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UNIVERSITI SAINS MALAYSIA

1<sup>st</sup>. Semester Examination  
2004/2005 Academic Session  
*Peperiksaan Semester Pertama  
Sidang Akademik 2004/2005*

October 2004

**EAS253E/3 – Theory of Structures**  
***EAS253E/3 – Teori Struktur***

*Duration: 3 hours*

*Masa : 3 jam*

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**Instructions to candidates:**

**Arahan kepada calon:**

1. Ensure that this paper contains **EIGHT (8)** printed pages.  
*Sila pastikan kertas peperiksaan ini mengandungi LAPAN (8) muka surat bercetak sebelum anda memulakan peperiksaan ini.*
2. This paper contains **SIX (6)** questions. Answer **ALL** questions.  
*Kertas ini mengandungi ENAM (6) soalan. Jawab SEMUA soalan.*
3. All questions **CAN BE** answered in English or Bahasa Malaysia or combination of both languages.  
*Semua soalan boleh dijawab dalam Bahasa Inggeris atau Bahasa Malaysia ataupun kombinasi kedua-dua bahasa.*
4. All question **MUST BE** answered on a new sheet.  
*Semua jawapan MESTILAH dijawab pada muka surat yang baru.*
5. 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) Explain the meaning of statical determinacy without using any equation. (2 marks)
- (a) Terangkan erti kebolehtentuan statik tanpa menggunakan persamaan. (2 markah)
- (b) Determine whether the structures shown in Figure 1.0 (i) and (ii) are statically determinate or indeterminate ones. (2 marks)
- (b) Tentukan samada struktur dalam Rajah 1.0 (i) dan (ii) adalah struktur boleh tentu statik ataupun tidak-boleh tentu statik. (2 markah)

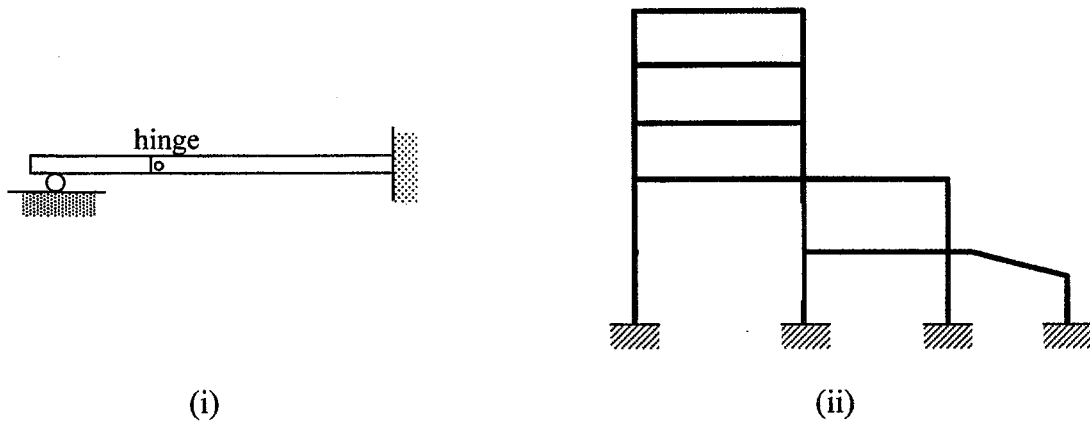


Figure 1.0

- (c) Figure 2.0 shows a two-member frame. Supports at A and C are of hinged and roller type, respectively. Horizontal and vertical loads of 25kN and 70kN act at joint B and point D, respectively. Member AB is subjected to a horizontal uniformly distributed load of 35kN/m. Draw the shear and bending moment diagram for the frame. Sketch the qualitative deflected shape. (16 marks)
- (c) Rajah 2.0 menunjukkan satu kerangka yang terdiri daripada dua anggota. Penyokong A adalah jenis sendi manakala penyokong C adalah jenis 'roller'. Satu beban tertumpu ufuk 25kN bertindak pada sambungan B manakala satu beban tertumpu pugak 70kN bertindak pada titik D. Anggota AB dikenakan satu beban teragih seragam ufuk 35kN/m. Lukiskan gambarajah daya ricih dan momen lentur untuk kerangka berkenaan. Lakarkan bentuk pesongan kualitatif. (16 markah)

