UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2015/2016 Academic Session

June 2016

EAS254 – 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. [a] Determine the vertical and horizontal displacements at point C for the truss shown in **Figure 1**. 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 tegak dan ufuk di titik C untuk kekuda yang ditunjukkan dalam **Rajah 1**. Luas keratan rentas setiap ahli diberikan dalam kurungan (mm^2) dan modulus keanjalan ialah 200 GPa. Guna kaedah kerja maya.*

[16 marks/*markah*]

[b] If member BC is short by 5 mm and it is forced into place, calculate the vertical and horizontal displacements at point C due to the fabrication error and the external load.

Jika anggota BC adalah pendek sebanyak 5 mm dan dipaksa dipasangkan, kira anjakan tegak dan ufuk di titik C akibat kesilapan fabrikasi dan beban luaran.

[4 marks/*markah*]

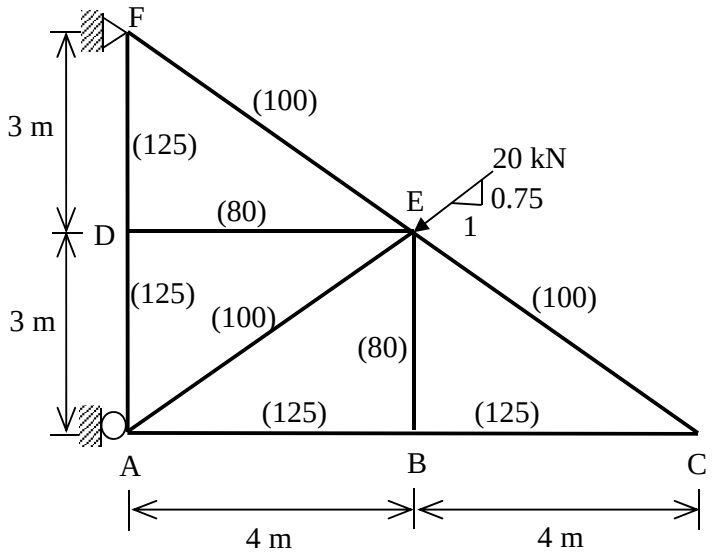


Figure 1 / *Rajah 1*

2. A two-span continuous steel beam as shown in **Figure 2** is supporting two uniformly distributed loads of 30 kN/m and 20 kN/m along span AB and BC, respectively. The continuous beam is supported by a pin at A and by a roller at B and C. Determine the reaction at all supports A, B and C of the continuous beam by the method of least work. The span AB and BC of the beams have the second moment of area of 79100 cm^4 and 57100 cm^4, respectively. The elastic modulus of the steel beam is 200 GN/m^2. Ignore the self-weight of the beam.

   *Satu rasuk keluli selanjar dua-rentang seperti ditunjukkan dalam **Rajah 2** menyokong dua beban teragih seragam sebanyak masing-masing 30 kN/m dan 20 kN/m sepanjang rentang AB dan BC. Rasuk selanjar tersebut disokong oleh satu pin di A dan satu rola di B dan C. Tentukan tindakbalas di semua penyokong A, B dan C rasuk selanjar tersebut menggunakan kaedah kerja terkurang. Rentang AB dan BC rasuk tersebut mempunyai momen luas kedua masing-masing 79100 cm^4 dan 57100 cm^4. Modulus keanjalan rasuk keluli ialah 200 GN/m^2. Abaikan berat-diri rasuk tersebut.*

   [20 marks/*markah*]

