



43654

Library
Brainware University
398, Ramkrishnapur Road, Barasat
Kolkata, West Bengal-700125



BRAINWARE UNIVERSITY

Term End Examination 2025-2026

Programme – M.Sc.(MATH)-2024

Course Name – Finite Element Method

Course Code - MSCME402A

(Semester IV)

Full Marks : 60

Time : 2:30 Hours

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question)

1 x 15=15

1. Choose the correct alternative from the following :

- (i) Select the correct option: The Finite Element Method is
 - a) Analytical method
 - b) Numerical method
 - c) Experimental method
 - d) Statistical method
- (ii) The number of nodes in a quadratic triangular element is
 - a) 3
 - b) 2
 - c) 4
 - d) 6
- (iii) Select the correct option: The number of nodes in a linear triangular element is
 - a) 3
 - b) 2
 - c) 4
 - d) 6
- (iv) Describe the purpose of assembly in FEM
 - a) Combine element equations
 - b) Apply BC
 - c) Perform integration
 - d) Reduce error
- (v) Interpret the effect of higher-order elements
 - a) Reduce accuracy
 - b) Increase error
 - c) Improve accuracy
 - d) Cause instability
- (vi) Describe the meaning of degree of freedom in 1D finite element method
 - a) Stress
 - b) Strain
 - c) Force
 - d) Displacement
- (vii) Apply heat flux boundary condition to identify its type
 - a) Essential
 - b) Mixed
 - c) Natural
 - d) Initial
- (viii) Determine the applicability of plane strain condition
 - a) Thin plates
 - b) Beams
 - c) Shells
 - d) Long structures

- (ix) Apply continuity equation in fluid flow FEM to ensure
- a) Energy conservation
 - b) Momentum balance
 - c) Mass conservation
 - d) Force equilibrium
- (x) Analyze FEM convergence requirement
- a) Stability only
 - b) Accuracy only
 - c) Boundary conditions only
 - d) Consistency and stability
- (xi) Analyze effect of insufficient boundary conditions
- a) Accurate solution
 - b) Singular matrix
 - c) Stable solution
 - d) Faster convergence
- (xii) Analyze consistency condition in FEM
- a) Guarantees convergence
 - b) Guarantees accuracy
 - c) Eliminates error
 - d) Diagonalizes matrix
- (xiii) Illustrate the reason that distorted elements reduce accuracy
- a) Poor interpolation
 - b) Better integration
 - c) Exact mapping
 - d) Reduced DOF
- (xiv) Evaluate the role of assumptions in finite element method
- a) No effect
 - b) Affect accuracy and validity
 - c) Only theoretical
 - d) None of these
- (xv) Evaluate finite element method efficiency improvement method
- a) Optimal mesh design
 - b) Dense mesh everywhere
 - c) No refinement
 - d) None of these

Library
Brainware University
398, Ramkrishnapur Road, Barasat
Kolkata, West Bengal-700125

Group-B

(Short Answer Type Questions)

3 x 5=15

2. A 1D bar has 5 elements and 1 degree of freedom per node. Identify the total degree of freedom. (3)
3. Illustrate essential boundary condition. (3)
4. Illustrate shape functions for a one-dimensional linear element. (3)
5. Define a two-dimensional simplex element and write its shape functions. (3)
6. Illustrate the governing equation of 2D steady-state heat conduction. (3)

OR

Evaluate Jacobian for 1D element.

(3)

Group-C

(Long Answer Type Questions)

5 x 6=30

7. For a linear triangular element with nodal values $u_1 = 2, u_2 = 4, u_3 = 6$ and area coordinates $L_1 = 0.2, L_2 = 0.5, L_3 = 0.3$, evaluate the value of u at the given point. (5)
8. A uniform bar of length 2 m is divided into two equal linear finite elements. Given: $E=200$ GPa, $A=0.005$ m². Apply boundary condition $u_1=0$ and force $F_3=100$ kN. Evaluate Stress in element 2. (5)
9. Identify the solution of the boundary value problem $-\frac{d^2u}{dx^2} = x, 0 \leq x \leq 1$ along with boundary conditions $u(0) = 0$ and $u(1) = 0$ using Galerkin's method. (5)
10. Identify the solution of the boundary value problem $-\frac{d^2u}{dx^2} = x, 0 \leq x \leq 1$ along with the boundary conditions $u(0) = 0$ and $u(1) = 0$ using Ritz method. (5)
11. A bar is divided into two linear elements. Evaluate the global stiffness matrix. (5)
12. A uniform bar of length 2 m is divided into two equal linear finite elements. Given: $E=200$ GPa, $A=0.005$ m². Evaluate the global stiffness matrix for the bar. (5)

OR

Evaluate the solution of the differential equation:

$$\frac{d^2y}{dx^2} = 6x$$

given $y(0) = 1, y'(0) = 0$.

Library
Brainware University
398, Ramkrishnapur Road, Barasat
Kolkata, West Bengal-700125

(5)
