First Semester Examination
2017/2018 Academic Session

January 2018

EAS253 – Teori Struktur
(Theory of Structures)

Duration : 3 hours
(Masa : 3 jam)

Please check that this examination paper consists of ELEVEN (11) pages of printed material including appendix before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi SEBELAS (11) muka surat yang bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini].

Instructions: This paper contains ***SEVEN*** **(7)** questions. **PART A IS COMPULSORY** and answer **TWO (2)** questions in **PART B.**

[Arahan*: Kertas ini mengandungi* ***TUJUH (7)*** *soalan.* ***BAHAGIAN A WAJIB DIJAWAB*** *dan jawab* ***DUA (2)*** *soalan di* ***BAHAGIAN B****.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

PART A: Answer **ALL** questions.
BAHAGIAN A: *Jawab* ***SEMUA*** *soalan.*

1. **Figure 1** shows a beam structure with pinned support at A, roller supports at B, D and hinge joint at C. The beam is loaded with a uniformly distributed load 20 kN/m and 10 kN/m along spans AB and BD, respectively; and a point load of 10 kN at free end E. Draw the shear force and bending moment diagrams of the beam. Sketch also the qualitative deflected shape.

   Rajah 1 *menunjukkan satu struktur rasuk dengan penyokong pin di A, penyokong rola di B, D dan sambungan sendi di C. Rasuk berkenaan membawa beban teragih seragam 20 kN/m di sepanjang rentang AB , beban teragih seragam 10 kN/m di sepanjang rentang BD dan satu beban tertumpu 10 kN di hujung bebas E. Lukiskan gambarajah daya ricih dan momen lentur untuk rasuk berkenaan. Lakarkan juga bentuk terpesong kualitatif.*

   [*20 marks/markah*]

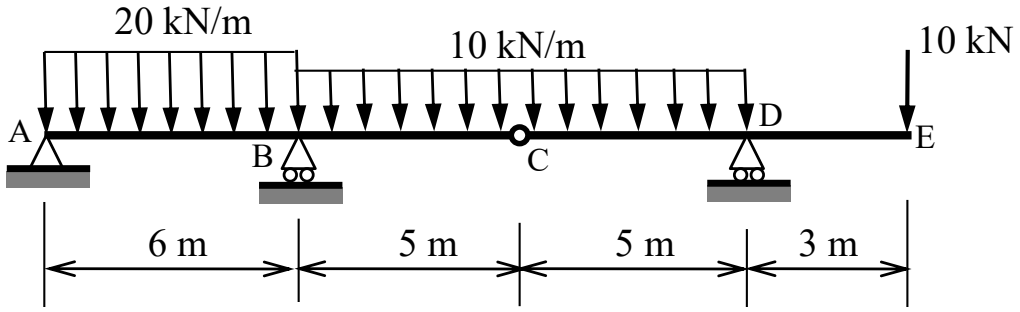


Figure 1/*Rajah 1*

2. (a). The moment-area method utilizes graphical interpretations of integrals involved in the solution of the deflection differential equation in terms of the areas and the moments of areas of the *M/EI* diagram. Use a beam subjected to arbitrary loading and equation relating the change in slope ($d\theta$) of the elastic curve over the differential length dx is given by $d\theta = \frac{M}{EI}\, dx$, derive the moment-area theorems.

Kaedah momen-luas menggunakan interpretasi grafik integral yang terlibat dalam penyelesaian bagi persamaan perbezaan pesongan dalam sebutan luas dan momen luas untuk gambarajah M/EI. Menggunakan rasuk yang dikenakan beban sembarangan dan perubahan dalam kecerunan ($d\theta$) bagi lengkung elastik terhadap jarak pembezaan, dx diberikan oleh $d\theta = \frac{M}{EI}\, dx$, dapatkan teorem momen-luas.

