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Question Paper Code: 99702

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

Seventh Semester

Mechanical Engineering

19UME702 – FINITE ELEMENT ANALYSIS

(Regulation 2019)

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 art of subdividing a structure into a convenient number of smaller element is known as……. CO1- U

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

   (c) Discretization of structure (d) None of the above

3. _____ is a force acting at a particular point which causes displacement. CO1- U

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

4. Assemblage of bars is called_____ CO1- U

   (a) Truss (b) Beams (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. In plane strain analysis CO1- U

   (a) $\rho_z = 0$ (b) $\gamma_{xz} = 0$ (c) $\gamma_{yz} = 0$ (d) All of the above

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

   (a) Cycle (b) Frequency (c) Counter flow (d) Damping

8 The causes of vibration is/are CO1- U

(a) Winds (b) Earthquakes (c) Elastic Nature (d) All of the above

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

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

10 _____ is imaginary line that connects a series of points CO1- U

(a) Path Line (b) Stream Line (c) Inviscid Flow (d) None of the above

PART – B (5 x 2= 10Marks)

11 Explain the Aspect Ratio. CO1- U

12 Explain Degrees of freedom. CO1- U

13 Write down the stress-strain relationship matrix for plane strain condition. CO1- U

14 State difference between Direct and Iterative methods for solving system of equations. CO1- U

15 Write down the expression for stiffness matrix in 2D fluid mechanics. CO1- U

PART – C (5 x 16= 80 Marks)

16 (a) The following differential equation is available for a physical phenomenon. CO2- App (16)

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

and the trial function is $y = a_{1X}(10-x)$ with boundary conditions as

y(0) = 0 and y(10) = 0. Find the value of the parameter a_1 by the following methods.

(i) Point Collocation Method
(ii) Sub-domain Collocation Method
(iii) Least Squares Method
(iv) Galerkin's Method

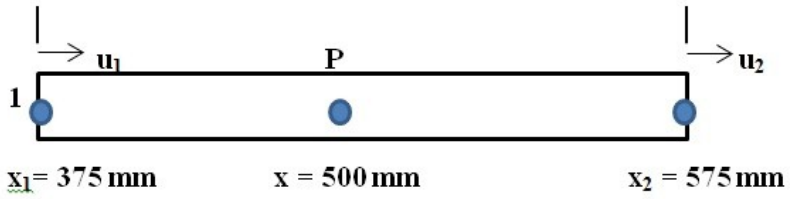
Or

(b) A beam AB of span L simply supported at ends and carrying a concentrated load W at the centre C. Analyze the deflection at mid-span by using Rayleigh Ritz method and compare with exact solution. CO4- Ana (16)

17 (a) Consider a bar as shown in figure. Cross-sectional area of the bar is 750mm^2 and Young's Modulus is 2 X 10^5 N/mm^2. If u_1=0.5mm and u_2 = 0.625mm, calculate the following: CO2- App (16)

(i) Displacement at point, P
(ii) Strain, Ɛ
(iii) Stress, σ
(iv) Strain Energy, U

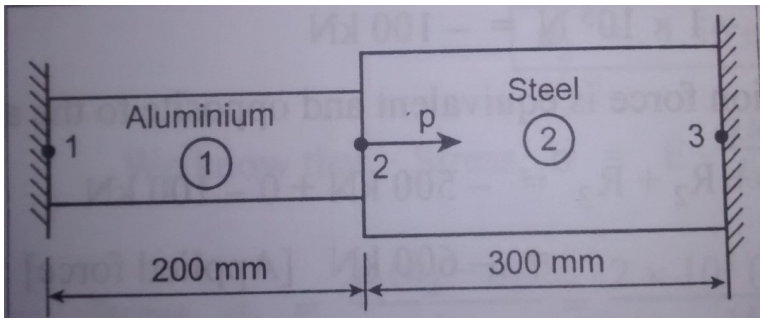
(v) Element Stiffness Matrix [K]



Or

(b) 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. Calculate the following: CO2- App (16)

(i) Assemble the K and F matrices
(ii) Nodal Displacements
(iii) Stresses in each material
(iv) Reactions at each nodal point



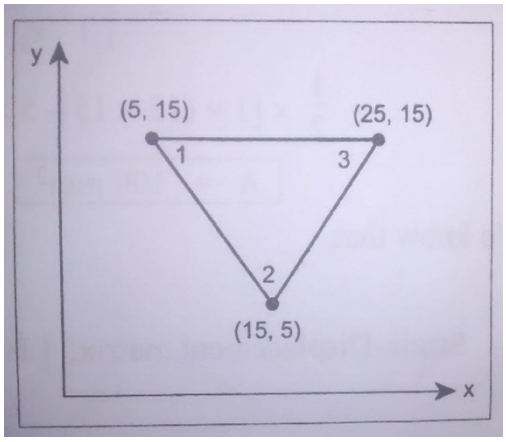
18 (a) For the plane strain element as shown in figure the nodal displacements are CO2- App (16)

$u_1 = 0.005$ mm; $v_1 = 0.002$ mm

$u_2 = 0$ mm; $v_2 = 0$ mm

$u_3 = 0.005$ mm; $v_3 = 0$ mm

Determine the element stressesσ_x, σ_y, τ_{xy}, σ_1 and σ_2 and the principal angel Θ_p. Let E = 70Gpa, v = 0.3 and use unit thickness. All coordinates are in mm



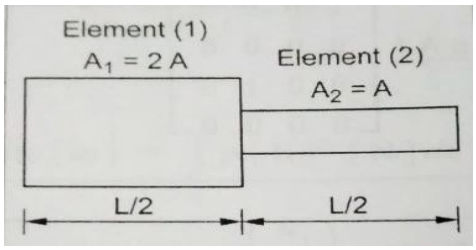
Or

(b) (i) Evaluate the integral $\int_{-1}^{1} \frac{\cos x}{1-x^2}$ dx by applying 3 point Gaussian Quadrature. CO2- App (8+8)

(ii) Evaluate the integral $\int_{-1}^{1}(2 + x + x^2)$ dx and compare with exact solution.

Or

19 (a) Compare the natural frequencies of longitudinal vibration of the unconstrained stepped bar as shown in the figure. CO4- Ana (16)

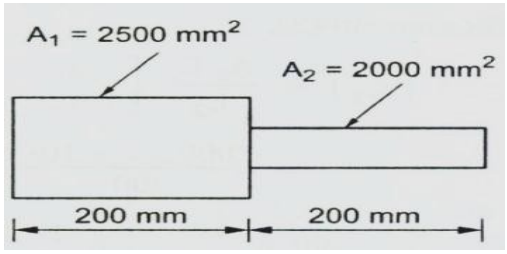


Or

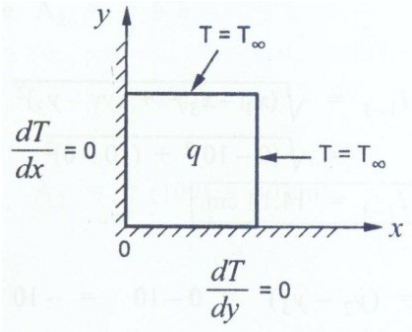
(b) Compare the eigen values and frequencies for the stepped bar as shown in the figure. CO4- Ana (16)

Take,Young's modulus E = 2 x10^5 N/mm^2,

Unit weight Density = 0.8 x 10^{-4} N/mm^3



20 (a) 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)



Or

(b) A steel rod of diameter d= 2 cm, Length L=5 cm 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)