Code No: R1941032 **R19** **Set No. 1**

IV B. Tech I Semester Regular Examinations, November – 2022
FINITE ELEMENT METHODS
(Common to Mechanical Engineering and Automobile Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any FIVE Questions
ONE Question from Each unit
All Questions Carry Equal Marks
*****

UNIT-I

1 a) List out advantages and engineering applications of FEM. [8]
b) What is the need of discretization in FEM? Explain with suitable example. [7]

(OR)

2 a) Explain plane stress and plane strain condition with suitable examples. [8]
b) Discuss about stress-strain relation for Isotropic material. [7]

UNIT-II

3 Derive stiffness matrix for a beam element. [15]

(OR)

4 Consider the four bar truss shown in Figure1. It is given that E = 2 x 10^5 MPa and A = 650 mm^2 for each element. Determine nodal displacements and stresses in each element. [15]

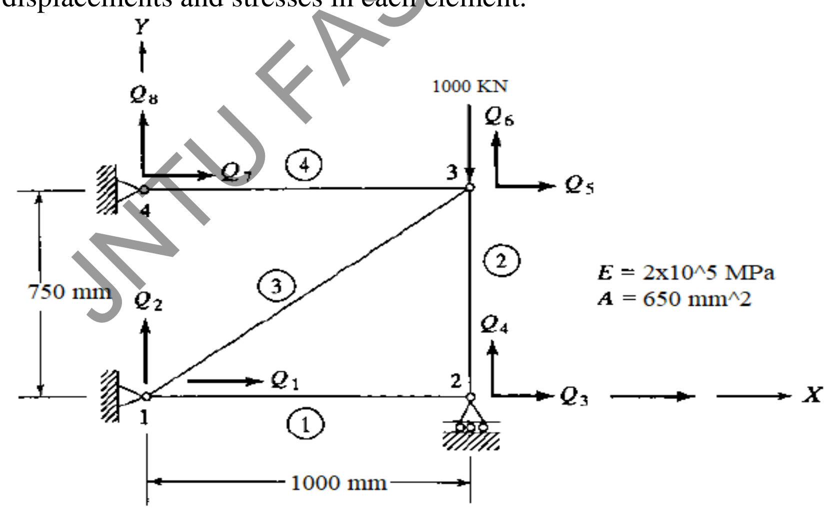

Figure 1.

UNIT-III

5 a) The nodal coordinates of the triangular element are shown in Figure 2. At the interior point P, the x-coordinate is 3.3 and $N_1 = 0.3$ Determine N_2,N_3 and the y-coordinate at point P. [8]

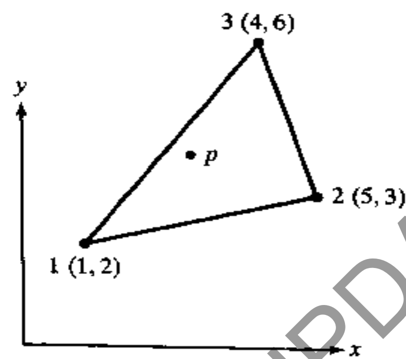

Figure 2.

b) Determine the Jacobian for the (x, y) - (ξ, η) transformation for the element shown in Figure 3. Also, find the area of the triangle. [7]

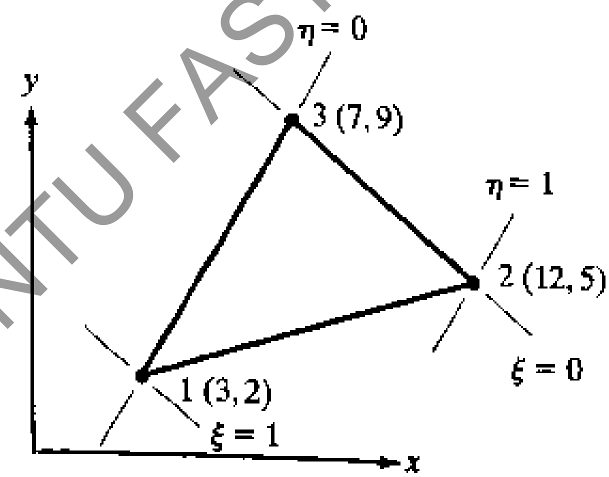

Figure 3.

