Second Semester Examination
2018/2019 Academic Session

June 2019

EAS254 – *Structural Analysis* (Analisis Struktur)

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of **TEN (10)** pages of printed material including appendix before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **SEPULUH (10)** 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.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

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1. (a). Most energy methods are based on the conservation of energy principles. Using a simple truss system, explain the principle of virtual forces for deformable bodies.

Kebanyakan kaedah tenaga adalah berdasarkan prinsip pemuliharaan tenaga. Menggunakan satu sistem kekuda yang ringkas, jelaskan prinsip daya maya untuk jasad boleh ubah bentuk.

[5 marks/*markah*]

(b). Determine the vertical displacement at point B for the trusses shown in **Figure 1** if a concentrated load of 20 kN is applied vertically downward at point E. The cross-sectional area of each member is given in parentheses (mm^2) and the modulus of elasticity is 200 GPa. Consider the axial deformation only. Use virtual work method.

*Kirakan anjakan tegak di titik B untuk kekuda yang ditunjukkan dalam **Rajah 1** jika satu beban tumpu 20 kN dikenakan menegak ke bawah di titik E. Luas keratan rentas setiap anggota diberikan dalam kurungan (mm^2) dan modulus keanjalan ialah 200 GPa. Pertimbangkan ubahbentuk paksi sahaja. Guna kaedah kerja maya.*

[13 marks/*markah*]

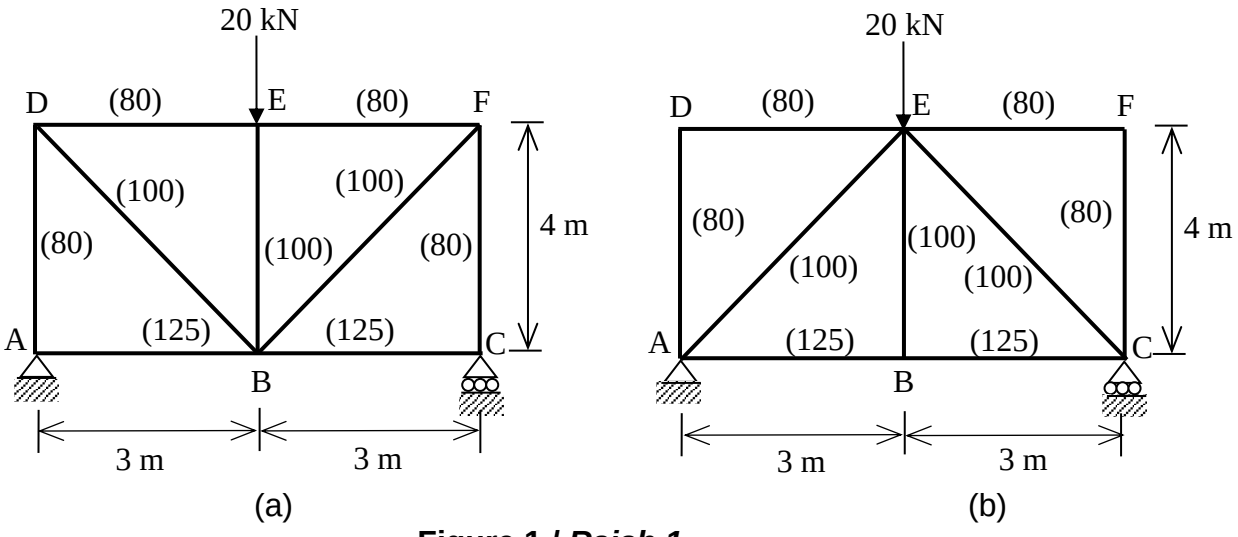

Figure 1 / *Rajah 1*

(c). Give comment on the efficiency of both trusses to support the applied load.

Beri komen ke atas kecekapan kedua-dua kekuda dalam menanggung beban yang dikenakan.

[2 marks/*markah*]

2. (a). A concrete beam as shown in **Figure 2** supports a uniformly distributed load of 30 kN/m along span AB and a concentrated load of 75 kN at B. The beam is supported by a pin at A and is fixed at C. Determine the reactions at supports A and C of the beam by using the method of least work. The elastic modulus of the concrete beam and second moment of area of the beam section are 30 GN/m^2 and 45000 cm^4, respectively. Ignore the self-weight of the beam.

