

**M.E. / M.Tech. - DEGREE EXAMINATIONS, NOV / DEC 2025**

Second Semester

**M.E. - CAD/CAM**

**24PCDPC202 - ADVANCED FINITE ELEMENT ANALYSIS**

Regulations - 2024

Duration: 3 Hours

Max. Marks: 100

**PART - A (MCQ) (10 × 1 = 10 Marks)**

Answer ALL Questions

	Marks	K- Level	CO
1. Variational Approach method that make use of variational principles, such as _____ to determine approximate solutions of the problems. (a) Principle of virtual work (b) Principle of minimum potential energy (c) Both a and b (d) None of the above	1	K1	CO1
2. Initial conditions are used for _____ problems. (a) time-dependent problems (b) boundary value problems (c) control volume problems (d) finite difference problems	1	K1	CO1
3. For CST element, if N1 = 0.3 and N2 = 0.2 what is the value of N3 (a) 0.6 (b) 0.4 (c) 0.7 (d) 0.5	1	K2	CO2
4. An imaginary line that connects a series of points in space at a given instant in such a manner that all particles falling on the line at that instant have velocities whose vectors are tangent to the line is called a) Path Line (b) Stream Line (c) Base Line (d) None of the above	1	K1	CO2
5. Damping in a vibrating system can be classified as _____-proportional or stiffness-proportional damping. (a) temperature (b) mass (c) load (d) time	1	K1	CO3
6. In vibration analysis, the damping matrix is typically: (a) Proportional to the mass matrix (b) Proportional to the stiffness matrix (c) A combination of mass and stiffness matrices (d) Independent of both mass and stiffness matrices	1	K1	CO3
7. Heat transfer takes place according to which of the following law? (a) Newton's second law of motion (b) First law of thermodynamics (c) Newton's law of cooling (d) Second law of thermodynamics	1	K1	CO4
8. Unit of thermal conductivity in S.I. units is (a) J/m <sup>2</sup> sec (b) J/m °K sec (c) W/m °K (d) Option (B) and (C) above.	1	K1	CO4
9. A nonlinear differential equation is one in which: (a) The dependent variable appears with power one (b) The dependent variable and its derivatives appear linearly (c) The dependent variable appears with power >1 or multiplied together (d) It has constant coefficients	1	K1	CO5
10. Material nonlinearity occurs due to _____ (a) Small deformations (b) Nonlinear stress-strain behaviour (c) Constant cross-section (d) Linear elastic modulus	1	K1	CO5

**PART - B (12 × 2 = 24 Marks)**

Answer ALL Questions

11. What are structural and non-structural problems?	2	K1	CO1
12. During discretization, mention the places where it is necessary to place a node?	2	K1	CO1
13. Define 2D vector variable problems.	2	K1	CO2
14. Write the Stiffness Matrix equation for Four noded Iso parametric Quadrilateral elements.	2	K2	CO2

- |   |   |    |     |
|---|---|----|-----|
| 15. Define Resonance.   | 2 | K1 | CO3 |
| 16. Write down the expression of longitudinal vibration of bar element. | 2 | K2 | CO3 |
| 17. Differentiate Conduction, Convection and Radiation.                 | 2 | K2 | CO4 |
| 18. Write down the Stiffness Matrix for 1D Heat conduction element.     | 2 | K2 | CO4 |
| 19. Why do axially loaded bars exhibit material nonlinearity?           | 2 | K1 | CO5 |
| 20. Distinguish between material and geometric nonlinearity.            | 2 | K2 | CO5 |
| 21. What is meant by Axisymmetric Solid?                                | 2 | K1 | CO2 |
| 22. List out the various elasticity equations.                          | 2 | K1 | CO2 |

**PART - C (6 × 11 = 66 Marks)**

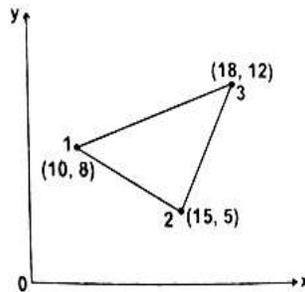
Answer ALL Questions

- |        |   |    |    |     |
|--------|---|----|----|-----|
| 23. a) | Solve the differential equation $d^2y/dx^2 + y + x = 0$ , $0 \leq x \leq 1$ subjected to the boundary conditions $y(0) = y(1) = 0$ using Galerkin Method. | 11 | K3 | CO1 |
|--------|---|----|----|-----|

**OR**

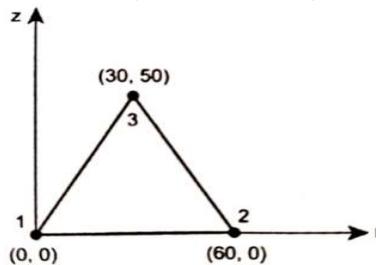
- |    |  |    |    |     |
|----|--|----|----|-----|
| b) | Solve the ordinary differential equation $d^2y/dx^2 + 10x^2 = 0$ , $0 \leq x \leq 1$ with boundary conditions as $y(0) = 0$ and $y(1) = 0$ using the Galerkin's method with the trial function $a_1x(1-x^2)$ . | 11 | K3 | CO1 |
|----|--|----|----|-----|

