Code No: RR422105

**Set No. 1**

**IV B.Tech II Semester Regular Examinations, Apr/May 2006**
**FINITE ELEMENT METHODS**
**(Aeronautical Engineering)**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

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1. (a) Explain the natural and geometric boundary conditions.
   (b) Explain different approaches of getting the finite element equations. [16]

2. (a) A long rod is subjected to loading and temperature increase of $30^0$C. The total strain n at a point is measured to be $1.2\times 10^{-5}$ If E=200GPa and $\alpha$=12 $\times 10^{-6}/^0$C. Determine stress at the point.
   (b) Consider the rod shown in figure 1 where strain at any point x is given by e=1+2$x^2$ Find the tip displacement. [16]

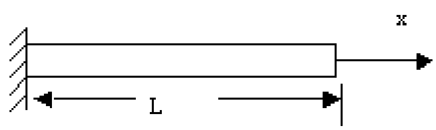


Figure 1:

3. Use the stiffness matrix to calculate the end moments and shear forces of a beam subjected to a load of 5KN/m.The 3 sections are of same length of 2m each. The total beam is subjected to a uniform load of 5KN/m. as shown in figure 2 [16]

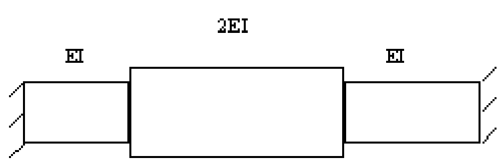


Figure 2:

4. What is a plane stress and plane strain problem? Give suitable example and explain? [16]

5. (a) Examine the limits of exactness of Gaussian quadrature formula with
      i. n=3
      ii. n=4.

(b) What is difference between Newton -Cotes and Gauss quadrature formulations. [16]

6. Determine the temperature distribution for the plate as shown figure 3. [16]

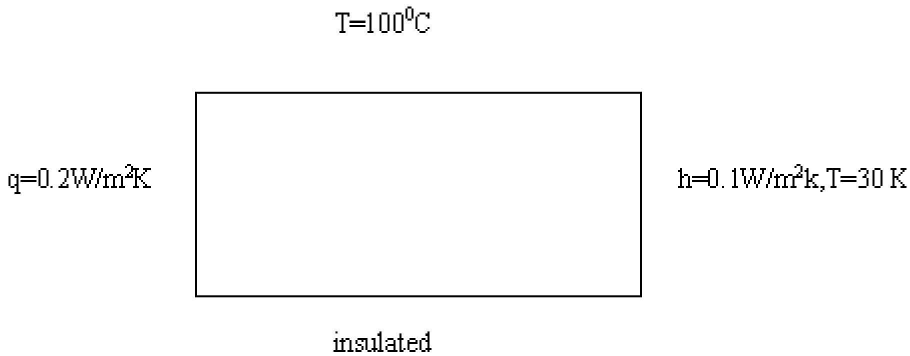


Figure 3:

7. Find the natural frequencies for a cantilever bar vibrating freely in the axial direction by using one and two elements respectively. The exact solution is $\omega = (n\pi/2L)\left(\sqrt{E}/\rho\right)$ where n = 1,3,5.. is the mode number. Find the percentage of error in both the cases. Shown in figure 4 [16]

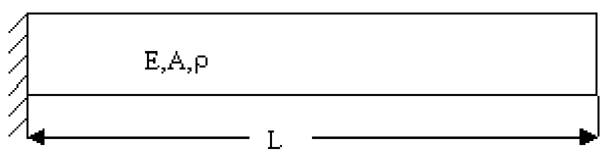


Figure 4:

8. Write the subroutines to compute the shape functions, using these routines develop a sub routine to compute the [B] matrix at a given Gauss point for a three noded triangular element. [16]

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Code No: RR422105

**Set No. 2**

IV B.Tech II Semester Regular Examinations, Apr/May 2006

# FINITE ELEMENT METHODS

(Aeronautical Engineering)

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

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1. Explain various types of boundary conditions encountered in the finite element analysis of structural problems. [16]

2. (a) What is displacement function?
   (b) Derive stresses and strains relations.
   (c) Derive equivalent nodal force vectors. [16]

3. For the beam and load shown in figure 1 determine slope at 2 and 3 and at the mid point of the distributed load. E=200GPa,I=5 $\times$ $10^6 mm^4$. [16]