*Sebuah rasuk konkrit seperti ditunjukkan dalam **Rajah 2** menanggung beban teragih seragam 30 kN/m di sepanjang rentang AB dan satu beban tumpu 75 kN di B. Rasuk tersebut disokong dengan pin di A dan diikat tegar di C. Tentukan tindakbalas di penyokong A dan C menggunakan kaedah kerja terkurang. Modulus keanjalan rasuk konkrit dan momen luas kedua keratan rasuk masing-masing adalah 30 GN/m^2 dan 45000 cm^4. Abaikan berat-diri rasuk tersebut.*

[20 marks/*markah*]

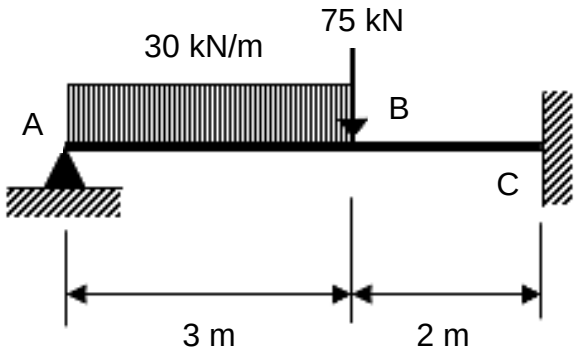

Figure 2 / Rajah 2

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3. **Figure 3** shows a frame carrying a point load of 15 kN on member BE and 25 kN which is acting at certain angle at the end of overhang portion BD. Supports A, C and E are fixed, pinned and roller, respectively. The flexural rigidity of member DBE and ABC are $2I$ and I, respectively. *E* is constant for the frame.

Rajah 3 *menunjukkan satu kerangka membawa beban tumpu sebanyak 15 kN di rentang BE dan 25 kN yang bertindak pada sudut tertentu di hujung bahagian terjulur BD. Penyokong A, C dan E masing-masing adalah terikat tegar, bercemat dan rola. Ketegaran lenturan bagi rentang DBE dan ABC ialah masing-masing* $2I$ *dan* I*. E adalah malar untuk kerangka tersebut.*

(a). Based on your understanding, conclude the conditions for a frame to be considered as no sidesway frame.

Berdasarkan pemahaman anda, simpulkan keadaan bagi sesuatu kerangka untuk dianggap sebagai kerangka tiada huyung sisi.

[2 marks/*markah*]

(b). 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.***

[18 marks/*markah*]

