UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2010/2011 Academic Session

April/May 2011

EAS 254/3 – Structural Analysis
[*Analisis Struktur*]

Duration : 3 hours
[*Masa : 3 jam*]

Please check that this examination paper consists of **SEVENTEEN (17)** pages of printed material including appendix before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi* ***TUJUH BELAS (17)*** *muka surat yang bercetak termasuk 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.*

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) Figure 1 shows a cantilever beam subjected to a point load P=25kN and a concentrated couple M_0=5kNm at C. Determine the vertical displacement of point B which is located at a distance of 1m from support A. Use method of virtual work.

It is claimed that by increasing *I* of portion AB to 2*I*, vertical displacement at point B can be reduced by 50%. Verify if this claim is true.

[6 marks]

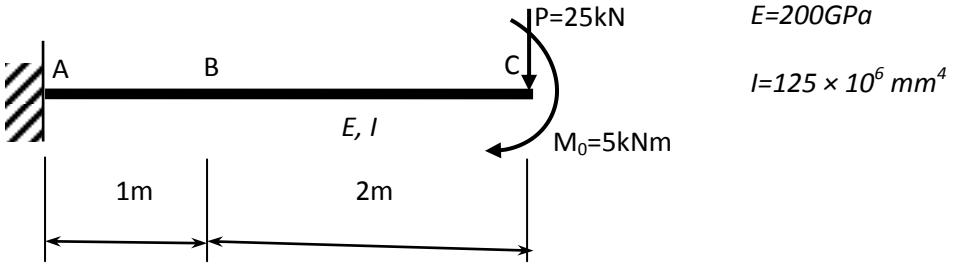


Figure 1

(b) Figure 2 shows a simple 2-member frame which is pinned at A and roller supported at C. A linearly distributed load acts along member AB and a uniformly distributed load acts along member BC. It is given that E=200GPa and $I=90\times10^6$ mm^4.

(i) Determine the rotation of joint B by using method of virtual work.

(ii) Two options to reduce the rotation of joint B have been suggested: Option A(see Figure 3(a)) and Option B(see Figure 3(b)). Verify the effectiveness of each option on the reduction of the rotation of joint B.

[14 marks]

