Reg. No. :

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B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018

Sixth Semester

Mechanical Engineering

ME 2353 – FINITE ELEMENT ANALYSIS

(Common to Automobile Engineering, Mechanical and Automation Engineering/ Industrial Engineering and Management and Seventh Semester Mechanical Engineering (Sandwich))

(Regulations 2008)

Time : Three Hours

Maximum : 100 Marks

(Any missing data may be suitably assumed.)

Answer ALL questions.

PART – A

(10×2=20 Marks)

1. Distinguish between Error is solution and Residual.
2. What are the advantages of weak formulation ?
3. What is discretization ?
4. Write down the expression of stiffness matrix for a truss element.
5. What is the salient feature of an isoparametric element ? Give an example.
6. Define Jacobian.
7. Define dynamic analysis.
8. What is meant by transverse vibrations ?
9. Define element capacitance matrix for unsteady state heat transfer problems.
10. Define the stream function for a two dimensional incompressible flow.

PART – B (5×16=80 Marks)

11. a) Develop the weak form and determine the displacement field for a cantilever beam subjected to a uniformly distributed load and a point load acting at the free end.

(OR)

b) Consider a plane wall with a uniformly distributed heat source. Obtain the finite element formulation for the above case based on the stationarity of a functional.

12. a) Determine the maximum deflection and slope in the beam, loaded as shown in Fig.12 (a). Determine also the reactions at the supports. E = 200 GPa, $I = 20 \times 10^{-6}$ m^4 q = 5 kN/m and L = 1m.

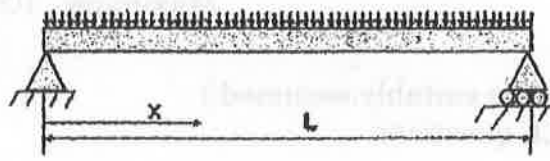

Fig.12(a)

(OR)

b) Derive using Lagrangian Polynomials the shape functions for a one dimensional three noded bar element. Plot the variation of the same. Hence derive the stiffness matrix and load vector.

13. a) Calculate the value of pressure at the point A which is inside the 3 noded triangular element as shown in fig 13(a). The nodal values are ϕ_1 = 40 MPa, ϕ_2=34 MPa and ϕ_3 = 46 MPa, Point A is located at (2, 1.5). Assume pressure is linearly varying in the element. Also determine the location of 42 MPa contour line.

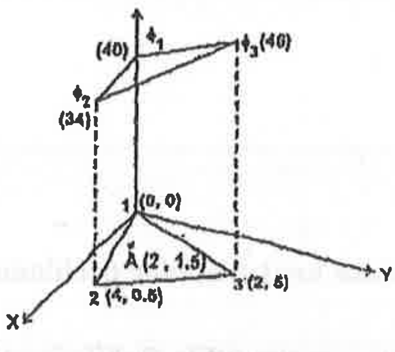

Fig.13(a)

(OR)

b) For the plane stress element whose coordinates are given by (100, 100), (400, 100) and (200, 400), the nodal displacements are ul = 2.0 mm, v1 = 1.0 mm, u2 = 1.0 mm v2 = 1.5 mm, u3 = 2.5 mm, v3 = 0.5 mm. Determine the element stresses. Assume $E = 200\ GN/m^2$, $\mu = 0.3$ and t = 10 mm. All coordinates are in mm.

14. a) For the bar as shown in fig. Q.14 (a) with length 2L, modulus of elasticity E, mass density ρ, and cross sectional area A, determine the first two natural frequencies.

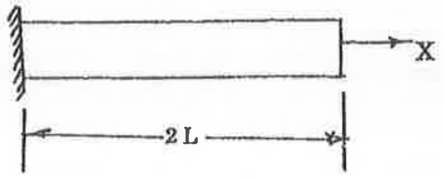

Fig. Q. 14(a)

(OR)

b) Determine the eigen values and natural frequencies of a system whole stiffness and mass matrices are given below.

$$[K] = \frac{2AE}{L}\begin{bmatrix} 3 & -1 \\ -1 & 1 \end{bmatrix}, m = \frac{\rho AL}{12}\begin{bmatrix} 6 & 1 \\ 1 & 2 \end{bmatrix}$$

15. a) Derive a finite element equation for one dimensional heat conduction with free end convection.

(OR)

b) i) In the finite element analysis of a two dimensional flow using triangular elements, the velocity components u and v are assumed to vary linearly within an element(e) as

$$u(x,y) = a_1 U_i^{(e)} + a_2 U_j^{(e)} + a_3 U_k^{(e)}$$
$$v(x,y) = a_1 V_i^{(e)} + a_2 V_j^{(e)} + a_3 V_k^{(e)}$$

where $\left(U_i^{(e)}, V_i^{(e)}\right)$ denote the values of (u, v) at node i. Find the relationship between $\left(U_i^{(e)}, V_i^{(e)} \ldots V_k^{(e)}\right)$ which is to be satisfied for the flow to be incompressible.

ii) Explain the potential function formulation of finite element equations for ideal flow problems.