(OR)

6 a) Evaluate the axisymmetric stiffness matrix 'K' of the triangular element shown in the Figure 4. Consider the coordinates of nodes as 1 (2, 1), 2 (4, 0), and 3 (3,2). Also assume E = 2.6 GPa and ν = 0.2 [8]

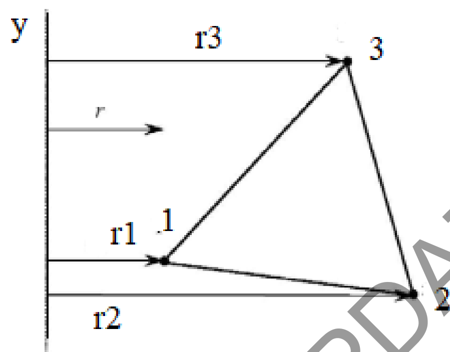

Figure 4.

b) Discuss axisymmetric formulation with examples. [7]

UNIT-IV

7 a) Derive shape functions for a four- node quadrilateral element and discuss salient points. [8]

b) Write short notes on isoparametric elements and their advantages. [7]

(OR)

8 a) Explain one and two-point point Gaussian quadrature. [7]

b) Evaluate the integral $\int_{-1}^{+1}\left[3e^{x} + x^{2} + \frac{1}{(x+2)}\right]dx$ by applying one and two-point point Gaussian quadrature. [8]

UNIT-V

9 A metallic fin, with thermal conductivity k =360 W/m°C, 0.1 cm thick, and 10 cm long, extends from a plane wall whose temperature is 235°C. Determine the temperature distribution and amount of heat transferred from the fin to the air at 20°C with h = 9 W/m²- °C. Take the width of fin to be 1 m. [15]

(OR)

10 Determine natural frequencies of a stepped bar whose details are given below: Areas of 2 segments of bar are 50 mm2 and 100 mm² and lengths are 500 mm and 1000 mm respectively. Assume E = 200 GPa and mass density is 8000 Kg/m³. The 100 mm² segment of bar is fixed at one end and another end is connected to 50 mm² segment. [15]

Code No: R1941032 **R19** **Set No. 2**

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UNIT-I

1 a) List and briefly describe the five typical areas of engineering where the finite element method is applied. [8]
b) Discuss the factors to be considered in discretization of a domain. [7]

(OR)

2 a) Explain the properties of stiffness matrix. [7]
b) List and briefly describe the general steps of the finite element method. [8]

UNIT-II

3 A four bar truss shown in Figure 1. Determine nodal displacement and element stresses by taking E = 200 GPa, area of each element A = 500 mm^2. [15]

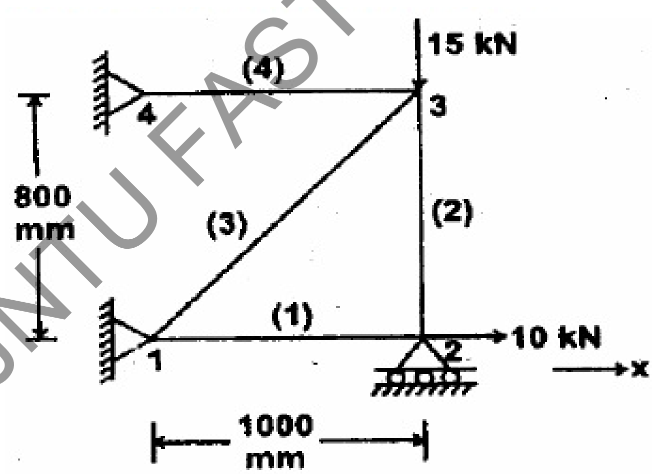

Figure 1.

(OR)

4 a) Compare the characteristics of the beam element with the truss element. [7]
b) What is a beam? Derive the hermite shape functions in a beam element? [8]

UNIT-III

5 a) For point 'P' located inside the triangle shown in Figure 2. The shape functions N_1 and N_2 are 0.15 and 0.25 respectively. Determine the x- and y-coordinates of point P. [8]

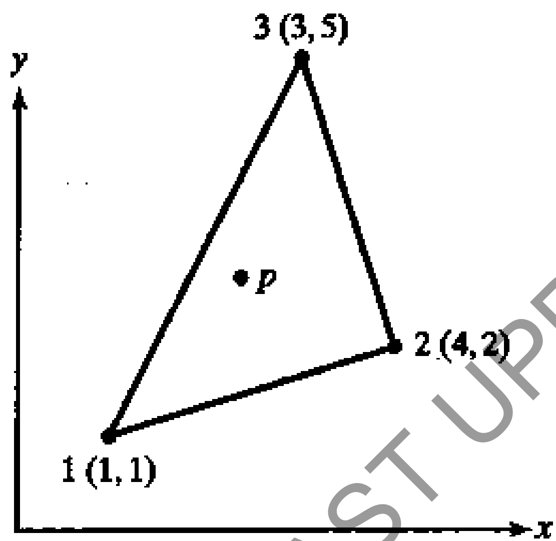

Figure 2.