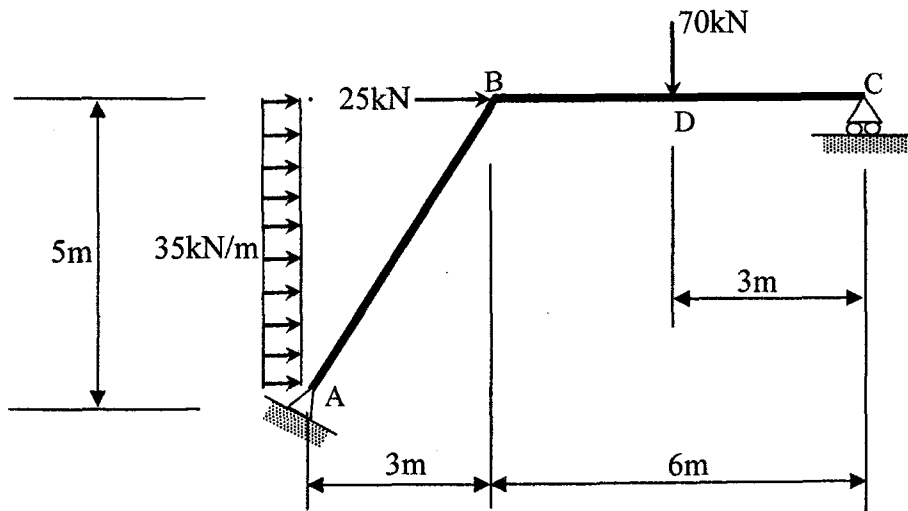


Figure 2.0

2. (a) Describe briefly three characteristics of truss structures and the three methods of analyzing the truss structure.

(5 marks)

(a) *Jelaskan dengan ringkas tiga ciri-ciri struktur kekuda dan tiga kaedah menganalisa struktur kekuda.*

(5 markah)

(b) Determine the member forces DF, DE and CE for the truss shown in Figure 3.0 by the method of sections and classify whether they are in tension or compression.

(6 marks)

(b) *Kira daya dalam anggota kekuda DF, DE dan CE dalam Rajah 3.0 menggunakan kaedah keratan. Nyatakan samada anggota tersebut mengalami daya mampatan atau tegangan.*

(6 markah)

(c) Find the member forces of AB, AC and BC using graphical method. Sketch the Maxwell diagram using Bow notation. Assume scale of 1cm:2kN. Classify whether they are in tension or compression.

(9 marks)

(c) *Dapatkan nilai daya dalam anggota AB, AC dan BC menggunakan kaedah grafik. Lakarkan rajah Maxwell dengan menggunakan notasi "Bow". Gunakan skala 1cm:2kN. Nyatakan samada anggota tersebut mengalami daya mampatan atau tegangan.*

(9 markah)

