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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2013/2014

COURSE NAME	:	STEEL AND TIMBER STRUCTURE DESIGN
COURSE CODE	:	BFC4033/BFC43003
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	DECEMBER 2013/JANUARY 2014
DURATION	:	3 HOURS
INSTRUCTION	:	A) ANSWER **THREE (3)** QUESTIONS B) ANSWER **ALL** QUESTIONS ALL DESIGN WORKS SHOULD BE BASED ON RELEVENT DESIGN CODES

THIS QUESTION PAPER CONSISTS OF **ELEVEN (11)** PAGES

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SECTION A

Q1 A 406 x 178 x 54 UB of grade S275 and span 7.5 m is used to support a timber floor. The end supports of the simply supported beam are connected through the double angle web cleat as shown in Figure **Q1**.

(a) Classify the respective I-section beam in accordance with BS EN 1993-1-1
(4 marks)

(b) Determine the effective length of the beam
(1 marks)

(c) Determine the moment buckling resistant, $M_{b, Rd}$.
(15 marks)

(d) Calculate the maximum factored design load in kN/m that the beam can safely carry by assuming the moment buckling resistant, $M_{b,Rd}$ governed. Noted: The beam is simply supported beam and loaded with uniform distributed load from timber floor.
(5 marks)

Q2 A 7.5 m column is under simple construction and subjected to a combined bending and axial force as shown in Figure **Q2**. The end condition of the column is effectively held in position at both ends but only restrained in direction at the bottom.

(a) Explain briefly the term of simple construction.
(4 marks)

(e) Check the suitability of a 254 x 254 x 73 UC with steel grade S275 against section resistance is not exhibit class 4.
(5 marks)

(f) Check axial buckling resistance, lateral torsional buckling resistance and bending resistance if the column satisfies all requirements under simple construction. Assume the ultimate load due to self-weight of column is 6 kN.
(16 marks)

Q3 (a) Calculate the tensile strength of the bar as shown in Figure **Q3 (a)** that connected together with a lap splice to form a tie.

(10 marks)

(b) Figure **Q3 (b)** shows a truss system of an commercial building. From the analysis, member AB is subjected to a tension force of 450kN and member CD is subjected to a 400kN of compression force. All joints are pinned connected.

i) Check the adequacy of a single angle of 150x150x15L for tension member if it is connected using a single row of 3 nos of 16mm diameter rivet with Grade 4.6 and distance between rivet is 40mm.

(5 marks)

ii) Check the compression and buckling resistance of the compression member if the same cross-section was used.

(10 marks)

Use steel grade S275, $\gamma_{M0} = \gamma_{M1} = 1.0$ and $\gamma_{M2} = 1.25$

Q4 (a) Check whether the connection shown in Figure **4(a)** is safe to be used to carry a permanent action of 65kN and a variable action of 90kN. Use steel grade S355 and 10 mm thickness.

(15 marks)

(b) If the same cross-section was connected using 10 nos. of 20mm bolt Grade 5.6 to carry the same loading as shown in Figure **4(b)**, check shear resistance of the bolt. Use $\gamma_{M0} = \gamma_{M1} = 1.0$ and $\gamma_{M2} = 1.25$.

(10 marks)

PART B

Q5 (a) Propose **Two (2)** methods to promote the use of timber as building structures.

(2 marks)

(b) Describe briefly **Three (3)** modification factors in to timber beam design.

(3 marks)

(c) Design the solid timber beam based on the data given. The beam depth is restricted to 200 mm. The design must satisfy bending, shear and deflection requirements.

Beam span	=	6 m
Beam spacing	=	0.5 m
Live load	=	1.5 kN/m^2
Total dead load	=	0.75 kN/m^2
Timber Grade	=	SG3, standard grade, dry

(10 marks)

(d) Consider a timber column of 4.5 m height subjected to a total axial load of 60 kN. The column is fixed at one end and pinned at the other end. Timber grade SG2, green (wet) > 19%. Column is carrying medium term load and no load sharing. Determine the column size. Assume E_{min} = 9800 N/mm^2.

