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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2013/2014

COURSE NAME	:	STEEL AND TIMBER STRUCTURE DESIGN
COURSE CODE	:	BFC4033/BFC43003
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2014
DURATION	:	3 HOURS
INSTRUCTION	:	A) ANSWER **THREE (3)** QUESTIONS ONLY B) ANSWER **ONE (1)** QUESTION ONLY ALL DESIGN WORKS SHOULD BE BASED ON RELEVENT DESIGN CODES

THIS QUESTION PAPER CONSISTS OF **TWELVE (12)** PAGES

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SECTION A

Q1 A simply supported beam 610 x 229 x 125 UB grade S275 as shown in Figure **Q1** supports uniformly distributed characteristics permanent load and variable loads of 180 kN/m and 90 kN/m respectively. Both flanges of the beam are laterally and torsionally restrained. Verify;

(a) bending capacity.

(8 marks)

(b) shear capacity

(5 marks)

(c) deflection capacity

(5 marks)

(d) give comments and suggestions from results (a),(b) and (c)

(7 marks)

Q2 The truss to be designed is to support a roof which is only accessible for normal maintenance and repair. The truss is 1.4 m span with 15° pitch. The dimensions of the truss are shown in the Figure **Q2** below with spacing between truss is 6 m. The total permanent actions and variable action are taken as 0.90 kN/m^2 and 0.60 kN/m^2 respectively. Truss analysis is carried out by placing concentrated loads at the joints of the truss. All of the joints are assumed to be pinned in the analysis and therefore only axial forces are carried by members.

(a) Determine the design actions by using *equation 6.10b* **BS EN 1990** by taking reduction factor ξ = 0.925. Then, determine the concentrated load, F_d.

(5 marks)

(b) Determine the internal force F_{AB}. Is the member AB in tension or compression?

(3 marks)

(c) Check resistance of 100 x 100 x 5 square hollow section in S355 steel at top chord of member AB

(14 marks)

(d) Check the resistance against deflection if deflection at the rafter was found to be 6.4 mm

(3 marks)

Q3 Figure **Q3** shows details of beam to column end plate connection to carry factored load 170 kN. The connection consist of 3 rows of M16 bolts (total 6 bolts) Grade 8.8 and weld. The bolts use in connection are fully threaded, non-preload, 60 mm long. Given:

Beam	= 406 x 178 x 60 UKB in S275 steel
Column	= 203 x 203 x 46 UKC in 275 steel
Endplate thickness	= 10 mm

(a) Verify bolt connection resistance

(12 marks)

(b) Determine the suitable fillet weld size

(13 marks)

Q4 (a) List the criteria that should be satisfied in the design of column of Class 1, 2 or 3 cross-section in simple design contruction method.

(3 marks)

(b) Sketch buckling occured at major and minor axis of column shown in Figure **Q4a**.

(4 marks)

(c) Determine the maximum axial load can be carried by the column shown in Figure **Q4b** when 203x203x46 UC is employed with its end condition is pin-ended. The column is effectively held in position at mid-height and restrained in the z-axis direction but free in y-axis. Use steel grade S355.

(18 marks)

SECTION B

Q5 (a) List **FIVE (5)** types of defects that can affect the strength of timber.

(5 marks)

(b) A column of 5 m height is to be designed using Nyatoh with standard grade at 19% of moisture content as shown in Figure **Q5**. The column is restrained in different conditions at every level and loaded with concentric load, P.

(i) calculate the critical slenderness ratio, λ if the surface of the column is 100 mm x 200 mm.

(12 marks)

(ii) Determine the maximum allowable concentric load, P that column can adequately resist due to short term loading conditions.

(8 marks)

Q6 (a) Discuss the provisions of MS544 Specifications effecting the design of timber beam for maximum bending moment.

(10 marks)

(b) The nominal 150 x 200mm timber beam in Figure **Q6** is be use as a crane beam and has a vertical load of 20kN that can act anywhere along the length of the beam. The beam is in very good condition and has no splits. For simplicity, assume the weight of the beam itself is negligible.

Consider:

Interior beam with smooth surfaces.

