Reg. No. | | | | | | | | | |

M.E./M.TECH. DEGREE EXAMINATIONS, MAY/JUNE 2017

SECOND SEMESTER

COMPUTER AIDED DESIGN

CD16201 FINITE ELEMENT METHODS IN MECHANICAL DESIGN

(Regulation 2016)

Q. Code: 849193

Time: Three Hours **Maximum : 100 Marks**

Answer **ALL** questions

PART A - (10 X 2 = 20 Marks)

1. Describe the characteristics of shape function.
2. Distinguish between boundary value problem and initial value problem.
3. Differentiate between 2D scalar variable and vector variable problems.
4. Evaluate the following area integrals for the three nodded triangular element $\int N_i\, N_j^2 N_k^3$ dA.
5. Give the Jacobian matrix for CST element.
6. With the schematic representation write down the body force and surface force matrix using the natural coordinate system.
7. Briefly explain Gaussian Quadrature integration techniques.
8. Define the h and p versions of finite element method.
9. State Fourier's Law of heat conduction used in Finite Element Analysis.
10. With the schematic representation write the expression of governing equation for free axial vibration of rod.

PART B - (5 X16 = 80 Marks)

11. (a) Consider a tapered elastic bar is subjected to an applied tensile load P at one end and attached to a fixed support at the other end. The cross sectional area varies linearly from A_0 at the fixed support at x = 0 to $A_0/2$ at x=L. Calculate the displacement at the end of the bar (a) by modeling the bar as a single element having cross sectional area equal to the area of the actual bar at its midpoint along length, (b) using two bar elements of equal length and similarly evaluating the area at the midpoint of each, and (c) using integration to obtain the exact solution. (16)

(OR)

(b) A circular rod has an outside diameter of 6 cm, length of 100 cm, and is perfectly insulated on its circumference. The left half of the cylinder is aluminum for which k_x = 200 W/m °C and the right half is copper having k_x = 389 W/m °C. The extreme right end of the cylinder is maintained at a temperature of 80°C, while the left end is subjected to a heat input rate 4000 W/m^2. Using four equal-length elements, determine the steady-state temperature distribution in the cylinder. (16)

12. (a) Use the direct stiffness method to form the structure stiffness matrix of a rectangular element comprising 4 triangular elements. Assume single degree of freedom for each node. (16)

(OR)

(b) On a four nodal quadrilateral plane stress element the nodes are (0,0), (6,2), (6,6) and (1,5). A concentrated load whose x and y components are 10 kN, 16 kN respectively is applied at a point (4,5). Find the equivalent nodal forces. (16)

13. (a) (i) Establish the Jacobian operator [J] and Jacobian determinant for the two dimensional element. The nodal co-ordinates of the element are 1 (1, 1), 2 (5, 2), 3 (4, 5) and 4 (2, 4). (10)

(ii) Evaluate $\int_1^3 \frac{dx}{x}$ using Gaussian three point formula. (6)

(OR)

(b) A quadrilateral element global coordinates are given as 1(1, 1), 2(3, 1), 3(2.5, 2) and 4(1.25, 1.75). Show that the mapping described by geometric expressions are correctly describes the line connecting nodes 2 and 3 and determine the (x, y) coordinates corresponding to (r, s) = (1, 0.5). (16)

14. (a) (i) With an example explain Skyline Procedure method. (12)

(ii) With sketch explain the procedure of free meshing and mapped meshing. (4)

(OR)

(b) Determine the nodal displacement of the truss system as shown in figure 1 using banded solver method. (16)

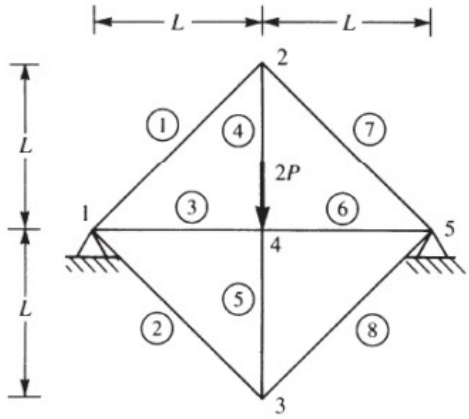

Figure 1

15. (a) Consider the three element model of the fixed-free bar undergoing axial vibrations. Let L = 1 m, A = $30X10^{-6}$ m^2, E = $2x10^{11}$ N/m^2 , ρ = 7800 kg/m^3. Using generalized Jacobi method, calculate the natural frequencies of the system. (16)

(OR)

(b) Find the natural frequency for the three bar truss system shown in figure 2. (16)

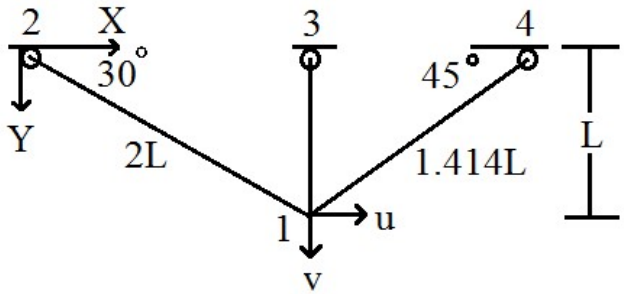

Figure 2