UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2013/2014 Academic Session

June 2014

EAS254/3 – STRUCTURAL ANALYSIS
[Analisis Struktur]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **NINE (9)** pages of printed material including **ONE (1)** appendix before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN (9)** muka surat yang bercetak termasuk **SATU (1)** lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions : This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions.
*[**Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan.]*

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

In the event of any discrepancies, the English version shall be used.
[Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]

1. **Figure 1** shows a beam section carrying a uniformly distributed load of 40 kN/m (span AC) and point load 10 kN at joint D. Support A is fixed and supports B and C can be treated as hinges. Assuming that E is constant.

Rajah 1 *menunjukkan bahagian rasuk yang membawa beban teragih seragam 40 kN/m (rentang AC) dan beban tumpu sebanyak 10 kN di penyokong D. Penyokong di A adalah jenis terikat dan penyokong di B dan C boleh dianggap sebagai engsel. Anggap E adalah malar.*

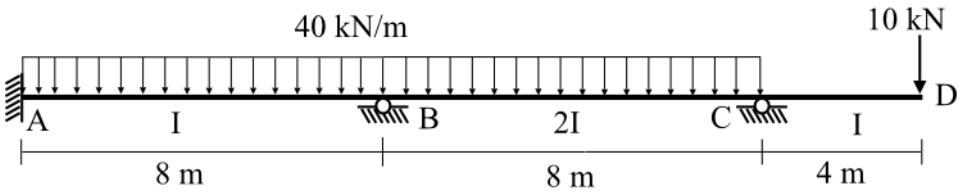


Figure 1/*Rajah 1*

(a) Compute the internal moments at the joint of the section by using the moment distribution method.

Kira nilai momen dalaman di setiap penyokong keratan tersebut dengan menggunakan kaedah agihan momen.

[15 marks/*markah*]

(b) Sketch the shear force diagram, bending moment diagram and deflected shape for the beam.

Lakarkan gambarajah daya ricih, gambarajah momen lentur dan gambarajah pesongan bagi rasuk tersebut.

[5 marks/*markah*]

2. **Figure 2** shows a frame carrying a triangular load varying from 0 to 10 kN/m for span BC and point load 5 kN at mid-point on span AB. Supports at A and D are fixed. Assume that EI is constant except for member CD.

Rajah 2 *menunjukkan satu kerangka yang membawa beban segitiga yang berubah dari 0 ke 10 kN/m pada rentang BC dan beban tertumpu 5 kN di titik tengah rentang AB. Penyokong di A dan D adalah terikat. Anggap EI adalah pemalar kecuali bagi rentang CD.*

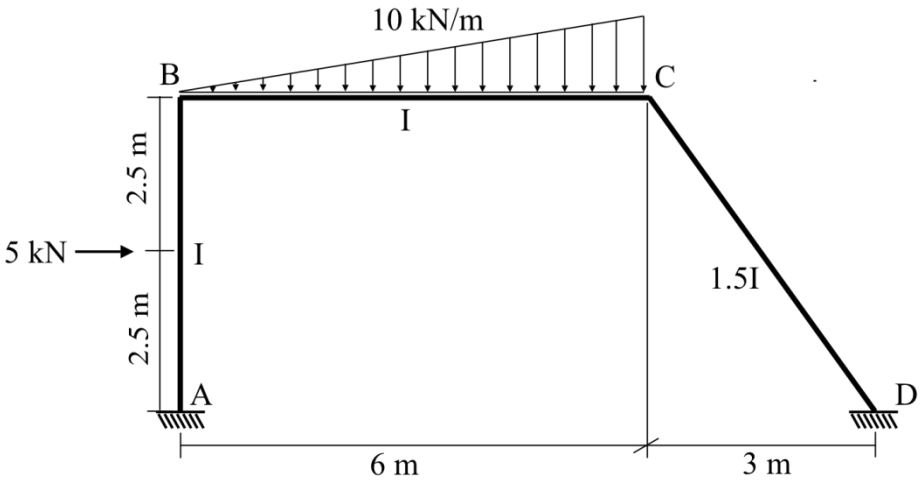


Figure 2/*Rajah 2*

Compute the internal moments at the joint of the frame by using the Slope Deflection Method.

Kira nilai momen dalaman di setiap penyokong kerangka tersebut dengan menggunakan Kaedah Cerun Pesongan.

[20 marks/*markah*]

3. (a) Determine the horizontal displacement at point D for the truss shown in **Figure 3**. The cross-sectional area of each member is given in parentheses (mm^2) and the modulus of elasticity is 200 GPa. Use virtual work method.