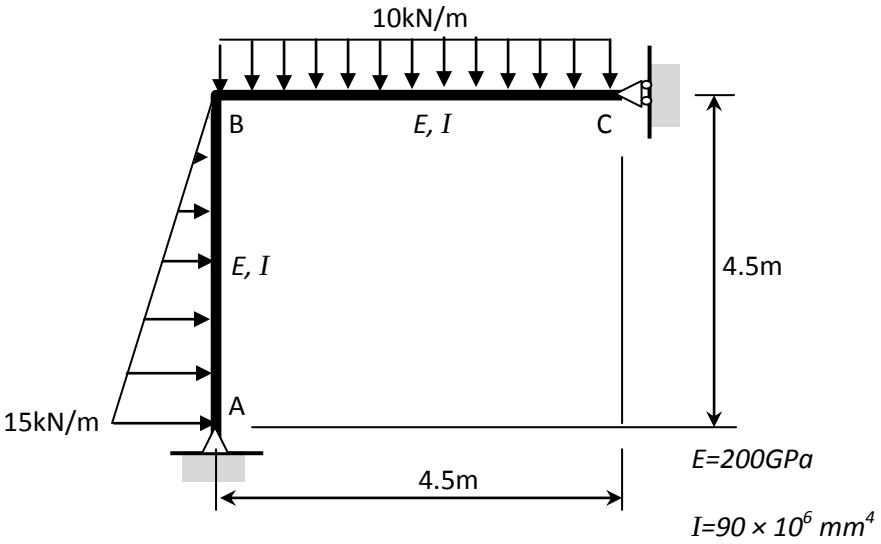


Figure 2

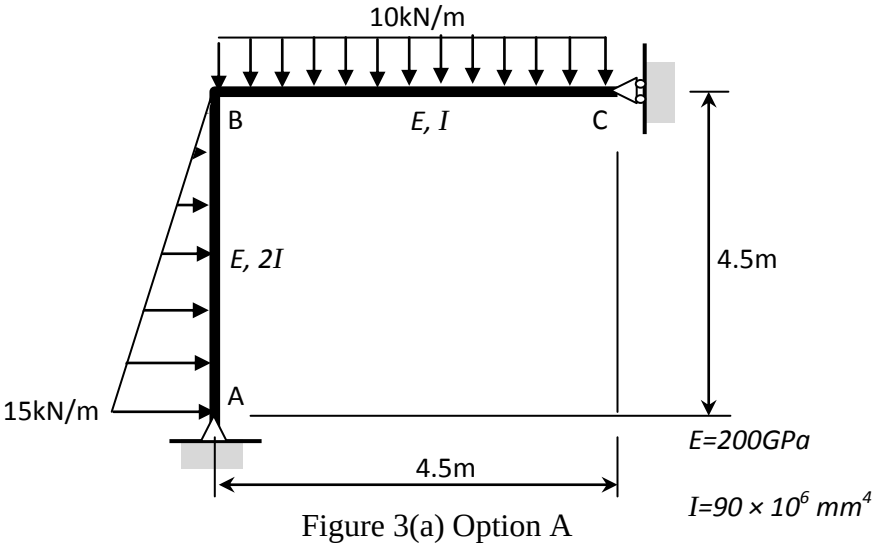


Figure 3(a) Option A

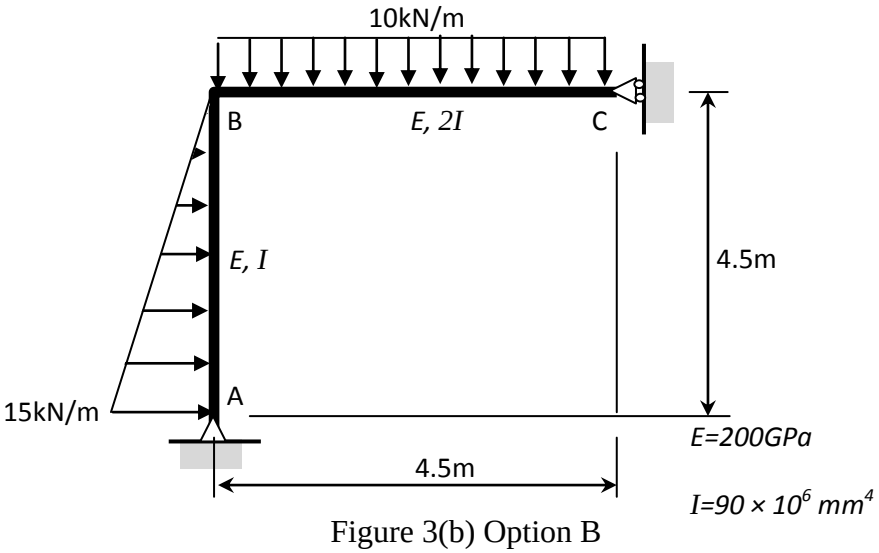


Figure 3(b) Option B

2. (a) Figure 4 shows a beam carrying a uniformly distributed load of 20 kN/m on span AB, a triangular load varies from 10 kN/m to 0 kN/m on span BC and a point load of 100kN at mid span CD. Support A and D are fixed and support B and C are on roller. The support at C is displaced (settlement) 30 mm. Given that E = 200 GPa and I = 600 x 10^6 mm^4. Using Moment Distribution Method, calculate internal moments at the supports of the beam. Then sketch the deflected shape and bending moment of the beam. Neglect axial deformation.

[17 marks]

(b) Without any calculation, sketch new deflected shape and bending moment diagram if support D is pinned.

[3 marks]

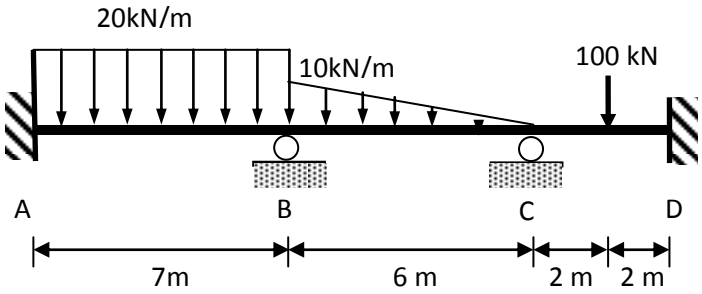


Figure 4

3. (a) Figure 5 shows a frame carrying a uniformly distributed load of 24 kN/m along span AB and point load of 20kN at mid span of BC. Supports A, C and D are fixed. Each member has the value of I as shown in Figure 5. Determine the internal moments at all joints A,B,C and D of the frame by using Slope Deflection Method. Then sketch the deflected shape and bending moment of the frame.

[16 marks]

(b) Explain with the aid of sketches, behaviour of the frame as shown in Figure 5, in terms of bending moment and deflected shape, if point load 20kN at the midspan of BC is removed.

[4 marks]

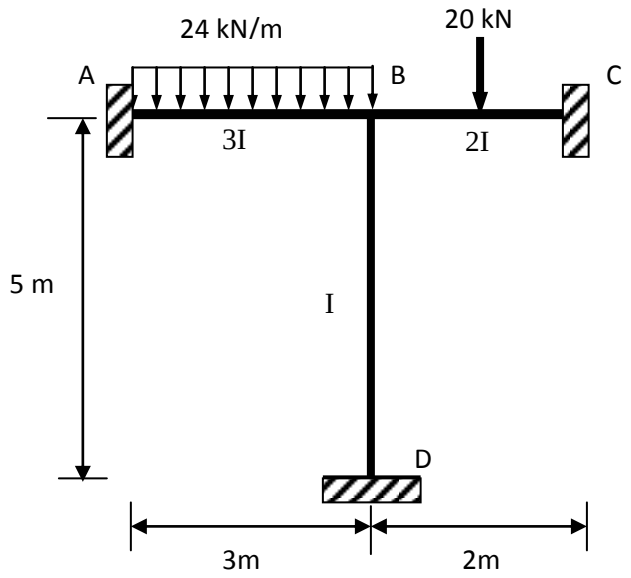


Figure 5

4. (a) Show that the reaction force at A is equal to $1.5M_0/L$ for the propped cantilever beam shown in Figure 6. Use method of least work.

[4 marks]

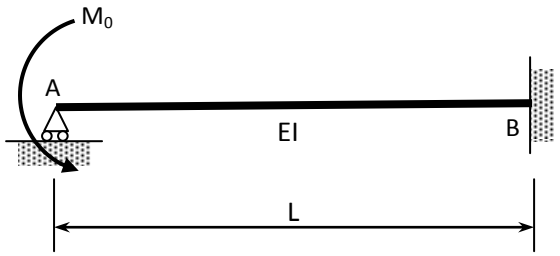


Figure 6

(b) Figure 7 shows a T-shape frame with fixed support at D where an additional tie AD has been installed with the aim of reducing bending moment at end B of the vertical column BD. Both member ends of the tie AD are pinned. Member AB and BC of the frame carry uniformly distributed load of 10kN/m. A point load of 50kN acts at point C.

