Reg. No.															

Question Paper Code	13414

B.E. / B.Tech. - DEGREE EXAMINATIONS, APRIL / MAY 2025

Seventh Semester

Mechanical Engineering

20MEPC701 - FINITE ELEMENT ANALYSIS

Regulations - 2020

Duration: 3 Hours | Max. Marks: 100

PART - A (MCQ) (10 × 1 = 10 Marks)

Answer ALL Questions

		Marks	K – Level	CO
1.	Total potential energy = (a) Strain energy x work potential (b) Strain energy / work potential (c) Strain energy + work potential (d) Strain energy - work potential	1	K1	CO1
2.	When a body falls freely towards the earth, then its total energy (a) Decreases (b) Increases (c) First increases and then decreases (d) Remains constant	1	K1	CO2
3.	Number of shape functions in two noded beam element are (a) 2 (b) 3 (c) 4 (d) 5	1	K1	CO2
4.	The value of the shape function at the specified point is (a) Zero (b) Unity (c) Infinity (d) None of the above	1	K1	CO3
5.	In Rayleigh-Ritz Method, which series is considered for approximating function (a) Laplace series (b) Inverse Fourier series (c) Inverse laplace series (d) Fourier series	1	K1	CO4
6.	What type of interpolation is typically used with iso-parametric quadrilateral elements? (a) Polynomial interpolation (b) Trigonometric interpolation (c) Exponential interpolation (d) Logarithmic interpolation	1	K1	CO5
7.	For a 1D integral, how many points are typically used in Gaussian quadrature for a second-degree polynomial? (a) 1 (b) 2 (c) 3 (d) 4	1	K1	CO5
8.	Undamped vibration is also known as_____ (a) Calculative (b) Deterministic (c) In-deterministic (d) Non-Calculative	1	K1	CO6
9.	Temperature at the end tip of the fin having uniform cross-sectional area is (a) maximum (b) minimum (c) similar to the heat generation temperature (d) unpredictable	1	K1	CO6
10.	In dynamic analysis, a common element used for two-dimensional vibration problems is the _____ element. (a) linear bar (b) triangular element (c) beam element (d) tetrahedral element	1	K1	CO6

PART - B (12 × 2 = 24 Marks)

Answer ALL Questions

		Marks	K – Level	CO
11.	During discretization, mention the places where it is necessary to place a node.	2	K1	CO1
12.	Why polynomial type interpolation functions are mostly used in FEM?	2	K1	CO1
13.	Differentiate between truss and frame.	2	K2	CO2
14.	Illustrate shape function of a two node bar element.	2	K2	CO2
15.	What is meant by plane stress analysis?	2	K1	CO3
16.	What is meant by Axisymmetric Solid?	2	K1	CO3
17.	State the principle of minimum potential energy.	2	K1	CO4
18.	State the advantages of the Rayleigh Ritz method.	2	K1	CO4
19.	Differentiate between Isoparametric, super parametric and sub-parametric elements.	2	K2	CO5

20.	Write down the Guassian Quadrature expression for Numerical Integration.		2	K1	CO6
21.	State the assumptions for the boundary conditions while solving finite element problems.		2	K2	CO5
22.	Define Longitudinal and Transverse vibrations.		2	K2	CO6

PART - C (6 × 11 = 66 Marks)

Answer ALL Questions

23.	a)	Describe the step by step procedure of solving Finite Element Analysis.	11	K2	CO1
		OR			
	b)	Solve the differential equation for a physical problem expressed as $d^2y/dx^2 + 50 = 0$, $0 \le x \le 10$ with boundary conditions as y(0)=0 and y(10)=0 using (i) Least square method and (ii) Galerkin method	11	K2	CO1
24.	a)	For a tapered bar of uniform thickness t = 10mm as shown in figure 1. Predict the displacements at the nodes by forming into two element model. The bar has a mass density ρ = 7800 kg/m^3, the young's modulus E = 2x10^5 MN/m^2. In addition to self-weight, the bar is subjected to a point load P = 1 kN at its Centre.	11	K3	CO2

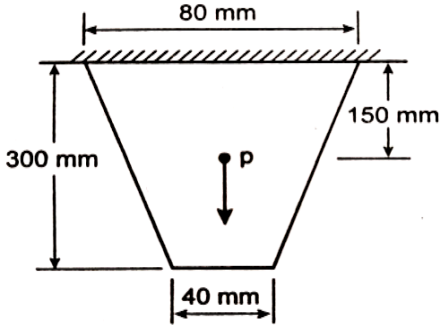

Figure 1.

OR

	b)	For the two bar truss shown in the figure 2, Estimate the displacements of node 1 and the stress in element 1-3.Take E = 70 GPa, A = 200 mm^2	11	K3	CO2

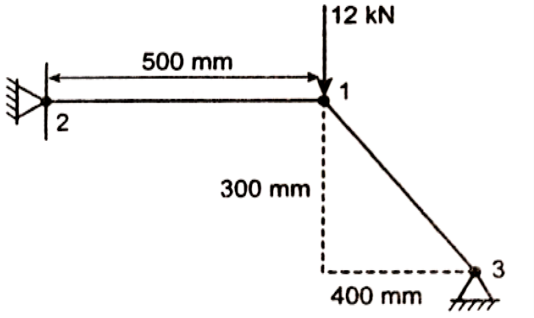

Figure 2.

