Hall Ticket Number:

Code No. : 17551 N/O

VASAVI COLLEGE OF ENGINEERING *(AUTONOMOUS)*, HYDERABAD

Accredited by NAAC with A++ Grade

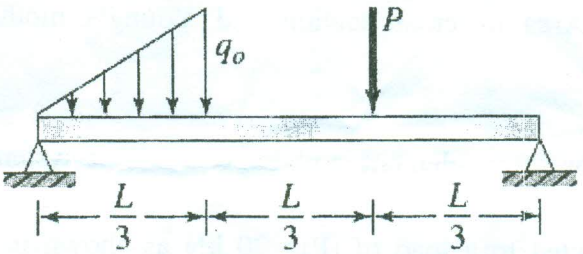
B.E. (Mech. Engg.) VII-Semester Main & Backlog Examinations, Dec.-23/Jan.-24

Finite Element Analysis

Time: **3 hours** Max. Marks: **60**

*Note: Answer all questions from **Part-A** and any **FIVE** from **Part-B***

Part-A (10 × 2 = 20 Marks)

Q. No.	Stem of the question	M	L	CO	PO
1.	What is the role of stiffness matrix and shape function in the finite element method?	2	1	1	1
2.	Mention the various locations at which nodes has to be positioned during discretization.	2	1	1	1
3.	For the beam as shown in the figure below, considering the minimum number of elements for discretization , compute the global nodal load vector 	2	3	2	2
4.	Sketch the shape functions for the beam element (Hermite shape functions).	2	1	2	1
5.	Write the material matrix for plane stress condition in the finite element method.	2	1	3	1
6.	Sketch a 6-noded linear triangular element	2	1	3	1
7.	State the convergence requirements of displacements functions.	2	1	4	1
8.	Calculate the Integral $I = \int_{-1}^{1} \left[x^2 + \sin\left(\frac{\pi x}{2}\right) \right] dx$. using 2-point Gaussian Quadrature Method. Given the gauss points are $\pm\left(\frac{1}{\sqrt{3}}\right)$ and their weights are 1 , 1 .	2	3	4	2
9.	What is a coefficient matrix and characteristic polynomial in vibration analysis using FEM approach?	2	1	5	1
10.	Write the lumped and consistent matrices for a beam element.	2	1	5	1
	Part-B (5 × 8 = 40 Marks)				
11. a)	Discuss in brief the concept of Minimum Potential Energy as applied to finite element method.	3	2	1	1

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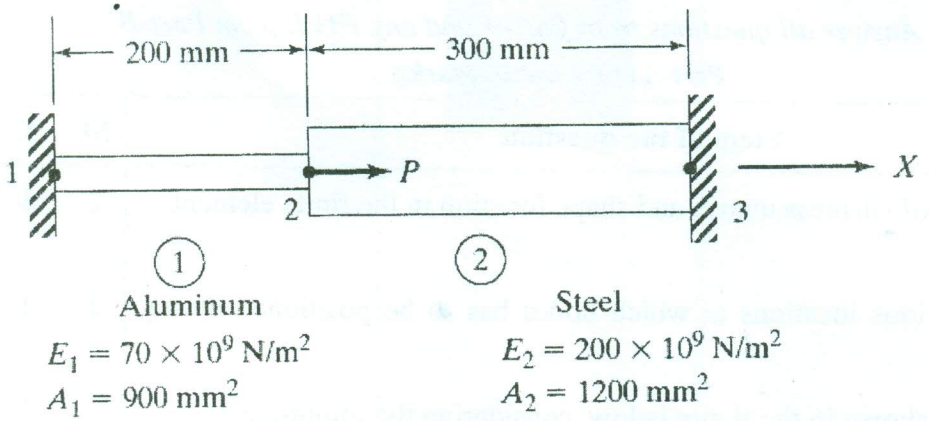
b)	Calculate the nodal displacements in the stepped bar, when an axial load (P) = 200 kN acts on it as shown in the figure below	5	3	1	2



