Code No: NR422105 **Set No.1**

IV B.Tech. II Semester Regular Examinations, April/May -2005
FINITE ELEMENT METHODS
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

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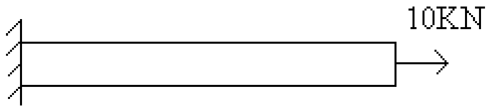
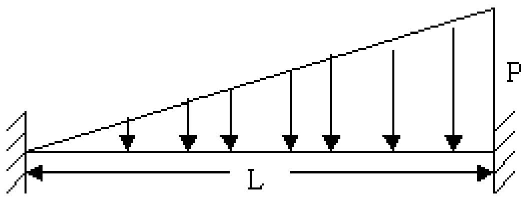
1. (a) Explain the application of calculus of variations to solid mechanics problems and discuss the principle of minimum potential energy giving example
   (b) Outline different types of finite elements used in FEM giving size of element stiffness matrix in each case.

2. A bar under axial load is shown below, determine the deflection at load applied by discretizing the bar into two elements, compare the solution with theoretical solution and comment. E =210GPa L=30cm,Load P =10000N diameter=2cm



3. Compute the nodal load vector for a 2D beam member subjected to an uniformly varying load as shown.



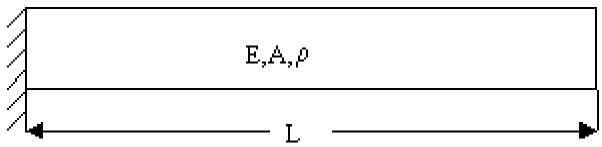
4. Why are polynomials chosen as displacement models ? what are the convergence requirements, explain?

5. (a) What is a Lagrangian ? Define the principle involved in arriving it.
   (b) Explain about numerical integration and Gaussian quadrature.

6. 2-Dimensional simplex elements have been used for modelling a heated flat plate. The (x,y) co-ordinates of nodes i,j and k of an interior element are given by (5,4), (8,6) and (4,8) respectively. If the nodal temperatures are found to be $T_i = 110^0C$, $T_j = 70^0C$ and $T_k = 130^0C$ find
   (a) The temperature gradient inside the element and
   (b) The temperature at the point P located at $(x_p, y_p) = (6,5)$.

7. Write the subroutines to compute the shape functions, their derivatives, Jacobian matrix [J] ,$[J]^{-1}$ and $|J|$ at a given Gauss point for a four noded quadrilateral element.

8. Evaluate the lowest Eigen value and the corresponding Eigen modes for the beam shown in the figure E= 200 GPa and ρ=7840kg/m^3, I = 2000 mm^4, A=240 mm^2, L =300 mm.



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Code No: NR422105 **Set No.2**

IV B.Tech. II Semester Regular Examinations, April/May -2005
FINITE ELEMENT METHODS
(Aeronautical Engineering)

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

Answer any FIVE Questions
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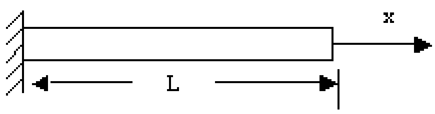
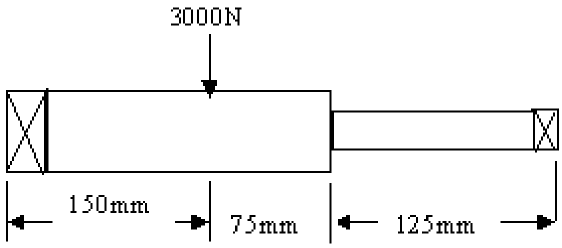
1. (a) How a structure is descritized? What are the criteria to select large number of elements of smaller size and smaller number of elements of large sized elements?
   (b) Explain about the following:
      i. theory of direct stiffness method
      ii. Higher order elements.
2. (a) A long rod is subjected to loading and temperature increase of 30^0C.The total strain n at a point is measured to be 1.2x 10^{-5} If E=200GPa and α=12 x $10^{-6}/^0$C.Determine stress at the point.
   (b) Consider the rod shown in figure where strain at any point x is given by $\varepsilon=1+2x^2$ Find the tip displacement.



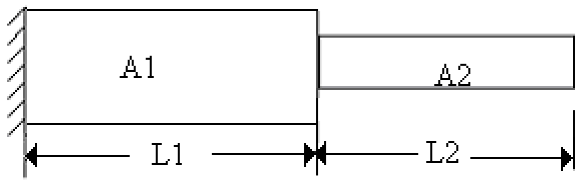
3. Find the deflection at the load and the slopes at the ends for the steel shaft shown in figure consider the shaft to be simply supported at the bearings A and B $I_1=1.25\times10^5$ mm^4 $I_2=4\times10^4$mm^4.



4. Derive the load vectors for the three types of loads encountered in elasticity problems viz., udl, surface load, body forces.
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?

6. Consider a brick wall of thickness 0.3 m , k=0.7 W/m K . The inner surface is at 28^0C and the outer surface is exposed to cold air at -15^0C . The heat transfer coefficient associated with the outside surface is 40W/m^2 K. Determine the steady state temperature distribution with in the wall and also the heat flux through the wall. Use two elements and obtain the solution.

7. By hand calculations, determine the natural frequencies and mode shapes for the rod shown in figure using characteristic polynomial technique. Use a lumped mass model and compare the results obtained with the consistent mass model.



L_1=300mm, L_2=400mm, A_1=1200mm^2 , A_2=900mm^2 ρ =7830Kg/m^3.

