CODE NO: 07A7EC05 | R07 | SET - 1

IV B.TECH - I SEMESTER EXAMINATIONS - MAY, 2011
FINITE ELEMENT METHODS
(COMMON TO MECHANICAL ENGINEERRING, AUTOMOBILE ENGINEERING)

Time: 3hours — **Max. Marks: 80**

Answer any FIVE questions
All Questions Carry Equal Marks
- - -

1\. a) With the help of a neat diagram, describe the various components of stress and strains.
b) Derive the stress, strain relationship and strain displacement relationship. [8+8]

2\. For the three-stepped bar shown in Figure: 1 the bars fit snugly between the rigid walls at room temperature. The temperature is then raised by 40°C. Determine the displacement at 2 and 3 and stresses in the three sections. [16]

Aluminum: E = 70 GPa, A = 900 mm^2, $\alpha = 23 \times 10^{-6}$ / °C
Brass: E = 105 GPa, A = 400 mm^2, $\alpha = 19 \times 10^{-6}$ / °C
Steel: E = 200 GPa, A = 200 mm^2, $\alpha = 12 \times 10^{-6}$ / °C
Δ = 40°C

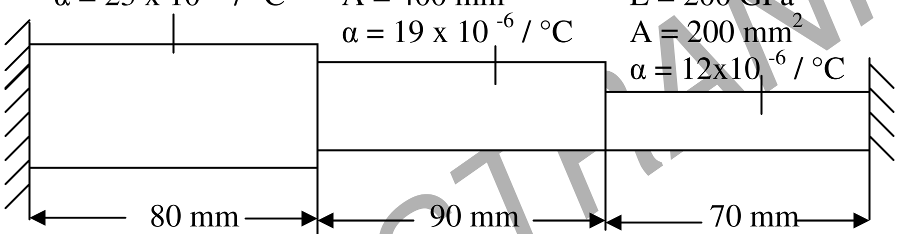

Figure: 1

3\. a) Explain about Local and global Co-ordinate system with element connectivity.
b) The nodal coordinates and its functional value of a triangular linear element is given below. Calculate the value at (20, 6). [8+8]

Node	**Co-ordinates**	**Value**
Node 1	(12,1)	180
Node 2	(25,6)	160
Node 3	(12,12)	185

4\. Explain the Finite element modeling of axisymmetric solids subjected to axisymmetric loading using triangular element and write the following: [16]
i) Relationship between strains and displacement.
ii) Element material matrix D.
iii) Jacobian Matrix.

5. For the two element plate shown in Figure: 2. Determine the B Matrices for the two elements. Determine the element stiffness, matrices if thickness t = 10mm, the material is aluminum with Young's Modulus E = 70 GPa, and Poisson's ratio, ν = 0.33. Assume Plane stress Condition. [16]

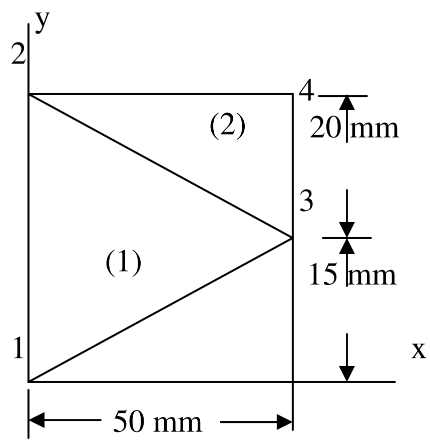

Figure: 2

6. Consider a cantilever beam with uniform distributed load as shown in Figure: 3. Estimate the deflection at the end of the beam. E = 100 GPa;A = 500 mm^2 , I= 2000 mm^4. [16]

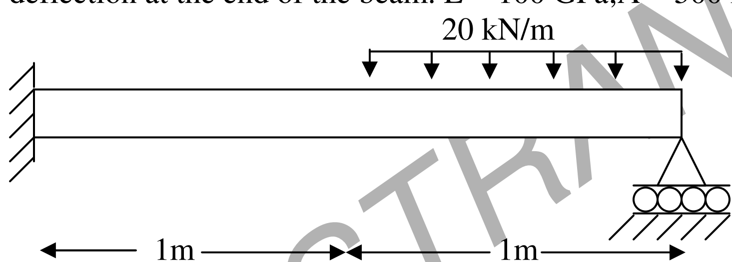

Figure: 3

7. Explain the following with examples.
   a) Lumped parameter model.
   b) Consistent mass matrix model. [8+8]

8. Consider the axial vibrations of a steel bar shown in the Figure: 4.
   a) Develop global stiffness and mass matrices,
   b) Determine the natural frequencies and mode shapes?
   Assume E = 3 x 10^5 N/mm^2, Density = 7250 kg / mm^3 [8+8]

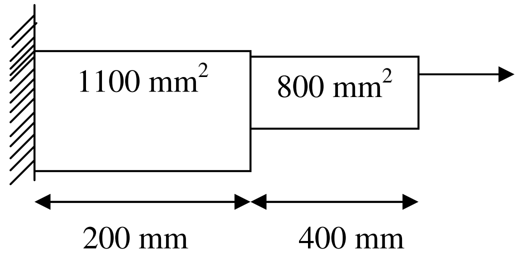

Figure: 4

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IV B.TECH - I SEMESTER EXAMINATIONS - MAY, 2011
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Time: 3hours **Max. Marks: 80**

