UNIVERSITI SAINS MALAYSIA

Second Semester Examination

Academic Session 2008/2009

April/May 2009

EAS 254/3 – Structural Analysis
[Analisis Struktur]

Duration: 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of **FOURTHEEN (14)** printed pages including appendix before you begin the examination.
*[Sila pastikan kertas peperiksaan ini mengandungi **EMPAT BELAS (14)** muka surat bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

Instructions: This paper consists of **SIX (6)** questions. Answer **FIVE (5)** questions only. All questions carry the same marks.

*[**Arahan**: Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan sahaja. Semua soalan membawa jumlah markah yang sama.]*

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.]*

Write the answered question numbers on the cover sheet of the answer script.
[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]

1. a) State **TWO (2)** reasons why calculation of deflections forms an essential part of structural analysis.

[2 Marks]

b) Figure 1 shows a frame with pin and roller supports at A and D, respectively. The frame is subjected to: a uniformly distributed load of 10kN/m along AB, a uniformly distributed load of 5kN/m along BC and a uniformly distributed load of 2.5kN/m along the vertical member BD. EI for members AB and BC are the same, while that of member BD is 0.5 times that of members AB and BC. Compute the vertical displacement of point C by using method of virtual work.

[18 Marks]

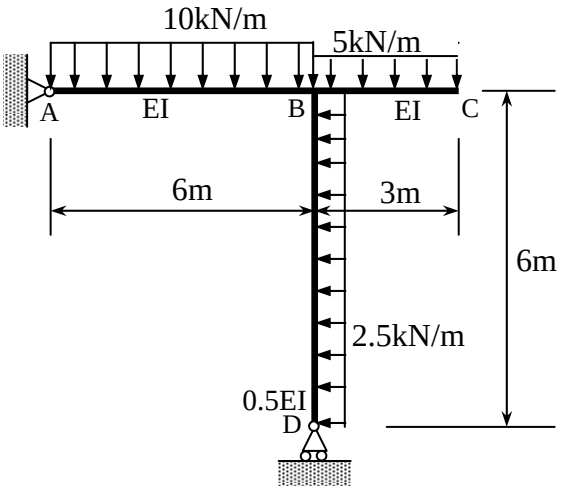


Figure 1

2. a) Prove that the reaction force at A is equal to 3/8wL for the propped cantilever beam shown in Figure 2(a). Use method of least work.

[4 Marks]

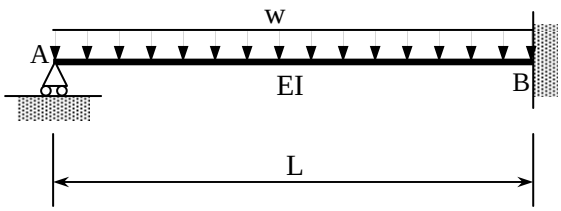


Figure 2(a)

b) Figure 2(b) shows a three-member truss subjected to a vertical load of 75kN at D. All supports A, B and C are of pin type. It is later found that due to some construction errors, the horizontal movement of support B cannot be effectively restrained. Compute the change in the magnitude of force in member BD due to the ineffectiveness of horizontal restraint at support B. Comment on the change in magnitude which occurs.

[16 Marks]

