b) i) Assuming plane stress condition, evaluate stiffness matrix for the element shown in Fig. 14(b). Assume E = 200 GPa, Poisson's ratio 0.3. **(10)**

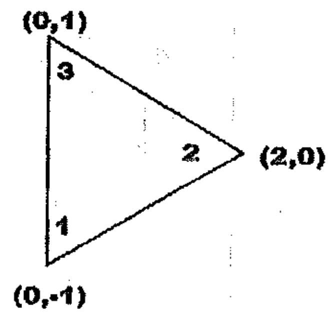

Fig. 14(b)

ii) Determine the pressure at the location (7, 4) in a rectangular plate with the data shown in Fig. 14(c) and also draw 50 MPa contour line. **(6)**

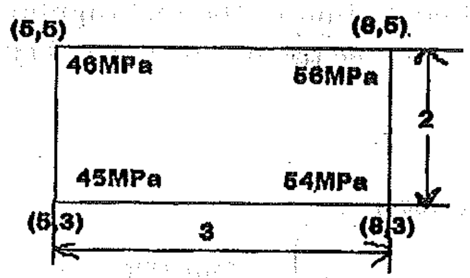

Fig. 14(c)

15. a) i) For the four noded element shown in Fig. 15 (a), determine the Jacobian and evaluate its value at the point (1/3, 1/3) **(8)**

ii) Using energy approach derive the stiffness matrix for a 1D linear isoparametric element. **(8)**

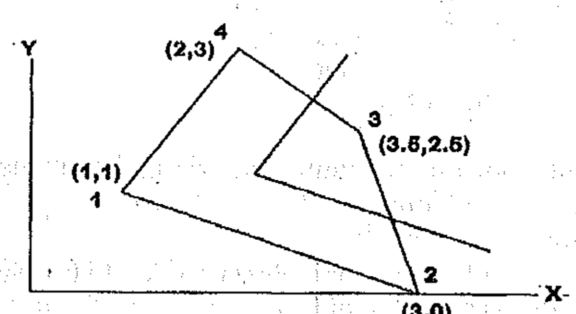

Fig. 15(a)

(OR)

b) i) Derive the shape functions for all the corner nodes of a nine noded quadrilateral element. **(8)**

ii) Using Gauss Quadrature evaluate the following integral using 1, 2 and 3 point integration. **(8)**

$$\int_{-1}^{1} \frac{\sin s}{S(1-s^2)} ds$$

Reg. No. :

Question Paper Code : 50882

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017

Sixth/Seventh Semester

Mechanical Engineering

ME 6603 – FINITE ELEMENT ANALYSIS

(Regulations 2013)

(Common to Mechanical Engineering (Sandwich)/Automobile Engineering/ Manufacturing Engineering/Mechanical and Automation Engineering)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions.

PART – A **(10×2=20 Marks)**

1. List the various weighted residual methods.
2. Write the stiffness matrix for a one dimensional 2 noded linear element.
3. Give the Governing equation and the primary and secondary variables associated with the one dimensional beam element.
4. Write the natural frequency of bar of length 'L', Young's modulus 'E" and cross section 'A' fixed at one end and carrying lumped mass 'M' at the other end.
5. Write the governing equation for the torsion of non-circular sections and give the associated boundary conditions.
6. Why a CST element so called ?
7. What are the ways by which a 3D problem can be reduced to a 2D problem ?
8. Write down the shape functions for a 4 noded bi-linear rectangular element.
9. What are the advantages of natural coordinate system ?
10. Write the Jacobian for the one dimensional 2 noded linear element.

PART – B **(5×16=80 Marks)**

11. a) Using any one of the Weighted Residual Method, find the displacement of given governing equation.

$$\frac{d}{dx}\left[x\frac{du}{dx}\right] - \frac{2}{x^2} = 0, 1 < x < 2$$

$$\text{at } x = 1, u = 2, \text{ at } x = 2, x\frac{du}{dx} = -\frac{1}{2}$$ **(16)**

(OR)

b) Using Collocation method, find the solution of given governing equation

$$\frac{d^2\phi}{dx^2}+\phi+x=0,\ 0\le x\le 1$$ subject to the boundary conditions $\phi(0)=\phi(1)=0$.

Use $x=\frac{1}{4}$ and $\frac{1}{2}$ as the collocation points. **(16)**

12. a) Determine the maximum deflection for the beam loaded as shown in Fig. 12(a), Youngs modulus 200 GPa and density 0.78×10^6 kg/m^3. The beam is of 'T' cross section shown in Fig. 12(b). **(16)**

