Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	STEEL AND TIMBER STRUCTURE DESIGN
COURSE CODE	:	BFC43003
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	DECEMBER 2014 / JANUARY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	SECTION A: ANSWER **ALL** QUESTIONS SECTION B: ANSWER **TWO (2)** QUESTIONS ONLY ALL DESIGN WORKS SHOULD BE BASED ON RELEVENT DESIGN CODES

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

SECTION A
Answer ALL questions

Q1 Consider a simply supported lateral restrained beam of 6 m span. The uniformly distributed load on the beam is 45 kN/m. Determine the most suitable and least expensive UB hot rolled section of grade S275 for this beam based on both bending and deflection criteria only.

(15 marks)

Q2 (a) A 10 mm thick steel plate is subjected to tensile load as shown in Figure **Q2(a)**. The holes are to fit M20 bolts. Compute the net area of the plate that should be used in the connection design.

(5 marks)

(b) A single angle tensile member, 125 mm × 75 mm × 8 mm made from steel grade S275 is connected to a gusset plate with M20 bolts as shown in Figure **Q2(b).** The spacing between bolts is 50 mm. Determine the adequacy of the member if the design axial tensile load is 375 kN.

(10 marks)

Q3 Figure **Q3(a)** shows a simple truss system with 400 kN joint load applied horizontally at point C. The chord of the steel truss is made up of two (2) angles of equal legs and the steel grade is S235. The joints are welded connections as illustrated in Figure **Q3(b)**. By using the information given:

(a) Identify the tension members and their forces in the truss

(5 marks)

(b) Estimate the most suitable equal angle size for member AB

(5 marks)

(c) Using the information from Q1 (b), calculate the minimum weld length at A for member AB. The fillet weld size is 10 mm.

(5 marks)

Q4 (a) Your client has engaged you to propose and design a timber chalet with timber flooring for him. The size of the chalet is 10 m × 6 m. Present a suitable proposal for your client. The proposal should include a suitable layout of the roof trusses, the timber beams (bearers and joists) of the floor and the position of the stumps. Additional cross-sections or/and elevations

will be an advantage to your presentation to your client. The proposal should be well labelled and contain typical dimensions in accordance to standard practice.

(7 marks)

(b) An opening of 4.8 m wide requires a lintel beam to support the wall above the opening. The total height from the floor to the ceiling is 3.2 m while the height of the opening is 2 m. The wall load is 1.5 kN/m^2. Check the adequacy of a double 75 mm × 225 mm SG4 Standard Grade Dry beam for the lintel construction. Take the finished size of a single beam as 72 mm × 220 mm.

(8 marks)

SECTION B
Answer TWO (2) questions only

Q5 Figure **Q5** shows the base plate connection of a column using UB section. The connection which comprises of grade 4.6 M24 bolts and 6 mm fillet weld is subjected to design demands of bending moment and horizontal shear force amounting 50 kNm and 200 kN, respectively. The bolts are only required to resist the tensile force due to the design bending moment, while the fillet weld is required to resist the combined shear and tension force due to the design bending moment. Given the tensile area, A_s of M24 bolt is 353 mm^2, ultimate strength, f_u of steel plate is 410 N/mm^2, correlation factor, β_w is 0.85 and resistance of 6 mm fillet weld is 1.25 kN/mm. Check the capacity of the bolts and fillet weld and determine whether the connection is adequate in resisting the design demands.

(20 marks)

Q6 The column shown in Figure **Q6** is restrained from rotating about the minor axis at the top and mid-height using tie beams. The design axial force, P of the column resulting from the reaction of the roof truss is 200 kN. The connection between the roof truss and column is considered as simple construction. The column is nominally pinned at the top, the base and mid-height. A S275 203 × 203 × 46 UC section is proposed for the column. 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 $\frac{\chi_{LT} W_y f_y}{\gamma_{M1}}$.
- χ_{LT} is the reduction factor due to lateral-torsional buckling.
- $\bar{\lambda}_{LT}=\frac{L/i_z}{96}$
- $M_{z,cb,Rd}$ 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.