b) Explain behaviour of shape function in CST with suitable example. [7]

(OR)

6 a) For the axisymmetric element shown in Figure 3.Determine the element stiffness matrix. Take E=200 GPa, and υ=0.3 [8]

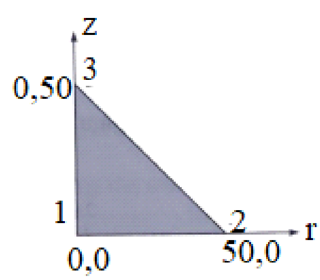

Figure 3.

b) Discuss a few applications of axisymmetric elements. [7]

UNIT-IV

7 a) Derive Shape functions for a four- node quadrilateral element and discuss salient points. [8]

b) Evaluate jacobian matrix at ξ = η = 0.5 for the linear quadrilateral element shown in Figure 4. [7]

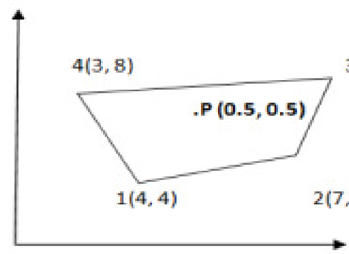

Figure 4.

(OR)

8 a) Evaluate the integral $\int_{-1}^{+1} cos\frac{\pi x}{2}$ by applying one and two-point point Gaussian quadrature. Compare the results with exact results and comment. [8]

b) Explain one and two-point point Gaussian quadrature. [7]

UNIT-V

9 A metallic fin, with thermal conductivity k =360 W/m°C, 0.1 cm thick, and 10 cm long, extends from a plane wall whose temperature is 235°C. Determine the temperature distribution and amount of heat transferred from the fin to the air at 20°C with h = 9 W/m²- °C. Take the width of fin to be 1 m. [15]

(OR)

10 Consider the axial vibrations of a steel bar shown in the Figure 5. [15]

- Develop global stiffness and mass matrices,
- Determine the natural frequencies?

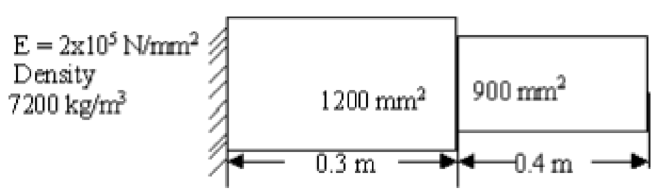

Figure 5.

Code No: R1941032 **R19** **Set No. 3**

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UNIT-I

1 Consider a bar as shown in Figure 1. An axial load of 200kN is applied at a point P. Take A_1=2400 mm^2, E_1=70x10^9 N/mm^2, A_2=600 mm^2 and E_2 = 200x10^9 N/mm^2. Calculate the following (i) Nodal displacement at point,P (ii) Stress in each element (iii) Reaction force. [15]

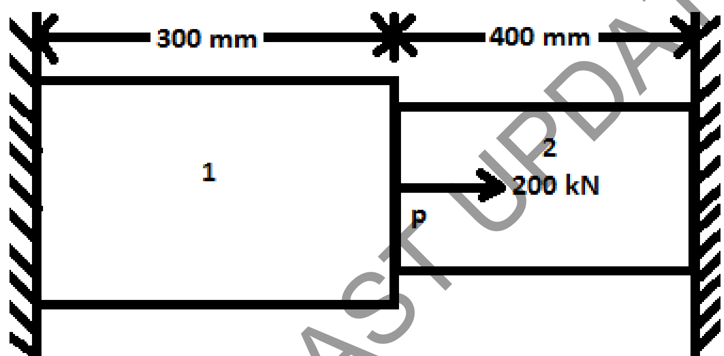

Figure 1.