*Kira anjakan ufuk di titik D untuk kekuda yang ditunjukkan dalam **Rajah 3**. Luas keratan rentas setiap anggota diberikan dalam kurungan (mm^2) dan modulus keanjalan ialah 200 GPa. Guna kaedah kerja maya.*

[17 marks/*markah*]

(b) If member BC is short by 5 mm and it is forced into place, calculate the horizontal displacement at point D with the applied load of 15 kN.

Jika anggota BC adalah pendek 5 mm dan dipaksa dipasangkan. Kira anjakan ufuk di titik D dengan daya luar 15 kN.

[3 marks/*markah*]

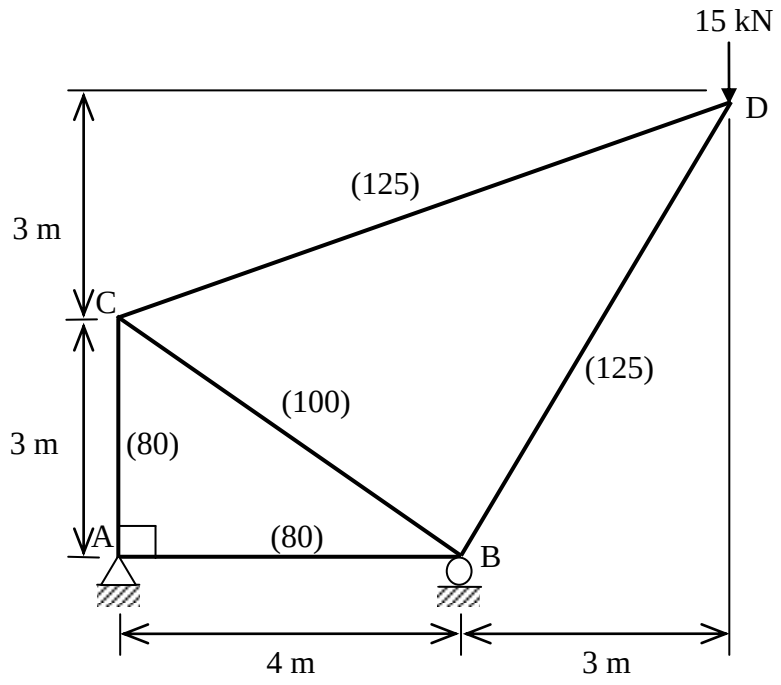


Figure 3/*Rajah 3*

4. **Figure 4** shows a rigid-jointed frame to carry the working loads. If the collapse load factor is to be 1.8, determine the required plastic moment capacity (M_p) for the frame.

Rajah 4 *menunjukkan sebuah kerangka terikat tegar dengan beban kerja. Jika faktor beban runtuh ialah 1.8, tentukan kapasiti momen plastik (M_p) yang diperlukan untuk kerangka tersebut.*

[20 marks/*markah*]