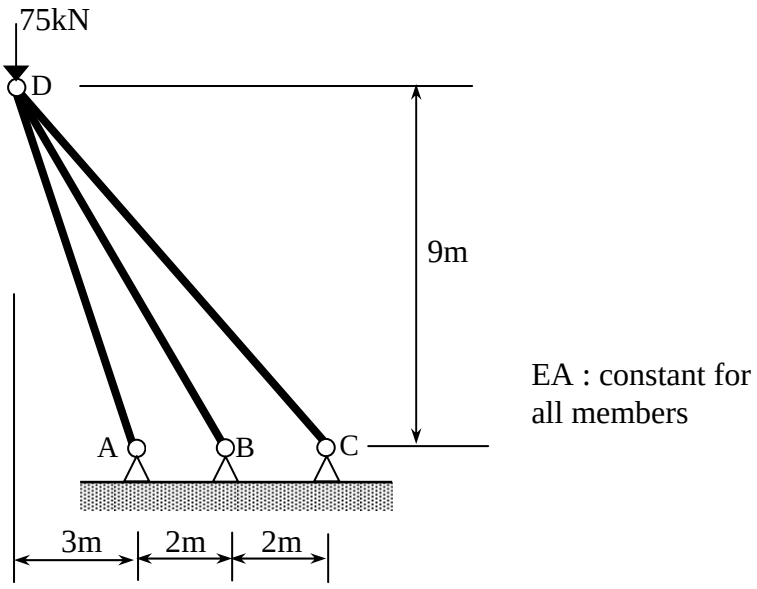


Figure 2(b)

3. a) Figure 3 shows a continuous beam carrying a uniformly distributed load of 2kN/m and point load of 100 kN on span AB while two point loads of 200kN and 80 kN on span BC and CD, respectively. Support A is fixed, support B and C are rollers and cantilevered end at D. Using moment distribution method, calculate internal moments at all supports of the beam. Assume value of EI is constant and neglect axial deformation. Hence, sketch the deflected shape and bending moment diagram of the beam.

[18 Marks]

3. b) If point D for the continuous beam in Figure 3 is roller, sketch the new bending moment diagram and deflected shape of the beam.

[2 Marks]

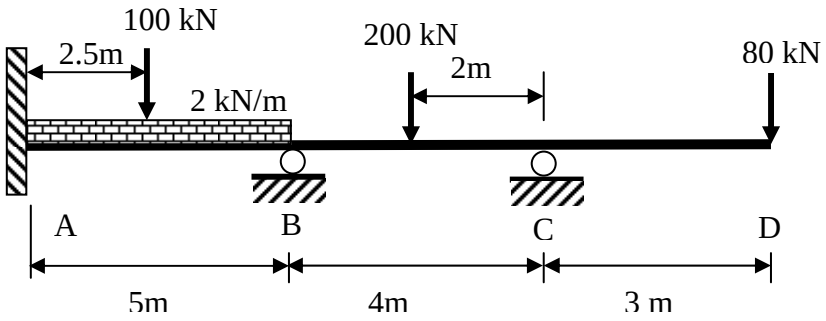


Figure 3

4. a) Figure 4 shows a frame carrying a uniformly distributed load of 14 kN/m on span AB and a point load of 5 kN at point C. Support D and E are fixed. The value of I each member is shown labeled in Figure 4. Determine the internal moments at the joints of the frame by using the slope deflection method. Hence sketch the deflected shape and bending moment diagram of the frame.

[17 Marks]

b) If support C is replaced with fixed support, sketch new bending moment diagram and deflected shape of the frame.

[3 Marks]

