SATHYABAMA UNIVERSITY

(Established under section 3 of UGC Act, 1956)

Course & Branch: B.E – Aeronautical
Title of the paper: Finite Element Method
Semester: VI — Max.Marks: 80
Sub.Code: 526E01-AEE01(2006) — Time: 3 Hours
Date: 05-05-2009 — Session: FN

PART – A (10 x 2 = 20)

Answer All the Questions

1. What is meant by stiffness matrix?

2. Why is a convergence criterion very important in finite element method?

3. Give stiffness matrix of a simple beam element.

4. What is meant by stability analysis?

5. List any four commonly used axisymmetric elements.

6. What are the advantages of lumped matrix over consistent matrix?

7. When is an element called as isoparametric element?

8. What is the role of numerical integration in the solution of finite elements?

9. What is the difference between explicit and implicit solution of assembled matrix?

10. What is the characteristic matrix of 1D potential flow element?

PART – B (5 x 12 = 60)

Answer All the Questions

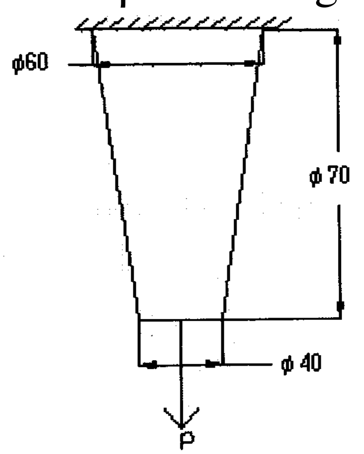
11. Explain in detail the solution of a structural problem using finite element method.

(or)

12. Explain in detail the various procedures for the formulation of finite element problem.

13. (a) Derive the stiffness matrix for a bar element (4)

(b) Find the displacement a truncated cone bar subjected to axial load as shown in Fig 1using finite element technique. Take the P=50KN, E=210 GPA and ρ = 8000kg/m^3 (8)



All units are in mm

FIG 1

(or)

14. Derive the stiffness matrix for a 3D frame Element.

15. Derive the stiffness matrix for a plane stress triangular element using

(a) Principle of minimum potential energy

(b) Galerkin method

(or)

16. The corner nodes of a CST element represented in Cartesian coordinates are I,J,K. The global coordinates of the nodes are I (20,10), J (10,10) and K (15,20) all units are in mm. The displacement at the nodes I,J,K are (5,0), (0,10), and (10,3) mm

along global directions respectively. What will be the displacement at a point P (12mm, 12mm) in the element? Determine the strain in the element. Take thickness t = 10 mm, E= 210 GPA and ρ = 8000kg/m^3

17. A boundary value problem governed by Laplace equation is stated as $\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} = 0$ in A $\phi = \phi_0$ on C

    The characteristic (stiffness) matrix of an element corresponding to this problem can be expressed as

$$[K]^e = \iint_A [B]^T [D][B] dA \quad Where [D] = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, [B] = \begin{bmatrix} \frac{\partial N_1}{\partial x} & \frac{\partial N_2}{\partial x} & \cdots & \frac{\partial N_P}{\partial x} \\ \frac{\partial N_1}{\partial y} & \frac{\partial N_2}{\partial y} & \cdots & \frac{\partial N_P}{\partial y} \end{bmatrix},$$

    A^e is the area of the element. Derive the matrix [B] for quadratic quadrilateral isoparameteric element.

(or)

18. Evaluate the intergral I = $\int_{-1}^{1} \left(a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4\right) dx$ using the two point Gauss integration method and three point Gauss integration method.

19. Find the Solution of the finite element equation using Cholesky method.

    E= 210GPa, A= 10mm^2, L = 100mm, P=10KN

$$\frac{EA}{L}\begin{bmatrix} 2 & -2 & 0 \\ -2 & 3 & -1 \\ 0 & -1 & 1 \end{bmatrix}\begin{Bmatrix} u_1 \\ u_2 \\ u_3 \end{Bmatrix} = \begin{Bmatrix} F_1 \\ F_2 \\ F_3 \end{Bmatrix}$$

    Load and boundary conditions (BC) are,

    $u_1 = u_3 = 0, \qquad F_2 = P$

(or)

20. Derive the finite element equation for a straight uniform fin with one dimensional heat transfer.