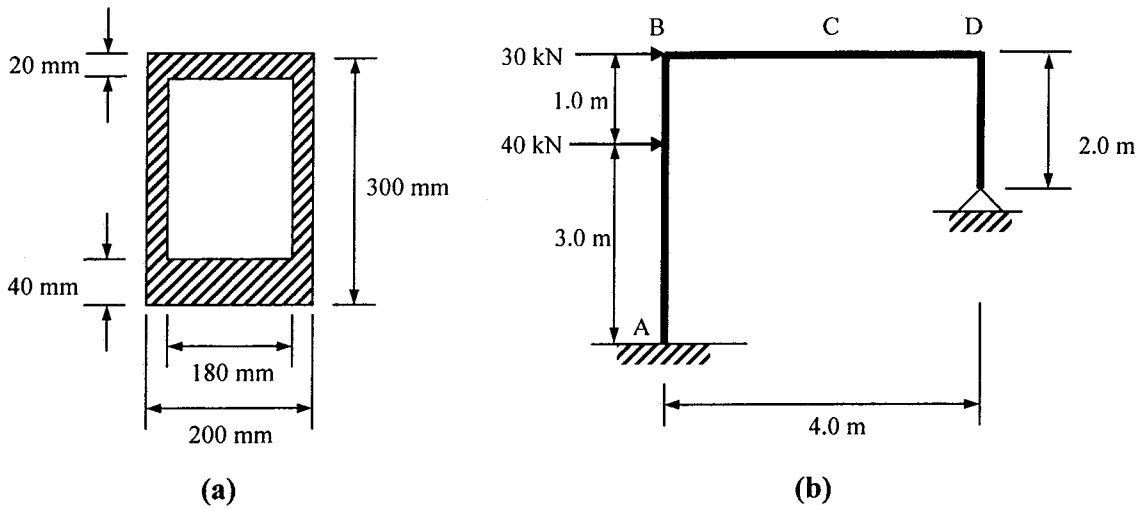


Figure / *Rajah 6*

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 cemat di A dan disokong rola di C dan D. Anggap EI adalah malar.

(a) Draw the influence line diagram for the vertical reaction at support C. Plot numerical values at every 2.0 m interval.

Lukiskan gambarajah garis imbas bagi tindak balas di C. Plotkan nilai berangka pada setiap 2.0 m selaan.

[8 marks / *markah*]

(b) Draw the influence line diagram for the shear force at B. Plot numerical values at every 2.0 m interval.

Lukiskan gambarajah garis imbas bagi daya ricih di B. Plotkan nilai berangka pada setiap 2.0 m selaan.

[12 marks / *markah*]

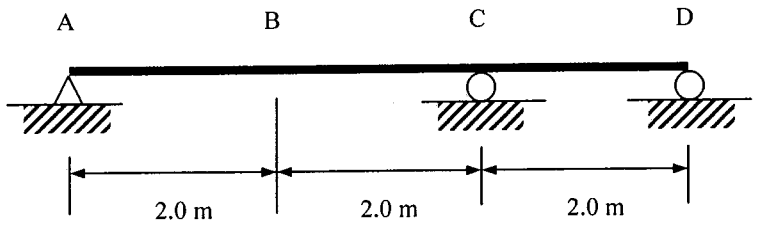
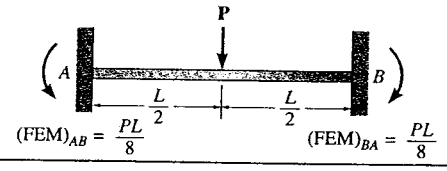


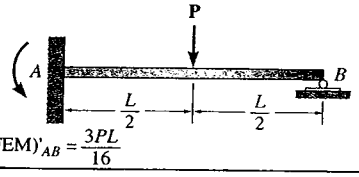
Figure / *Rajah 7*

LAMPIRAN

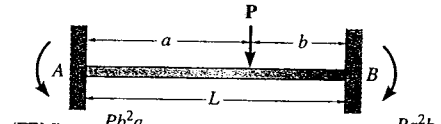
Fixed End Moments



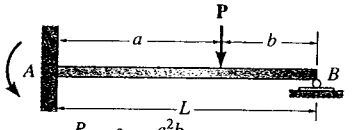
$(FEM)_{AB} = \frac{PL}{8}$ $(FEM)_{BA} = \frac{PL}{8}$



