

Code No: 126EE

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, March - 2024

FINITE ELEMENT METHODS

(Mechanical Engineering)

Time: 3 Hours

Max. Marks: 75

- Note:** i) Question paper consists of Part A, Part B.
 ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.
 iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A**(25 Marks)**

- 1.a) What is meant by discretization? [2]
- b) What is meant by stiffness matrix? [3]
- c) Sketch a typical truss element showing local, global transformation. [2]
- d) Write down the expressions for the element stiffness matrix and force vector of a beam element. [3]
- e) How axisymmetric element can be equalized to the CST element? [2]
- f) Write down the stiffness matrix equation for four-noded iso-parametric quadrilateral elements. [3]
- g) What is the thermal conductivity matrix for 2D heat transfer problems? [2]
- h) Write down the governing differential equation for the steady-state one-dimensional conduction heat transfer. [3]
- i) What is transient dynamic analysis? [2]
- j) Define Eigen value and Eigen vector. [3]

PART – B**(50 Marks)**

2. For the spring system shown in the figure 1. Find the displacements at the nodes and the reactions. Given $K_1=100$ N/mm, $K_2=200$ N/mm, $K_3=100$ N/mm, $P=500$ N. [10]

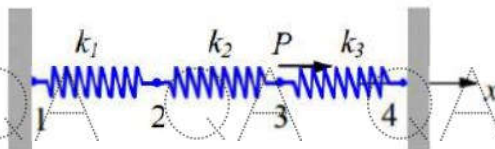


Figure 1

OR

- 3.a) Consider a simple one-dimension structure with three elements, explain the process of stiffness matrix and load vector assembly. [5+5]
- b) Explain the steps of FEM with the help of an example. [5+5]
4. For the two-bar Truss shown in the figure 2. Determine: (a) Nodal displacements (b) Element stresses (c) Reaction forces. Take $E=200$ Gpa, $A=200$ mm². [3+3+4]

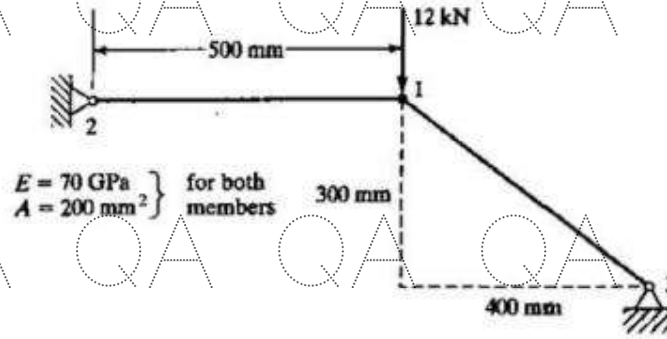


Figure 2

OR

5. For the beam having box loading on it end shown in the figure 3 determine: (a) slope at 2 and 3 (b) vertical deflection at the midpoint of the load Take $E = 200 \text{ GPa}$, $I = 4000000 \text{ mm}^4$. [5+5]

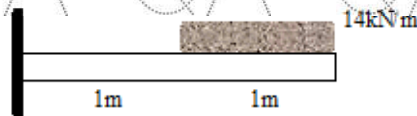


Figure 3

- 6.a) Briefly discuss elimination approach to handle boundary conditions for solution of system of equations.
 b) Evaluate the integral by two- and three-point gauss quadrature rule. [5+5]

$$I = \int_{-1}^1 (5x^3 - 3x^2 - 2x - 3) dx$$

OR

7. Nodal coordinates for an Axi-Symmetric element are given below figure 4. Evaluate Stiffness Matrix, $E = 2 \times 10^5 \text{ N/mm}^2$, $\nu = 0.25$. [10]

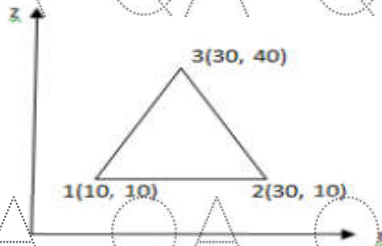


Figure 4

- 8.a) Determine the temperature distribution along a circular fin of length 5 cm and radius 1 cm. The fin is attached to boiler whose wall temperature 140°C and the free end is open to the atmosphere. Assume $T_a = 40^\circ\text{C}$, $h = 10 \text{ W/cm}^2/^\circ\text{C}$, $k = 70 \text{ W/cm}^\circ\text{C}$.
 b) Derive the consistence mass matrix of a two-node bar element. [7+3]

OR

9. A wall of 0.6m thickness having thermal conductivity of 1.2 W/mK. The wall is to be insulated with a material of thickness 0.06 m having an average thermal conductivity of 0.3 W/mK. The inner surface temperature is 1000 and outside of the insulated is exposed to atmospheric air at 30°C with heat transfer coefficient of $35 \text{ W/m}^2\text{K}$. Calculate the nodal temperatures. [10]

QA QA QA QA QA QA QA (

- 10.a) Explain the following (i) Consistent mass matrix (ii) Lumped mass matrix.
b) Determine the Eigen values and Eigen Vectors for the stepped bar as shown in figure 5. [2+8]

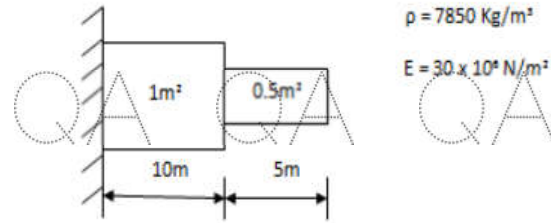


Figure 5
OR

11. Derive mass matrices for 1D Bar Element and Truss Element. [10]
QA QA QA QA QA QA QA (

---ooOoo---

QA QA QA QA QA QA QA (

QA QA QA QA QA QA QA (

QA QA QA QA QA QA QA (

QA QA QA QA QA QA QA (

QA QA QA QA QA QA QA (