Department of Aerospace Engineering
Indian Institute of Technology, Kharagpur

Subject: FEM in Aerospace Structures (114022)
Spring Semester Final Examination, April 2001
4th Year B.Tech. and M.Tech

Full Marks: 60 Time: 3 Hours

Answer all the questions

1. Define (a) shear correction factor (b) super-parametric element (c) non-conforming element and (d) shear locking problem.
   Explain that the four noded rectangular thin plate element having w, θ_x, and θ_y as the degrees of freedom at each node is a non-conforming element. Give an example of a conforming thin plate element.

2. Write the shape functions of the four noded rectangular plane stress element having u and v as the degrees of freedom at each node.
   If the nodal displacements of such an element are u_1=1.0cm, v_1=0.5cm, u_2=1.5cm, v_2=0.6cm, u_3=1.4cm, v_3=0.4cm, u_4=0.8cm and v_4=0.7cm, calculate the strain components at the centre of the element. The nodal coordinates of the element are x_1=100cm, y_1=50cm, x_2=200cm, y_2=50cm, x_3=200cm, y_3=100cm, x_4=100cm and y_4=100cm.

3. Write the shape functions of the four noded isoparametric element.
   The nodal coordinates of such an element are x_1=10cm, y_1=5cm, x_2=20cm, y_2=6cm, x_3=25cm, y_3=10cm, x_4=8cm and y_4=10cm. Calculate the determinant of the Jacobian at the element centre (s=0 and t=0). Also evaluate the integral $\int(5+3s)(2-4s)dxdy$ over the area of the element.

4. Evaluate the stiffness matrix and load vector of the frame shown in Fig. P-4. Take E=200GPa, A=100cm^2 and I_z=25000cm^4 for all the members.

5. The nodal coordinates of a curved beam element as shown in Fig. P-5 are x_1=10cm, y_1=10cm, x_2=15cm, y_2=11.34cm, x_3=18.66cm and y_3=15cm. The degrees of freedom at each node are w, θ_s, and θ_t in local axis system while these are w, θ_x, and θ_y in the global axis system as shown. Evaluate the transformation matrix [T] of the element to be used to express nodal displacement vector in local axis system to that in global axis system.

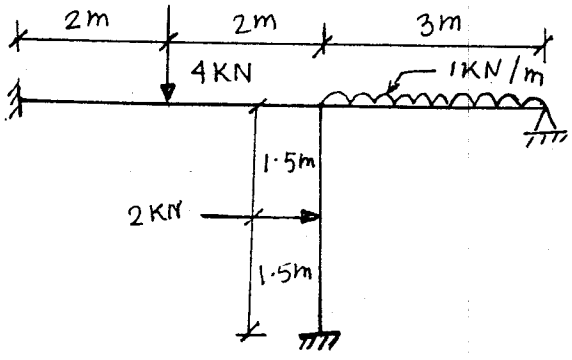

Fig. P-4

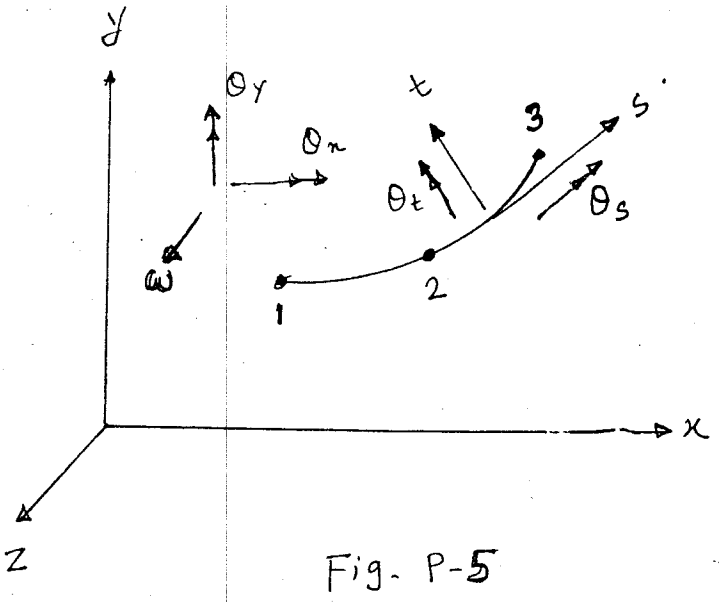

Fig. P-5