THE OPEN UNIVERSITY OF SRI LANKA
Diploma in Technology (Civil) / Bachelor of Technology – Level 3
CEX 3231 – Structural Analysis & Design 1
Final Examination – 2005/2006
Time Allowed 3 hours

Date 26th of March 2006 — Time – 9.30 – 12.30 hrs

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

SECTION A

Q1 a). State the differences between statically determinate structure and statically indeterminate structures.
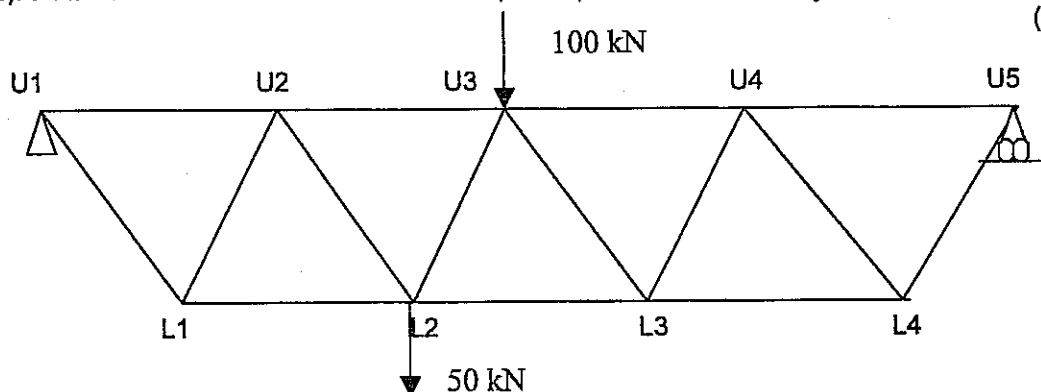
(4 Marks)

b). A pin-jointed truss formed with 2m length members is hinged to a support at U1, on a roller support at U5 and loaded as shown in the figure below. Determine the forces in all the members of the frame by the 'method of joints'.
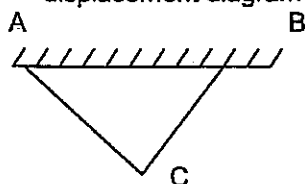
(12 Marks)

c). Determine the forces in members U2U3, U2L2, L1L2 of the truss by the 'method of section".

(4 Marks)

2. a). Describe the method of finding out displacement of C of truss shown below with "Williot displacement diagram method".
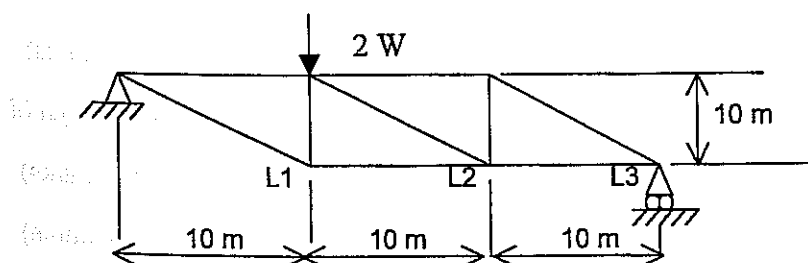
(7 Marks)

b). A pin-jointed frame is hinged to the support at U1 and on a roller support at L3 as shown in the figure below. Take EA as constant for all members.
Calculate the following and indicate the direction of the movement caused by the given load:

    i).   the vertical deflection of the point U2   (7 Marks)
   ii).   the vertical deflection of the point L1   (6 Marks)

3. a) Draw a influence lines of a following actions of the given beam below.
   i). Reaction at A
   ii). Bending moment at mid span of AB
   iii.) Bending moment at B
   iv.) Shear force at A

(8 Marks)

b). Find out the maximum effect of bending moment at mid span of AB and shear force at A for
   i). Moving <u>two concentrated loads</u> each of 5 kN and which are apart of distance 4 m.
   ii). Moving uniformly distributed load of 5 kN/m only 2 m long.

(12 marks)
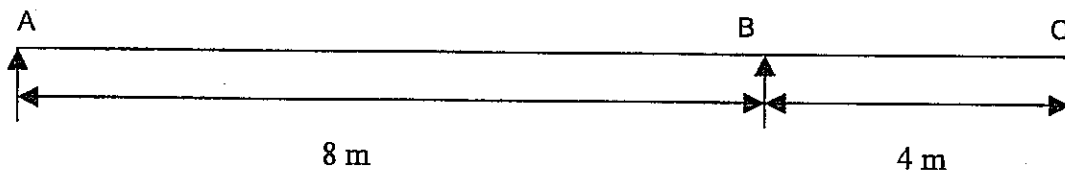
SECTION B
Data sheets are available and should be returned please, before you leave the examination hall

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

b). A truss has double angle members forming the bottom chords. A bottom chord of the truss is subjected to 50 kN of maximum tensile force and 4 kNm of maximum bending moment. Check the suitability of the 70x70x10 double angle members for above mentioned bottom chord. The double angle members are bolted with 16 mm diameter bolts to both sides of the gusset plate. Take allowable stress in axial tension as 170 N/mm^2 and allowable tensile bending stress as 170 N/mm^2.

