UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2011/2012 Academic Session

June 2012

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

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

Please check that this examination paper consists of **FOURTEEN (14)** pages of printed material including 1 appendix before you begin the examination.
[*Sila pastikan bahawa kertas peperiksaan ini mengandungi* ***EMPAT BELAS (14)*** *muka surat yang bercetak termasuk 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*].

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 sebarang percanggahan, versi Bahasa Inggeris hendaklah diguna pakai*].

1. (a) The principal difference between statically determinate structures and statically indeterminate ones is the existence of redundancy in the latter. State the advantage of redundancy.

[2 marks]

(b) The frame shown in **Figure 1** is pinned supported at C and roller supported at D. Uniformly distributed load with intensity of 5kN/m and 10kN/m act along member AB and BC, respectively. A linear distributed load varying from 5kN/m at D to 0 kN/m at B acts along vertical member BD. Free end A of the frame is subjected to a point load of 20kN. For the frame problem shown in Figure 1, draw the corresponding virtual system for the determination of :

(i) vertical displacement at A
(ii) slope at B

Next, compute vertical displacement at A. Use method of virtual work.

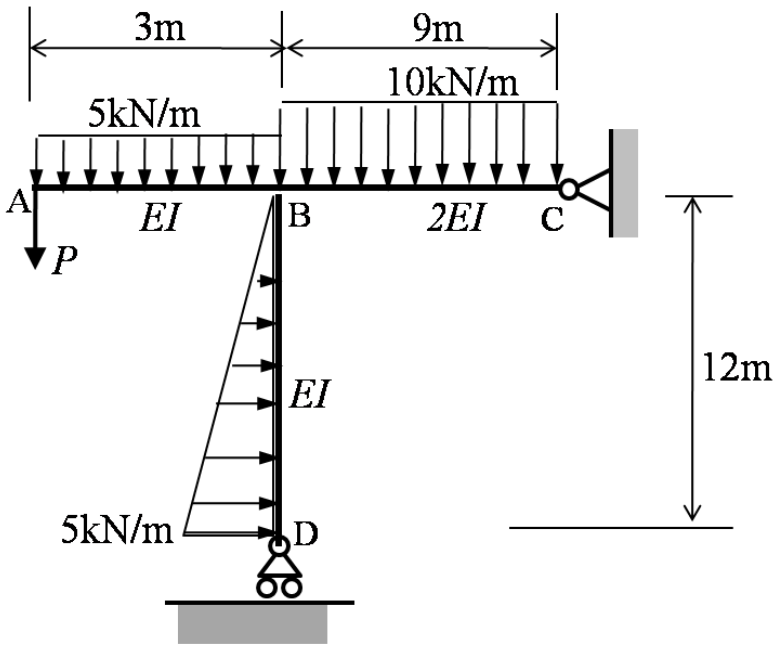


Figure 1

A proposal to increase the flexural rigidity of member BC from 2EI to 2.5EI in order to reduce the vertical displacement at A has been made. Re-calculate the vertical displacement at A and conclude about the effectiveness of the proposal.

[18 marks]

2. (a) Using method of least work, determine the reaction at support C for the frame shown in **Figure 2**.

[6 marks]

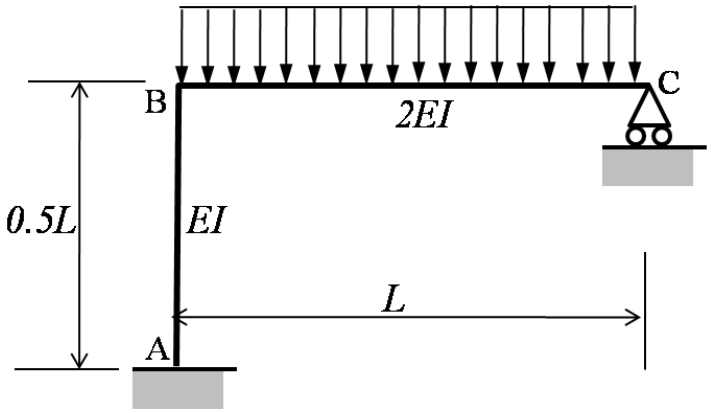
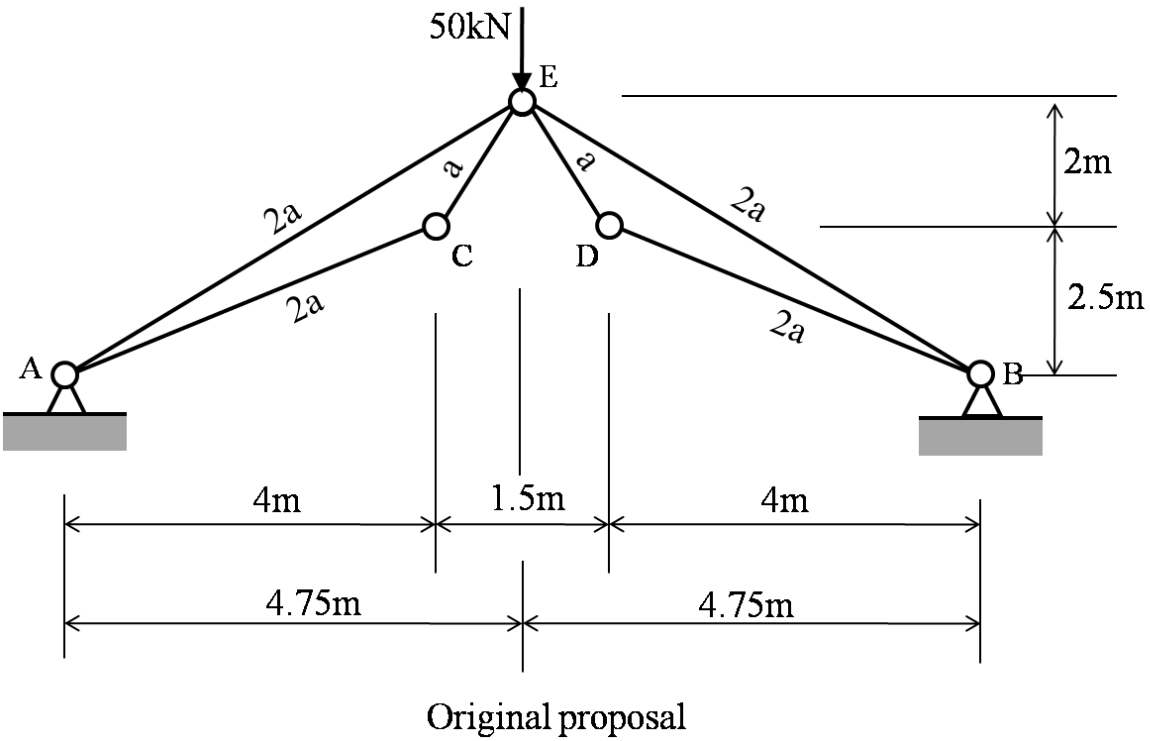


