UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	STEEL STRUCTURE AND TIMBER DESIGN
COURSE CODE	:	BFC 4033/ BFC 43003
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **THREE (3)** QUESTIONS IN **PART A** AND **ONE (1)** QUESTION IN **PART B** DESIGN SHOULD BE BASED ON BS 5950: Part 1: 2000 MS 544 : Part 2 : 2001

THIS QUESTION PAPER CONSISTS OF **SIXTEEN (16)** PAGES

PART A (ANSWER THREE QUESTIONS ONLY)

Q1   A beam size of 457 x 152 x 74 UB GRADE S275 steel grade is subjected to the pair of point loads at point B and C transferred by cross beams as shown in Figure **Q1**. The cross beams may reasonably be assumed to provide full lateral and torsional restrained at B and C and further assumption that at point A and D are similarly restrained.

   (a)   Draw the shear force (SFD) and bending moment (BMD) diagrams.

(6 marks)

   (b)   Calculate the lateral torsional buckling resistance moment, M_b.

(9 marks)

   (c)   Check the adequacy of web bearing and web buckling under point load at B if the cross beam is 305 x 127 x 37 UB grade S275. Assume the cross beams are located at top of the main beam.

(10 marks)

Q2   Figure **Q2** shows the elevations of two-storey warehouse structure.
   Given the design data:
         Rolled section for column B2 :   254 x 254 x 73 UC S275
         End reactions of column B2 from:

                  Beam B/1-2   : 240 kN
                  Beam B/2-3   : 125 kN
                  Beam 2/A-B   : 80 kN
                  Beam 2/B-C   : 45 kN

   (a)   Classify the section classification of column B2

(5marks)

   (b)   Prepare checking for compression resistance of the section.

(7 marks)

   (c)   Analyse the nominal moments due to eccentricity.

(6 marks)

   (d)   Produce design calculations for the combined axial force and moment checking.

(7 marks)

Q3 (a) The detailing of beam to column connection is shown in Figure **Q3 (a)**. Check whether the connection at the end of the beam is able to transmit the ultimate shear force of 200 kN. Given tensile area, $A_t = 245$ mm^2.

(13 marks)

(b) A steel section 533 x 210 x 92 UB is used for bracket connection as shown in Figure **Q3(b)**. The bracket is connected to the column of 305 x 305 x 118 UC with 6 mm weld using electrode E35. Determine the load, P that can be carried by the bracket. Assume center of rotation to be at x-x axis and eccentricity, e = 250 mm.

(12 marks)

Q4 Figure **Q4** shows the roof structure for a factory. The truss spacing is 4.5 m and the span is 24 m with 3.0 m truss depth at the apex. Table **Q4** shows the internal forces for selected truss members. The dead and imposed loads are given as follows;

Weight of insulation and purlins (on slope)	= 0.5 kN/m^2
Corrugated steel sheeting (on slope)	= 0.6 kN/m^2
Self-weight of truss (on slope)	= 0.25 kN/m^2
Imposed load (on plan)	= 0.75 kN/m^2

All the connections are welded.

(a) Determine point load, P at the purlins

(5 marks)

(b) Design the purlins using rectangular hollow section (RHS)

(5 marks)

$2/150 \times 90 \times 10$

(c) Check whether double angle 2/200 x 150 x 12 is suitable for member AB.

(8 marks)

(d) Check whether double angle 2/200 x 150 x 12 is suitable for member AM.

(7 marks)

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PART B (ANSWER ONLY ONE QUESTION ONLY)

Q5 (a) List **THREE (3)** group of Malaysian hardwood.

(3 marks)

(b) Figure **Q5** shows an electrical transmission timber post holding 2.5 kN of cable load at the end of cantilever beam about 1.0 m from column centroid. If the column is restrained at one end in position and direction but free at the other end, provide design calculation for:

Given:
Duration of loading   : Long term
Moisture content   : > 19%
Species   : Merbau
Timber grade   : Standard
Finished column size : 125 mm x 125 mm

(i) Axial capacity of the column.

(8 marks)

(ii) Bending capacity of the column.

(6 marks)

(iii) Combination of axial and bending capacities of the column.