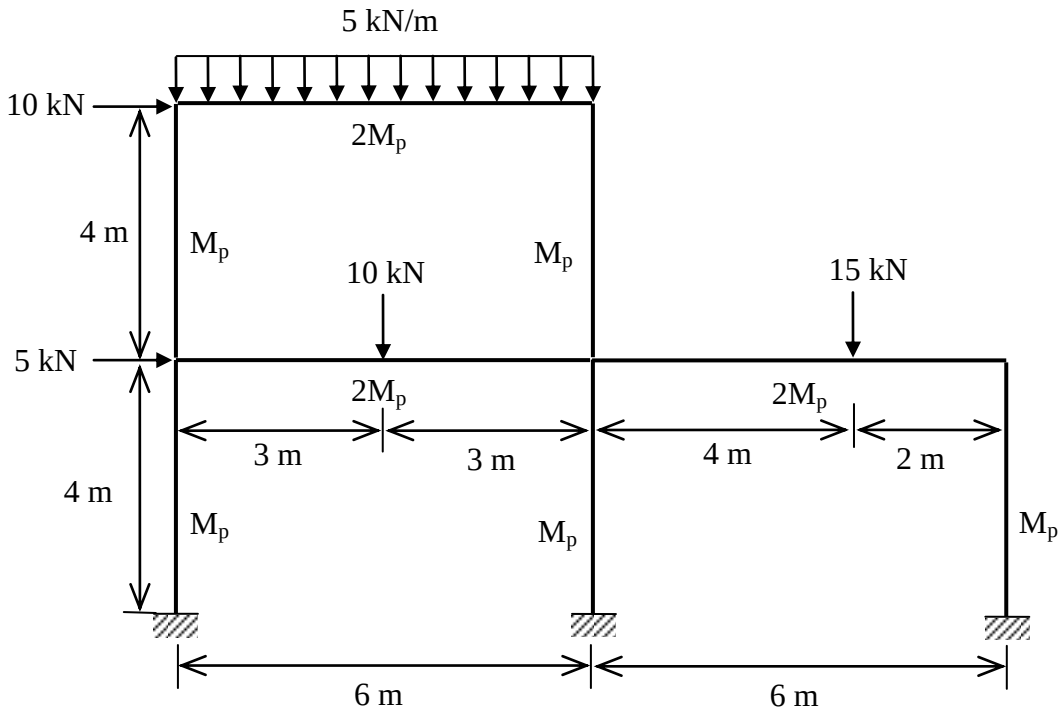


Figure 4/*Rajah 4*

5. (a) A strut BC with both end pinned has been attached to the free end of a cantilever column AB in order to restraint the horizontal displacement of the free end B as shown in **Figure 5**. The height of the cantilever column is *H* and the flexural rigidity is *EI*. The length of the strut BC is *L* with axial rigidity *EA*. A uniformly distributed load *w* acts on the cantilever column AB. Determine the compression force in the strut. Use method of least work.

Satu topang BC dengan kedua-dua hujung sendi telah disambung pada hujung bebas tiang julur AB untuk mengekang anjakan ufuk hujung bebas B seperti yang ditunjukkan dalam ***Rajah 5****. Tinggi tiang julur adalah H dengan ketegaran lenturan EI. Panjang topang BC adalah L dengan ketegaran paksi EA. Satu beban teragih seragam w bertindak di sepanjang tiang julur. Tentukan daya mampatan dalam topang. Guna kaedah kerja terkecil.*

[5 marks/*markah*]

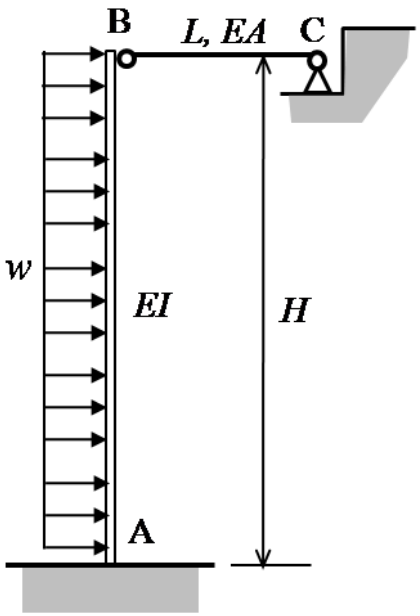


Figure 5/*Rajah 5*

(b) **Figure 6** shows a rigid frame ABC with one end pinned at A supported by a truss structure EFG at C. A uniformly distributed load of 10 kN/m acts along member BC. Show by using appropriate free body diagram that the problem is statically indeterminate with degree of statical indeterminacy equals to ONE (1). Subsequently, by choosing suitable unknown force as the redundant, determine the member forces in the truss structure EFG. Consider effect of axial deformation of the frame. Use method of least work.

Rajah 6 *menunjukkan satu kerangka tegar ABC dengan satu hujung pin disokong pada hujung C oleh satu struktur kekuda EFG. Satu beban teragih seragam 10kN/m bertindak di sepanjang anggota BC. Dengan menggunakan gambarajah jasad bebas yang sesuai, tunjukkan bahawa masalah dalam* ***Rajah 6*** *adalah satu masalah tidak-bolehtentu statik dengan darjah ketidakboleh tentuan statik sama dengan SATU (1). Seterusnya, dengan memilih daya tidak diketahui yang sesuai sebagai daya terlebih, tentukan daya dalam anggota struktur kekuda EFG. Pertimbangkan kesan ubahbentuk paksi kerangka. Guna kaedah kerja terkecil.*

[15 marks/*markah*]

