B.E. Eighth Semester (Mechanical Engineering) (C.B.S.)

Elective - II : Finite Element Method

P. Pages : 4 **NKT/KS/17/7582**

Time : Three Hours Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Due credit will be given to neatness and adequate dimensions.
7. Assume suitable data whenever necessary.
8. Illustrate your answers whenever necessary with the help of neat sketches.
9. Use of non programmable calculator is permitted.

1. a) Derive element stiffness matrix for one dimensional two noded bar element using shape functions approach. **10**

b) Ana axial load P = 20 kN is applied at the rod as shown in fig.1 b The temperature is then raised to 60°C. **10**

i) Assemble global stiffness matrix

ii) Assemble global force matrix

iii) Determine nodal displacement

iv) Determine element stresses.

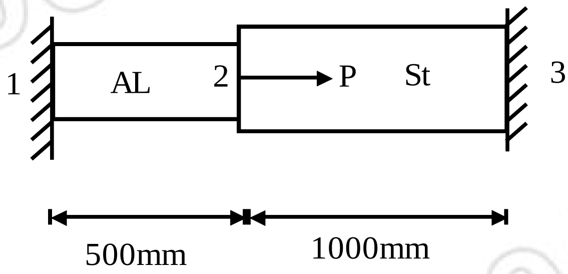


Fig. 1 (b)

$E_{AL} = 70$ GPa $\quad E_{St} = 200$ GPa

$A_{AL} = 900\,mm^2 \quad A_{St} = 1200\ mm^2$

$\alpha_{AL} = 23 \times 10^{-6}/°C \quad \alpha_{St} = 11.7 \times 10^{-6}/°C$

OR

2. a) A steel shaft and an aluminium tube are connected to a fixed support and a rigid disc as shown in fig. 2 (a). If the torque applied at the end is equal to T = 6,325 N-m. Determine the shear stresses in the steel. Shaft & aluminium tube. Use $G_{St} = 77$ GPa & $G_{AL} = 27$ GPa. **14**

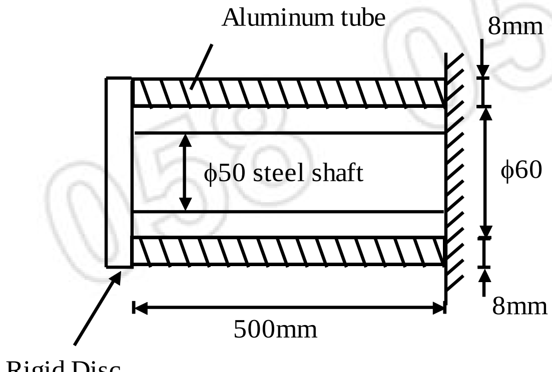


Fig. 2(a)

b) Explain : **6**

i) Types of forces in FEM.

ii) Types of elements in FEM.

3. a) Determine the nodal displacements, element stresses and support reactions for the three bar bus as shown in fig. 3 (a). Take $A = 1000\ mm^2$ & $E = 205$ GPa for all members. **14**

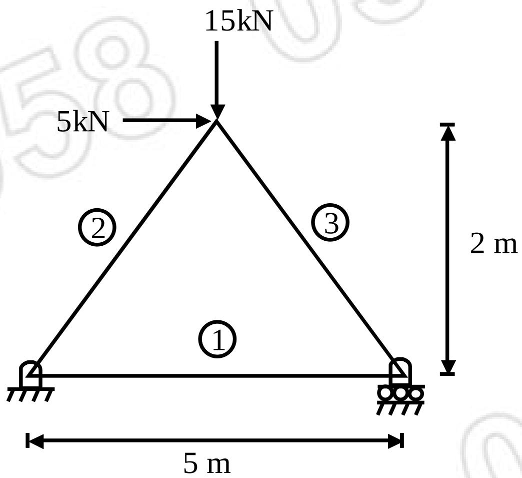
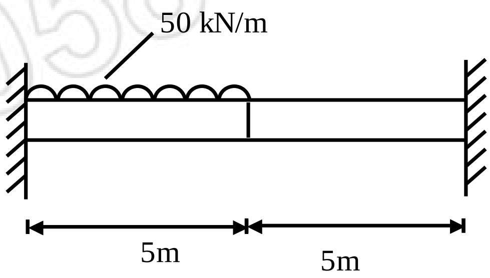


Fig. 3 (a)

b) Derive an element stiffness matrix for truss element. **6**

OR

4. a) Determine the nodal deflections and support reactions for the beam shown in fig. 4 (a). Also determine deflection at mid point of an UDL. **14**



Take EI = 9000 kN-m^2

Fig. 4 (a)

b) Explain & write Hermit shape functions for beam element. **6**

5. a) Two dimensional model of an anchor of a communication tower's guy cable is shown in fig. 5 (a). The anchor consists of a triangular steel plate, which is subject to force 'P'. Thickeness of plate is 8 mm. Take E = 200 GPa and $\nu = 0.25$. **16**