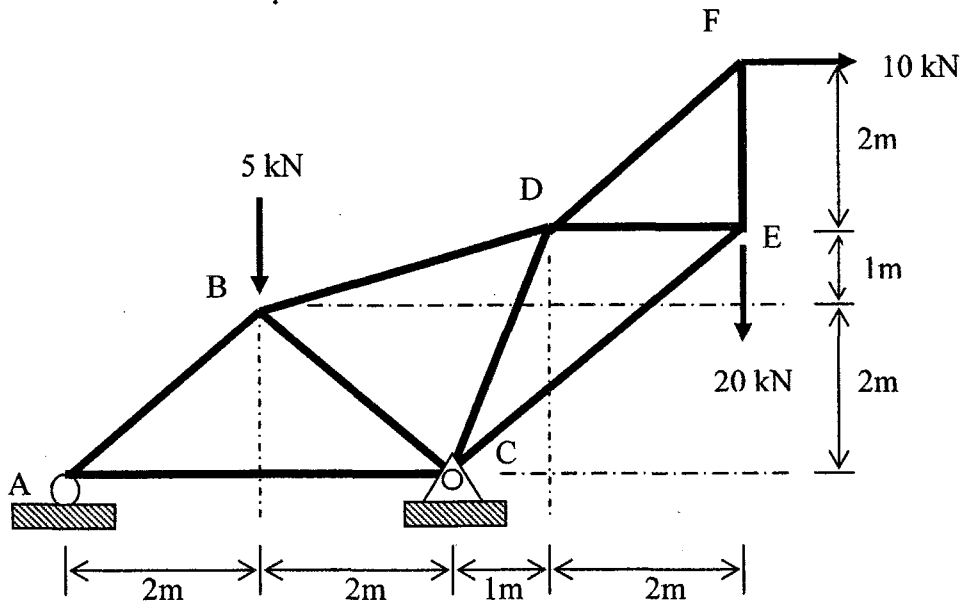


Figure 3.0

3. (a) What is the main different between the cable structures and the arch structures?

(2 marks)

(a) Apakah perbezaan utama antara struktur kabel dan struktur gerbang?

(2 markah)

(b) The cable system shown in Figure 4.0 carries a uniformly distributed load of 5kN/m between the supports and three point loads of 10 kN, 15 kN and 20 kN at 15m interval. The horizontal distance between supports is 60m and the vertical distance between the lowest point and the left support is 3m. The right support is 6m higher than the left support.

Determine:

- i. the lowest point of the cable (x)
- ii. the maximum and minimum tension between A and B ( $T_{min}$  and  $T_{max}$ )
- 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 = 14000 kN/m<sup>2</sup>.

(13 marks)

(b) Satu sistem kabel seperti yang ditunjukkan dalam Rajah 4.0, menanggung beban teragih seragam sebanyak  $5 \text{ kN/m}$  di sepanjang rentang antara kedua-dua penyokong dan tiga beban tumpu  $10 \text{ kN}$ ,  $15 \text{ kN}$  dan  $20 \text{ kN}$  berjarak  $15 \text{ m}$  antara satu sama lain. Jarak ufuk antara penyokong ialah  $60 \text{ m}$  dan jarak menegak dari titik terendah dan penyokong di sebelah kiri ialah  $3 \text{ m}$ . Penyokong di sebelah kanan berada  $6 \text{ m}$  lebih tinggi daripada penyokong kiri.

Kira:

- i. kedudukan titik terendah kabel ( $x$ )
- ii. nilai tegangan maksima dan minima kabel antara penyokong A dan B ( $T_{\min}$  dan  $T_{\max}$ )
- 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 keratan rentas kabel yang diperlukan sekiranya tegasan kabel tersebut ialah  $14000 \text{ kN/m}^2$ .

(13 markah)

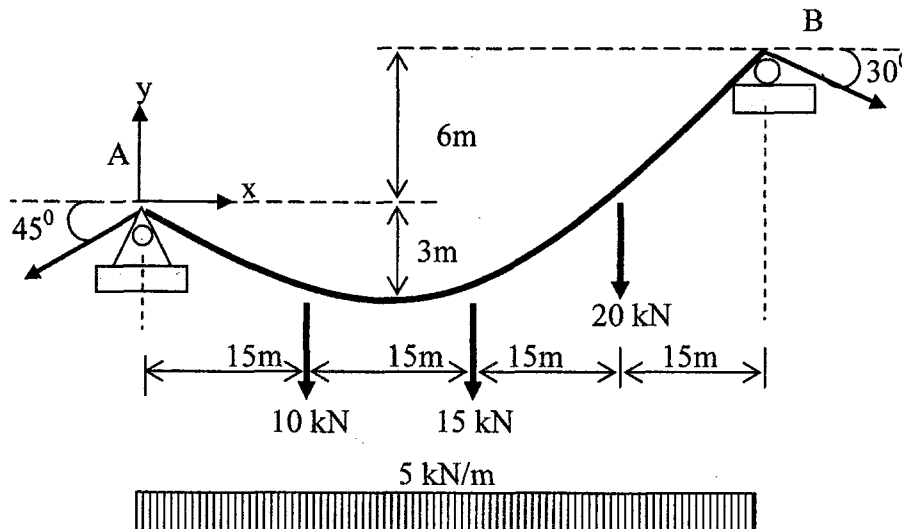


Figure 4.0

4. (a) Sketch and explain why the three pinned arch can be used for longer spans than the simply supported beam?