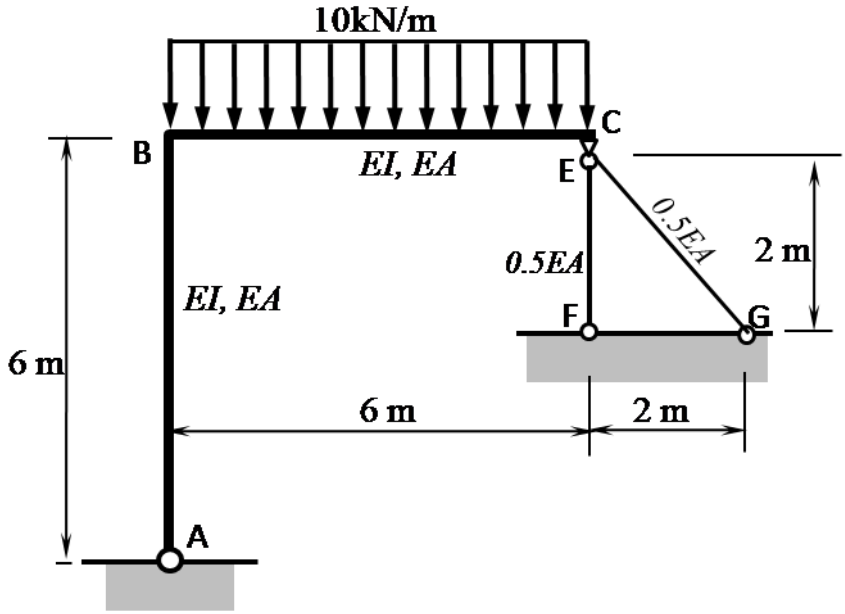


Figure 6/*Rajah 6*

6. (a) Use the virtual work method to determine the vertical deflection at joint E of the frame shown in **Figure 7**.

Guna kaedah kerja maya untuk kira anjakan tegak sambungan E untuk kerangka yang ditunjukkan dalam ***Rajah 7****.*

[12 marks/*markah*]

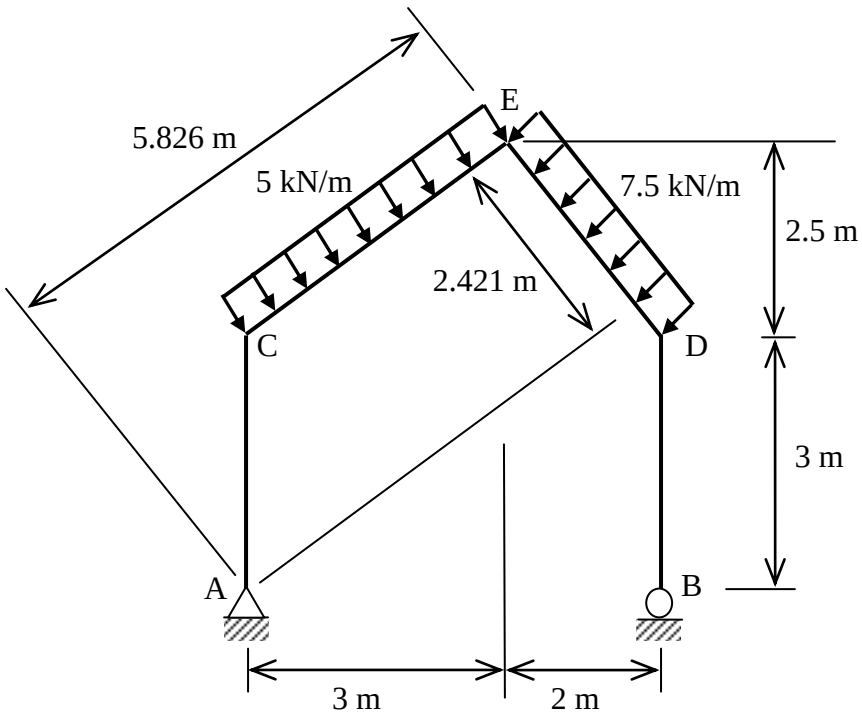


Figure 7/*Rajah 7*

(b) The section of a steel beam for a frame is shown in **Figure 8**. Determine the plastic moment capacity, elastic moment capacity and shape factor of the beam section. The yield stress of steel is 275 N/mm^2.

*Keratan rasuk keluli untuk kerangka diberikan dalam **Rajah 8**. Kira kapasiti momen plastik, kapasiti momen elastik dan faktor bentuk keratan rasuk. Tegasan alah untuk keluli ialah 275 N/mm^2.*

[8 marks/*markah*]