(OR)

2 a) In a plane strain problem σ_x = 1400 MPa , σ_y = -100 MPa and 200 GPa, v=0.3. Determine σ_z [7]

b) List out advantages and engineering applications of FEM. [8]

|''|''|||''|'''|||'|

UNIT-II

3 A Plane truss structure shown in Figure 2. Determine the nodal displacements and support reactions. Take E = $2x10^5$ MPa and area of each element A = 1500 mm^2 [15]

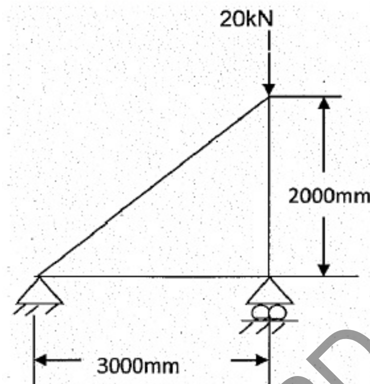

Figure 2.

(OR)

4 Derive stiffness matrix for a beam element. [15]

UNIT-III

5 a) Evaluate shape functions N_1, N_2 and N_3 at the interior point 'P' of the triangular element shown in Figure 3. [8]

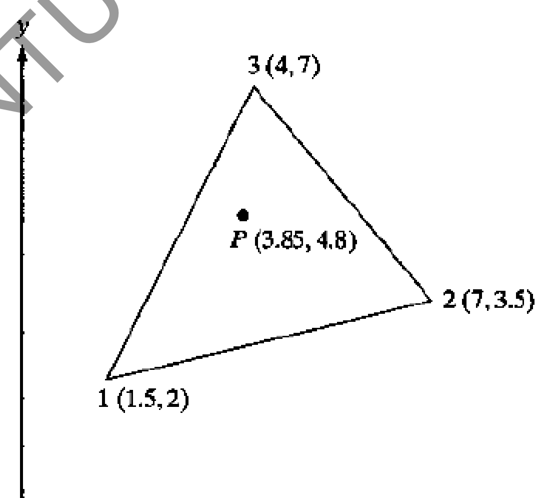

Figure 3.

b) Explain behaviour of shape function in CST with suitable example. [7]

(OR)

6 An axisymmetric triangular element is described by the following details. Determine the element stresses at the centroid for Young's modulus 80 GPa and Poisson's Ratio 0.25. [15]

	Node 1	Node 2	Node 3
Radial Coordinate from the axis (r)	5 mm	1 mm	3 mm
Axial coordinate (z)	5 mm	5 mm	2mm
Deformation in radial direction (u)	0.02 mm	0.06 mm	0.01 mm
Deformation in axial direction (u)	-0.04 mm	0	0.02 mm

UNIT-IV

7 a) Derive shape functions for a four- node quadrilateral element and discuss salient points. [8]

b) Write short notes on isoparametric elements and their advantages. [7]

(OR)

8 a) Explain one and two-point point Gaussian quadrature [7]

b) Evaluate the integral $\int_{-1}^{+1}\left[3e^{x}+x^{2}+\frac{1}{(x+2)}\right]dx$ by applying one and two-point point Gaussian quadrature. [8]

UNIT-V

9 A metallic fin, with thermal conductivity k = 360 W/m°C, 0.1 cm thick, and 10 cm long, extends from a plane wall whose temperature is 235°C. Determine the temperature distribution and amount of heat transferred from the fin to the air at 20°C with h = 9 W/m²- °C. Take the width of fin to be 1 m. [15]

(OR)

10 Consider the axial vibrations of a steel bar shown in the Figure 4. [15]

- Develop global stiffness and mass matrices,
- Determine the natural frequencies?

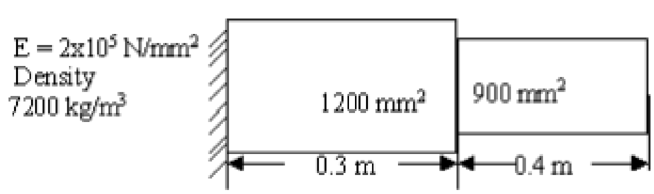

Figure 4.

Code No: R1941032 **R19** **Set No. 4**

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UNIT-I

1 Consider a bar as shown in Figure 1. An axial load of 100 N is applied. Take Young's modulus E=2 x 105 N/mm^2, A_1= 2 cm^2, A_2 = 1cm^2. Calculate the following (i) Nodal displacement (ii) Stress in each element and (iii) Reaction forces [15]

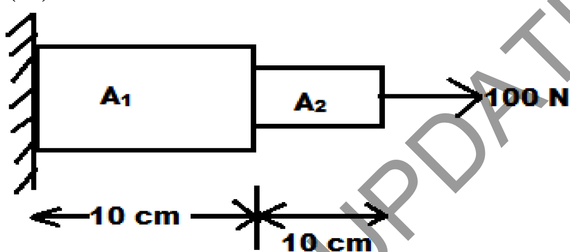

Figure 1.

