Register Number: ……………………..

B.E DEGREE EXAMINATIONS: APRIL/MAY 2014

(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)

1. FEM is a generalization of
   a) Rayleigh-Ritz method b) Weighted residual method
   c) Finite difference method d) Finite volume method
2. Primary variable in FEM structural analysis is
   a) Displacement b) Force
   c) Stress d) Strain
3. In consistent loads, end moment of a simply supported beam of length 'L' with a concentrated load 'p' at the mid point is
   a) $\frac{PL}{4}$ b) $\frac{PL}{8}$
   c) $\frac{PL}{12}$ d) $\frac{PL}{16}$
4. A truss element in space has a stiffness matrix of order
   a) 2 x 2 b) 4 x 4
   c) 6 x 6 d) 1 x 1
5. A 3-D dam is usually modeled
   a) 2-D plane stress elements b) 2-D plane strain elements
   c) 3-D solid elements d) 3-D shell elements
6. A triangular plane stress element has -------- D.O.F
   a) 6 b) 9
   c) 12 d) 15
7. When more nodes are used to define the geometry than are used to define the displacement, the element is called __ element
   a) Super parametric element b) sub parametric element
   c) Isoparametric element d) complex element
8. Accuracy of stiffness matrix improves with

   a) More number of Gaussians points b) More number of nodes
   c) Size elements d) Shape of elements
9. One possible load in structural analysis is the specified
   a) Nodal temperature b) Stress in an element
   c) Heat flow d) Strain in an element
10. Assembled stiffness matrix after applying boundry conditions is NOT
   a) Square b) Symmetric
   c) Banded d) Singular

PART B (10 x 2 = 20 Marks)

11. List out the different weighted-residual methods.
12. Demonstrate the discretization process with suitable example.
13. Write down the expression of stiffness matrix for a truss element.
14. State the properties of stiffness matrix and shape function.
15. Distinguish with suitable examples plane stress and plane strain analysis.
16. What are the conditions for a problem to axi symmetric? and Give the stiffness matrix equation for an axi-symmetric triangular element.
17. What is meant by sub parametric elements?
18. What are the serendipity elements?
19. Give the governing equation for heat conduction in a solid body in cylindrical coordinate system.
20. State the assumption in the theory of pure torsion & write down the finite element equation for torsional bar element.

PART C (5 x 14 = 70 Marks)

21. a) Using Rayleigh–Ritz method determine the expressions for deflection and bending moments in a simply supported beam subjected to uniformly distributed load over entire span as shown figure 1. Find the deflection and moment at midspan and compare with exact solutions using Rayleigh-Ritz method. Use $Y=a_1\sin\frac{\pi x}{l}+a_2\sin\frac{3\pi x}{l}$

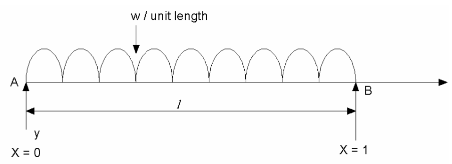

Figure .1

(OR)

b) i) Explain briefly the general procedure of finite element analysis with help of suitable block diagram. (7)

ii) The following differential equation is available for a physical Phenomenon. (7)

$D^2y/dx^2+50=0$ $0 \le x \le 10$ Trial function $y=a_1x(10-x)$ boundry condition are y(0)=0,y(0)=10 Find the value of parameter a_1 by the (a) point collocation method (b)subdomain method (c)least squares method (d) Galerkin method.

22. a) The thin plate of uniform thickness 20 mm, is as shown in Figure.2. In addition to the self weight, the plate is subjected to a point load of 400N at mid-depth. The Young's modulus $E = 2 \times 10^5$ N/mm² and unit weight $\rho = 0.8x10^{-4}$ N/mm². Analyze the plate after modeling it with two elements and find the stresses in each element. Determine the support reactions also.

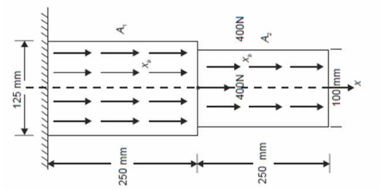

Figure .2

(OR)

b) i) Derive the stiffness matrix for beam element. (10)

ii) Distinguish with suitable examples Global co-coordinates, Local Co-ordinates and Natural co-ordinates. (4)

23. a) Derive an expression for strain displacement matrix, stress strain relation matrix and element matrix for an CST element.

(OR)

b) Determine the stiffness matrix for the constant strain triangular element whose nodal coordinates are given as (x1,y1) = (10,7.5); (x2,y2) = (15,5) and (x3,y3) = (15,10) The coordinates are in mm. Assume plane stress condition. Take E = 210 GPa, μ = 0.25 and t = 10 mm.

24. a) Derive the element stiffness matrix for a linear isoparametric quadrilateral element.

(OR)

b) i) Evaluate the Cartesian coordinate of the point P which has local coordinates ε = 0.6 and η = 0.8 as shown in the Figure 3. (7)

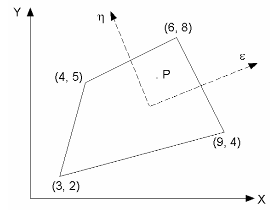

Figure.3

ii) Evaluate the integrals (a) $I=\int_{-1}^{1}[x^2+\cos(\frac{x}{2})]\,dx$ and (b) $I=\int_{-1}^{1}(3^x-x)dx$ using three point Gaussian quadrature. By taking the three Gauss points and weights are $x_1=x_3=\pm0.77459..$,$x_2=0.000.$, $W_1=W_3=\frac{5}{9}$, and $W_2=\frac{8}{9}$ and compare with the exact solution. (7)

25. a) Derive the finite element equation for i) one dimensional heat conduction with free end convection ii) one dimensional element with conduction,convection and internal heat generation.

(OR)

b) Calculate the temperature distribution in a one dimension fin with physical properties given in figure .4. The fin is rectangular in shape and is 120 mm long, 40mm wide and 10mm thick. Assume that convection heat loss occurs from the end of fin. Use two elements. Take k=0.3W/mmºC; $h=1x10^{-3}$W/mm²ºC, T_∞ =20ºC.

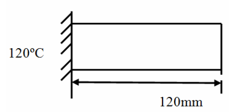

Figure .4

****