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

Question Paper Code: U6703

B.E. / B.Tech. DEGREE EXAMINATION, APRIL/MAY 2025

Sixth Semester

Mechanical Engineering

21UME603- FINITE ELEMENT ANALYSIS- 1

(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. ….. temperature or fluid pressure at each nodal point is obtained. CO1-U

   (a) Non – Structural Problems (b) Structural Problems

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

3. Assemblage of beams is called_____ CO1-U

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

4. _____ is a distributed force acting on every elemental volume of the body. CO1- U

   (a) Traction force (b) Body force (c) Point load (d) None of the above

5. In plane strain analysis CO1-U

   (a) $\rho_z = 0$ (b) $\gamma_{xz} = 0$ (a) $\rho_z = 0$ (b) $\gamma_{xz} = 0$

6. ….. is/ are consider as two dimensional elements. CO1- U

   (a) Triangular Element (b) Beam Element (c) Both a &d (d) Rectangular Element

7. Frequency is _____ to Time period CO1- U

   (a) Directly Proportional (b) Inversely Proportional

   (c) Equal (d) None of the above

8. Direct Method has _____ value. CO1-U

(a) approximate (b) Exact (a) approximate (b) Exact

9. In non-structural problems _____ at each nodal point is obtained CO1- U

(a) Displacement (b) Temperature (c) Stress (d) Strain

10. Heat transfer from one body to another without any transmitting medium is known as CO1-U

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

PART – B (5 x 2= 10 Marks)

11. Explain the Aspect Ratio. CO1- U

12. Differentiate essential and natural boundary conditions. CO1- U

13. State axisymmetric element. CO1- U

14. Write the methods of elimination of the undesirable vibrations. 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= 80Marks)

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

$$\frac{d^2y}{dx^2} - 10x^2 = 5; \quad 0 \le x \le 1$$

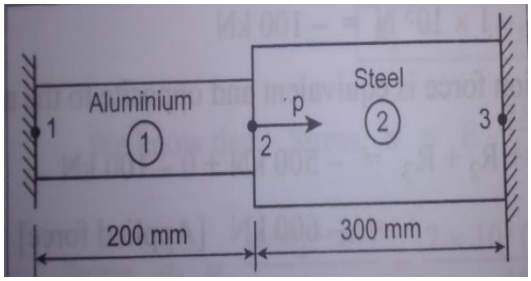
with boundary conditions as y(0) = 0 and y(1)= 0

By using Galerkins method of weighted residuals to find an approximate solution of the above different equation and also compare with exact solution.

Or

(b) A simply supported beam subjected to uniformly distributed load over entire span and subjected to a point load at the centre of the span. Analyze the bending moment and deflection at mid-span by using Rayleigh Ritz method and compare with exact solution. CO4 -Ana (16)

17. (a) An axial load of $4x10^5$ N is applied at 30°C to the rod as shown in the figure. The temperature is then raised to 60°C. CO2 -App (16)



For Aluminium

$A1 = 1000\ mm^2$

$E1 = 0.7 \times 10^5\ N/mm^2$

For Steel

$A2 = 1500\ mm^2$

$E2 = 2 \times 10^5\ N/mm^2$

Thermal coefficient = 20×10^{-6}/ degCelcius

12×10^{-6}/ deg Celcius

Calculate the following:

(i) Assemble the K and F matrices iii) Nodal Displacements

(ii) Stresses in each material iv) Reactions at each nodal point

Or

(b) Derivate the stiffness matrix for One dimensional Linear Bar Element. And also list out the properties of stiffness matrix. CO3 -App (16)

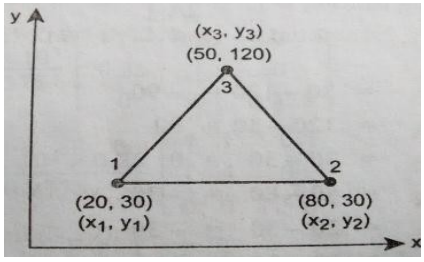
18. (a) For the plane stress element as shown in figure the nodal displacements are: CO2 -App (16)

$u_1 = 2$ mm; $v_1 = 1$ mm , $u_2 = 0.5$ mm; $v_2 = 0$ mm, $u_3 = 3$ mm; $v_3 = 1$ mm

Determine the element stresses σ_x, σ_y, τ_{xy}, σ_1 and σ_2 and the principal angel Θ_p.

Let E = 210 Gpa, v = 0.25, t = 10mm.

All coordinates are in mm



Or

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

(i) Jacobian Matrix

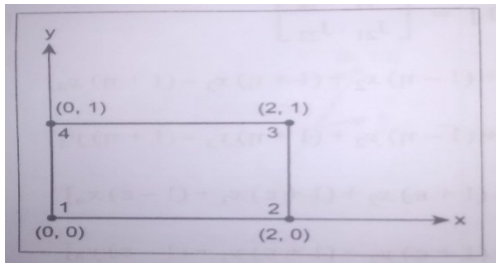
(ii) Strain-Displacement Matrix.

(iii) Element Stresses

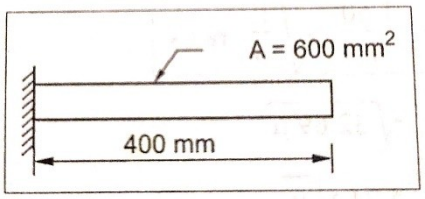
Take $E = 2 \times 10^5\ N/mm^2$, v = 0.25,

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

Assume plane stress condition.

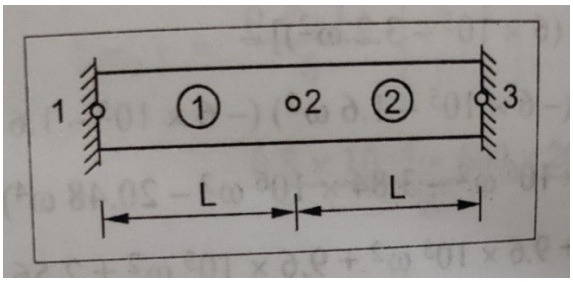


19. (a) For the One dimensional bar having Area, A = 600mm^2, Length L= 400m, Young's modulus E = 2 x10^5 N/mm^2, Density ρ = 0.8 x 10^{-4} N/mm^3, Compare the natural frequencies of longitudinal vibration using two elements of equal length. CO4 -Ana (16)



Or

(b) Compare the natural frequency of vibration for a beam fixed at both ends. The beam has mass density ρ, modulus of elasticity E, cross sectional area A, moment of inertia I, and length 2L. The beam is discretized into two elements of length L. CO4 -Ana (16)



20. (a) An aluminium alloy fin of 7mm thick and 50mm long protrudes form a wall, which is maintained at 120°C. The ambient air temperature is 22°C. The heat transfer coefficient and thermal conductivity of the fin material are 140W/m^{2}K and 55W/mK respectively. Evaluate the temperature distribution of fin. 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$_\infty$=50°C, q=100W/cm^3. CO6 -Eva (16)