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UNIVERSITI SAINS MALAYSIA

KSCP Examination  
Academic Session 2008/2009

June 2009

**EAS 253/3 – Theory of Structures**  
*[Teori Struktur]*

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

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Please check that this examination paper consists of **THIRTEEN (13)** printed pages before you begin the examination.

*[Sila pastikan kertas peperiksaan ini mengandungi **TIGA BELAS(13)** muka surat bercetak sebelum anda memulakan peperiksaan ini.]*

[Instructions: This paper contains **SEVEN(7)** questions. Answer **THREE (3)** compulsory questions in Part A and choose **TWO (2)** questions in Part B.

*[**Arahan:** Kertas ini mengandungi **SEVEN (7)** soalan. Jawab **THREE (3)** soalan wajib di Bahagian A dan pilih **DUA (2)** soalan di Bahagian B]*

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.

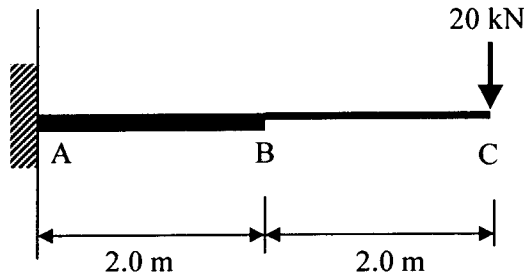
*[Semua soalan **MESTILAH** dijawab pada muka surat baru.]*

Write the answered question numbers on the cover sheet of the answer script.

*[Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.]*

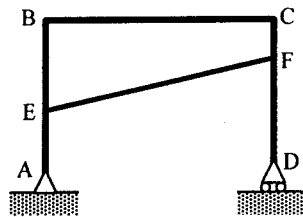
**PART A**

1. (a) Define the first and the second theorem of conjugate-beam method. (4 marks)
- (b) Without any calculation, state the analysis procedures to determine the displacement and slope at a specified point on the elastic curve of a beam using conjugate-beam method. (6 marks)
- (c) A cantilever beam shown in Figure 1 is subjected to a concentrated load of 20 kN at free end C. The moment of inertia of segment AB of the beam is  $2I$ , whereas the segment BC has a moment of inertia  $I$ . Given  $I = 90 \times 10^6 \text{mm}^4$  and elastic modulus of 200GPa. Determine the deflection at C using the **moment area method**. (10 marks)



**Figure 1**

2. (a) Check statical indeterminacy of the frame shown in Figure 2. (2 marks)



**Figure 2**

- (b). Figure 3 shows a beam structure with a pinned support at A, roller supports at B and D and a hinge joint at C. The beam is loaded with a uniformly distributed load 20kN/m along portion BCD, a point load 20kN at free end E and a couple 20kNm at pinned support A. Draw the shear force and bending moment diagrams for the beam. Sketch also the qualitative deflected shape.

(18 marks)

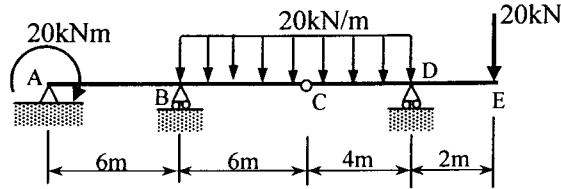


Figure 3

3. (a) Determine the member forces CF, CE and ED for the truss shown in Figure 4 by the method of sections and classify whether they are in tension or compression.

( 8 marks)

- (b) Find reactions at supports A and D, hence calculate member forces of AC, AB and BD using method of joint. Classify whether they are in tension or compression.

