
UNIVERSITI SAINS MALAYSIA

First Semester Examination
2007/2008 Academic Session

October / November 2007

EAS 253/3 – Theory of Structure
[Teori Struktur]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of TEN pages of printed material including appendices before you begin the examination.

[Sila pastikan kertas peperiksaan ini mengandungi SEPULUH muka surat bercetak termasuk lampiran 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. All questions carry the same marks.

*[Arahan: Kertas ini mengandungi **TUJUH (7)** soalan. Jawab **TIGA (3)** soalan wajib di Bahagian A dan pilih **DUA (2)** di Bahagian B. 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 sheet.

*[Semua jawapan **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 : Answer all THREE (3) questions

1. (a) For the frames shown in Figure 1(a), (b) and (c), check the corresponding statical determinacy.

Untuk struktur kerangka yang ditunjukkan dalam Rajah 1(a), (b) dan (c), semak kebolehtentuan statik untuk setiap satunya.

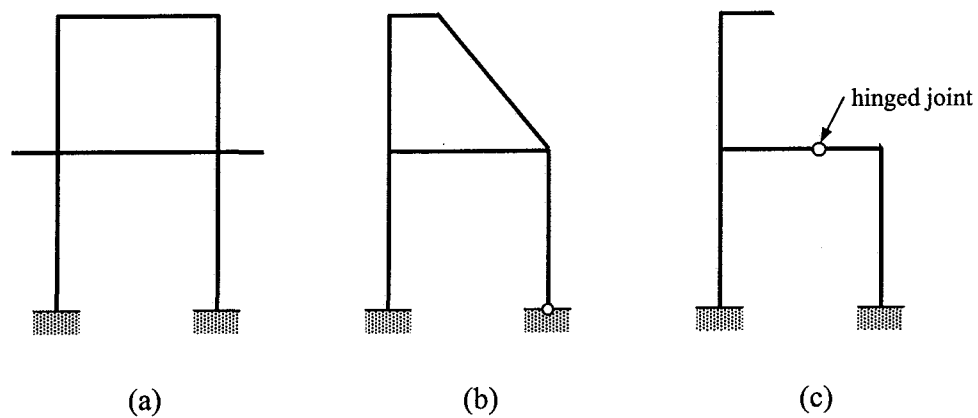


Figure 1

(6 marks)

- (b) Figure 2 shows a two-span beam with a hinge joint at B. The beam is supported at A by hinge support and both C and D by roller supports. Draw the corresponding shear force and bending moment diagrams. Sketch also the qualitative deflected shape.

Rajah 2 menunjukkan satu rasuk dua rentang dengan sambungan engsel dalam pada B. Rasuk berkenaan disokong oleh penyokong sendi pada A dan penyokong rola pada kedua-dua titik C dan D. Lukiskan gambarajah daya ricih dan momen lentur untuk rasuk berkenaan. Lakarkan juga bentuk pesongan kualitatif.

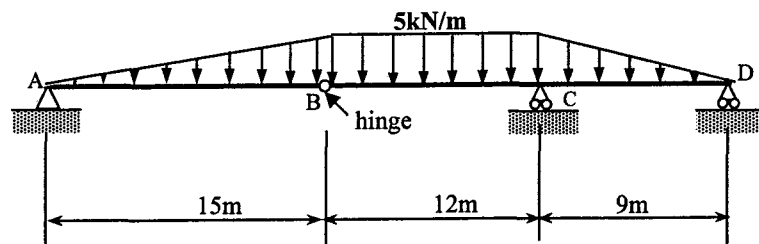


Figure 2

(14 marks)

2. The beam in Figure 3 has a moment of inertia of $210 \times 10^6 \text{ mm}^4$ is subjected to two concentrated loads of 100 kN and 50 kN at 2 m and 8 m from support A, respectively. Determine the slope and deflection at C. Use the Conjugate-Beam Method and take $E = 200 \text{ GPa}$.