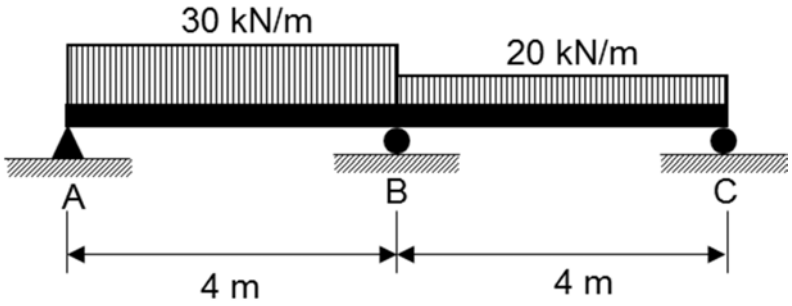


Figure 2 / *Rajah 2*

3. **Figure 3** shows a frame carrying a uniformly distributed load of 30 kN/m for member DBC, with overhang portion DB. Supports A and C are fixed. The flexural rigidity of member DBC and AB are 4I and I, respectively. *E* is constant for the frame.

Rajah 3 *menunjukkan satu kerangka dengan bahagian terjulur DB membawa daya teragih seragam sebanyak 30 kN/m bagi rentang DBC. Penyokong A dan C adalah jenis terikat. Ketegaran lenturan bagi rentang DBC dan AB adalah masing-masing 4I dan I. E adalah malar untuk kerangka tersebut.*

[a] Compute the internal moments at the joint of the frame by using Slope Deflection Method. Fixed end moment is given in the **Appendix**.

Kira nilai momen dalaman di setiap sambungan kerangka tersebut dengan menggunakan Kaedah Cerun Pesongan. Momen terikat hujung diberikan dalam ***Lampiran.***

[15 marks/*markah*]

[b] Draw the shear force and bending moment diagrams for member BC.

Lukiskan gambarajah daya ricih dan momen lentur bagi anggota BC.

[5 marks/*markah*]

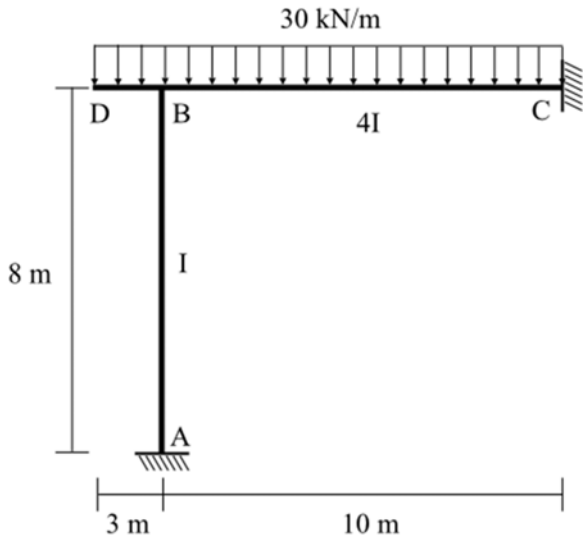


Figure 3 / ***Rajah 3***

4. **Figure 4** shows a beam carrying a uniformly distributed load of 40 kN/m for span BC and a point load of 25 kN at the end of cantilever CD. Support A is fixed, whereas supports B and C are roller. Assume EI is constant for the beam.

Rajah 4 *menunjukkan rasuk yang membawa beban teragih seragam sebanyak 40 kN/m bagi rentang BC dan beban tumpu sebanyak 25 kN di hujung rentang julur CD. Penyokong A adalah terikat tegar manakala B dan C adalah rola. Anggap EI adalah malar untuk rasuk tersebut.*

[a] Compute the internal moments at the joint of the beam by using Moment Distribution Method. Fixed end moment is given in the **Appendix**.

Kira nilai momen dalaman di setiap sambungan rasuk tersebut dengan menggunakan Kaedah Agihan Momen. Momen terikat hujung diberikan dalam ***Lampiran****.*

[16 marks/*markah*]

[b] Sketch the bending moment diagram and the qualitative deflected shape for the beam.

Lakarkan gambarajah momen lentur dan bentuk pesongan kualitatif bagi rasuk tersebut.