(i) Determine the axial force in the tie AD and the resulting bending moment at end B of the column BD.

(ii) Determine also the percentage change in the magnitude of bending moment at end B of column BD as a result of adding the tie AD.

It is given that: section moment inertia I for members of the frame is $190\times10^6\text{mm}^4$; cross-sectional area A for the tie AD is 2500mm^2, Young's modulus E for members of the frame and tie AD is 205GPa.

Use method of least work.

[16 marks]

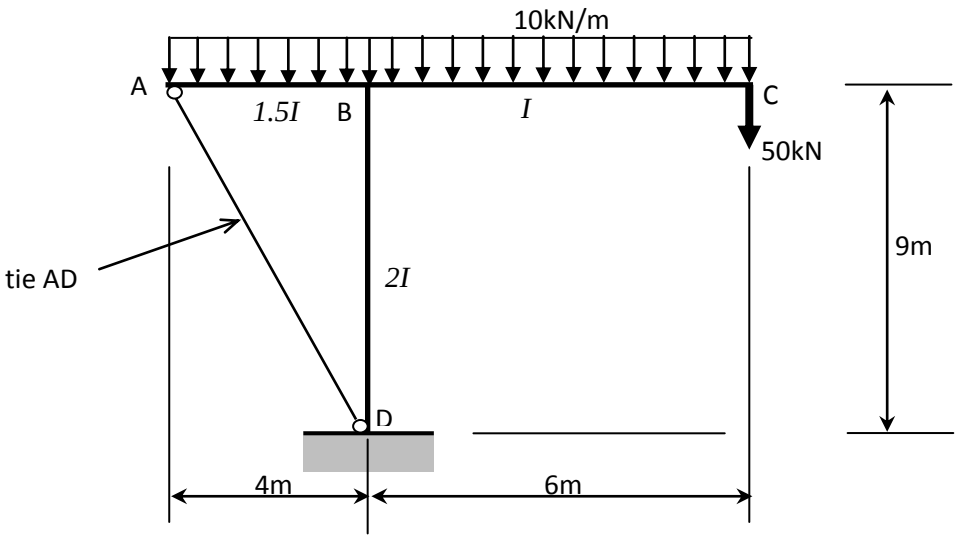


Figure 7

5. (a) With the help of the stress-strain diagram of ductile material such as mild steel, explain the elastic and plastic behaviours of the ductile material and formation of plastic hinge of the material subjected to bending. Your explanation shall include stress block sketches corresponding to elastic and plastic states of the material.

[6 marks]

(b) Sketch all possible collapse mechanisms for the two bay portal frame to carry the working loads as shown in Figure 8 and determine the collapse load factor. The plastic moment capacities of all members are given in the figure. It is given that the plastic moment capacity M_p is 30 kNm.

[14 marks]

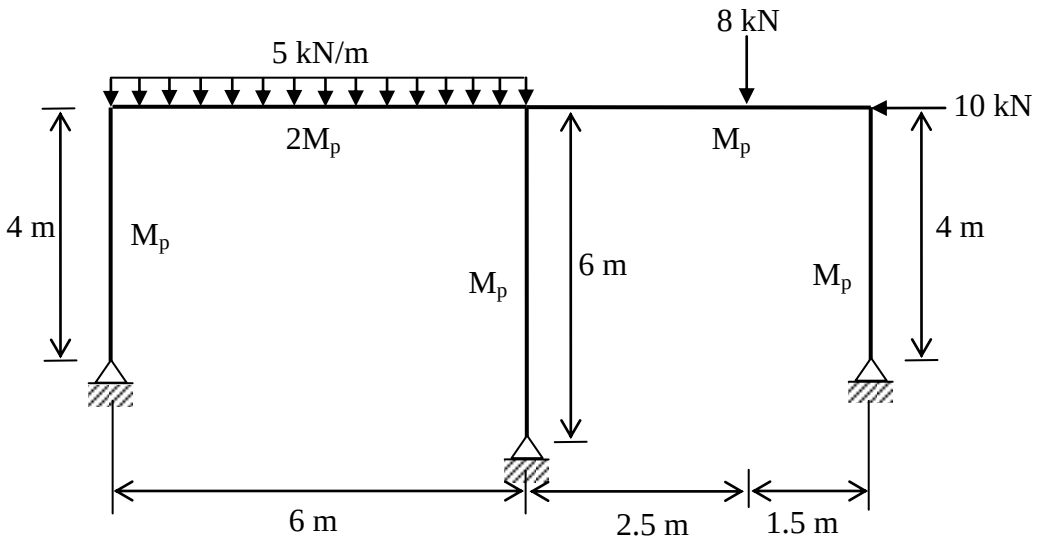


Figure 8

6. (a) For the truss shown in Figure 9, calculate the vertical displacement of roller support C if member AB and BC suffer a temperature increase of 20°C, member AC is shorter by 25mm. Data of member length is given as follows: AB=2.828m, BC=5m, AC=6.083m.

