A **Reg. No. :** | | | | | | | | | | | | |

Question Paper Code: U6703

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2024

Sixth Semester

Mechanical Engineering

21UME603 FINITE ELEMENT ANALYSIS

(Regulations 2021)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. _____ is a Numerical method for solving problems of Engineering and mathematical physics CO1 U

   (a) Finite Element Analysis (b) Finite Element Method

   (c) Both A&B (d) None of the above.

2. The number of element to be selected for discretization depends upon the following factor is/are…… CO1 U

   (a) Accuracy desired (b) Size of the elements.

   (c) Number of degrees of freedom involved (d) All the above.

3. _____ can resist only axial loads. CO1- U

   (a) Bar (b) Beam (c) Both a & b (d) None of the above

4. Assemblage of bars is called_____ CO1- U

   (a) Truss (b) Bar (c) Spring (d) None of the above

5. Linear Strain Triangular Element has _____ number of nodes. CO1- U

   (a) 3 (b) 6 (c) 12 (d) 24

6. Constant Strain Triangular Element has _____ number of nodes. CO1- U

   (a) 3 (b) 6 (c) 12 (d) 24

7. A motion which repeats itself after equal interval of time is called CO1- U

   (a) Cycle (b) Frequency (c) Periodic Motion (d) Damping

8. Direct Method has _____ value.

(a) approximate (b)Exact (c)Zero (d) All the above

9. Heat transfer between two solid mediums is called CO1- U

(a) Conduction (b) Convection (c) Radiation (d) None of the above

10. Generally, matter exists in _____ state(s). CO1- U

(a) Solid (b) Liquid (c) Gas (d) All the above

PART – B (5 x 2= 10 Marks)

11. State the three phases of finite element method. CO1- U

12. Compare Global co-ordinates and Natural co-ordinates. CO1- U

13. Explain the purpose of Isoparametric Element CO1- U

14. Write down the expression of Transverse vibration of beam element CO1- U

15. Write down the Finite element equation for 1-D Heat Conduction with free end Convection. CO1- U

PART – C (5 x 16= 80 Marks)

16. (a) The following differential equation is available for a physical phenomenon. CO4 Ana (16)

$$\frac{d^2y}{dx^2} + 50 = 0 \quad , 0 \leq x \leq 10$$

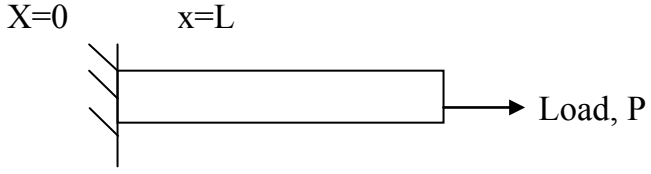
and the trial function is $y = a_1 x(10-x)$ with boundary conditions as y(0) = 0 and y(10) = 0. Compare the value of the parameter a_1 by the following methods.

(i) Point Collocation Method
(ii) Sub-domain Collocation Method
(iii) Least Squares Method

Galerkin's Method

Or

(b) A bar of uniform cross section is clamped at one end and left free at the other end and it is subjected to a uniform axial load P as shown in Fig. Analyze the displacement and stress in a bar by using two terms polynomial and three terms polynomial, compare with exact solutions. CO4 - Ana (16)



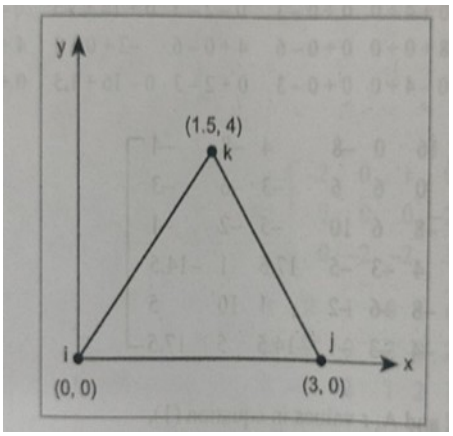
17. (a) Using two finite elements, find the stress distribution in a uniformly tapering bar of circular cross- sectional area 3 cm^2 and 2 cm^2at their ends, length 100 mm, subjected to an axial tensile load of 50 N at smaller end and fixed at larger end. Take the value of Young's modulus E= $2x10^5$ N/mm^2. CO2- App (16)

Or

(b) Derivate the displacement function ***u*** and shape function ***N*** for one dimensional Linear bar element based on global co-ordinate approach. CO2- App (16)

18. (a) Determine the stiffness matrix for the CST element shown in figure. CO2 - App (16)

The co-ordinates are given in units of millimeters. Assume plane stress conditions. Take E=2.1 x 10^5 N/mm^2, v=0.25 and t=10 mm.



Or

(b) A fournoded Rectangular element as shown in figure. Determine the following: CO2 - App (16)

(i) Jacobian Matrix

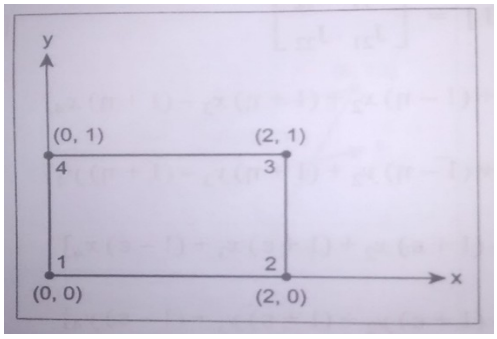
(ii) Strain-Displacement Matrix.

(iii) Element Stresses

Take E = $2x10^5$ N/mm^2, v = 0.25,

u = $[0, 0, 0.003, 0.004, 0.006, 0.004, 0, 0]^T$, $\varepsilon = 0, \eta = 0$

Assume plane stress condition.

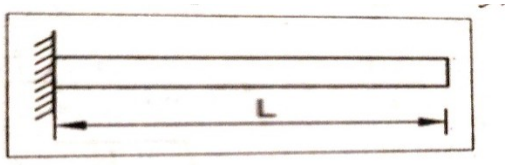


19. (a) Analyze the eigen values and natural frequencies of a system whose stiffness and mass matrices are given below: CO4- Ana (16)

$$[K] = \frac{2AE}{L}\begin{bmatrix} 3 & -1 \\ -1 & 1 \end{bmatrix},\ m = \frac{\rho A L}{12}\begin{bmatrix} 6 & 1 \\ 1 & 2 \end{bmatrix}$$

Or

(b) Consider a uniform cross-section bar as shown in figure of length "L" made up of a material whose Young's modulus and density are given by E and **ρ.** Estimate the natural frequencies of axial vibration of the bar using both lumped and consistent mass matrix. CO4- Ana (16)



20. (a) A steel rod of diameter d= 2cm, Length L=5cm and thermal conductivity k = 50W/m°C is exposed at one end to a constant temperature of 320°C. The other end is in ambient air of temperature 20°C with a convection coefficient of h = 100 W/m^2°C. Evaluate the temperature at the midpoint of the rod. CO6 – Eva (16)

Or

(b) Evaluate the temperature distribution in a square region with uniform energy generation as shown in figure. Assume that there is no temperature variation in the z -direction. Take k=30W/cm°C, l=10cm, T_∞=50°C, q=100W/cm^3. CO6 – Eva (16)