25.	a)	Calculate the temperature force vector for the plane stress CST element shown in figure 3. The element experiences a 20^{o}C increase in temperature. Assume α = 6x10^{-6} C. Take E = 2x10^5 N/mm^2, v = 0.25, t = 5mm.	11	K3	CO3

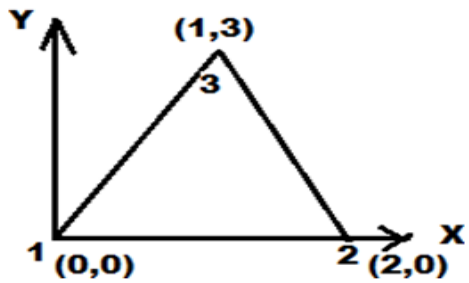

Figure 3.

OR

b) For the axisymmetric triangular elements as shown in figure 4. Evaluate the Strain displacement Matrix. Take the modulus of elasticity E = 210 GPa. Poisson's ratio = 0.25. The coordinates are given in millimeters. *11 K3 CO3*

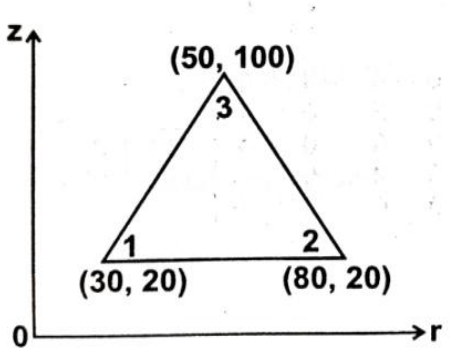

Figure 4.

26. a) Using variational method, Solve the given differential equation *11 K3 CO4*

$\frac{d^2y}{dx^2} + 300x^2 = 0 \; ; \; 0 \leq x \leq 1$

with boundary conditions y(0) = 0 and y(l) = 0. The functional corresponding to this problem to be extremized is given by

$$I = \int_0^1 \left\{ -\frac{1}{2}\left(\frac{dy}{dx}\right)^2 + 300x^2 y \right\} dx$$

Find the solution of the problem using Rayleigh Ritz method using a one term solution as $y = ax(1-x^2)$

OR

b) Solve the following simultaneous equations using the Gaussian elimination method. *11 K3 CO4*

2a + b + 2c - 3d = -2
2a - 2b + c - 4d = -15
a + 2c - 3d = -5
4a + 4b - 4c + d = 4

27. a) Evaluate the Jacobian matrix for the iso-parametric quadrilateral element shown in the figure 5. *11 K3 CO5*

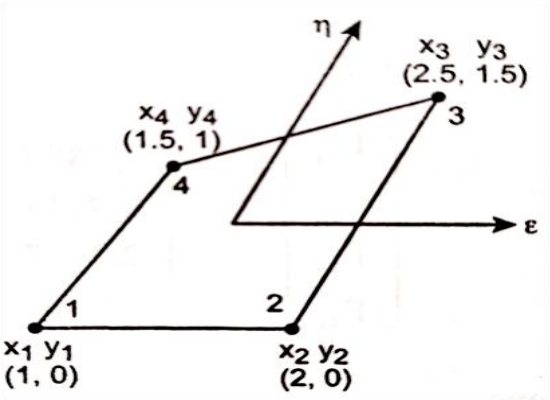

Figure 5.

OR

b) Evaluate the integral by two point Gaussian Quadrature, *11 K3 CO5*

$$I = \int_{-1}^{1}\int_{-1}^{1} (2x^2 + 3xy + 4y^2)\,dx\,dy$$

Gauss points are +0.57735 and -0.57735 each of weight 1.0000.

28. a) A metallic fin 20 mm wide and 4 mm thick is attached to a furnace whose wall temperature is 180°C. The length of the fin is 120 mm. if the thermal conductivity of the material of the fin is 350 W/m°C and convection coefficient is 9 W/m^2°C, determine the temperature distribution assuming that the tip of the fin is open to the atmosphere and that the ambient temperature is 25°C. *11 K3 CO6*

OR

b) A furnace wall is made up of three layers, inside layer with thermal conductivity of 8.5 W/mK, middle layer with thermal conductivity of 0.25 W/mK, outer layer with thermal conductivity of 0.08 W/mK. The respective thickness of inner, middle and outer layer are 25 cm, 5 cm and 3 cm respectively. The inside temperature of the wall is 600^o C and outside of the insulation is exposed to atmospheric air at 30^{o}C with Heat transfer coefficient of 45 W/m^{2}K. Calculate the nodal temperatures. *11 K3 CO6*