[10 marks]

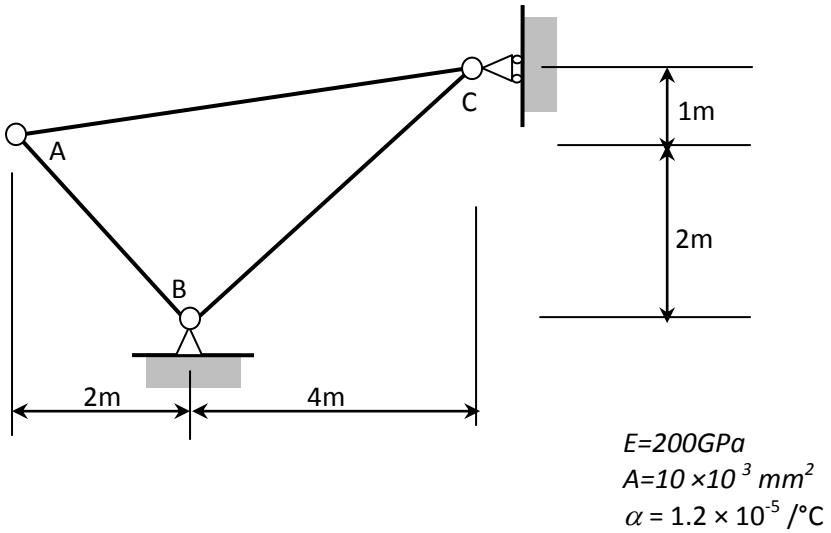


Figure 9

(b) (i) Show that the shape factor for a circular hollow shape steel section as shown in Figure 10(a) is 1.27.

[5 marks]

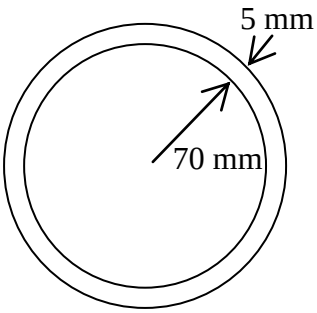


Figure 10(a)

(ii) Determine the plastic moment for the beam loaded as shown in Figure 10(b) by virtual work method.

[5 marks]

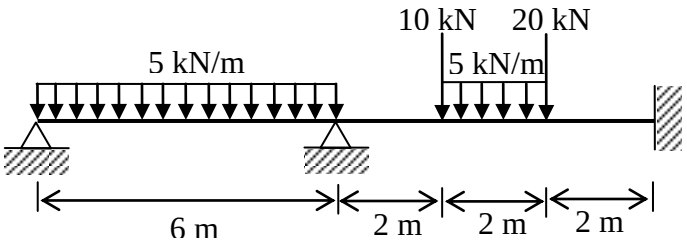
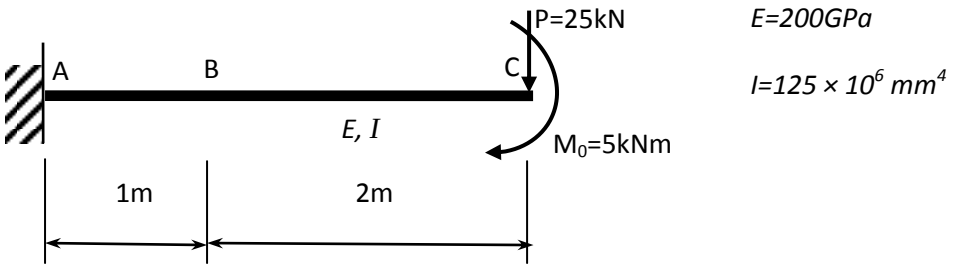


Figure 10(b)

1. (a) *Rajah 1 menunjukkan satu rasuk julur yang dikenakan satu beban tertumpu P=25kN dan satu momen tertumpu M_0=5kNm pada C. Tentukan anjakan pugak titik B yang terletak pada jarak 1m dari penyokong A. Gunakan kaedah kerja maya.*

Kenyataan bahawa anjakan pugak pada B akan mengurang sebanyak 50% sekiranya momen sifatekun keratan bahagian AB ditingkatkan dari I ke 2I. Sahkan samada kenyataan di atas adalah benar atau tidak.

[6 markah]



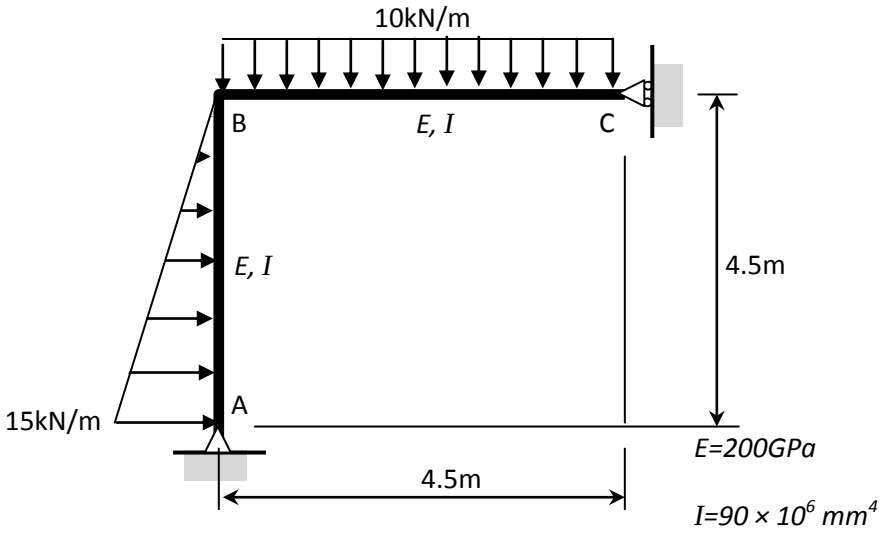
Rajah 1

(b) *Rajah 2 menunjukkan satu kerangka 2- anggota yang ringkas. Kerangka berkenaan disokong melalui sambungan pin pada A dan sambungan rola pada C. Satu beban teragih lelurus bertindak di sepanjang anggota AB manakala satu beban teragih seragam bertindak di sepanjang anggota BC. Diberi bahawa E=200GPa dan $I=90\times10^6$ mm^4.*