( 12 marks)

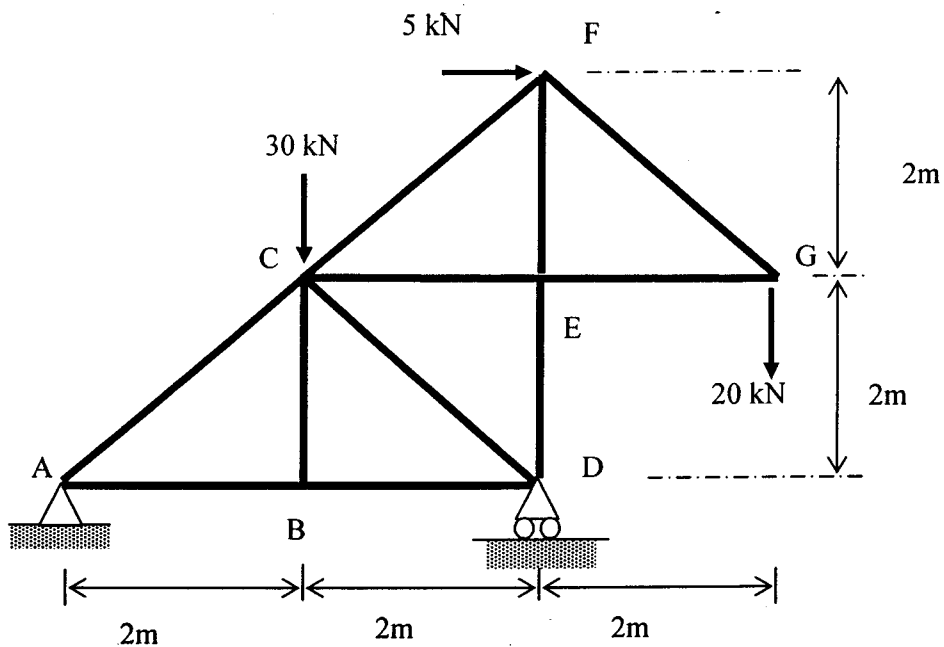
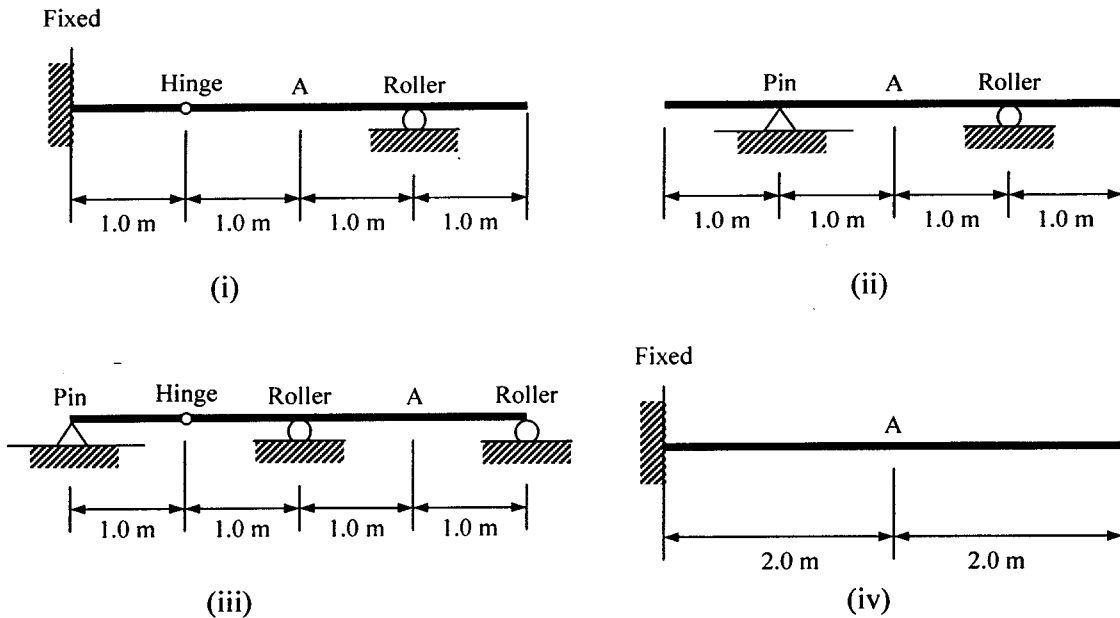


Figure 4

**PART B : Choose TWO (2) questions**

4. (a) Draw a qualitative influence lines diagram for bending moment at A for the beam shown in Figure 5 (i) to (iv).