(4 marks)

(c) Recommend a method to encourage people to choose timber as structural materials

(4 marks)

Q6 (a) Briefly explain about fiber saturation point.

(4 marks)

(b) Figure **Q6** shows a simple truss subjected to concentrated loads at all joints and mid-member of AB and BC. Produce design calculations for:

Given:
Dead load on rafter (on slope)   : 0.50 kN/m^2
Imposed load on rafter (on slope) : 0.75 kN/m^2
Dead load on ceiling (on plan)   : 0.25 kN/m^2
Imposed load on ceiling (on plan) : 0.75 kN/m^2
Duration of loading   : Medium term

Moisture content	: > 19%
Species	: Kapur
Timber grade	: Standard
Finished member size	: 45 mm x 95mm
Length, L	: 4 m
Truss spacing	: 0.6 mm
Purlin spacing	: 1.04 m

(i) Axial capacity of member AF.

(8 marks)

(ii) Bending capacity by taking $M_{max} = wL^2/32$ at joint F.

(6 marks)

(iii) Combination of axial and bending capacities.

(4 marks)

(c) Recommend a method to increase timber uses in structural application, but at the same time protecting forest against extinction.

(3 marks)

BAHAGIAN A (JAWAB TIGA SOALAN SAHAJA)

S1   Satu rasuk bersaiz 457 x 152 x 74 UB dengan gred keluli S275 dikenakan beban tumpu pada titik B dan C yang dipindahkan oleh rasuk melintang seperti di dalam Rajah **Q1**. Rasuk melintang boleh diandaikan menyediakan halangan sisi dan kilasan pada titik B dan C dan andaian halangan yang sama pada titik A and D.

(a)   Lukiskan gambarajah daya ricih (GDR) dan momen lentur (GML).

(6 markah)

(b)   Kirakan momen rintangan lengkokan sisi, M_b.

(9 markah)

(a)   Semak keupayaan galas web dan lengkokan web pada beban tumpu di titik B jika rasuk melintang ialah 305 x 127 x 37 UB gred S275. Anggap rasuk melintang berada di atas rasuk utama.

(10 marks)

S2   Rajah **Q2** menunjukkan struktur gudang dua tingkat. Diberikan data rekabentuk seperti berikut:

Keratan tergelek bagi tiang B2 :   254 x 254 x 73 UC S275
Tindakbalas hujung tiang B2 dari:

Rasuk B/1-2	: 240 kN
Rasuk B/2-3	: 125 kN
Rasuk 2/A-B	: 80 kN
Rasuk 2/B-C	: 45 kN

(a)   Lakukan pengkelasan keratan bagi tiang B2.

(5 markah)

(b)   Semakan rintangan mampatan bagi tiang tersebut.

(7 markah)

(c)   Analysis nominal moment disebabkan kesipian.

(6 markah)

(d)   Hasilkan rekabentuk pengiraan bagi semakan kombinasi beban paksi dan momen.

(7 markah)

S3 (a) Perincian sambungan rasuk-tiang ditunjukkan pada Rajah **Q3(a)**. Semak samada sambungan pada hujung rasuk tersebut mampu untuk mengagihkan daya ricih muktamad 200 kN. DIberika keluasan tegangan, $A_t = 245$ mm^2

(12 markah)

(b) Keratan keluli 533 x 210 x 92 UB digunakan sebagai pendakap untuk sambungan seperti dalam Rajah **Q3(b)**. Sambungan pendakap pada tiang yang bersaiz 305 x 305 x 118 UC dengan 6 mm kimpalan menggunakan elektrod E35. Tentukan beban, P yang boleh ditanggung oleh pendakap. Anggap pusat putaran pada paksi x-x dan kesipian, e = 250 mm.

(13 markah)

S4 Rajah **Q4** menunjukkan kekuda bumbung untuk sebuah kilang. Jarak diantara kekuda ialah 5 m dan rentang kekuda ialah 24 m dengan ketinggian 3 m dipuncaknya. Beban mati dan kenaan adalah seperti berikut:

Lapisan penebat dan berat gulung-gulung	= 0.5 kN/m^2
Kepingan keluli bumbung berombak	= 0.6 kN/m^2
Berat kekuda	= 0.25 kN/m^2
Beban kenaan	= 0.75 kN/m^2

Semua sambungan adalah secara cara kimpalan.

