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Paper Code : AUE-803C

FINITE ELEMENT METHODS AND ITS APPLICATION

Time Allotted : 3 Hours | *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) Elements that help in reducing a 3D problem to a 2D in a finite element formulation is called

   a) CST element b) LST element

   c) Line element d) Axisymmetric.

   ii) A planar CST element has

   a) 2 degrees of freedom

   b) 4 degrees of freedom

   c) 6 degrees of freedom

   d) 8 degrees of freedom.

iii) In FEM physical 1D vecor problem deals with

a) Spring and Bar b) Truss

c) Shell and Plate d) Beam.

iv) Number of d.o.f. (degree of freedom) per node for a beam element is

a) one b) two

c) three d) four

e) None of these.

v) Shape function used for beam element is

a) Hermite shape function

b) Lagrangian shape function

c) Area shape function

d) None of these.

vi) The boundary condition which is prescribe on $\Phi' + x = 2$ is a/an

a) Mixed boundary condition

b) Natural boundary condition

c) Essential boundary condition

d) None of these.

vii) Element are connected by

a) Node b) Hard point

c) Glue d) Boundary layer.

viii) If K is a stiffness matrix, F is a force matrix and Q is the displacement matrix then the assembled equation can be written in matrix form as

a) $[Q]\{F\} = \{K\}$ b) $[F]\{K\} = \{Q\}$

c) $[K]\{Q\} = \{F\}$ d) $[K]\{F\} = \{Q\}$.

ix) Force are generally applied on

a) Elements b) Edges

c) Surfaces d) Nodes.

x) In a five-noded bar element which node number is at the last ?

a) 5 b) 4

c) 3 d) 2.

xi) In an element node numbers are assigned on which dissimilarity ?

a) Geometric b) Property

c) Loading d) All of these.

xii) An element has three shape functions, namely N_1, N_2 and N_3. If $N_1 = 0{\cdot}25$, and $N_3 = 0{\cdot}35$, then N_2 is equal to

a) 0·30 b) 0·40

c) 0·50 d) 0·60.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. What is the physical significance of the stiffness matrix ? Why is the stiffness matrix banded ?

3. On what factors does the convergence of a finite element method depend upon ?

4. Derive the element equation for a truss member having length L, cross section A and modulus of elasticity E in a 2D space.

5. A spring is connected by node number 1, 3. If the order of the stiffness matrix is 5 × 5 then write down the stiffness matrix for that element. Take k = 6N/mm.

6. Assemble the element stiffness matrices of the truss shown in the figure-1. Cross-sectional area (A) and Young's modulus are same for each element. Lengths of elements — 1, 2 and 3 are 100 mm, 100 mm and 200 mm respectively

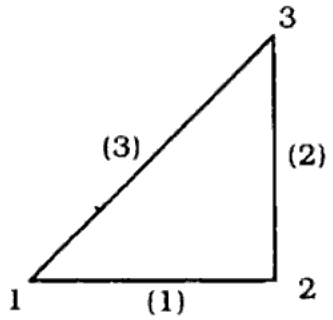

Figure 1

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. Derive the strain-displacement matrix for four noded plane strain element using iso-parametric formulation.

8. Find the displacement at nodes and induced stresses in each element for the two bar truss supported by a spring shown in Figure-2. Both bars have E = 210 Gpa and circular area of cross-section of d = 0·02 m. First and second bar have length of 5 m and 10 m respectively. The spring stiffness k = 2000 kN/m. Take $\Phi = 30^\circ$. Show the system is equilibrium in both directions.

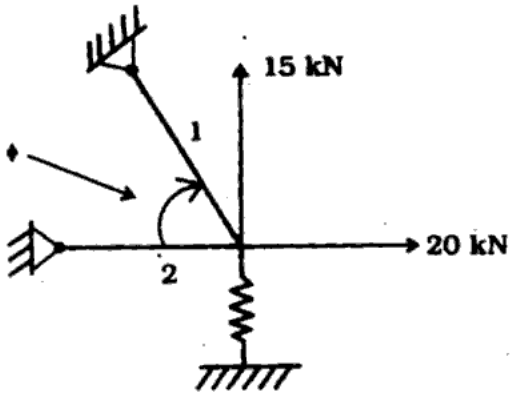

Figure 2

9. A tapered elastic bar subjected to an applied tensile load P at one end (Figure-3) and attached to a fixed support at the other end. The cross-sectional area varies linearly from A_0 at the fixed support at x = 0 to $A_0/2$ at x = L. Calculate the displacement of the end of the bar :

   a) by modeling the bar as a single element having cross-sectional area equal to the area of the actual bar at its midpoint along the length

   b) using two bar elements of equal length and similarly evaluating the area the midpoint of each

   c) using integration to obtain the exact solution. Take Young's modulus E.

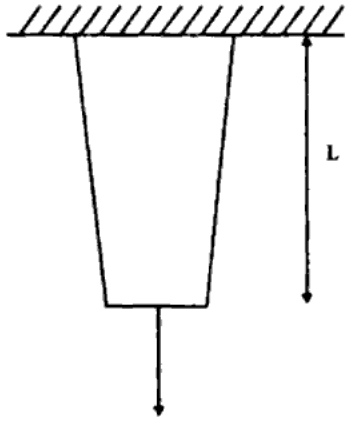

Figure 3

10. Solve the differential equation $\Phi'' - \Phi = x^2$ with boundary condition $\Phi(x = 0) = 0$ and $\Phi(x = 1) = 0$, by Point Collation Raleigh-Ritz method and compare the result with the exact solution.

11. a) Determine the Cartesian coordinate of the point $P(\xi = 0 \cdot 5 \ : \ \eta = 0 \cdot 6)$ shown in figure-4.

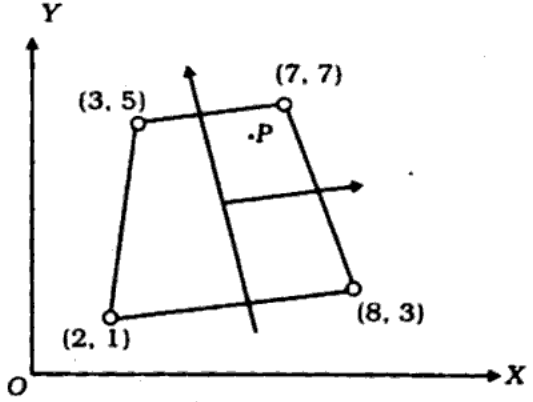

Figure 4

b) Using a 2 × 2 rule, evaluate the integral $I = \int_2^6 (x^2 + 5x + 3)$ by Gaussian quadrature method.

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