(6 marks)

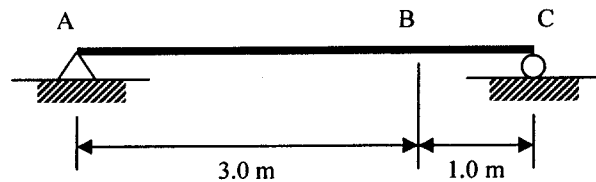


**Figure 5**

- (b) A beam subjected to a moving load which travel from A to C is shown in Figure 6. The beam is pin supported at A and supported by a roller at C.

- (i) Derive the influence line equation for reaction at A and C
- (ii) Derive the influence line equation for shear at point B for segment AB and BC. State clearly the range of  $x$  taken, in order to derive the equations for each segment of the beam
- (iii) Draw the influence lines for the shear at point B

(14 marks)



**Figure 6**

5. The cable system shown in Figure 7 carries a uniformly distributed load of 5 kN/m between the supports and two point loads of 10 kN and 20 kN at 10 m away from support A and B respectively. The horizontal distance between supports is 50 m and the vertical distance between the lowest point and the left hand support is 3 m. The right hand support is 6 m higher than the left support.

Determine:

- (i) the lowest point of the cable ( $x$ ).
- (ii) the maximum and minimum tension between A and B ( $T_{\max}$  and  $T_{\min}$ ).
- (iii) the tension in anchor cables ( $T_A'$  and  $T_B'$ ).
- (iv) vertical and horizontal reactions at supports ( $R_{vA}$ ,  $R_{hA}$  and  $R_{vB}$ ,  $R_{hB}$ ).
- (v) size of the cable, if the allowable stress is 15500 kN/m<sup>2</sup>.

(20 marks)

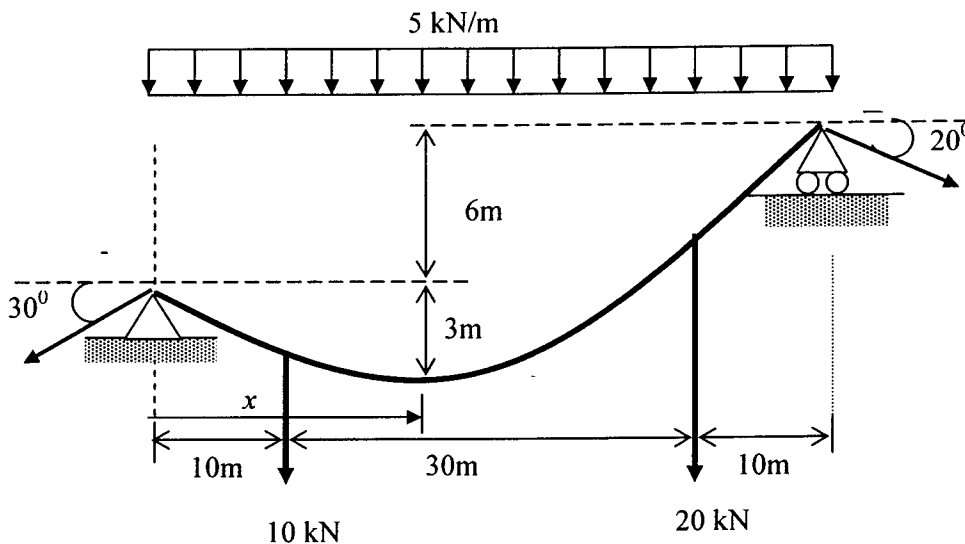


Figure 7

6. A three pinned arch shown in Figure 8 is in the form of  $y = \frac{4hx(L-x)}{L^2}$ . It is designed to carry a uniformly distributed load of 4 kN/m spanning 35m on span BCDE and a point load of 6 kN and 8 kN at point B and 10 kN at point D. Joints A, C and E are hinged.