Rasuk dalam Rajah 3 menanggung dua beban tumpu 100 kN dan 50 kN iaitu masing-masing 2 m dan 8 m daripada sokong A. Tentukan cerun dan lenturan rasuk di C dengan menggunakan Kaedah Rasuk-Konjugat. Nilai momen inerti rasuk ialah $210 \times 10^6 \text{ mm}^4$ dan $E = 200 \text{ GPa}$.

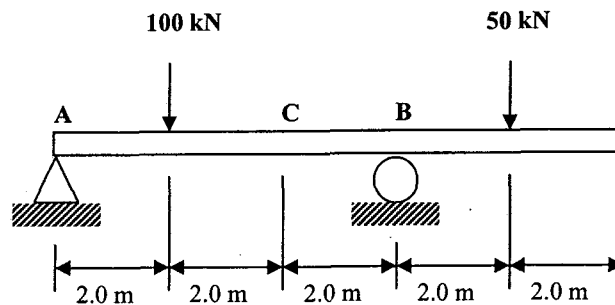


Figure 3

(20 marks)

3. (a) Figure 4(a) shows four different types plane trusses. Check for the statical determinacy of the trusses.

(4 marks)

Rajah 4(a) menunjukkan empat kekuda satah yang berbeza. Semak kebolehtentuan statik kekuda berkenaan.

- (b) Figure 4(b) shows a plane truss with pinned supports at A and G. Find the reactions at supports A and G. Identify any zero force member.

(7 marks)

Rajah 4(b) menunjukkan satu kekuda satah yang dicemat di penyokong A dan G. Kira nilai daya tindakbalas di penyokong A dan G. Kenalpasti anggota kekuda yang mungkin mempunyai daya sifar.

- (c) Determine the forces in member BC, AC and BD for the truss shown in Figure 4(b) by using section method and classify whether they are in tension or compression.

(7 marks)

Kira daya dalam anggota BC, FC, CD dan CG bagi kekuda dalam Rajah 4(b) menggunakan kaedah keratan. Nyatakan samaada anggota tersebut mengalami daya mampatan atau tegangan.

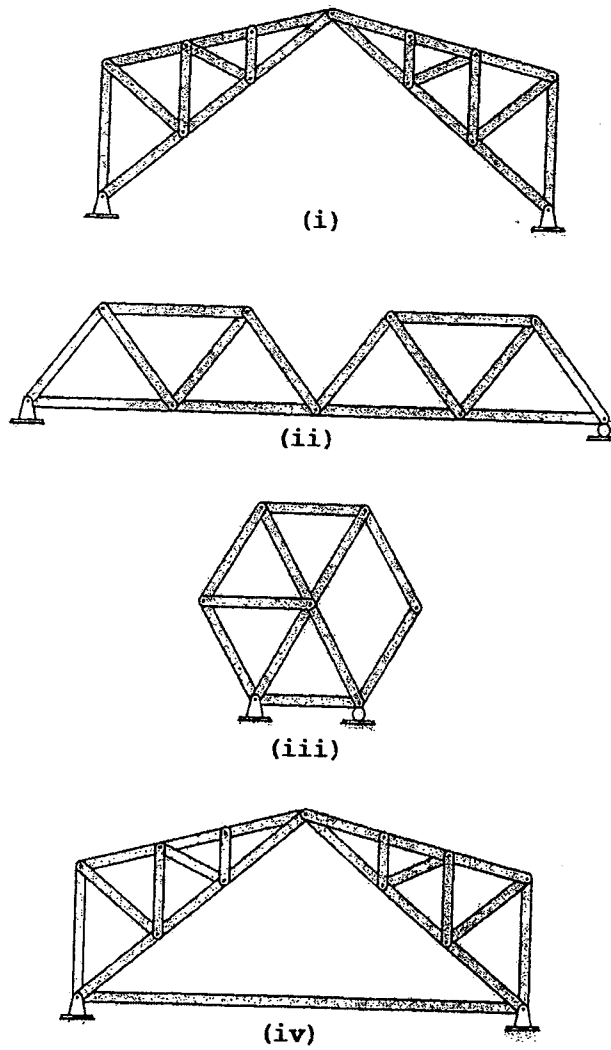


Figure 4(a)

3. (d) Determine the forces in member GF and FD for the truss shown in Figure 4(b) by using joint method. Classify whether they are in tension or compression. (2 marks)

Kira daya bagi anggota GF dan FD menggunakan kaedah sambungan. Nyatakan samada anggota tersebut mengalami daya mampatan atau tegangan.