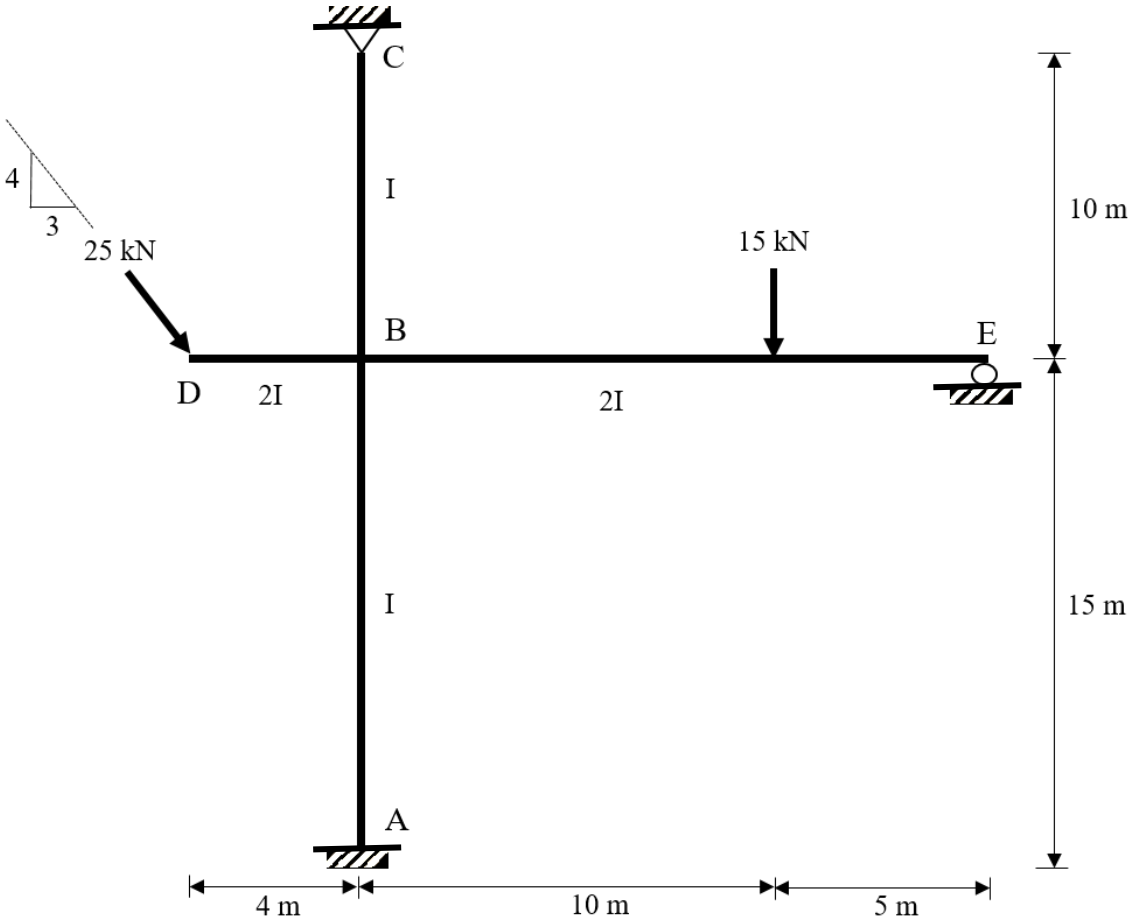

Figure 3 / ***Rajah 3***

4. **Figure 4** shows a beam carrying a uniformly distributed load of 4 kN/m on span BC and a point load of 16 kN on span CD. Meanwhile, another 5 kN force acts at the end of cantilever DE. Support A is fixed, whereas supports B, C and D are roller. The flexural rigidity of members AB, BC and CDE are $\boldsymbol{I}$, 1.5$\boldsymbol{I}$ and 2$\boldsymbol{I}$, respectively. *E* is constant for the beam.

Rajah 4 *menunjukkan rasuk yang membawa beban teragih seragam sebanyak 4 kN/m di rentang BC dan beban tumpu sebanyak 16 kN di rentang CD. Manakala daya lain sebanyak 5 kN bertindak di hujung rentang julur DE. Penyokong A adalah terikat tegar manakala penyokong B, C dan D adalah rola. Ketegaran lenturan bagi rentang AB, BC dan CDE ialah masing-masing* $\boldsymbol{I}$*, 1.5*$\boldsymbol{I}$ *dan 2*$\boldsymbol{I}$*. Anggap E adalah malar untuk rasuk tersebut.*

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(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**.*

[12 marks/*markah*]

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

Lakarkan gambar rajah daya ricih, gambar rajah momen lentur dan bentuk pesongan kualitatif bagi rasuk tersebut.

[8 marks/*markah*]

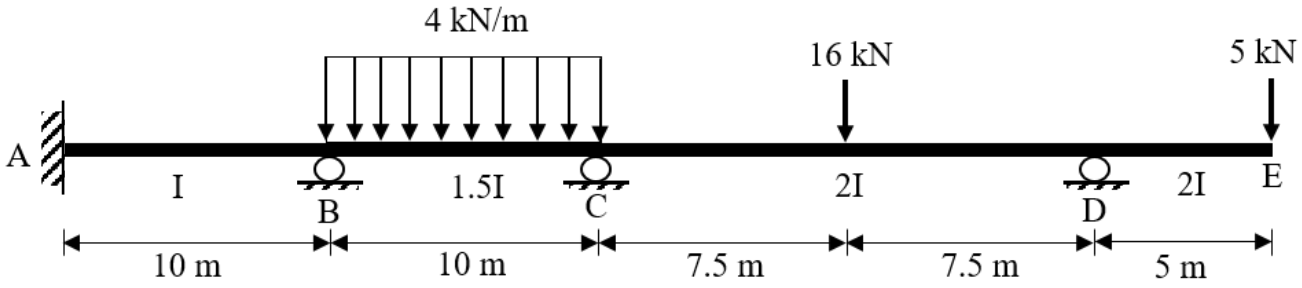


Figure 4 / ***Rajah 4***

5. **Figure 5** shows a rigid-jointed frame to carry the working loads. If the collapse load factor is to be 1.4, determine the required plastic moment capacity (M_p) for all independent mechanisms and any five combined mechanisms.

