Registration No: | | | | | | | | | | |

Total Number of Pages: 02 **M.TECH**

HTPE212

2nd Semester Back Examination 2016-17

FINITE ELEMENT METHODS IN THERMAL ENGINEERING

Branch: HEAT POWER & THERMAL ENGG, HEAT POWER ENGG, THERMAL ENGG, THERMAL POWER ENGG

Time: 3 Hours

Max Marks: 70

Q.CODE: Z1077

Answer Question No.1 which is compulsory and any five from the rest.

The figures in the right hand margin indicate marks.

Q1 **Answer briefly the following questions:** **(2x10)**

a) What is meant by Finite Element Analysis?

b) Briefly describe about various types of elements used in FEM?

c) Distinguish between FDM and FEM.

d) What is Pascal triangle, state its importance?

e) What is meant by post processing in FEA?

f) Define convergence criteria for FEM?

g) Classify various type of materials based on number of independent elastic constants.

h) State four FEM softwares used in industrial applications?

i) What is Rayleigh-Ritz method?

j) Write down the governing equation for two-dimensional steady state heat conduction equation.

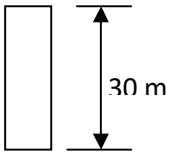
Q2 **a)** What is Finite Element Method (FEM). What are the advantages of FEM **(4)**

b) Briefly describe different steps involved in FEM analysis. **(6)**

Q3 Derive the finite element formulation for the transient heat conduction problem which is expressed by the equation $\frac{\partial u}{\partial t} - \frac{\partial^2 u}{\partial x^2} = 0$ for 0 < x < 1 with boundary conditions: u(0,t) = 0, $\frac{\partial u}{\partial t}(1, t) = 0$ and initial condition u(x,0) = 1.0. **(10)**

Q4 Derive a finite element formulation for one dimensional unsteady heat conduction with free end convection. **(10)**

Q5 For the one dimensional bar fixed at both ends and subjected to a uniform temperature rise T=50 °C, determine the reactions at the fixed ends and axial stress in the bar. Let E=200 GPa, A= 4 m^2, L =4 m, and α=0.57/K. **(10)**



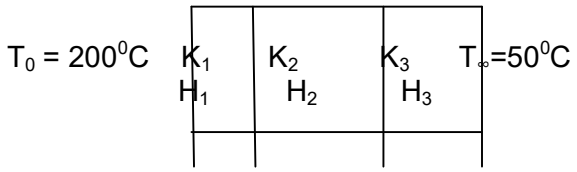
Q6 A steel rod of diameter D = 0.05 inch, length L = 0.05m, and thermal conductivity k = 50W/(m.^{0}C) is exposed in ambient air at T_∞ =–20^{0}C with a heat transfer coefficient β = 120W/(m^2 ^{0}C). The rod acts as a fin. The left end of the rod is maintained at temperature T_0 = 330^{0}C and the other end is insulated. Compute the temperature distribution and the heat input at the left end of the rod. **(10)**

The governing equation for the rod is: $\frac{d^2\theta}{dx^2} - m^2\theta = 0$ for $0 < x < L$.

Where θ = T - T_∞ and m^2 = (βP)/(Ak). The boundary conditions are: at x = 0, θ = 310^{0}C, at x = L, dθ/dx = 0.

Q7 **a)** What is Isoparametric linear element? **(3)**

b) A composite wall consists of three materials as shown. The inside wall temperature is 200^{0}C and the outside temperature is 50^{0}C with a convection coefficient of β = 10 W/(m^2 ^{0}K). Determine the temperature along the composite wall. (H_1 = 2cm, H_2 =2.5cm, H_3=4 cm, K_1 = 70 w/(m^{0}K), K_2 = 40 w/(m^{0}K), K_3=20 w/(m^{0}K), A=1). The governing equation is: $-KA\frac{\partial^2 T}{\partial x^2} = 0$ for 0 < x < L and is subjected to the boundary conditions T(0) = T_0, $\left[KA\frac{dT}{dx} + \beta A(T - T_\infty)\right]_{x=L} = 0$ **(7)**



Q8 **Write short notes on any two.** **(5x2)**

a) Briefly describe about Variational Approach.

b) Jacobian of a matrix.

c) Global stiffness matrix.

d) Heat conduction formulation in FEM.