(10 marks)

-END OF QUESTION-

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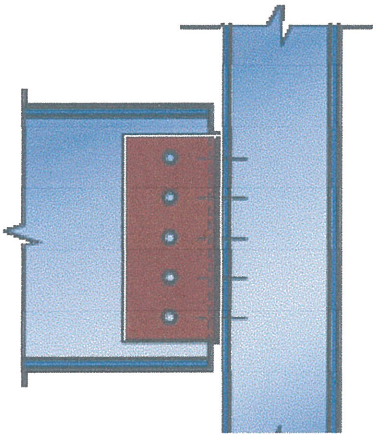

Double angle web cleat

Conditions of restraint at supports	Common detail (see Figure 7.4)	Loading Condition: Normal	Loading Condition: Destabilising
Compression flange laterally restrained and nominal restraint against rotation about longitudinal axis	(a) Both flanges fully restrained against rotation on plan	$0.70\ L_{LT}$	$0.85\ L_{LT}$
	(b) Both flanges partially restrained against rotation on plan	$0.80\ L_{LT}$	$0.95\ L_{LT}$
	(c) Both flanges free to rotate on plan	$1.00\ L_{LT}$	$1.20\ L_{LT}$
Compression flange laterally unrestrained and both flanges free to rotate on plan	(d) Partial torsional restraint against rotation about longitudinal axis provided by connection of bottom flange to supports	$1.0L_{LT} + 2D$	$1.0L_{LT} + 2D$
	(e) Partial torsional restraint against rotation about longitudinal axis provided by pressure of bottom flange onto supports	$1.0L_{LT} + 2D$	$1.0L_{LT} + 2D$

Note: L_{LT} is the segment length equal to the span

FIGURE Q1

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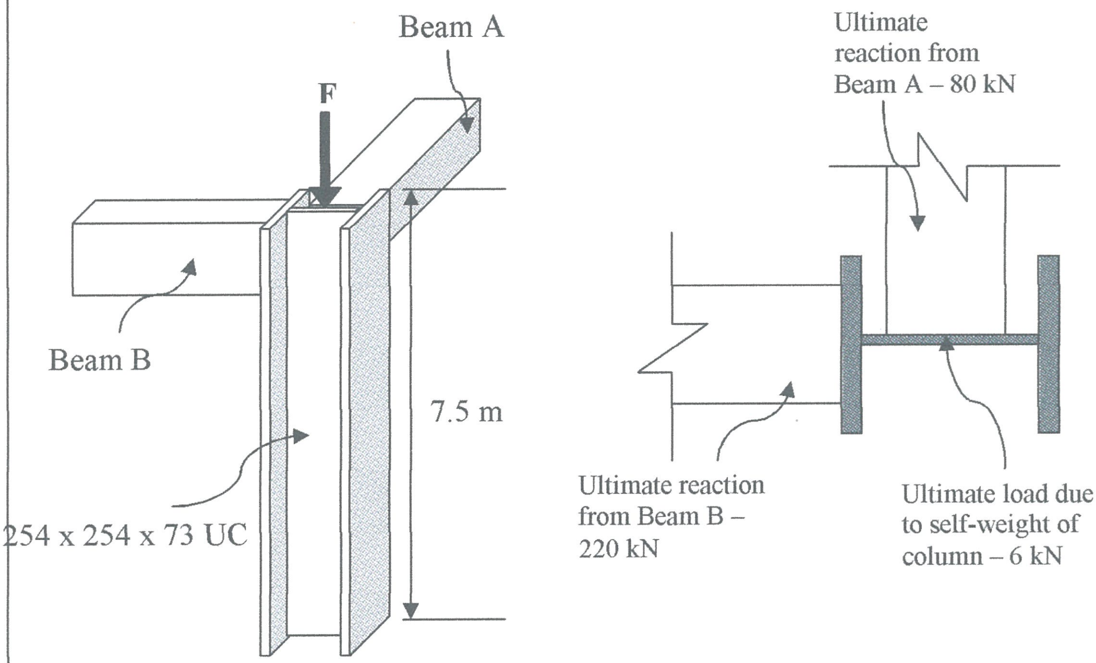