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- - -

1. What are the basic steps involved in finite element analysis and explain them briefly with reference to static structural problems with example. [16]

2. Figure: 1 depicts an assembly of two bar elements made of different materials. Determine the nodal displacements, element stresses, and the reaction force.
E_1 = 220 GPa, E_2 = 150 GPa. [16]

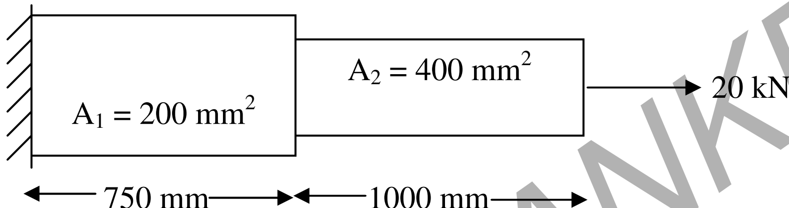

Figure: 1

3. a) Establish the Jacobian operator [J] of the two dimensional element shown in Figure: 2 also find the Jacobian Determinant.

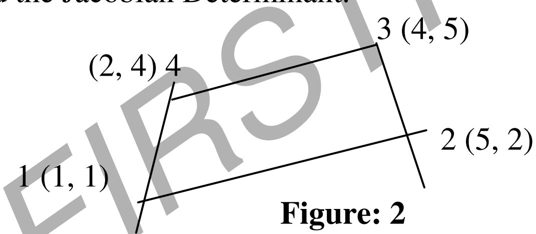

Figure: 2

b) Describe the procedure of obtaining stiffness matrix by properly choosing shape functions for CST element. [8+ 8]

4. Explain the Finite element modeling of axisymmetric solids subjected to axisymmetric loading using triangular element and also write the following
   - i) Relationship between stresses and strains.
   - ii) Element material matrix D.
   - iii) Strain displacement matrix [16]

5. Consider a cantilever beam with uniform distributed load as shown in Figure: 3. Estimate the deflection at the end of the beam. E = 200 GPa;A = 625 mm^2, I=1500 mm^4. [16]

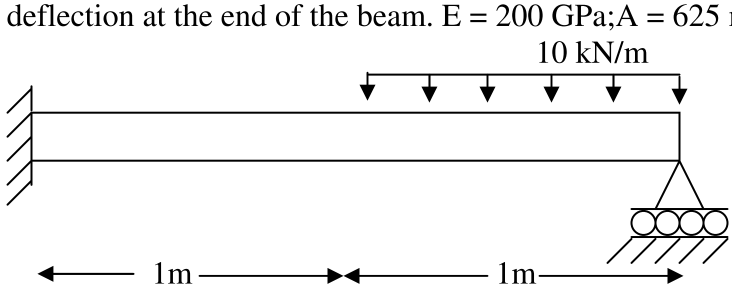

Figure: 3

6. a) With reference to one dimensional heat transfer problems derive dT / dX and Thermal conductivity matrix.
   b) Derive the elemental lumped and consistent mass matrices for 1-D bar element. [8+8]

7. One side of the brick wall of width 5 m, height 4 m and thickness 0.5 m is exposed to a temperature of – 25° C while the other surface is maintained at 32°C. If the thermal conductivity is 0.75 W/m K and the heat transfer coefficient on the colder side is 50 W/m^2 K. Determine
   a) The temperature distribution in the wall and
   b) Heat loss from the wall. [16]

8. Discuss the methodology to solve the Eigen value problem for the estimation of natural Frequencies of a stepped bar. [16]

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SET - 3

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1. With a suitable example, explain the physical interpretation of finite element method for one dimensional analysis. [16]

2. Find the strain – nodal displacement matrices B^e for the elements shown in figure: 1. Use local numbers given at the corners. [16]

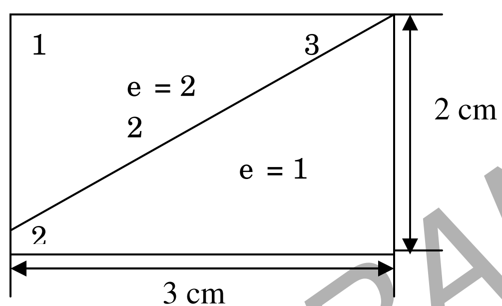

Figure: 1

3. The nodal Co-ordinates of the triangular element are shown in Figure: 2. At the interior point P, the X coordinate is 3.3 and $N_1 = 0.3$. Determine N_2, N_3 and the Y coordinate at point 'P'. [16]