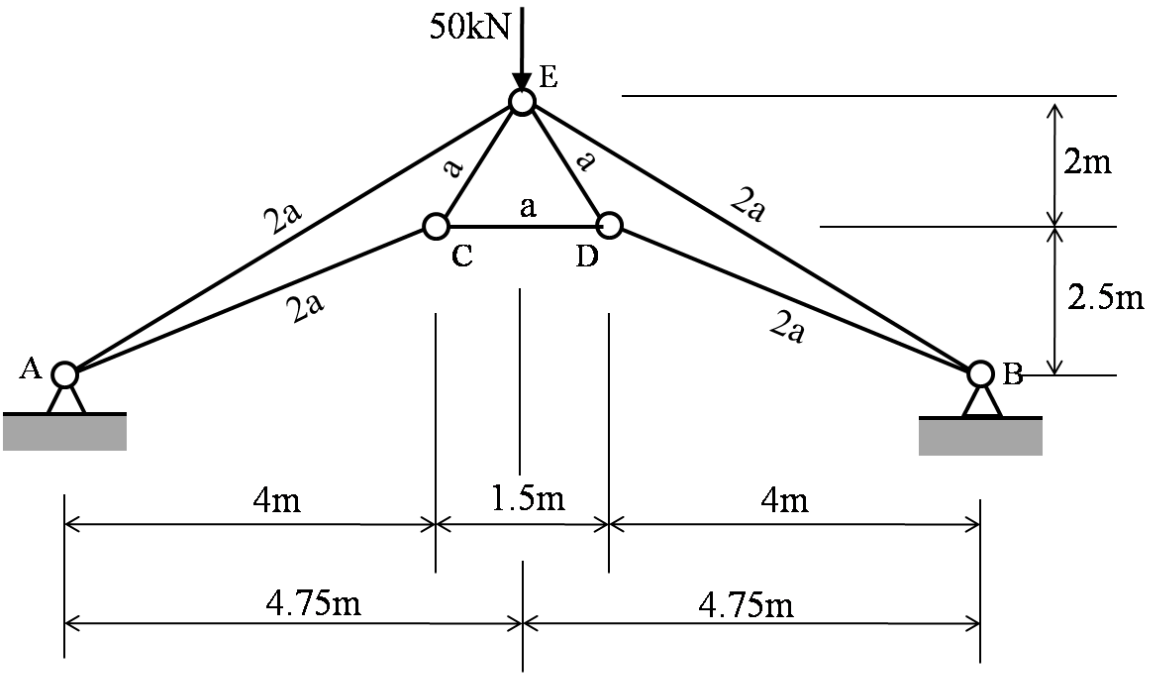
Figure 2

(b) **Figure 3** and **4** show the original proposal and revised proposal for a roof truss structure. The original proposal has been revised by addition of a horizontal member CD. Cross-sectional area of each member is indicated next to the corresponding member. Data about member length is given in **Table 1**.



Original proposal

Figure 3



Revised proposal

Figure 4

Table 1

Member	Length(m)
AC	4.717
DB	4.717
CD	1.500
CE	2.136
DE	2.136
AE	6.543
BE	6.543

Compute changes in magnitude of axial forces in members AE, AC, BE and BD as a result of addition of member CD. Evaluate the change in magnitude of force in member CD if the cross-sectional area is reduced from *a* to 0.75*a*. Use method of least work.

[14 marks]

3. (a) **Figure 5** shows a pinned jointed cantilever truss structure carrying vertical loads 4kN and 6kN at joint D and E, respectively. All members have the same cross-sectional area of $A=0.01m^2$.