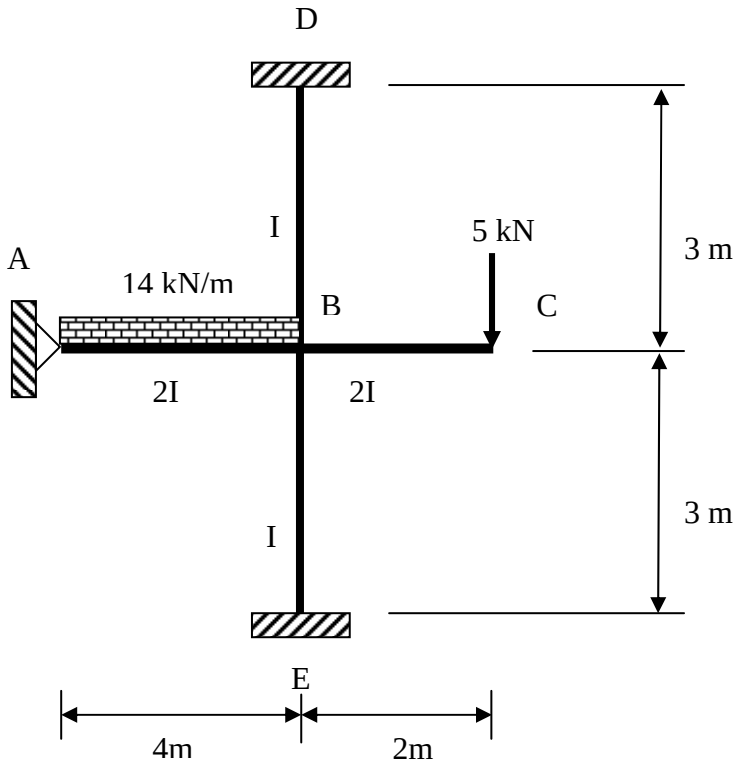


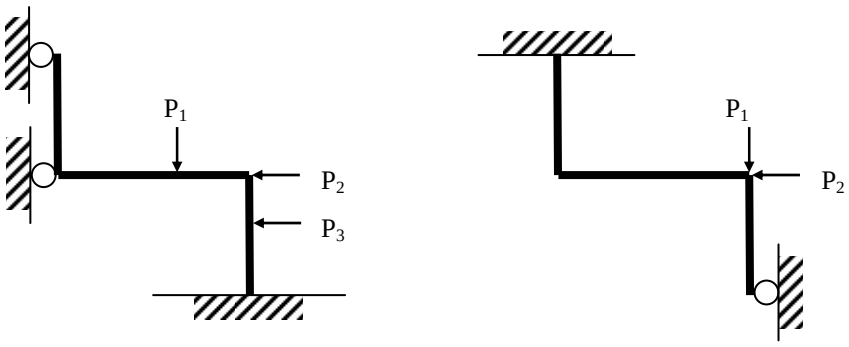
Figure 4

5. a) Sketch the possible types of plastic mechanism of the frame given in Figure 5(a) and (b). Name the mechanism, mark the plastic hinge location and label the angle of rotation as well as the displacement of the frame.

[5 Marks]

b) Draw **THREE (3)** collapse mechanisms of the frame as shown in Figure 6 and determine the collapse load, P, of the frame for each mechanism. Take load factor as 1.0. If the column and the beam of the frame were constructed using the section as given in Table 1, draw the plastic bending moment diagram of the frame as well as show the important values.

[15 Marks]



(a) (b)

Figure 5

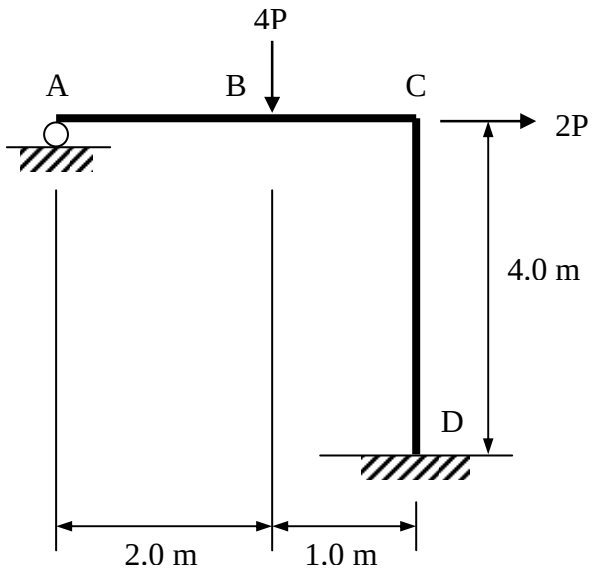
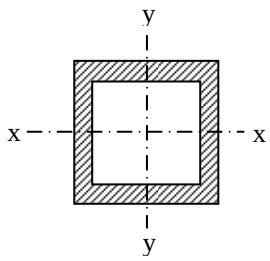
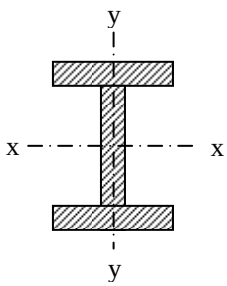


