Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2021/2022

COURSE NAME	:	STRUCTURAL STEEL DESIGN
COURSE CODE	:	BFC 44903
PROGRAMME CODE	:	BFF
EXAMINATION DATE	:	JANUARY / FEBRUARY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **FOUR** QUESTIONS ONLY. 2. UNLESS OTHERWISE SPECIFIED, ALL CALCULATIONS TO BE BASED ON BS EN 1993. 3. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **OPEN BOOK**.

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

Q1 (a) List **THREE (3)** factors that affect local buckling.

(6 marks)

(b) Determine the cross-section classification of a beam with the size of 356 x 171 x 45 UB subjected under combined bending moment of 200 kNm and axial load of 150 kN. Use steel grade S275.

Given:

$$\alpha = \frac{1}{c_w}\left(\frac{h}{2} + \frac{1}{2}\frac{N_{Ed}}{t_w f_y} - (t_f + r)\right) \leq 1$$

(9 marks)

(c) A 533 x 312 x 151 UB section is designed with lateral restrained provided only at the support. Check the suitability for buckling resistance to withstand design bending moment of 350 kNm and design shear force of 180 kN. Use nominal value of yield strength of 355 N/mm^2 and ignore beam self-weight.

Use elastic critical moment, M_{cr} = ****** x 10^4 Nmm.
****** is your Matric card number. For example, your Matric card number is AF 180051. Therefore M_{cr} = 180051 x 10^4 Nmm.

(10 marks)

Q2 **Figure Q2** shows a three-storey corner column for a simple non-sway frame. The size of the column is 203 × 203 × 60 UC with steel grade of S275. The beam support reactions are as shown in the figure.

(a) Justify the column can be designed as simple construction.

(1 mark)

(b) Determine the total axial load of the column. Include the self-weight of the column in your calculation.

(1 mark)

(c) Determine the moment about major and minor axes at joint B.

(4 marks)

(d) Determine the bending stiffness of column AB, BC and CD for both y and z axes.

(4 marks)

(e) Determine the value of design moment for upper column (M_{BC}) and lower column (M_{BA}) at joint B. Consider the moment about y-y axis only.

(5 marks)

(f) Prove that the design moment can be equally distribute between the upper column and the lower column at Joint C. Calculate the design moment about y-y axis.

(5 marks)

(g) If column AB and BC are using the same section of 203 × 203 × 60 UC; meanwhile the column CD is using 203 × 203 × 46 UC. What will be the effect in the column analysis? Justify your answer with calculation.

(5 marks)

Q3 A cantilever truss is subjected to an applied load 1000 kN at welded joints (B and C) on its rafter as shown in **Figure Q3**. All truss members are made from circular hollow section with S275 grade.

(a) Determine member forces in member BC and CD.

(5 marks)

(b) Design member BC. Strictly consider economical aspect. (Tips: Determine the member initial sizes by assuming $\chi = 0.5$ if it is compression member).

(10 marks)

(c) Design member CD. Strictly consider economical aspect.. (Tips: Determine the member initial sizes by assuming $\chi = 0.5$ if it is compression member).

(10 marks)

Q4 **Figure Q4** shows a structural system to be built to carry a maximum load of 15 tonne at P. PQ is a SHS 100 × 100 × 3 and PR is a heavy duty chain. The system is connected to a 457 × 191 × 82 UB roof unit and the wall, respectively, at R and Q.

You are the structural engineer appointed for the design of this structural system.

(a) Calculate the internal force in kN that must be resisted by the heavy duty chain PR. Indicate the type of stress, whether compressive or tensile stress, that has to be resisted by the chain.

(3 marks)

(b) Present a full design calculation for the bolted connection at point R. You can only use 4 bolts as illustrated in Detail A. Specify the type and size of bolts to be used. An overdesign connection will turn down the client resulting in the loss of the job.

(7 marks)

(c) Present a full design calculation for the fillet weld that connects the 20 mm thick eye plate to the 20 mm thick plate as shown in Detail A.

(6 marks)

(d) Summarise your design with a complete detailing sketch of Detail A and cross section B-B. Provide important labelling and the required dimensions for L1 and L2 in unit mm.

