Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.TECH(SE)/SEM-1/SE-103/2012-13

2012

ADVANCED STRUCTURAL ANALYSIS

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

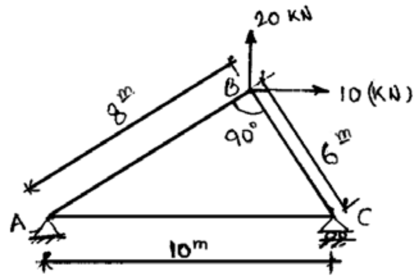
Candidates are required to give their answers in their own words as far as practicable.

Answer any *five* questions. $5 \times 14 = 70$

1. A portal frame *ABCD* is fixed at *A* and *D*. Columns *AB* and *CD* are 3·5 m and 4·5 m respectively. Beam BC is horizontal and 8 m long. Flexural rigidity of beam *BC* is 3×10^4 kN m^2 and for both columns is 2×10^4 kN m^2. The portal is subjected to a horizontal load of 30 kN at *B* acting towards *C* and a vertical load of 150 kN acting downwards at a distance of 3 m from *B* on *BC*. Analyze the portal by Matrix stiffness method and draw the bending moment diagram.

2. A three-span continuous beam *ABCD* has ends *A* and *D* fixed and *B, C* simply supported. *AB* = 3 m, *BC* = 6 m and *CD* = 4 m. Flexural rigidity of *AB* and *CD* are *EI* and that of *BC* = 2 *EI*. A concentrated load of 100 KN acts at mid-span of *AB*. *BC* supports a UDL of 20 KN/m and *CD* carries two loads of 40 KN each at 1·5 m from two ends. Analyze the beam by matrix stiffness method and draw bending moment diagram.

3. Using flexibility method analyze the truss in figure given below and find out vertical and horizontal displacement of joint *B* as well as horizontal displacement of joint *C*. All members have equal axial rigidity *EA*.



4. a) Derive the 'shape functions' for three noded one-dimensional element following natural co-ordinate system.

   b) Using the above 'shape functions' for three noded one-dimensional element, develop 'shape functions' for nine noded rectangular element in natural co-ordinate system. 7 + 7

5. Derive the stiffness matrix of one-dimensional bar using three noded one-dimensional element if it is subjected to axial force only.

6. a) Derive 'shape functions' for one corner node and one mid-side node of 8-noded Serendipity element in 'natural co-ordinate system'.

   b) Form the stain-displacement matrix for the above element having two degrees of freedom (u, v) per node in 'plane stress condition'. The strain component for this case are $\{\varepsilon_x, \varepsilon_y, \gamma_{xy}\}^{\tau}$.

c) Evaluate the following integral by 2 × 2 Gauss-quadrature rule.

$$I = \int_{-1}^{+1}\int_{-1}^{+1} \frac{1-\xi^2}{2+\eta^2}\, d\xi\, d\eta$$

Given for sampling point, $\xi_i = \pm\left(1\sqrt{3}\right)$,

weight factor, $\omega_i = 0$. 5 + 5 + 4

7. Write short notes on the following topics : 4 × 3½

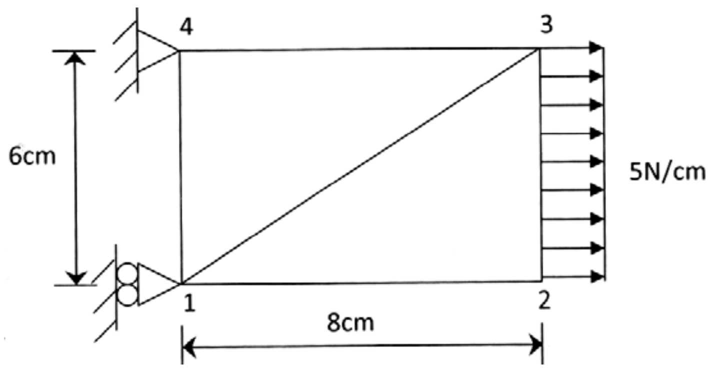
a) Shape functions and its utility in finite element analysis

b) Use of 'Jacobian Matrix' in analysis of two-dimensional problems

c) Isoparametric finite element formation

d) Area co-ordinate and shape functions of triangular element based on that.

8. A thin rectangular plate subjected to inplane loads and supported as shown in the figure given below. Develop the stiffness matrix using three noded triangular elements :



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