Dry Dark Red Meranti with standard grade

Long-term of duration of loading

i) determine the maximum shear force of the beam

(3marks)

ii) verify if the beam is adequate for shear parallel to grain

(6 marks)

ii) verify if the beam is acceptable for compression perpendicular to grain. (Assume the bearing length of the beam on the wall is 150 mm)

(6 marks)

- END OF QUESTION -

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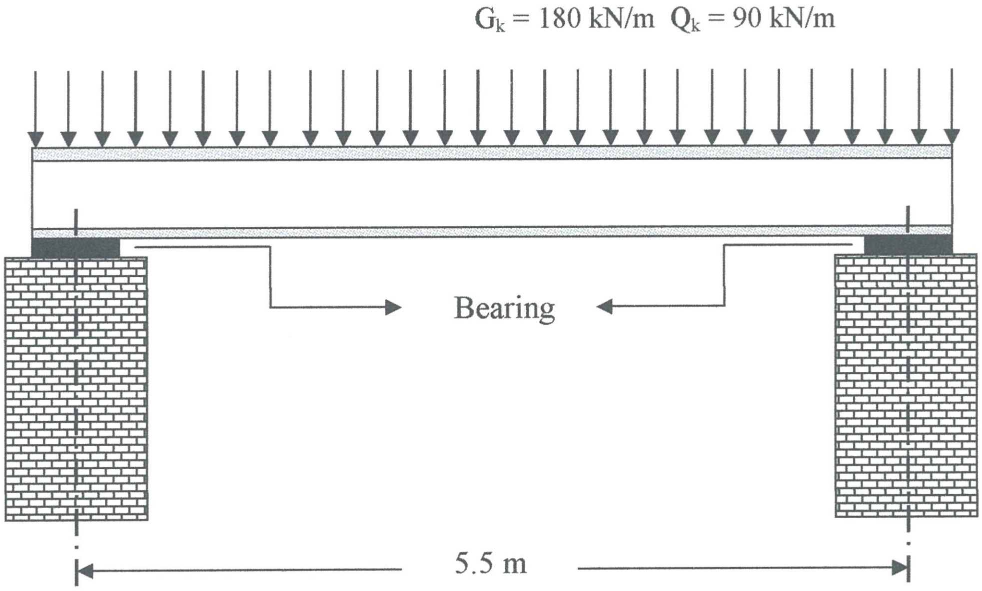

