T.E. / Mech / VI sem / CBCS / FEA

(3 Hours) Max. Marks: 80

**Note:**

1. Question 1 is Compulsory
2. Solve any three from remaining five
3. Figures to right indicate full marks
4. Assume suitable data if necessary

10 DEC 2019

Q.1 Attempt any **four** 20

a) Write element matrix equation in the following fields explaining each term:
   i. 1D steady state, heat transfer by conduction
   ii. Torsion Analysis

b) Prove that linear triangular element is CST element.

c) Explain different types of Boundary conditions with examples.

d) Explain plane stress and plane strain conditions with examples.

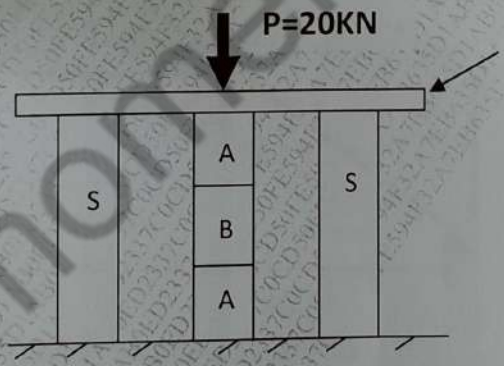
e) What do you mean by consistent mass matrix and lumped mass matrix. Give suitable mathematical expression?

Q.2 a) Solve the following differential equation using Method of least square and Galerkin method. 10

$$\frac{d^2y}{dx^2} - 10x^2 = 5 \; ; \; 0 \le y \le 1; \; y(0) = 0, \; y(1) = 0$$

Compare answer with exact solution at x = 0.5

b) Find the displacement at nodes and stresses over each element. 10



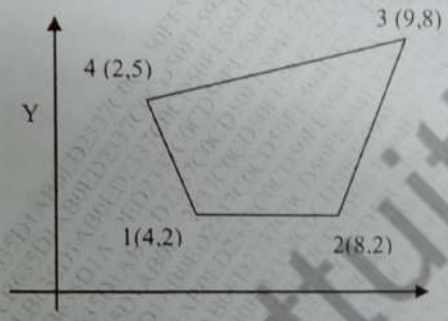

| PROPERTIES | STEEL (S) | ALUMINIUM (A) | BRASS (B) |
|---|---|---|---|
| AREA, $mm^2$ | 200 | 370 | 370 |
| E, $N/mm^2$ | $2x\ 10^5$ | $7x\ 10^4$ | $8.8x\ 10^4$ |
| Length, mm | 1000 | 350 | 300 |

Q.3 a) A copper fin of diameter 2 cm, length 6 cm and thermal conductivity is 100 W/m $^0$C and is exposed to ambient air at 30 $^0$C with a heat transfer coefficient 25 W/m$^2$ $^0$C. If one end of the fin is maintained at temperature 500 $^0$C and other end is at 200 $^0$C . Solve the following differential equation for obtaining the temperature distribution over the length of a fin. **14**

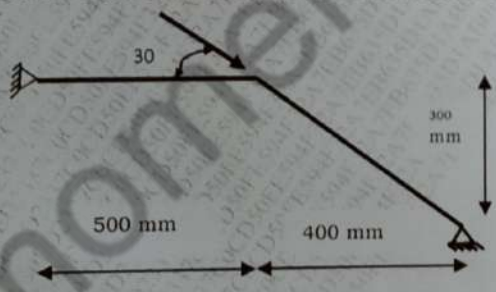
$$kA.\frac{d^2\theta}{dx^2} - hp\theta = 0$$

θ= Temperature difference=Tx -Ta.
Use Rayleigh-Ritz method, mapped over general element, taking Lagrange's linear shape functions and three linear elements.
Write all the steps clearly. Compare your answer with exact at x= 2,4 cm

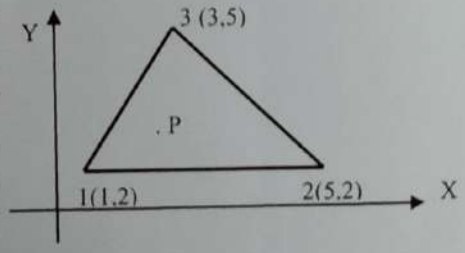
b) For the iso parametric quadrilateral element shown in figure. Determine Cartesian coordinates of point P which has local coordinates (ξ,η) = (0.57735, 0.57735). **6**



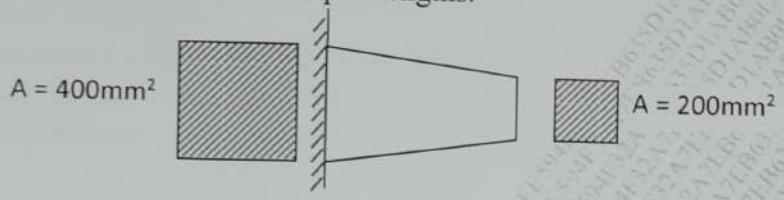

Q.4 a) Compute the stress developed in the members of the truss shown in figure. E=200 GPa. Area of the each member is 200 mm$^2$. **10**



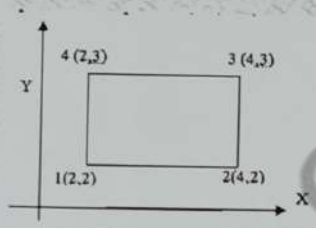

b) The nodal coordinate of the triangular element are as shown in figure. Take the nodal displacement vector $Q^T$=[2.0,1.0,3.0,2.0,5.0,3.0] in mm. Obtained the displacement at the interior point P whose x and y coordinate is (1.5). **10**



Q.5 a) Evaluate the natural frequencies for the bar with varying cross sections shown in figure. $L = 200$ mm, $E = 200$ GPa and $\rho = 8000$ kg/m$^3$. Consider two elements of equal lengths. **10**




b) Quadrilateral element is shown in figure. The temperatures at the nodes are $T_1$=100°C, $T_2$=60°C , $T_3$=50°C and $T_4$=90°C respectively. Determine the temperature at a point P (2.5, 2.5) **10**

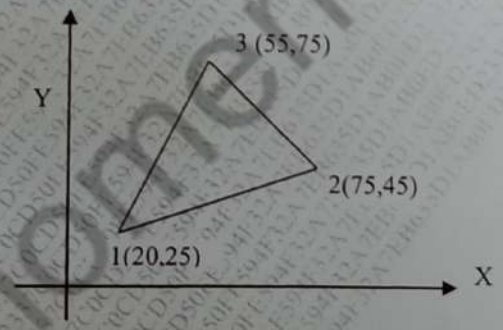



Q.6 a) A CST element is shown in figure. The modulus of elasticity and Poisson's ratio for plate material are 70 x 10$^3$ N/mm$^2$ and 0.3 respectively. Upon loading of the plate, the nodal deflections were found to be in x and y direction respectively as **12**

$u_1$= 0.01mm and $v_1$= -0.04mm, $u_2$= 0.03mm and $v_2$= 0.02mm, $u_3$= -0.02mm and $v_3$= -0.04mm.

Determine :

i. The Jacobian for (x,y)-(ξ,η) transformation
ii. The strain-displacement relation matrix
iii. The stress in plate




b) Explain Convergence criteria. What do you understand by h & p method of Finite Element Analysis? **08**