[4 marks/*markah*]

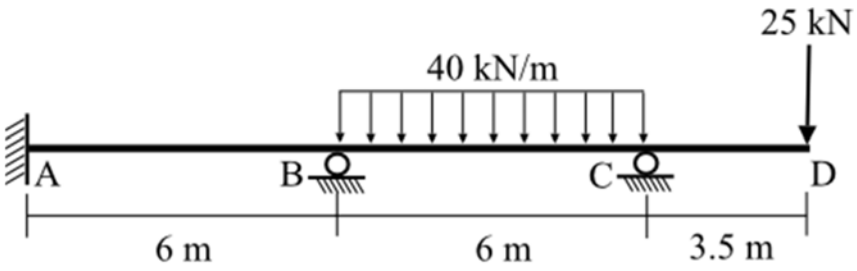


Figure 4 / ***Rajah 4***

5. A rigid-jointed frame is designed to carry the working loads as shown in **Figure 5**. If the collapse load factor is 1.8, determine the required plastic moment capacity (M_p) for all independent mechanisms and any five combined mechanisms.

   *Sebuah kerangka terikat tegar direkabentuk untuk menanggung beban kerja seperti ditunjukkan dalam **Rajah 5**. Jika faktor beban runtuh ialah 1.8, tentukan kapasiti momen plastik (M_p) yang diperlukan untuk semua mekanisma bebas dan mana-mana lima mekanisma gabungan.*

[20 marks/*markah*]

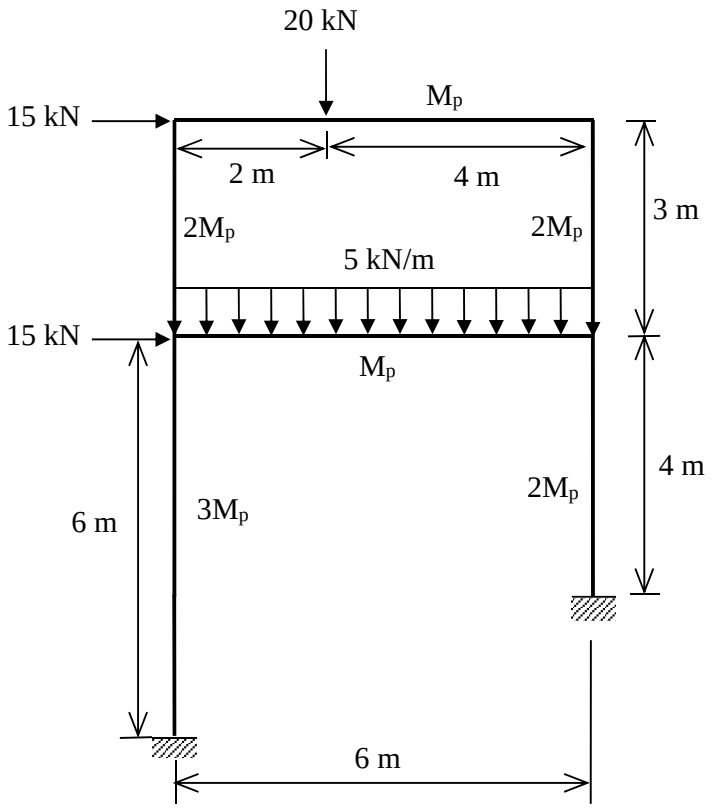


Figure 5 / *Rajah 5*

6. [a] **Figure 6(a)** shows a portal frame that carries uniformly distributed load of 5 kN/m along span BC and CD with pin and roller supports at A and E, respectively. The load is perpendicular to the spans. Two horizontal concentrated loads of 15 kN are acting at joints B and D. Use the virtual work method to determine the vertical deflection at joint C of the frame shown in **Figure 6(a)**. Take E = 200 GPa and I = 600×10^6 mm^4.

