UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2016/2017 Academic Session

June 2017

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 appendix before you begin the examination.
*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEMBILAN (9)** muka surat yang bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.*]

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

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.*]

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 displacement 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 di titik C untuk kekuda yang ditunjukkan dalam **Rajah 1.** Luas keratan rentas setiap anggota diberikan dalam kurungan (mm^2) dan modulus keanjalan ialah 200 GPa. Guna kaedah kerja maya.*

[16 marks/*markah*]

[b] If member CF is too short of 5 mm and it is forced into place, calculate the vertical displacement at point C due to the fabrication error and the external load.

Jika anggota CF adalah pendek 5 mm dan terpaksa dipasangkan. Kira anjakan tegak di titik C akibat kesilapan pemfabrikatan dan beban luaran.

[4 marks/*markah*]

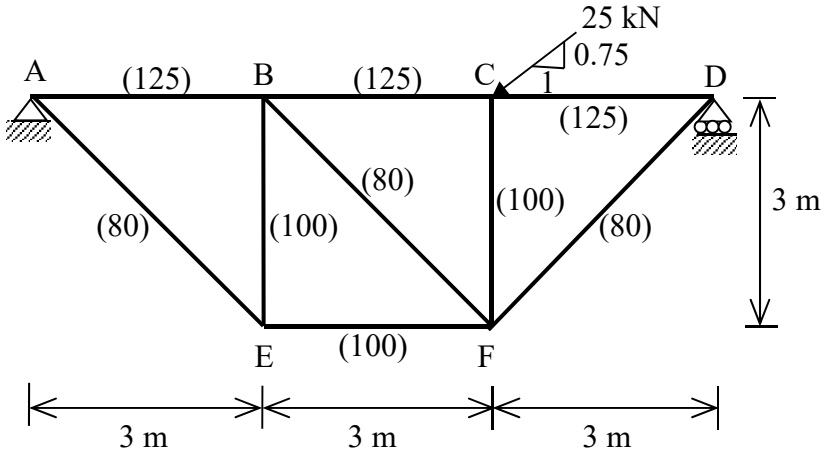


Figure 1/*Rajah 1*

2. A concrete beam as shown in **Figure 2** is subjected to a uniformly distributed load of 2 kN/m along span AB and a concentrated load of 3 kN at C. The beam that has a cross section of 150 mm width by 300 mm depth is fixed at A and the support at B is a roller. The modulus of elasticity of the beam is 30 GN/m^2.

*Sebuah rasuk seperti ditunjukkan dalam **Rajah 2** dibebani satu beban teragih seragam sebanyak 2 kN/m di sepanjang rentang AB dan satu beban tumpu sebanyak 3 kN di C. Rasuk tersebut yang mempunyai keratan rentas dengan lebar 150 mm dan kedalaman 300 mm diikat tegar di A dan penyokong di B ialah rola. Modulus keanjalan rasuk tersebut ialah 30 GN/m^2.*

[a] Determine the reactions at supports of the beam using method of least work.

Tentukan tindak balas di penyokong rasuk menggunakan kaedah kerja terkurang.

[12 marks/*markah*]

[b] If the roller support is replaced by a steel cable as shown in **Figure 3**, determine the percentage change in magnitude of vertical reaction force at A. The modulus of elasticity and diameter of the steel cable are 150 GN/m^2 and 10 mm, respectively.

*Sekiranya penyokong rola digantikan dengan satu kabel besi seperti ditujukkan dalam **Rajah 3** , tentukan peratus perubahan magnitud daya tindak balas pugak di A. Modulus keanjalan dan diameter rasuk masing-masing ialah 150 GN/m^2 dan 10 mm.*

[8 marks/*markah*]

