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B.E DEGREE EXAMINATIONS: APRIL/MAY 2014

(Regulation 2009)

Seventh Semester

MECHATRONICS ENGINEERING

MCT146 : Introduction To Finite Element Analysis

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The primary variables in FEM structural analysis is
   a) Displacement b) Force
   c) Stress d) Strain
2. Which of one is the variational method
   a) Galerkins method b) Least square method
   c) Rayleigh Ritz method d) Subdomain method
3. The structure made of several bars, riveted of welded together is called
   a) member b) body
   c) frame d) truss
4. 1D structural element is
   a) truss element b) beam element
   c) pipe element d) all of them
5. The commonly used 2D elements are
   a) four node quadrilateral and three node triangular elements b) three node quadrilateral and three node triangular elements
   c) eight node quadrilateral and six node triangular elements d) all of the above
6. The stiffness matrix for a triangular element in a 2D problem is often derived using
   a) surface coordinates b) area coordinates
   c) volume coordinates d) all the above
7. Elements with no internal nodes but nodes only on the boundaries is called
   a) Serendipity element b) Linear element
   c) Cubic element d) Quadratic element
8. The global stiffness matrix is
   a) singular b) square

   c) singular and square d) symmetric
9. Plates with hole are analysis using
   a) Plane stress analysis b) plane strain analysis
   c) stress – strain analysis d) none of these
10. A pipe element differs from a beam element by inclusion of
   a) cold cut b) internal pressure
   c) anchors d) sliding supports

PART B (10 x 2 = 20 Marks)

11. What is the basis of finite element method?
12. Explain stiffness method.
13. What is truss element?
14. State the principle of minimum potential energy.
15. What is CST element?
16. Define plane strain analysis.
17. What are the conditions for a problem to be axisymmetric?
18. Write down the shape functions for an axisymmetric triangular element.
19. Write down the stiffness matrix equation for one dimensional heat conduction element.
20. Define heat transfer.

PART C (5 x 14 = 70 Marks)

21. a) Explain the FEM Procedure with suitable example.

(OR)

b) The differential equation of a physical phenomenon is given by $\frac{d^2y}{dx^2} - 10x^2 = 5$.
Obtain two term Galerkin solution by using the trial functions: $N_1(x) = x(x-1)$; $N_2(x) = x^2(x-1)$; $0 \leq x \leq 1$
Boundary conditions are: y (0) =0; y (1) =0.

22. a) A stepped bar is subjected to an axial load of 200 KN at the place of change of cross section and material as shown in Figure.1. Find (a) The nodal displacements (b) the reaction forces (c) the induced stresses in each material.

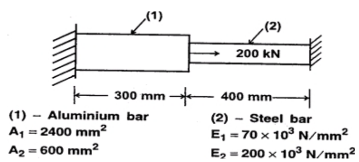


Figure.1

(OR)

b) For a tapered bar of uniform thickness t=10mm as shown in Figure.2. Find the displacements at the nodes by forming into two element model. The bar has a mass density ρ = 7800 Kg/M^3, the young's modulus E = 2x105 MN/m^2. In addition to self weight, the bar is subjected to a point load P= 1 KN at its centre. Also determine the reaction forces at the support.

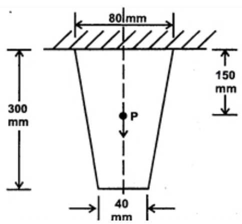
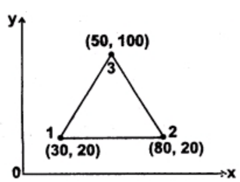


Figure.2

23. a) Derive the stiffness matrix and equations for a LST element.

(OR)

b) For the plane stress element shown in Figure.3. Evaluate the stiffness matrix. Assume E = 210 X 10^3 N/mm^2, poisson's ratio μ=0.25 and element thickness t=10mm. The coordinates are given in millimeters.



24. a) Derive the shape functions for an axisymmetric triangular element.

(OR)

b) The nodal coordinates for an axisymmetric triangular element at its three nodes

are (r1 , z1) = (30,10), (r2 , z2) = (50,10), (r3 , z3) = (40,60). Determine the strain displacement matrix for that element.

25. a) A wall of 0.6 m thickness having thermal conductivity of 1.2 W/mK. The wall 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^{2}K. Calculate the nodal temperatures.

(OR)

b) Derive the temperature function and shape function for one dimensional heat conduction.

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