Code No: RR412112 **Set No.1**

IV B.Tech. I Semester Regular Examinations, November -2005
APPROXIMATE METHODS IN STRUCTURAL MECHANICS
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Comment on the statement "All engineering solutions are approximate"

   (b) Determine the displacements of nodes 2 and 3 of the spring system shown in figure 1 below, by potential energy method. [4+12]

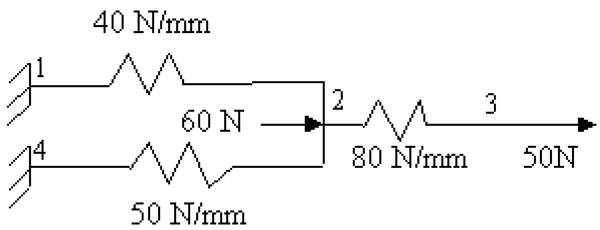

Figure 1:

2. (a) Explain the terms - resilience, proof resilience and modulus of resilience.

   (b) Calculate the reactions at the three supports of a continuous beam using Castigliano's theorem. Shown in Figure 2. [6+10]

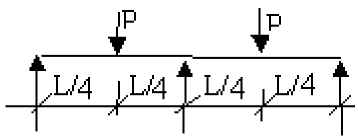

Figure 2:

3. Calculate deflections at points A, B, C and D of the combination of beams shown in figure 3 below, using Castigliano's theorem. Assume I = $0.4m^4$ and E = 200 GPa for all the beams. Load applied is 'P' at B and '2P' at C. [16]

4. (a) What are the conditions to be satisfied by the displacement function in weighted residual methods ?

   (b) Calculate the maximum deflection in a cantilever beam, subjected to uniformly distributed load 'w', by any one of the weighted residual methods. Shown in Figure 4. [6+10]

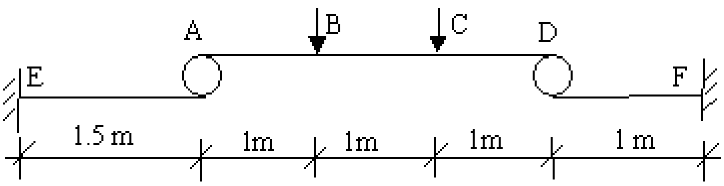

Figure 3:

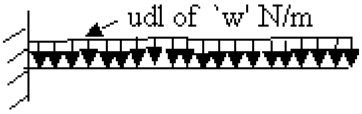

Figure 4:

5. (a) Derive finite difference expressions for d^4y/dx^4 and d^2y/dx^2 using central differences with equal intervals.

   (b) Calculate maximum axial compressive load for stable equilibrium of a column with hinged ends by finite difference method, choosing four equal divisions along the column. Calculate percentage error, compared to the exact solution. [6+10]

6. Determine the nodal displacements, element stresses and reactions of the truss, shown in figure 5 below, by FEM. Assume A= 100 mm^2, L = 2 m and E = 200GPa for all the three members. [16]

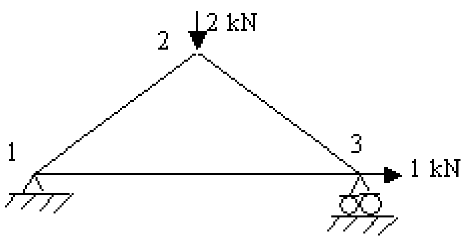

Figure 5:

7. (a) What is the influence of rigid body motion in finite element analysis?

   (b) Derive the stiffness matrix of a beam element for bending in one plane, by the variational method. [4+12]

8. (a) If a displacement field is described by u = $3x^2$-2xy+$6y^2$; v = $4x^2$+6xy-$8y^2$, determine normal strains and shear strain at point x = -1 and y = 1.

   (b) What are the different types of elasticity matrices used for 2-D elements? Give one example for each type. Derive any one of them from Hooke's law. [4+12]

⋆⋆⋆⋆⋆

Code No: RR412112

Set No.2

IV B.Tech. I Semester Regular Examinations, November -2005
APPROXIMATE METHODS IN STRUCTURAL MECHANICS
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) What are the basic differences between exact methods and approximate methods?

   (b) Determine the displacements of nodes 2 and 3 of the spring system shown in Figure 6 below, by potential energy method. Assume nodes 1 and 4 to be fixed. [4+12]

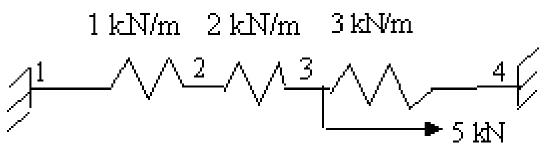

Figure 6:

2. (a) What are the strain energies stored in a bar fixed at one end when subjected to gradually applied and suddenly applied axial load 'P'?

