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.

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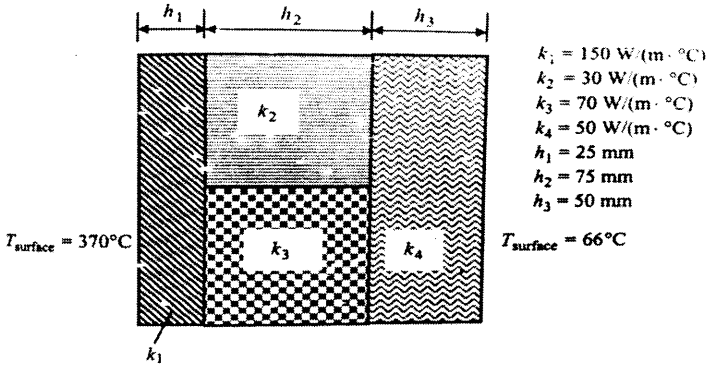
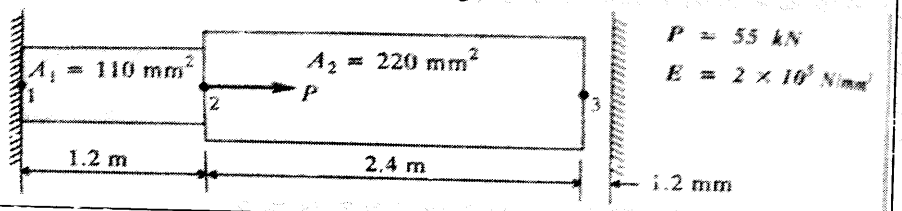
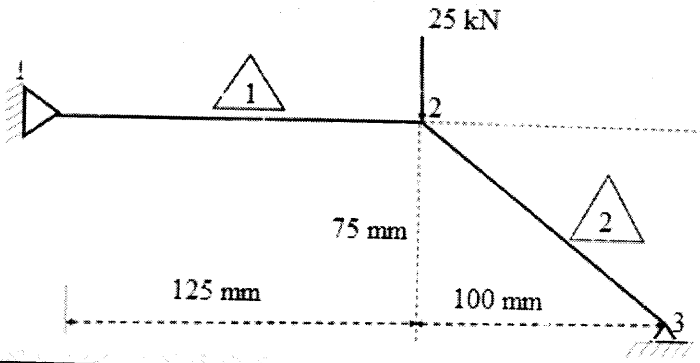
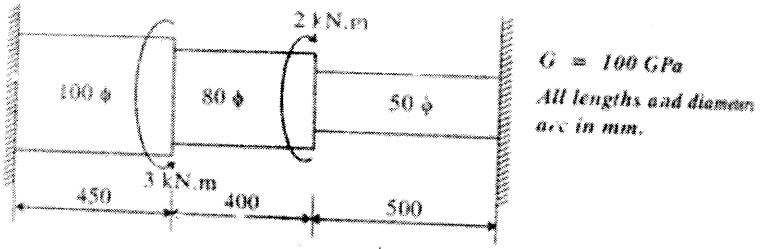
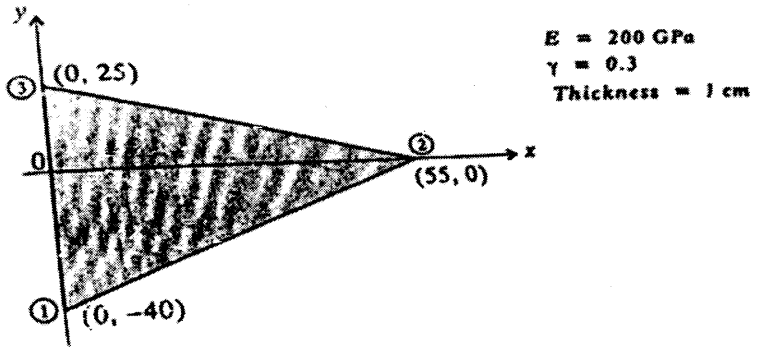
4	The sum of the shape functions over the element is always equal to
Option A	Zero
Option B	Infinity
Option C	Unity
Option D	Half
5	The size of stiffness matrix for 8 node rectangular element is:
Option A	4 x 4
Option B	8 x 8
Option C	16 x 16
Option D	64 x 64
6	The range of natural coordinates is between
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	Crammer
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	Horizonial directional
Option C	Inclined direction
Option D	Axial direction

Q.2	**Solve any Two out of Three** **10 Marks Each**
A	Find the heat transfer per unit area through the composite wall as shown. Flow is one dimensional. 

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

Q.3	Solve any Two out of Three **10 Marks Each**
A	Derive the shape functions of rectangular element in local coordinate system.
B	Determine the nodal displacement and stresses in each element. Consider the cross-sectional area of each member of truss as 100 mm² and modulus of elasticity as 100 GPa. 
C	For three stepped bar shown, determine the displacement at nodes, stresses in three sections and reaction at the ends. 

Q.4	**Solve any Two out of Three** **10 Marks Each**
A	Find stresses for the CST element shown below. Assume plane stress condition. Nodal displacements are given as: $u_1 = 1mm$, $u_2 = 0.5mm$, $u_3 = 2mm$, $v_1 = 1mm$, $v_2 = 0$ mm, & $v_3 = 1mm$. 
B	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 $\eta = 0.2$.
C	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 $E = 70 \times 10^9$ N/m^2 and $\rho = 2700$ kg/m^3.