University of Mumbai

Examination 2021 under cluster 9 (FAMT)

Examinations Commencing from 1st June 2021

Program: Mechanical Engineering

Curriculum Scheme: 2016

Examination: TE Semester VI

Course Code: MEC603 and Course Name: Finite Element Analysis

Time: 2 hour Max. Marks: 80

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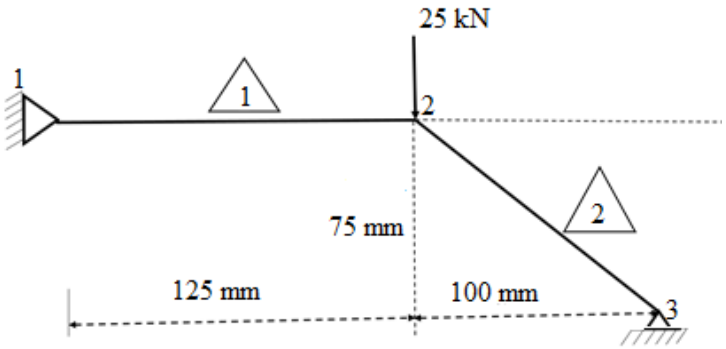
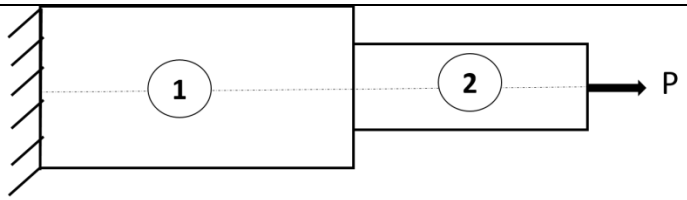
Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks**
1.	Which of the following is the advantage of FEM?
Option A:	FEM is an approximation and results are not correct
Option B:	Results depend on the experience and judgment of the designer
Option C:	Solve and analyze the complex geometry problems
Option D:	High end hardware is needed
2.	The process of stitching of all elements together is called as
Option A:	Assemblage
Option B:	Discretization
Option C:	Continuum
Option D:	Traction
3.	How Rayleigh-Ritz method can be differentiated from other numerical methods?
Option A:	Weighted residue
Option B:	Weak form type
Option C:	Non-weak form type
Option D:	Variational
4.	What is the axial rigidity of an axial bar of length ‘L’ with a uniform cross sectional Area ‘A’ and Modulus of Elasticity ‘E’?
Option A:	EA
Option B:	E/A
Option C:	EA/L
Option D:	A/E
5.	What is number of internal nodes of a linear element?
Option A:	0
Option B:	2
Option C:	1
Option D:	3
6.	What is the order of a 1D quadratic element?
Option A:	1
Option B:	2
Option C:	3
Option D:	4

7.	What is the balance of secondary variables at a given node in the absence of external secondary variable?
Option A:	One
Option B:	Zero
Option C:	Not equal to zero
Option D:	Exactly two
8.	What is the exact solution for ODE 3y''-y' = 0; 0 ≤ x ≤ 1? Boundary Conditions: y(0) = 0, y(3) = 1
Option A:	$-0.6814 + 0.6814e^{x}$
Option B:	$-0.5814 + 0.5814e^{x/3}$
Option C:	$-0.5814 + 0.5814e^{x}$
Option D:	$-0.6814e^{x/3} + 0.6814e^{x/3}$
9.	According to Lagrange polynomial the shape function at node one of a five noded element is given by ……
Option A:	$\Phi_1 = \frac{(x-x_1)(x-x_3)(x-x_4)(x-x_5)}{(x_1-x_2)(x_1-x_3)(x_1-x_4)(x_1-x_5)}$
Option B:	$\Phi_1 = \frac{(x_1-x_2)(x_1-x_3)(x_1-x_4)(x_1-x_5)}{(x_1-x_2)(x_1-x_3)(x_1-x_4)(x_1-x_5)}$
Option C:	$\Phi_1 = \frac{(x-x_2)(x-x_3)(x-x_4)(x-x_5)}{(x_2-x_1)(x_3-x_1)(x_4-x_1)(x_5-x_1)}$
Option D:	$\Phi_1 = \frac{(x-x_2)(x-x_3)(x-x_4)(x-x_5)}{(x_1-x_2)(x_1-x_3)(x_1-x_4)(x_1-x_5)}$
10.	In the …..element, the load is assumed to act uniformly over the entire cross-section.
Option A:	Truss
Option B:	Plane strain
Option C:	Thin shell
Option D:	Thick shell
11.	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.
12.	In a structure, if there are 2 fixed dof and the size of global stiffness matrix is 6 x 6, then as per elimination approach the storing stiffness matrix has the order of ….
Option A:	2 x 2
Option B:	3 x 3
Option C:	4 x 4
Option D:	6 x 6
13.	Serendipity elements are element with
Option A:	Only internal node
Option B:	Only external nodes
Option C:	Both internal and external nodes
Option D:	Only nodes at boundary

14.	Patch test is performed to ensure
Option A:	Formulation Criteria
Option B:	Discretization criteria
Option C:	Convergence criteria
Option D:	Divergence Criteria
15.	Which error is caused due to truncation
Option A:	Discretization error
Option B:	Formulation error
Option C:	Numerical error
Option D:	Convergence error
16.	In a CST element
Option A:	Displacement is constant
Option B:	Displacement is linear
Option C:	Displacement is quadratic
Option D:	Displacement is cubic
17.	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
18.	The total DOF of a CST element is
Option A:	3
Option B:	4
Option C:	6
Option D:	8
19.	The size of the element mass matrix of a CST element for the plane stress condition is ……..
Option A:	2 x 2
Option B:	4 x 4
Option C:	6 x 6
Option D:	8 x 8
20.	…….. represents a set of relative displacements in various degrees of freedom.
Option A:	Mode shape
Option B:	Eigenvalues
Option C:	Eigenvectors
Option D:	Characteristic equation

Q2 (20 Marks)	**Solve any Two Questions out of Three (10 marks each)**
A	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
B	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. 
C	The nodal coordinates of a three node triangular element are (4, 6), (13, 8) and (10, 12). Determine the shape functions at a point P (9, 8).

Q3 (20 Marks)	**Solve any Four out of Six (5 marks each)**
A	Solve the following governing differential equation using least square method. $3\frac{dy}{dx} - x = 0$ in the domain $0 \le x \le 1$ Boundary condition is: y(0) = 1
B	Solve the following Governing Differential Equation considering the two linear elements by directly using Element Matrix Equation (Avoid its development) for displacements and forces at nodes. Take A = 0.1m^2, E = 100GPa. External force, P = 10 kN as shown in figure 1. $\frac{d}{dx}\left[AE\frac{du}{dx}\right] = 0 \quad 0 \le x \le 12cms$  Fig 1.Horizontal Bar subjected to axial load
C	Determine the nodal displacement for the step bar shown in figure. Consider, L1 = L2 = 100 mm, A1 = 100 mm2, A2 = 50 mm2, E1 = E2 = 100 GPa, and P = 5,000 N.

	
D	Explain Jacobian Matrix
E	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 local coordinate ξ= 0.8 and η= 0.2
F	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 x 10^9 N/m^2 and ρ = 2700 kg/m^3.