Figure 6

Table 1

Member	Column	Beam
Cross-section		
Cross-sectional area	11514 mm^2	31400 mm^2
Modulus of elasticity	200 GPa	200 GPa
Yield stress of the section	275 N/mm^2	275 N/mm^2
Elastic section modulus	1.085 x 10^6 mm^3	4.113 x 10^5 mm^3
Plastic section modulus	1.262 x 10^6 mm^3	5.605 x 10^6 mm^3

6. Figure 7 shows a continuous beam supported at A and C. The support at A is fixed and C is a roller. Assume the flexural rigidity of the beam is constant.

a) Without any calculation, state the analysis procedures to draw qualitative influence lines for the indeterminate beam.

[5 Marks]

b) Draw the influence line for the moment at B. Plot numerical values every 1.0 m.

[15 Marks]

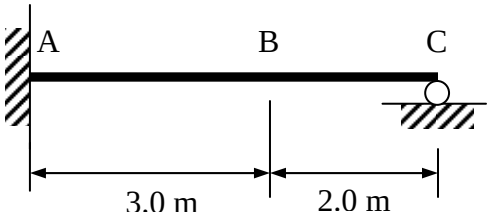
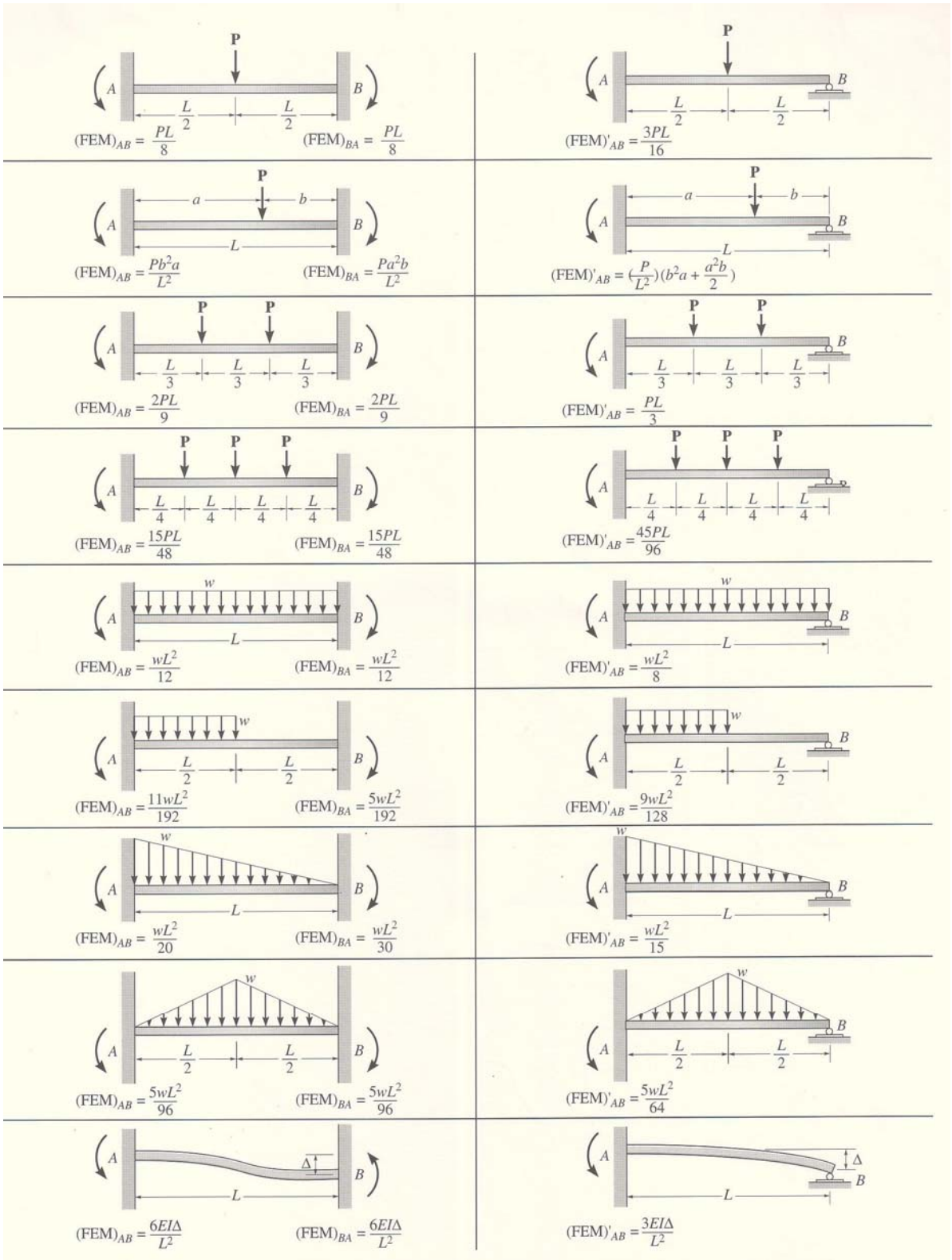


