



**B.E DEGREE EXAMINATIONS: NOV 2015**  
(Regulation 2009)

Seventh Semester

**AERONAUTICAL ENGINEERING**

AER131: Finite Element Method

**Time: Three Hours**

**Maximum Marks: 100**

**Answer all the Questions:-**  
**PART A (10 x 1 = 10 Marks)**

- Which one of the following is required for designing and assembling the products by an analyst \_\_\_\_\_
  - Stress distribution
  - Natural frequencies
  - a & b
  - Boundary conditions
- General finite element equation is given by
  - $\{F\} = [K]\{u\}$
  - $\{F\} = [K]-\{u\}$
  - $\{F\} = [K]/\{u\}$
  - $\{F\} = [K][u]$
- Shape function (N) for 1-D bar element is
  - $u=N_1u_1 -N_2u_2$
  - $u=N_1u_1 /N_2u_2$
  - $u=N_1u_1 +2N_2u_2$
  - $u=N_1u_1 +N_2u_2$
- The art of sub dividing a structural in to a convenient number of smaller components is known as \_\_\_\_\_
  - Preprocessing
  - Analyzing
  - Discretization
  - Post processing
- The truss elements transmit only \_\_\_\_\_ to the other element
  - Radial force
  - Axial force
  - Bending moment
  - Temperature
- The general expression for element stiffness matrix is
  - $[BDB^T dV]$
  - $[B^T BD dV]$
  - $[B^T DB dV]$
  - $[B^{-1} BD dV]$
- A diagonal matrix in which all the diagonal elements are equal is known as
  - Equal matrix
  - Unit matrix
  - Scalar matrix
  - Row matrix
- Any motion which repeats itself after an interval of time is called
  - Vibration
  - Frequency
  - Damping
  - Resonance
- The process of heat transfer ,from one particle of the to another by the actual motion of heated particles is called
  - Conduction
  - Convection

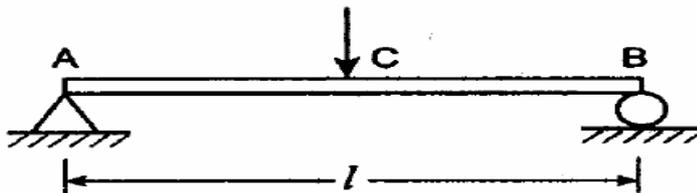
- c) Radiation  
d) Both a & b
10. The amount of radiation depends upon  
a) Temperature of the body only  
b) Surface area of the body only  
c) Nature of the body  
d) Based on surroundings

**PART B (10 x 2 = 20 Marks)**

11. Why polynomial types of interpolation function are mostly used in FEM?
12. Define shape function.
13. State the difference between local and global coordinates system.
14. If a displacement field in x direction is given by  $u = 2x^2 + 4y^2 + 6xy$ . Determine the Strain in x direction.
15. Distinguish between plane stress and plane strain problems.
16. What is axisymmetric element? What are the conditions for a problem to be an axisymmetric?
17. Define Isoparametric element. What is the purpose of isoperimetric elements?
18. Write down the shape function for 4 noded rectangular element using natural co-ordinate system.
19. Define streamline.
20. Write down the finite element equation for one dimensional heat conduction with free end convection.

**PART C (5 x 14 = 70 Marks)**

21. a) A beam AB of span 'L' simply supported at ends and carrying a point load 'W' at the centre 'C'. Determine the deflection at midspan by using Rayleigh-Ritz method and compare with exact result.



(OR)

- b) A simply supported beam is subjected to uniformly distributed load over entire span. Determine the bending moment and deflection at the mid span using Rayleigh-Ritz method and compare with exact solution. Use a two term trial function  $y = a_1 \sin(\pi x/l) + a_2 \sin(3\pi x/l)$
22. a) A thin plate of uniform thickness 25mm is subjected to a point load of 420N at mid depth as shown in figure 1. The plate is also subjected to self-weight. If Young's modulus,  $E = 2 \times 10^5 \text{ N/mm}^2$  and unit weight density,  $\rho = 0.8 \times 10^{-4} \text{ N/mm}^3$ , Calculate the following:  
(i) Displacement at each nodal point.  
(ii) Stresses in each element.

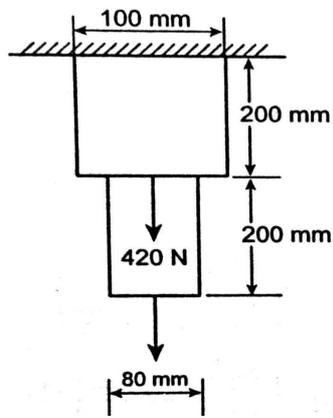


Fig.1

(OR)

- b) A fixed beam of length  $2L$  m carries a uniformly distributed load of ' $w$ ' (N/m) which runs over a length of  $L$  m from the fixed end, as shown in figure 2. Calculate the rotation at point B.

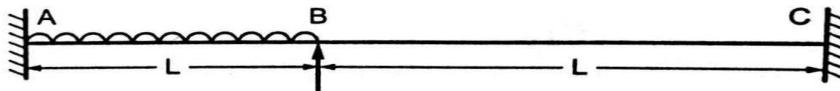


Fig.2

23. a) Calculate the element stresses  $\sigma_x$ ,  $\sigma_y$ ,  $\tau_{xy}$ ,  $\sigma_1$  and  $\sigma_2$  for the element shown in figure 3. Take  $U_1 = 2.0\text{mm}$ ;  $V_1 = 1.0\text{mm}$ ;  $U_2 = 0.5\text{mm}$ ;  $V_2 = 0.0\text{mm}$ ;  $U_3 = 3.0\text{mm}$ ;  $V_3 = 1.0\text{mm}$ . Take  $E = 2 \times 10^{11} \text{GPa}$  and  $\nu = 0.25$ . Assume Plane stress condition.