- |        |   |    |    |     |
|--------|---|----|----|-----|
| 24. a) | For the plane stress CST element as shown in the figure, nodal displacements are $u_1 = 2$ mm, $u_2 = 0.5$ mm, $u_3 = 1.2$ mm, $v_1 = 1$ mm, $v_2 = 1.5$ mm, $v_3 = 2.8$ mm. Determine the element stresses. Assume $E = 210$ GPa, $\nu = 0.25$ , $t = 10$ mm. All coordinates are in mm. | 11 | K3 | CO2 |
|--------|---|----|----|-----|

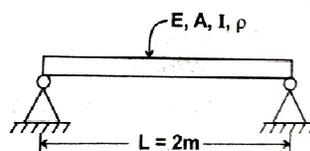


**OR**

- |    |   |    |    |     |
|----|---|----|----|-----|
| b) | For the axisymmetric element shown in figure, determine stresses. Take $E = 2.1 \times 10^5$ N/mm <sup>2</sup> , $\nu = 0.25$ . The coordinates are in mm. The nodal displacements are: $u_1 = 0.05$ mm, $u_2 = 0.02$ mm, $u_3 = 0$ mm, $v_1 = 0.03$ mm, $v_2 = 0.02$ mm, $v_3 = 0$ mm. | 11 | K3 | CO2 |
|----|---|----|----|-----|

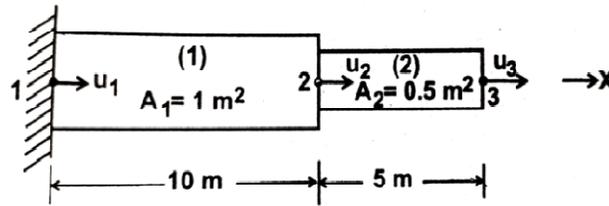


- |        |   |    |    |     |
|--------|---|----|----|-----|
| 25. a) | Find the Natural frequencies in the vibration of two elements simply supported beam having the parameters as length $L = 2$ m, area of cross-section $A = 30 \times 10^{-4}$ m <sup>2</sup> and moment of inertia $I = 4 \times 10^{-10}$ m <sup>4</sup> , density $\rho = 7800$ kg/m <sup>3</sup> and Young's modulus $E = 200$ GPa. | 11 | K3 | CO3 |
|--------|---|----|----|-----|

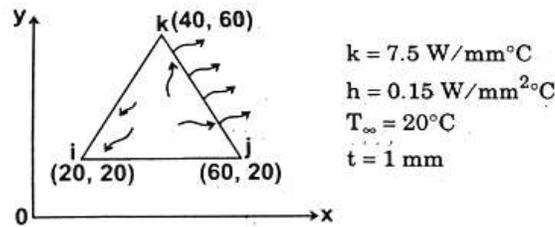


OR

- b) Determine the first two natural frequencies of longitudinal vibration of the stepped steel bar shown in fig. All the dimensions are in m  $E=30 \times 10^{10}$  N/m<sup>2</sup>. and  $\rho = 8500$  kg/m<sup>3</sup>. 11 K3 CO3

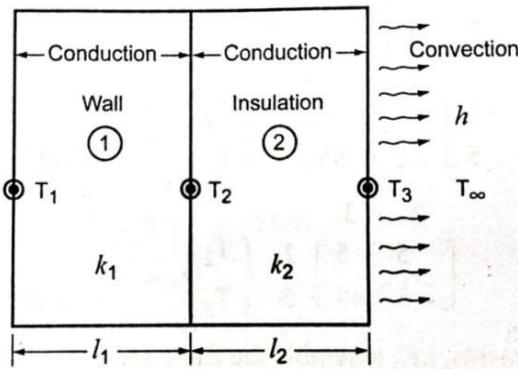


26. a) Calculate the element equations for the element shown in figure, which experiences convection on the side jk and its upper face. 11 K3 CO4



OR

- b) A wall of 0.6 m thickness having thermal conductivity of 1.2 W/mK. The wall is to be insulated with a material of thickness 0.06 m having an average thermal conductivity of 0.3 W/mK. The inner surface temperature is 1000° C and outside of the insulation is exposed to atmospheric air at 30° C with Heat transfer coefficient of 35 W/m<sup>2</sup>K. Calculate the nodal temperatures. 11 K3 CO4



27. a) Explain in detail the various sources of nonlinearity in structural engineering. Give examples for each type. 11 K2 CO5

OR

- b) Derive the Newton–Raphson method for solving nonlinear algebraic equations. Discuss its convergence characteristics. 11 K2 CO5

28. a) The following differential equation is available for a physical phenomenon,  $d^2y/dx^2 + 400x^2 = 0$ ,  $0 \leq x \leq 1$  with boundary conditions as  $y(0) = 0$  and  $y(1) = 0$ . Find an approximate solution of the above differential equation by using (i) Point Collocation Method (ii) Sub Domain Collocation Method, taking two term trial function. 11 K2 CO1

OR

- b) Explain in detail about Weighted residual Methods. 11 K2 CO1