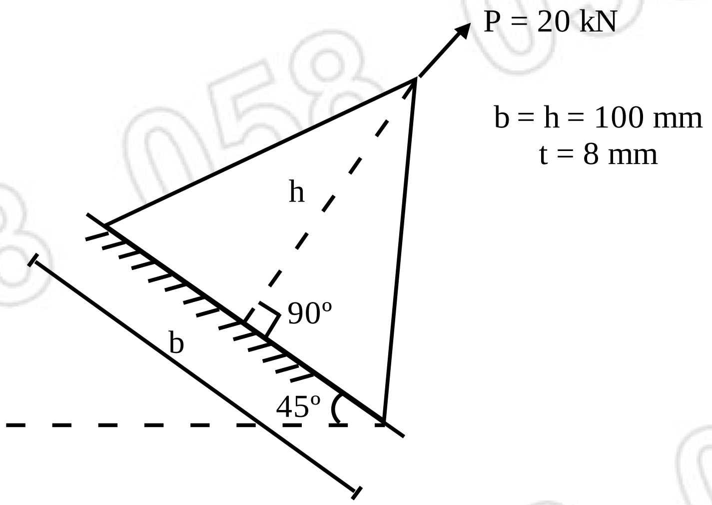


Fig. 5(a)

Determine the nodal displacement and stresses using plane stress condition [Neglect body & transaction force].

b) State the significance of following matrices for CST element - **4**

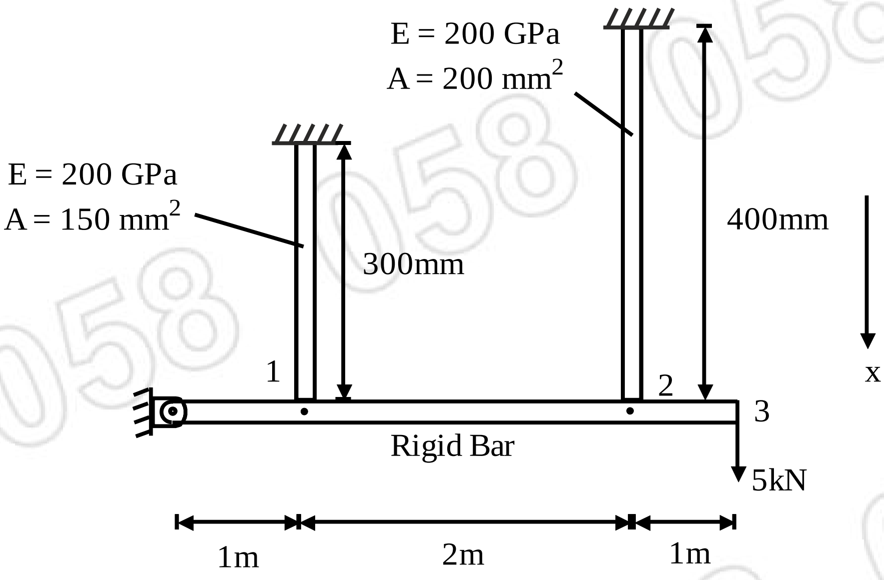
i) Jacobian matrix (J)

ii) Strain displacement relation matrix (B)

iii) Strain transformation matrix (D)

OR

6. a) The rigid horizontal bars shown in fig. 6 (a) is attached to two vertical bars. A vertical load is applied at the free end designated by 3. Determine the deflection and stresses in the vertical members. **16**



[Use the multipoint constraints are $Q_2 = 3Q_1$ and $Q_3 = 4Q_1$]

b) Derive shape function for 2-D, CST element. **4**

7. a) The furnace wall shown in fig. 7 (a) consists of 25 cm of fire brick $[K_1 = 0.012 \text{ W/(cm°C)}]$, 10 cm of insulation brick $[K_2 = 0.0014 \text{ W/(cm°C)}]$ and 20 cm of red brick $[K_3 = 0.0086 \text{ W/(cm°C)}]$. **16**

The specified inner and outer temperatures are 500°C and 150°C respectively. Determine the internal temperature distillation.

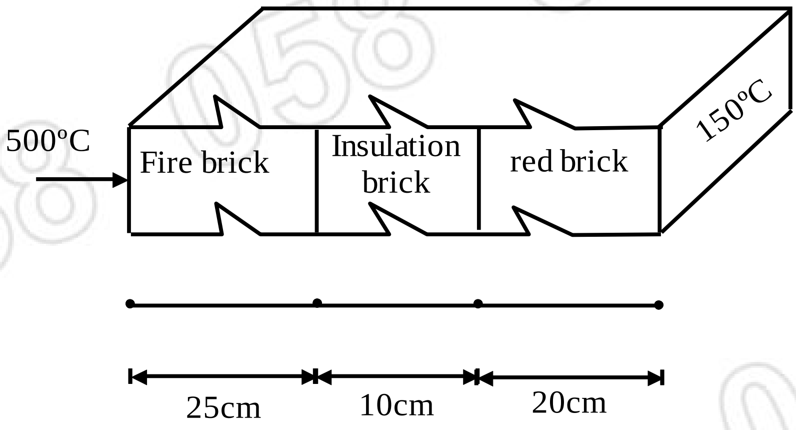


Fig. 7 (a)

b) Explain in brief mesh generation technique. **4**

OR

8. a) Explain step by step the node element for axi symmetric analysis of along cylinder by considering state of plain strain in the length direction of the cylinder. Elaborate all steps clearly. **16**

b) State the significance of following matrices for CST element. **4**

i) Jacobian matrix (J)

ii) Strain displacement relation matrix (B)

iii) Strain transformation matrix (D)

****