Code No:**R31031** **R10** **Set No. 1**

III B.Tech I SemesterSupplementary Examinations, June - 2015

FINITE ELEMENT METHODS

(Common to Mechanical Engineering and Automobile Engineering)

Time: 3 hours **Max. Marks:75**

Answer any FIVE Questions
All Questions carry equal marks
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1 a) What is the difference between the plane stress and plane strain condition? [8]
b) Using the stress-equilibrium equations, derive the governing differential equation for a prismatic bar subjected to body load only. [7]

2 a) What is the importance of natural coordinate system in the formulation of the finite element equations? Obtain the interpolation functions for a two noded axial element using local coordinate system, global coordinate system and natural coordinate system [9]
b) Discuss the effect of element shape and size on the convergence of the finite element solution. [6]

3 How many DOFs does a two-nodal, planar truss element have in its local coordinatesystem, and in the global coordinate system? Why is there a difference in DOFs inthese two coordinate systems? [15]

4 a) What are essential and natural boundary conditions for a beam element? [8]
b) Calculate the deflection at the centre and slopes at the ends of a simply supported beam of 2 m length subjected to a Uniformly Distributed Load (UDL) of 50 kN/m throughout the length. Take EI = 700 Nmm^2. [7]

5 The (x, y) co-ordinates of nodes of a triangle element are given by (0, 0), (3, 0) and (0, 3) mm respectively. Evaluate the shape functions at an interior point P (1, 1) mm. What is the Jacobian matrix at this point? Also obtain the strain displacement relation for the same triangular element. [15]

6 a) Derive the shape functions for 8-noded serendipity element using the natural coordinate system. Check the properties of the shape functions. [8]
b) Using the gauss quadrature method evaluate the following integral and compare the results with the exact solution. $\int_{-1}^{1}(6x+x^2)dx$ [7]

7 Determine the temperature distribution for the component assembly shown in figure 1. There is no heat loss at the interface.Outside diameter = 60 mm for both members, heat flux q_{in} = 4000 W/m^2. Also find the temperature gradient in both the members. [15]

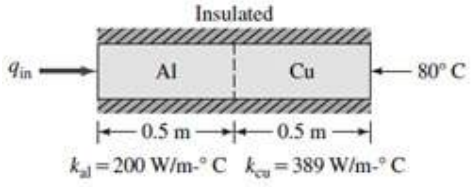

Figure 1

8 a) Find the first two natural frequencies of a cantilever beam using one element model. [8]
b) Differentiate between the transient dynamic analysis and eigenvalue analysis. [7]

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Code No:**R31031** **R10** **Set No. 2**

III B.Tech I Semester Supplementary Examinations, June - 2015

FINITE ELEMENT METHODS

(Common to Mechanical Engineering and Automobile Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

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1 a) Derive the constitutive relation for the plane strain condition. [8]

b) Use the minimum potential energy principle to determine the force F_3 required for the displacement of δ for the spring system in figure 1 [7]

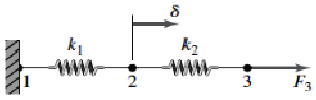

Figure 1

2 a) Derive the shape functions for a two noded axial element using natural coordinate system. Present these shape functions graphically [6]

b) Define the band width of a global stiffness matrix. Explain the various parameters that affect the band width. [6]

c) A one dimensional prismatic bar is divided into 5 elements each element with two nodes. What is the node numbering scheme for minimum band width? [3]

3 What are the characteristics of the joints in a truss structure and what are the effects of this on the deformation and stress properties in a truss element? [15]

4 Find the deflections and support reactions for the beam shown in Figure 2. Take E = 200 GPa. [15]

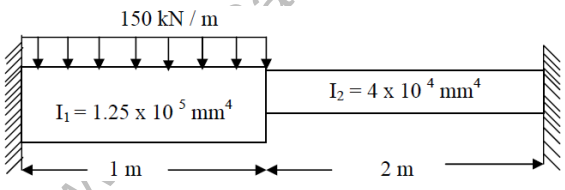

Figure 2

5 a) The (x, y) co-ordinates of nodes of a triangle element in a domain are given by A (0, 0), B (30, 0) and C (0, 30) mm respectively. The edge BC is acted upon by a uniform pressure of 2 MPa throughout its length. Determine the force vector for the element if the thickness of the element is 5 mm. [8]

b) Present the strain displacement relation an axisymmetric solid and explain the terms involved in it. [7]

6 Derive the weights and sampling points for a two point Gauss quadrature rule and evaluate the following integral using the same. Compare the result with the exact value. [15]

$$\int_0^2 (x^2 + 3x + 5)dx$$

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7 The solution for temperature distribution in a trianglegives the nodaltemperature as T_A = 200^0C, T_B = 180^0C and T_C = 160^0C. The coordinates of the nodal points are A(20mm, 20 mm), B(60mm, 40 mm) and C (40mm, 60 mm). Calculate thetemperature at a location given by point P (30mm, 40 mm). Calculate the coordinates ofthe isotherm corresponding to 170^0C. Calculate the heat flux in the x and y directions ifthe thermal conductivity is 0.5 W/m^{0}C. [15]

8 a) Explain the Hamilton principle and Lagrangian function. [5]
b) Present the general form of finite element equation for the eigen value analysis and how it is different from the static analysis. [5]
c) Discuss the various methods to obtain the eigen values and their corresponding eigen vectors. [5]

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Code No:**R31031** **R10** **Set No. 3**

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FINITE ELEMENT METHODS

(Common to Mechanical Engineering and Automobile Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

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1 a) Differentiate between the weighted residual methods and the variational methods [6]

b) Find the approximate solution to the following boundary value problem by using Galerkin method. Compare the solution with the exact solution. [9]

$$\frac{d^2u}{dx^2} = x \quad 0 < x < 1; \quad u(0) = 0 \quad and \quad u(1) = 0$$

2 a) Define the shape function? What are the properties of the shape functions? [5]

b) Explain the considerations to be taken into account while selecting the order of the interpolation polynomial [6]

c) What are the conditions for the constant field variable within the element? [4]

3 The plane truss shown in Figure-1 is composed of members having a square 15 mm × 15 mm cross section and modulus of elasticity E = 69 GPa. [15]

(**a**) Assemble the global stiffness matrix.