FIGURE Q1

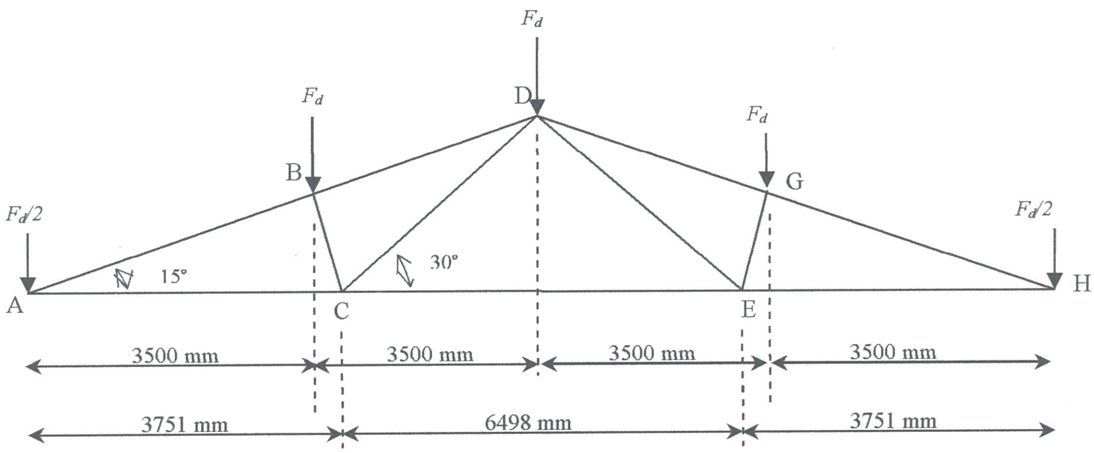

FIGURE Q2

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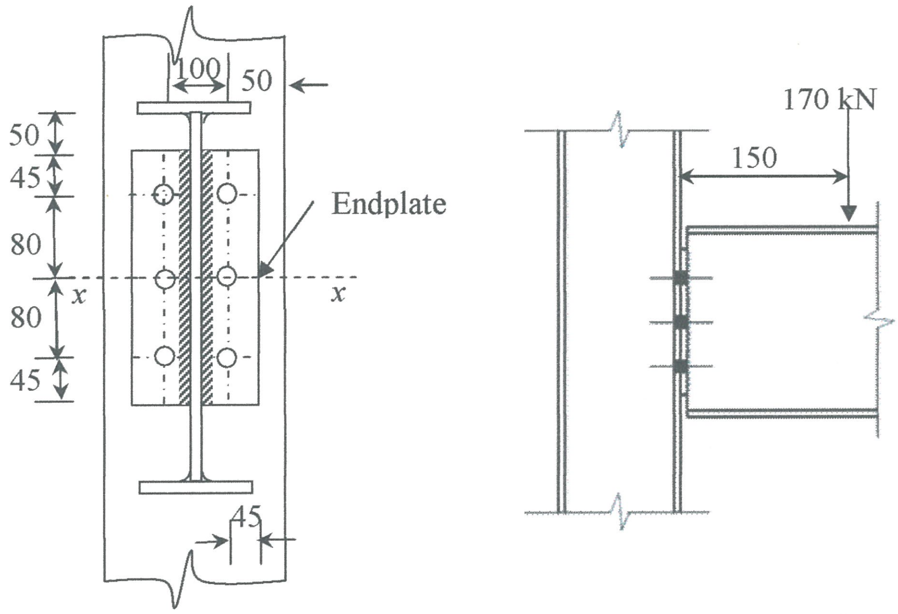
COURSE NAME : MECHANICS OF MATERIAL COURSE CODE: BFC 20903



(All dimension in mm)

FIGURE Q3

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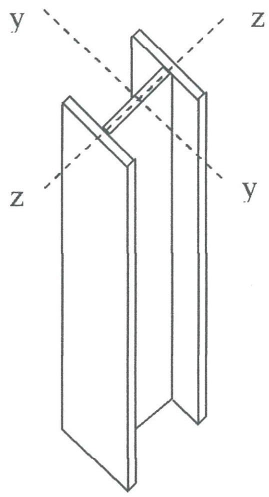

FIGURE Q4a

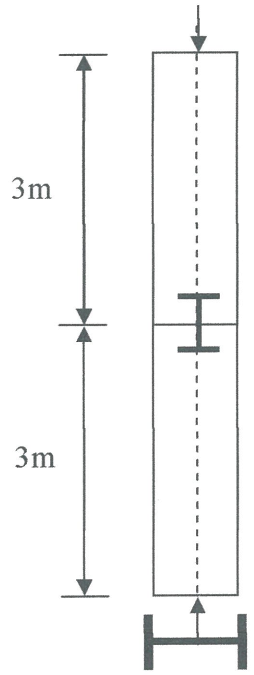

FIGURE Q4b

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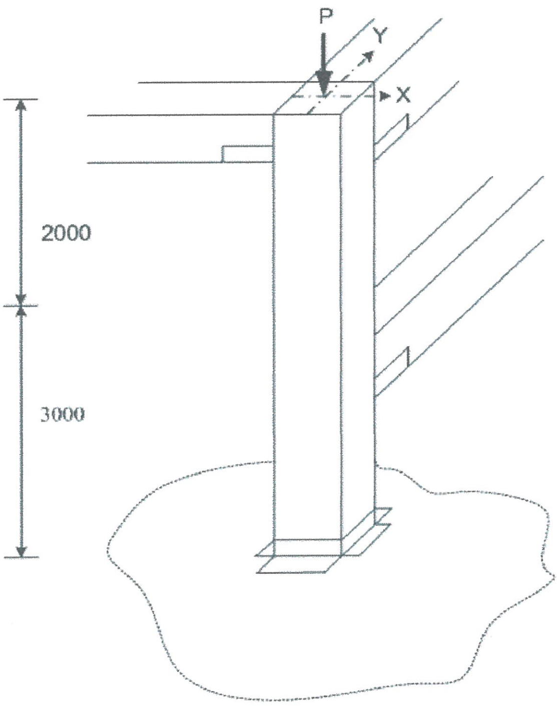