[6 marks/*markah*]

(b). A beam as shown in **Figure 2** is subjected to two point loads of 15 kN and 20 kN at points B and C, respectively, and a concentrated moment of 5 kNm at point A. Using E = 200 GPa and I = 150(10^6) mm^4, calculate the maximum deflection of the beam. Use either moment-area method or conjugate-beam method.

*Satu rasuk seperti yang ditunjukkan dalam **Rajah 2** dikenakan beban tumpu 15 kN dan 20 kN di titik B dan C dan momen tertumpu 5 kNm di titik A. Menggunakan E = 200 GPa dan I = 150(10^6) mm^4, kirakan pesongan maksimum rasuk tersebut. Guna kaedah momen-luas atau kaedah rasuk konjugat.*

[14 marks/*markah*]

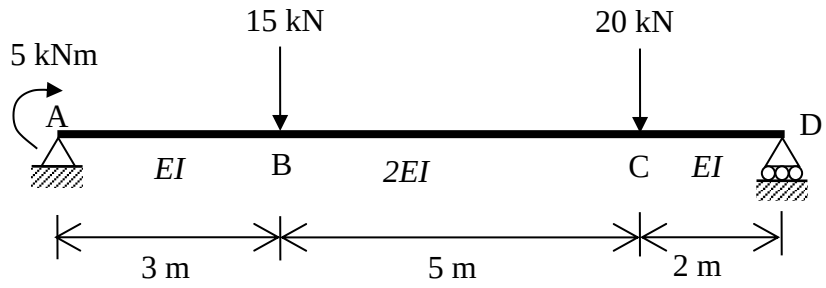


Figure 2/*Rajah 2*

...4/-

3. (a). **Figure 3** shows a plane truss for a pedestrian bridge deck. Check the statical determinacy of the truss. Support J is pinned and support A is roller. All member connections are pinned. Find the reactions at both supports and identify zero force members, if any. Determine forces in members EF, DG and DF by using section method and forces in members AC, AB and BC by using joint method. State whether they are in tension or compression.

Rajah 3 *menunjukkan satu kekuda satah geladak jambatan pejalan kaki. Semak kebolehtentuan statik kekuda berkenaan. Penyokong J adalah pin dan penyokong A adalah rola. Semua sambungan anggota adalah pin. Kira nilai daya tindakbalas di kedua-dua penyokong dan kenalpasti anggota kekuda yang mungkin mempunyai daya sifar, sekiranya ada. Kira daya dalam anggota EF, DG and DF menggunakan kaedah keratan dan daya dalam anggota AC, AB dan BC menggunakan kaedah sambungan. Nyatakan sama ada anggota tersebut mengalami daya mampatan atau tegangan.*

[16 marks/*markah*]

(b). If the arrangement of the members DF and FG in the truss shown in **Figure 3** is rearranged to become members EF and FH as shown in **Figure 4**, determine the changes of the forces in horizontal members EH and DF.

Sekiranya susunan anggota kekuda DF dan FG dalam ***Rajah 3*** *diubahsuai menjadi anggota EF dan FH seperti dalam* ***Rajah 4****, tentukan perubahan nilai daya dalam anggota mendatar EH dan DF.*

[4 marks/*markah*]

