U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

February / March 2023 Semester End Main Examinations

Programme: B.E. **Semester: VII**
Branch: Institutional Elective **Duration: 3 hrs.**
Course Code: 21CV7OEFEA **Max Marks: 100**
Course: Finite Element Analysis **Date: 22.02.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) Derive stress strain relation for plane-stress condition. **06**

b) The stress tensor at a point is given as **08**

$$\begin{bmatrix} 200 & 160 & -120 \\ 160 & -240 & 100 \\ -120 & 100 & 160 \end{bmatrix} kN/m^2$$

Determine the strain tensor at this point. Take E = 210 x 10^6 kN/m^2 and μ = 0.3.

c) Derive equation of equilibrium for two dimensional stress state. **06**

OR

2 a) A simply supported beam is subjected to a point load at the center. Determine maximum deflection using Rayleigh Ritz method. **12**

b) What is FEM? Sketch the different types of elements used based on geometry in finite element analysis. **04**

c) Explain (i) Principle of minimum potential energy (ii) Rayleigh-Ritz method **04**

UNIT - II

3 a) Derive the shape function for a 3-noded bar element in natural coordinate system. **05**

b) Find nodal displacements for the stepped bar loaded as shown in Fig. 1. Take E_s = 200 GPa and Ec = 100 GPa. **05**

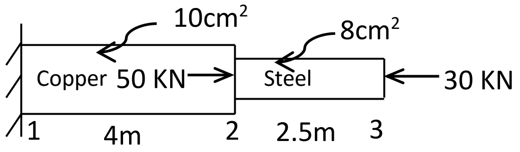

Fig. 1

c) What are the convergence requirements of shape function? **05**

d) Derive stiffness matrix for a 2-noded bar element (derivation of shape function is not required). **05**

UNIT - III

4 Find all possible displacements at B and C and also find elemental forces for the beam loaded as shown in Fig. 2. **20**

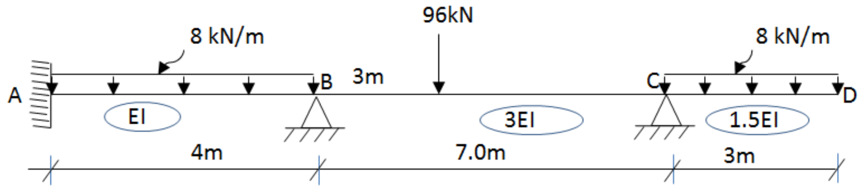

Fig. 2

UNIT - IV

5 a) Obtain expression for shape functions of CST element. Sketch their variations. **10**

b) Distinguish between Lagrange and Serendipity family elements with examples. Also derive shape functions for a 4-noded quadrilateral element using Lagrange polynomials. **10**

UNIT - V

6 a) Derive the strain displacement and stiffness matrix for a 4-noded quadrilateral isoparametric element. **14**

b) Explain isoparametric, subparametric and super-parametric elements. **06**

OR

7 a) The co-ordinate of the triangular element is shown in Fig. 3. At the interior point 'P' the x-co-ordinate is 3.3 and N_1 = 0.3. Determine N_2 , N_3 and the 'y' co-ordinate at point 'P'. **05**

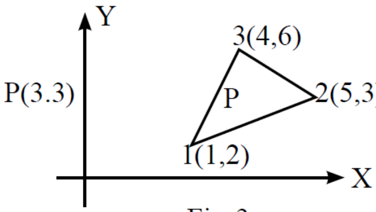

Fig. 3

b) A four-noded quadrilateral element has coordinates 1(10, 10), 2(50, 10), 3(60, 60) and 4(10, 40). If the element nodal displacement vector is given by {q}={0, 0 ,1, 2, 0, 1.5, 1, 0} mm, determine (i) the x & y coordinates of point P which has ξ = 0.5 and η= 0.5 and (ii) displacements u & v of the point P. **10**

c) For the quadrilateral element shown in figure 4, find the Jacobian matrix at $\xi = 1/4$ and $\eta = 1/4$. **05**

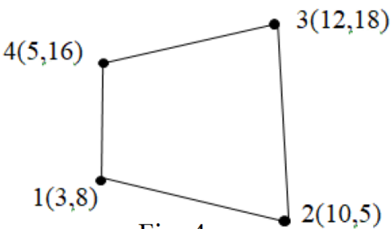

Fig. 4

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