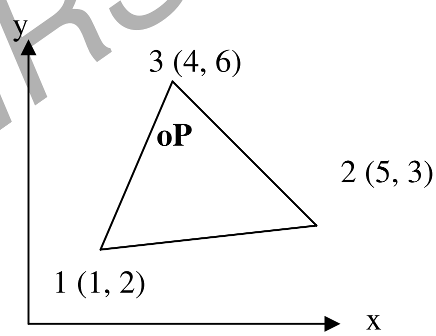

Figure: 2

4. Find the deflections and support reactions for the beam shown in Figure: 3. Take E = 200 GPa. [16]

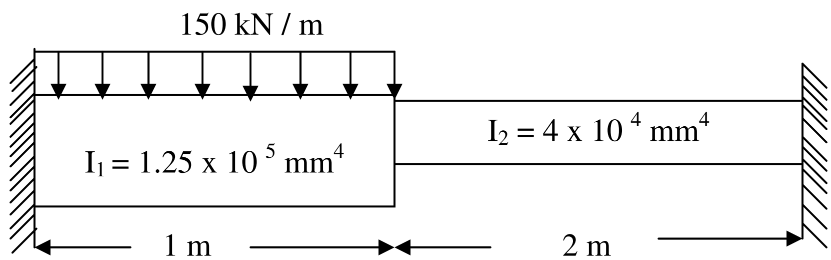

Figure: 3

5. Explain the Finite element modeling of axisymmetric solids subjected to axisymmetric loading using triangular element and also write the following
   i) Relationship between stresses and strains.
   ii) Element material matrix D.
   iii) Strain displacement matrix. [16]

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

7. Explain in detail how the element stiffness matrix and load vector are evaluated in isoparametric formulations. [16]

8. Consider the axial vibrations of a steel bar shown in the Figure: 4.
   a) Develop global stiffness and mass matrices,
   b) Determine the natural frequencies and mode shapes?
   Assume E = 2 x 10^5 N/mm^2, Density = 7200 kg / mm^3. [8+8]

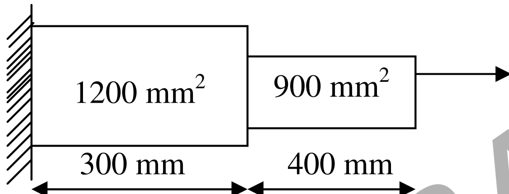

Figure: 4

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FINITE ELEMENT METHODS
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Time: 3hours **Max. Marks: 80**

Answer any FIVE questions
All Questions Carry Equal Marks
- - -

1. a) If a displacement field is described by
$u = 2x^2+2y^2+6xy$
$v = 3x+6y-2y^2$.
Determine ε_x, ε_y, γ_{xy} at the point x = -1, y = 0.
b) A long rod is subjected to loading and a temperature increase of 600° C. The total strain at a point is measured to be $4x10^{-6}$. If E = 300 Gpa and $\alpha = 12x10^{-6}$ per °C.
Determine i) Stress at the point ii) Initial strain. [8+8]

2. Find the Displacement at the free end and the Element stresses for the following problem given in figure 1, Assume $E = 2 \times 10^5$ N / mm^2. [16]

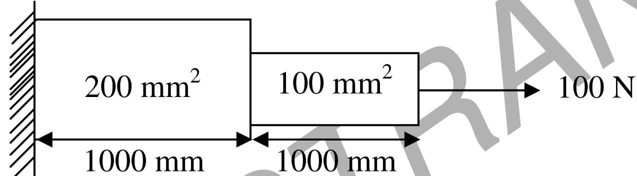

Fig: 1

3. a) What is a constant strain triangular element? State its properties and applications.
b) The nodal coordinates of the triangular element are shown in Figure: 2. At the interior Point P, the X co-ordinate is 2.6 and N_1 =0.4. Find N2, N_3 and the Y coordinate at Point P. [8+8]

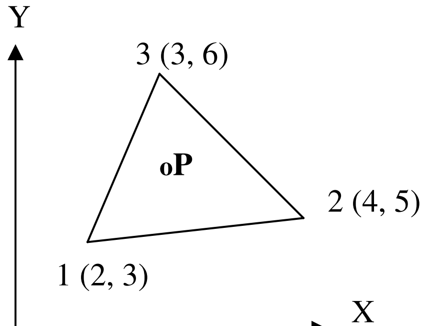

Fig: 2

4. Derive the elemental stiffness matrix and load vector for two noded beam element? [16]

5. Explain the Finite element modeling of axisymmetric solids subjected to axisymmetric using triangular element and write the following
i) Relationship between strains and displacement.
ii) Element material matrix D.
iii) Jacobian Matrix. [16]

6. Write the following :
   a) 2D four noded iso-parametric master element.
   b) Finite element modeling of conduction-convection systems. [8+8]

7. Derive the element conductivity matrix and load vector for solving 1-D heat conduction Problems, if one of the surfaces is exposed to a heat transfer coefficient of h and ambient Temperature of T_∞? [16]

8. Evaluate the eigen values, eigen vectors and natural frequencies of a beam of cross section 360 cm^2 of length 600 mm. Assume young's modulus as 200 GPa, density 7850 kg/m^3 and Moment of Inertia of 3000 mm^4. Make into two elements of 300 mm length each. [16]

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