Figure 7

APPENDIX / LAMPIRAN

Fixed End Moment



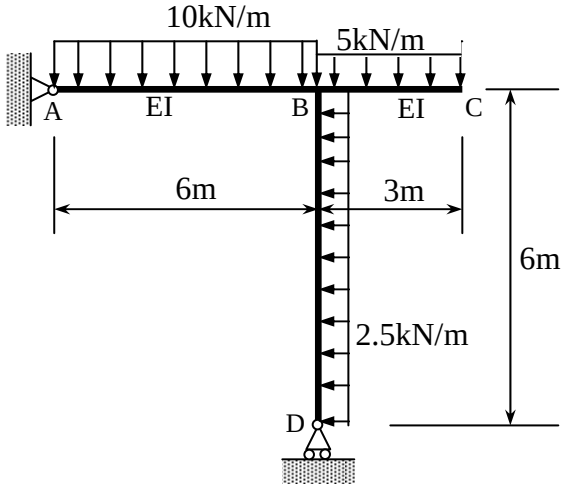
(TERJEMAHAN)

1 a) *Nyatakan **DUA (2)** sebab mengapa pengiraan pesongan merupakan satu bahagian penting dalam analisis struktur.*

[2 Markah]

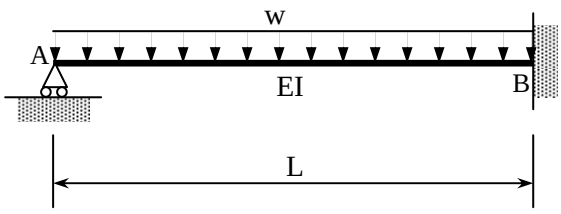
b) *Rajah 1 menunjukkan satu kerangka dengan penyokong jenis pin pada A dan jenis rola pada D. Kerangka berkenaan dikenakan : satu beban teragih seragam 10kN/m di sepanjang AB, satu beban teragih seragam 5kN/m di sepanjang BC dan satu lagi beban teragih seragam 2.5kN/m di sepanjang anggota pugak BD. EI untuk anggota AB dan BC adalah sama; manakala EI untuk anggota BD adalah 0.5 kali nilai untuk anggota AB dan BC. Kirakan anjakan pugak titik C dengan menggunakan kaedah kerja maya.*

[18 Markah]