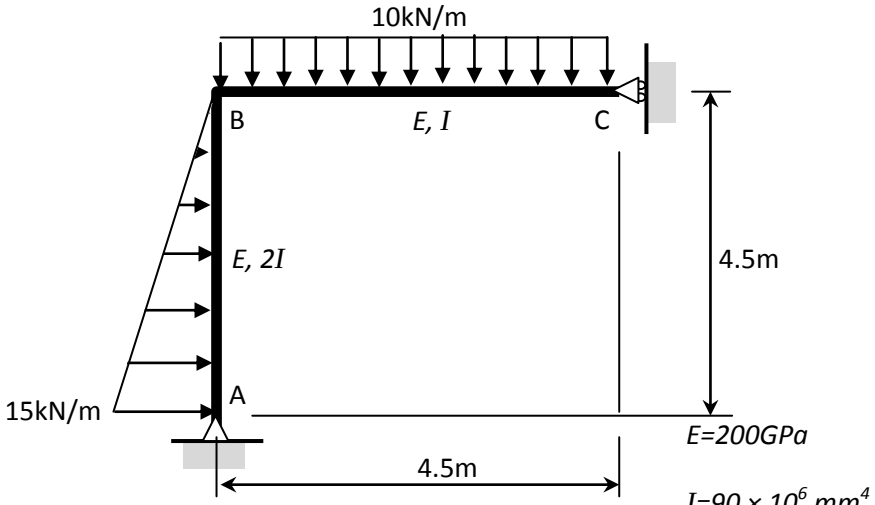
(i) *Tentukan putaran sambungan B dengan menggunakan kaedah kerja maya*

(ii) *Dua pilihan untuk mengurangkan putaran pada sambungan B telah dicadangkan: Pilihan A (rujuk Rajah 3a) dan Pilihan B (rujuk Rajah 3b). Sahkan keberkesanan setiap pilihan untuk mengurangkan putaran sambungan B.*

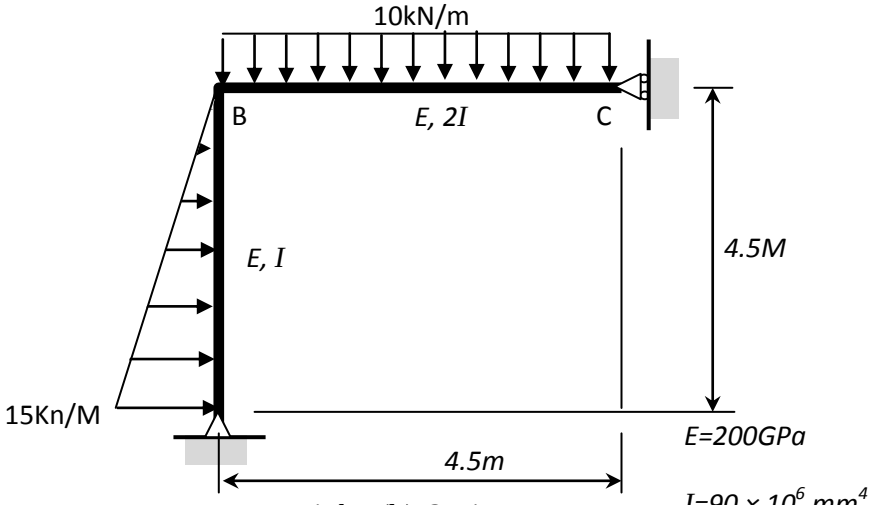
[14 markah]



Rajah 2



Rajah 3(a) Option A



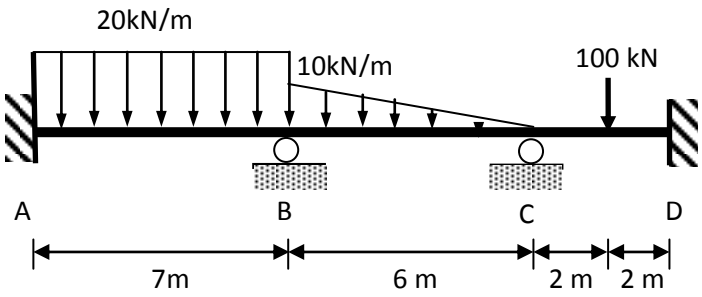
Rajah 3(b) Option B

2. (a) *Rajah 4 menunjukkan satu rasuk yang membawa beban teragih seragam 20kN/m bertindak di sepanjang rentang AB, beban segitiga berubah dari 10 kN/m ke 0 kN/m di rentang BC dan beban tumpu 100 kN di tengah rentang CD . Penyokong A dan D adalah jenis tegar dan penyokong B dan C ialah rola. Penyokong C mengalami enapan sebanyak 30mm. Nilai E = 200 GPa dan I = 600 x 10^6 mm^4 . Dengan menggunakan Kaedah Agihan Momen, kira nilai momen dalaman di setiap penyokong rasuk tersebut. Seterusnya lakarkan bentuk terpesong kerangka tersebut dan rajah momen lentur. Abaikan pesongan paksi.*