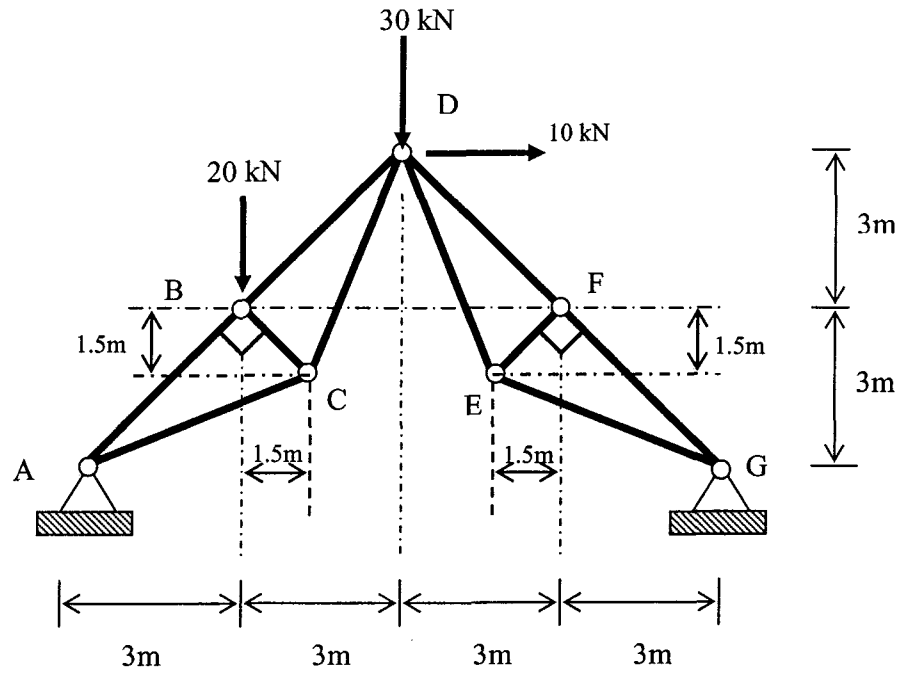


Figure 4(b)

PART B : Choose TWO (2) questions

4. (a) Describe briefly
- TWO (2)**
- characteristics of cables.

(2 marks)

Jelaskan dengan ringkas DUA (2) ciri kabel.

- (b) A symmetrical cable system shown in Figure 5 carries a uniformly distributed load of 3 kN/m and point loads of 20 kN and 40 kN between the supports A and B with a span of 40m. The lowest point of the cable is located at a distance of 8m vertically from the supports. Determine:

- the horizontal distance of the lowest point of the cable from supports.
- the maximum and minimum tension between A and B (T_{\min} and T_{\max}).
- the tension in anchor cables ($T_{A'}$ and $T_{B'}$) and vertical and horizontal reactions at supports (R_{VA} , R_{HA} and R_{VB} , R_{HB}). Repeat the calculations if the angle of anchor cable is reduced to 30° . State the relation between change in angle of anchor cable and tension in anchor cable.
- The allowable stress of the cable if the diameter of the circular cable is 0.1m.

(18 marks)

Satu sistem kabel simetri seperti yang ditunjukkan dalam Rajah 5, menanggung beban teragih seragam sebanyak 3 kN/m dan beban tumpu 20 kN dan 40 kN di sepanjang rentang antara kedua-dua penyokong A dan B yang berjarak 40m antara satu sama lain. Jarak menegak kedudukan terendah kabel ialah 8m daripada penyokong. Tentukan:

- Jarak mengufuk kedudukan terendah kabel daripada penyokong*
- nilai tegangan maksima dan minima kabel antara penyokong A dan B (T_{\min} dan T_{\max}).*
- tegangan kabel sauh ($T_{A'}$ dan $T_{B'}$) dan tindakbalas menegak dan mengufuk di penyokong (R_{VA} , R_{HA} dan R_{VB} , R_{HB}). Ulangi pengiraan sekiranya nilai sudut kabel sauh dikurangkan kepada 30° . Nyatakan hubungan antara perubahan sudut kabel sauh dengan tegangan kabel sauh.*
- tegasan kabel tersebut sekiranya garis pusat kabel bulat yang diperlukan ialah 0.1 m.*

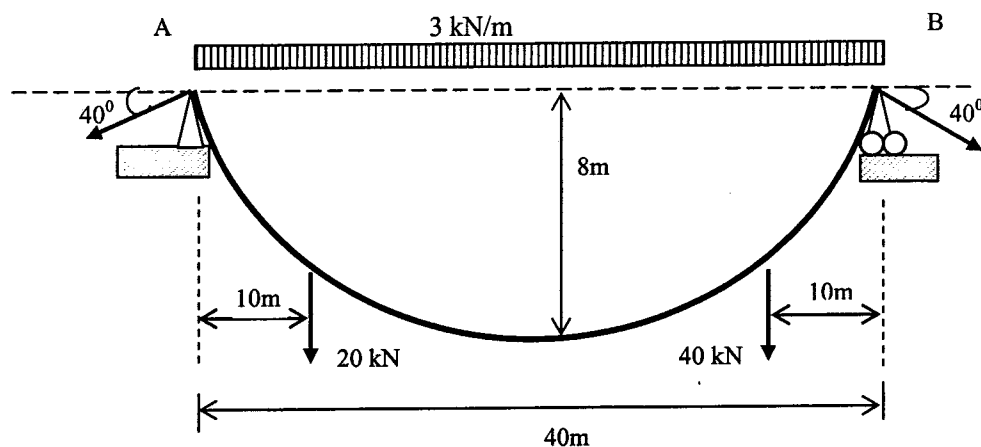


Figure 5

5. (a) What is the main difference between the arch structures and the cable structures? (2 marks)

Apakah perbezaan utama antara struktur gerbang dan struktur kabel?

- (b) Unsymmetrical three pinned arch shown in Figure 6 is in the form of $y = \frac{4hx(L-x)}{L^2}$, where $L = 40$ m and $h = 8$ m. Support A is 2.88m lower than support E. It is designed to carry a uniformly distributed load of 5 kN/m spanning 26m on span BCDE. A horizontal uniformly distributed load of 2 kN/m is applied from A to point B. 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 at point B and D (with loading).
- iv. Sketch the bending moment diagram of the arch.

(18 marks)

Gerbang tiga engsel tidak simetri dalam Rajah 6 dibentuk dari persamaan $y = \frac{4hx(L-x)}{L^2}$, iaitu $L = 40$ m dan $h = 8$ m. Penyokong A berada 2.88m ke bawah daripada penyokong E. Ia direkabentuk untuk membawa beban teragih seragam sebanyak 5 kN/m di sepanjang rentang 26m di bahagian BCDE. Beban teragih seragam mengufuk sebanyak 2 kN/m dikenakan sepanjang AB. 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 titik B dan D (dengan beban kenaan).
- iv. lakarkan rajah momen lentur untuk gerbang tersebut.