Lateral torsional buckling reduction factors, χ_{LT}

$\bar{\lambda}_{LT}$	Rolled I, H Sections		
	h/b ≤ 2	2 < h/b ≤ 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
1.60	0.39	0.35	0.31

(20 marks)

Q7 Figure **Q7** shows a beam to column flexible end plate connection. This connection is categorized as a simple connection that is designed to transmit the shear forces from the beam to the column. The applied design force onto the connection is therefore equal to the shear force at the beam end. Given:

Beam Size	=	356 x 171 x 45 UB
Endplate length, h_p	=	250mm
Endplate width, b_p	=	200mm
Endplate thickness, t_p	=	8mm
Steel grade	=	S275
Bolt size	=	M16 grade 8.8

Shear force $F_v = \frac{P}{n}$

Tensile force $F_t = \frac{P.e.y_1}{2\Sigma y^2}$

(a) Determine the spacing of bolt if the position of end distance and edge distance is the maximum allowable position of hole is applied.

(4 marks)

(b) Using the shear capacity of the beam UB section, calculate the applied design force P for the connection.

(8 marks)

(c) Check the capacity of the connection under combined shear and tensile actions. Consider the force P is located 100mm from the column face.

(8 marks)

- END OF QUESTION -

FINAL EXAMINATION

SEMESTER/SESSION:	SEM I/2014/2015	PROGRAMME:	BFF
COURSE NAME:	STEEL AND TIMBER STRUCTURE DESIGN	COURSE CODE:	BFC43003

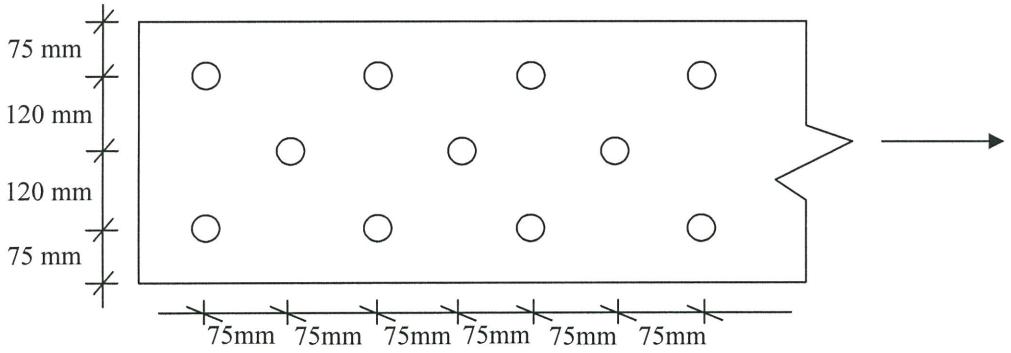


FIGURE Q2a

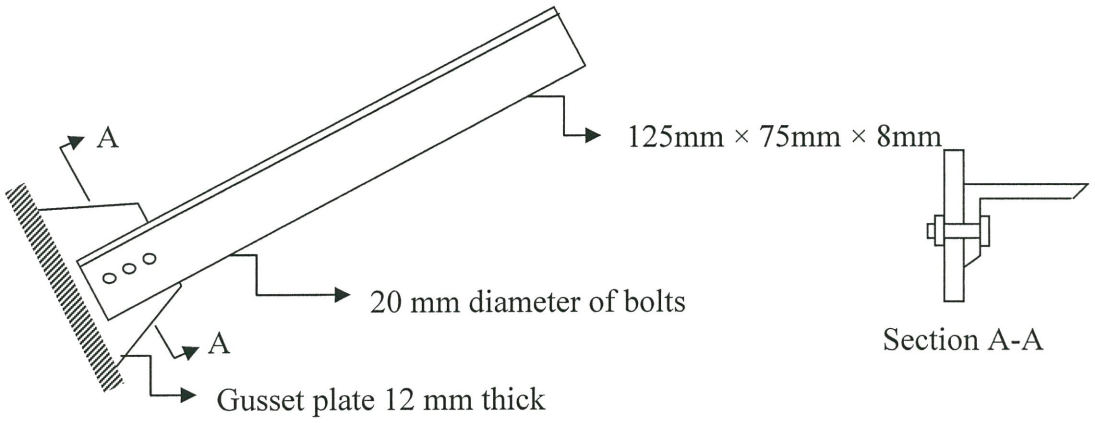


FIGURE Q2b

FINAL EXAMINATION

SEMESTER/SESSION:	SEM I/2014/2015	PROGRAMME:	BFF
COURSE NAME:	STEEL AND TIMBER STRUCTURE DESIGN	COURSE CODE:	BFC43003

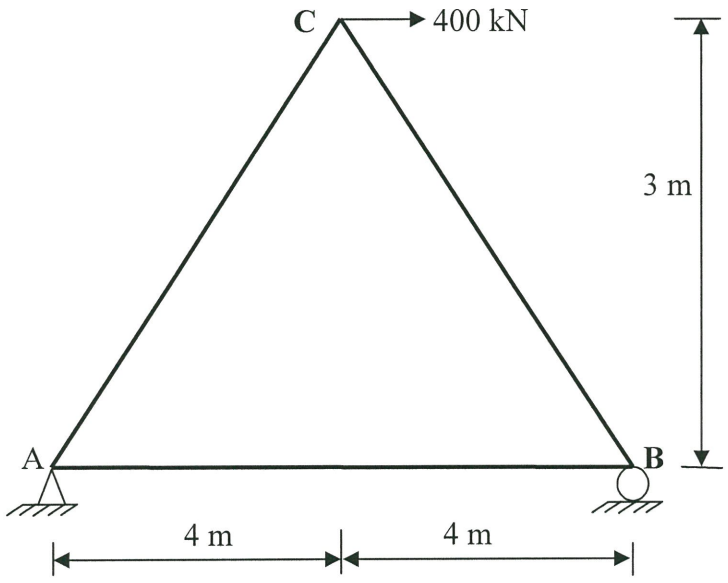


FIGURE Q3(a)

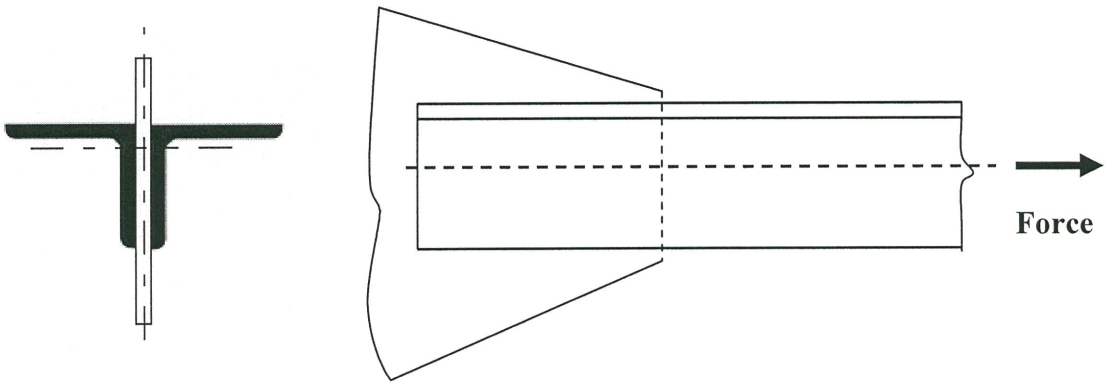


FIGURE Q3(b)