(5 marks)

(e) If 15 tonne is to be carried also at Q, what would be the vertical component force at R in kN? How will this change your bolt and fillet weld connection design? fillet weld connection design?

(4 marks)

Q5 (a) Define **THREE (3)** types of bracing that can contribute to avoiding out-of-plane buckling.

(3 marks)

(b) **Figure Q5** shows the bending moment diagram of an industrial building. Given:

Steel Grade	=	S275
Column Size	=	610 X 229 X 125 UB
Rafter Size	=	533 X 210 X 92 UB

Using the design guideline from EN1993-1-1

(i) Calculate the plastic section modulus by assuming the section is class 1.

(2 marks)

(ii) Check the position of first torsional restraint of the column if the position to be suggested at 3m from top of the column (Assume no reduction in bending resistance for shear).

(17 marks)

(iii) Discuss the position of torsional restraint in **Q5(b)(ii)**

(2 marks)

(iv) Draw the location of the first torsional restraint.

(1 mark)

– END OF QUESTIONS –

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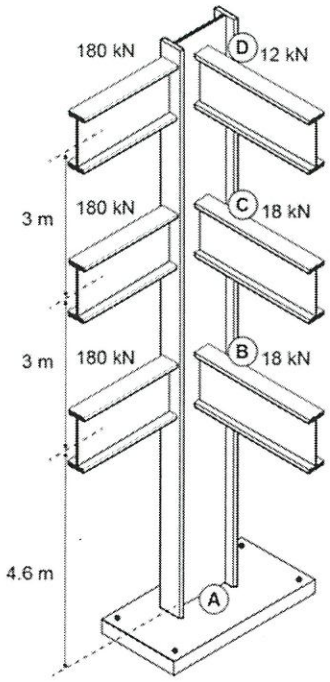

FIGURE Q2

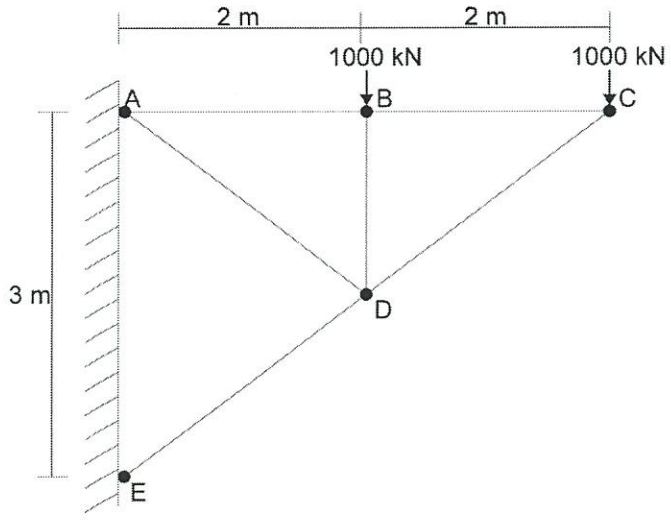

FIGURE Q3

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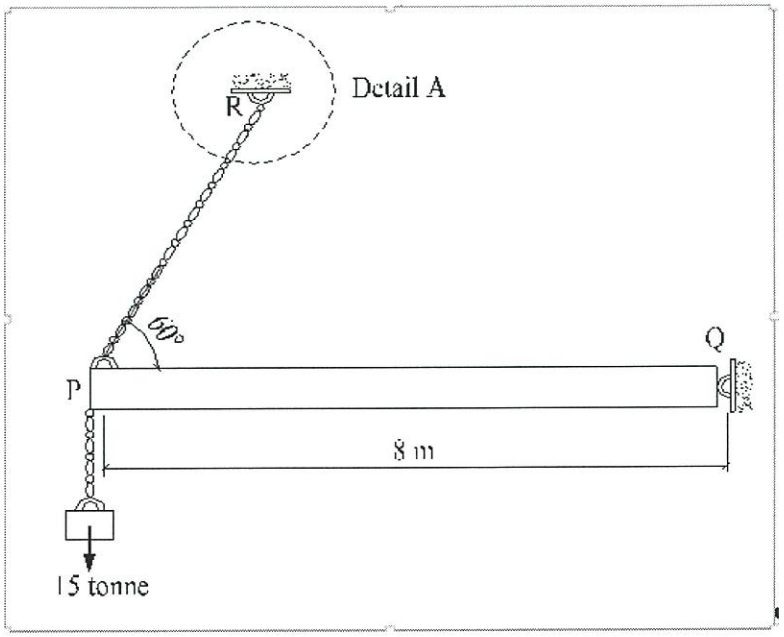

