THE OPEN UNIVERSITY OF SRI LANKA
Diploma In Technology (Civil) / Bachelor of Technology – Level 3
CEX 3231 – Structural Analysis & Design 1
Final Examination – 2006/2007
Time Allowed 3 hours

Date 21st of March 2007 Time – 9.30 – 12.30 hrs

Answer Five questions selecting not less than two questions from each section.
Please write answers clearly showing any derivations required and stating necessary assumptions.

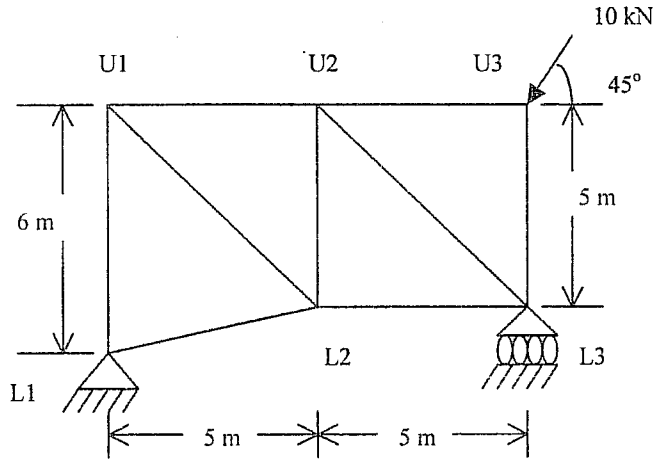
SECTION A

Q1a). State four assumptions used in analyzing of pin-jointed trusses

(6 Marks)

b). A pin-jointed truss is hinged to a support at L1, on a roller support at L3 and loaded as shown in the figure below. Determine the forces in all the members of the frame by the 'method of joints'.
(10 Marks)

c). Determine the forces in members U2U1, U2L2, L2L3 of the truss by the 'method of section".
(4 Marks)



Q2.) a). Discuss the advantages of virtual work method for calculation of displacement of trusses over strain energy method.

(5 Marks)

b).

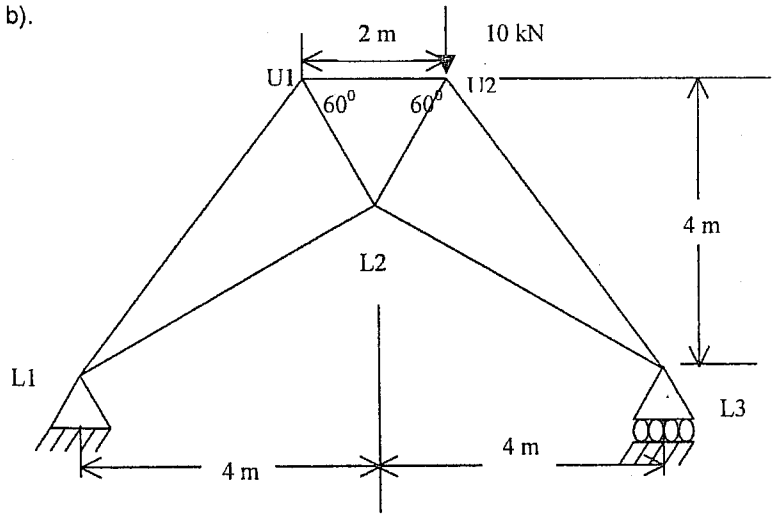


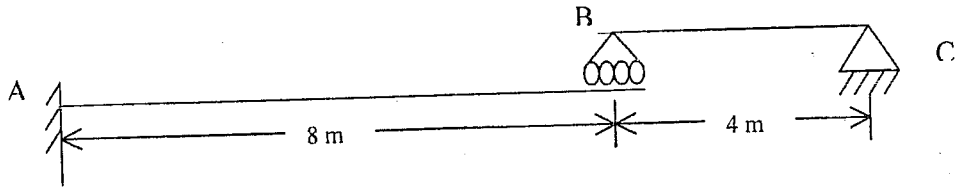
Figure 2 shows a pin-jointed frame, which is hinged to the support at L1 and on a roller support at L3. Take EA as constant for all members.
Calculate movements of the following joints in the specified directions due to the given load:

i). the vertical deflection of the point U2 (9 Marks)
ii). the vertical deflection of the point L2 (6 Marks)

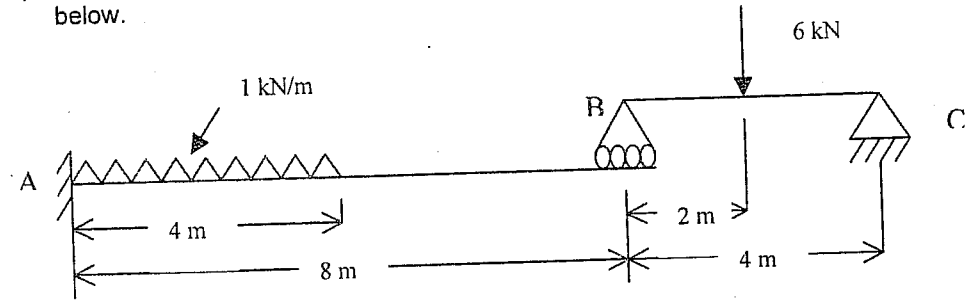
3.a) Draw the influence lines of following actions of the beam given below.

i). Reaction at A
ii). Moment at A
iii). Bending moment at mid span of AB

(3x3 Marks)



b). Draw the Shear force diagram and the bending moment diagram for section **AB** of beam given below.