(i) Compute vertical displacement at D. Use method of virtual work.

(ii) If member CE is too short by 5mm, re-calculate the vertical displacement at D. Conclude whether the lack of fit problem has any effect on the vertical displacement at D.

[10 marks]

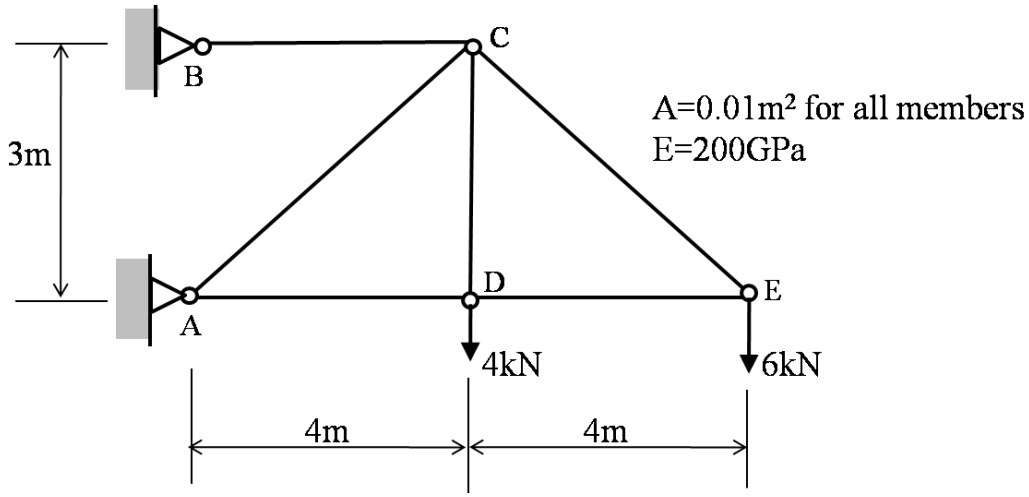


Figure 5

(b) A beam shown in **Figure 6** is loaded with uniformly distributed and point loads. Compute the plastic moment for the beam loaded as shown by virtual work method.

[10 marks]

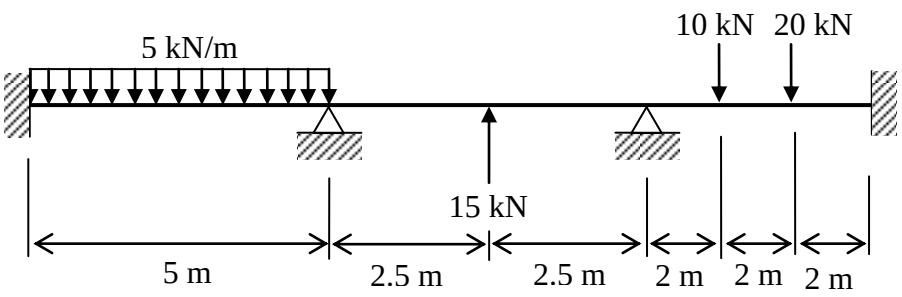


Figure 6

4. (a) **Figure 7** shows a beam carrying a uniformly distributed load of 20 kN/m on span ABC, a triangular load varying from 20 kN/m to 0 kN/m on span CD and a point load of 100kN at mid span BC. Supports A and D are fixed and supports B and C are on roller. The values of E and I are given as 200 GPa and 600 $\times$ 10^6 mm^4, respectively. Using Moment Distribution Method, calculate internal moments at the supports of the beam. Hence sketch the deflected shape and bending moment of the frame. Neglect axial deformation.

[16 marks]

(b) Without any calculation, sketch new deflected shape and bending moment diagram if supports A and D are pinned.

[4 marks]

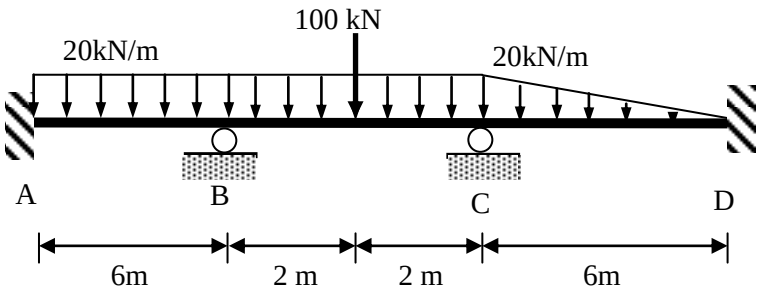


Figure 7

5. (a) **Figure 8** shows a frame carrying a uniformly distributed load of 6 kN/m on span BD and a horizontal point load of 35kN at point C. Supports A and D are fixed and pinned, respectively. Each member has the value of I as shown in **Figure 8**. Determine the internal moments at joints A and B of the frame by using Slope Deflection Method. Hence sketch the deflected shape, shear force diagram and bending moment diagram of the frame.

[16 marks]

(b) With the aid of sketches, explain the behaviour of the frame as shown in **Figure 8** in terms of bending moment and deflected shape, if the uniform distributed load 6 kN/m is replaced by a point load of 20 kN at the midspan of BD.