(a) Tentukan nilai beban tumpu, P pada gulung-gulung,

(5 markah)

(b) Rekabentuk gulung-gulung menggunakan keratan sesiku

(5 markah)

(c) Semak samada keratan sesiku kembar 2/150 x 90 x 10 sesuai digunakan untuk anggota AB.

(8 markah)

(d) Semak samada keratan 2/150 x 90 x 10 sesuai digunakan untuk anggota AM.

(7 markah)

BAHAGIAN B (JAWAB SATU SOALAN SAHAJA)

S5   (a)   Senaraikan **TIGA (3)** kumpulan kayu keras Malaysia.

(3 markah)

         (b)   Rajah **S5** menunjukkan satu tiang transmisi elektrik yang menyokong 2.5 kN beban kabel pada hujung rasuk julur sepanjang 1.0 m dari pusat tiang. Sekiranya tiang dikekang pada satu hujung pada kedudukan dan arah tetapi bebas pada hujung lain, hasilkan pengiraan rekabentuk bagi:

                Diberi:
                Tempoh pembebanan : Jangka panjang
                Kandungan lembapan : > 19%
                Spesis   : Merbau
                Gred kayu   : *Standard*
                Saiz sebenar tiang   : 125 mm x 125 mm

             (i)   Keupayaan paksi tiang.

(8 markah)

             (ii)   Keupayaan lenturan tiang.

(6 markah)

             (iii)   Gabungan keupayaan paksi dan lenturan tiang.

(4 markah)

         (c)   Cadangkan satu kaedah untuk menggalakkan orang ramai memilih kayu sebagai bahan struktur.

(4 markah)

S6   (a)   Terangkan secara ringkas tentang titik tepu fiber.

(4 markah)

         (b)   Rajah **S6** menunjukkan kekuda mudah ditindaki kepada beban tumpu pada semua sambungan dan di pertengahan anggota AB dan BC. Hasil pengiraan untuk:

                Diberi :
                Beban mati pada kasau (pada cerun)   : 0.50 kN/m^2
                Beban kenaan pada kasau (pada cerun)   : 0.75 kN/m^2
                Beban mati pada siling (pada plan)   : 0.25 kN/m^2

Beban kenaan pada siling (pada plan)	: 0.75 kN/m^2
Tempoh pembebanan	: Jangka sederhana
Kandungan lembapan	: > 19%
Spesis	: Kapur
Gred Kayu	: *Standard*
Saiz anggota sebenar	: 45 mm x 95mm
Jarak, L	: 4 m
Jarak kekuda	: 0.6 m
Jarak gulung-gulung	: 1.04 m

(i)   Keupayaan paksi anggota AF.

(8 markah)

(ii)   Keupayaan lenturan dengan mengambil $M_{max} = wL^2/32$ pada sambungan F.

(6 markah)

(iii)   Gabungan keupayaan paksi dan lenturan.

(4 markah)

(c)   Cadangkan satu kaedah bagaimana untuk meningkatkan penggunaan kayu dalam aplikasi struktur dan pada masa yang sama melindungi hutan terhadap kepupusan.

(3 markah)

