



# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

M.Tech II Semester End Examinations (Regular) - May, 2019

Regulation: IARE-R18

## FINITE ELEMENT METHOD IN STRUCTURAL ENGINEERING

Time: 3 Hours

(STE)

Max Marks: 70

Answer ONE Question from each Unit

All Questions Carry Equal Marks

All parts of the question must be answered in one place only

### UNIT – I

- What are the steps involved in Finite Element Method. Define Degree of freedom and principle of virtual work. [7M]
  - Discuss about the direct stiffness method with an example. Explain about discretization of finite element method? [7M]
- Illustrate the concept of element strain and stress. Distinguish between the problems of 'Plane stress' and 'Plane strain' [7M]
  - For the truss shown in Figure 1,  $\theta_1 = \pi/4$ ,  $\theta_2 = 0$  and the element properties are such that  $k_1 = A_1 E_1 / L_1$ ,  $k_2 = A_2 E_2 / L_2$ . Transform the element stiffness matrix of each element into the global reference frame and assemble the global stiffness matrix. [7M]

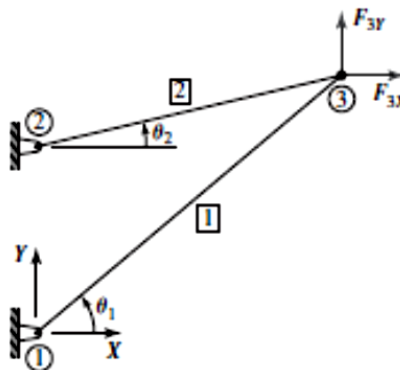


Figure 1

### UNIT – II

- Define shape function, What are the characteristics of interpolation function and shape function. [7M]
  - What is displacement and shape function? Derive the element stiffness matrix for beam elements. [7M]

4. (a) Explain the concept of element load vector for beam elements. Write the shape function for constant strain triangle by using polynomial function? [7M]
- (b) Using 2 DOF truss element determine the horizontal and vertical displacement of joints and the forces in all the members of the plane pin jointed frame shown in fig. joints B,C,D are at the same level as shown in Figure 2,  $c/s \text{ area} = 2400 \text{ mm}^2$ ,  $E = 2 \times 10^5 \text{ N/mm}^2$ . [7M]

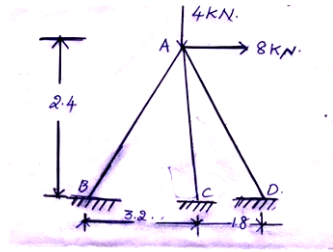


Figure 2

### UNIT – III

5. (a) Write short note on Galerkin's method in FEA. List some disadvantages of using 3-D elements. [7M]
- (b) Write a note on isoparametric formulations and how the geometric as well as field variables are taken in to account. [7M]
6. (a) Derive the equation of polynomial forms for one dimensional element. [7M]
- (b) Define drilling degree of freedom. Write short notes on interpolation functions in FEM. [7M]

### UNIT – IV

7. (a) Write short notes on three-dimensional elements and explain with suitable examples. [7M]
- (b) Determine the shape functions  $N_1$ ,  $N_2$  and  $N_3$  for the triangular element with co-ordinates of (2,3), (5,7) and (4,5) all the units are in meters. Hence determine the value of  $N_1$ ,  $N_2$  and  $N_3$  at centroid of the element. [7M]
8. (a) What are the isoparametric elements and derive the B matrix for the 4 noded isoparametric quadrilateral element. [7M]
- (b) Discuss about Gaussian quadrature in FEM. Explain about interpolation or shape function and polynomial shape function. [7M]

### UNIT – V

9. (a) Write short notes on i) Plane stress and strain and ii) Plane stress and strain for CST element. [7M]
- (b) Explain various axi-symmetric elements. Obtain Generate stiffness matrix for 4 noded Quadrilateral element. [7M]
10. (a) What are the steps involved and uses of general purpose finite element analysis software? [7M]
- (b) Discuss the use of commercial FEA software. Explain about Von mises stress and Volume Co-ordinates. [7M]