USN | | | | | | | | | | **10ME64**

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Finite Element Methods

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Explain the basic steps involved in FEM. **(06 Marks)**
b. Explain briefly about node location system and node numbering scheme. **(08 Marks)**
c. Explain plane stress and plane strain problem with examples and write the relation between stress and strain. **(06 Marks)**

2 a. Derive the stiffness matrix of bar element using direct approach. **(05 Marks)**
b. Using Rayleigh – Ritz method, determine the deflection of a cantilever beam subjected to point load at its end. **(10 Marks)**
c. Determine the displacement at nodes of spring system shown Fig. Q2(c) using principle of minimum potential energy, **(05 Marks)**
$K_1 = 40$ N/mm ; $K_2 = 60$N/mm ; $K_3 = 80$ N/mm ; $F_1 = 60$ N $F_2 = 50$ N.

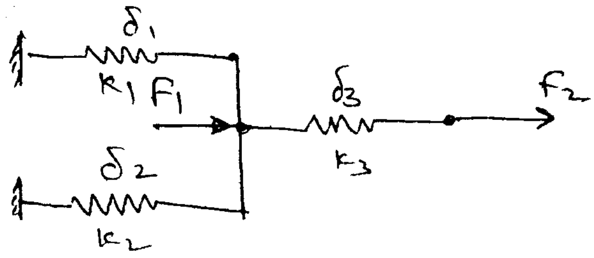

Fig. Q2(c)

3 a. Explain simplex, complex and multiplex elements using element shapes. **(06 Marks)**
b. Find the shape functions at point P for the CST element shown in Fig. Q3(b). Also find the area and Jacobian matrix for the element. **(08 Marks)**

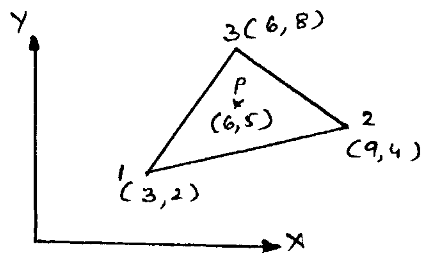

Fig. Q3(b)

c. What are the convergence requirements that an isoperimetric element should satisfy? Sketch and explain 2D Pascal triangle. **(06 Marks)**

4 a. Obtain the element stresses of the stepped bar shown Fig. Q4(a), take E = 200 GPA.
$A_1 = 400\ mm^2$; $L_1 = 200$ mm ; $A_2 = 300\ mm^2$; $L_2 = 150$ mm. **(10 Marks)**

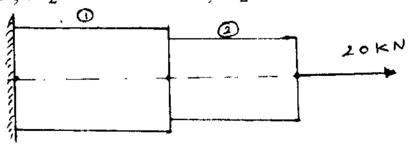

Fig. Q4(a)

b. Obtain the element stresses of the stepped bar shown in Fig. Q4(b) using penalty approach.
$A_1 = 2400\ mm^2$ $L_1 = 150$ mm ; $E_1 = 70$ GPa ; $A_2 = 750\ mm^2$ $L_2 = 300$ mm $E_2 = 200$ GPa ; $P = 200 \times 10^3$N. **(10 Marks)**

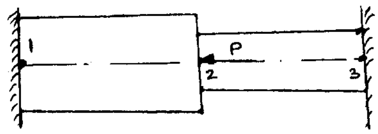

Fig. Q4(b)

PART – B

5 a. Explain briefly the iso-parametric, sub-parametric and super parametric elements, **(06 Marks)**

b. Derive the shape function of 2D quadrilateral element of linear model. **(08 Marks)**

c. Evaluate the following integral using two-point and 3–point gauss–integration method.

$$I = \int_{-1}^{+1} \left(3\xi^3 + 2\xi^2 + \xi + 2\right) d\xi \quad .$$ **(06 Marks)**

6 a. Derive the stiffness matrix for a 1 – D truss element. **(08 Marks)**

b. For the two – bar truss shown in Fig. Q6(b) determine the nodal displacement. Take E = 200 GPa ; $A_1 = A_2 = 200\ mm^2$. **(12 Marks)**

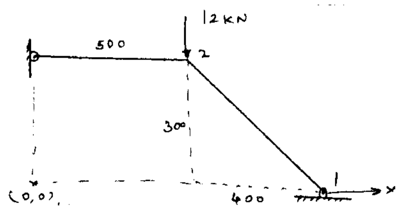

Fig. Q6(b)

7 a. Derive Hermite shape function for beam element. **(06 Marks)**

b. A uniform C – S beam is fixed at one end and supported by a roller at the other end. A concentrated load 20 kN is applied at the mid length of beam as shown in Fig. Q7(b). Determine the deflection under load. **(14 Marks)**

E = 200 GPa
$I = 2500 \times 10^4\ mm^4$

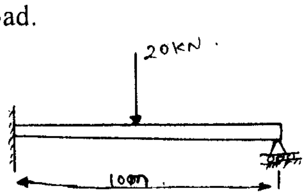

Fig. Q7(b)

8 a. Discuss the Galerkin approach for 1 – D heat conduction problem. **(10 Marks)**

b. Consider the brick wall of thickness L = 0.3m, k = 0.7 W/m°C. The inner surface is at 28°C and outer surface is exposed to cold air at –15°C. Heat transfer coefficient on outer surface h = 40 W/m^2°C. Determine steady state temperature distribution with the wall and heat flux through the wall. Use two element model. **(10 Marks)**

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