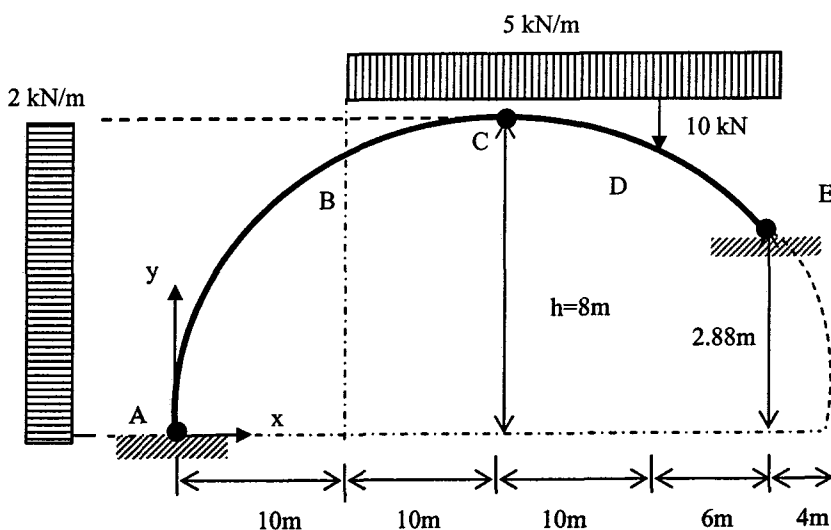


Figure 6

6. (a) Sketch the qualitative deflected shape for the beams shown in Figure 7(a) and (b). The corresponding bending moment diagram is shown directly beneath each beam.

Lakarkan bentuk pesongan kualitatif untuk rasuk yang ditunjukkan dalam Rajah 7(a) dan (b). Gambarajah momen lentur untuk setiap rasuk ditunjukkan di bawah setiap rasuk yang berkaitan.

(4 marks)

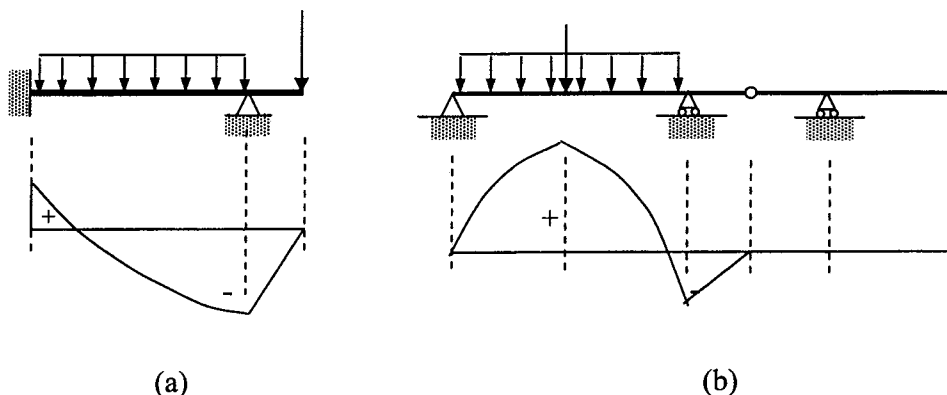


Figure 7

- (b) Figure 8 shows a frame with an internal hinge joint at C. It is supported by two hinge supports at A and E. Draw the corresponding shear force and bending moment diagrams. Sketch also the qualitative deflected shape.

Rajah 8 menunjukkan satu struktur kerangka dengan satu sambungan engsel dalaman pada C. Kerangka berkenaan disokong oleh dua penyokong sendi pada A dan E. Lukiskan gambarajah daya ricih dan momen lentur untuk kerangka berkenaan. Lakarkan juga bentuk pesongan kualitatif.

(16 marks)