Rajah 5 *menunjukkan sebuah kerangka terikat tegar dengan beban kerja. Jika faktor beban runtuh ialah 1.4, tentukan kapasiti momen plastik (M_p) yang diperlukan untuk semua mekanisme bebas dan mana-mana lima mekanisme gabungan.*

[20 marks/*markah*]

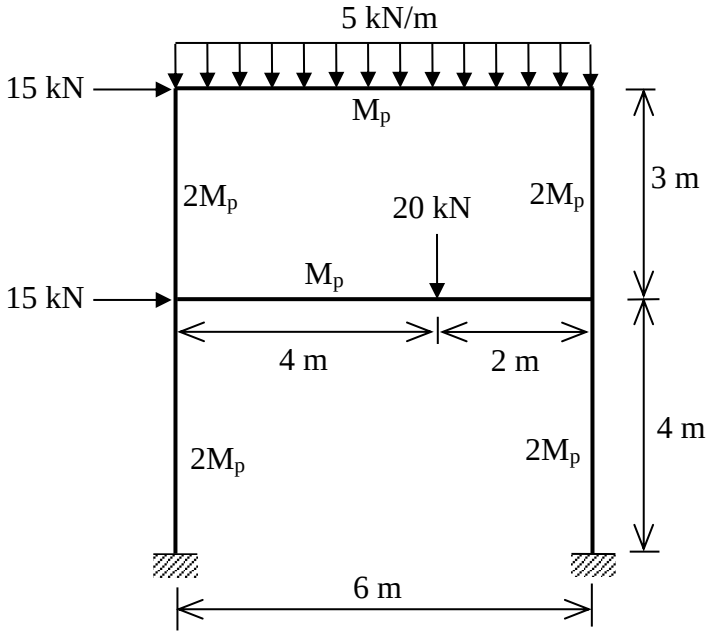


Figure 5 / ***Rajah 5***

6. (a). **Figure 6** shows a frame subjected to a concentrated moment of 10 kNm about point B and a uniformly distributed load of 5 kN/m along span AB. Use the virtual work method to determine the horizontal deflection at joint B of the frame. Take E = 200 GPa and $\boldsymbol{I}$ = 300 × 10^6 mm^4. Neglect the deflection due to axial work.

Rajah 6 *menunjukkan sebuah kerangka yang dikenakan momen tumpu sebanyak 10 kNm di titik B dan beban teragih seragam 5 kN/m di sepanjang rentang AB. Guna kaedah kerja maya untuk kira anjakan ufuk di sambungan B kerangka tersebut. Guna E = 200 GPa dan* $\boldsymbol{I}$ *= 300 × 10^6 mm^4. Abaikan anjakan disebabkan kerja paksi.*

[10 marks/*markah*]

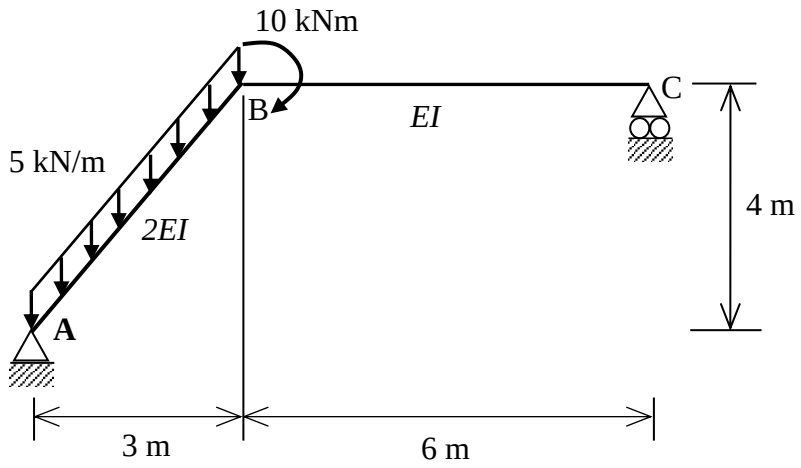


Figure 6 / ***Rajah 6***

(b). A beam shown in **Figure 7** is loaded with uniformly distributed and point loads. Determine the required plastic moment resistance for the beam to carry the given load with a load factor of 1.25 by virtual work method. Assume that the beam has constant cross-section.

*Satu rasuk yang ditunjukkan dalam **Rajah 7** dibebani oleh teragih seragam dan beban tumpu. Tentukan rintangan momen plastik yang diperlukan bagi rasuk menanggung beban yang diberikan dengan faktor beban 1.25 menggunakan kaedah kerja maya. Andaikan rasuk mempunyai keratan yang sama.*

[10 marks/*markah*]