(OR)

2 a) Derive stiffness matrix for one dimensional bar element. [8]

b) Differentiate global and local coordinates. Also explain the significance of node numbering in FEM. [7]

UNIT-II

3 A truss structure shown in Figure 2, is carrying a vertical load of 100 KN. Determine the displacement and stresses. Take E = 210 GPa, area of each element A = 1200 mm^2 [15]

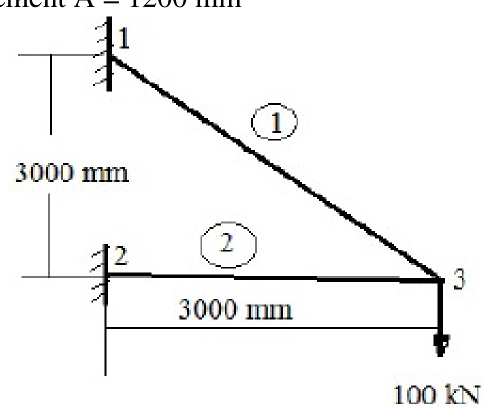

Figure 2.

(OR)

4 a) Compare the characteristics of the beam element with the truss element. [7]

b) What is a beam? Derive the hermite shape functions in a beam element? [8]

UNIT-III

5 a) Evaluate shape functions N_1, N_2 and N_3 at the interior point 'P' of the triangular element shown in Figure 3. [8]

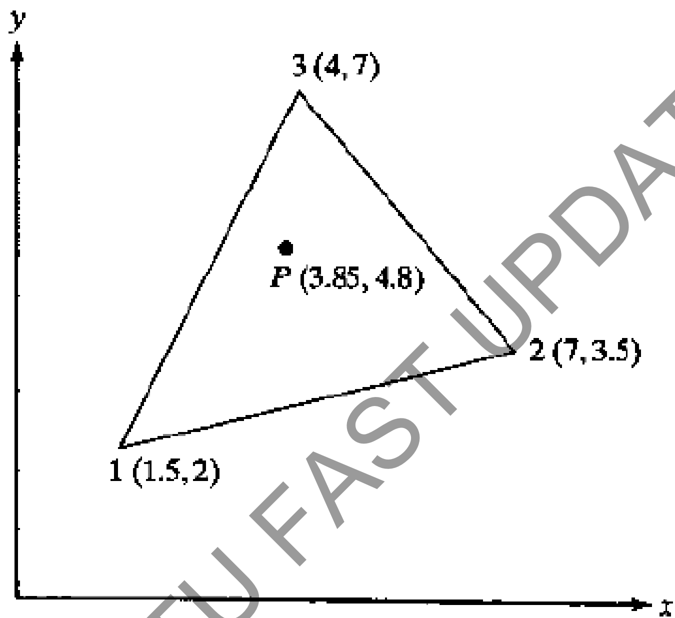

Figure 3.

b) Explain behaviour of shape function in CST with suitable example [7]

(OR)

6 An axisymmetric triangular element is described by the following details. Determine the element stresses at the centroid for the Young's Modulus 80 GPa and Poisson's Ratio 0.25. [15]

	Node 1	Node 2	Node 3
Radial Coordinate from the axis (r)	5 mm	1 mm	3 mm
Axial coordinate (z)	5 mm	5 mm	2mm
Deformation in radial direction (u)	0.02 mm	0.06 mm	0.01 mm
Deformation in axial direction (u)	-0.04 mm	0	0.02 mm

UNIT-IV

7	a)	Derive the element 'B' matrix for a one dimensional quadratic element.	[7]
	b)	Explain the applications of isoparametric elements in two dimensional stress analysis.	[8]
		(OR)	
8	a)	Evaluate the integral $\int_{-1}^{+1}\left[3e^{x} + x^{2} + \frac{1}{(x+2)}\right]dx$ by applying one and two-point point Gaussian quadrature.	[8]
	b)	Explain one and two-point point Gaussian quadrature.	[7]

UNIT-V

9		Derive the conductivity matrix for 1-D fin element? And also derive the load vector if the lateral surface and tip is exposed to a heat transfer coefficient of 'h' and ambient temperature 'Tα'?	[15]
		(OR)	
10		Discuss the methodology to solve the Eigenvalue problem for the estimation of natural frequencies of a stepped bar?	[15]