Enrollment No: _____ Exam Seat No:_____

C.U.SHAH UNIVERSITY
Summer Examination-2018

Subject Name : Finite Element Methods

Subject Code : 5TE02FEM1 **Branch : M.Tech (Mechanical) (CAD/CAM)**

Semester : 2 **Date : 25/04/2018** **Time : 10:30 To 01:30** **Marks : 70**

Instructions:

(1) Use of Programmable calculator & any other electronic instrument is prohibited.
(2) Instructions written on main answer book are strictly to be obeyed.
(3) Draw neat diagrams and figures (if necessary) at right places.
(4) Assume suitable data if needed.

Section - I

Q-1 (a) Draw the distribution of linear shape functions over the nodes. 02
(b) Explain Galerkin approach. 02
(c) Write the properties of stiffness matrix. 02
(d) What is plane stress problem? Illustrate with example. 01

Q-2 (a) Explain basic steps involved in Finite Element Method and illustrate them with example. 05
(b) With reference to finite element analysis, discuss the treatment of boundary condition using elimination approach. 05
(c) Write down the types of symmetry encountered in engineering problems. Explain each with example. 04

OR

Q-2 (a) Explain in detail how size and shape of element will effect on result of FEA. 05
(b) List and explain the properties of approximate function. 05
(c) Explain the effect of temperature on 1D structural element. 04

Q-3 (a) Consider the problem of finding the function u(x) that satisfies the differential equation, 07

$$-\frac{d}{dx}\left(a\cdot\frac{du}{dx}\right)+cu-f=0 \qquad \text{for } 0 < x < L$$

and the boundary conditions

$$u(0) = u_0, \quad \left(a\cdot\frac{du}{dx}\right)_{x=L} = Q_0$$

where a, c and f are constants

Develop the weak form for this equation.

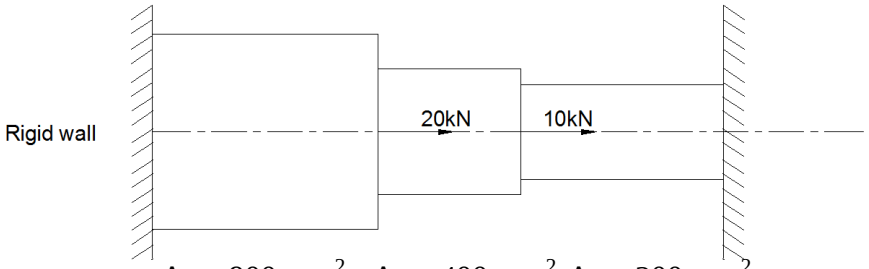
(b) Derive shape function for 1D quadratic element using property of shape function and draw its distribution over the nodes. 07

OR

Q-3 (a) A steel tapered bar of 1200 mm length has the cross – sectional areas of 450 mm^2 and 150 mm^2 at two ends. It is fixed at large and subjected to tensile load of 35 kN at free end. The modulus of elasticity for the bar material is 2 x 10^5 N/mm^2. Model the bar with three finite element each having length of 400 07

mm and calculate the stresses in each element.

(b) Find the values of displacement strain and stresses for the steeped bar as shown in Figure 1. 07



$A_1 = 900\ mm^2$ $A_2 = 400\ mm^2$ $A_3 = 200\ mm^2$
$L_1 = 80$ mm $L_2 = 90$ mm $L_3 = 70$ mm
$E_1 = 70$ GPa $E_2 = 105$ GPa $E_3 = 200$ GPa

Figure 1

Section - II

Q-4 (a) Define subparametric element. 02

(b) Draw the distribution of shape functions over the nodes for CST element. 02

(c) What is mapping. Explain in brief. 02

(d) Write the element equation for heat transfer through steel rod. 01

Q-5 (a) What do you mean by Lumped mass matrices? Explain in details. 05

(b) Draw the distributions of Hermite shape functions used in the Euler-Bernoulli beam element. 05

(c) Using FEM find the temperature distribution in one dimensional fin. 04

OR

Q-5 (a) Explain step by step procedure for 3D structural analysis including commands used, in any Finite Element analysis software through suitable example. 05