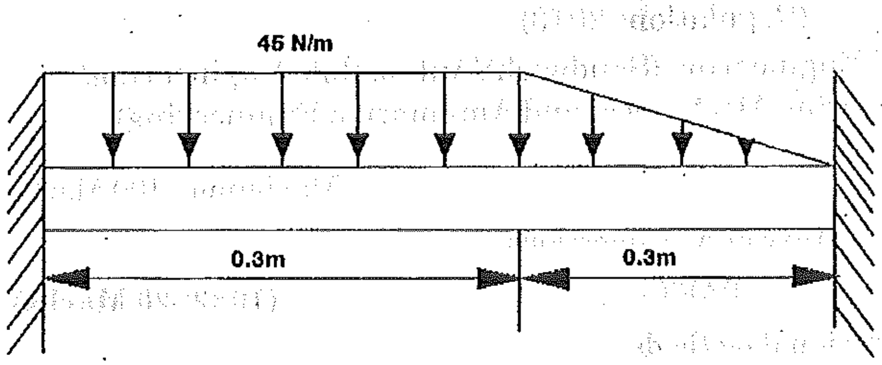

Fig. 12(a)

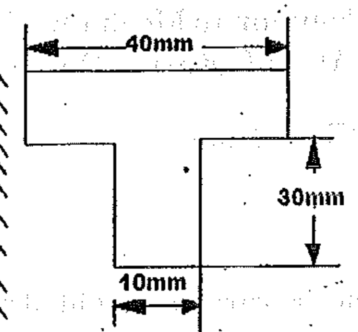

Fig. 12(b)

(OR)

b) A metallic fin 20 mm wide and 4 mm thick is attached to a furnace whose wall temperature is 180°C. The length of the fin is 120 mm. If the thermal conductivity of the material of the fin is 350 W/m°C and convection coefficient is 9 W/m^2 °C, determine the temperature distribution assuming that the tip of the fin is open to the atmosphere and that the ambient temperature is 25°C. **(16)**

13. a) For the square shaft of cross section 1 cm × 1 cm as shown in Fig. 13(a). It was decided to determine the stress distribution using FEM by solving for the stress function values. Considering geometric and boundary condition symmetry 1/8th of the cross section was modeled using two triangular elements and one bilinear rectangular element as shown. The element matrices are given below. Carry out the assembly and solve for the unknown stress function values. **(16)**

$$\text{for triangle } K=\frac{1}{2}\begin{bmatrix}1&-1&0\\-1&2&-1\\0&-1&1\end{bmatrix}\quad r=\begin{bmatrix}29.1\\29.1\\29.1\end{bmatrix}$$

$$\text{for rectangle } K=1/6\begin{bmatrix}4&-1&-2&-1\\-1&4&-1&-2\\-2&-1&4&-1\\-1&-2&-1&4\end{bmatrix}\quad r=\begin{bmatrix}43.6\\43.6\\43.6\\43.6\end{bmatrix}$$

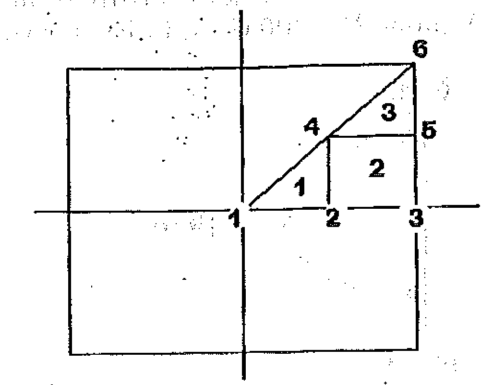

Fig. 13(a)

(OR)

b) Determine the temperature distribution in the rectangular fin shown in Fig. 13(b). The upper half can be meshed taking into account symmetry using triangular elements. **(16)**

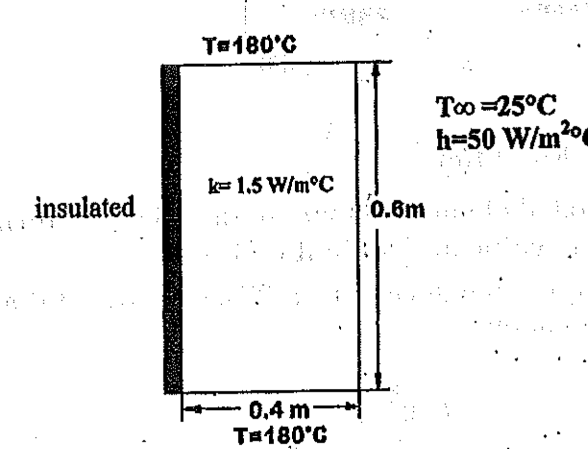

Fig. 13 (b)

14. a) i) The nodal co-ordinates for an axi-symmetric triangular element are given below. r_1=10mm, r_2=40 mm, r_3=40 mm, z_1=10 mm, z_2=10 mm, z_3=50 mm. Evaluate strain displacement matrix. **(10)**

ii) Nodal values of the triangular element is shown in Fig. 14 (a). Evaluate element shape functions and calculate the value of temperature at a point whose coordinates are given(5,7). **(6)**

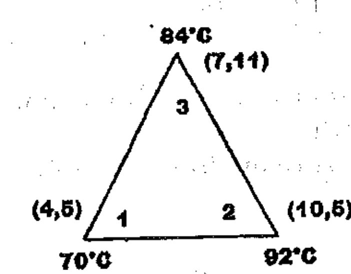

Fig. 14(a)

(OR)