CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	STEEL AND TIMBER STRUCTURE DESIGN
COURSE CODE	:	BFC 4033/BFC 43003
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2015/JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 A plate is connected on column flange surface using twelve normal bolts as shown in **FIGURE Q1**. Load position is located 300 mm from column neutral axis. Given the plate thickness is 10 mm and bolt with Grade 4.6 has diameter of 20 mm.

(a) Calculate shear load, moment load and resultant load.

(9 marks)

(b) If the shear failure occurs at bolt tread, verify the safety of the connection in shear and give your comments. ($A = 314\ mm^2$ and $A_s = 245\ mm^2$).

(5 marks)

(c) If plate ultimate stress is 410 N/mm^2, check bearing resistance of the connection and give your comments.

(11 marks)

Q2 Design the simply-supported beam shown in **FIGURE Q2**. The uniformly distributed permanent load is equal to 25 kN/m and the uniformly distributed live load is equal to 20 kN/m. A concentrated live load equal to 50 kN acts at the mid-span. Lateral restraints are provided at the end reactions and at the mid-span.

(a) Calculate and draw the reaction force, shear force and bending moment diagrams.

(5 marks)

(b) Determine the initial size of the beam.

(6 marks)

(c) Check the moment capacity for both cross-section and buckling of the beam and give your comments. Use beam size 254×146×43 kg/m and $M_{cr,o} = 189.5\times10^6$ kNm.

(14 marks)

Q3 A S275 grade 203 × 203 × 46 UC section has been proposed as a column to support a 30 m span Duo-pitch Pratt truss. The on-plan permanent and variable actions on the truss are 3 kN/m and 4.5 kN/m, respectively. The truss is connected to the face of the column flange while tie beams are connected to the column web at mid-height and full height of the column. The purpose of the tie beams is to provide out of plane stability to the whole column-truss frame. The full height of the column is 6 m. All connections including column to base form a simple type construction. Check the capacity of the proposed section and determine whether the section is adequate in resisting the combined actions of axial compression and nominal bending moment. Ignore the self-weight of column and tie beams. Use the following given simplified interaction criteria.

$$\frac{N_{Ed}}{N_{\min,b,Rd}} + \frac{M_{y,Ed}}{M_{y,b,Rd}} + 1.5\frac{M_{z,Ed}}{M_{z,cb,Rd}} \leq 1.0$$

where:

- N_{Ed}, $M_{y,Ed}$ *and* $M_{z,Ed}$ are the design values of the compression force and the maximum moments about the y-y axis (major) and z-z axis (minor) along the member, respectively.
- $N_{min,b,Rd}$ is the lesser of $\frac{\chi_y f_y A}{\gamma_{M1}}$ and $\frac{\chi_z f_y A}{\gamma_{M1}}$.
- χ_y and χ_z are the reduction factors due to flexural buckling about the major and minor axes respectively.
- $M_{b,y,Rd}$ is given by $\frac{\chi_{LT} W_y f_y}{\gamma_{M1}}$.
- is the reduction factor due to lateral-torsional buckling and $\overline{\lambda_{LT}} = \frac{L/i_z}{96}$.
- $M_{z,cb,Rd}$ is given by $\frac{W_{pl,z} f_y}{\gamma_{M1}}$ for Class 1 and 2 sections and $\frac{W_{el,z} f_y}{\gamma_{M1}}$ for Class 3 sections.

(25 marks)

Q4 The truss span illustrated in **FIGURE Q4** is 15 m between point A and B. Make the usual assumptions for truss analysis and neglect the self-weight of the truss.

(a) Determine the support reaction at A and B due to vertical load of 60 kN.

(6 marks)

(b) Calculate the internal force in AE member.

(6 marks)

(c) If the AE member of the truss is composed of single angle of 50 x 50 x 5L section connected by welding connections, determine the resistance of this member. ($f_y = 235$ N/mm^2)

(6 marks)

(d) Suggest a design modification for AE member so that it is more economic.

(7 marks)

Q5 (a) Explain the classification of Malaysian timber including the types of timber on each class.

(6 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 a concentric load, P.

(i) Calculate the critical slenderness ratio, λ if the surface of the column is 200 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.