Rajah 6(a) *menunjukkan kerangka portal yang menanggung beban teragih seragam sebanyak 5 kN/m di sepanjang rentang BC dan CD dengan penyokong A dan E masing-masing adalah pin dan rola. Beban tersebut adalah serenjang terhadap rentang. Dua beban tumpu ufuk 15 kN bertindak di sambungan B dan D. Guna kaedah kerja maya untuk kira anjakan tegak di sambungan C untuk kerangka yang ditunjukkan dalam* ***Rajah 6(a)****. Guna E = 200 GPa and I = 600 $\times 10^6$ mm^4.*

[10 marks/*markah*]

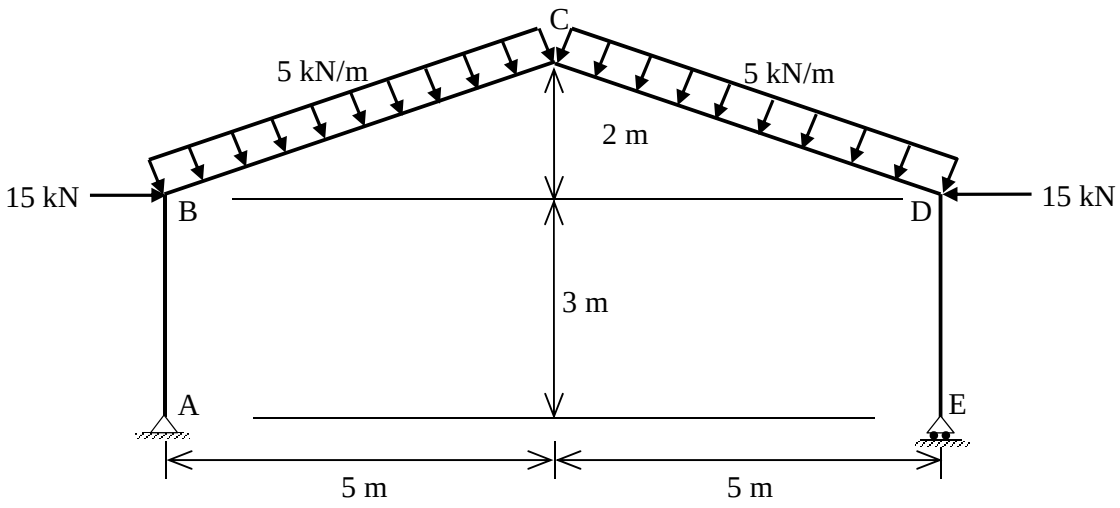


Figure 6(a) / ***Rajah 6(a)***

[b] The section of the steel beam for a frame is shown in **Figure 6(b)**. 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 6(b)****. Kira kapasiti momen plastik, kapasiti momen elastik dan faktor bentuk keratan rasuk. Tegasan alah untuk keluli ialah 275 N/mm*^{2}.

[10 marks/*markah*]