[17 markah]

(b) *Tanpa sebarang pengiraan, lakarkan rajah pesongan dan momen lentur sekiranya penyokong D adalah pin.*

[3 markah]



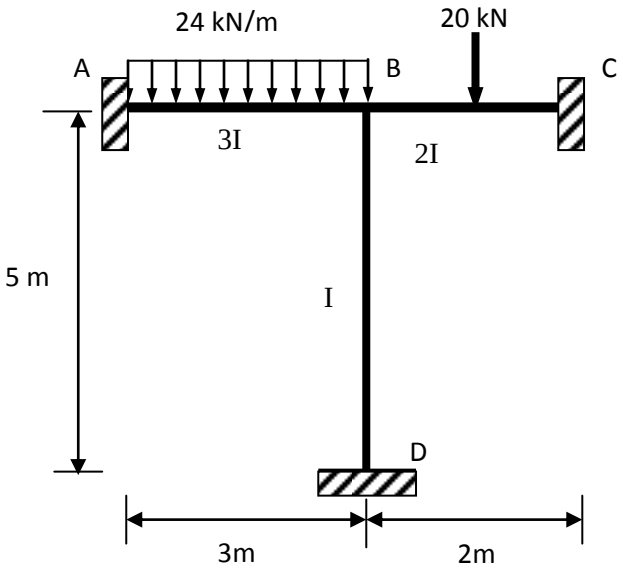
Rajah 4

3. (a) *Rajah 5 menunjukkan satu kerangka yang membawa beban teragih seragam sebanyak 24 kN/m di rentang AB dan beban tumpu 20 kN di pertengahan rentang BC. Penyokong A, C dan D adalah tegar. Setiap anggota kerangka diberi nilai I seperti yang ditunjukkan dalam Rajah 5. Kira nilai momen dalaman di setiap sambungan kerangka tersebut menggunakan Kaedah Cerun Pesongan. Seterusnya lakarkan bentuk terpesong kerangka tersebut dan rajah momen lentur.*

[16 markah]

(b) *Bincangkan dengan bantuan lakaran, apakah yang akan berlaku kepada bentuk momen lentur dan pesongan kerangka dalam Rajah 5, sekiranya beban tumpu 20 kN di pertengahan rentang BC dialihkan.*

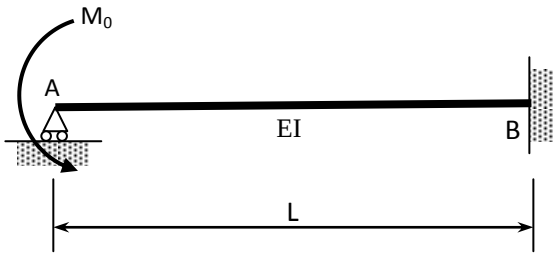
[4 markah]



Rajah 5

4. *(a)* *Tunjukkan bahawa daya tindakbalas pada A adalah sama dengan $1.5M_0/L$ untuk rasuk julur tertupang seperti yang ditunjukkan dalam Rajah 6. Gunakan kaedah kerja terkecil.*

[4 markah]



Rajah 6

(b) *Rajah 7 menunjukkan satu kerangka berbentuk T dengan penyokong jenis tegar pada D. Satu anggota pengikat tambahan AD dengan tujuan untuk mengurangkan momen lentur pada hujung B anggota pugak BD. Kedua-dua hujung anggota pengikat AD disambung melalui sambungan pin kepada kerangka. Anggota AB dan BC kerangka membawa beban teragih seragam 10kN/m. Satu beban tertumpu 50kN bertindak pada titik C.*

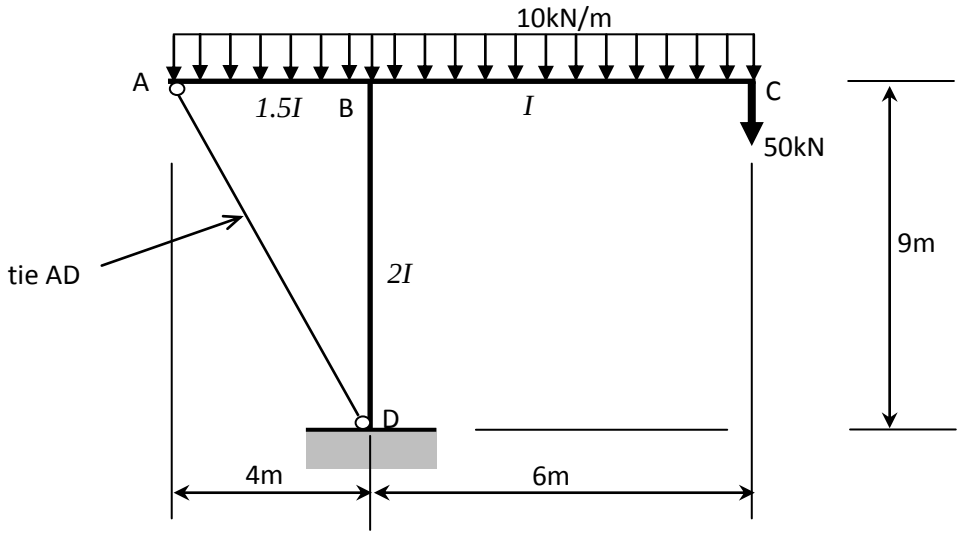
(i) *Tentukan daya paksi dalam anggota pengikat AD dan momen lentur yang terhasil pada hujung B tiang BD.*

