WEST BENGAL UNIVERSITY OF TECHNOLOGY

AUE-803C

FINITE ELEMENT METHODS AND ITS APPLICATION

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP A
(Multiple Choice Type Questions)

1. Answer *all* questions. 10×1 = 10

(i) Order of the global stiffness matrix is
(A) Element number × Node number (B) DOF × Node number
(C) DOF × Element number (D) Node number × Unknown number

(ii) If the number of element is increased
(A) we will get more accurate solution
(B) less accurate solution
(C) solution remains same
(D) none of these

(iii) Order of the differential equation $\Phi'' - \Phi' = x^2$ is
(A) 1 (B) 3
(C) 2 (D) 0

(iv) Trial functions of a differential equation must be
(A) liner with each other (B) non-linear with each other
(C) equal with each other (D) taken arbitrarily

(v) $f(x, y) = x^n\Phi(y/x)$ is a
(A) non-homogeneous function of degree n
(B) homogeneous function of degree n
(C) liner function of degree n
(D) none of these

(vi) The boundary condition which is prescribed on $\Phi' + x = 2$ is a/an
(A) mixed boundary condition (B) natural boundary condition
(C) essential boundary condition (D) none of these

(vii) Elements are connected by
(A) node (B) hard point (C) boundary layer (D) none of these

(viii) If K is a stiffness matrix, F is a force matrix and Q is the displacement matrix then the assembled equation can be written in matrix form as
(A) [Q]{F} = {K} (B) [F]{K} = {Q}
(C) [K]{Q} = {F} (D) [K]{F} = {Q}

(ix) Force are generally applied on
(A) elements (B) edges (C) surfaces (D) nodes

(x) Tetrahedral element have
(A) four nodes (B) three nodes (C) five nodes (D) six Nodes

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. Describe Essential Boundary Condition and Natural Boundary Condition.

3. What are the difference between Finite Element Solution and the Exact Solutions?

4. A spring is connected by node number 2, 4. If the order of the stiffness matrix is 5 × 5 then write down the stiffness matrix for that element. Take k = 2N/mm.

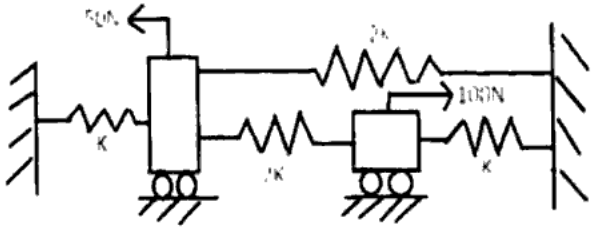
5. Drive the element equation for a truss member of length 'L' in a 2D space using direct stiffness methods.

6. Explain different steps of FEM.

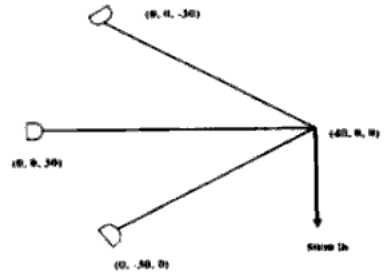
GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

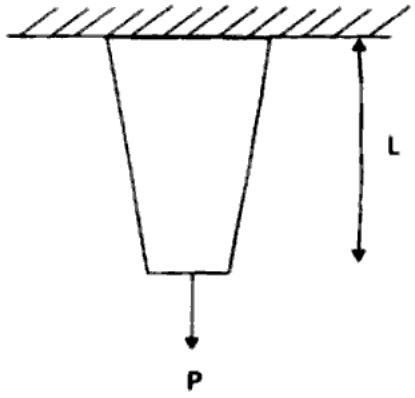
7. Find out the reaction force, nodal displacement and spring force for the following spring system using Direct Stiffness Method. Take k = 5N/mm.



8. Find out the deformation for the following truss member. Take Young's modulus 15×10^6 psi. Cross-section area of the member is 1 inch^2.



9. A tapered elastic bar subjected to an applied tensile load P at one end and attached to a fixed support at the other end. The cross-sectional area varies linearly from A_0 at the fixed support at $x = 0$ to $\frac{A_0}{2}$ at $x = L$. Calculate the displacement of the end of the bar (a) by modeling the bar as a single element having cross-sectional area equal to the area of the actual bar at its midpoint along the length, (b) using two bar elements of equal length and similarly evaluating the area at the midpoint of each, (c) using integration to obtain the exact solution. Take Young's modulus E.



10. Solve the differential equation $\Phi'' - \Phi' = x^2$ with boundary condition $\Phi(x = 0) = 0$ and $\Phi(x = 1) = 0$, by Point Collation and Raleigh-Ritz method and compare the result with the exact solution.

11. By using the Galerkin's weighted residual method obtain an approximate solution of the differential equation

$$-\frac{d^2u}{dx^2} - u + x^2 = 0$$

In $0 < x < 1$. Subjected to $u(0) = 0$ and $u'(1) = 1$.