Total No. of Questions : 12]

SEAT No. :

P3322

[Total No. of Pages : 5

[4959]-45

B.E. (Mechanical Engineering)
FINITE ELEMENT METHOD
(2008 Pattern) (Semester - II) (Elective - III) (402049 B)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) ***Solve Q1 or Q2, Q3 or Q4, Q5 or Q6 from Section - I and Q7 or Q8, Q9 or Q10, Q.11 or Q.12 from Section - II.***
2) ***Answer to the two section should be written in separate answer books.***
3) ***Draw Neat diagrams wherever necessary.***
4) ***Assume suitable data, wherever necessary.***
5) ***Figures to the right side indicate full marks.***

SECTION - I

Q1) a) Explain The concept of FEM briefly and outline the procedure. **[8]**

b) Explain Principle of minimum potential energy used in deriving element stiffness metrix and equations. **[8]**

OR

Q2) a) Explain essential and natural boundary conditions. **[8]**

b) Explain in brief matrix decomposition and partitioning of matrix. **[8]**

Q3) a) For the plane truss as shown in fig. 3a, determine the following. Each element has $E = 20 \times 10^6$ N/cm^2. **[10]**

i) Write down the elemental stiffness matrices for each element,

ii) Assemble k matrices to get global stiffness matrix K.

iii) Find horizontal and vertical displacement of node 2.

iv) Evaluate stresses in each element.

P.T.O.

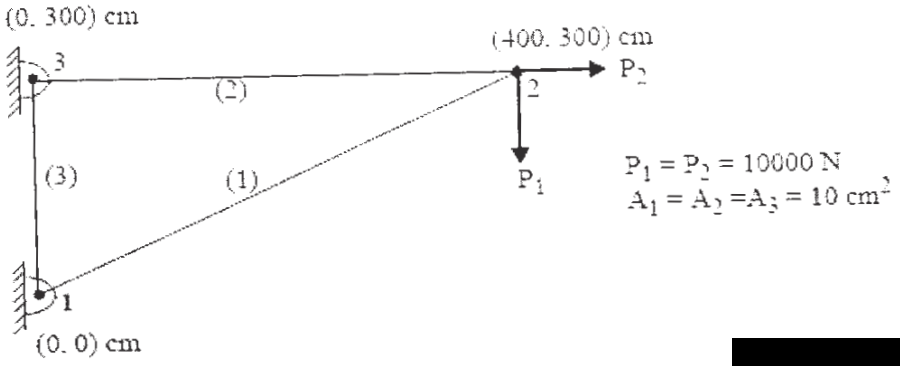

Fig. 3a

b) Consider the bar loaded as shown in figure 3b. E = 200 × 10^9 N/m². Determine **[8]**

i) Stiffness matrix for each element

ii) Global stiffness matrix

iii) Nodal displacements

iv) Elemental stresses

v) Support reactions

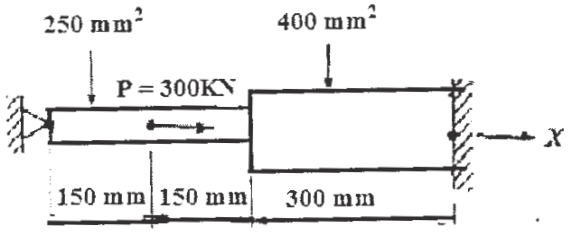

Fig. 3b

OR

Q4) a) Determine the slope and deflection at load point for the beam as shown in fig. 4a. taking the modulus of elasticity of material as 20 × 10^6 N/cm² and moment of Inertia as 2509 cm⁴. **[8]**

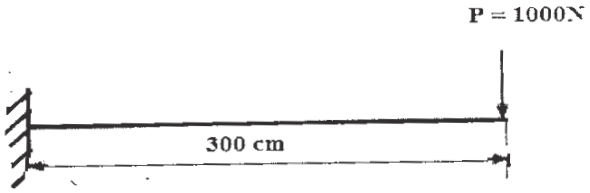

Fig. 4a

b) Derive elemental stiffness matrix and force vector for two noded (linear) bar element using Principal of Minimum Potential Energy (PMPE) Method. **[10]**

