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12MTP12

First Semester M.Tech. Degree Examination, February 2013
Finite Element Method

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. State the law of conservation of mass, momentum and energy, with simple examples. **(10 Marks)**

b. Explain the steps involved in solving the continuum problem by finite element method. **(10 Marks)**

2 a. Derive the element shape function and temperature derivatives for one-dimensional quadratic element. **(14 Marks)**

b. Calculate the temperature of an slim long bar at a distance of 5 cm from one end where the temperature is 120°C with the other end at a temperature of 200°C. Assume the temperature variation between the two end points as being linear. **(06 Marks)**

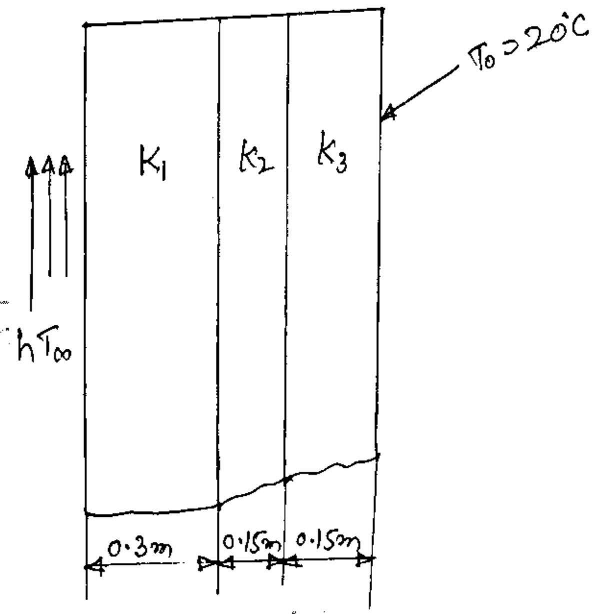
3 a. Derive the shape function and temperature derivatives of a two dimensional linear triangular element. **(10 Marks)**

b. The solution for the temperature distribution on a linear triangle gives the nodal temperatures as T_i = 200°C, T_J = 180°C and T_K = 160°C. The coordinates of i, J and K are (x_i = 2 cm, y_i = 2 cm), (x_J = 6 cm, y_J = 4 cm) and (x_K = 4 cm, y_K = 6 cm). Calculate the temperature at a location given by x = 3 cm and y = 4 cm. Also calculate the coordinates of isotherms, corresponding to 170°C. Calculate the heat flux in x and y directions, if the thermal conductivity is 0.5 W/m °C. Also show that the sum of shape functions at (x = 3 cm, y = 4 cm) is unity. **(10 Marks)**

4 a. A metallic fin with thermal conductivity K = 360 W/m °C, 0.1 cm thick and 10 cm long extends from a plane wall, whose temperature is 235°C. Determine the temperature distribution and amount of heat transferred from the fin to the ambient air at 20°C, with h = 9 W/m^2 °C. Take width of fin to be 1 m. **(10 Marks)**

b. A fin of cross section 2 mm × 3 mm and 20 mm long, is attached to a base at 100°C. The fin is exposed to ambient air at 25°C. Heat transfer coefficient is 120 W/m^2 °C. The thermal conductivity of fin material is 200 W/m °C. Determine the temperature distribution, heat dissipation and efficiency of the fin using (i) one linear element, (ii) two linear elements. **(10 Marks)**

5 A composite wall consists of three materials as shown in Fig.Q5. The outer temperature is T_0 = 20°C, convective heat transfer takes place on the inner surface of the wall with T_∞ = 800°C and h = 25 W/m^2 °C. Determine the temperature distribution in the wall. **(20 Marks)**



$K_1 = 20$ W/m °C

$K_2 = 30$ W/m °C

$K_3 = 50$ W/m °C

$h = 25$ W/m^2 °C

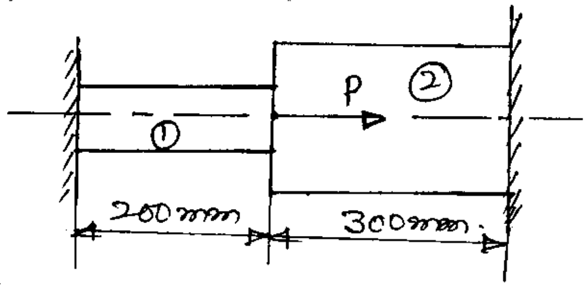
$T_\infty = 800$°C

Fig.Q5

6 a. Explain the application of Galerkin method for transient equation subjected to appropriate boundary and initial conditions. **(10 Marks)**

b. Explain the following:
i) Application of FEM to solidification problems
ii) Inverse heat conduction problems. **(10 Marks)**

7 a. An axial load of 4×10^5 N is applied at 30°C to the rod as shown in Fig.Q7(a). The temperature is then raised to 60°C. Calculate the following:
i) Assemble the K and F matrices ii) Nodal displacements and stresses in each element.



$A_1 = 1000$ mm^2
$A_2 = 1500$ mm^2
$E_1 = 0.7\times10^5$ N/mm^2
$E_2 = 2\times10^5$ N/mm^2
$\alpha_1 = 23\times10^{-6}$ /°C
$\alpha_2 = 12\times10^{-6}$ /°C

Fig.Q7(a) **(14 Marks)**

b. What are plane stress and plane strain problems? **(06 Marks)**

8 Write short notes on :
a. Convergence
b. Transient convection
c. Convection in porous media
d. Characteristic based split scheme **(20 Marks)**

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