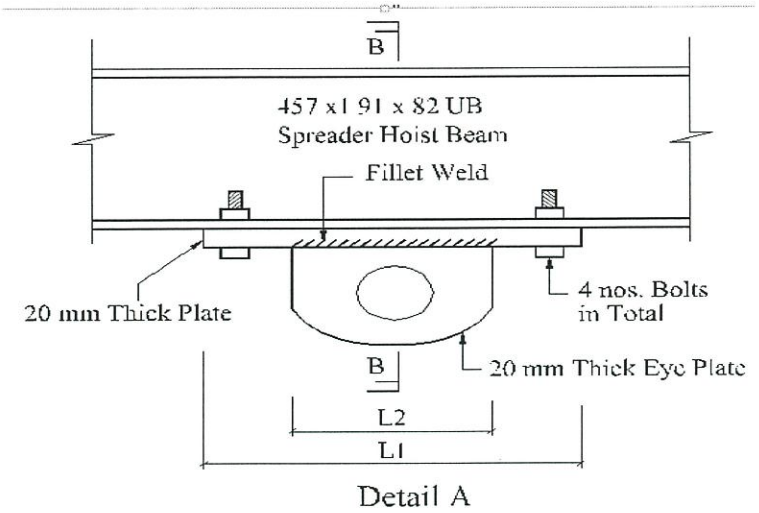

FIGURE Q4

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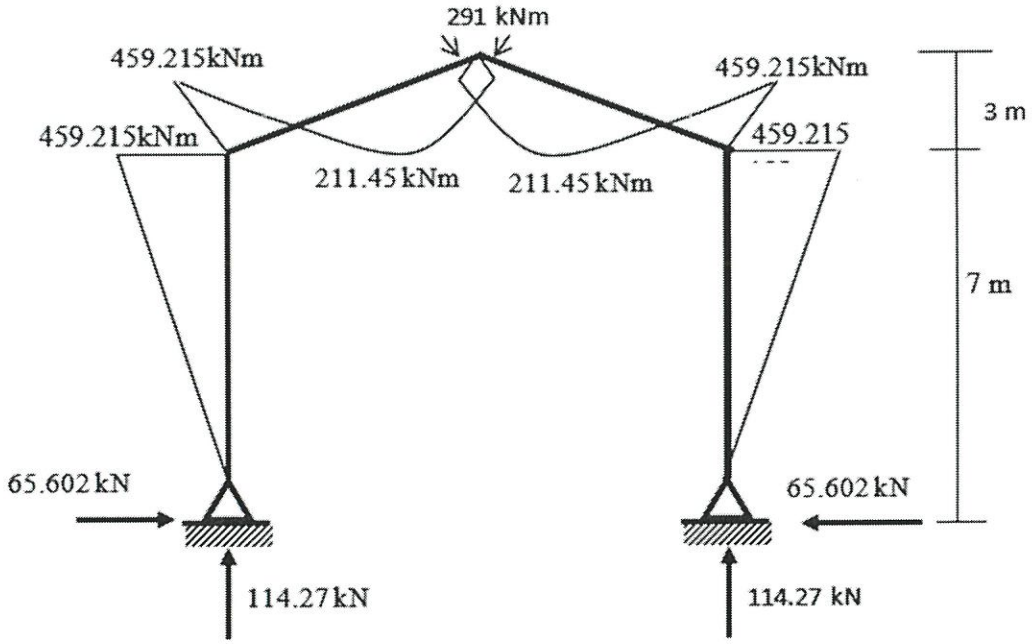

FIGURE Q5