(ii) *Tentukan peratus perubahan dalam magnitud momen lentur pada hujung B tiang BD akibat penambahan anggota pengikat AD.*

Diberi bahawa: momen sifatekun keratan I untuk anggota kerangka adalah $190\times10^{6}mm^{4}$ *; luas keratan rentas A anggota pengikat AD adalah* $2500mm^{2}$*; modulus Young E untuk anggota kerangka dan pengikat adalah 205GPa.*

Guna kaedah kerja terkecil.

[16 markah]



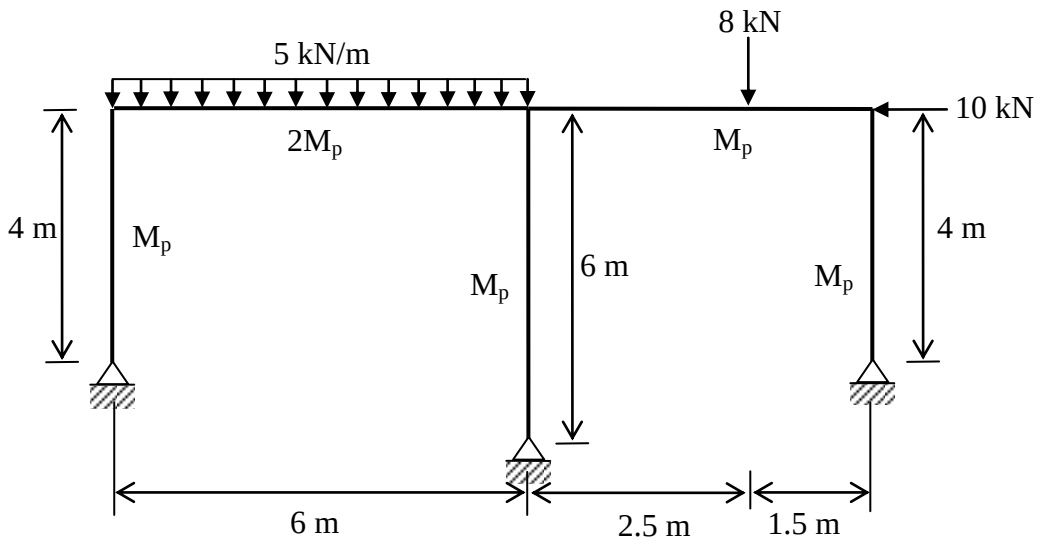
Rajah 7

5. (a) *Dengan bantuan gambarajah tegasan-terikan untuk bahan mulur seperti keluli lembut, jelaskan kelakuan elastik dan plastik bahan mulur tersebut dan pembentukan engsel plastik pada bahan berkenaan di bawah lenturan. Penjelasan anda perlu meliputi lakaran-lakaran blok tegasan yang menunjukkan keadaan elastik dan plastik bahan berkenaan.*

[6 markah]

(b) *Lakarkan semua mekanisma runtuh yang berkemungkinan untuk sebuah kerangka portal dua bay yang menampung beban kerja seperti ditunjukkan dalam Rajah 8 dan tentukan faktor beban runtuh. Kapasiti momen plastik untuk semua anggota diberikan dalam rajah tersebut. Diberikan kapasiti momen plastik M_p ialah 30 kNm.*

[14 markah]



Rajah 8

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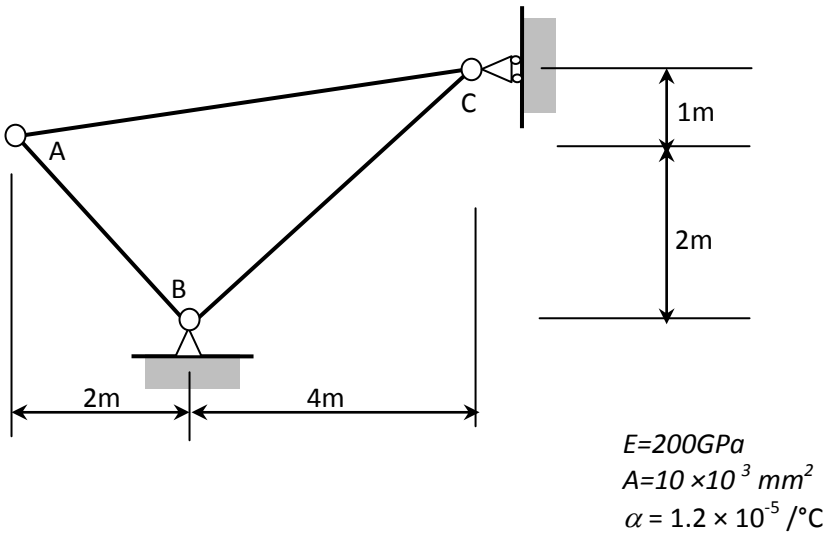
6. (a) *Untuk kekuda yang ditunjukkan dalam Rajah 9, kirakan anjakan pugak rola C sekiranya anggota AB dan BC mengalami peningkatan suhu 20°C, anggota AC adalah 25mm lebih pendek. Data panjang anggota adalah seperti berikut: AB=2.828m, BC=5m dan AC=6.083m.*

