

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

CLASS: MTECH/PRE-PHD
BRANCH: MECHANICAL

SEMESTER: I
SESSION: MO/22

SUBJECT: ME511 FINITE ELEMENT ANALYSIS

TIME: 3Hrs

FULL MARKS: 50

INSTRUCTIONS:

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.

Q.1 Evaluate the following integrals related to the force vector for the rectangular element. [10]

$$\int_A GN_i N_j dA, \text{ and } \int_A QN_i dA$$

Q.2(a) What is variational method and how do we apply it in finite element methods, and what is its limitation? [5]

Q.2(b) Obtain an approximate displacement equation for the simply supported beam shown in Figure 1 using the trial solution $y(x)=A \sin \pi x/H$. Compare the deflection at the center with the theoretical value $y=-0.06415M_0H^2/EI$. The governing differential equation is

$$EI \frac{d^2y}{dx^2} - \frac{M_0x}{H} = 0$$

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

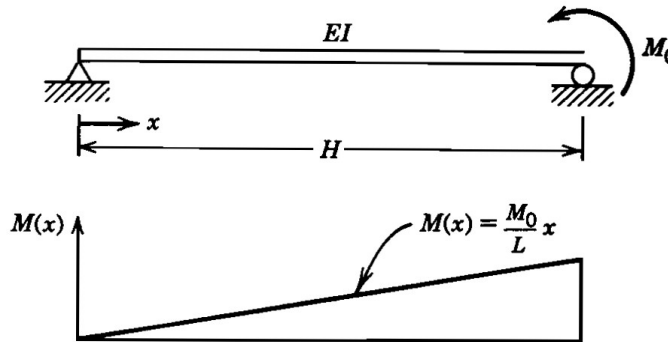


Figure 1

Q.3(a) Evaluate the following integrals for triangular elements [5]

a) $\int l_1^2 l_2^2 l_3^2 dA$

b) $\int l_1^2 l_2^2 l_3^3 dA$

Q.3(b) Derive the shape function for 4 noded rectangular Element in natural Coordinate system. And prove the following: [5]

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.4 Derive the shape function for triangular element in Cartesian coordinate [10]

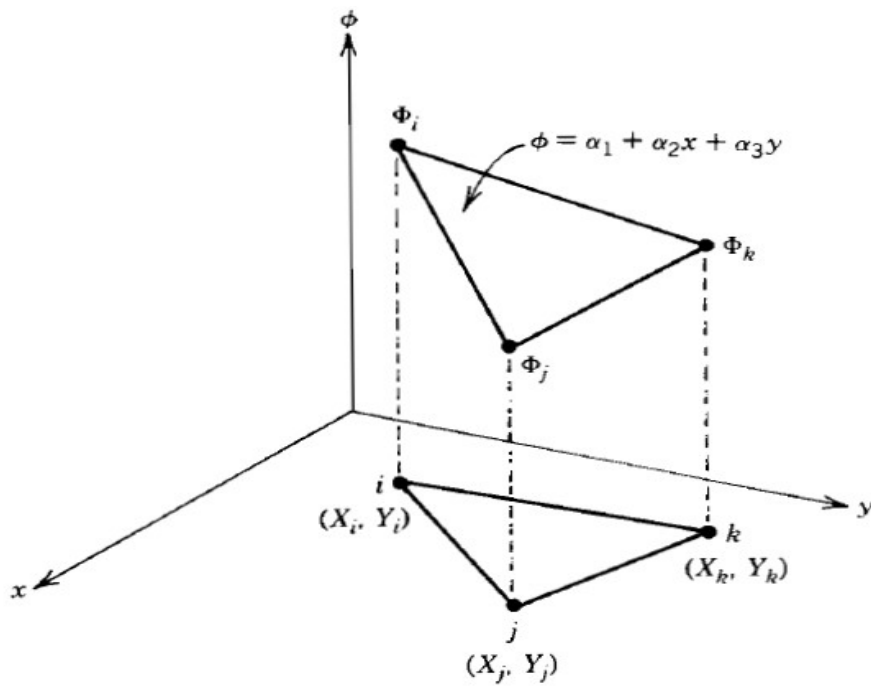


Figure 2

Q.5 The residual equation is given by

[10]

$$R_s = \frac{-D^{(s-1)}Y_{s-1} + [D^{(s-1)} + D^{(s)}]Y_s - D^{(s)}Y_{s+1}}{L} - L \frac{(Q_{s-1} + 4Q_s + Q_{s+1})}{6} = 0$$

to obtain the nodal displacements for the beam shown in figure. The governing differential equation is

$$EI \frac{d^2\phi}{dx^2} - M(x) = 0$$

And $M(x)$ is given in the Figure 3. Each element is 300 cm long; $EI=2(10^{10})$ N. cm².

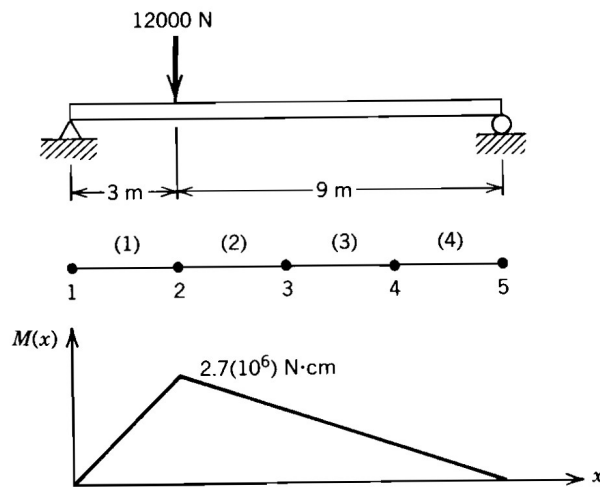


Figure 3