   (b) Calculate displacement at A in the figure 7 shown below, when a concentrated load of 500N is applied at the free end of the structure, consisting of three equal springs and a beam BC. Assume E=200 GPa and I=0.4m^4 for the beam. [6+10]

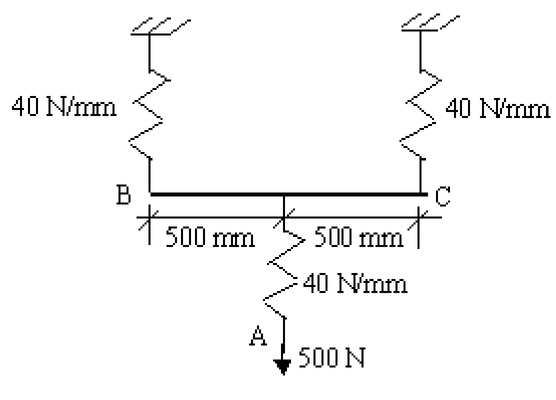

Figure 7:

3. Calculate deflections at points A, B and C of the combination of beams shown in figure 8 below, if the points B and C do not come in contact with beam DE. Assume I = $0.4m^4$ and E = 200 GPa. Load applied is 'P' at B and C. [16]

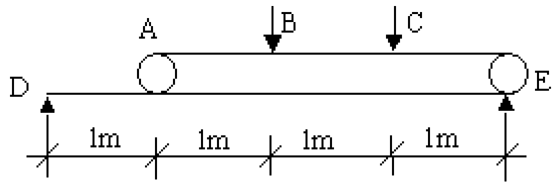

Figure 8:

4. (a) Distinguish between collocation method and Galerkin method.
   (b) Calculate the maximum deflection in a cantilever beam, subjected to udl of 'w' N/m over its length, by 1-term collocation method and 1-term Galerkin method. Compare the results. Shown in figure 9. [6+10]

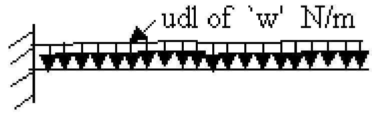

Figure 9:

5. (a) Suggest boundary conditions in terms of derivatives of normal deflection 'w' in a square plate, subjected to uniform bending load over the entire plate, when the edge is
      i. simply supported and
      ii. clamped. [4]
   (b) Derive finite difference expression for $\partial^4 w/\partial x^4$, $\partial^4 w/\partial y^4$ and $\partial^4 w/\partial x^4 \partial y^2$ for a plate with equal intervals along x and y, where 'w' is the deflection normal to the plate. [4+4+4]

6. Determine the displacements of node 2, stresses in bars 1 & 2 and reactions at fixed supports in the truss structure shown in figure 10 below, assuming points 1 and 3 to be fixed. Use E=200 GPa and A=1000 mm^2. [16]

7. (a) What is a 'Degree of freedom' ? Explain dof relevant to a general beam element in various modes of behaviour.
   (b) Calculate deflections at B and C and reactions at A and C of a propped cantilever beam of length 3m, depth 200 mm and width 120 mm. Assume E = 2x10^5 N/mm^2. Shown in figure 11 [4+12]

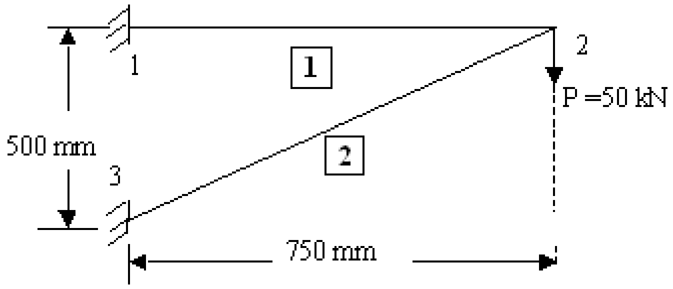

Figure 10:

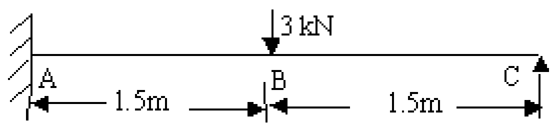

Figure 11:

8. (a) Explain the terms
   i. geometric isotropy,
   ii. aspect ratio and
   iii. inter-element compatibility

   (b) The nodal coordinates and the nodal displacements of a triangular element, under a specific load condition are given below.
   $X_i = 0$, $Y_i = 0$, $X_j = 1$ mm, $Y_j = 3$ mm, $X_k = 4$ mm, $Y_k = 1$ mm
   $u_i = 1$ mm, $v_i = 0.5$ mm, $u_j =$ -0.05 mm, $v_j = 1.5$ mm, $u_k = 2$ mm, $v_k =$ -1 mm
   If E = 2 x 10^5 N/mm^2 and $\mu = 0.3$, find the stresses in the element. [6+10]

⋆⋆⋆⋆⋆

Code No: RR412112 **Set No.3**

IV B.Tech. I Semester Regular Examinations, November -2005
APPROXIMATE METHODS IN STRUCTURAL MECHANICS
(Aeronautical Engineering)

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

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

1. (a) Explain briefly Rayleigh-Ritz method of analysis.
   (b) Calculate the displacement at node 2 of a fixed beam, subjected to an axial load of 50kN at node 2 by Rayleigh-Ritz method. Take E.= 200 GPa and A = 1000mm^2.Shown in Figure 12. [6+10]

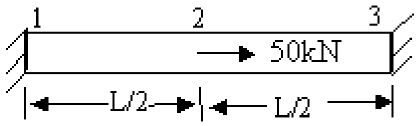

Figure 12:

2. (a) Explain the terms - resilience, proof resilience and modulus of resilience
   (b) Calculate tip displacements of a quarter circular bar AB of radius R when a load P is applied at its free end, as shown in Figure 13 below. [6+10]

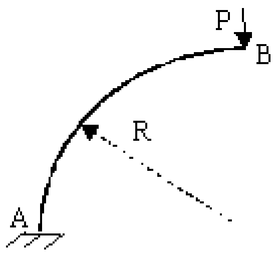

Figure 13:

3. (a) Explain the principle of superposition w.r.t. beams.
   (b) Calculate the location at which maximum deflection occurs and the expression for maximum deflection in a simply supported beam AB subjected to uniformly increasing load of '0' at A to 'w' N/m at B. Assume I = $0.4m^4$ and E = 200 GPa. Shown in Figure 14 [4+12]

4. (a) Distinguish between collocation method and Galerkin method.

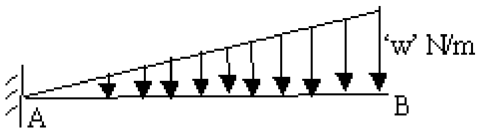

Figure 14:

(b) Calculate the maximum deflection in a cantilever beam, subjected to concentrated load 'P' at its free end, by 1-term collocation method and 1-term Galerkin method. Compare the results. Shown in figure 15. [6+10]

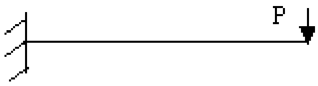

Figure 15:

5. (a) Suggest boundary conditions in terms of derivatives of normal deflection 'w' in a solid circular plate, subjected to uniform bending load over the entire plate, when the outer edge is
   i. simply supported,
   ii. clamped and
   iii. free
   (b) Derive finite difference form of equilibrium equation, in polar coordinates, for a solid circular plate subjected to uniformly distributed bending load 'q'. [6+10]

6. Determine the nodal displacements, element stresses and support reactions in the truss structure shown in figure 16 below, assuming points 1 and 3 to be fixed. Use E=70 GPa and A=200 mm^2. [16]

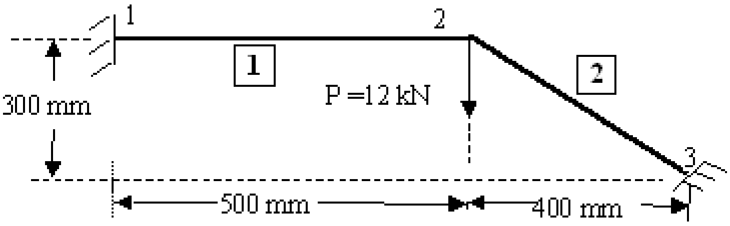

Figure 16:

7. Derive stiffness matrix of a beam element for bending in x-y plane. [16]

8. (a) If a rectangular plate is modeled by
   i. a rectangular element,
   ii. an assembly of two triangular elements and
   iii. an assembly of four triangular elements, what are the differences in the assembled stiffness matrix?