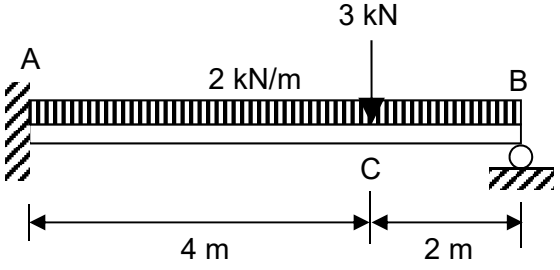


Figure 2/*Rajah 2*

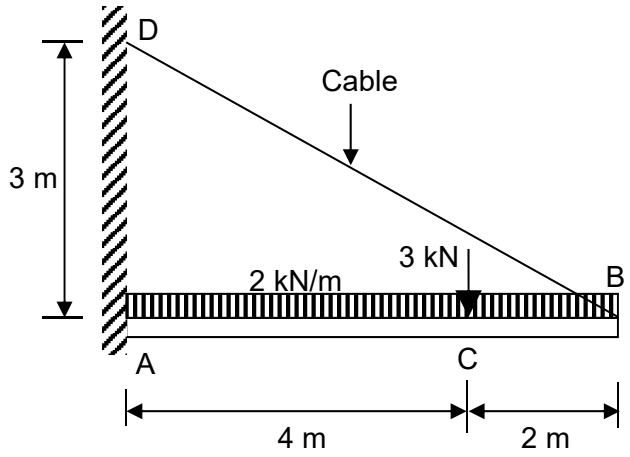


Figure 3/*Rajah 3*

3. **Figure 4** shows a beam carrying a uniformly distributed load of ***w*** on half of the span AB and a moment of 25 kNm at roller support B. The roller support at C is pushed downward 30 mm by the force **P.** Supports A and D are fixed. Assume *EI* is constant for the beam. Given that the $(FEM)_{BA}$ = 7.5 kNm.

Rajah 4 *menunjukkan rasuk yang membawa beban teragih seragam* ***w*** *pada setengah rentang AB dan momen sebanyak 25 kNm dikenakan pada penyokong rola B. Penyokong rola C dikenakan daya,* ***P*** *ke bawah sebanyak 30 mm. Penyokong A dan D adalah terikat tegar. Anggap EI adalah malar untuk rasuk tersebut. Diberikan juga.* $(FEM)_{BA}$ *= 7.5 kNm.*

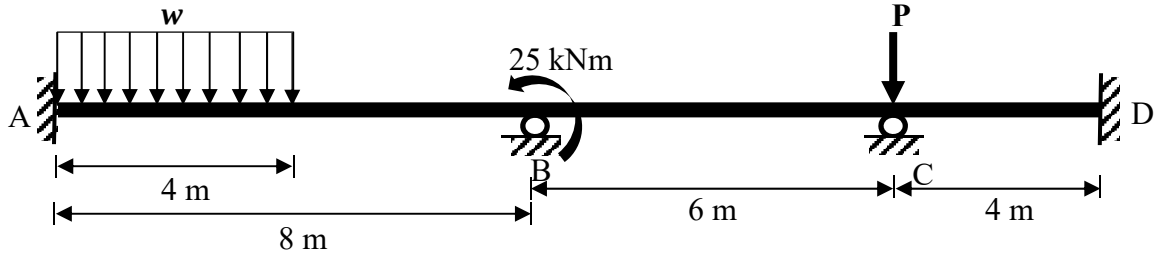


Figure 4/*Rajah 4*

[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.***

[16 marks/*markah*]

[b] Compute the force, **P** that is applied at the roller support C.

Kirakan daya, ***P*** *yang dikenakan pada penyokong rola C.*

[4 marks/*markah*]

4. **Figure 5** shows a beam carrying a uniformly distributed load of 30 kN/m on span ABCDE and concentrated loads of 20 kN at 3.5 m from supports A and E. Supports A and E are fixed, whereas supports B, C and D are roller. Assume *EI* is constant for the beam.

Rajah 5 *menunjukkan rasuk membawa beban teragih seragam sebanyak 30 kN/m pada rentang ABCDE dan beban tumpu sebanyak 20 kN pada 3.5 m dari penyokong A dan E. Penyokong A dan E adalah terikat tegar, manakala penyokong B, C dan D adalah rola. Anggap EI adalah malar untuk rasuk tersebut.*

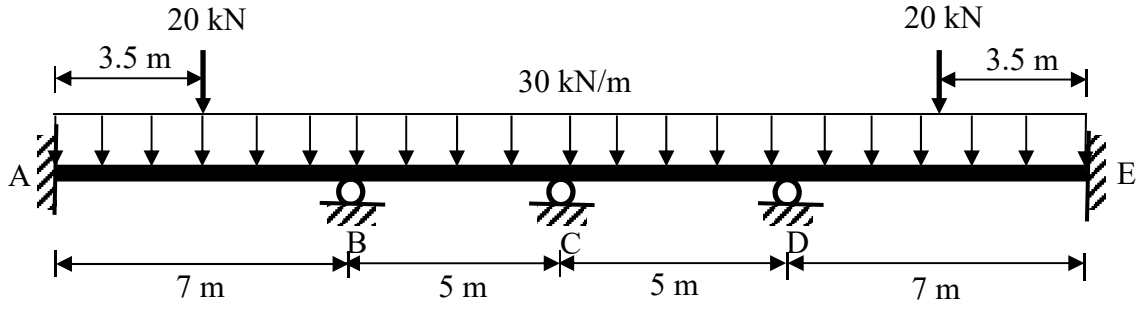


Figure 5/*Rajah 5*

[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***

[10 marks/*markah*]

[b] Draw the bending moment diagram and the qualitative deflected shape for span ABC only.