Rajah 1

2. a) *Buktikan bahawa daya tindakbalas pada A adalah bersamaan dengan 3/8wL untuk rasuk julur tertopang seperti yang ditunjukkan dalam Rajah 2(a). Gunakan kaedah kerja terkurang.*

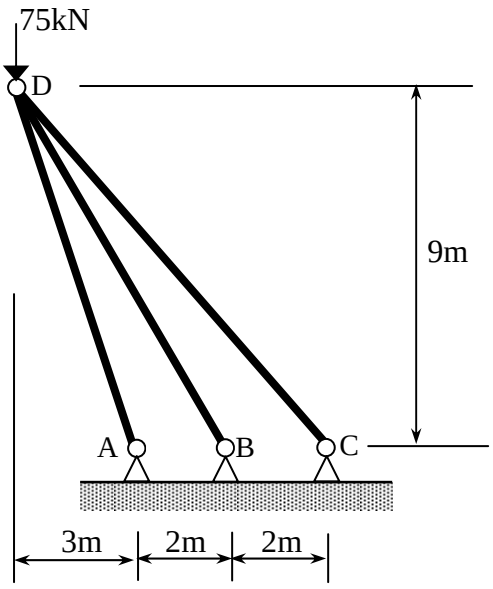


Rajah 2(a)

[4 Markah]

b) *Figure 2(b) menunjukkan satu struktur kekuda tiga-anggota yang dikenakan satu beban pugak 75kN di D. Kesemua penyokong A, B dan C adalah jenis pin. Akibat kesilapan semasa pembinaan, didapati bahawa anjakan ufuk penyokong B tidak dapat dikekang secara berkesan. Kirakan perubahan magnitud daya anggota BD akibat ketidakberkesanan kekangan anjakan ufuk pada penyokong B. Berikan komen tentang perubahan magnitud daya anggota yang berlaku.*

[16 Markah]



EA : Malar untuk semua anggota

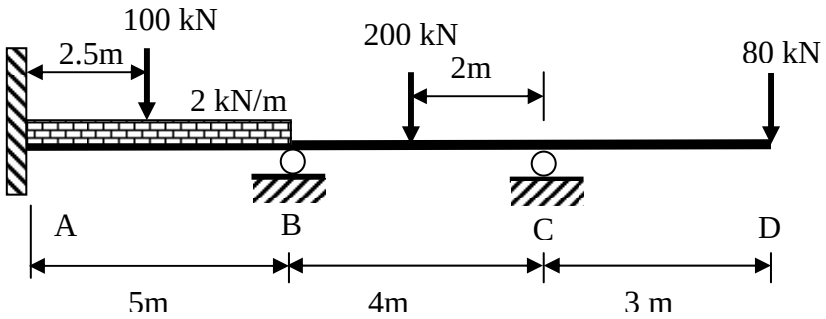
Rajah 2(b)

3. a) *Rajah 3 menunjukkan satu rasuk selanjar yang membawa beban teragih seragam 2 kN/m dan satu beban tumpu 100 kN bertindak di atas rentang AB mankala dua beban tumpu 200 kN dan 80 kN bertindak masing-masing di rentang BC dan CD. Penyokong A adalah terikat tegar, penyokong B dan C ialah rola dan hujung terunjur di D. Dengan menggunakan kaedah agihan momen, kira nilai momen dalaman di setiap penyokong rasuk tersebut. Anggap nilai EI adalah malar dan abaikan pesongan paksi. Seterusnya, lakarkan bentuk terpesong kerangka tersebut dan rajah momen lentur rasuk tersebut.*

[18 Markah]

3. b) *Sekiranya titik D bagi rasuk selanjar dalam Rajah 3 ialah rola, lakarkan gambarajah momen lentur dan bentuk terpesong baru rasuk tersebut.*

[2 Markah]



