

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEM EXAMINATION)**

CLASS: MTECH/PRE-PhD
BRANCH: MECHANICAL/PROD

SEMESTER: I
SESSION: MO/25

SUBJECT: ME511 FINITE ELEMENT ANALYSIS

TIME: 3Hrs
INSTRUCTIONS:

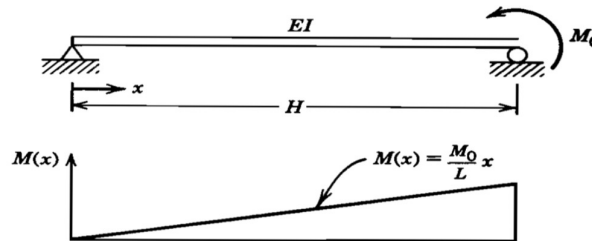
FULL MARKS: 50

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt All question.
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.

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|--|-----|----|----|
| Q.1(a) What is Least squares method and how do we apply it in finite element methods, explain with example? | [5] | 1 | 1 |
| Q.1(b) Obtain an approximate displacement equation by collocation method for the simply supported beam shown in Figure 1 using the trial solution $y(x)=A \sin \pi x/H$. The governing differential equation is | [5] | 1 | 4 |

$$EI \frac{d^2 y}{dx^2} - \frac{M_0 x}{H} = 0$$

Evaluate A by requiring the residual to vanish at (a) $x=H/2$, and (b) $x=0.577H$



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|---|------|---|---|
| Q.2(a) Evaluate the following integrals for triangular elements | [5] | 2 | 4 |
| a) $\oint l_1^2 l_2 l_3^2 dA$ b) $\oint l_1^2 l_2^2 l_3^3 dA$ | | | |
| Q.2(b) Derive the shape function for 4 noded rectangular Element in natural Coordinate system. And prove the following: | [5] | 2 | 2 |
| a) $N_i + N_j + N_k + N_m = 1$ b) $N_k = 1$ at k^{th} node and 0 on rest of the nodes. | | | |
| Q.3 Evaluate $[k^e]$ and $\{f^e\}$ for linear triangular element in a two dimensional field equation when $D_x = D_y = 1$, $G = 4$, $Q = 5$, and the coordinates are $X_i = 0.13$, $Y_i = 0.01$, $X_j = 0.25$, $Y_j = 0.06$, $X_k = 0.13$, $Y_k = 0.13$. | [10] | 4 | 4 |
| Q.4 Evaluate the following matrix | [10] | 3 | 3 |
| (a) $\int_A G[N]^T [N] dA$ for the triangular element.
and (b) $\int_A Q[N]^T dA$ for the rectangular element. | | | |
| Q.5 Determine the temperature distribution for the fin in figure using the grid shown where $k = 3W/(cm^\circ C)$, $h = 0.1 3W/(cm^2^\circ C)$, and $\varphi_f = 20^\circ C$. Assume that convection heat loss occurs from the end of the fin. | [10] | 5 | 4 |

