(*University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2021/2022 ACADEMIC YEAR

FOURTH YEAR SEMESTER ONE SUPPLEMENTARY/SPECIAL EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND STRUCTURAL ENGINEERING

COURSE CODE: CSE 411

COURSE TITLE: STRUCTURAL STEEL DESIGN

DATE: 04 OCTOBER 2022 **TIME:** 9:00-11:00 HRS

INSTRUCTIONS:

1. This paper contains FIVE questions
2. Attempt ALL questions in Section A and ANY TWO questions in SECTION B
3. Marks for each question are indicated in the parenthesis.
4. You are permitted to use a printed copy of (a)BS5950 as well as (b)Steel Section Tables. No additional information should be written.

Examination duration is **2 Hour**

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 6 Printed Pages. Please Turn Over.

SECTION A {COMPULSORY}

Question One **(30 marks)**

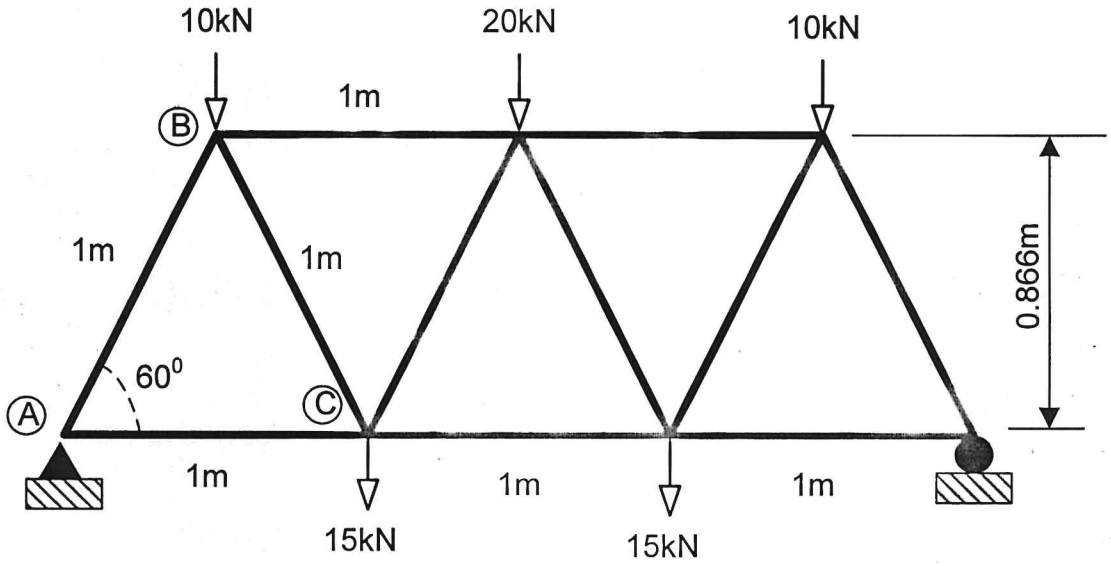
a) Briefly describe the possible failure modes for bolted connections **[6mks]**

b) Given the truss structure below

i. Determine the adequacy of using L60x60x5 grade S355 steel section as member A-B **[14mks]**

ii. Determine the adequacy of using L60x60x5 grade S355 steel section as member B-C **[10mks]**

Hint. $L_E = 1.0\, L_o$



SECTION B (Answer Any TWO Questions)

Question Two **(20 marks)**

a) Briefly describe the failure mechanisms that a steel column may fail **[4 marks]**

b) Determine the load capacity for a column to carry a compressive axial load made of (Rectangular Hollow Section) RHS 60x40x4 angle section of grade S355 steel. The column is 2.25m tall and is fully restrained at the bottom and pinned at the top. **[16 marks]**

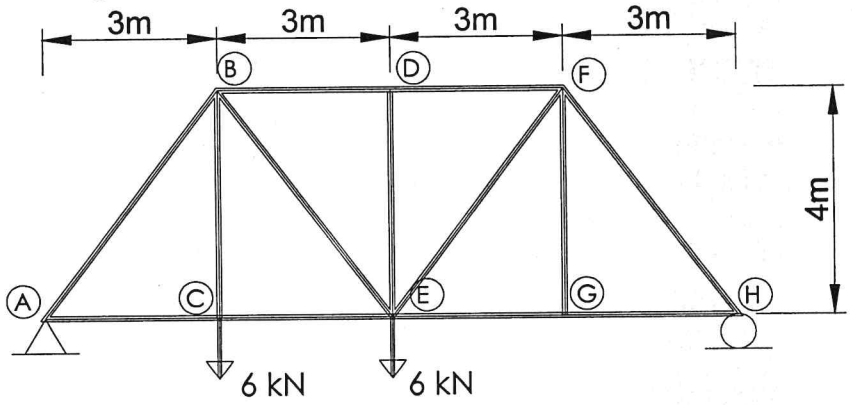
Question Three **(20 marks)**

Investigate the adequacy of a 6.5 metre long simply supported Grade S275 406x140UB46 steel section loaded with uniformly distributed permanent load of 20 kN/m and variable action 7 kN/m load, if the deflection is to be limited to span/250

(a) Calculate and draw the shear force diagram and bending moment diagram (2 mks)
(b) Classify the section accordingly (3 mks)
(c) Check the adequacy of Moment capacity of the section (6 mks)
(d) Check the adequacy of shear capacity of the section (6 mks)
(e) Check the deflection of the member (3 marks)

Question Four (20 marks)