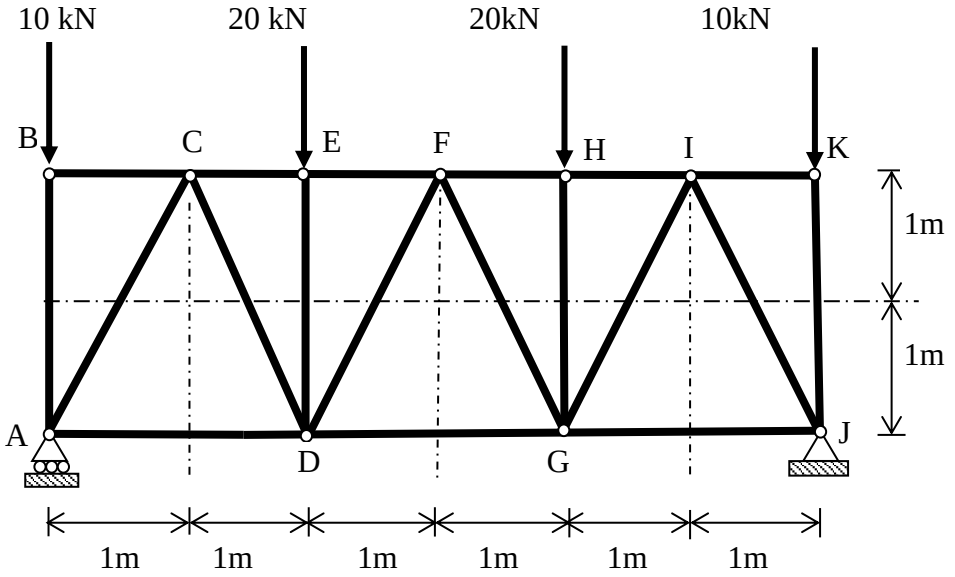


Figure 3/*Rajah 3*

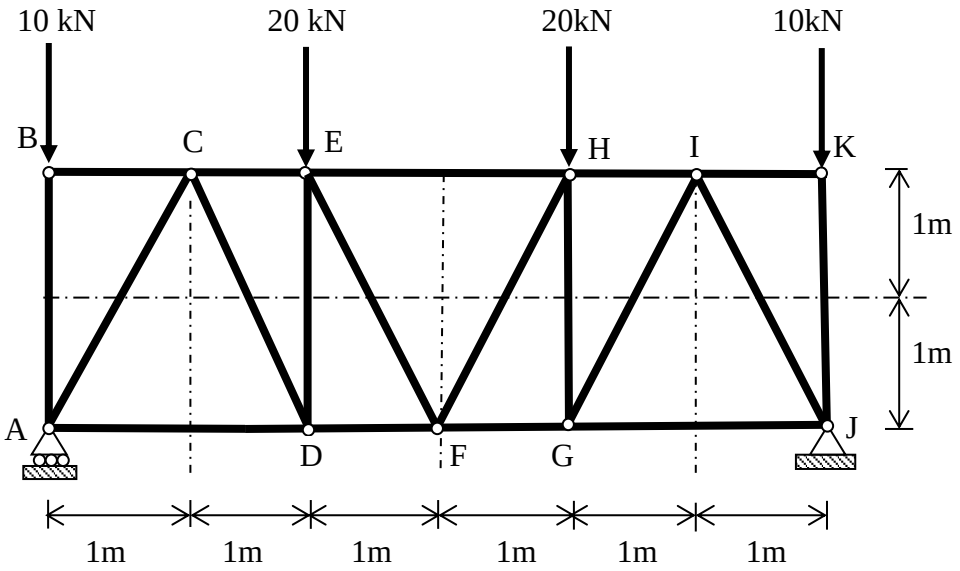


Figure 4/*Rajah 4*

PART B: Answer **TWO (2)** questions.
BAHAGIAN B: *Jawab* ***DUA (2)*** *soalan.*

4. **Figure 5** shows a two-member frame with pinned and roller supports at A and C, respectively. It is loaded by a uniformly distributed load 15 kN/m along inclined member BC, a horizontal concentrated load 25 kN and concentrated moment 5 kNm at joint B.

Rajah 5 *menunjukkan satu kerangka dua-anggota dengan penyokong pin dan penyokong rola di A dan di C. Kerangka berkenaan menyokong beban teragih seragam 15 kN/m di sepanjang anggota condong BC, beban tertumpu ufuk 25 kN dan momen tertumpu 5 kNm di B.*

(a). Draw the shear force and bending moment diagrams of the frame.

Lukiskan gambarajah daya ricih dan momen lentur untuk kerangka berkenaan.

(b). Calculate the axial force in inclined member AB.

Kirakan daya paksi dalam anggota condong AB.

(c). Sketch the qualitative deflected shape.

Lakarkan bentuk terpesong kualitatif.