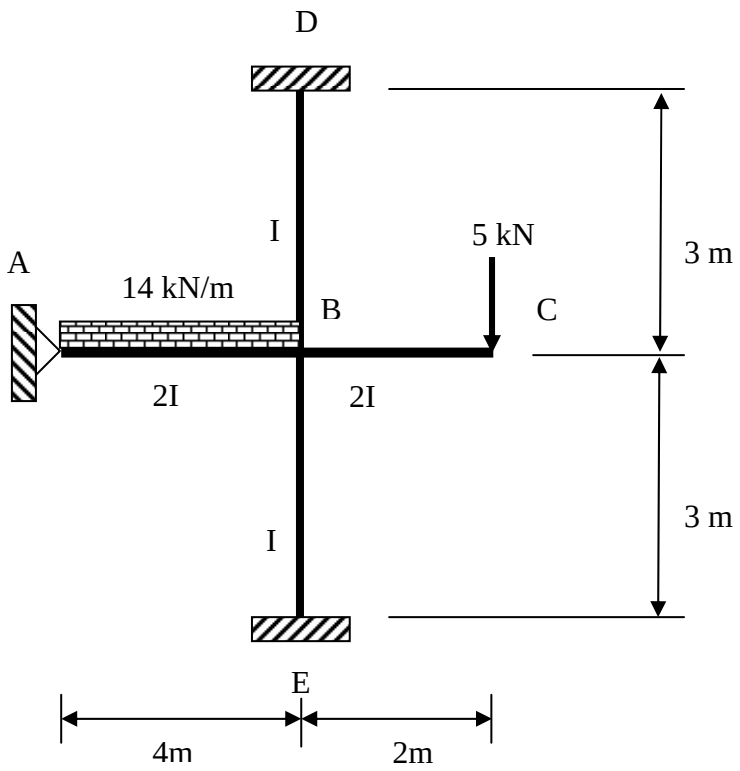
Rajah 3

4. a) *Rajah 4 menunjukkan satu kerangka yang menanggung beban teragih seragam 14 kN/m di atas rentang AB dan satu beban tumpu 5 kN di titik C. Penyokong D dan E adalah terikat tegar. Nilai I setiap anggota kerangka ditunjukkan dalam Rajah 4. Tentukan nilai momen dalaman di setiap sambungan kerangka tersebut menggunakan kaedah cerun pesongan. Seterusnya lakarkan bentuk terpesong dan gambarajah momen lentur kerangka tersebut.*

[17 Markah]

4. b) *Sekiranya penyokong C digantikan dengan penyokong tegar, lakarkan gambarajah momen lentur dan bentuk terpesong baru kerangka tersebut.*

[3 Markah]



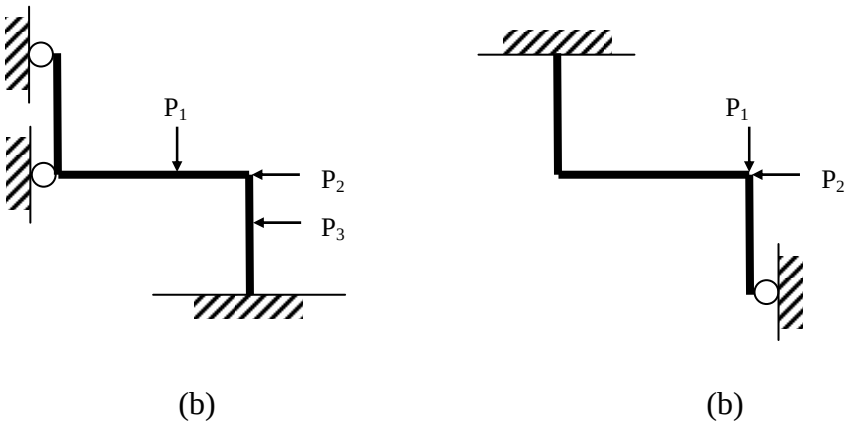
Rajah 4

5. a) *Lakarkan jenis mekanisma plastik yang berkemungkinan bagi struktur kerangka yang diberikan dalam Rajah 5(a) dan (b). Namakan mekanisma berkenaan, tandakan kedudukan engsel plastik dan labelkan sudut putaran serta anjakan kerangka tersebut..*