FIGURE Q2

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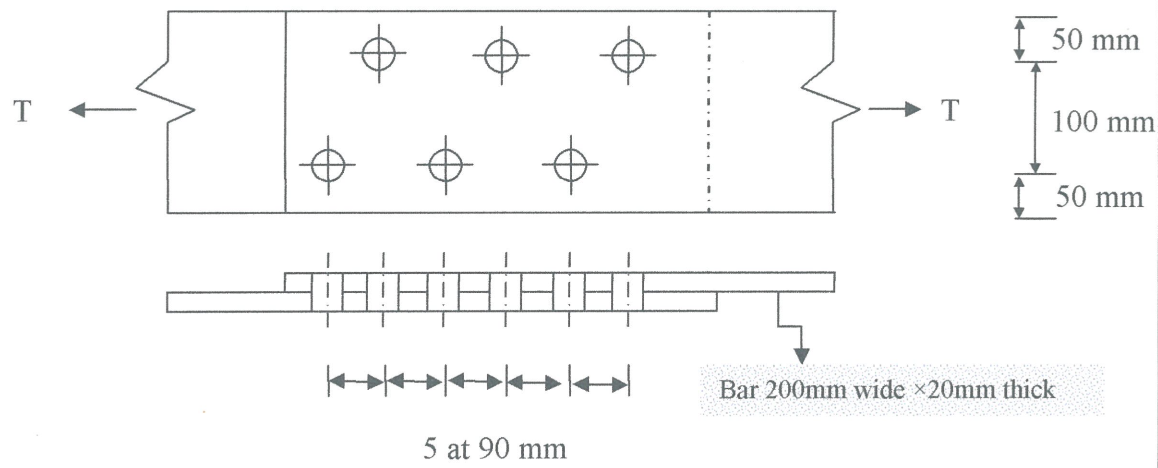

FIGURE Q3(a)

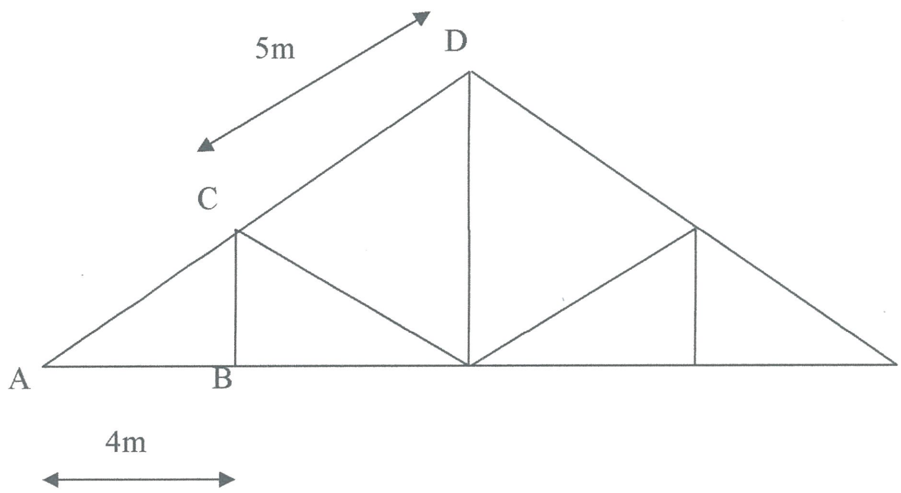

FIGURE Q3(b)

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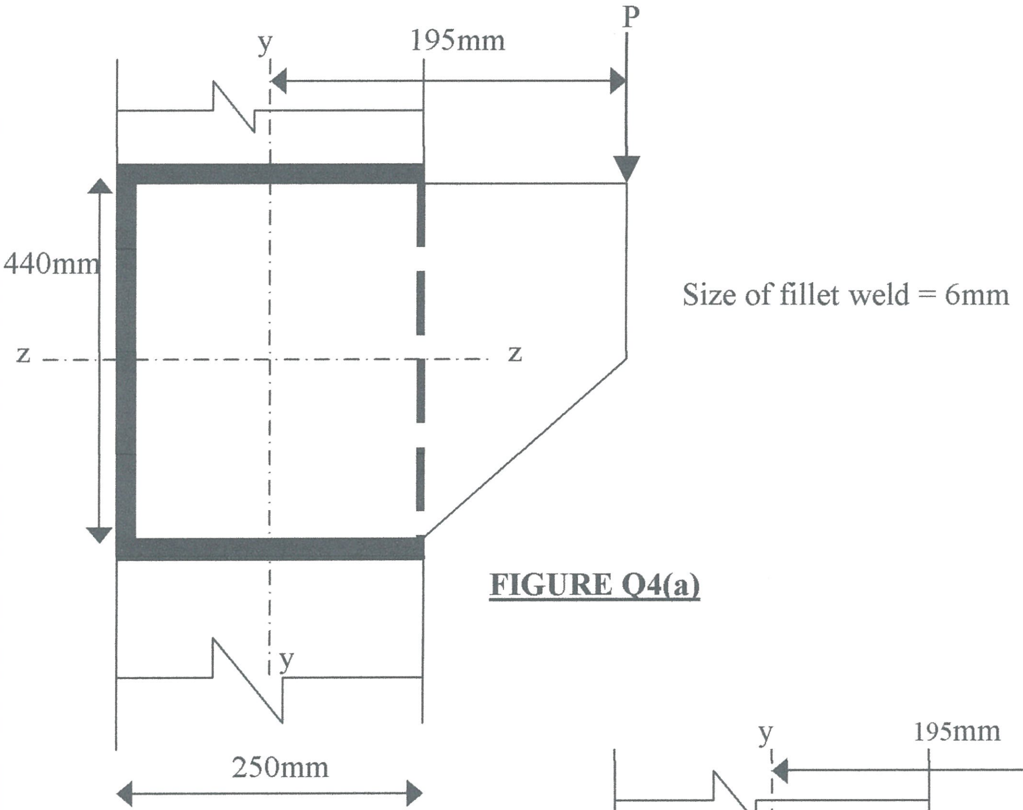

