Reg. No. :

Question Paper Code : X10038

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2021
Sixth Semester
Aeronautical Engineering
AE 8601 – FINITE ELEMENT METHODS
(Common to Aerospace Engineering)
(Regulations 2017)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions

PART – A **(10×2=20 Marks)**

1. List any two advantages and limitations of finite element methods.
2. Define degree of freedom.
3. Why are polynomial functions generally used as approximation functions in FEM ?
4. Differentiate between local coordinate system and global coordinate system.
5. State the conditions for a problem to be axi-symmetric.
6. Differentiate between CST and LST elements.
7. What are isoparametric elements ?
8. Write any two properties of stiffness matrix.
9. List any four types of errors that can occur in FEM.
10. Write the expression of shape function for one dimensional heat conduction.

PART – B **(5×13=65 Marks)**

11. a) The following differential equation is available for a physical phenomenon.
$d^2y/dx^2 + 500x^2 = 0, 0 \leq x \leq 1$
Trial function is, $y = a_1 (x - x^3) + a^2 (x - x^5)$
Boundary conditions are $y(0) = 1$ and $Y(1) = 0$
Find the value of the parameters a_1 and a_2 by the Galerkin method.

(OR)

b) Describe the following :
i) Factors to be considered during discretization. **(7)**
ii) Convergence criteria of finite element method. **(6)**

12. a) Determine the nodal displacement and element stresses for the bar shown in figure 1.

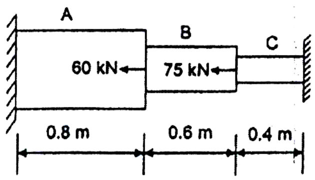

Figure 1

Portion	Material	E (GPa)	Area(mm^2)
A	Bronze	8.3	2400
B	Aluminium	70	1200
C	Steel	200	600

(OR)

b) For the beam and loading as shown in figure 2, calculate the slopes at nodes 2 and 3. Take E = 200 GPa and $I = 4 \times 10^{-6}$ m^4. Assume that each element is 1 m long.

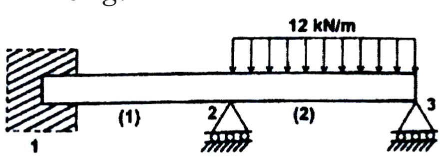

Figure 2

13. a) Derive the shape function for an axi-symmertric triangular element.

(OR)

b) Calculate the element stiffness matrix for the plane stress element shown in figure 3. Take Young's modulus $E = 2 \times 10^5$ N/mm^2, Poisson's ratio v = 0.25, thickness of the plate t = 5 mm.

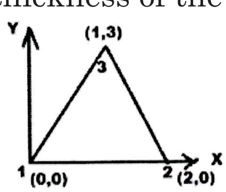

Figure 3

14. a) Determine the Jacobian matrix for the quadrilateral element whose Cartesian coordinates of the corner nodes are given by (0, – 1), (– 2, 3), (2, 4) and (5, 3). Evaluate the Jacobian matrix at the point (0.5, 0.5).

(OR)

b) Derive the shape functions for an eight noded quadrilateral element using natural coordinate system.

15. a) A metallic fin 20 mm wide and 4 mm thick is attached to a furnace whose wall temperature is 180°C. The length of the fin is 120 mm. If the thermal conductivity of the material of the fin is 350 W/m°C and convective heat transfer coefficient is 9 W/m^2°C, determine the temperature distribution assuming that the tip of the fin is open to the atmosphere and that the ambient temperature is 25°C.

(OR)

b) A wall of 0.6 m thickness having thermal conductivity of 1.2 W/mK is to be insulated with a material of thickness 0.06 m having an average thermal conductivity of 0.3 W/mK. The inner surface temperature is 1000°C and outside of the insulation is exposed to atmospheric air at 30°C with heat transfer coefficient of 35 W/m^2K. Calculate the nodal temperatures.

PART – C **(1×15=15 Marks)**

16. a) A beam AB span '*l*' is simply supported at the ends carrying a concentrated load 'W' at the centre 'C' as shown in figure 4. Determine the deflection at the mid span by using Rayleigh-Ritz method.

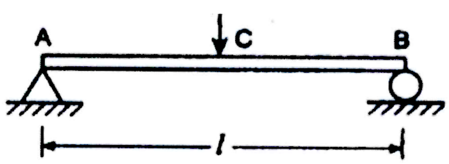

Figure 4

(OR)

b) A plane truss is composed of three joints and three elements as shown in figure 5. Determine nodal displacements and stress in each element.

Take area of cross section of each element as 2000 m^2 and Young's modulus of the materials as 200 GPa.

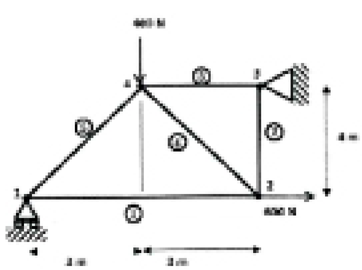

Figure 5