   (b) Which polynomials do you suggest for representing displacement field, for the following cases
   i. Constant strain 2-D axisymmetric triangular element
   ii. Linear strain 2-D plane stress quadrilateral element
   iii. Triangular plate bending element
   iv. Triangular thin shell element. [6+10]

⋆⋆⋆⋆⋆

Code No: RR412112 **Set No.4**

IV B.Tech. I Semester Regular Examinations, November -2005
APPROXIMATE METHODS IN STRUCTURAL MECHANICS
(Aeronautical Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks

⋆⋆⋆⋆⋆

1. Calculate by potential energy approach and RayleighRitz method and compare the displacements at node 2 of a fixed beam shown in Figure 17 below subjected to an axial load of 50kN at node 2. Take E = 200 GPa and A = 1200mm^2 for the bigger block made of steel and E = 70 GPa and A = 900mm^2 for the smaller block made of aluminium. [16]

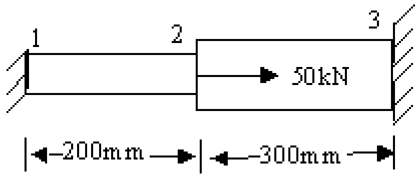

Figure 17:

2. (a) Give expression for the strain energy density, when a rod fixed at one end is subjected to
   i. bending moment 'M' and
   ii. torsional moment 'T' at its free end, one at a time
   (b) Calculate the reactions at the three supports of a continuous beam using Castiglianos theorem. Shown in Figure 18. [6+10]

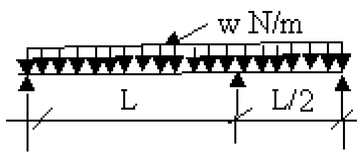

Figure 18:

3. Calculate period of longitudinal vibration of a mass of 50 kg, suspended from a 50cm long spring of stiffness 200 N/mm. If the spring length is halved, what is the period of vibration? If the two halves are again connected in series, what is the period of vibration? [16]

4. (a) Distinguish between least squares method and Galerkin method.

(b) Calculate the maximum deflection in a cantilever beam, subjected to udl of 'w' N/m, by least squares method and Galerkin method. Compare the result. Shown in figure 19

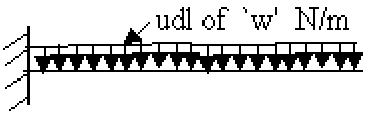

Figure 19:

5. Calculate deflection and slope at the free end of a cantilever beam of length 'L', with overhang of 'L/4 on either side, subjected to concentrated loads 'P' at the two free ends and at the center of the beam, by finite difference method. Shown in figure 20 [16]

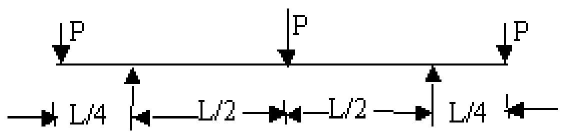

Figure 20:

6. For the three bar truss shown in figure 21 below, determine the displacements of node 'A' and the stresses in the three elements, assuming that the other three nodes are fixed. Take A=300 mm^2 ; E=200 GPa. [16]

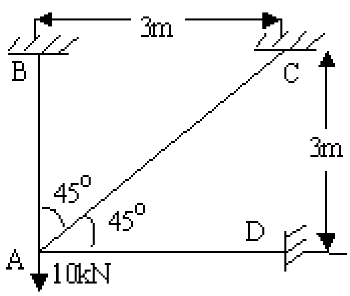

Figure 21:

7. (a) What is a 'Degree of freedom' ? Explain through the examples of a truss, beam, plane stress and axisymmetric elements.

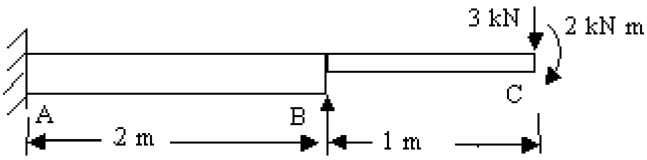

Figure 22:

(b) Calculate deflections at B and C and reactions at A and B of a stepped cantilever beam of length 3m. Assume E = 2x10^5 N/mm^2, I_{AB}=400mm^4 and I_{BC}=200mm^4. Shown in figure 22. [4+12]

8. (a) Explain with suitable examples different types of symmetry.

   (b) Explain differences between 2-D elements in plane strain and axi-symmetric cases with suitable examples. [8+8]

⋆ ⋆ ⋆ ⋆ ⋆