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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.

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)

$K_1 = 40 \text{ N/mm}$; $K_2 = 60 \text{ N/mm}$; $K_3 = 80 \text{ N/mm}$; $F_1 = 60 \text{ N}$; $F_2 = 50 \text{ N}$.

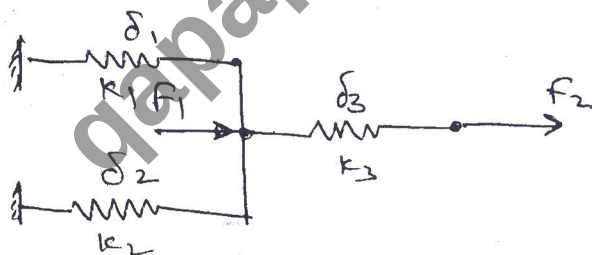


Fig. Q2(c)

- 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)

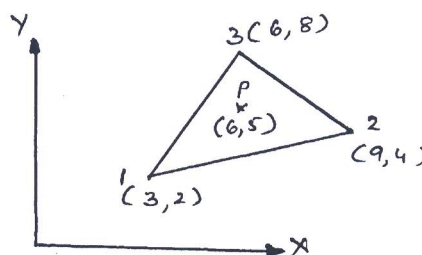


Fig. Q3(b)

- 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 $E = 200 \text{ GPa}$.
 $A_1 = 400 \text{ mm}^2$; $L_1 = 200 \text{ mm}$; $A_2 = 300 \text{ mm}^2$; $L_2 = 150 \text{ mm}$. (10 Marks)

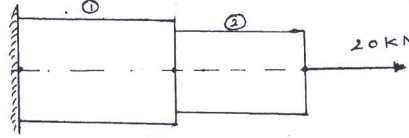


Fig. Q4(a)

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

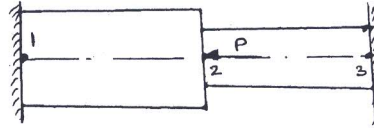


Fig. Q4(b)

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.

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

- 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 $E = 200 \text{ GPa}$; $A_1 = A_2 = 200 \text{ mm}^2$. (12 Marks)

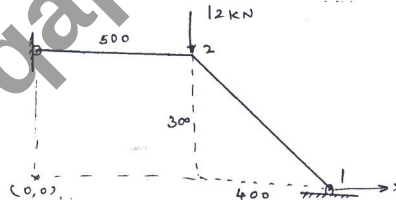


Fig. Q6(b)

- 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)
 $E = 200 \text{ GPa}$
 $I = 2500 \times 10^4 \text{ mm}^4$

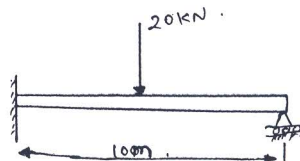


Fig. Q7(b)

- 8 a. Discuss the Galerkin approach for 1-D heat conduction problem. (10 Marks)
 b. Consider the brick wall of thickness $L = 0.3 \text{ m}$, $k = 0.7 \text{ W/m}^\circ\text{C}$. The inner surface is at 28°C and outer surface is exposed to cold air at -15°C . Heat transfer coefficient on outer surface $h = 40 \text{ W/m}^2\text{C}$. Determine steady state temperature distribution with the wall and heat flux through the wall. Use two element model. (10 Marks)