(3 marks)

(a) Lakar dan terangkan kenapa gerbang tiga engsel boleh digunakan untuk rentang yang lebih panjang berbanding rasuk disokong mudah?

(3 markah)

4. (b) Unsymmetrical three pinned arch shown in Figure 5.0 is in the form of  $y = \frac{4hx(L-x)}{L^2}$ , where  $L = 40$  m and  $h = 10$  m. Support A is 3.6m higher than support E. It is designed to carry a uniformly distributed load of 2 kN/m spanning 26m on ABCD and a point load of 8 kN and 5 kN at point B and D respectively. Joint A, C and E are hinged.

Determine:

- i. support reactions at A and E.
- ii. bending moment at B and D.
- iii. shear force,  $Q$  and thrust,  $N$  on the right hand side of point C and D (with loading).

(12 marks)

- (b) Gerbang tiga engsel tidak simetri dalam Rajah 5.0 dibentuk dari persamaan  $y = \frac{4hx(L-x)}{L^2}$ , iaitu  $L = 40$  m dan  $h = 10$  m. Penyokong A berada 3.6m lebih tinggi daripada penyokong E. Ia direkabentuk untuk membawa beban teragih seragam sebanyak 2 kN/m di sepanjang rentang 26m di bahagian A BCD dan beban tumpu 8 kN di titik B dan 5kN di titik D. Sambungan A, C dan E adalah engsel.

Tentukan:

- 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 sebelah kanan titik C dan D (dengan beban keraan)

(12 markah)

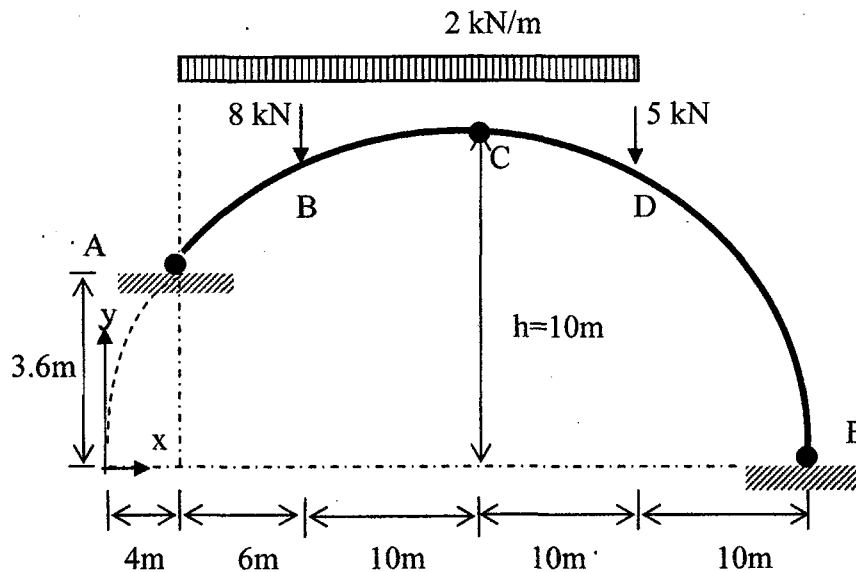


Figure 5.0

5. (a) Explain the fundamental difference between influence lines and the diagrams of structural response such as shear force and bending moment diagrams.

(3 marks)

(a) *Jelaskan perbezaan asas antara garis imbas dengan gambarajah-gambarajah sambutan struktur seperti gambarajah daya ricih dan gambarajah momen lentur.*

(3 markah)

(b) Figure 6.0 shows a bridge frame which is constructed to allow a moving truck travel on it. Draw the influence lines for:

- i. the vertical reaction at support A,
- ii. the vertical and horizontal reactions at support F,
- iii. the shear force at point D where is just to the left of beam to column connection,
- iv. the bending moment at point C
- v. determine the maximum bending moment at point C.