Consider the following Pratt truss bridge;



Determine

(a) Calculate the reactions (3 mks)

(b) Calculate the member forces (17 mks)

	Member	Force, magnitude, kN	Compressive (C) or Tensile (T)
1	GH		
2	FH		
3	FG		
4	EG		
5	EF		
6	DF		
7	DE		
8	BD		
9	BC		
10	AB		
11	BE		
12	AC		
13	CE		

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MEMORY AIDE/ REFERENCE

i) Calculation of deflections for simple supported beams

Deflection due to point load (P kN) at midspan of beam L m long $\delta = \frac{Pl^3}{48EI}$

Deflection due to a uniformly distributed load (ω kN/m) of a simply supported beam L meters long $\delta = \frac{5\omega l^4}{384EI}$

ii) Bolt Areas

Diameter of bolt=d (mm)	12	16	20	24	30
Area=A_s (mm²)	84.3	157	245	353	561

iii) vii) Loading

BS EN 1990-A1.3.2(4) $UDL_{Ultimate} = 1.35 \times G_k + 1.5 \times Q_k$

iv) Angle connected with one leg

EC3-1-8 3.10.3

With 2 bolts

$$N_{u,Rd} = \frac{\beta_2 A_{net} f_u}{\gamma_{M2}}$$

With 3 or more bolts

$$N_{u,Rd} = \frac{\beta_3 A_{net} f_u}{\gamma_{M2}}$$

Pitch	p_1	$\leq 2.5\ d_o$	$\geq 5.0\ d_o$
2 bolts	β_2	0.4	0.7
3 bolts or more	β_3	0.5	0.7

v) Concrete compressive strength

Concrete class	C25/30	C30/37	C35/40	C40/50
f_{ck} (N/mm²)	30	37	40	50
f_{cd} (N/mm²) Design compressive strength	14.2	16.8	17	22.7

3.1.3 Other properties

For the elastic properties of steel, the following values should be used.

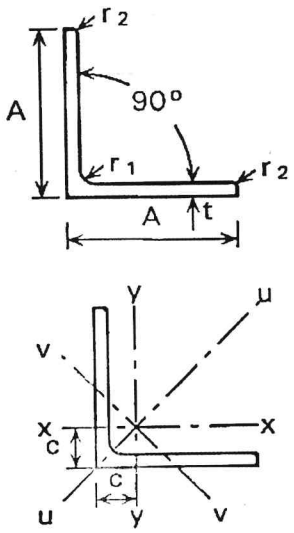
— Modulus of elasticity: $E = 205\ 000$ N/mm²

— Shear modulus: $G = E/[2(1 + \nu)]$

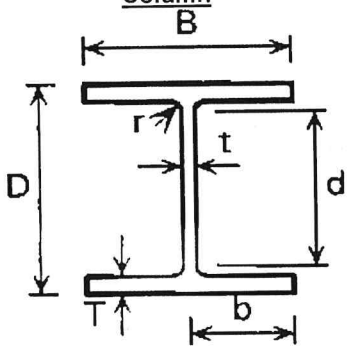
— Poisson's ratio: $\nu = 0.30$

— Coefficient of linear thermal expansion (in the ambient temperature range): $\alpha = 12 \times 10^{-6}$ per °C

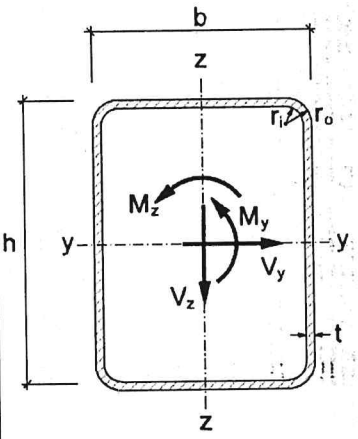
Equal angle



Universal Beam and Universal Column



Rectangular Hollow section



Section properties

				Universal Beam	Universal Column	Equal Angle	Rectangular Hollow Section
				406x140x46	**305x305x97**	**60x60x5**	**60x40x4**
Mass per metre			kg/m	46.0	96.9	4.57	5.64
Depth of section		h	mm	403.2	307.9	60	60
Width of section		b	mm	142.2	305.3	60	40
		C	mm			1.64	
Thickness	Web	t_w	mm	6.8	9.9		
	Flange	t_f	mm	11.2	15.4		
		T	mm				4
Root radius		r	mm	10.2	15.2		
	root	r_1	mm			8	
	toe	r_2	mm			4	
Depth between fillets		D	mm	360.4	246.7		
Ratios for local buckling	Web	c_w/t_w		53.0	24.9		
	Flange	c_f/t_f		5.13	8.6		
		c_w/t					12.0
		c_f/t					7.00
Second moment of area	Axis y-y		cm4	15700	22200	19.4	32.8
	Axis z-z		cm4	538	7310	19.4	17.0
	Axis u-u		cm4			30.7	
	Axis v-v		cm4			8.03	
Radius of gyration	Axis y-y		cm	16.4	13.4	1.82	2.14
	Axis z-z		cm	3.03	7.69		1.54
	Axis u-u		cm			2.3	
	Axis v-v		cm			1.17	
Elastic modulus	Axis y-y		cm3	778	1450	4.45	10.9
	Axis z-z		cm3	75.7	479	4.45	8.52
Plastic modulus	Axis y-y		cm3	888	1590		13.8
	Axis z-z		cm3	118	726		10.3
Area of section		A	cm2	58.6	123	5.82	7.19