FIGURE Q4(a)

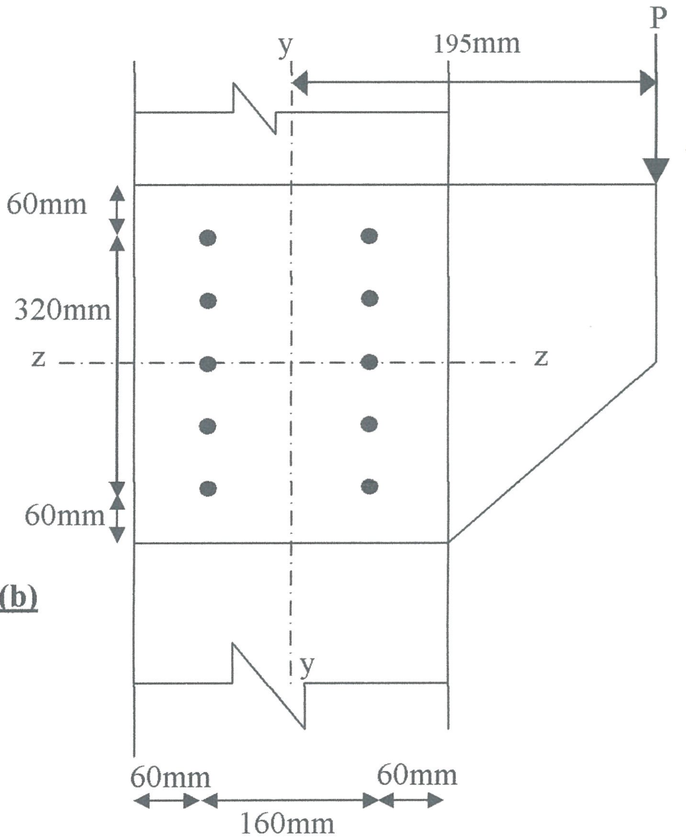

FIGURE Q4(b)

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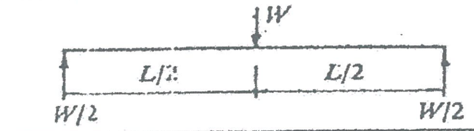
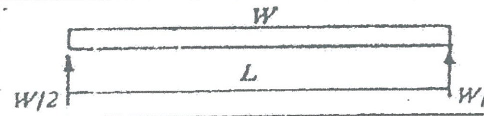
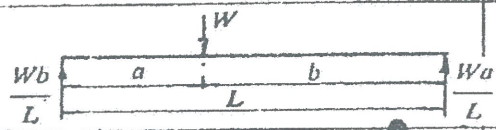
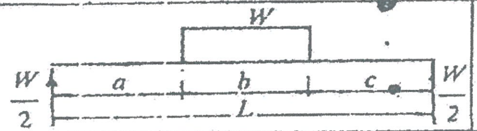
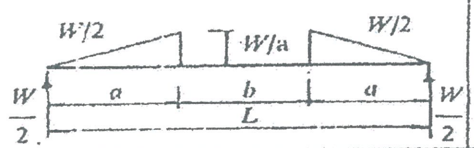
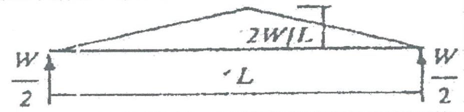
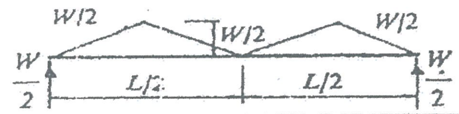
APPENDIX