Aluminum

$E_1 = 70 \times 10^9$ N/m^2

$A_1 = 900$ mm^2

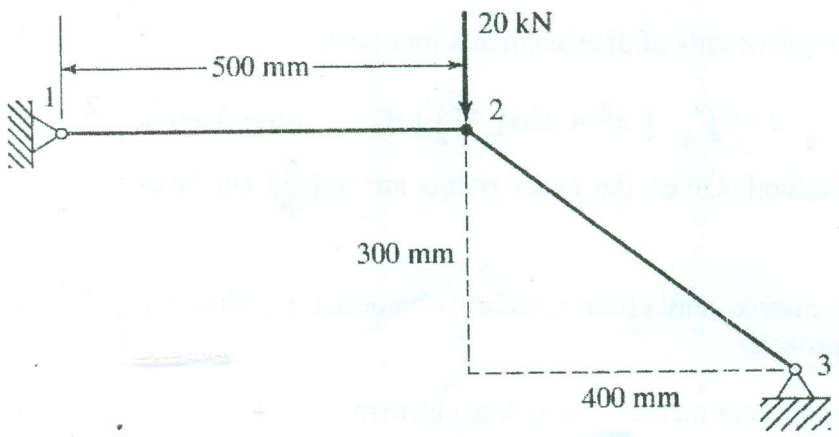
Steel

$E_2 = 200 \times 10^9$ N/m^2

$A_2 = 1200$ mm^2

Where A, E denotes the Area of cross section and Young's modulus respectively.

12. a)	Derive the stiffness matrix for a truss element in global co-ordinate system.	3	2	2	1
b)	For the two-bar truss subjected to a load of (P)= 20 kN as shown in the figure below, compute the a) Element stiffness matrix for each element b) Global stiffness matrix	5	3	2	2



Both the bars are having same Young's Modulus (E) = 200GPa and same cross sectional area (A) = 300mm^2

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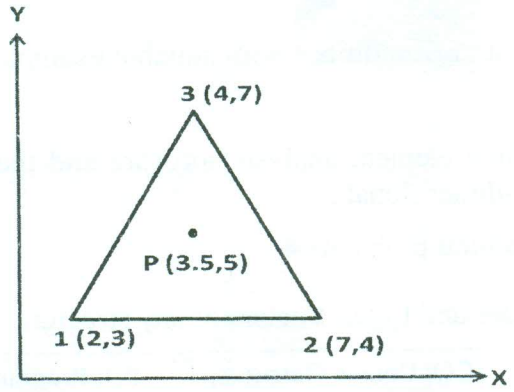
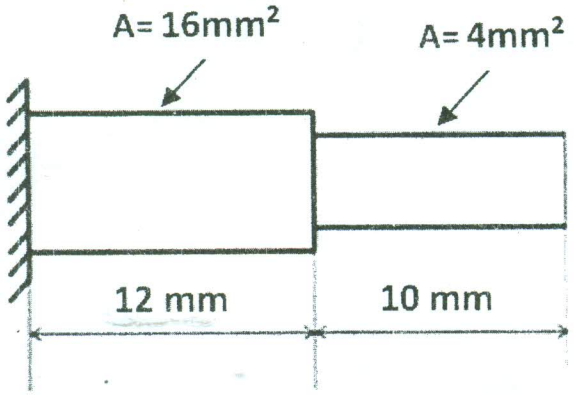
13. a)	Derive the shape functions for a 3-noded linear triangular element.	4	2	3	1
b)	Calculate the shape functions N1 , N2 and N3 at the interior point P for the triangular element as shown in the figure below. 	4	3	3	2
14. a)	Derive the thermal stiffness matrix due to heat transfer by conduction alone in the case of 1-dimensional linear element	4	2	4	1
b)	Explain in detail the sequence of steps for a structural problem solving through FE software.	4	3	4	2
15. a)	Derive the consistent mass matrix for a 1-dimensional linear Bar element.	3	3	5	2
b)	Compute the natural frequencies of longitudinal vibration of the steel stepped bar as shown in the figure below. Consider young's modulus (E) = $2x10^5$ N/mm^2, density (ρ) = 7830 Kg/m^3.  Where A denotes the Area of cross section.	5	3	5	2
16. a)	List the steps involved in finite element formulation and discuss about any two engineering applications of the Finite Element Method.	4	2	1	1

Contd... 4

b)	Explain the FEM procedure adopted for analyzing any beam subjected to static load. Consider at least 2-elements, point load and distributed load in the finite element model, clearly indicating the stiffness matrices, force vector and the boundary conditions.	4	2	2	1
17.	Answer any *two* of the following:				
a)	Discuss about plane stress and plane strain conditions with suitable example for each condition.	4	2	3	1
b)	Explain the various stages in any finite element analysis software and the type of elements used for analyzing 1-dimensional , 2-dimensional and 3-dimensional structural problems.	4	2	4	1
c)	Discuss the importance of Eigen Values and Eigen Vectors of any structure	4	2	5	1

M : Marks; L: Bloom's Taxonomy Level; CO; Course Outcome; PO: Programme Outcome

i)	Blooms Taxonomy Level – 1	20%
ii)	Blooms Taxonomy Level – 2	40%
iii)	Blooms Taxonomy Level – 3 & 4	40%

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