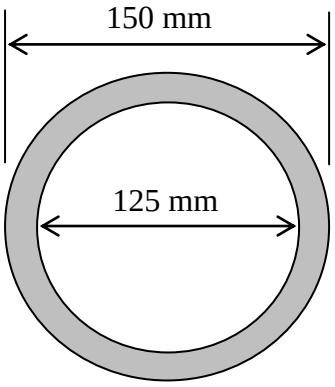
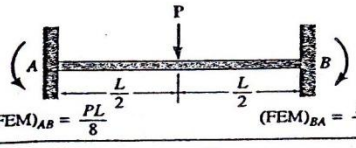
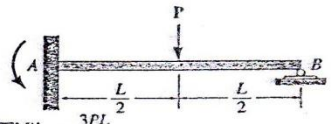
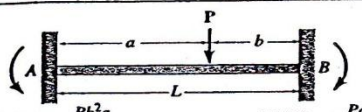
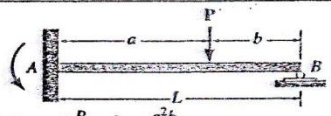
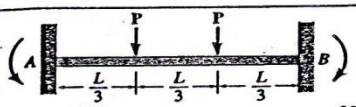
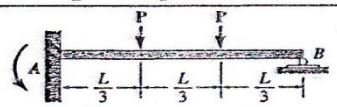
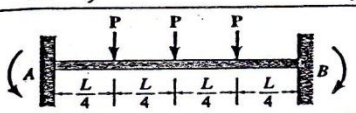
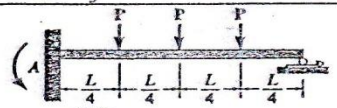
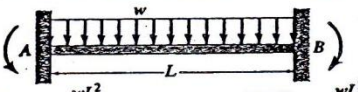
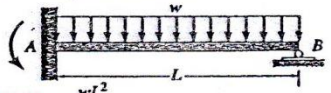
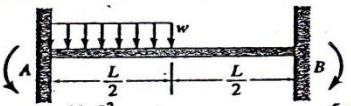
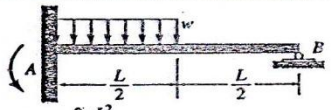
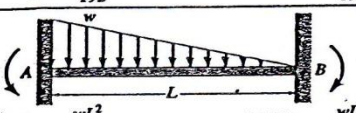
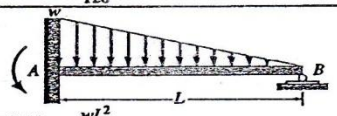
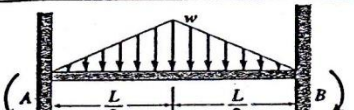
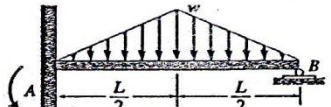
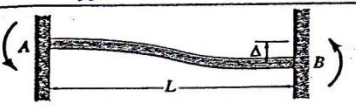


Figure 8/*Rajah 8*

ATTACHMENT
LAMPIRAN

Fixed End Moments

 $(FEM)_{AB} = \frac{PL}{8}$ $(FEM)_{BA} = \frac{PL}{8}$	 $(FEM)'_{AB} = \frac{3PL}{16}$
 $(FEM)_{AB} = \frac{Pb^2a}{L^2}$ $(FEM)_{BA} = \frac{Pa^2b}{L^2}$	 $(FEM)'_{AB} = (\frac{P}{L^2})(b^2a + \frac{a^2b}{2})$
 $(FEM)_{AB} = \frac{2PL}{9}$ $(FEM)_{BA} = \frac{2PL}{9}$	 $(FEM)'_{AB} = \frac{PL}{3}$
 $(FEM)_{AB} = \frac{15PL}{48}$ $(FEM)_{BA} = \frac{15PL}{48}$	 $(FEM)'_{AB} = \frac{45PL}{96}$
 $(FEM)_{AB} = \frac{wL^2}{12}$ $(FEM)_{BA} = \frac{wL^2}{12}$	 $(FEM)'_{AB} = \frac{wL^2}{8}$
 $(FEM)_{AB} = \frac{11wL^2}{192}$ $(FEM)_{BA} = \frac{5wL^2}{192}$	 $(FEM)'_{AB} = \frac{9wL^2}{128}$
 $(FEM)_{AB} = \frac{wL^2}{20}$ $(FEM)_{BA} = \frac{wL^2}{30}$	 $(FEM)'_{AB} = \frac{wL^2}{15}$
 $(FEM)_{AB} = \frac{5wL^2}{96}$ $(FEM)_{BA} = \frac{5wL^2}{96}$	 $(FEM)'_{AB} = \frac{5wL^2}{64}$
 $(FEM)_{AB} = \frac{6EI\Delta}{L^2}$ $(FEM)_{BA} = \frac{6EI\Delta}{L^2}$	 $(FEM)'_{AB} = \frac{3EI\Delta}{L^2}$