[5 Markah]

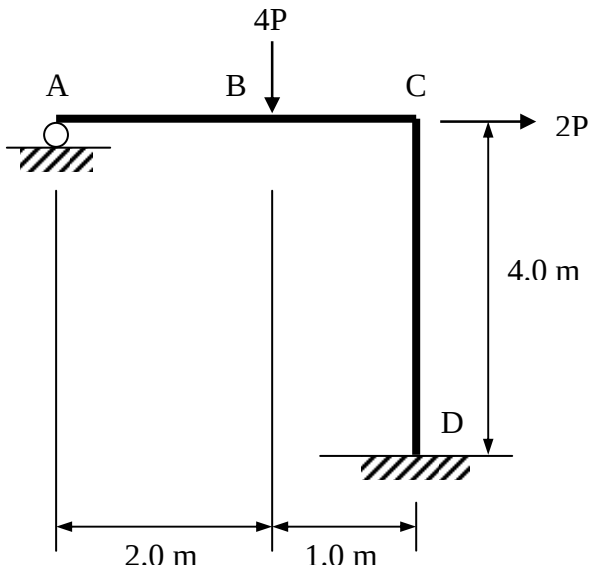
b) *Lukiskan **TIGA (3)** mekanisma runtuh bagi struktur kerangka dalam Rajah 6 dan tentukan beban runtuh bagi setiap mekanisma struktur kerangka tersebut. Ambil faktor daya sebagai 1.0. Sekiranya tiang dan rasuk kerangka tersebut dibina menggunakan keratan seperti dalam Jadual 1, lukiskan gambarajah momen lentur plastik kerangka tersebut serta tunjukkan nilai-nilai utama.*

[15 Markah]



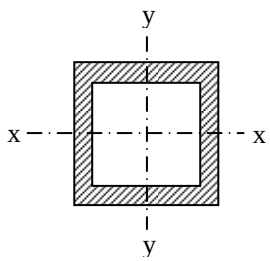
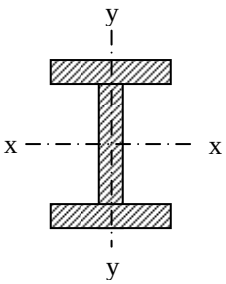
(b) (b)

Rajah 5



Rajah 6

Jadual 1

Anggota	***Tiang***	***Rasuk***
Keratan rentas		
Luas keratan rentas	11514 mm^2	31400 mm^2
Modulus keanjalan	200 GPa	200 GPa
Tegasan alah keratan	275 N/mm^2	275 N/mm^2
Modulus keratan anjal	1.085 x 10^6 mm^3	4.113 x 10^5 mm^3
Modulus keratan plastik	1.262 x 10^6 mm^3	5.605 x 10^6 mm^3

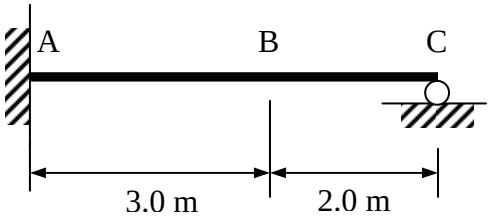
6. *Rajah 7 menunjukkan satu rasuk selanjar diikat tegar di A dan disokong rola di C. Andaikan ketegaran lenturan rasuk tersebut adalah malar.*

a) Tanpa sebarang pengiraan, nyatakan tatacara analisis untuk melukis garis imbas kualitatif bagi rasuk tidakboleh tentu statik.

[5 Markah]

b) Lukiskan gambarajah garis imbas bagi momen di B. Plotkan nilai numerik untuk setiap selaan 1.0 m.

[15 Markah]



Rajah 7

oooOOOooo