[4 marks]

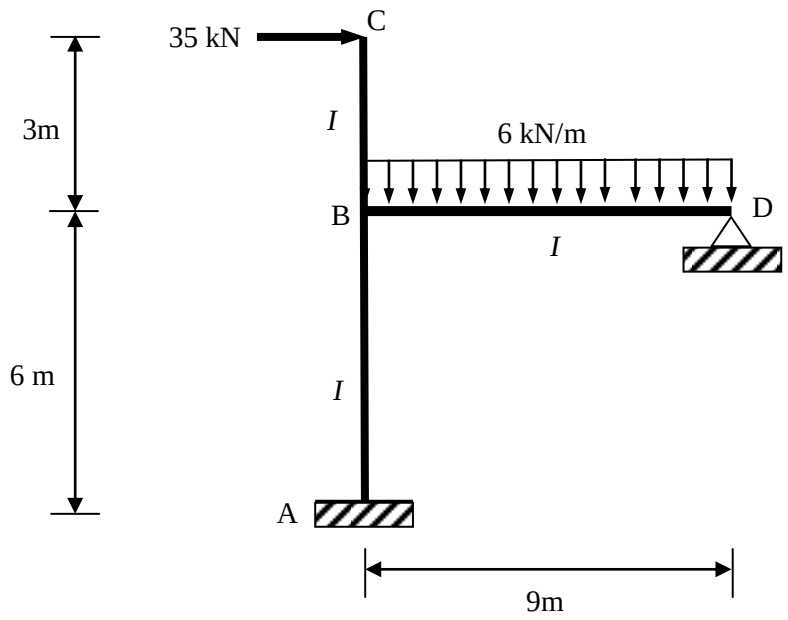


Figure 8

6. (a) With the help of a sketch, explain briefly the formation of a plastic hinge at a section of a beam and the beam is in the collapse mechanism.

[3 marks]

(b) Sketch all possible collapse mechanisms for a rigid-jointed frame to carry the working loads as shown in **Figure 9** and determine the collapse load factor. The plastic moment capacities of all members are given in the figure where M_p is 50 kNm.

[17 marks]

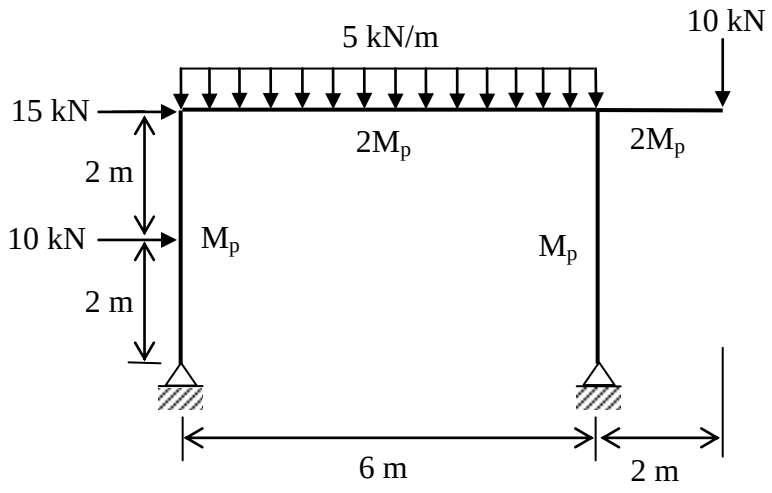


Figure 9

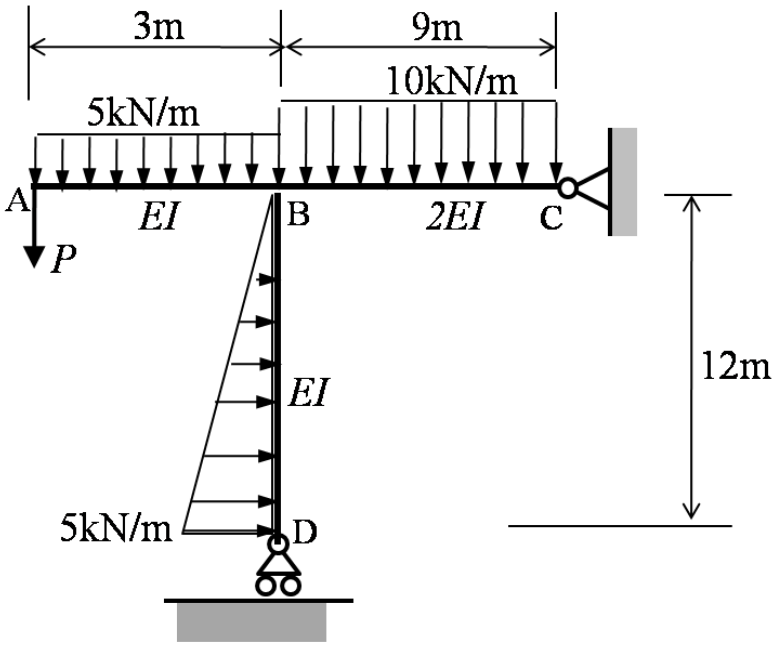
1. (a) *Perbezaan utama antara struktur bolehtentu statik dan struktur tidak-bolehtentu statik adalah pewujudan keterlebihan dalam struktur tidak-bolehtentu statik. Nyatakan kelebihan keterlebihan.*

[2 markah]