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457 x 152 x 74 UB

145 kN   115 kN

A   B   C   D

152 x 152 x 23 UC

3 m   3 m   3 m
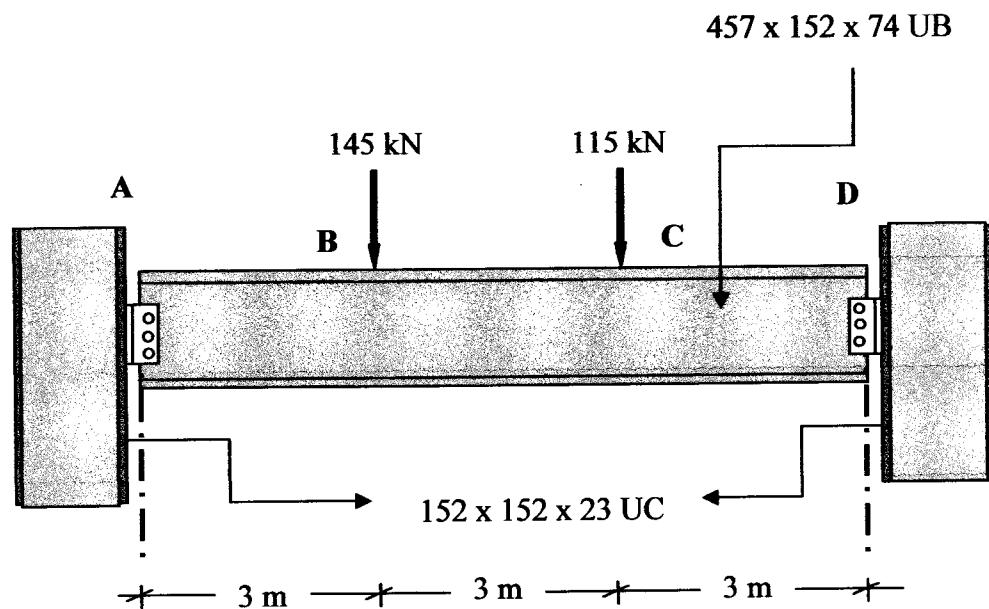
FIGURE Q1

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*All joints are assumed to be pinned*

4 m

6 m

Front Elevation

Ⓐ

Ⓑ

Ⓒ

13 m   6 m

① ② ③

Floor Plan

Beam 2/ A-B

Beam B/ 1-2   Beam B/ 2-3

Beam 2/ B-C
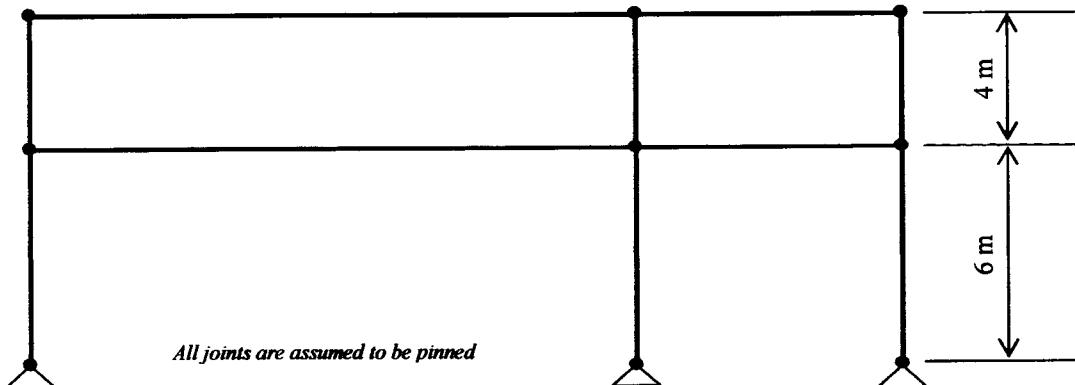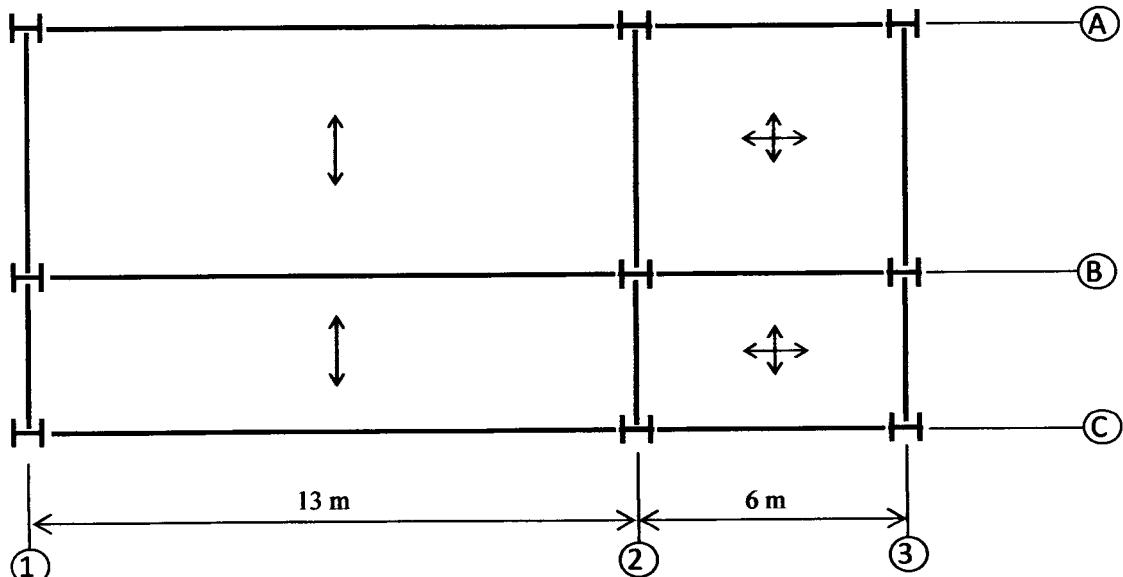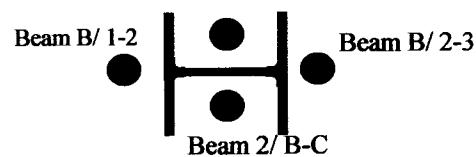
**FIGURE Q2**