Q5) Evaluate Following integrals using three point Gaussian quadrature method. **[16]**

a) $\int_{-1}^{1} s^4 \, ds$

b) $I = \int_{-1}^{1} \left(2 + x + x^2\right) dx$

OR

Q6) a) For the triangular element as shown in fig. 6a the nodal values of displacements at node 1, 2 and 3 are (2,1), (3,2) and (5,3) respectively. For point p within the element, determine

i) the natural coordinates

ii) The shape functions

iii) The displacements

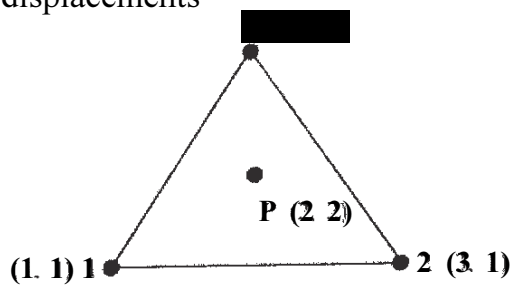

Fig. 6a **[8]**

b) What is 'serendipity family element'? Using this concept find shape function of quadratic serendipity family element. **[8]**

SECTION - II

Q7) The fin as shown in fig. 7 a is insulated on the perimeter. The left end has a constant temperature of 100°C. A positive heat flux of q = 5000 W/m^2 acts on the right end.

Let Kxx = 6w/m°c and cross section area A = 0.1m^2. Determine the temperatures

at L/4, L/2, 3L/4, and L, where L = 0.4m. **[16]**

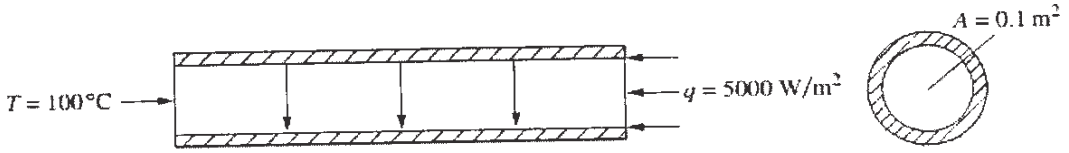

Fig. 7a

OR

Q8) For the composite wall shown in fig.8a, determine the interface temperatures. What is the heat flux through 8 cm portion? Use the finite element method. Use three elements with the nodes shown. **[16]**

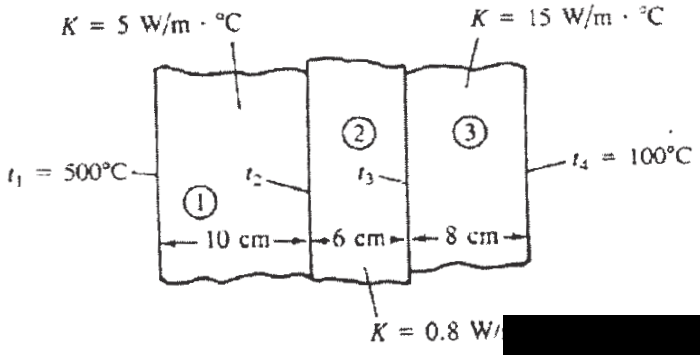

Fig. 8a

Q9) Find the natural frequencies longitudinal vibration of the constrained stepped shaft of areas A and 2A and of equal length L, as shown in the fig. 9a. Compare the result obtained using lumped mass matrix approach and consistent mass matrix approach. **[16]**

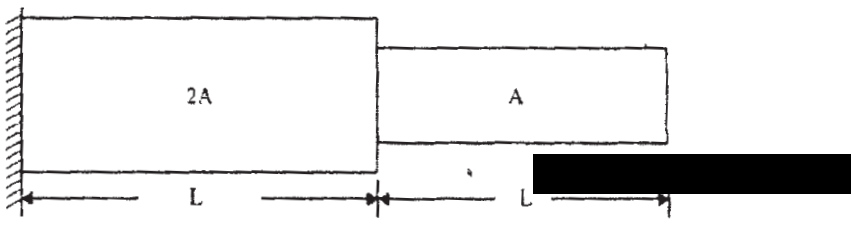

Fig. 9a

OR

Q10)a) Differentiate between consistent mass matrix and lumped mass matrix. **[8]**

b) Derive the consistent mass matrix for bar element. **[8]**

Q11)a) Explain free and mapped meshing. What are the advantages and limitations of free &mapped meshing in finite element method? **[8]**

b) Explain the terms **[10]**

i) Elemental connectivity

ii) Strain & Stress recovery

OR

Q12)a) Define skew, jacobian and distortion. Explain their significance in FEM. **[8]**

b) Write a short note on (any two) **[10]**

i) Preprocessor

ii) Postprocessor

iii) Static and Modal analysis.