[*20 marks/markah*]

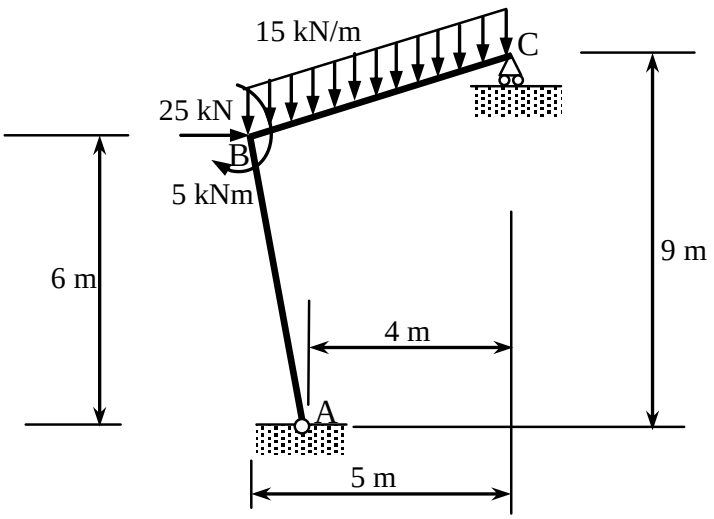


Figure 5/*Rajah 5*

...7/-

5. (a). **Figure 6** shows a bridge girder which is constructed to allow vehicle to travel on it. Point E is an internal hinge. Draw the influence lines for

Rajah 6 *menunjukkan satu galang jambatan yang dibina untuk membenarkan kenderaan melaluinya. Titik E ialah sambungan sendi dalaman. Lukis garis imbas untuk*

(i). the vertical reactions at supports B and F,

tindakbalas pugak di penyokong B dan F,

(ii). the shear force at point B which is just to the right of support, and

daya ricih di titik B yang berada hanya sedikit kanan penyokong, dan

(iii). the bending moment at point C.

momen lentur di titik C.

[16 marks/*markah*]

(b). Determine the maximum values of the shear force at point B which is just to the right of support and bending moment at point C due to a truck travels from point A to point F.

Tentukan nilai maksimum untuk daya ricih di titik B yang berada hanya sedikit kanan penyokong dan momen lentur di titik C disebabkan sebuah lori yang bergerak dari titik A ke titik F.

[4 marks/*markah*]

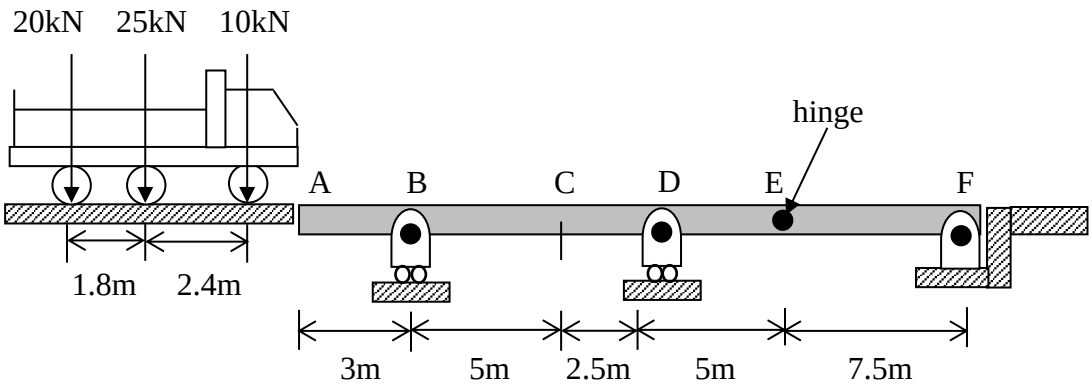


Figure 6/*Rajah 6*

6. The cable system shown in **Figure 7** carries a uniformly distributed load of 15 kN/m between the supports and two point loads of 10 kN and 20 kN at 10 m away from both supports 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:

*Satu sistem kabel seperti yang ditunjukkan dalam **Rajah 7**, menanggung beban teragih seragam sebanyak 15 kN/m di sepanjang rentang antara kedua-dua penyokong dan dua beban tumpu 10 kN dan 20 kN yang berjarak 10 m masing-masing dari kedua-dua penyokong A dan B. Jarak ufuk antara penyokong ialah 50 m dan jarak menegak dari titik terendah dan penyokong di sebelah kiri ialah 3 m. Penyokong di sebelah kanan berada 6 m lebih tinggi daripada penyokong kiri. Tentukan:*

(a). the lowest point of the cable (*x*).

kedudukan titik terendah kabel (x).

(b). the maximum and minimum tension in cable between A and B (T_{max} and T_{min}).

nilai tegangan maksimum dan minimum kabel antara penyokong A dan B (T_{max} dan T_{min}).

(c). the tension in anchor cables (T_A' and T_B').

tegangan kabel sauh (T_A' dan T_B').

(d). vertical and horizontal reactions at supports (R_{vA}, R_{HA} and R_{vB}, R_{HB}).

tindakbalas menegak dan mengufuk di penyokong (R_{vA}, R_{HA} dan R_{vB} , R_{HB}).

(e). minimum size of the cable, if the allowable stress is 15500 kN/m^2.

saiz minima kabel yang diperlukan sekiranya tegasan kabel dibenarkan ialah 15500 kN/m^2.

[20 marks/*markah*]

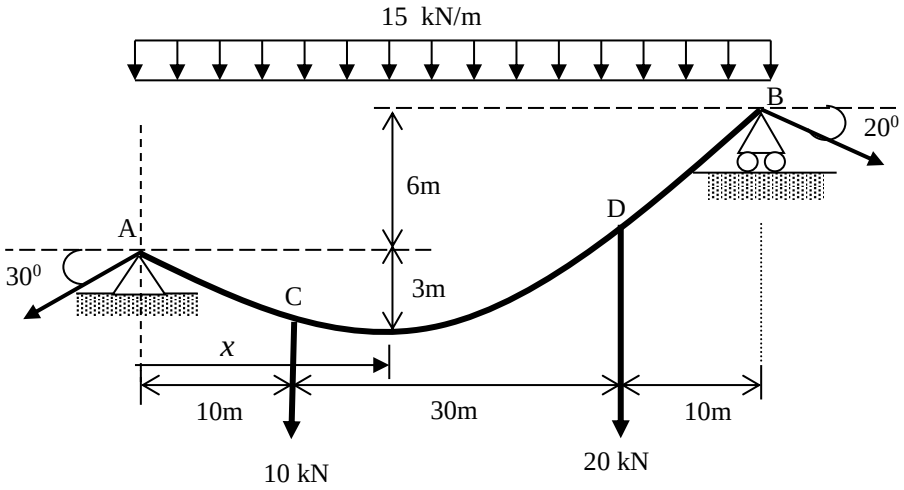


Figure 7/*Rajah 7*

7. (a). What is the main difference between arch structures and cable structures?

Apakah perbezaan utama antara struktur gerbang dan struktur kabel?

[2 marks/*markah*]

(b). Unsymmetrical three pinned arch shown in **Figure 8** is in the form of $y = \frac{4hx\,(L-x)}{L^2}$, where L = 40 m and h = 8 m. Support A is 2.88 m lower than support E. It is designed to carry a uniformly distributed load of 5 kN/m spanning 26 m on span BCDE and a point load of 10 kN at D. A horizontal point load of 20 kN is applied at point B. Joints A, C and E are hinged.