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200 kN

50 mm

$d_{bolt} = 20$ mm
grade 8.8

100 mm

$e = 50$
150
150
$e = 50$

Beam with web
thickness is 6.9 mm

Plan view

colum

2 nos 90 x 90 x 10L with
400 mm long angle cleat
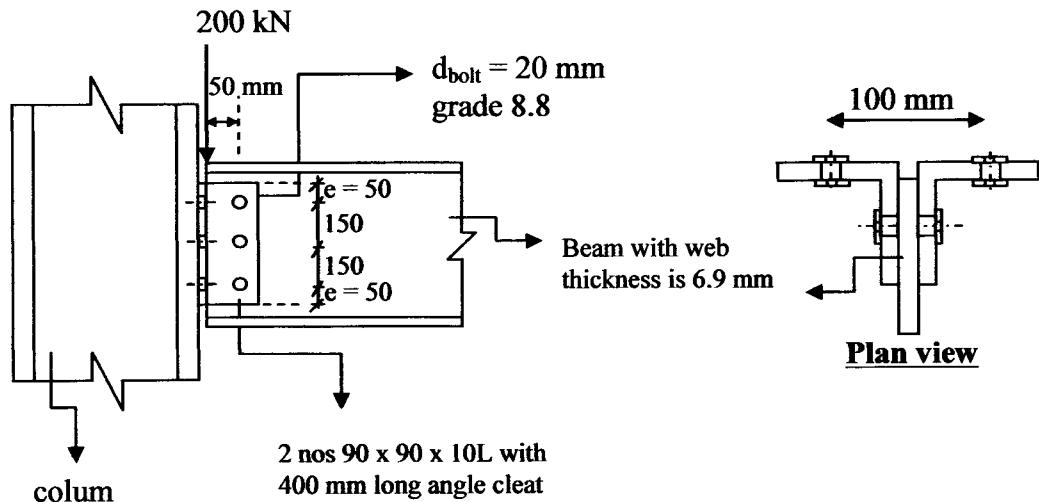
Elevation view

FIGURE Q3(a)
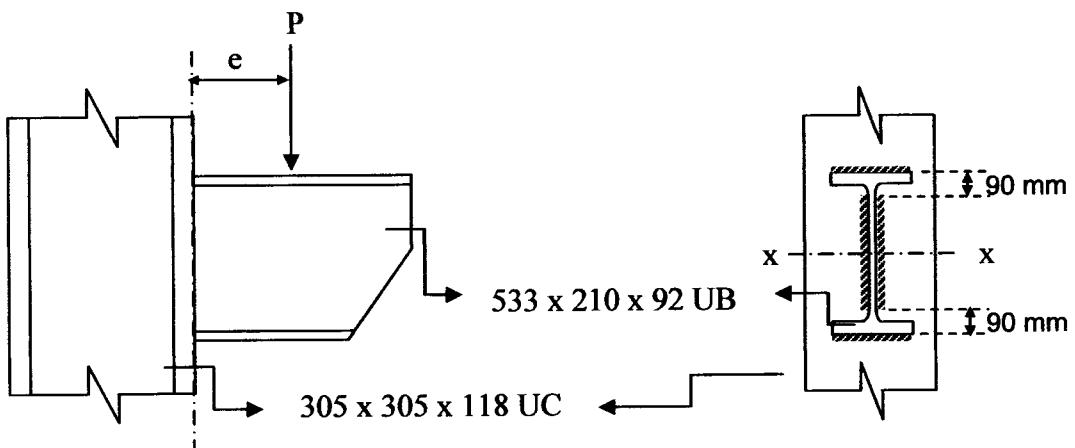
P

e

533 x 210 x 92 UB

90 mm

x   x

90 mm

305 x 305 x 118 UC

FIGURE Q3(b)