(b) *Kerangka yang ditunjukkan dalam **Rajah 1** disokong oleh penyokong jenis pin di C dan penyokong jenis rola di D. Beban teragih seragam dengan nilai keamatan 5kN/m bertindak di sepanjang AB dan 10kN/m bertindak di sepanjang BC. Satu beban teragih secara lelurus dengan keamatan berubah dari 5kN/m pada D sehingga 0 kN/m pada B di sepanjang anggota pugak BD. Hujung bebas A kerangka dikenakan satu beban tertumpu pugak 20kN. Untuk masalah kerangka seperti yang ditunjukkan dalam Rajah 1, lukiskan sistem maya yang berkaitan untuk tujuan penentuan:*

(i) anjakan pugak pada A
(ii) kecerunan pada B

Seterusnya, kira anjakan pugak pada A. Guna kaedah kerja maya



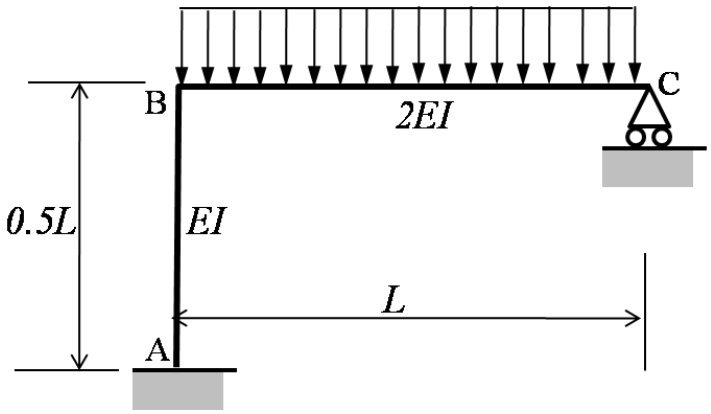
Rajah 1

Satu cadangan untuk meningkatkan ketegaran lenturan anggota BC dari 2EI ke 2.5EI untuk tujuan mengurangkan anjakan pugak pada A telah dibuat. Kira semula anjakan pugak pada A dan buat kesimpulan tentang keberkesanan cadangan di atas.

[18 markah]

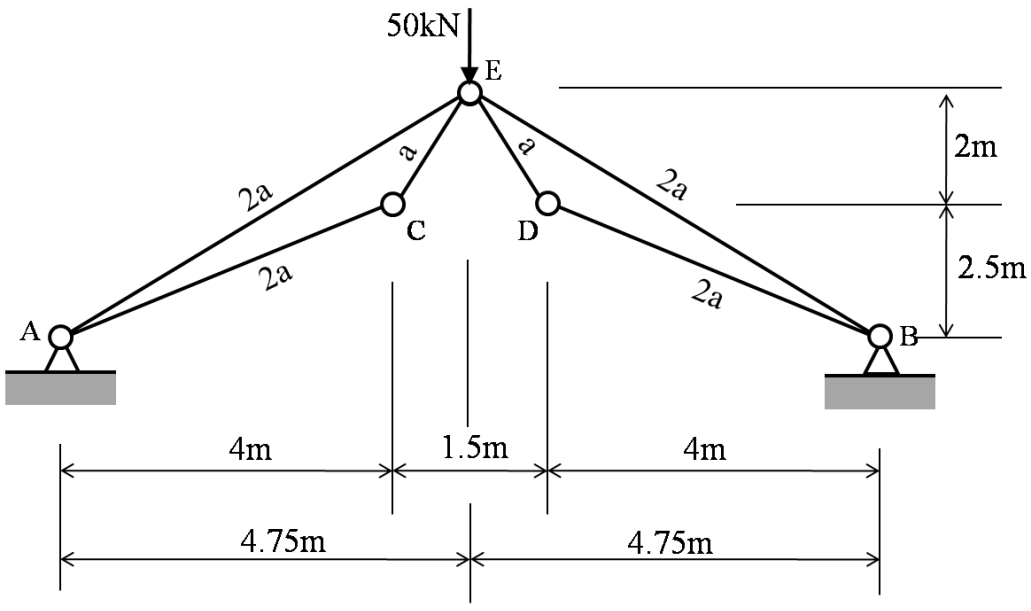
2. (a) *Dengan menggunakan kaedah kerja terkecil, tentukan daya tindak balas pada penyokong C untuk kerangka yang ditunjukkan dalam* ***Rajah 2.***

[6 markah]