Lukiskan gambarajah momen lentur dan bentuk pesongan kualitatif bagi rentang ABC sahaja.

[10 marks/*markah*]

5. **Figure 6** shows a rigid-jointed frame to carry the working loads. If the collapse load factor is to be 2, determine the required plastic moment capacity (M_p) for the frame.

Rajah 6 *menunjukkan sebuah kerangka terikat tegar dengan beban kerja. Jika faktor beban runtuh ialah 2, tentukan kapasiti momen plastik (M_p) yang diperlukan untuk kerangka tersebut.*

[20 marks/*markah*]

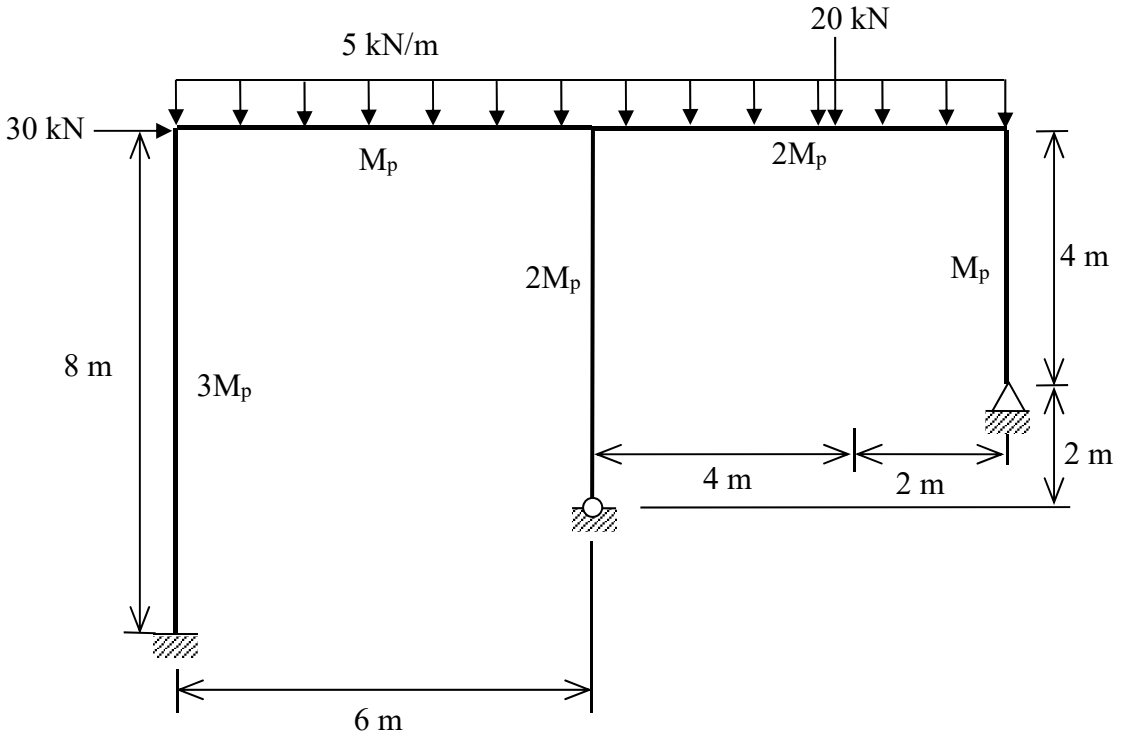


Figure 6/*Rajah 6*

6. Use the virtual work method to determine the horizontal deflection and rotation angle at joint C of the frame shown in **Figure 7**. Take E = 200 GPa and I = 600 × 10^6 mm^4.

*Guna kaedah kerja maya untuk kira anjakan ufuk dan sudut putaran di sambungan C untuk kerangka yang ditunjukkan dalam **Rajah 7**. Guna E = 200 GPa dan I = 600 × 10^6 mm^4.*

[20 marks/*markah*]