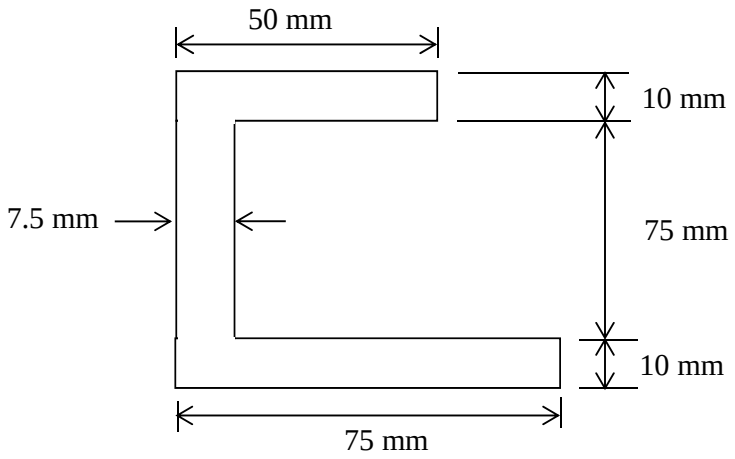
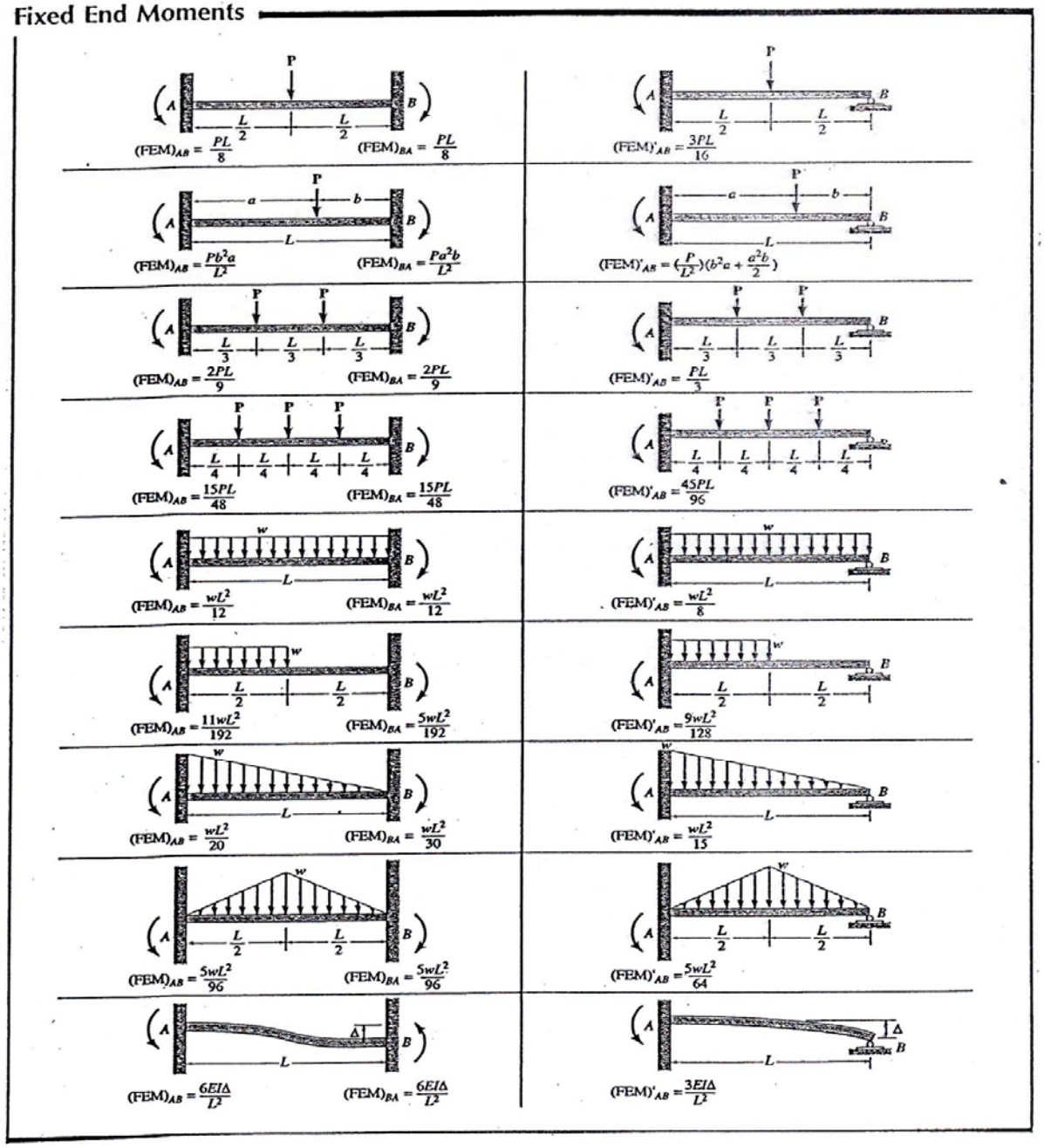


Figure 6(b) / ***Rajah 6(b)***

APPENDIX / *LAMPIRAN*

Fixed End Moments



- oooOooo -