A Centre of Excellence

TECHNICAL UNIVERSITY OF MOMBASA (TUM)

UNIVERSITY REGULAR EXAMINATIONS FOR:

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 4327: STRUCTURAL DESIGN I

END OF SEMESTER EXAMINATION
SERIES: 2024/2025
TIME: 2 HOURS

Instructions to Candidates:

i. This paper contains **FOUR** questions
ii. Answer Question **ONE and** any **other TWO**
iii. Marks for each question are indicated in the parentheses.
iv. Relevant standard codes are allowed.
v. Tables with properties of UC, UB and Angles are allowed
vi. The usual notations apply

ECV 4327: STRUCTURAL DESIGN I

Question One [30 marks]

(a) Briefly explain the demerits of using structural steel. **[6 marks]**

(b) Discuss the factors which influence the strength of timber and explain how the strength of timber is assessed in practice. **[12 marks]**

(c) Briefly explain any **FIVE** advantages and disadvantages of using welded connection connections. **[5 marks]**

(d) Explain the Lateral torsional buckling of steel beam using a sketch. **[3 marks]**

(e) Outline the Classification of steel cross-sections. **[4 marks]**

Question Two [20 marks]

A mechanically graded timber column of strength class C16 consists of a 100 mm square section (figure Q2) which is restrained at both ends in position but not in direction. Assuming that the service conditions comply with Service Class 2 and the actual height of the column is 4m.

i) Calculate the axial load capacity of the column can support. **[12 marks]**

ii) Check the adequacy of the column to resist a long-term design axial load of $10\,\text{kN}$ applied 40 mm Eccentric to its y–y axis. **[8 marks]**

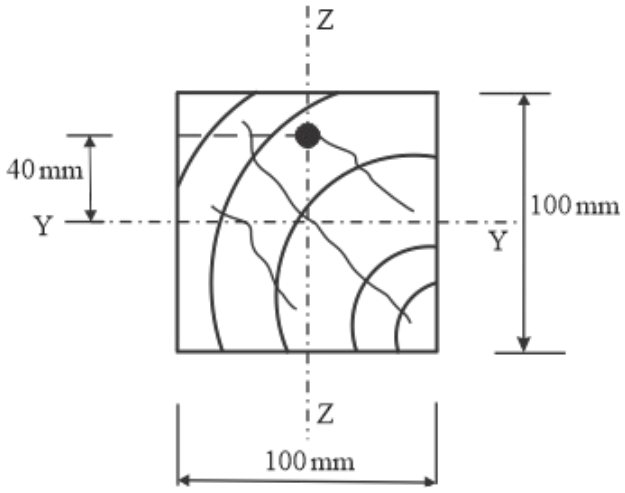

Figure Q2

Question Three [20 marks]

Check the suitability of $356\times171\times67\,\text{kg/m}$ UB section in S275 steel loaded by uniformly distributed loading $g_k = 7\,\text{kN/m}$ and $q_k = 5\,\text{kN/m}$ as shown in Figure Q3. Assume that the beam is fully laterally restrained and that the beam sits on 100 mm bearings at each end. Ignore self-weight of beam.

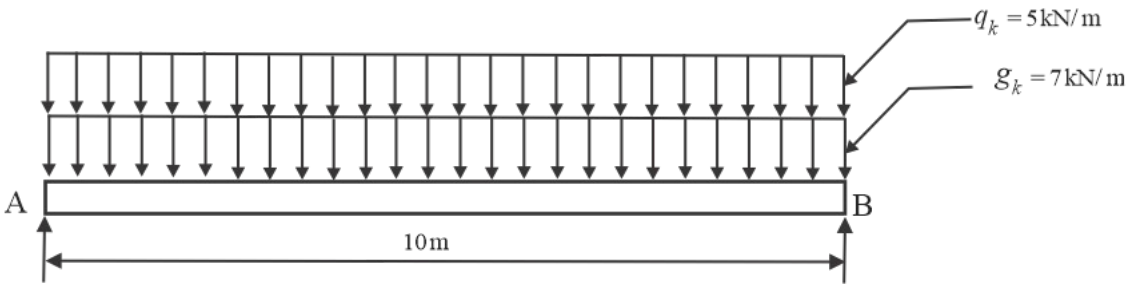

Figure Q3

Question four [20 marks]

Calculate the design resistance of the connection detail shown in figure Q4. The cover plates are made of S275 steel and connected with either

a) non-preloaded bolts of diameter 20 mm and class 4.6 or **[14 marks]**

b) Prestressed bolts of diameter 16 mm and class 8.8 **[6 marks]**

Assume that in both cases, the shear plane passes through the unthreaded portions of the bolts.

