

University of Mumbai

Examination Summer 2022

Program: Mechanical Engineering

Curriculum Scheme: REV- 2019 'C' Scheme

Examination: TE

Semester: V

Course Code: MEC504

Course Name: Finite Element Analysis

Time: 2 hour 30 Minutes

Max. Marks: 80

Q.1	Choose the correct option for following questions. All questions are compulsory and carry equal marks. 2 marks each
1	What is number of internal nodes of a quadratic element?
Option A:	0
Option B:	2
Option C:	1
Option D:	3
2	What is the order of a 1D linear element?
Option A:	1
Option B:	2
Option C:	3
Option D:	4
3	The global stiffness matrix is always
Option A:	Square, un-symmetric, non-singular and positive definite.
Option B:	Square, symmetric, non-singular and negative definite.
Option C:	Non-square, non-symmetric, non-singular and positive definite.
Option D:	Square, symmetric, singular and positive definite.

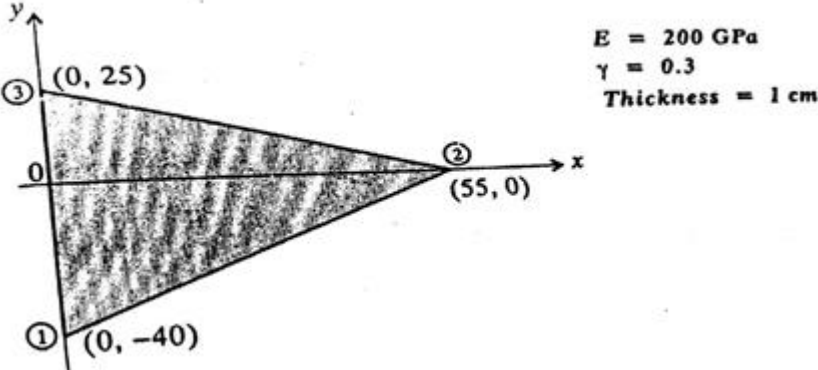
4	The sum of the shape functions over the element is always equal to
Option A	Zero
Option B	Infinity
Option C	Unity
Option D	Half
5	The size of stiffness matrix for 8 node rectangular element is:
Option A	4 x 4
Option B	8 x 8
Option C	16 x 16
Option D	64 x 64
6	The range of natural coordinates is between
Option A	0 to 1
Option B	-1 to +1
Option C	0 to -1
Option D	0 to ∞
7	In FEM, _____ method is used to convert Cartesian coordinate to local coordinate
Option A	Cramer
Option B	Henry
Option C	Jacobian
Option D	Newton
8	The dimension of the Stress-Strain Relation (D) matrix for 2D analysis is

Option A	2x2
Option B	3x3
Option C	4x4
Option D	6x6
9	In iso-parametric element the number of nodes defining geometry as compared to number of nodes defining dependent variable are
Option A	Less
Option B	More
Option C	Same
Option D	Not related
10	The truss element can deform only in the
Option A	Vertical direction
Option B	Horizontal directional
Option C	Inclined direction
Option D	Axial direction

Q.2	Solve any Two out of Three	10 Marks Each
Find the heat transfer per unit area through the composite wall as shown. Flow is one dimensional.		
	$k_1 = 150 \text{ W/(m} \cdot \text{°C)}$ $k_2 = 30 \text{ W/(m} \cdot \text{°C)}$ $k_3 = 70 \text{ W/(m} \cdot \text{°C)}$ $k_4 = 50 \text{ W/(m} \cdot \text{°C)}$ $h_1 = 25 \text{ mm}$ $h_2 = 75 \text{ mm}$ $h_3 = 50 \text{ mm}$	

B	<p>Solve the following differential equation and determine y at $x=0.5$ using Galerkin Method.</p> $\frac{d^2y}{dx^2} - 10x^2 - 5 = 0 \text{ in the domain } 0 \leq x \leq 1$ <p>Boundary conditions are: $y(0) = 0$ and $y(1) = 0$.</p>
C	<p>Analyze the following stepped bar shown in fig.</p>

Q.3	Solve any Two out of Three	10 Marks Each
A	Derive the shape functions of rectangular element in local coordinate system.	
B	<p>Determine the nodal displacement and stresses in each element. Consider the cross-sectional area of each member of truss as 100 mm^2 and modulus of elasticity as 100 GPa.</p>	
C	<p>For three stepped bar shown, determine the displacement at nodes, stresses in three sections and reaction at the ends.</p>	

Q.4	Solve any Two out of Three 10 Marks Each
A	<p>Find stresses for the CST element shown below. Assume plane stress condition. Nodal displacements are given as: $u_1 = 1\text{mm}$, $u_2 = 0.5\text{mm}$, $u_3 = 2\text{mm}$, $v_1 = 1\text{mm}$, $v_2 = 0\text{mm}$, & $v_3 = 1\text{mm}$.</p>  <p style="text-align: right;"> $E = 200\text{ GPa}$ $\gamma = 0.3$ Thickness = 1 cm </p>
B	<p>A iso parametric four node quadrilateral element ABCD has coordinates A(10,5), B(12,6), C(15,8) and D(8,4). Determine the Cartesian coordinate of a point P which has natural coordinates as $\xi = 0.8$ and $\eta = 0.2$.</p>
C	<p>Determine the natural frequency of vibration using consistent mass matrix with one bar element. An aluminum bar has a uniform cross-section, length 1 m and made up of a material having $E = 70 \times 10^9\text{ N/m}^2$ and $\rho = 2700\text{ kg/m}^3$.</p> 