Determine:

- (i) reactions supports at A and E.
- (ii) bending moment at B and D .
- (iii) shear force, Q and thrust, N at point D (with loading).

(20 marks)

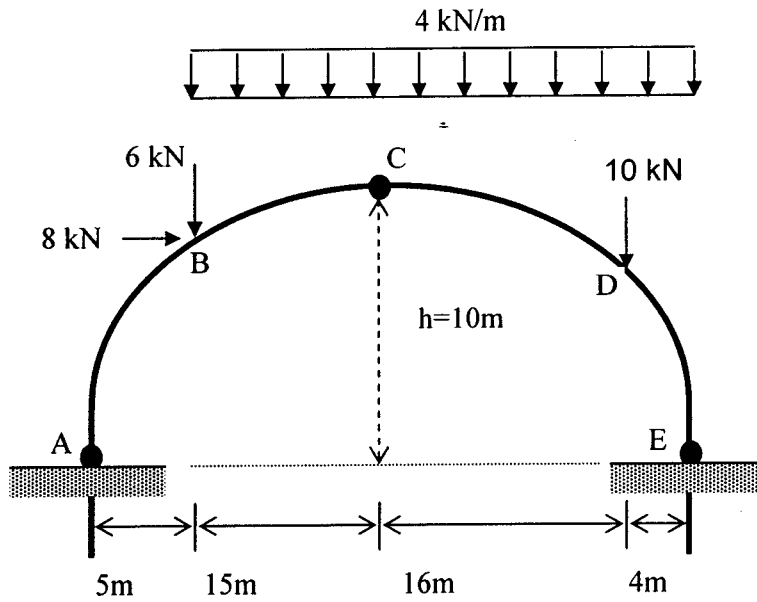


Figure 8

7. (a) Prove that the beam shown in Figure 9 is statically indeterminate with degree of statical indeterminacy equals to ONE (1).

(2 marks)

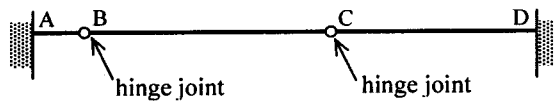


Figure 9

- (b) Figure 10 shows a frame with roller and pinned supports at D and E, respectively. It is loaded by a uniformly distributed load  $0.5\text{kN/m}$  along inclined member AB, a uniformly distributed load  $2\text{kN/m}$  along member BCD and a concentrated load  $25\text{kN}$  at C. Draw the shear force and bending moment diagrams for the frame. Sketch also the qualitative deflected shape.

(18 marks)

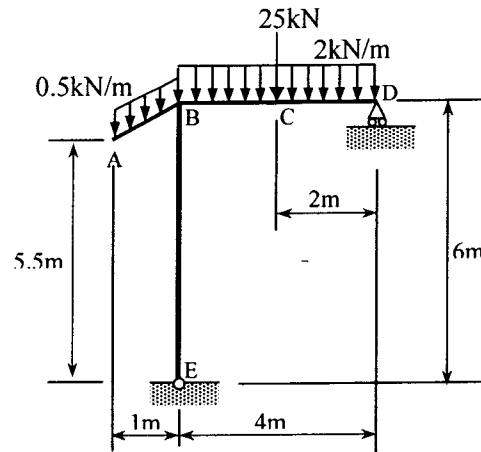


Figure 10

**BAHAGIAN A**

1. (a) Berikan definisi untuk teorem pertama dan kedua bagi kaedah rasuk-konjugat.