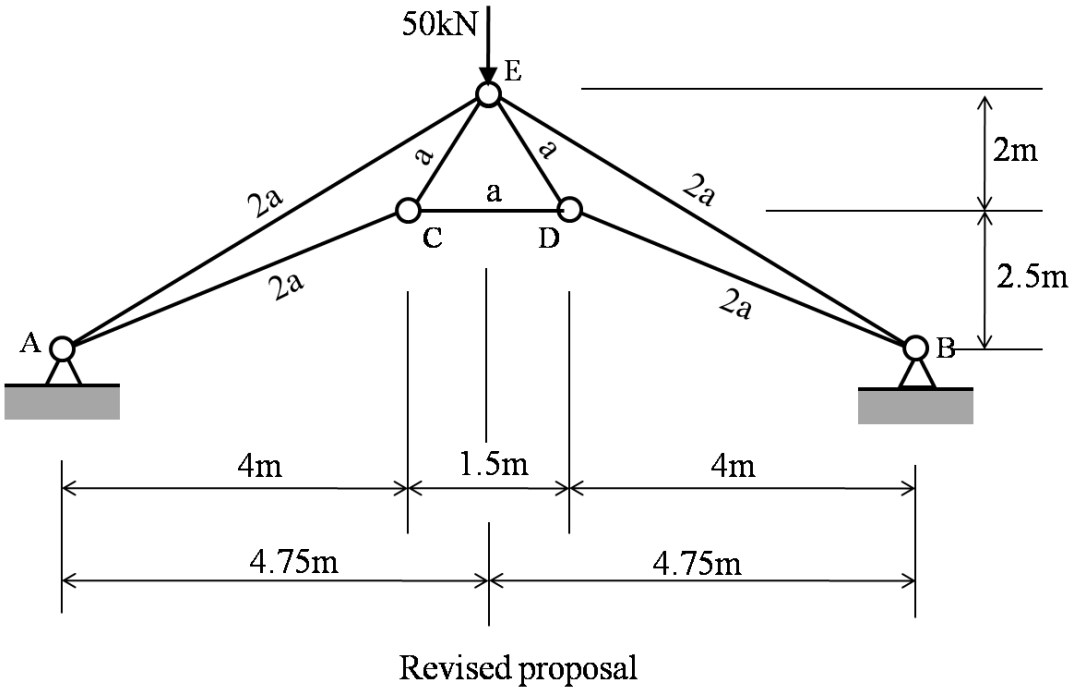
Rajah 2

(b) ***Rajah 3*** *dan* ***4*** *masing-masing menunjukkan cadangan asal dan cadangan terubahsuai untuk satu struktur kekuda bumbung. Cadangan terubahsuai telah dibuat dengan menambahkan satu anggota ufuk CD. Luas keratan setiap anggota ditunjukkan bersebelahan dengan anggota berkaitan. Data tentang panjang anggota diberi dalam* ***Jadual 1****.*



Original proposal

Rajah 3



Revised proposal

Rajah 4

Jadual 1

Member	Length(m)
AC	4.717
DB	4.717
CD	1.500
CE	2.136
DE	2.136
AE	6.543
BE	6.543

Kira perubahan dalam magnitud daya paksi dalam anggota AE, AC, BE dan BD akibat penambahan anggota ufuk CD. Tentukan perubahan dalam magnitud daya dalam anggota CD sekiranya luas keratan anggota dikurangkan dari a kepada 0.75a. Guna kaedah kerja terkecil.

[14 markah]

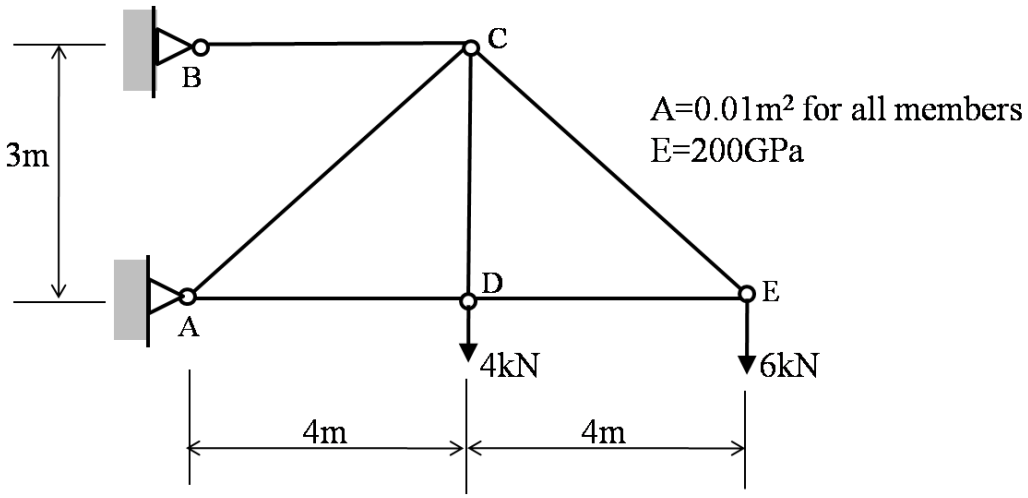
3. (a) ***Rajah 5*** *menunjukkan satu kekuda dengan sambungan pin yang membawa beban pugak 4kN pada D dan 6kN pada E. Luas keratan semua anggota adalah sama dengan* $A=0.015m^2$.

(i) *Kira anjakan pugak pada D. Guna kaedah kerja maya.*

(ii) *Sekiranya anggota CE adalah 5mm terlalu pendek, kira semula anjakan pugak pada D.*

Buat kesimpulan samada masalah "lack of fit" mempunyai sebarang kesan ke atas anjakan pugak pada D.