(7 marks)

- END OF QUESTION –

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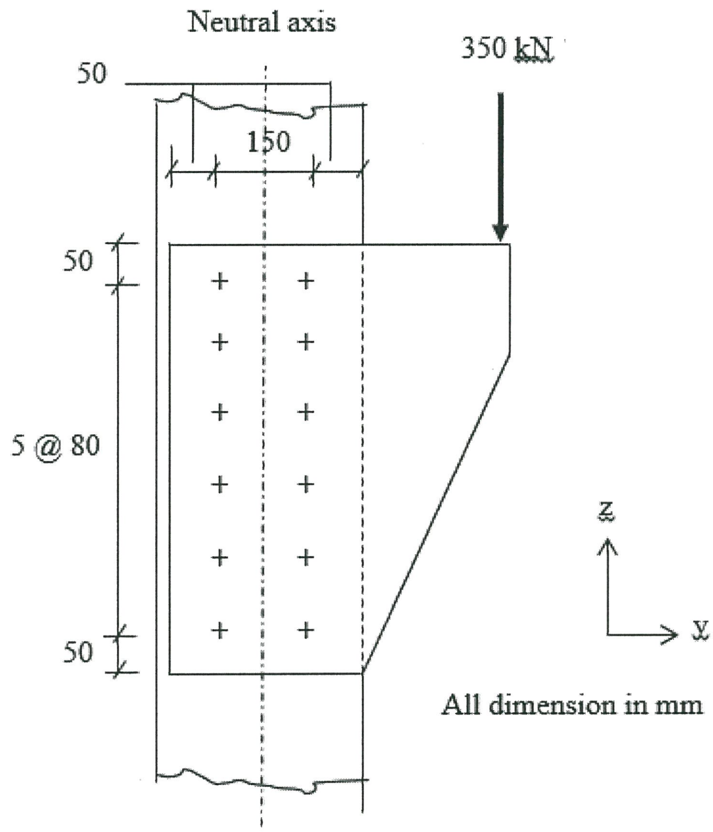

Figure Q1

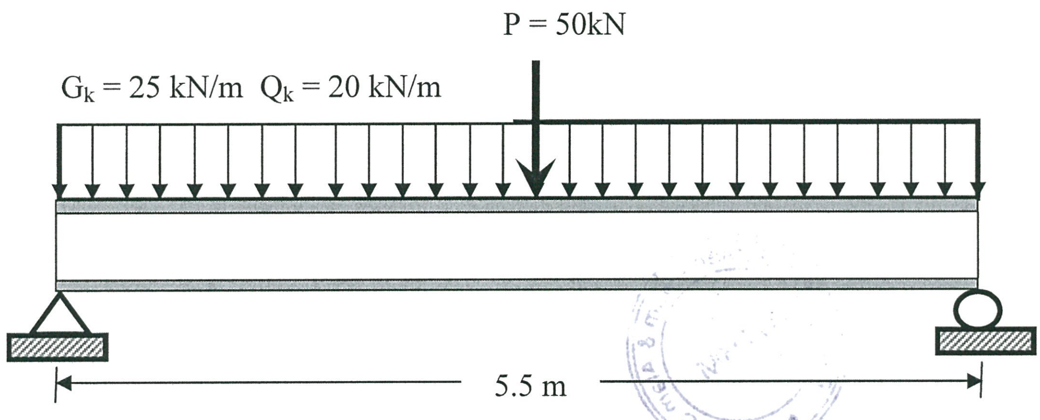

Figure Q2

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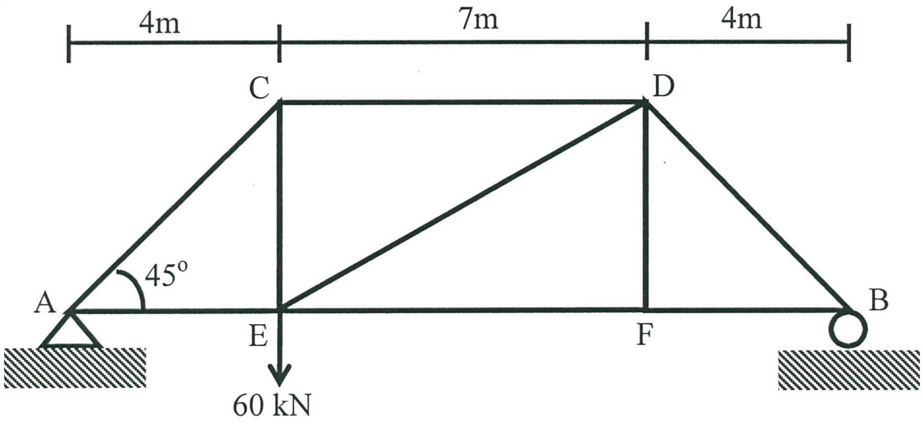