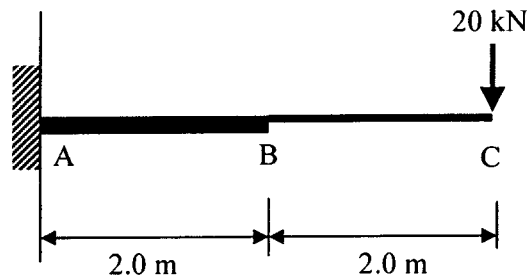
(4 markah)

(b) Tanpa sebarang pengiraan, nyatakan tatacara analisis untuk menentukan anjakan dan putaran di titik tertentu di atas lengkung anjal rasuk menggunakan kaedah rasuk-konjugat.

(6 markah)

(c) Rasuk lurus yang ditunjukkan dalam Rajah 1 menanggung satu beban tumpu 20kN di hujung bebas D. Momen inersia bagi rasuk di bahagian AB ialah  $2I$ , manakala di bahagian BC ialah  $2I$ . Diberi nilai  $I = 90 \times 10^6 \text{ mm}^4$  dan modulus keanjalan adalah 200GPa. Tentukan anjakan di C dengan menggunakan kaedah luas- momen.

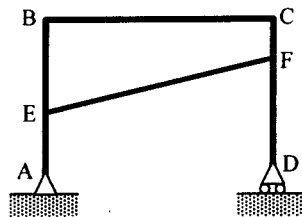
(10 markah)



**Rajah 1**

2. (a) Semak kebolehtentuan statik struktur kerangka yang ditunjukkan dalam Rajah 2.

(2 markah)

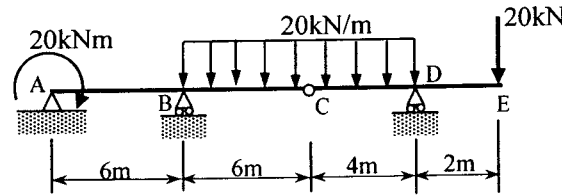


**Rajah 2**



- (b) Rajah 3 menunjukkan satu rasuk dengan penyokong pin di A, penyokong rola di B, D dan satu sambungan jenis sendi di C. Rasuk berkenaan membawa beban teragih seragam  $20\text{kN/m}$  di sepanjang bahagian BCD, satu beban tertumpu  $20\text{kN}$  pada hujung bebas E dan satu momen gandingan  $20\text{kNm}$  pada penyokong pin A. Lukiskan gambarajah daya ricih dan momen lentur untuk rasuk berkenaan. Lakarkan juga bentuk terpesong kualitatif.

(18 markah)



