BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

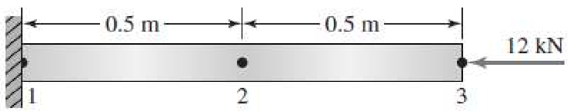
CLASS: M.TECH. | **SEMESTER : II**
BRANCH: CIVIL | **SESSION : SP/2024**

SUBJECT: CE506 FINITE ELEMENT METHOD

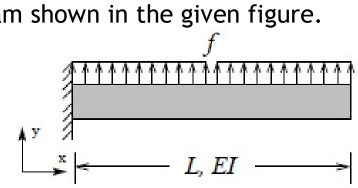
TIME: 3 HOURS | **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

			CO	BL
Q.1(a)	Derive the global stiffness matrix for an axially loaded bar, inclined to x axis by an angle θ, of a plane truss using the element transformation.	[5]	1	2
Q.1(b)	A steel rod subjected to compression is modeled by two bar elements, as shown in the given figure. Determine the nodal displacements and the axial stress in each element. Take E = 200 GPa and A = 500 mm^2.	[5]	1	3

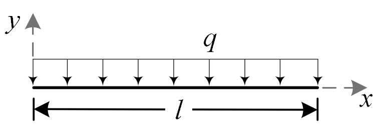


			CO	BL
Q.2(a)	Derive the method of weighted residual statements (both strong form and weak form) the beam shown in the given figure.	[5]	1	2



			CO	BL
Q.2(b)	Calculate the equivalent nodal load vector for the beam given in Figure 3. Interpolation functions for two-nodded beam element is given by	[5]	1	4

$$N_1 = 1 - \frac{3x^2}{L^2} + \frac{2x^3}{L^3}, \quad N_2 = x - \frac{2x^2}{L} + \frac{x^3}{L^2}, \quad N_3 = \frac{3x^2}{L^2} - \frac{2x^3}{L^3}, \quad N_4 = -\frac{x^2}{L} + \frac{x^3}{L^2}$$

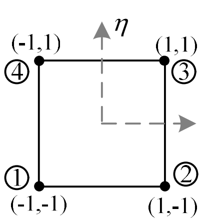


			CO	BL
Q.3(a)	Use Galerkin's method of weighted residuals to obtain an approximate solution of the differential equation.	[5]	1	3

$$\frac{d^2 y}{dx^2} - 5x^2 = 3 \qquad 0 \le x \le 1$$

With boundary condition $y(0) = 0$, $y(1) = 0$.

			CO	BL
Q.3(b)	Derive the polynomial form of all the shape functions (N_1 - N_4) for the following rectangular element.	[5]	3	3



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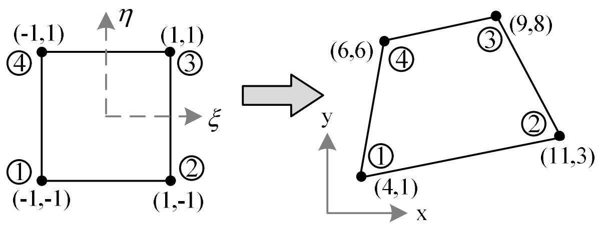
Q.4(a)	Derive the Jacobian matrix for the isoperimetric mapping of linear element (shown in the figure). Use the shape function derived in Q.3(b).	[5]	3	3



Q.4(b)	Evaluate the following integral using 2-point Gauss quadrature: $\int_{-1}^{1}\int_{-1}^{1}(1+2x+3x^2y)\,\mathrm{d}x\,\mathrm{d}y$	[5]	3	3
Q.5(a)	Explain the following steps in context of any commercial FE Application: a) Pre-Processing b) Analysis c) Post-processing	[5]	2	1
Q.5(b)	Derive then relation between the derivates with respected global Cartesian co-ordinates (x, y) and local co-ordinates (ξ, η) for isoperimetric mapping of 2D rectangular element.	[5]	3	2

:::::23/04/2024 E:::::