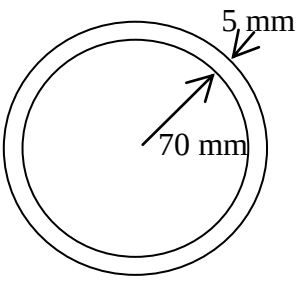
[10 markah]



Rajah 9

(b) (i) *Tunjukkan bahawa faktor bentuk untuk keluli dengan keratan bulat bergeronggang seperti yang ditunjukkan dalam Rajah 10(a) ialah 1.27.*

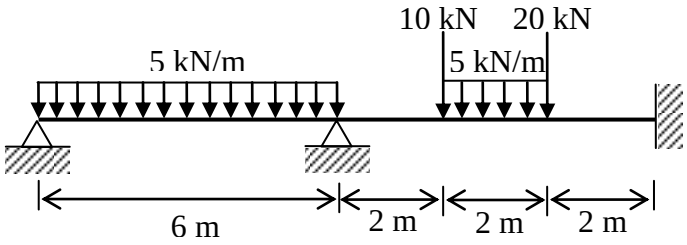
[5 markah]



Rajah 10(a)

(ii) *Tentukan momen plastik bagi rasuk dibebankan seperti yang ditunjukkan dalam Rajah 10(b) dengan menggunakan kaedah kerja maya.*

[5 markah]

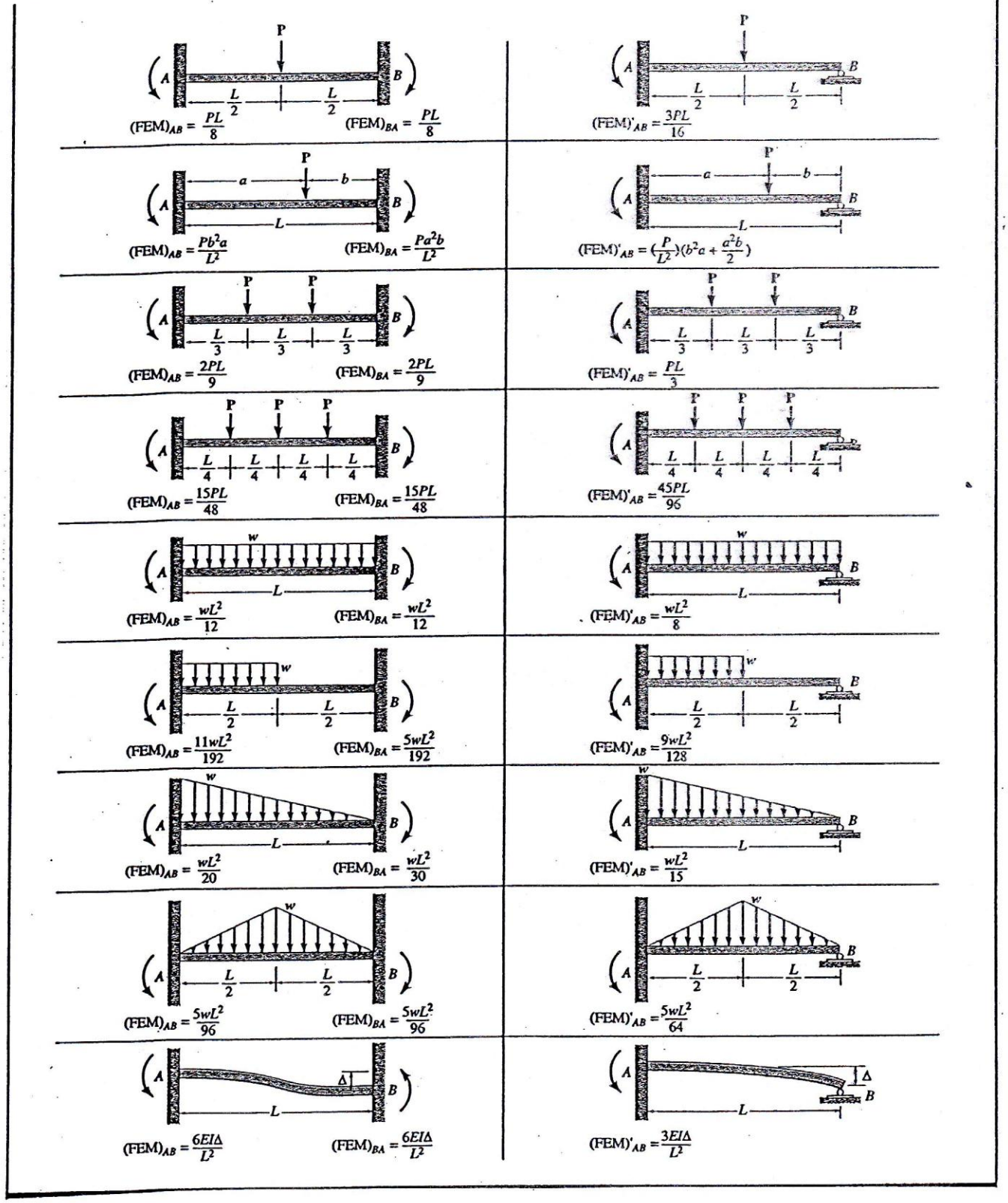


Rajah 10(b)

Appendix

Lampiran

Fixed End Moments



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