Total No. of Questions : 8]

SEAT No. :

P3540

[Total No. of Pages : 4

[4959]-1225

B.E. (Automobile Engineering)

B : FUNDAMENTALS OF FINITE ELEMENT ANALYSIS

(2012 Pattern)

Time : 2:30 Hours] *[Max. Marks : 70*

Instructions to the candidates:-

1) ***Answer Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of Logarithmic tables, slide rule, electronic pocket calculator is allowed.***
5) ***Assume suitable data if necessary.***

Q1) a) Describe in detail the steps involved in solving structural problem. **[6]**

b) Determine the nodal displacement and support reactions of the axially loaded bar as shown in Figure 1.1. Take E = 200 GPa and P = 30 kN, A_1 = 250 mm^2, A_2 = 400 mm^2. **[8]**

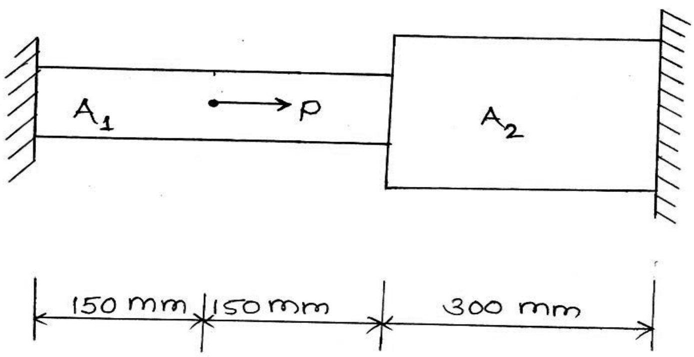

Figure 1.1

c) Explain the term shape function and write a shape function for CST & LST elements. **[6]**

OR

Q2) a) Explain the Reyleigh-Ritz & Galerkin Methods. **[6]**

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b) Determine the displacement of nodes 1 and 2 in the spring system shown in Figure 2.1. Use minimum potential energy principle to assemble equation of equilibrium. **[8]**

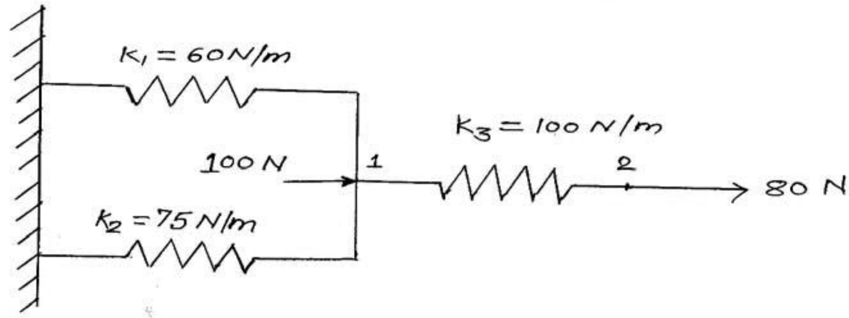

Figure 2.1

c) Evaluate the shape function N_1, N_2 and N_3 at the interior point P for the triangular element shown in Figure 2.2 **[6]**

Table 2.1

Point	X-coordinate	Y-Coordinate
1	1.5	2
2	7	3.5
3	4	7
P	3.85	4.8

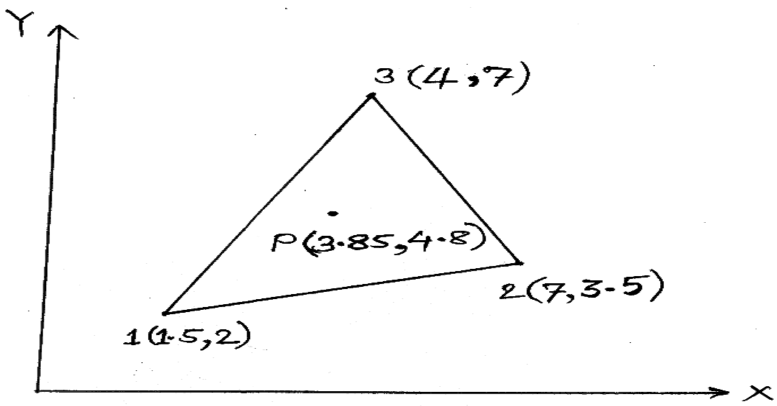

Figure 2.2

Q3) a) Explain the terms iso-parametric, sub-parametric & super-parametric, Jacobian matrix. **[8]**