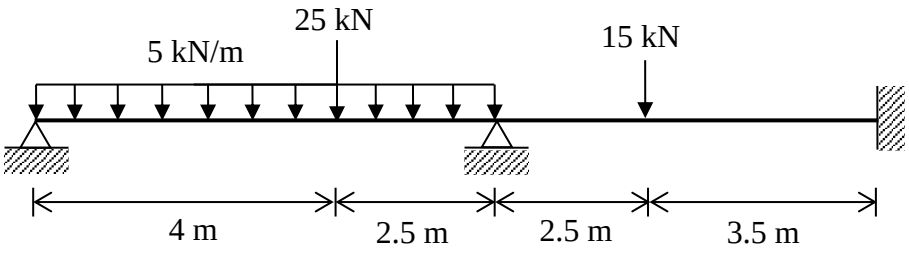
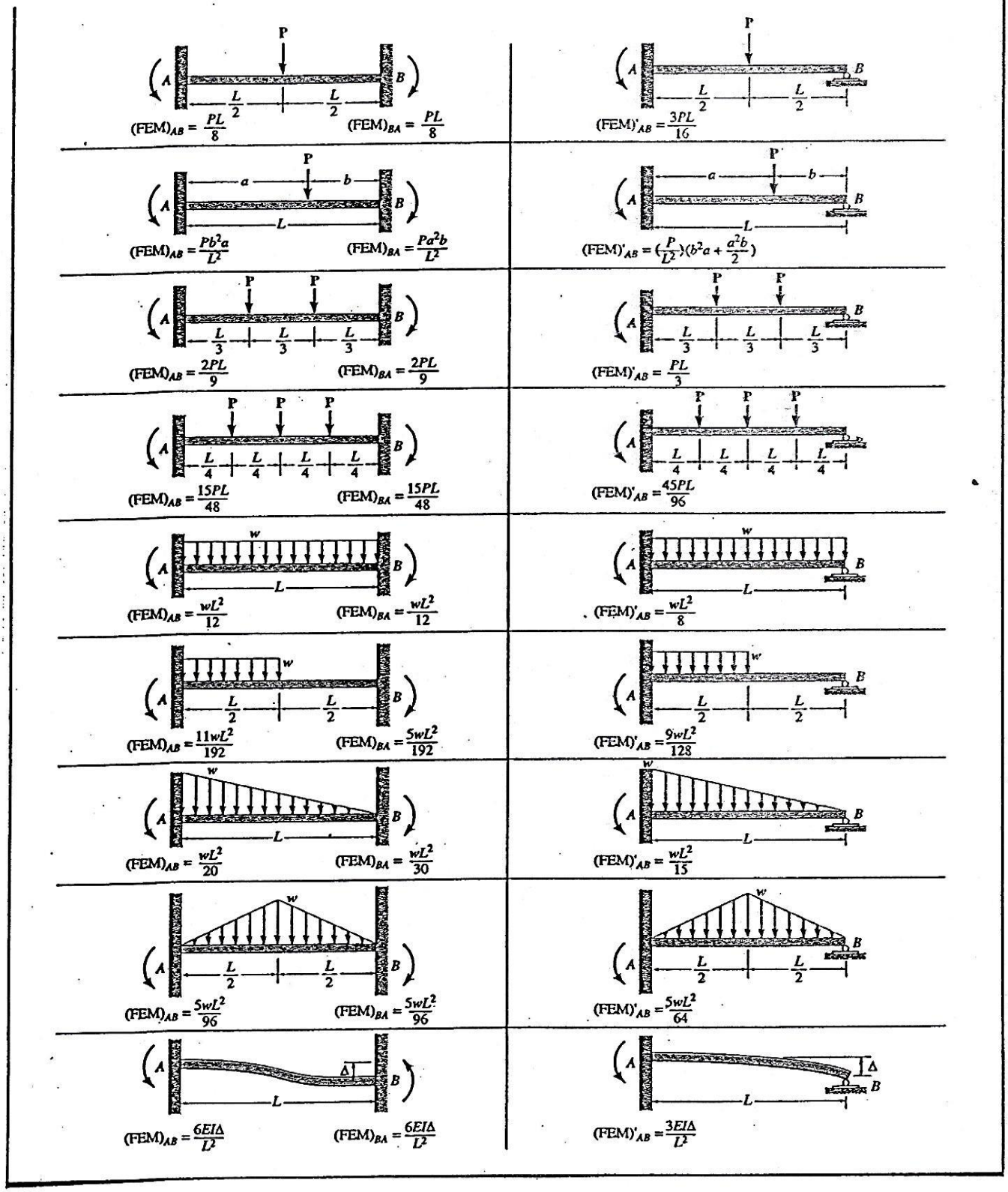


Figure 7 / *Rajah 7*

APPENDIX / LAMPIRAN

Fixed End Moments



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