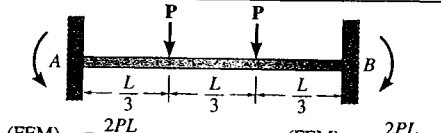
$(FEM)'_{AB} = \frac{3PL}{16}$



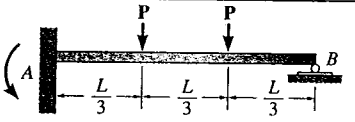
$(FEM)_{AB} = \frac{Pb^2a}{L^2}$ $(FEM)_{BA} = \frac{Pa^2b}{L^2}$



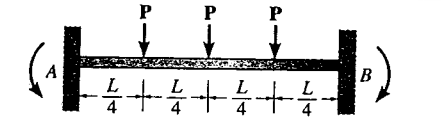
$(FEM)'_{AB} = (\frac{P}{L^2})(b^2a + \frac{a^2b}{2})$



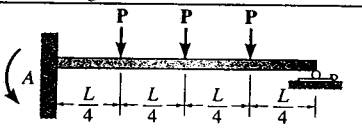
$(FEM)_{AB} = \frac{2PL}{9}$ $(FEM)_{BA} = \frac{2PL}{9}$



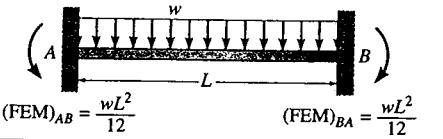
$(FEM)'_{AB} = \frac{PL}{3}$



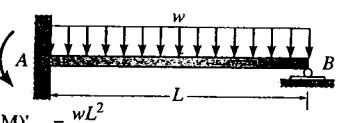
$(FEM)_{AB} = \frac{15PL}{48}$ $(FEM)_{BA} = \frac{15PL}{48}$



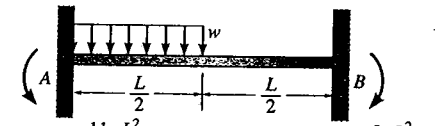
$(FEM)'_{AB} = \frac{45PL}{96}$



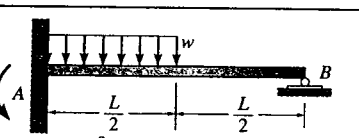
$(FEM)_{AB} = \frac{wL^2}{12}$ $(FEM)_{BA} = \frac{wL^2}{12}$



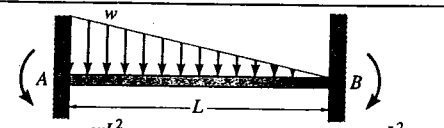
$(FEM)'_{AB} = \frac{wL^2}{8}$



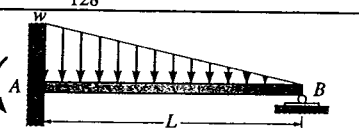
$(FEM)_{AB} = \frac{11wL^2}{192}$ $(FEM)_{BA} = \frac{5wL^2}{192}$



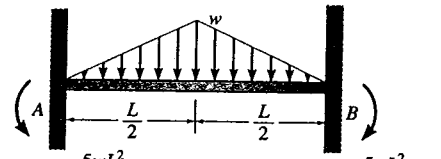
$(FEM)'_{AB} = \frac{9wL^2}{128}$



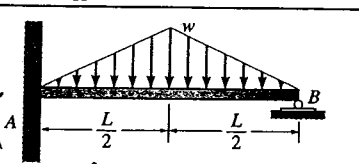
$(FEM)_{AB} = \frac{wL^2}{20}$ $(FEM)_{BA} = \frac{wL^2}{30}$



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

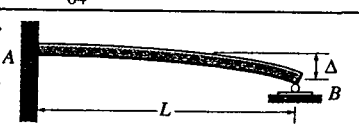


$(FEM)_{AB} = \frac{5wL^2}{96}$ $(FEM)_{BA} = \frac{5wL^2}{96}$



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

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



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