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FIGURE Q4

TABLE Q4

Member	Internal force (kN)
AB	-630.8
BC	-504.3
CD	-504.7
AM	612
ML	612
LK	244.8
BM, DK	0
BL	-126.1
CL	-61.2
LD	153

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Plan View

y

x   x

y

1 m

Bolts

Assume
rigid joint   2.5 kN

3 m

Front View
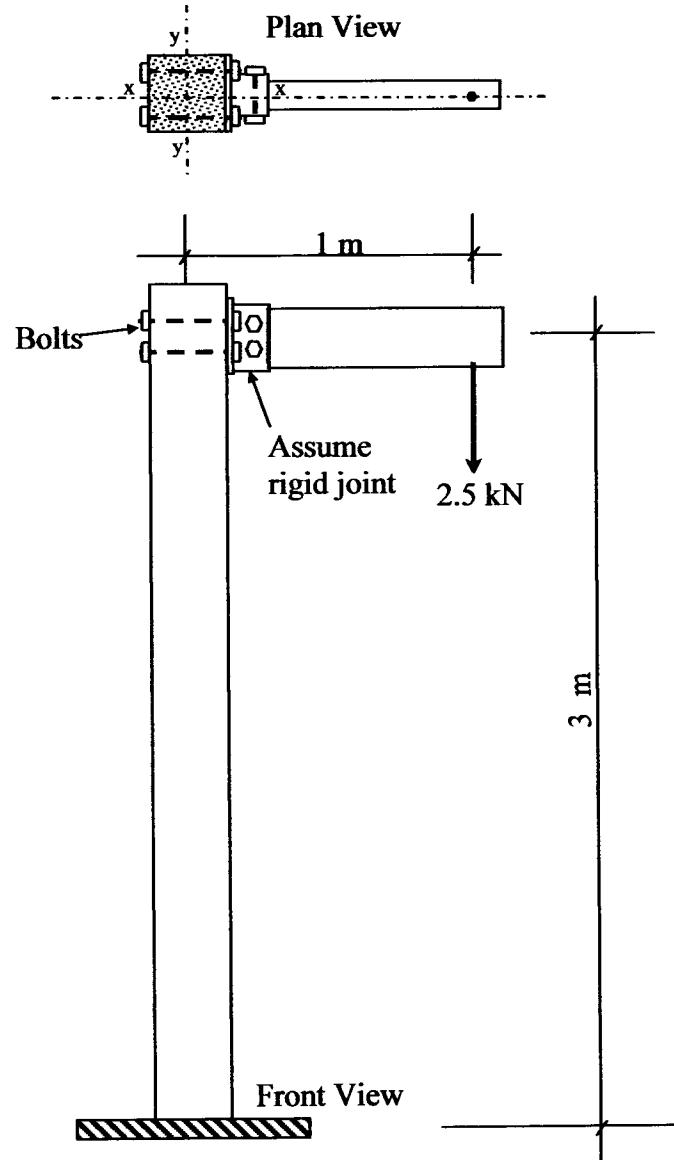
FIGURE Q5

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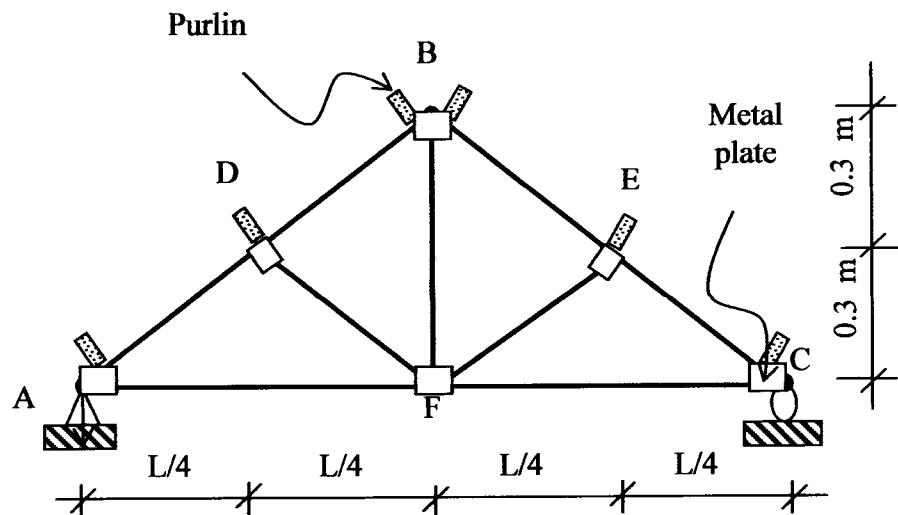
FIGURE Q6

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Rasuk dan beban	Momen maksimum	Pesongan di pertengahan rentang
W at midspan, $L/2$ | $L/2$, reactions $W/2$	$WL/4$	$\dfrac{WL^3}{48EI}$
W distributed over L, reactions $W/2$	$WL/8$	$\dfrac{5WL^3}{384EI}$
W at distance a, b; reactions $\dfrac{Wb}{L}$, $\dfrac{Wa}{L}$	Wab/L	$\dfrac{WL^3}{48EI}\left[\dfrac{3a}{L}-4\left(\dfrac{a}{L}\right)^3\right]$