(b) Temperature at Node 1 is 100° C and at Node 2 is 40° C. The length of the element is 200 mm. Evaluate the shape function associated with Node 1 and Node 2. Calculate the temperature at point 'P' situated at 150 mm from Node 1. Assume a linear shape function. 05

(c) Discuss in brief 04

1. Geometric non linearity
2. Material non linearity

Q-6 (a) Figure 2 shows a truss consisting of three elements whose EA/L value is 1000 N/mm using FEM determine the deflection at node 2 and reaction force at support. 07

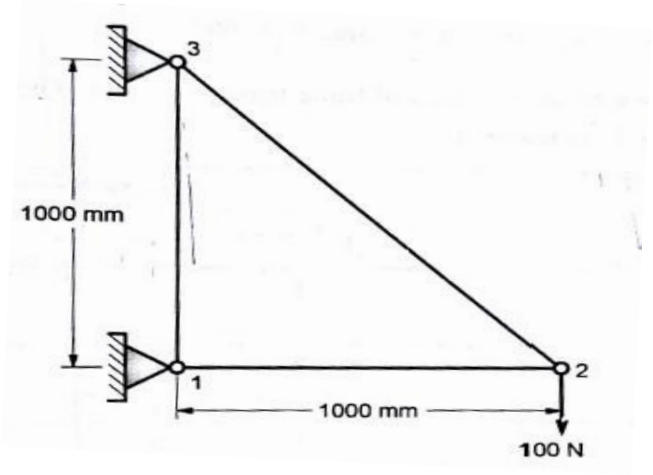


Figure 2

(b) The interior wall of a room is maintained at temperature of 21° C. The wall is built using partial board insulation and bricks as shown in Figure 3. On a mild day the outside air temperature has a convection co-efficient of 20 W/m^2 ° C. Determine the temperature at wall interfaces and the rate of heat loss from the room per sq. m. 07

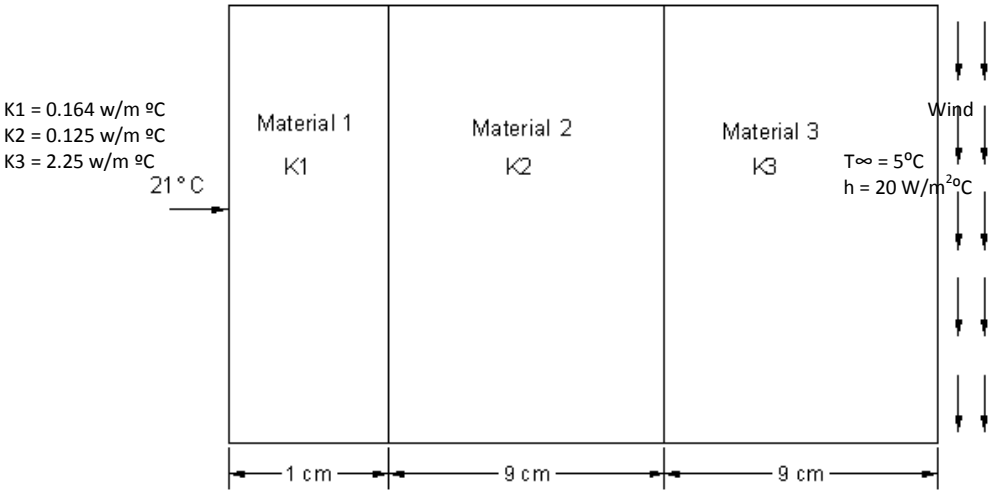


Figure 3

OR

Q-6 (a) What is CST element? Obtain the strain matrix for CST element. 07

(b) Consider heat transfer in a plane wall of total thickness L. The left surface is maintained at temperature T_1 and the right surface is exposed to ambient temperature T∞ with heat transfer co-efficient h. Determine the temperature distribution in the wall and heat input at the left surface of the wall for the following data : 07

L = 0.1 m, K = 0.01 W/m ºC, h = 25 W/m^2 ºC T_1 = 50ºC, T∞ = 5ºC. Solve for nodal temperature and the heat at the left wall using,

1. Two linear finite elements
2. One quadratic element