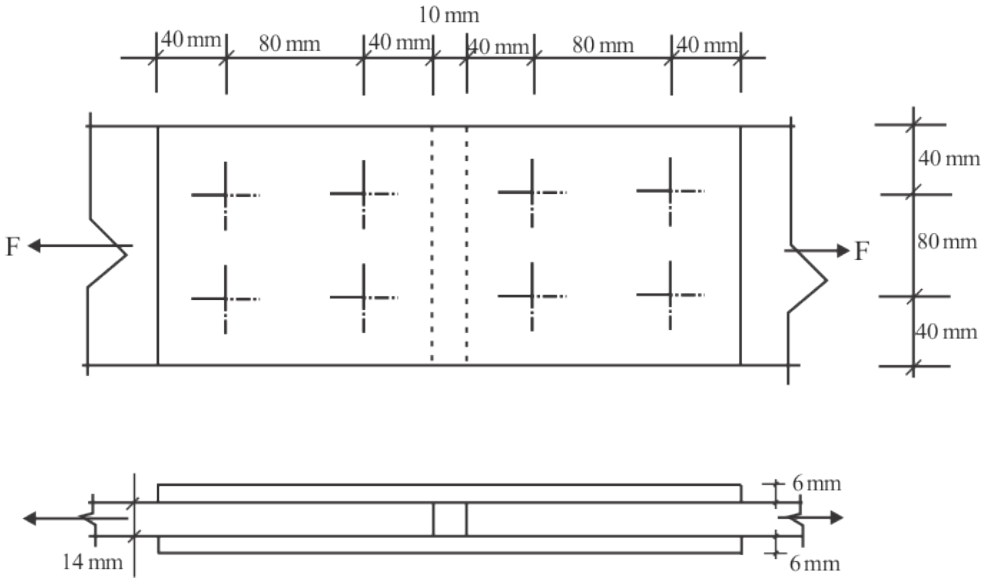

Figure Q4

Nominal size and thread diameter (mm)	*Tensile stress area, A_t (mm^2)*
12	84.3
16	157
20	245
22	303
24	353
27	459
30	561

Table 2. Proof load of HSFG bolts, P_o

Nominal size and thread diameter (mm)	*Minimum shank tension or proof load (kN)*
12	49.4
16	92.1
20	144
22	177
24	207
27	234
30	286
36	418

GRADE STRESS AND MODULUS OF ELASTICITY FOR C16

Values in N/mm^2 are as follows

Bending parallel to grain $\sigma_{m,g,\parallel}$	*Shear parallel to grain* τ_g	*Compression perpendicular to grain* $\sigma_{c,g,\perp}$	*Modulus of elasticity* E_{min}
5.3	0.67	1.7	5800

Geometrical properties of sawn softwoods

Customary target size*	Area	Section Modulus		Second of moment area		Radius of gyration	
mm	$10^3 mm^2$	About x–x $10^3 mm^3$	About y–y $10^3 mm^3$	About x–x $10^6 mm^4$	About y–y $10^6 mm^4$	About x–x mm	About y–y mm
22 × 100	2.20	36.6	8.1	1.83	0.089	28.9	6.35
38 × 100	3.80	63.3	24.1	3.17	0.457	28.9	11.0
38 × 150	5.70	143	36.1	10.7	0.686	43.3	11.0
38 × 175	6.54	194	42.1	17.0	0.800	50.5	11.0
38 × 200	7.60	253	48.1	25.3	0.915	57.7	11.0
38 × 225	8.55	321	54.2	36.1	1.03	65.0	11.0
47 × 75	3.53	44.1	27.6	1.65	0.649	21.7	13.6
47 × 100	4.70	78.3	36.8	3.92	0.865	28.9	13.6
47 × 125	5.88	122	46.0	7.65	1.08	36.1	13.6
47 × 150	7.05	176	55.2	13.2	1.30	43.3	13.6
47 × 175	8.23	240	64.4	21.0	1.51	50.5	13.6
47 × 200	9.40	313	73.6	31.3	1.73	57.7	13.6
47 × 225	10.6	397	82.8	44.6	1.95	65.0	13.6
47 × 250	11.8	490	92.0	61.2	2.16	72.2	13.6
47 × 300	14.1	705	110	106	2.60	86.6	13.6
63 × 150	9.45	236	99.2	17.7	3.13	43.3	18.2
63 × 175	11.0	322	116	28.1	3.65	50.5	18.2
63 × 200	12.6	420	132	42.0	4.17	57.7	18.2
63 × 225	14.2	532	149	59.8	4.69	65.0	18.2

Customary target size*	Area	Section Modulus		Second moment of area		Radius of gyration	
mm	$10^3 mm^2$	About x–x $10^3 mm^3$	About y–y $10^3 mm^3$	About x–x $10^6 mm^4$	About y–y $10^6 mm^4$	About x–x mm	About y–y mm
75 × 100	7.50	125	93.8	6.25	3.52	28.9	21.7
75 × 150	11.3	281	141	21.1	5.27	43.3	21.7
75 × 175	13.1	383	164	33.5	6.15	50.5	21.7
75 × 200	15.0	500	188	50.0	7.03	57.7	21.7
75 × 225	16.9	633	211	71.2	7.91	65.0	21.7
75 × 250	18.8	781	234	97.7	8.79	72.2	21.7
75 × 300	22.5	1130	281	169	10.5	86.6	21.7
100 × 100	10.0	167	167	8.33	8.33	28.9	28.9
100 × 150	15.0	375	250	28.1	12.5	43.3	28.9
100 × 200	20.0	667	333	66.7	16.7	57.7	28.9
100 × 225	22.5	844	375	94.9	18.8	65.0	28.9
100 × 250	25.0	1010	417	130	20.8	72.2	28.9
100 × 300	30.0	1500	500	225	25.0	86.6	28.9
150 × 150	20.0	563	563	42.2	42.2	43.3	43.3
150 × 300	30.0	2250	1130	338	84.4	86.6	43.3
300 × 300	90.0	4500	4500	675	675	86.6	86.6

Note. * Desired size of timber measured at 20% moisture content