*Gerbang tiga engsel tidak simetri dalam **Rajah 8** dibentuk dari persamaan* $y = \frac{4hx\,(L-x)}{L^2}$ *di mana L = 40 m dan h = 8 m. Penyokong A berada 2.88 m ke bawah daripada penyokong E. Ia direkabentuk untuk membawa beban teragih seragam sebanyak 5 kN/m di sepanjang rentang 26 m di bahagian BCDE dan beban tegak sebanyak 10 kN di titik D. Beban mengufuk sebanyak 20 kN dikenakan di titik B. Sambungan A, C dan E ialah engsel.*

...10/-

Determine:

Tentukan:

(i). support reactions at A and E.

daya tindakbalas di penyokong A dan E.

(ii). bending moment at points B and D.

momen lentur di titik B dan D.

(iii). shear force, Q and thrust, N at points B and D (with loading).

daya ricih, Q dan daya paksi N di titik B dan D (dengan beban kenaan)

(iv). sketch the bending moment diagram of the arch.

lakarkan rajah moment lentur untuk gerbang tersebut.

[18 marks/*markah*]

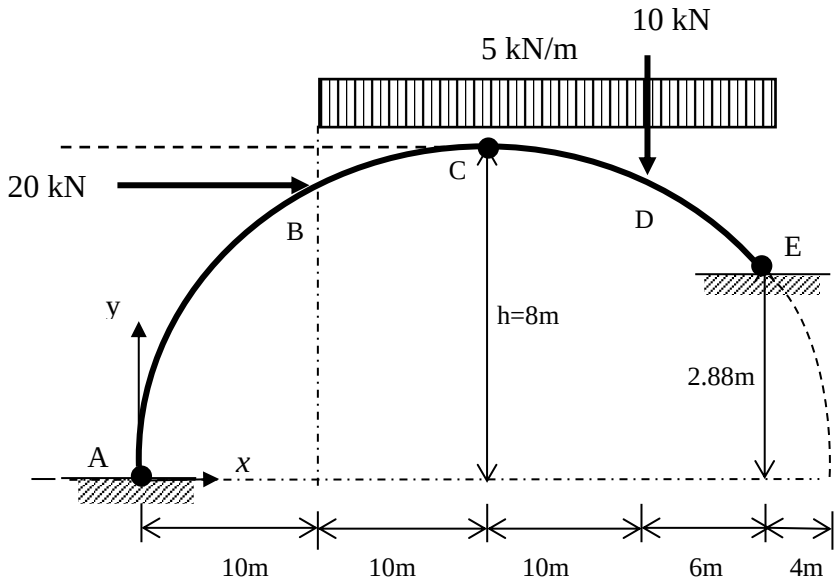
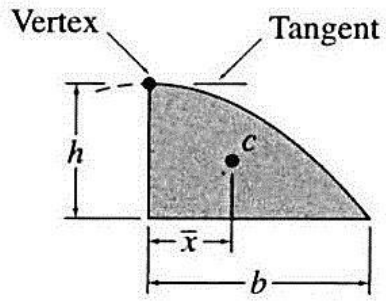
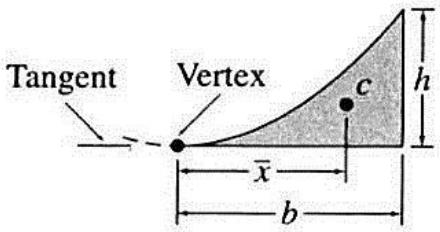
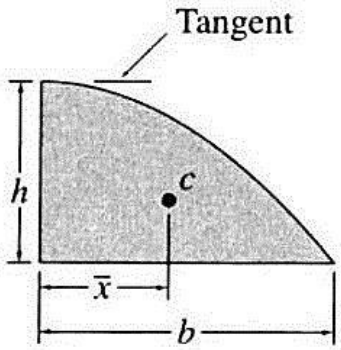
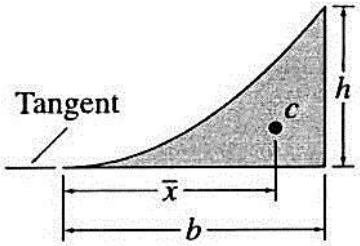


***Figure 8*/Rajah 8**

Areas and Centroids of Geometric Shapes

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

-oooOooo-