(12 Marks)

c). Check if two 16 mm diameter bolts are sufficient to connect the above tensile member to a 12 mm thick 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 18 mm diameter holes $= 28$ mm (4 Marks)

the properties of a 70x70x10 equal angle as follows
Area of Section = 13.1 cm^2, distance to centre of gravity c = 2.1 cm,
Second moment of area
relative to xx-axis and y-y axis =58.0 cm^4, relative u-u axis = 91.6 cm^4,
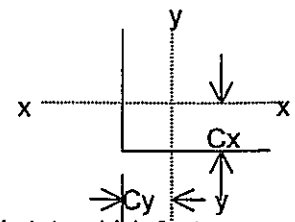relative v-v axis = 21.4 cm^4
Radius of gyration
relative to x-x axis and y-y axis = 2.1 cm

5 a). Define the term 'slenderness ratio' used in compression members and state which factors change/effect the 'slenderness ratio'. (4 Marks)

b). A double angle member formed with legs of 75 x 75 x 10 connected back to back to both sides of an 8 mm thick gusset plate. Find out r_{xx} and r_{yy} of given double angle.

(7 marks)

c). Check that the above-mentioned double angle is safe from buckling assuming effective length of the members for all axes as 3.5 m.

(6 Marks)

d). Find out the compression capacity of the above double angels.

(3 Marks)

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6. a). Sate the difference between permissible stress design method and Limit state design method
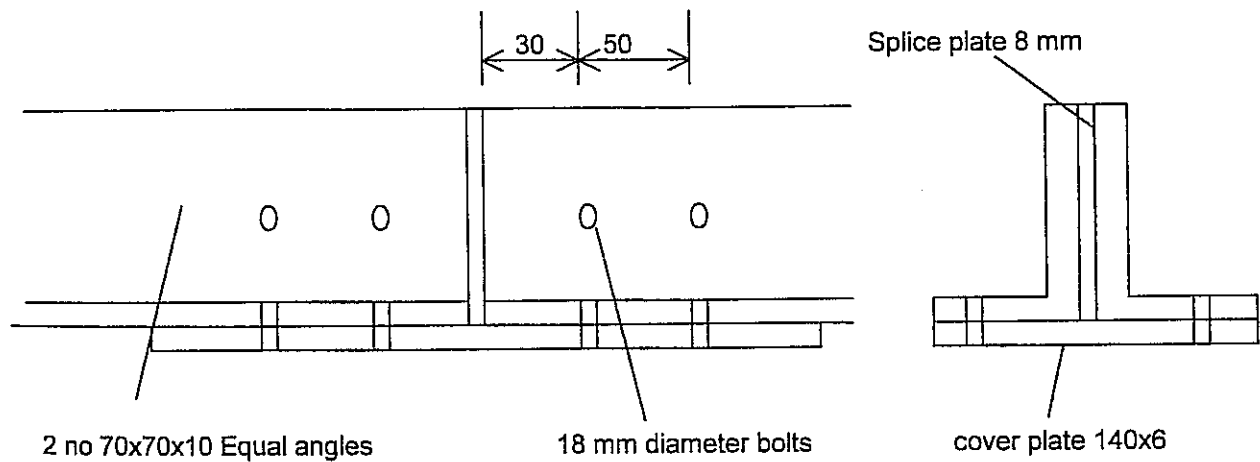
(5 Marks)

b). Explain the term "characteristic strength" of materials.

(5 Marks)

c). What do you understand by "lateral buckling" of flexural members and state the methods which can be adopted to reduce the tendency to lateral buckling.

(4 Marks)

d). Show that Euler buckling load of pinned strut is given by $P_{cr} = \dfrac{EI}{L^2} \Pi^2$

where E – Elastic modules of material
        I – Second moment of area of section
        L- Length of strut

(6 Marks)

7. a) State the difference between single shear bolt connection and double shear bolt connection.

(4 Marks)

b). A double angle member 70x70x10 of steel grade 43, subjected to a tensile load of 180 kN has to be spliced as shown in the figure. Check whether the joint is satisfactory.

(12 Marks)

30   50   Splice plate 8 mm

2 no 70x70x10 Equal angles   18 mm diameter bolts   cover plate 140x6

c). State the differences between butt weld and fillet weld used in connections of steel sections with suitable sketches

(4 Marks)