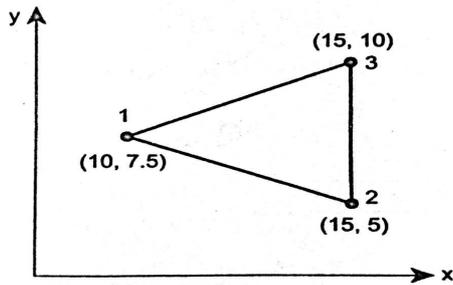


Fig.3

(OR)

- b) Evaluate strain displacement matrix,  $[B]$  for an axisymmetric triangular element shown in figure 4.

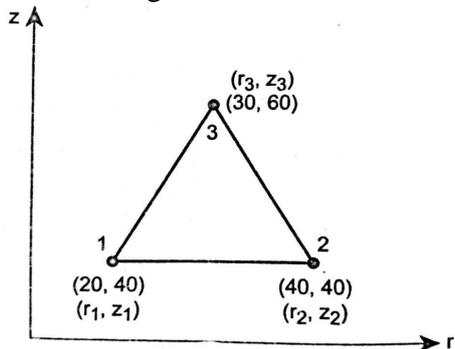


Fig.4

24. a) (i) For the isoparametric quadrilateral element shown in figure 5. Determine the local co-ordinates of the point 'P' which has Cartesian co-ordinates (7, 4). (6)

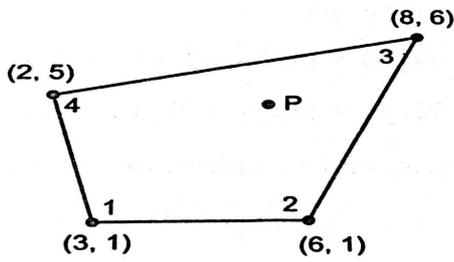


Fig.5

- (ii) Evaluate  $[J]$  at  $\xi = \eta = \frac{1}{2}$  for the linear quadrilateral element shown in figure 6. (8)

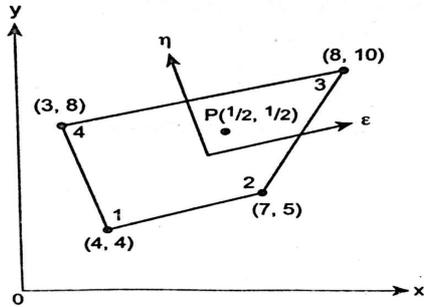


Fig.6

(OR)

- b) Evaluate the following integral  $f(r) = 1+r+r^2+r^3$  between the limits -1 and +1 using,  
 (i) Exact method  
 (ii) Gauss integration method and compare the results.

25. a) An aluminium alloy fin (figure 7) of 7mm thick and 50mm long protrudes from a wall, which is maintained at  $120^\circ\text{C}$ . The ambient air temperature is  $22^\circ\text{C}$ . The heat transfer coefficient and thermal conductivity of the fin material are  $140\text{W/m}^2\text{K}$  and  $55\text{W/mK}$  respectively. Determine the temperature distribution of fin.

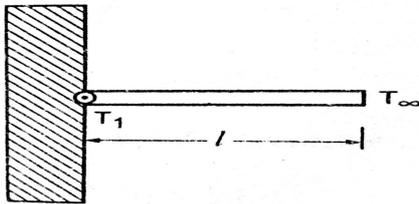


Fig.7

(OR)

- b) A wall of 1.5mm thickness and meter square cross sectional area (figure 8) having thermal conductivity of  $1.8\text{W/mK}$ . The wall is to be insulated with a material of thickness 0.1m having an average thermal conductivity of  $0.3\text{W/mK}$ . The inner surface temperature is  $1600^\circ\text{C}$  and outside of the insulation is exposed to atmospheric air at  $30^\circ\text{C}$  with heat transfer coefficient of  $40\text{W/m}^2\text{K}$ . Calculate the nodal temperatures.

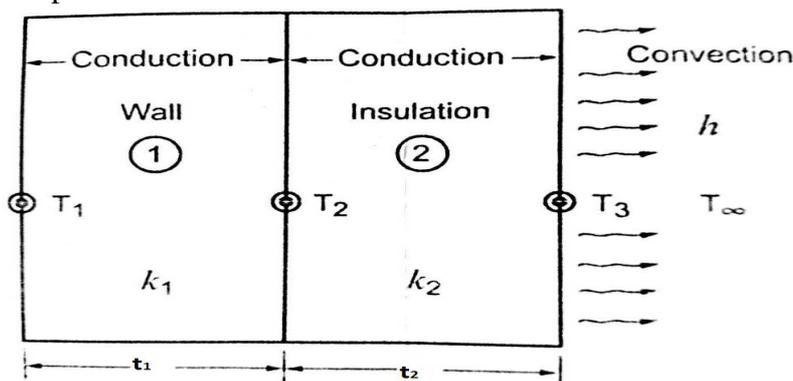


Fig.8

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