b) Evaluate the integrals using three point Gaussian quadrature (5 marks each). **[10]**

i) $I = \int_{-1}^{1}[x^2 + \cos\left(x/2\right)]dx$

ii) $I = \int_{-1}^{1}[3^x - x]dx$

OR

Q4) a) Explain Newton-Cotes and Gauss quadrature in brief. **[8]**

b) The iso-parametric shape functions for CST element as shown in Figure 4.1 are given as N1 = ζ, N2 = η, and N3 = 1– ζ – η. Evaluate shape functions at interior point P. Also, if temperatures at node 1,2 and 3 are 25°, 30°, and 50°respectively, evaluation the temperature at the interior point P. **[10]**

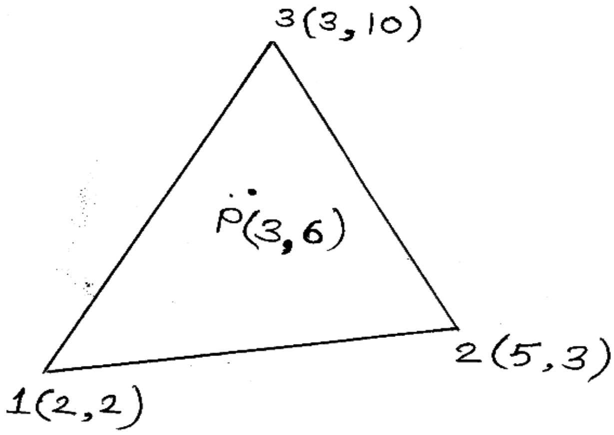

Figure 4.1

Q5) a) Formulate the one - dimensional heat transfer equations using a variational method. **[8]**

b) The thermal conductivity of a stainless steel rod of 0.1 m length and area of cross- section of 1 cm^2 is 20 W/m-°C. The rate of heat generation in the rod is 10^5 W/m^3. One end of the rod is kept at 0°C and the other end at 100°C. The rod is insulated except at the ends. Using finite element with two elements, find out the temperature at the mid-point of the rod. **[8]**

OR

Q6) Determine the temperature distribution along the length of rod shown in Figure 6.1 with an insulated perimeter. The temperature at the left end is constant 40°C and free stream temperature is - 10°C. Let h = 55W/m^2 °C and k = 35W/m °C. Consider four element **[16]**

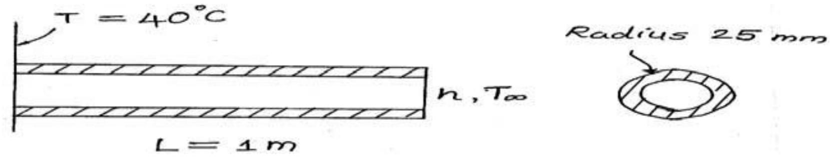

Figure 6.1

Q7) a) Explain the difference between lumped mass matrix and consistent mass matrix. **[8]**

b) For the bar shown in Figure 7.1 with length L, modulus of elasticity E, mass density ρ, and cross sectional area A, determine the first two natural frequencies using lumped mass matrix. **[8]**

Given: L = 2.5 m, ρ = 7850 kg/m^3, E = 210 GPa.

$$[m^e] = \frac{\rho AL}{2}\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

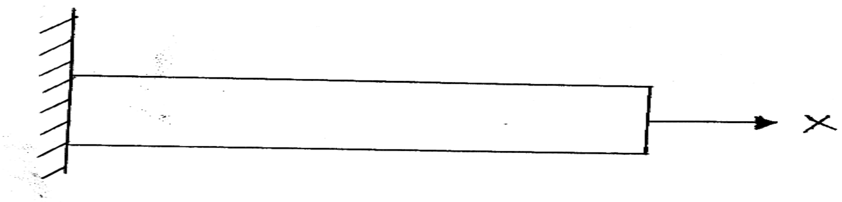

figure 7.1

OR

Q8) a) Explain in brief the Priori error estimates & Posteriori error estimates **[8]**

b) Obtain the expression for the first non-zero natural frequency of vibration for a uniform free-free (both ends free) rod by FEM with two elements & consistent mass matrix. **[8]**

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