Figure Q4

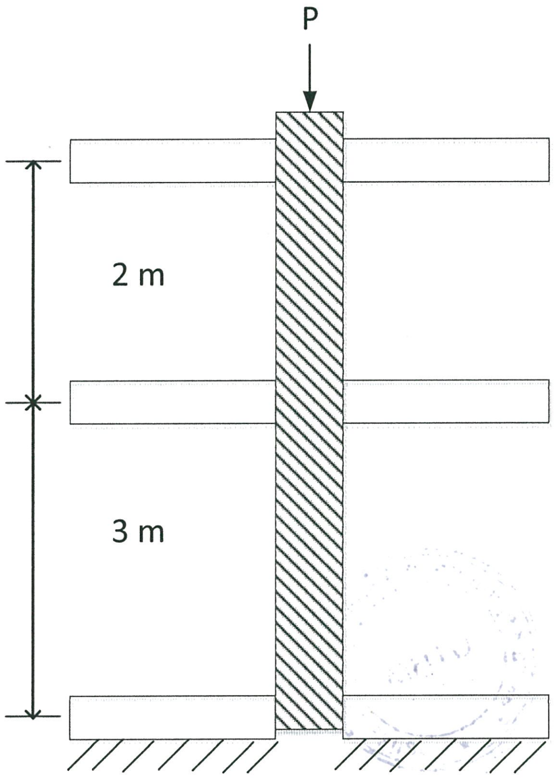

Figure Q5

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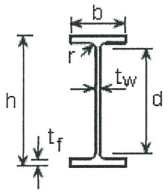
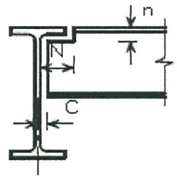
APPENDIX

BS EN 1993-1-1:2005
BS 4-1:2005

UNIVERSAL BEAMS

Advance UKB





Dimensions

Section Designation	Mass per Metre	Depth of Section	Width of Section	Thickness		Root Radius	Depth between Fillets	Ratios for Local Buckling		Dimensions for Detailing			Surface Area	
				Web	Flange			Flange	Web	End Clearance	Notch		Per Metre	Per Tonne
		h	b	t_w	t_f	r	d	c_f/t_f	c_w/t_w	C	N	n		
	kg/m	mm	mm	mm	mm	mm	mm			mm	mm	mm	m^2	m^2
305x127x48	48.1	311.0	125.3	9.0	14.0	8.9	265.2	3.52	29.5	7	70	24	1.09	22.7
305x127x42	41.9	307.2	124.3	8.0	12.1	8.9	265.2	4.07	33.2	6	70	22	1.08	25.8
305x127x37	37.0	304.4	123.4	7.1	10.7	8.9	265.2	4.60	37.4	6	70	20	1.07	28.9
305x102x33	32.8	312.7	102.4	6.6	10.8	7.6	275.9	3.73	41.8	5	58	20	1.01	30.8
305x102x28	28.2	308.7	101.8	6.0	8.8	7.6	275.9	4.58	46.0	5	58	18	1.00	35.5
305x102x25	24.8	305.1	101.6	5.8	7.0	7.6	275.9	5.76	47.6	5	58	16	0.992	40.0
254x146x43	43.0	259.6	147.3	7.2	12.7	7.6	219.0	4.92	30.4	6	82	22	1.08	25.1
254x146x37	37.0	256.0	146.4	6.3	10.9	7.6	219.0	5.73	34.8	5	82	20	1.07	28.9
254x146x31	31.1	251.4	146.1	6.0	8.6	7.6	219.0	7.26	36.5	5	82	18	1.06	34.0
254x102x28	28.3	260.4	102.2	6.3	10.0	7.6	225.2	4.04	35.7	5	58	18	0.904	31.9
254x102x25	25.2	257.2	101.9	6.0	8.4	7.6	225.2	4.80	37.5	5	58	16	0.897	35.7
254x102x22	22.0	254.0	101.6	5.7	6.8	7.6	225.2	5.93	39.5	5	58	16	0.890	40.5
203x133x30	30.0	206.8	133.9	6.4	9.6	7.6	172.4	5.85	26.9	5	74	18	0.923	30.8
203x133x25	25.1	203.2	133.2	5.7	7.8	7.6	172.4	7.20	30.2	5	74	16	0.915	36.5
203x102x23	23.1	203.2	101.8	5.4	9.3	7.6	169.4	4.37	31.4	5	60	18	0.790	34.2

Lateral torsional buckling reduction factors, χ_{LT}

$\bar{\lambda}_{LT}$	Rolled I, H Sections		
	$h/b \leq 2$	$2 < h/b \leq 3.1$	$h/b > 3.1$
1.30	0.52	0.47	0.41
1.35	0.50	0.45	0.39
1.40	0.47	0.43	0.37
1.45	0.45	0.41	0.36
1.50	0.43	0.39	0.34

$$F_{t,Ed} = [Per]/[\sum z^2 + \sum y^2]$$

$$F_{R,Ed} = [F_{v,Ed}{}^2 + F_{t,Ed}{}^2 + 2(F_{v,Ed})(F_{t,Ed})cos\emptyset]^{\frac{1}{2}}$$