(**b**) Compute the nodal displacements in the global coordinate system.

(**c**) Compute the axial stress in each element

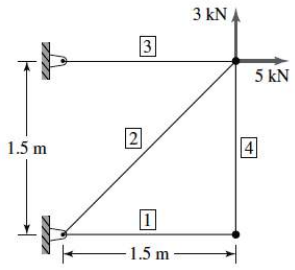

Figure-1

4 Consider a cantilever beam with uniform distributed load as shown in Figure 2. Estimatethe deflection at the end of the beam. Consider cross sectional area, and moment of inertia of the beam are A = 625 mm^2, I=1500 mm^4. The Young's modulus is taken as 200GPa [15]

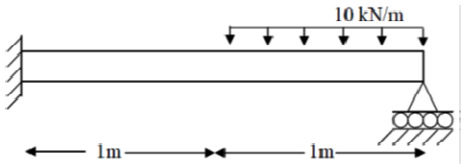

Figure-2

5 Establish the relation between the area coordinate system and natural coordinate system for a Constant Strain Triangle element. [15]

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6 a) Differentiate between the sub-parametric, iso-parametric and super-parametric formulation. [7]

b) Use two point Gaussian quadrature to obtain an exact value for the integral [8]

$$I = \int_{-1}^{1}\int_{-1}^{1} (r^3 - 1)(s-1)^2 \, dr ds$$

7 Calculate the surface temperature in a circular solid cylinder of radius 25 mm with a volumetric heat generation of 50 MW/m^3. The external surface of the cylinder is exposed to a liquid at a temperature of 20 ^{0}C with a surface heat transfer coefficient of 4000 W/m^{20}C. The thermal conductivity of the material is 20 W/m ^{0}C. Use three one dimensional elements to solve the problem. [15]

8 Define and distinguish between the lumped and consistent mass formulations. [15]
Use both the methods to derive the mass matrices for a three noded axial element.

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Code No:**R31031** **R10** **Set No. 4**

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FINITE ELEMENT METHODS

(Common to Mechanical Engineering and Automobile Engineering)

Time: 3 hours **Max. Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

*****

1 a) Define the minimum potential energy principle. Write the expression for a two dimensional elasticity problems and explain the terms involved in it. [8]

b) The functional form of a bar clamped at one end and left free at the other end and subjected to uniform axial load q is given by [7]

$$I = \int_0^L \left[\frac{1}{2} AE \left(\frac{du}{dx} \right)^2 - qu \right] dx$$

Obtain the approximate solution to the problem by using Rayleigh-Ritz method.

2 a) What are the convergence and compatibility requirements? Discuss in detail [7]

b) Derive the relationship between the area coordinates and Cartesian coordinates of a triangular element. [8]

3 a) The three member plane truss is shown in Figure 1. The cross sectional area of each member is 0.1 m^2 and modulus of elasticity E = 69 GPa. Determine [15]
(i) The global stiffness matrix.
(ii) The nodal displacements in the global coordinate system.
(iii) the axial stress in each element

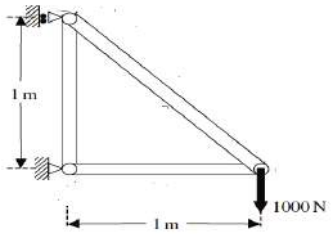

Figure 1

4 a) Derive Hermite shape functions and also discuss its properties. [7]

b) Obtain the finite element equations for a beam element using the Hermite shape functions. [8]

5 A long cylinder is subjected to an external pressure of 5 MPa and fitted to a shaft diameter of 100 mm. The outside diameter of the cylinder is 150 mm. Formulate the element matrices for the cylinder using two axisymmetric elements by taking Young's modulus as 200 GPa and Poisson's ratio as 0.25. Also find the nodal displacements [15]

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6 a) The vertices of a quadrilateral element are (0,0), (20,0), (20,30) and (0,30). All the dimensions are in mm only. Determine the area of the quadrilateral by using 2 point gauss quadrature method. [7]

b) Explain the procedure to evaluate the shape functions using Lagrangian method and apply this method to obtain the shape functions for a 4–noded one dimensional element. [8]

7 A circular fin of inner diameter 200 mm and outer diameter of 300 mm transfers heat from a small motorcycle engine. If the average engine surface temperature is 200^0C, determine the temperature distribution along the fin surface. The thermal conductivity of the fin material is 20 W/m ^{0}C and the convective heat transfer coefficient between the fin and the atmosphere is 120W/m^2 ^{0}C. Assume an atmospheric temperature of 30^0C. Use at least three one dimensional elements. [15]

8 Calculate natural frequencies and mode shapes of the stepped bar shown in figure 2. Consider Young's modulus as 200 GPa and density as 7200 kg/m^3. [15]

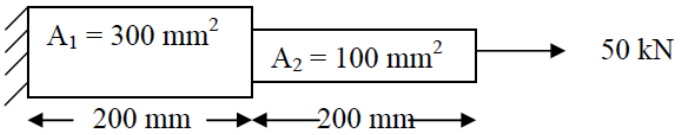

Figure 2

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