FIGURE Q5

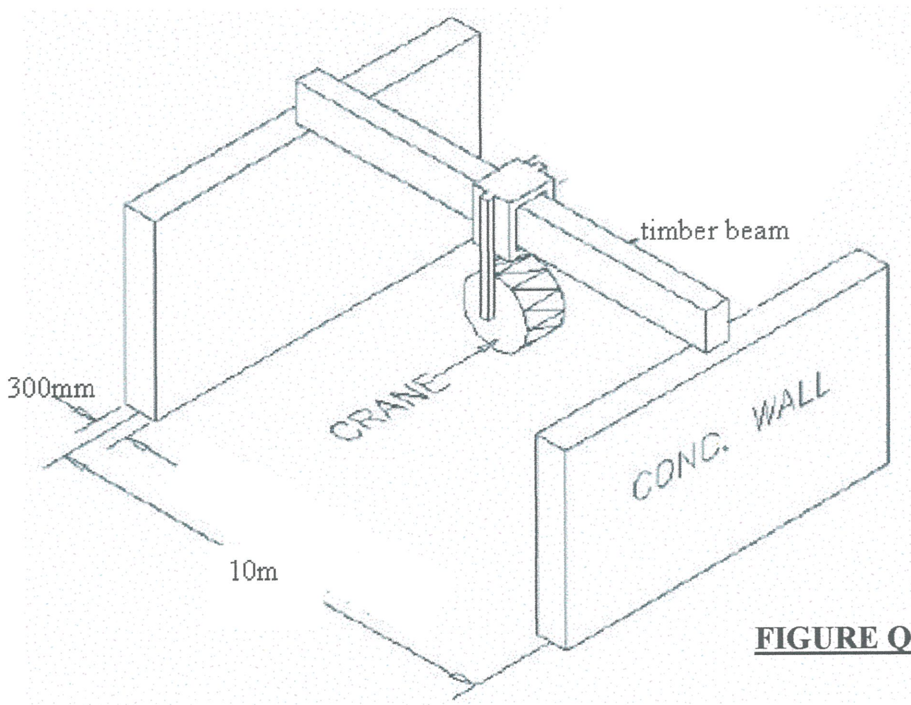

FIGURE Q6

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APPENDIX

Table 1: Bolt 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
As (mm^2)	36	58	84	115	157	192	245	303	353	459	561

Table 2: Design resistance of steel (Extract from Table 7 of EN10025-2)

Steel Grade	Yield strength, f_y (N/mm^2)				Ultimate strength , f_u (N/mm^2)	
	$t \le 16$	$>16 \le t \le 40$	$> 40 \le t \le 63$	$> 63 \le t \le 50$	$t_p < 3$	$\ge 3 \le t_p \le 100$
S 235	235	225	215	215	360	360
S 275	275	265	255	245	430	410
S 355	355	345	335	325	510	470

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$$Fs = \frac{P}{Weld\ effective\ length}\ per\ mm\ length$$

$$F_T = \frac{My}{I} = \frac{P.e.y}{I}\ per\ mm\ length$$

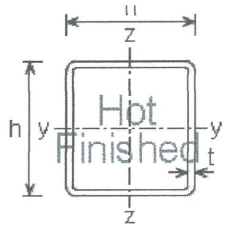
$$F_{w,Ed} = \sqrt{F_s^{\ 2} + F_T^{\ 2}}$$

$$F_{T,Ed} = \frac{P.e.r_1}{\left(\sum z^2 + y^2\right)}$$

$$F_{v,Ed} = \frac{P}{n}$$

$$F_{r,Ed} = \sqrt{\left(F_{v,Ed}^{\ 2} + F_{t,Ed}^{\ 2} + 2F_{v,ed}F_{t,Ed}\cos\phi\right)}$$