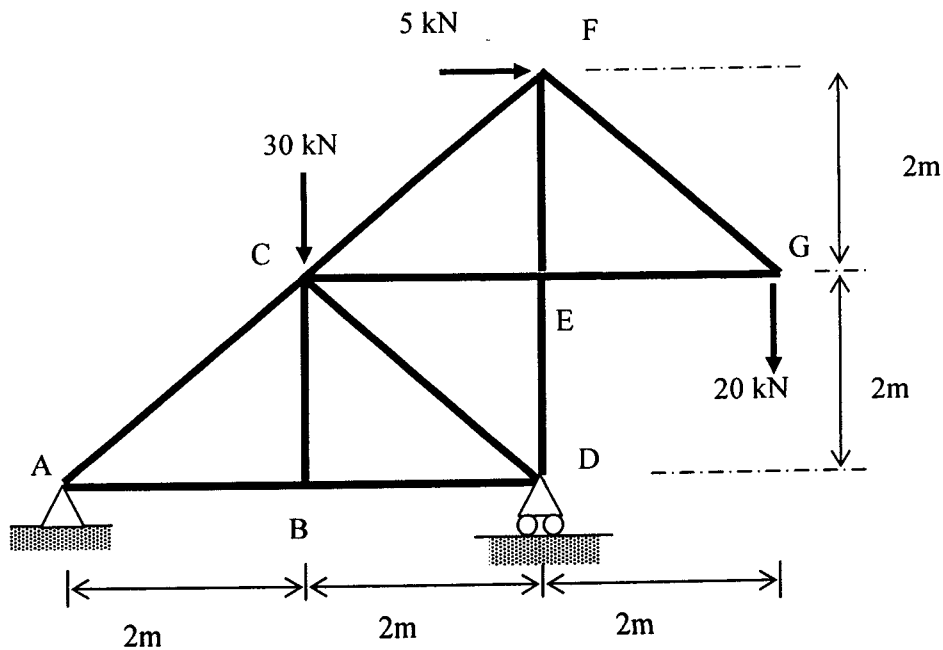
Rajah 3

3. (a) Kira daya dalam anggota kekuda CF, CE dan ED dalam Rajah 3 dengan menggunakan kaedah keratan. Nyatakan sama ada anggota tersebut mengalami daya mampatan atau tegangan

(8 markah)

- (b) Dapatkan nilai daya tindakbalas di penyokong A dan D dan kira daya dalam anggota AC, AB dan BD dengan menggunakan kaedah sambungan. Nyatakan samada anggota tersebut mengalami daya mampatan atau tegangan.

(12 markah)

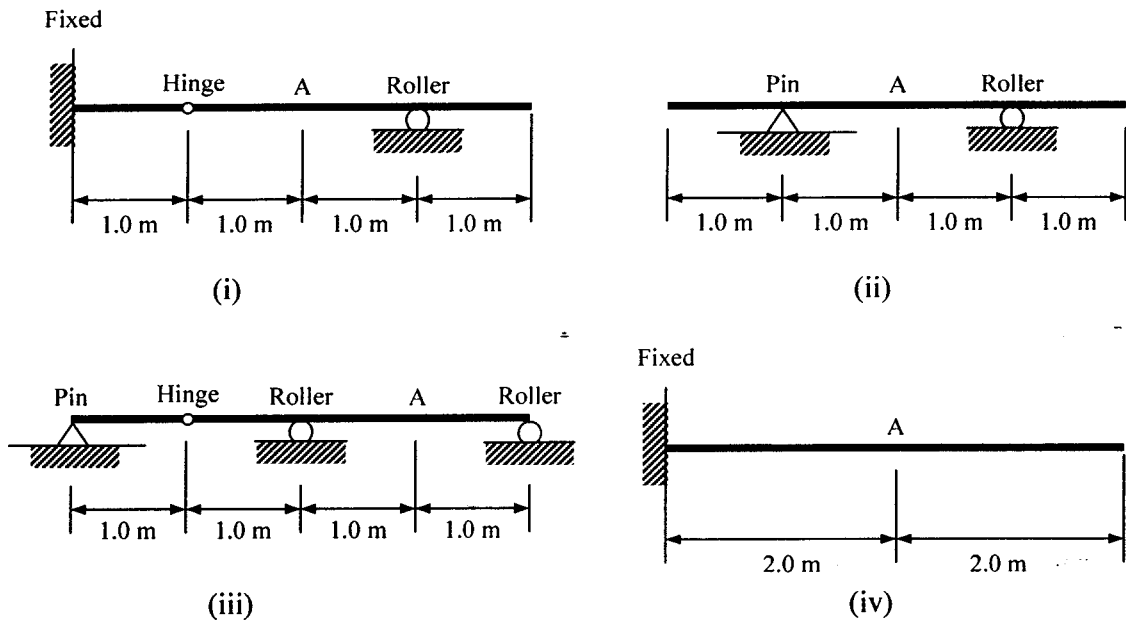


Rajah 4

**BAHAGIAN B : Jawab 2 sahaja dari 4 soalan**

4. (a) Lukiskan gambarajah garis imbas kualitatif bagi momen lentur di A untuk rasuk yang ditunjukkan dalam Rajah 5 (i) hingga (iv).

