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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEMESTER M. TECH DEGREE EXAMINATION, JUNE/JULY 2018

Branch: Mechanical Engineering

Stream(s):

1. **Machine Design**

Course Code & Name: 01ME6103, Finite Element Method

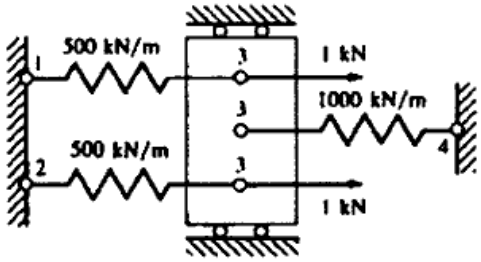
Answer *any two full* questions from *each* part

Limit answers to the required points.

Max. Marks: 60 Duration: 3 hours

PART A

1. a. For the spring assemblage shown in Figure, determine the nodal displacements, the forces in each element, and the reactions. Use the direct stiffness method. 6



b. What are the steps in a finite element analysis? 3

2. . Explain the following in the context of FEM

a. Patch Test 4

b. Shape Function 2

c. Transformation of coordinates 3

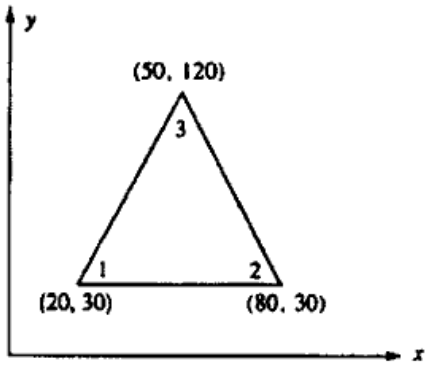
3. a. Derive the stiffness matrix for a two node beam element. 9

PART B

4. a. What are the differences in modelling plane stress and plane strain problems? Elaborate with example. Write constitutive relation for both type of problems. 4

   b. Discretize the rectangular mild steel plate of 100 mm X 50mm X 2mm with a hole of dimeter 20 mm at the center. What are the practical considerations one will take for this problem and how will one impose the boundary conditions when the plate is clamped at the shorter edges. Give the type of element used, nodal degrees of freedom, element degrees of freedom, the total degrees of freedom and the nodal connectivity. 5

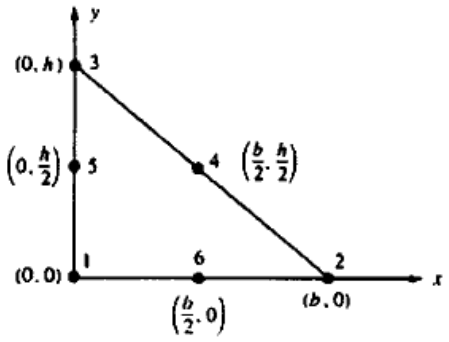
5. a. Evaluate the stiffness matrix for the element shown in Figure. The coordinates are given in units of millimeters. Assume plane stress conditions. Let E = 210 GPa, v = 0.25, and thickness t = 10 mm. 6



   b. Explain the boundary conditions (Neumann, Dirichlet and Robin) 3

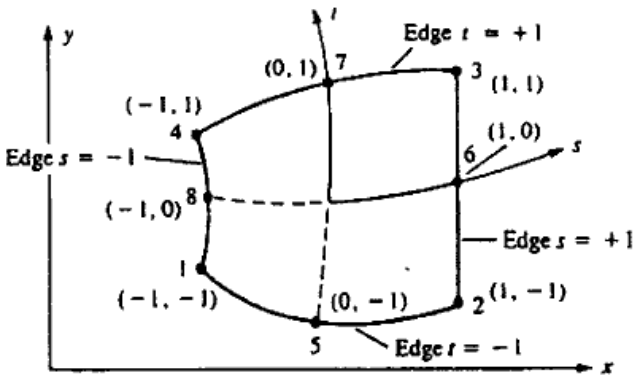
6. a. Consider a uniform bar subjected to a linearly varying load q = ax. The governing differential equation is given by $AE\frac{d^2u}{dx^2} + ax = 0$. Use Galerkin Weighted Residual procedure on a two-term trial function to get the solution of the governing equation. 4

   b. Obtain the shape functions for a LST element shown in the figure 5

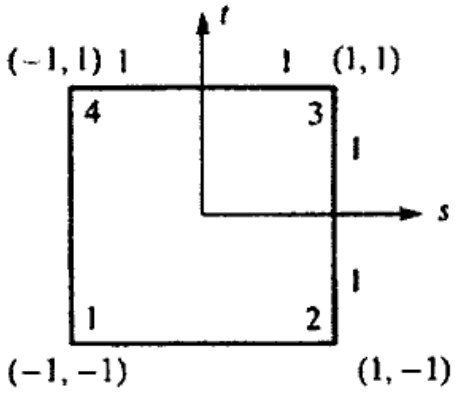


PART C

7. a. Write the shape functions of an isoparametric quadrilateral 8 node element 2



b. Derive the strain displacement **B** matrix for an isoparametric quadrilateral plate element shown on figure. 10



8. a. Derive the stiffness matrix for an axisymmetric triangular element 6

b. Derive the mass matrix for a beam element 6

9. a. Explain central difference technique (Newmark Beta Method) for solving transient analysis 6

b. Explain the Newton Raphson Technique for solving nonlinear FEM equations with flow chart 6