(11 Marks)

SECTION B

Data sheets are available and should be returned please, before you leave the examination hall

4. a).How does BS code allows for the effect of eccentricity of connections? (5 Marks)

b). Find out the tensile capacity of the 80x80x10 single angle member used as a web member of a roof truss. The single angle member is connected to a 12 mm thickness gusset plate with 18 mm diameter bolts. Take allowable stress in axial tension as 170 N/mm^2. (10 Marks)

c). If load applied on the tensile member is 50 kN, determine the number of bolts required to connect the member to gusset plate.
The allowable strengths are:
the allowable stress in bolts in clearance holes, in shear = 80 N/mm^2
the allowable stress in bolts in clearance holes, in bearing = 250 N/mm^2
the allowable bearing stresses on connected parts = 250 N/mm^2
the edge distance of 20 mm diameter holes = 30 mm (5 Marks)

the properties of a 80x80x10 equal angle as follows
Area of Section = 15.1 cm^2, distance to center of gravity c = 2.34 cm,
Second moment of area
relative to xx-axis , y-y axis =87.6 cm^4
Radius of gyration
relative to x-x axis and y-y axis = 2.41 cm and vv-axis =1.54 cm

5 a). State how the buckling failure in compression members of roof truss can be checked.

(4 Marks)

b). A single angle member 80x80x10 used in roof truss is 3.0 m long and which is connected by two 18 mm bolts. Determine its compressive strength.

(6 marks)

c). If the member is subjected to 30 kN axial compression load and 5 kNm maximum bending moment, check the suitability of 80x80x10 single angle.

(10 Marks)

6 a). Explain the difference between the "Normal" and "Post Disaster" buildings or structures.

(2 Marks)

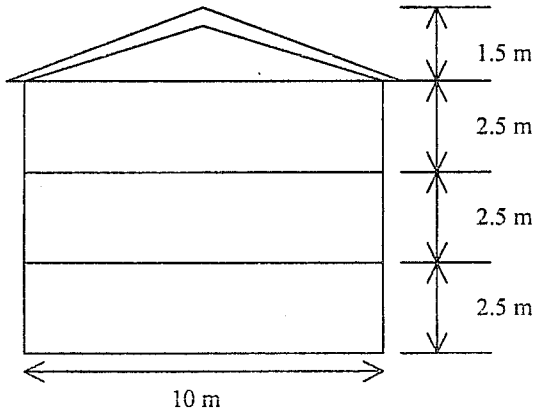
b). Discuss three factors used in determination of design wind speed according to BSCP 3 Chapter v part 2.

(6 Marks)

c). Explain the terms "Wind ward slope" and "Lee ward slope" used in wind load calculation with diagrams.

(2 Marks)

d).



Above figure shows a sketch of a typical frame of a school building situated in Matara area. Calculate the total wind load on the frame per 1 m width of the roof.

Wind loading conditions:

- The site is in ground roughness category type 3, i.e. a small town;
- The greatest horizontal dimension of the building is 20 m;
- Center to center distance of two frames is 5 m.
- Assume that only wind blowing parallel to the truss span is effective; i.e. $\alpha = 0°$
- Assume that the internal pressure coefficient Cpi = +0.1

(10 Marks)

7. (a) Discuss the failure modes of a bolted joint with suitable diagrams.

(6 Marks)

(b). Explain the differences between "edge distance" and "end distance" in relation to bolts

(3 Marks)

(c). Explain what you understand by the term "Factor of safety" used in elastic design method.

(6 Marks)

(d). State the assumptions used in derivation of "Euler Buckling load" of struts

(5 Marks)