(6 markah)

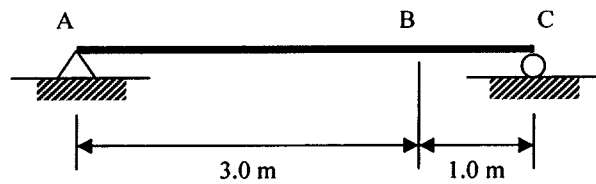


**Rajah 5**

(b) Satu rasuk menanggung beban bergerak dari A ke C ditunjukkan dalam Rajah 5. Rasuk tersebut disokong cemat di A dan disokong rola di C.

- (i) Terbitkan persamaan garis imbas bagi tindakbalas di A dan C
- (ii) Terbitkan persamaan garis imbas bagi ricih di titik B untuk bahagian AB dan BC. Nyatakan dengan jelas had nilai  $x$  yang digunakan untuk menerbitkan persamaan-persamaan tersebut bagi setiap bahagian rasuk.
- (iii) Lukiskan garis imbas bagi ricih di titik B

(14 markah)



**Rajah 6**

5. Satu sistem kabel seperti yang ditunjukkan dalam Rajah 7, menanggung beban teragih seragam sebanyak 5 kN/m disepanjang rentang antara kedua-dua penyokong dan dua beban tumpu 10 kN dan 20 kN yang berjarak 10m dari kedua-dua penyokong. Jarak ufuk antara penyokong ialah 50 m dan jarak menegak dari titik terendah dan penyokong di sebelah kiri ialah 3m. Penyokong di sebelah kanan berada 6 m lebih tinggi daripada penyokong kiri.
- Kira:

- (i) Kedudukan titik terendah kabel ( $x$ ).
- (ii) Nilai tegangan maksimum dan minimum kabel antara penyokong A dan B ( $T_{max}$  dan  $T_{min}$ )
- (iii) Tegangan kabel sauh ( $T_A'$  dan  $T_B'$ )
- (iv) Tindakbalas menegak dan mengufuk di penyokong ( $R_{VA}$ ,  $R_{HA}$  dan  $R_{VB}$ ,  $R_{HB}$ )
- (v) Saiz kabel yang diperlukan sekiranya tegasan kabel tersebut ialah  $15500 \text{ kN/m}^2$ .

(20 markah)

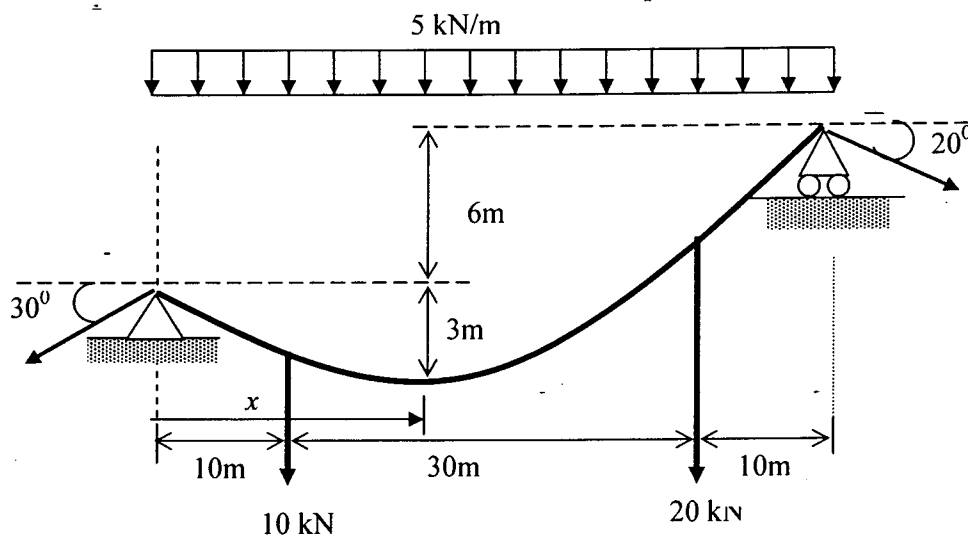


Figure 7

6. Gerbang tiga engsel dalam Rajah 8 dibentuk dari persamaan  $y = \frac{4hx(L-x)}{L^2}$ .

Ia direkabentuk untuk menanggung beban teragih seragam sebanyak 4 kN/m di sepanjang rentang 35m di bahagian BCDE dan beban tumpu 6 kN dan 8 kN di titik B dan 10kN di titik D. Sambungan A, C dan E adalah jenis engsel.

