Code No: 5401BZ

R17

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech II Semester Examinations, June/July - 2019

FINITE ELEMENT METHOD

(Common to TE, AMS, DFM)

Time: 3hrs **Max.Marks:75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

5 × 5 Marks = 25

1.a) Define the principle of minimum potential energy and explain its role in finite element method. [5]

b) In axially loaded cases, how do you find the support reactions after getting required displacements? [5]

c) What is Jacobian matrix? What is the orientation of an element if the determinant of the Jacobian matrix is negative? [5]

d) What is the difference between a membrane and a plate? [5]

e) What is the significance of convergence criteria in the non-linear analysis? [5]

PART - B

5 × 10 Marks = 50

2.a) Why polynomial type of approximate function is preferred over trigonometric functions in the Rayleigh-Ritz method?

b) Two springs of equal stiffness are connected in series. One end is fixed and other end is subjected to a force. Using this assembly of springs, explain the various steps involved in the finite element method. [4+6]

OR

3.a) The expressions for the two dimensional displacement field at a point is given by $u = 4x^2-12xy+3y^2$ and $v = 3x^2+4xy+2y^2$. Determine the normal and shear strains at a point (1,-1).

b) What are the constitutive relations in case of Plane stress and Plane strain problems? Explain the terms involved in them. [6+4]

4.a) Differentiate between the essential boundary conditions and natural boundary conditions with suitable examples.

b) The nodal coordinates of a three noded bar element are given by $x_1 = 2$ mm, $x_2 = 3$ mm and $x_3 = 4$ mm. The deformation at these points are $u_1 = -0.001$, $u_2 = 0$ and $u_3 = 0.001$ mm. Determine the shape functions and the deformation at the $x_p = 2.5$ mm and at 3.5 mm considering it as a three noded single element. [3+7]

OR

5. Derive the shape functions for a constant strain triangle element using area coordinate system. Using these shape functions, develop the strain displacement matrix for the element in terms of the nodal coordinates of the element. [10]

6. A quadrilateral element is described global coordinates A (10, 10) mm, B (20, 10) mm, C (12, 15) mm and D (20, 15) mm. Evaluate the stiffness matrix using one point Gauss quadrature rule. Assume Young's modulus as 200 GPa and Poisson's ratio as 0.3.[10]

OR

7. Derive the shape functions for a linear hexahedral element using isoparametric formulation. Also explain the procedure to derive the finite element equations. [10]

8. For the bending of plates, give expressions for the following relations and explain the terms involved in it.
   a) Transverse displacement function for a four noded rectangular element.
   b) Potential energy in the plate,
   c) Moment –curvature matrix for four noded rectangular plate [10]

OR

9.a) For a triangular plate bending elements, derive the strain displacement relations [B] matrix with a suitable polynomial approximation.

b) Prescribe degree of freedom for the following edge conditions of the plates: clamped, simply supported and free conditions. [7+3]

10.a) Explain the iterative procedure of handling geometric non-linearity problems in structural mechanics.

b) What are the strain displacement relations for plane stress condition if geometric nonlinearities are considered? [6+4]

OR

11.a) Differentiate between the force convergence and displacement convergence approaches in nonlinear analysis.

b) Write a short note on reduced stiffness method. [5+5]

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