(12 marks)

(b) *Rajah 6.0 menunjukkan satu kerangka jambatan yang dibina untuk trak bergerak melaluinya. Lakarkan garis imbas untuk:*

- i. *daya tindakbalas menegak di penyokong A,*
- ii. *daya tindakbalas menegak dan mengufuk di penyokong F,*
- iii. *daya ricih di titik D yang berada di bahagian kiri sambungan rasuk ke tiang,*
- iv. *momen lentur di titik C*
- v. *tentukan momen lentur maksimum di titik C.*

(12 markah)

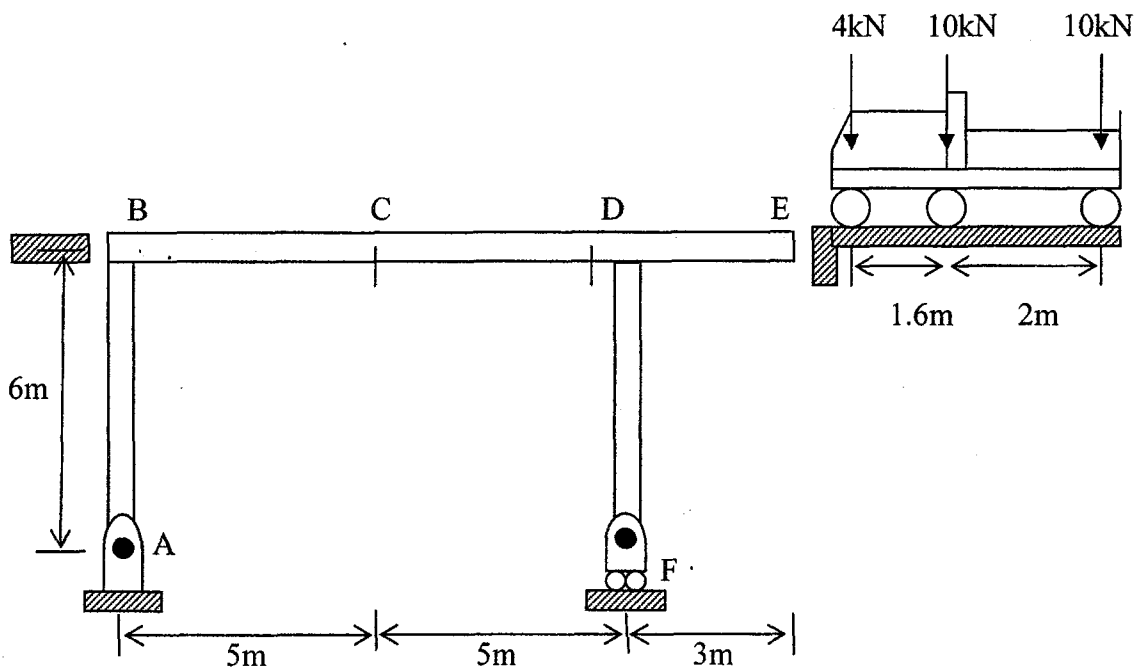


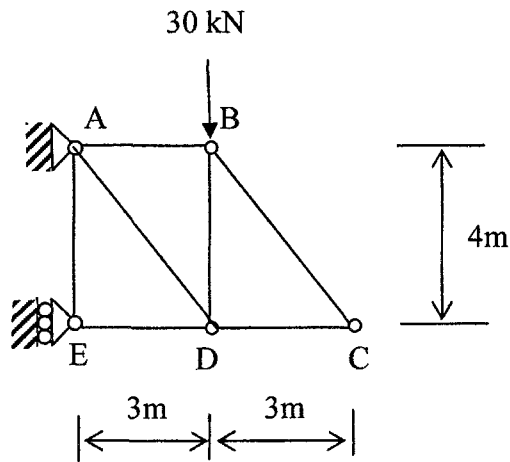
Figure 6.0

6. Figure 7.0 shows a pinned jointed truss, carrying a point load of 30 kN at point B. Calculate the vertical deflection at point D by assuming the cross sectional area of all members are  $200 \text{ mm}^2$  and the Young Modulus is 200 GPa.

(15 marks)

Rajah 7.0 menunjukkan sebuah kekuda bersendi pin yang membawa beban tumpu 30kN di sendi B. Kirakan pesongan pugak di sendi D dengan menganggap luas keratan rentas ialah  $200 \text{ mm}^2$  dan modulus Young ialah 200 GPa untuk semua anggota.

(15 markah)



Rajah 7.0