Celsius® SHS



Dimensions and properties

Section Designation		Mass per Metre	Area of Section	Ratio for Local Buckling	Second Moment of Area	Radius of Gyration	Elastic Modulus	Plastic Modulus	Torsional Constants		Surface Area	
Size	Thickness										Per Metre	Per Tonne
h x h	t		A	c/t (1)	I	i	W_{el}	W_{pl}	I_T	W_t		
mm	mm	kg/m	cm^2		cm^4	cm	cm^3	cm^3	cm^4	cm^3	m^2	m^2
100 x 100	4.0	11.9	15.2	22.0	232	3.91	46.4	54.4	361	68.2	0.390	32.7
	5.0	14.7	18.7	17.0	279	3.86	55.9	66.4	439	81.8	0.387	26.3
	6.3	18.2	23.2	12.9	336	3.80	67.1	80.9	534	97.8	0.384	21.1
	8.0	22.6	28.8	9.50	400	3.73	79.9	98.2	646	116	0.379	16.8
	10.0	27.4	34.9	7.00	462	3.64	92.4	116	761	133	0.374	13.6

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Table 4.3: Nominal buckling lengths L_{cr} for compression members (***Table 24 BS 5950***)

End Restraint (in the plane under consideration)		Buckling length, Lcr
Effectively held in position at both ends	Effectively retrained in direction at both ends	0.7L
	Partially retrained in direction at both ends	0.85L
	Restrained in direction at one end	0.85L
	Not restrained in direction at either end	1.0L

One end	**Other end**		**Buckling length, L_{cr}**
Effectively held in position at and restrained in direction	Not held in position	Effectively retrained in direction	0.7L
		Partially retrained in direction	0.85L
		Not restrained in direction	1.0L

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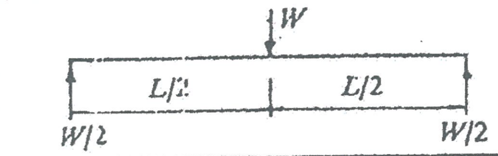
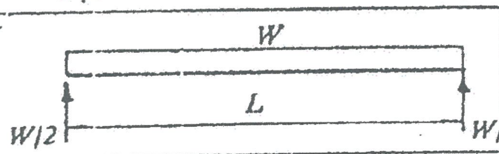
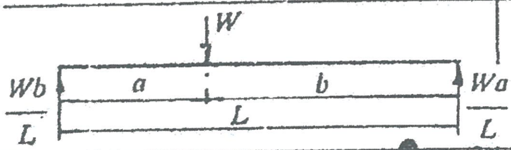
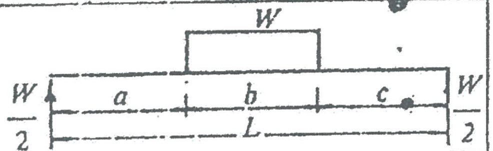
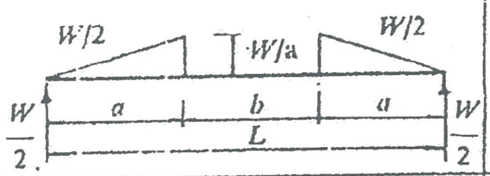
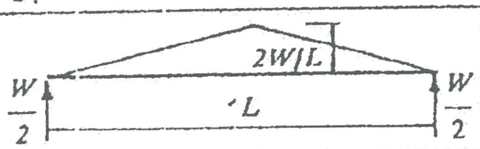
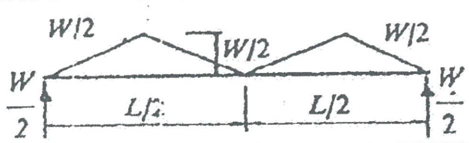
Beam and load	Maximum moment	Deflection at mid-span
	$WL/4$	$\frac{WL^3}{48EI}$
	$WL/8$	$\frac{5WL^3}{384EI}$
	Wab/L	$\frac{WL^3}{48EI}\left[\frac{3a}{L} - 4\left(\frac{a}{L}\right)^3\right]$
	$W\left(\frac{a}{2} + \frac{b}{8}\right)$	$\frac{W}{384EI}\left[8L^3 - 4Lb^2 + b^3\right]$
	$Wa/3$	$\frac{Wa}{120EI}\left[16a^2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