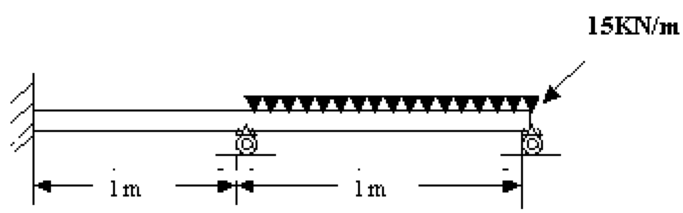


Figure 1:

4. Derive the expressions for the mass and stiffness matrices of a plate using triangular elements. [16]

5. (a) The nodal coordinates of the triangular element are 1 (1,1) , 2 (4,2) , 3 (3,5). at the interior point P, the x coordinate is 3.3 and $N_1$ is 0.3 . Determine $N_2$, $N_3$ and y coordinate at point P.
   (b) Explain natural and simple natural coordinates. [16]

6. Heat is generated in a large plate (K=0.8 W/$m^0$C) at the rate 4000 W/$m^3$. The plate is 25 cm thick. The outside surfaces of the plate are exposed to ambient air at $30^0$C with a convective heat transfer coefficient of 20W/$m^2$ $^0$C. Determine the temperature distribution in the wall. Shown in fugure 2. [16]

7. Using one element to idealize half of the beam as shown in figure 3. Find the lowest four mode natural frequencies. Compare the results with exact solutions. $\omega_n = (n\pi/L)^2 \left(\sqrt{E}I/\rho A\right)$ where n =1,2,3.. is the mode number. [16]

8. The cantilever beam is to be analysed using four eight noded plane stress rectangular elements. Compute the nodal degree of freedom array and column heights of

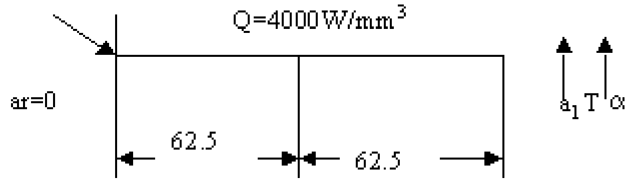


Figure 2:

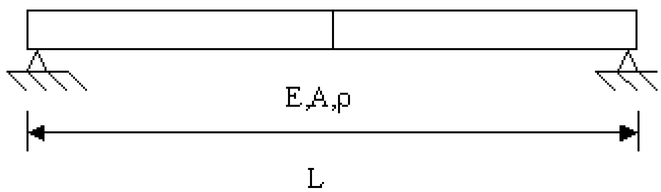


Figure 3:

the global stiffness matrix. The length of the beam is 3 m ,height of the beam is 1.5 m, thickness is 0.016 m, young's modulus E = $2.1 \times 10^4$ KN/$cm^2$. The first end is fixed. An axial tensile load of 500KN is applied at L = 3 m. [16]

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Code No: RR422105

**Set No. 3**

**IV B.Tech II Semester Regular Examinations, Apr/May 2006**
**FINITE ELEMENT METHODS**
**(Aeronautical Engineering)**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**
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1. Why a polynomial is chosen as a displacement model? On what factors does the order of polynomial depend? When do you call a displacement model as a conforming and complete? Explain. [16]

2. (a) What is displacement function?
   (b) Derive stresses and strains relations.
   (c) Derive equivalent nodal force vectors. [16]

3. Obtain the global stiffness matrix taking two elements 1 and 2 as beam elements for planar structure shown in figure 1. The length of the element one may be taken as L the values of E and I are same for both elements. [16]

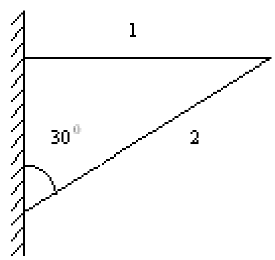


Figure 1:

4. By using principle of virtual work or minimization of total potential energy of system, obtain formulation of FEM i.e., show that
   $k =_{vol} \int B^T DB$ dvol
   Also indicate various terms that contribute to vector of forces. [16]

5. Prove how an isotropic axisymmetric solid element subjected to axisymmetric loading has effectively a 2-Dimensional state of stress. [16]

6. Calculate the temperature distribution and the heat dissipating capacity of a fin shown in figure 2. The thermal conductivity of the material is 200W/m k. The surface heat transfer coefficient is 0.5 W/$m^2$k. The ambient temperature is 30$^o$C. The thickness of the fin is 1 cm the width at the base is 2 cm and at the tip is 1 cm and varies uniformly along the length, what changes takes place in the heat dissipation capacity of the fin. [16]