Beam and loading	M_{max}	Deflection at mid span
	$WL/4$	$\frac{WL^3}{48EI}$
	$WL/8$	$\frac{5WL^3}{384EI}$
	Wab/L	$\frac{WL^3}{48EI}\left[\frac{3a}{L} - 4\left(\frac{a}{L}\right)^3\right]$
	$W\left(\frac{a}{2} + \frac{b}{8}\right)$	$\frac{W}{384EI}\left[8L^3 - 4Lb^2 + b^3\right]$
	$Wa/3$	$\frac{Wa}{120EI}\left[16a^2 + 20ab + 5b^2\right]$
	$WL/6$	$\frac{WL^3}{60EI}$
	$WL/8$	$\frac{WL^3}{73.14EI}$

Simply supported beam

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APPENDIX

4.12.4.2 ***Conditions***

For the empirical design method the following conditions should be met.

a) The members should be of steel to a minimum of grade S 275.

b) Unfactored loads should be used for empirical design.

c) The span of the members should not exceed 6.5 m centre-to-centre of main supports.

d) If the members generally span only one bay, each end should be connected by at least two bolts.

e) If the members are generally continuous over two or more bays, with staggered joints in adjacent lines of members, single bay members should have at least one end connected by two or more bolts.

4.12.4.3 ***Purlins***

Purlins satisfying **4.12.4.2** may be designed using the following empirical rules.

a) The slope of the roof should not exceed 30° from the horizontal.

b) The loading on the purlin should be substantially uniformly distributed. Not more than 10 % of the total roof load on the member should be due to other types of load.

c) The section modulus Z of a purlin about its axis parallel to the plane of the cladding should be not less than the larger of the two values Z_p and Z_q given in Table 27.

d) The member dimensions D perpendicular to the plane of the cladding, and (if applicable) B parallel to the plane of the cladding, should be not less than the respective values given in Table 27.

Table 27 — Empirical values for purlins

Purlin section	Z_p (cm³)	Z_q (cm³)		D (mm)	B (mm)
		Wind load from BS 6399-2	Wind load from CP3:Ch V:Part 2		
Angle	$W_pL/1\ 800$	$W_qL/2\ 250$	$W_qL/1\ 800$	$L/45$	$L/60$
CHS	$W_pL/2\ 000$	$W_qL/2\ 500$	$W_qL/2\ 000$	$L/65$	—
RHS	$W_pL/1\ 800$	$W_qL/2\ 250$	$W_qL/1\ 800$	$L/70$	$L/150$

NOTE 1 W_p and W_q are the total unfactored loads (in kN) on one span of the purlin, acting perpendicular to the plane of the cladding, due to (dead plus imposed) and (wind minus dead) loading respectively.

NOTE 2 L is the span of the purlin (in mm) centre-to-centre of main vertical supports. However, if properly supported sag rods are used, L may be taken as the sag rod spacing in determining B only.

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Bolts area

d (mm)	8	10	12	14	16	18	20	22	24	27	30
A (mm^2)	50	78	113	154	201	254	314	380	452	573	707
A_s (mm^2)	36	58	84	115	157	192	245	303	353	459	561

Throat thickness of fillet welds

Angle between fusion faces (degrees)	Factor (to be applied to leg length)
60 to 90	0.7
91 to 100	0.65
101 to 106	0.6
107 to 113	0.55
114 to 120	0.5

Design resistance of fillet weld

Steel Grade	Thickness of the Jointed part weaker (mm)	Ultimate strength , f_u (N/mm^2)	Correlation factor β_w
S 235	$t_p \leq 3$	360	0,8
	$3 \leq t_p \leq 100$	360	
S 275	$t_p \leq 3$	430	0,85
	$3 \leq t_p \leq 100$	410	
S 355	$t_p \leq 3$	510	0,9
	$3 \leq t_p \leq 100$	470	