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

CLASS: B.TECH **SEMESTER: VI**
BRANCH: MECHANICAL **SESSION: SP/23**

SUBJECT: ME351 FINITE ELEMENT METHODS

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 Stiffness and force matrix [5]

$\int_A GN_iN_j dA$, and $\int_A QN_i dA$

(a) for the rectangular element.
(b) for the triangular element.

[5]

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 πx/H. Compare the deflection at the center with the theoretical value $y=-0.06415M_0H^2/EI$. The governing differential equation is [5]

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

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

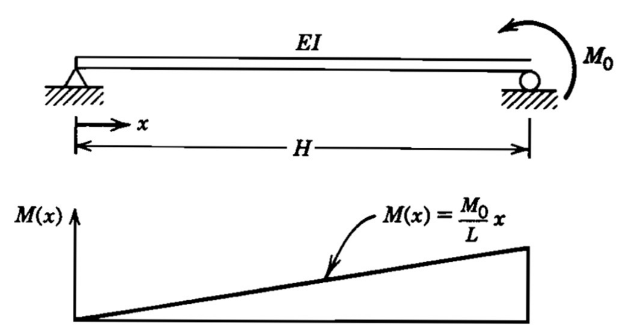

Figure 1

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

a) $\oint l_1^2 l_2 l_3^2 \, dA$
b) $\oint l_1^2 l_2^2 l_3^3 \, dA$

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.

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

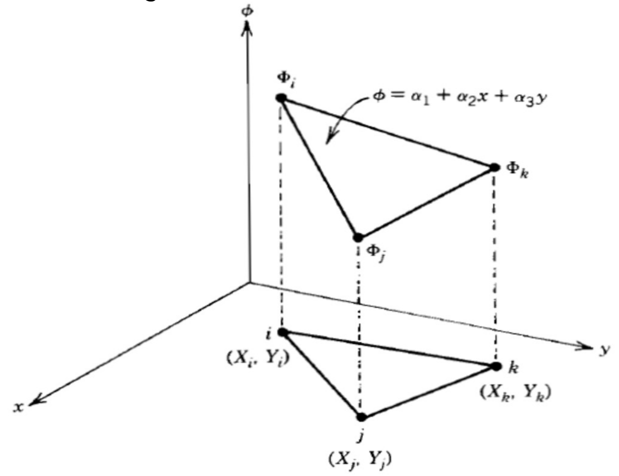

Figure 2

Q.5 The residual equation is given by [10]

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

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

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

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

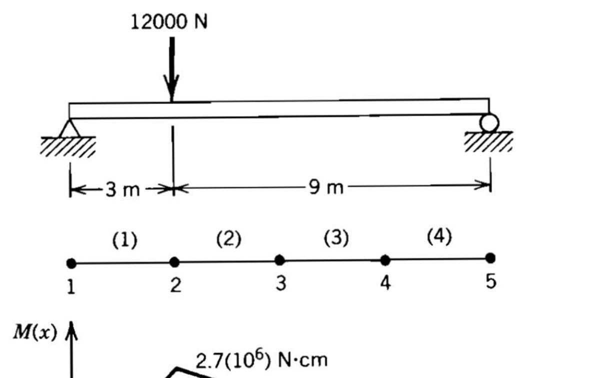

Figure 3

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