FINAL EXAMINATION

SEMESTER/SESSION:	SEM I/2014/2015	PROGRAMME:	BFF
COURSE NAME:	STEEL AND TIMBER STRUCTURE DESIGN	COURSE CODE:	BFC43003

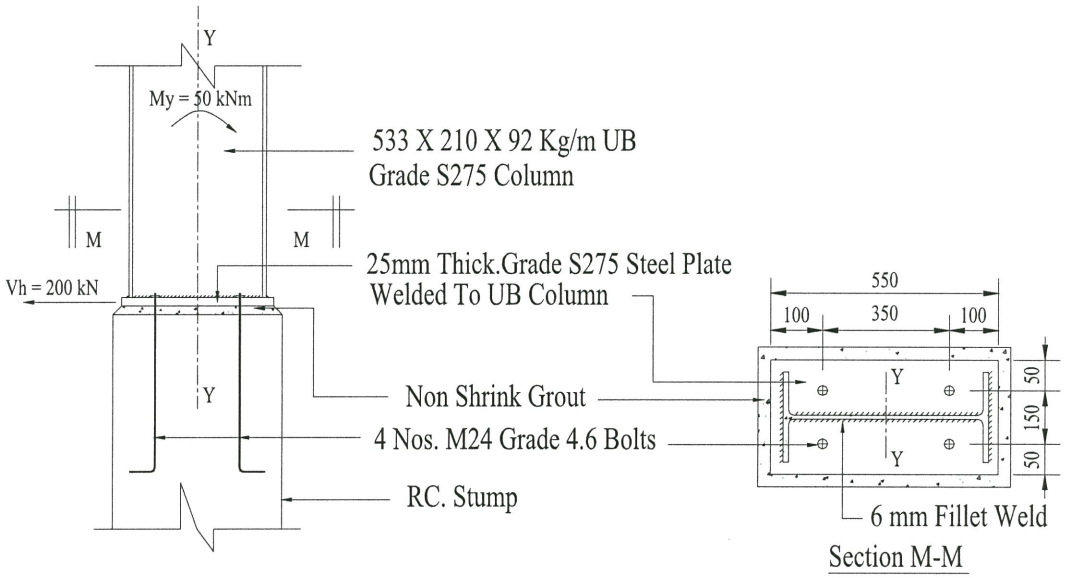


FIGURE Q5

FINAL EXAMINATION

SEMESTER/SESSION:	SEM I/2014/2015	PROGRAMME:	BFF
COURSE NAME:	STEEL AND TIMBER STRUCTURE DESIGN	COURSE CODE:	BFC43003

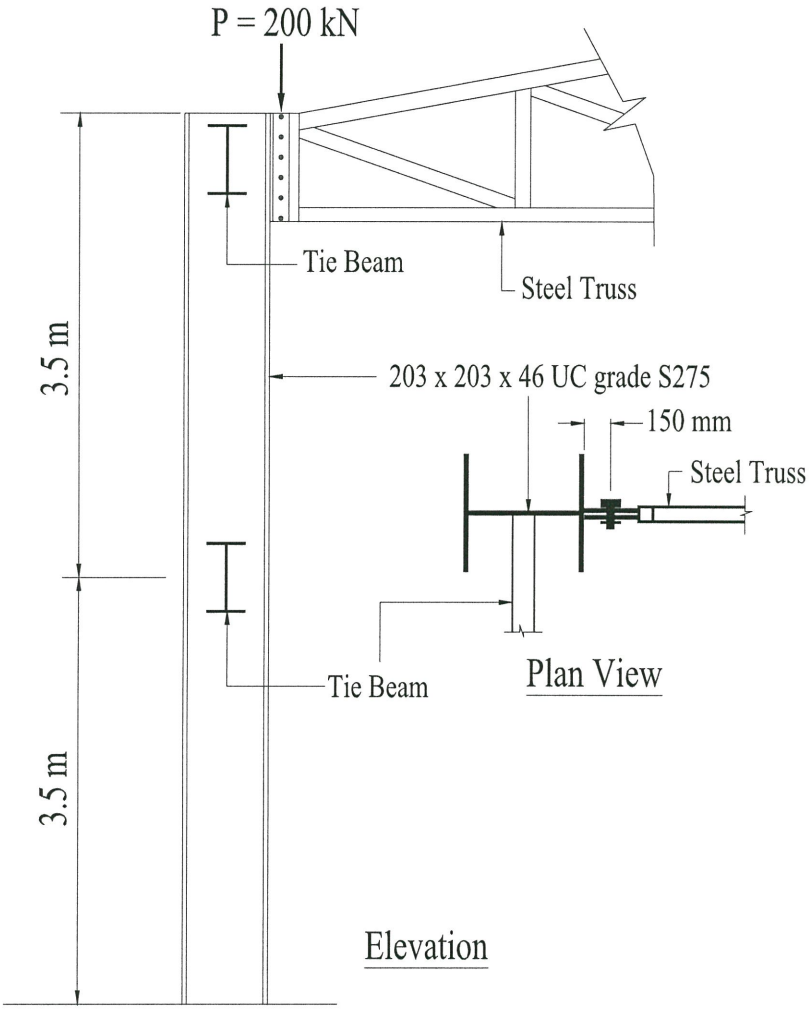
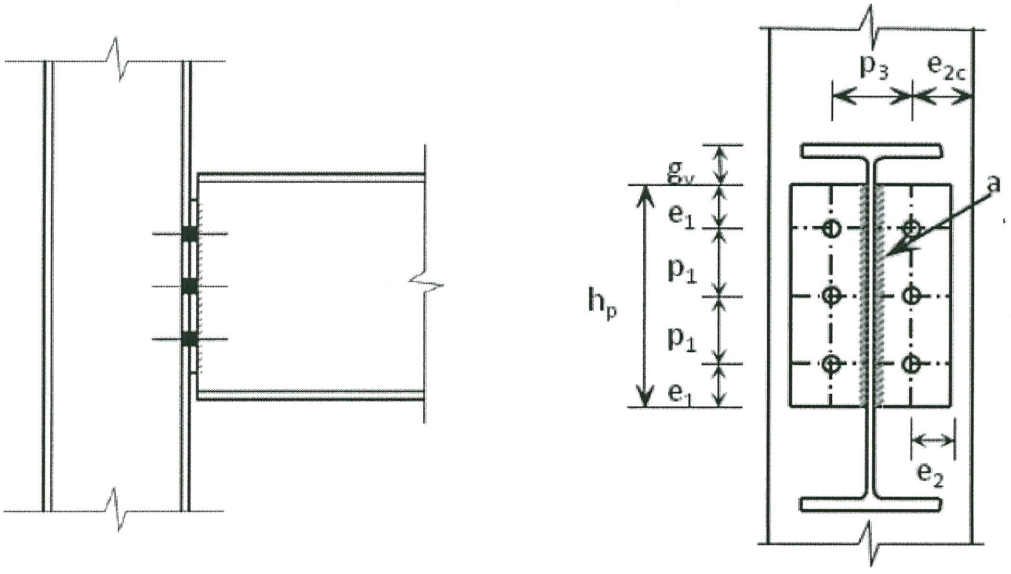


FIGURE Q6

FINAL EXAMINATION

SEMESTER/SESSION:	SEM I/2014/2015	PROGRAMME:	BFF
COURSE NAME:	STEEL AND TIMBER STRUCTURE DESIGN	COURSE CODE:	BFC43003



Side elevation **Cross section**

FIGURE Q7

FINAL EXAMINATION

SEMESTER/SESSION:	SEM I/2014/2015	PROGRAMME:	BFF
COURSE NAME:	STEEL AND TIMBER STRUCTURE DESIGN	COURSE CODE:	BFC43003

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)	
	$t \leq 16$	$16 < t \leq 40$	$40 < t \leq 63$	$63 < t \leq 50$	$t_p < 3$	$3 \leq t_p \leq 100$
S 235	235	225	215	215	360	360
S 275	275	265	255	245	430	410
S 355	355	345	335	325	510	470