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Total No. of Questions : 08] [Total No. of Pages : 03

M.Tech.

FINITE ELEMENT METHODS

SUBJECT CODE : CE - 516 (Elective - III)

Paper ID : [E0852]

[Note : Please fill subject code and paper ID on OMR]

Time : 03 Hours **Maximum Marks : 100**

Instruction to Candidates:

1) Attempt any **Five** questions.
2) Q.No.1 is **compulsory**.

Q1) *(10 × 2 = 20)*

a) Define aspect ratio for a mesh.

b) Enlist the main/major sources of error that may contribute to the inaccuracy of the finite element solution.

c) What are serendipity elements?

d) What is the maximum value of Poisson's ratio?

e) What is rigid body motion?

f) What is the difference between plane stress and plane strain?

g) What is 'C^o element'?

h) Enlist three important FEM convergency requirements.

i) If $A = A^T$, define the properties of matrix A.

j) Draw a 20 - noded quadrilateral element with node numbering.

Q2) (a) If a displacement field is described by

$$u = (-x^2 + 2y^2 + 6xy) * 10^{-4}$$

$$v = (3x + 6y - y^2) * 10^{-4}$$

Determine $\varepsilon_x, \varepsilon_y, \gamma_{xy}$ at the point $x = 1, y = 0$.

(b) Given that

$$A = \begin{bmatrix} 8 & -2 & 0 \\ -2 & 4 & -3 \\ 0 & -3 & 3 \end{bmatrix}, d = \begin{Bmatrix} 2 \\ -1 \\ 3 \end{Bmatrix}.$$

Determine the following:

(i) $I - dd^T$ (ii) Det (A).

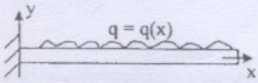
Q3) (a) Write a short note on Rayleigh-Ritz method for finding an approximate solution for continua.

(b) Derive the shape functions for a 2-noded 1-dimensional bar element in natural coordinates.

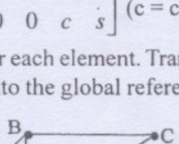
Q4) (a) Write a note on Reissinner-Mindlin plate theory.

(b) What do you understand by degenerated elements?

Q5) (a) The governing differential equation for a beam deflection in y-dimension is $EI\frac{d^4v}{dx^4} = q(x)$. Use the Galekin's approach to obtain the FE equation. The length of the beam is 'L'. Identify the essential and natural boundary conditions for the fixed-free beam.



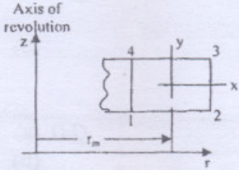
(b) For the truss structure shown in Figure, the element properties are such that $A_1 = A_2 = 100$ mm^2, $E_1 = E_2 = 200$ GPa, $l_1 = 500$ mm, $l_2 = 400$ mm and distance $AB = 300$ mm. Recall that the local stiffness matrix for a truss element is given by $K^e = \frac{AE}{l}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$ and transformation matrix is given by $L = \begin{bmatrix} c & s & 0 & 0 \\ 0 & 0 & c & s \end{bmatrix}$ ($c = \cos\theta$ and $s = \sin\theta$). Prepare a local stiffness matrix for each element. Transform the element stiffness matrix of each element into the global reference frame and assemble the global stiffness matrix.



Q6) (a) What is an 'Isoparametric element'? What are its advantages and how far the requirements of the finite element procedure are satisfied?

(b) Write a short note on element connectivity.

Q7) For the four node, eight degree of freedom axisymmetric element (1-2-3-4) shown in figure, evaluate nodal loads produced by spinning at angular velocity ω about z-axis. The size of the element is '2a' along x-axis and '2b' along y-axis.



Q8) Write a short note on following:

(a) Lagrange elements.

(b) Weak formulation.

(c) Incompatible modes.

(d) Galerkin's Method.

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