Total No. of Questions : 10]

SEAT No. :

P3715

[Total No. of Pages : 4

[5461]-524

B.E. (Mechanical)

FINITE ELEMENT ANALYSIS

(2015 Pattern) (Elective - I)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) *Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8, Q.9 or Q.10.*
2) *Figures to the right indicate full marks.*
3) *Neat diagrams must be drawn wherever necessary.*
4) *Use of scientific calculator is allowed.*
5) *Assume suitable data if necessary.*

Q1) a) What are the different steps of FEM? Explain each of them briefly. **[6]**

b) Explain the term shape function. Write the properties of shape function. **[4]**

OR

Q2) a) State different types of Analysis used in Finite Element Analysis. Explain any one of them briefly. **[4]**

b) Three bar elements assembled colinear as shown in Fig.1. Nodes 1 and 4 are fixed and axial loads of 10 kN and 20 kN are applied at nodes 2 and 3 respectively. Determine the displacements at node 2 and 3. Assume length of each element as one metre. Stiffness as 1200 kN/m, 1800 kN/m, 1500 kN/m for 1, 2 and 3rd element respectively. **[6]**

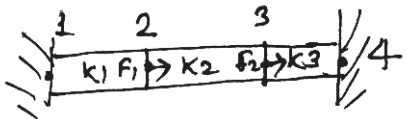
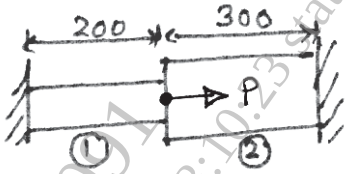


Fig. 1

P.T.O.

Q3) a) An axial load $P = 400 \times 10^3$ N is applied as shown at 20°C to the rod as shown in Fig. 2. The temperature is then raised to 60°C. Determine the elemental stress. **[6]**



$E_1 = 70 \times 10^9$ N/mm^2 $E_2 = 200 \times 10^9$ N/mm^2

$A_1 = 900$ mm^2 $A_2 = 1200$mm^2

$\alpha_1 = 23 \times 10^{-6}$ per °C $\alpha_2 = 11.7 \times 10^{-6}$ per °C

Fig.2.

b) Explain the term plain strain formulation and its importance. **[4]**

OR

Q4) a) A triangular element with cartesian coordinate as shown in Fig. 3. The shape functions at an interior point 'p' is 0.2, 0.3 and 0.5 respectively. What are the coordinates of point 'p'. **[4]**

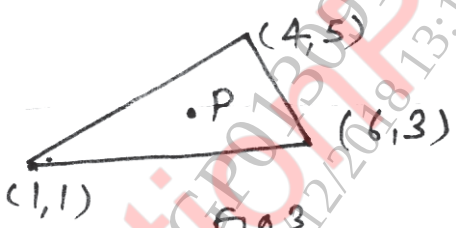
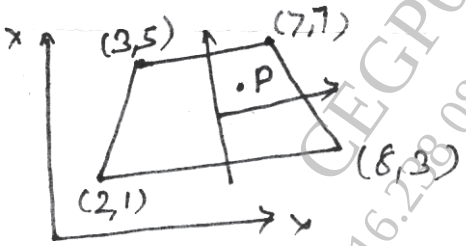


Fig.3

b) Explain the term compatibility and completeness requirement in case of 2D elements. **[6]**

Q5) a) Explain the concept of iso-parametric, subparametric and superparametric elements. **[9]**

b) Determine the cartesian coordinate of the point p ($\xi = 0.5$, $\eta = 0.6$) as shown in Fig. **[9]**



OR

Q6) a) Explain the terms 'substructuring and submodelling'. **[6]**

b) Compute the following integral by 2 point Gauss quadrature method. **[6]**

$$I = \int_{-1}^{1}\int_{-1}^{1} (r^2 + 2rs + s^2)\,dr.ds$$

c) Define the terms : **[6]**

i) Aspect ratio.

ii) Skewness.

iii) Warp Angle.

Q7) a) Write down governing equation of steady state heat transfer and also write down elemental stiffness matrix and compare with bar element. **[6]**

b) Find the temperature distribution in the one dimensional rod as shown in fig. 4. **[10]**

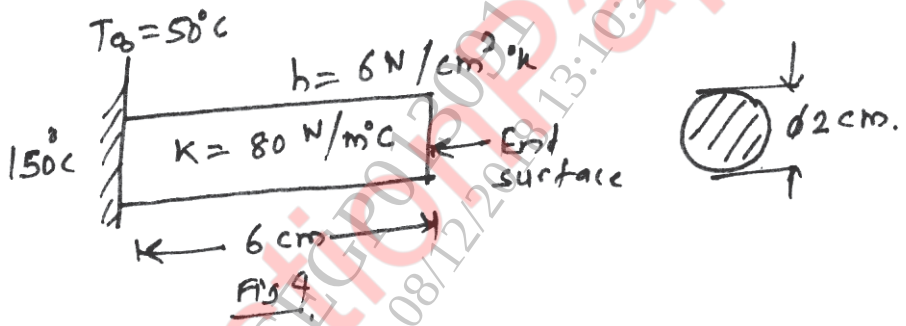


Fig 4.

OR

Q8) a) Derive FEA stiffness matrix for pin Fin Heat transfer problem. **[6]**

b) The fin shown in Fig. 5 is insulated on the perimeter. The left end has a constant temperature of 100°C. A positive flux of q = 5000 W/m² acts on the right end. Let K_{xx} = 6 W/m°C and cross sectional area A = 0.1 m². Determine the temperature at L/4, L/2, 3L/4 and L where L = 0.4m. **[10]**

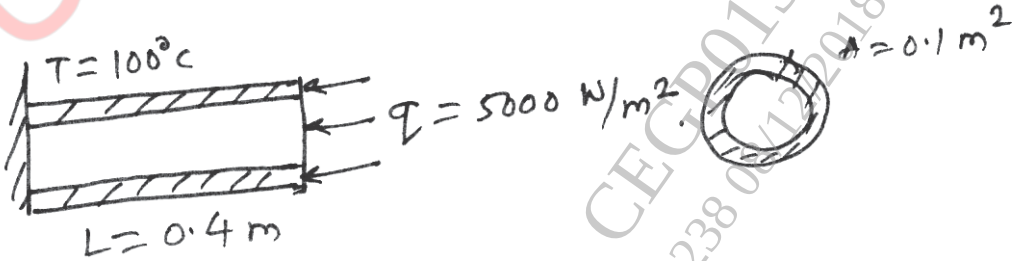


fig. 5.

Q9) a) Write down Consistent mass and Lumped Mass Matrix for. **[6]**

i) Bar element.

ii) Plane Stress Element.

b) Find the natural frequencies of longitudinal vibrations of the same stepped shaft of areas A = 1000 mm^2 and 2A = 2000 mm^2 and of equal lengths (L = 1m), when it is constrained at one end, as shown below. **[10]**

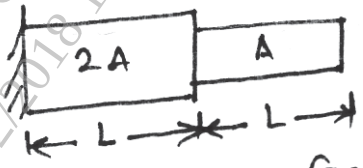


Fig 6.

OR

Q10) Find the natural frequency of vibration using consistent and lumped mass matrix method with one element to bar. **[16]**

E = 2×10^{11} N/m^2, ρ = 7800 kg/m^2, L = 1m.