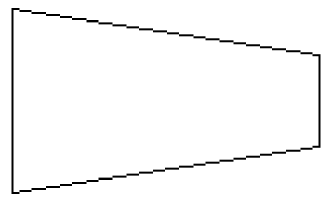

Figure 2:

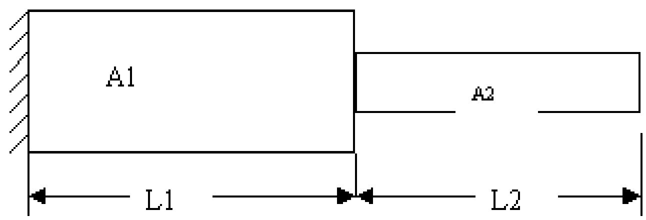


Figure 3:

7. Determine the Eigen values and Eigen vectors for the stepped bar shown in figure 3. E=30$times$ $10^6$ N/$m^2$ ,specific weight = 0.283 Kg/$m^3$ $A_1$= 1 $m^2$ $A_2$= 0.5 $m^2$ $L_1$=10 m. $L_2$ =5 m. [16]

8. For the cantilever beam, compute the nodal degree of freedom array and column heights of the global stiffness matrix using the mesh 2 for Discretization. The length of the beam is 4 m, height of the beam is 2 m, thickness is 0.016 m, young's modulus E = 2.1 × $10^4$ KN/$cm^2$. The first end is fixed. An axial tensile load of 1000KN is applied at L = 4 m. [16]

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**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**
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1. (a) What is Lagrangian? Define the principle involved in arriving it.
   (b) Explain about the Conforming and non conforming elements. [16]

2. Consider the truss element with the coordinates 1(10, 10) and 2(50, 40). If the displacement vector is q = $\begin{bmatrix} 15 & 10 & 21 & 43 \end{bmatrix}^T$ mm, then determine
   (a) the vector q
   (b) stress in the element and
   (c) stiffness matrix if E=70GPa and A=200$mm^2$ [16]

3. Compute the support reaction at the other end of continuous beam shown in figure 1. use the concept of boundary element EI=400 units. [16]

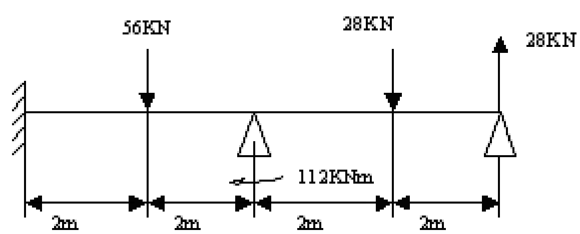


Figure 1:

4. In a plane stress problem $\sigma_x$=50MPa, $\sigma_y$=-25MPa,$\sigma_{xy}$=40MPa,E=200GPa, $\mu$=0.33.
   (a) Determine strain component $\varepsilon_z$.
   (b) If the problem is a case of plane strain case determine stress component $\sigma_z$. [16]

5. (a) Derive the shape function for a Hexahedral element.
   (b) Explain various convergence requirements related to isoparametric elements. [16]

6. A metallic fin with thermal conductivity K=360W/$m^o$C, 0.1 cm thick and 10 cm long extends from a plane wall whose temperature is 235$^o$C . Determine the temperature distribution and the amount of heat transferred from the fin to the air at 20$^o$C with h = 9W/$m^2$ $^o$C. Take the width of fin to be 1 m. [16]

7. For the stepped bar shown in the figure 2.

   (a) Develop the global stiffness and mass matrices.

   (b) Determine the natural frequencies and mode shapes using the characteristic polynomial technique. [16]
   Assume E=200GPa and mass density = 7850 kg/$m^3$
   $L_1 = L_2$=0.3 m, $A_1$=350$mm^2$,$A_2$=600$mm^2$

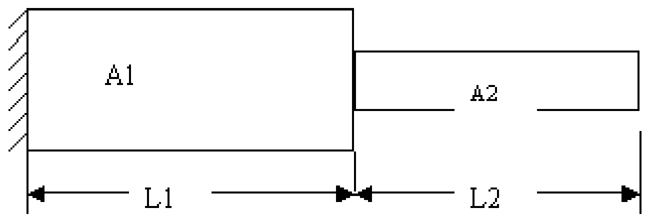


Figure 2:

8. Develop subroutines to compute the shape function, their derivatives, Jacobian matrix[J], at a given Gauss point for three noded isoparametric triangular element, using these subroutines develop a subroutine to compute [B] matrix , using the formulation for fast stiffness computation. [16]

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