W over middle b; segments a, b, c; reactions $\dfrac{W}{2}$	$W\left(\dfrac{a}{2}+\dfrac{b}{8}\right)$	$\dfrac{W}{384EI}\left[8L^3-4Lb^2+b^3\right]$
Trapezoidal $W/2$, W/a, $W/2$; segments a, b, a; reactions $\dfrac{W}{2}$	$Wa/3$	$\dfrac{Wa}{120EI}\left[16a^2+20ab+5b^2\right]$
Triangular $2W/L$; span L; reactions $\dfrac{W}{2}$	$WL/6$	$\dfrac{WL^3}{60EI}$
Double triangular $W/2$, $W/2$, $W/2$; $L/2$ | $L/2$; reactions $\dfrac{W}{2}$	$WL/8$	$\dfrac{WL^3}{73.14EI}$
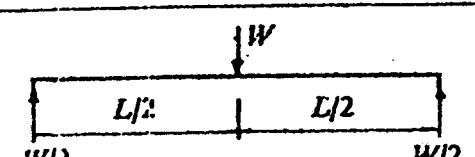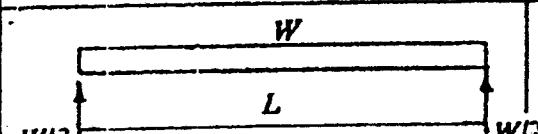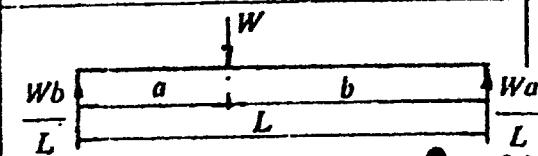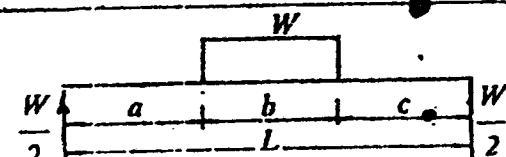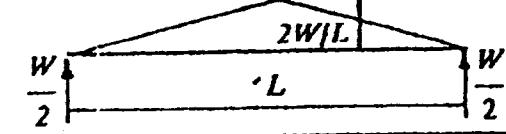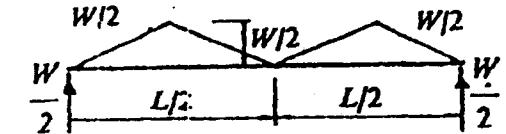
Rasuk-rasuk tersokong mudah: momen-momen maksimum dan pesongan-pesongan