Kira:

- (i) daya tindakbalas di penyokong A dan E.
- (ii) momen lentur di titik B dan D.
- (iii) daya ricih, Q dan daya paksi N di titik D (dengan beban kenaan).

(20 markah)

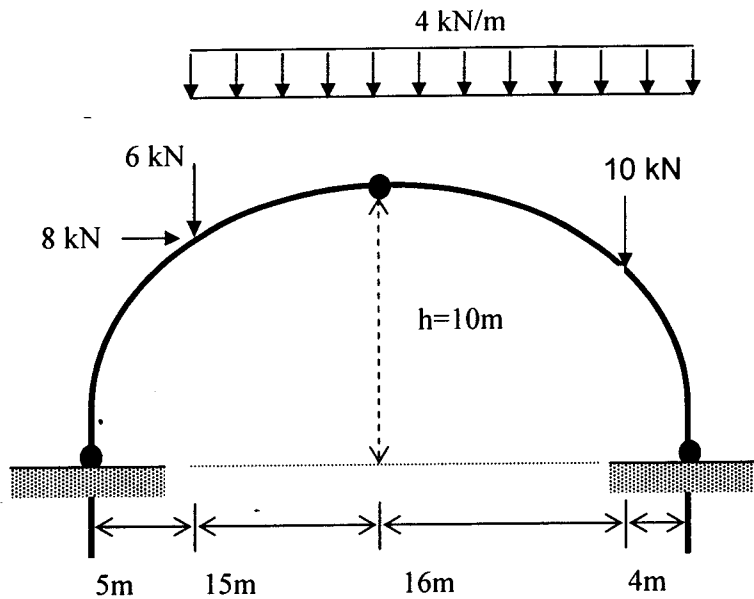
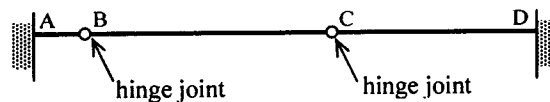


Figure 8

7. (a) Buktikan bahawa rasuk yang ditunjukkan dalam Rajah 9 adalah rasuk tidak boleh tentu statik dengan darjah ketidakboleh tentuan statik sama dengan SATU(1).

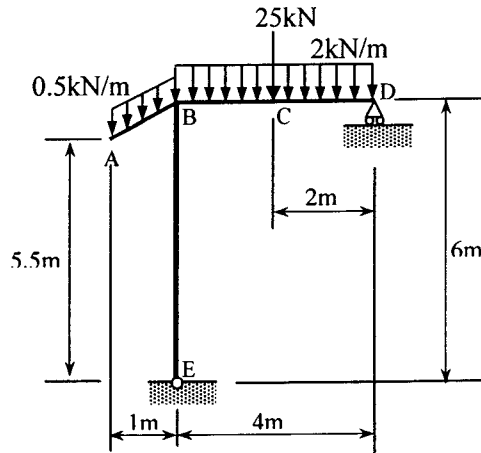
(2 markah)



Rajah 9

(b) Rajah 10 menunjukkan satu kerangka dengan penyokong rola pada D dan penyokong pin pada E. Kerangka berkaitan dibebankan dengan satu beban teragih seragam  $0.5\text{kN/m}$  di sepanjang anggota condong AB, beban teragih seragam  $20\text{kN/m}$  di sepanjang anggota BCD dan satu beban tertumpu pugak  $25\text{kN}$  pada C. Lukiskan gambarajah daya ricih dan momen lentur untuk kerangka berkenaan. Lakarkan juga bentuk terpesong kualitatif

(18 markah)



Rajah 10