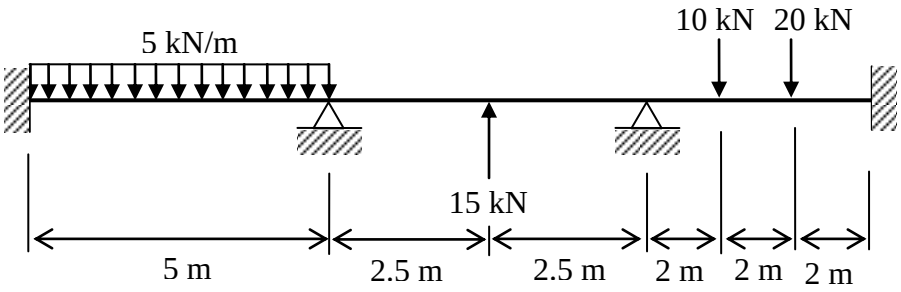
[10 markah]



Rajah 5

(b) *Rasuk yang ditunjukkan dalam **Rajah 6** dikenakan beban teragih seragam dan beban tumpu. Kirakan momen plastic bagi rasuk dibebankan seperti yang ditunjukkan dalam rajah dengan menggunakan kaedah kerja maya.*

[10 markah]



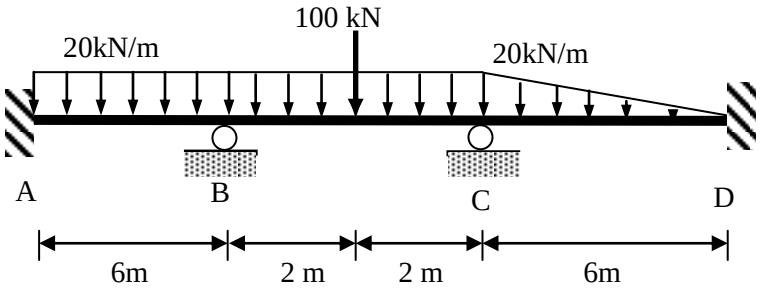
Rajah 6

4. (a) ***Rajah 7*** *menunjukkan satu rasuk yang membawa beban teragih seragam 20kN/m bertindak di sepanjang rentang ABC, beban segitiga berubah dari 20 kN/m ke 0 kN/m di rentang CD dan beban tumpu 100 kN di tengah rentang BC. Penyokong A dan D adalah jenis tegar dan penyokong B dan C ialah rola. 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.*

[16 markah]

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

[4 markah]



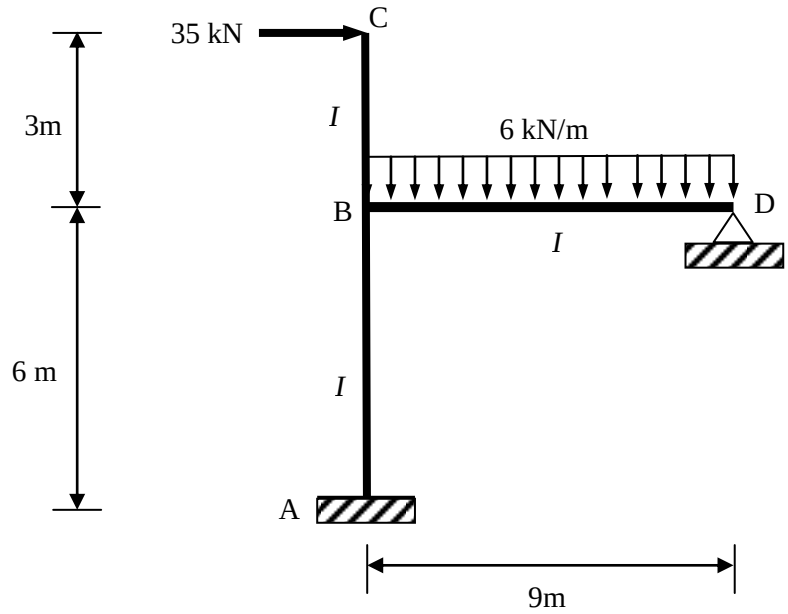
Rajah 7

5. (a) ***Rajah 8*** *menunjukkan satu kerangka yang membawa beban teragih seragam sebanyak 6 kN/m direntang BD dan beban tumpu mengufuk 35 kN di titik C. Penyokong A adalah tegar dan pentokong D adalah pin. Setiap anggota kerangka diberi nilai I seperti yang ditunjukkan dalam* ***Rajah 8****. Kira nilai momen dalaman di sambungan A dan B kerangka tersebut menggunakan Kaedah Cerun Pesongan. Seterusnya lakarkan bentuk terpesong kerangka tersebut, rajah daya ricih dan rajah momen lentur.*

[16 markah]

(b) *Bincangkan dengan bantuan lakaran, apakah yang akan berlaku kepada bentuk momen lentur dan pesongan kerangka dalam* ***Rajah 8****, sekiranya beban teragih seragam 6 kN/m digantikan dengan beban tumpu 20 kN dipertengahan rentang BD.*

[4 markah]