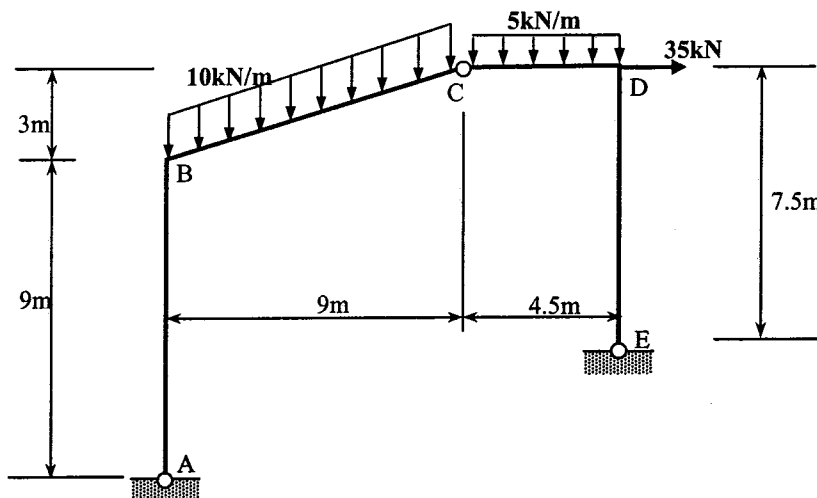


Figure 8

7. Draw the influence lines diagram for the vertical reaction at B and D, and bending moment at C of the beam shown in Figure 9(a) due to the moving loads which travel from A to E. The beam are supported by pinned at B and roller at D. Determine the maximum positive bending moment at C if the beam is subjected to the series of concentrated moving load as shown in Figure 9(b). Show all important values and equations of influence lines in the diagram.

Rajah 9(a) menunjukkan satu rasuk yang disokong pin di B dan rola di D. Lukiskan gambarajah garis imbas untuk tindakbalas tegak di B dan D, dan momen lentur di C. Tentukan momen lentur positif maksimum sekiranya beban yang ditanggung oleh rasuk ialah beban titik bersiri bergerak dari A ke E seperti ditunjukkan dalam Rajah 9(b). Nilai-nilai dan persamaan penting garis imbas mestilah ditunjukkan di gambarajah.

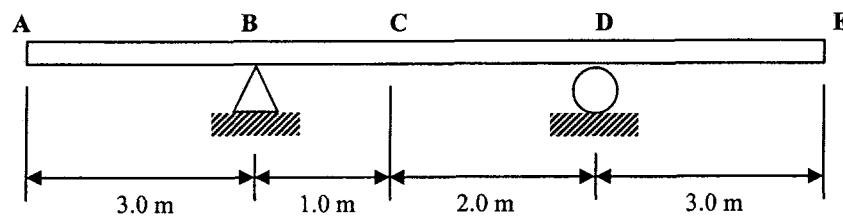


Figure 9(a)

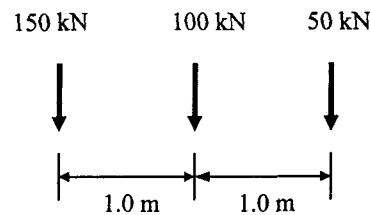
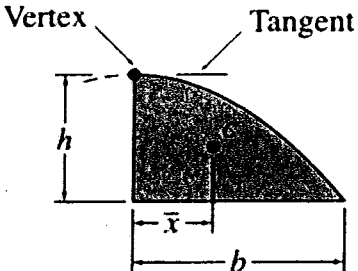
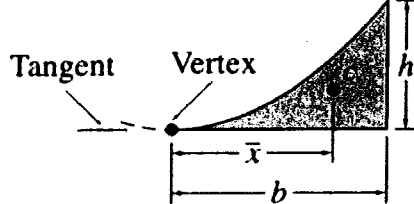
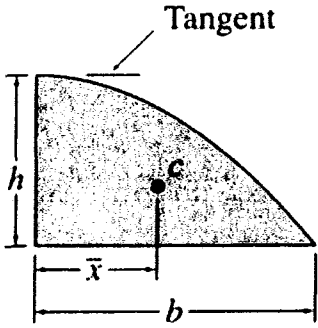
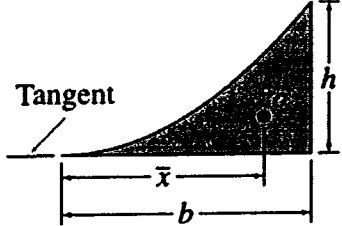


Figure 9(b)

(20 marks)

Areas and Centroids of Geometric Shapes

Shape	Area	Centroid
<p>Semi-parabola</p> 	$A = \frac{2bh}{3}$	$\bar{x} = \frac{3b}{8}$
<p>Parabolic spandrel</p> 	$A = \frac{bh}{3}$	$\bar{x} = \frac{3b}{4}$
<p>Cubic</p> 	$A = \frac{3bh}{4}$	$\bar{x} = \frac{2b}{5}$
<p>Cubic spandrel</p> 	$A = \frac{bh}{4}$	$\bar{x} = \frac{4b}{5}$