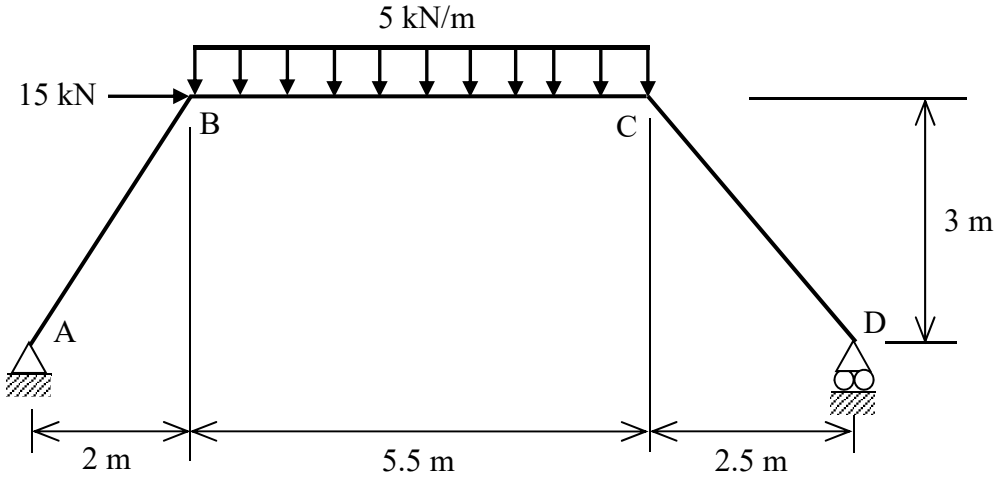
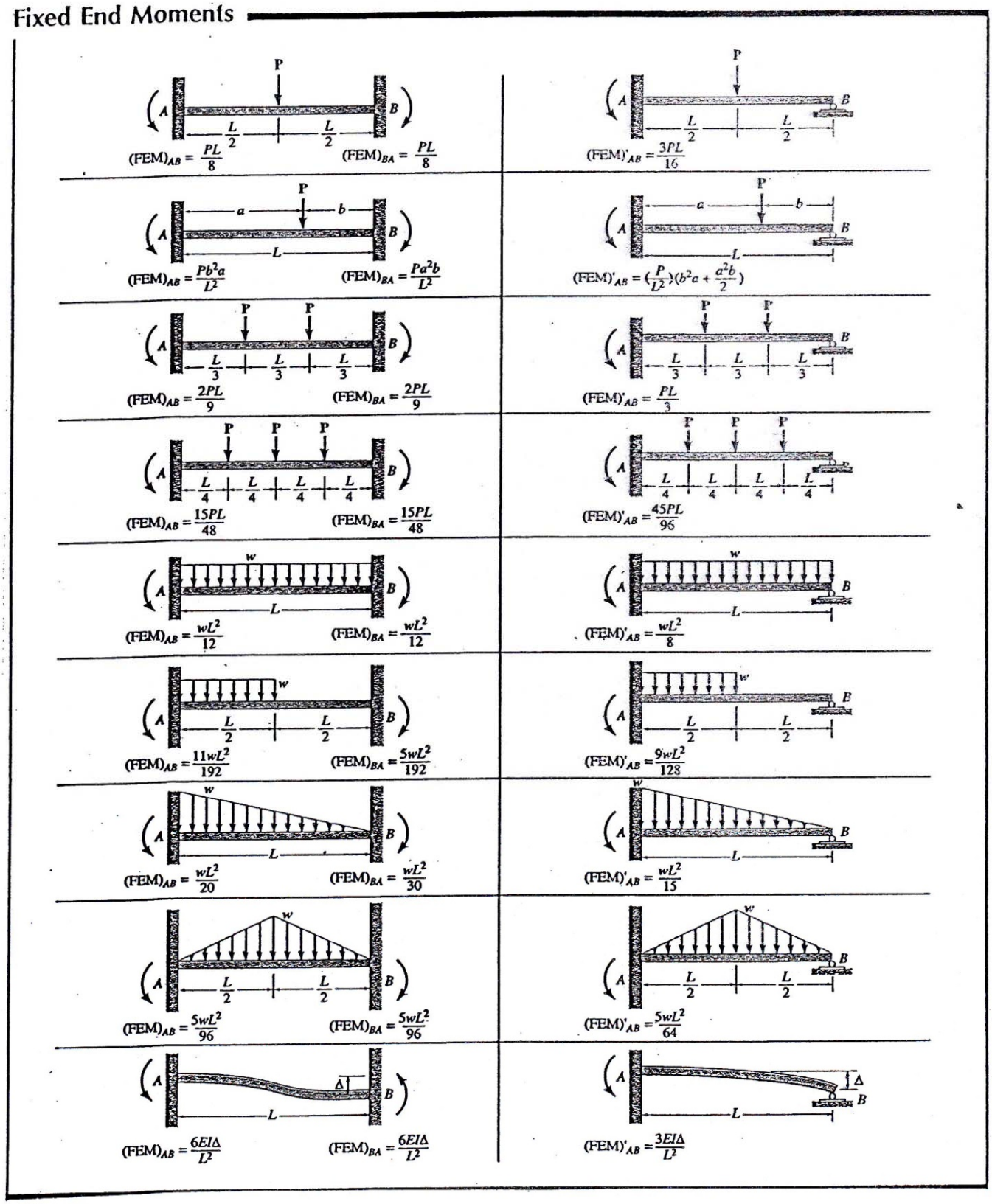


Figure 7/*Rajah 7*

APPENDIX / *LAMPIRAN*

Fixed End Moments



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