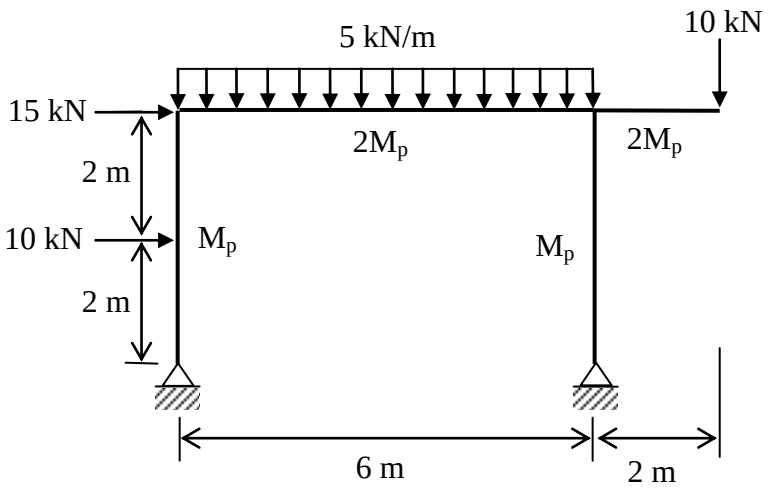
Rajah 8

6. (a) *Dengan bantuan gambarajah, jelaskan dengan ringkas pembentukan engsel plastik di satu keratan rasuk dan rasuk berada di mekanisme runtuh.*

[3 markah]

(b) *Lakarkan semua mekanisme runtuh yang berkemungkinan untuk sebuah kerangka terikat tegar yang menampung beban kerja seperti ditunjukkan dalam* ***Rajah 9*** *dan tentukan faktor beban runtuh. Kapasiti momen plastik untuk semua anggota diberikan dalam rajah tersebut. Diberikan kapasiti momen plastik M_p ialah 50 kNm.*

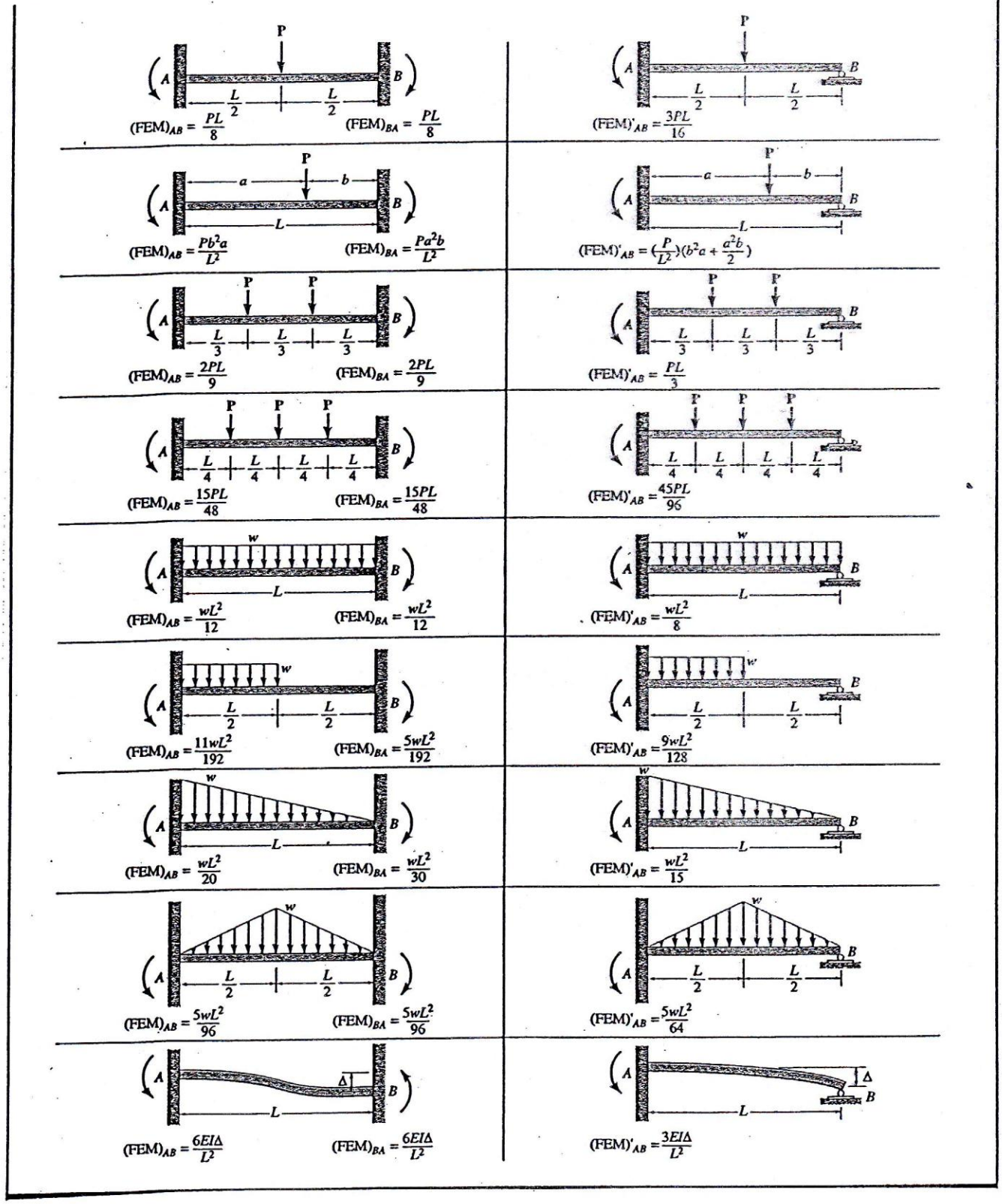
[17 markah]



Rajah 9

Attachment
Lampiran

Fixed End Moments



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