8. Develop subroutines to compute the shape function, their derivatives, Jacobian matrix[J], $[J]^{-1}$ and $|J|$ at a given Gauss point for three to six(variable) noded two- dimensional isoparametric triangular elements.

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Code No: NR422105 **Set No.3**

IV B.Tech. II Semester Regular Examinations, April/May -2005
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(Aeronautical Engineering)

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

Answer any FIVE Questions
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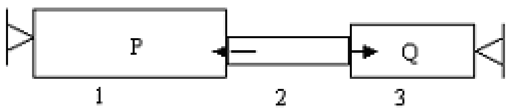
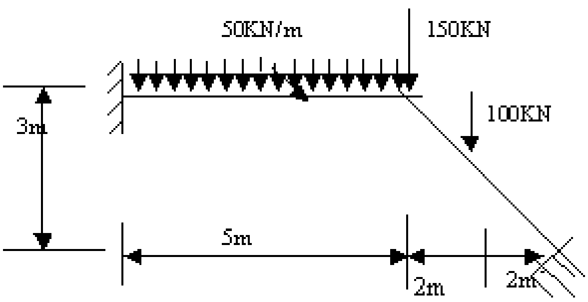
1. (a) What are various steps in solving a problem by finite element method, explain with suitable example.
   (b) Explain advantages, disadvantages and limitations of FEM.

2. Determine the displacements u_2,u_3,strains,stresses in the three elements shown in figure Assume E = 200KN/mm^2 for all the elements. Ends 1 and 4 are restrained P=Q=5KN,A1=20mm^2,A2=10mm^2,A3=16mm^2,L_1=L_2=400mm,L3=320mm



3. Determine the displacements and rotations of the joints for the portal frames shown in figure using FEM E=2x10^3KN/cm^2,A_1=1500 cm^2,A_2=2500cm^2

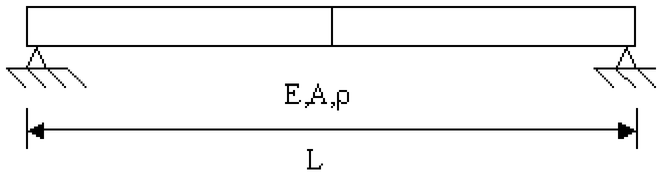


4. What is a plane stress and plane strain problem? Give suitable example and explain?

5. (a) Evaluate $_1\int^3$dx/x using Guassian three point formula
   (b) Explain the procedure of Guass quadrature

6. The outside of a heating tape is insulated, while the inside is attached to one face of a 2 cm thick stainless steel plate (K= 16.6 W/m^oC) the other face of the plate is exposed to the surroundings, which are at a temperature of 20^oC ,heat is supplied at a rate of 500W/m^2 ,the outside surface is maintained at $T_s = 70^oC$. Determine the temperature of the face to which the heating tape is attached. h = 5W/$m^{2o}C$.

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



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 four noded quadrilateral element .

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Code No: NR422105 **Set No.4**

IV B.Tech. II Semester Regular Examinations, April/May -2005
FINITE ELEMENT METHODS
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks
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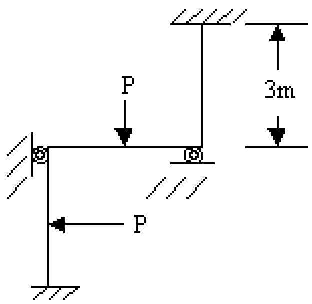
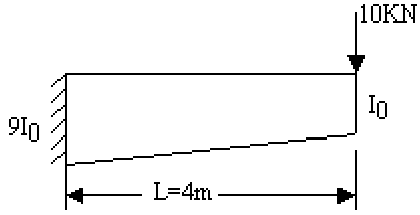
1. (a) How does the finite element solution is effected by the aspect ratio? Discuss with suitable example.
   (b) Show that the principle of virtual displacement is a necessary and sufficient conditions for equilibrium of a deformable system.

2. Develop the stiffness matrix for the structure shown in figure E is same for all the members. All the lengths of the links are equal.



3. A cantilever beam shown in figure. Analyze the beam and compute the slope and deflection at the tip of the following cases of model.
   (a) One non uniform beam element
   (b) Two non uniform beam elements
   (c) One uniform beam element
   (d) Two uniform beam elements



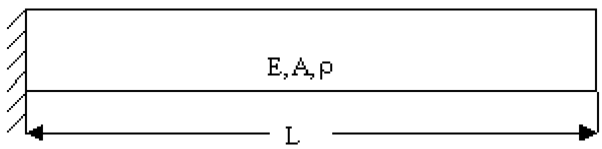
The variation of moment of inertia is given by I(x)=$I_0[1+r(x/L)^{\alpha}]$ where r=8, α=1

4. Describe the necessary equations to compute stiffness matrix of four noded quadrilateral element used for plane stress and plane strain analysis.

5. (a) Explain and differentiate Serendipity and Lagrangian family of elements.
   (b) Using Hermitian polynomial interpolation obtain shape functions for a flexural beam element.

6. In the steady state irrotational flow of a fluid at a point P , the pressure is 15 kg/cm^2 and the velocity is 10m/s. At point Q , which is located 5m vertically above P , the velocity is 5 m/s . If density of fluid is 0.001 kg/cm^3 , find the pressure at Q.

7. Find the natural frequencies for a cantilever bar shown in fig. vibrating freely in the axial direction by using one and two elements.



8. Develop subroutines to compute the shape function, their derivatives, Jacobian matrix[J], $[J]^{-1}$ and $|J|$ at a given Gauss point for four to eight (variable) noded two- dimensional isoparametric rectangular element.

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