Table 3. Ground roughness, building size and height above ground, factor S_2

H	(1) Open country with no obstructions			(2) Open country with scattered windbreaks			(3) Country with many windbreaks; small towns; outskirts of large cities			(4) Surface with large and frequent obstructions, e.g. city centres		
	Class			Class			Class			Class		
	A	B	C	A	B	C	A	B	C	A	B	C
m												
3 or less	0.83	0.78	0.73	0.72	0.67	0.63	0.64	0.60	0.55	0.56	0.52	0.47
5	0.88	0.83	0.78	0.79	0.74	0.70	0.70	0.65	0.60	0.60	0.55	0.50
10	1.00	0.95	0.90	0.93	0.88	0.83	0.78	0.74	0.69	0.67	0.62	0.58
15	1.03	0.99	0.94	1.00	0.95	0.91	0.88	0.83	0.78	0.74	0.69	0.64
20	1.06	1.01	0.96	1.03	0.98	0.94	0.95	0.90	0.85	0.79	0.75	0.70
30	1.09	1.05	1.00	1.07	1.03	0.98	1.01	0.97	0.92	0.90	0.85	0.79
40	1.12	1.08	1.03	1.10	1.06	1.01	1.05	1.01	0.96	0.97	0.93	0.89
50	1.14	1.10	1.06	1.12	1.08	1.04	1.08	1.04	1.00	1.02	0.98	0.94
60	1.15	1.12	1.08	1.14	1.10	1.06	1.10	1.06	1.02	1.05	1.02	0.98
80	1.18	1.15	1.11	1.17	1.13	1.09	1.13	1.10	1.06	1.10	1.07	1.03
100	1.20	1.17	1.13	1.19	1.16	1.12	1.16	1.12	1.09	1.13	1.10	1.07
120	1.22	1.19	1.15	1.21	1.18	1.14	1.18	1.15	1.11	1.15	1.13	1.10
140	1.24	1.20	1.17	1.22	1.19	1.16	1.20	1.17	1.13	1.17	1.15	1.12
160	1.25	1.22	1.19	1.24	1.21	1.18	1.21	1.18	1.15	1.19	1.17	1.14
180	1.26	1.23	1.20	1.25	1.22	1.19	1.23	1.20	1.17	1.20	1.19	1.16
200	1.27	1.24	1.21	1.26	1.24	1.21	1.24	1.21	1.18	1.22	1.21	1.18

Table 8. Pressure coefficients C_{pe} for pitch roofs of rectangular clad buildings

Building height ratio	Roof angle	Wind angle α 0°		Wind angle α 90°		Local coefficients			
		E F	G H	E G	F H				
	degrees								
$\frac{h}{w} \leq \frac{1}{2}$	0	−0.8	−0.4	−0.8	−0.4	−2.0	−2.0	−2.0	−
	5	−0.9	−0.4	−0.8	−0.4	−1.4	−1.2	−1.2	−1.0
	10	−1.2	−0.4	−0.8	−0.6	−1.4	−1.4		−1.2
	20	−0.4	−0.4	−0.7	−0.6	+1.0			−1.2
	30	0	−0.4	−0.7	−0.6	−0.8			−1.1
	45	+0.3	−0.5	−0.7	−0.6				−1.1
	60	+0.7	−0.6	−0.7	−0.6				−1.1
$\frac{1}{2} < \frac{h}{w} \leq \frac{3}{2}$	0	−0.8	−0.6	−1.0	−0.6	−2.0	−2.0	−2.0	−
	5	−0.9	−0.6	−0.9	−0.6	−2.0	−2.0	−1.5	−1.0
	10	−1.1	−0.6	−0.8	−0.6	−2.0	−2.0	−1.5	−1.2
	20	−0.7	−0.5	−0.8	−0.6	−1.5	−1.5	−1.5	−1.0
	30	−0.2	−0.5	−0.8	−0.8	−1.0			−1.0
	45	+0.2	−0.5	−0.8	−0.8				
	60	+0.6	−0.5	−0.8	−0.8				
$\frac{3}{2} < \frac{h}{w} < 6$	0	−0.7	−0.6	−0.9	−0.7	−2.0	−2.0	−2.0	−
	5	−0.7	−0.6	−0.8	−0.8	−2.0	−2.0	−1.5	−1.0
	10	−0.7	−0.6	−0.8	−0.8	−2.0	−2.0	−1.5	−1.2
	20	−0.8	−0.6	−0.8	−0.8	−1.5	−1.5	−1.5	−1.2
	30	−1.0	−0.5	−0.8	−0.7	−1.5			
	40	−0.2	−0.5	−0.8	−0.7	−1.0			
	50	+0.2	−0.5	−0.8	−0.7				
	60	+0.5	−0.5	−0.8	−0.7				

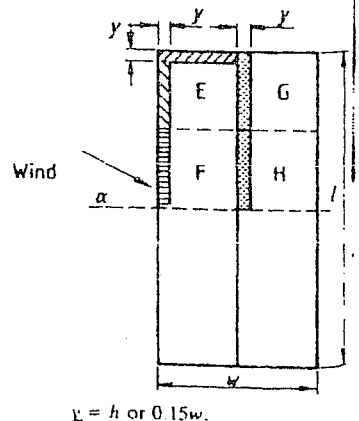
NOTE 1. h is the height to eaves or parapet and w is the lesser horizontal dimension of a building.

NOTE 2. The pressure coefficient on the underside of any roof overhang should be taken as that on the adjoining wall surface.

Where no local coefficients are given the overall coefficients apply.

NOTE 3. For hipped roofs the local coefficient for the hip ridge may be conservatively taken as the appropriate ridge value.

Key plan



$y = h$ or $0.15w$, whichever is the lesser.