www.firstranker.com

Code.No: 07A51402 | R07 | SET-1

III B.TECH – I SEM EXAMINATIONS, NOVEMBER - 2010
FINITE ELEMENT METHODS
(MECHANICAL ENGINEERING)
(MECHATRONICS)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) Explain the basic concept of FEM and list some of its advantages and applications.
b) Derive the equilibrium equation in Cartesian coordinates. [6+10]

2.a) Derive the finite element equation using the potential energy approach.
b) Derive the stiffness matrix for a bar element with one degrees of freedom at each node from basics. [8+8]

3.a) Derive the strain displacement matrix for a 2D beam element.
b) Determine the deflection and slope under the point load for the beam shown in fig. 1. E = 210GPa; $I = 4\times 10^{-6}$ m^4. [8+8]

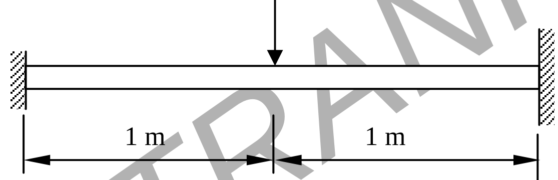

Fig. 1

4.a) Formulate the material property matrix [D] for a triangular element with E = 80 GPa and ν = 0.20 using plane stress and plane strain conditions.
b) Formulate the finite element equations for constant strain triangle element shown in fig.2. using plane stress assumption. [6+10]
E = 200 GPa; ν = 0.20; Thickness = 4 mm.

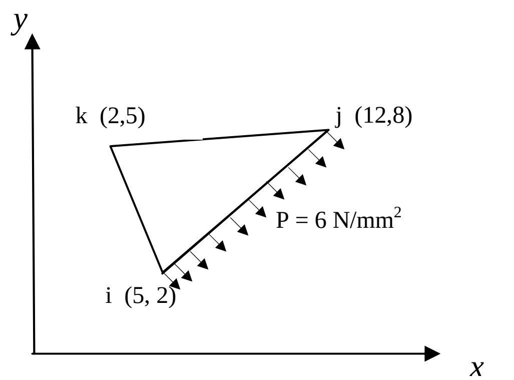

Fig. 2

5. Derive the strain displacement matrix for an axisymmetric problem. [16]

6.a) Explain in detail the applications of isoparametric elements in two and three dimensional stress analysis.
b) Using Gaussian quadrature evaluate the following integral $\int_{-1}^{+1}(4\xi+\xi^3)d\xi$. [8+8]

FIRSTRANKER

www.firstranker.com

www.firstranker.com

7. Calculate the conductance matrix [$K^{(e)}$] and load vector {$F^{(e)}$} for the triangle element shown in fig.4 . The thermal conductivities are $k_x = k_y = 6$ W/cm-°C and h = 0.4 W/cm^2 °C. Thickness of the element is 0.5 cm. All coordinates are given in cms. Convection occurs on the side joining modes *i* and *j*. [16]

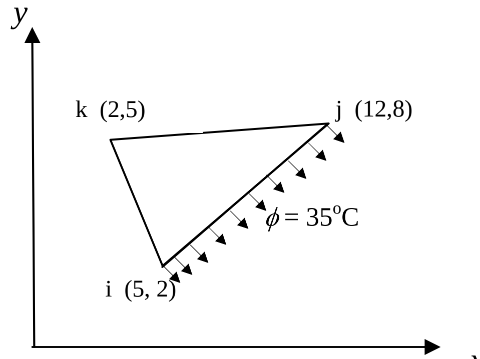

Fig. 4

8. Obtain the eigen values and eigen vectors for the cantilever beam of length 1m using consistant mass for translation dof with E = 210GPa, ρ = 7800kg/m^3. [16]

--ooOoo--

FIRSTRANKER

www.firstranker.com

www.firstranker.com

Code.No: 07A51402 | R07 | SET-2

III B.TECH – I SEM EXAMINATIONS, NOVEMBER - 2010
FINITE ELEMENT METHODS
(MECHANICAL ENGINEERING)
(MECHATRONICS)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) What is the necessity of compatibility equations? Write the compatibility equations in Cartesian coordinates.

b) Consider the following state of stress and strain:

$\sigma_{xx} = x^2, \quad \sigma_{yy} = y^2, \ \varepsilon_{xy} = -3xy, \ \sigma_{zz} = \varepsilon_{xz} = \varepsilon_{yz} = 0$

Determine whether the equilibrium equations are satisfied. [6+10]

2.a) Explain the different approaches for the treatment of boundary conditions in Finite Element Analysis.

b) Determine nodal displacements, element stresses in the bar shown in fig.1. [6+10]

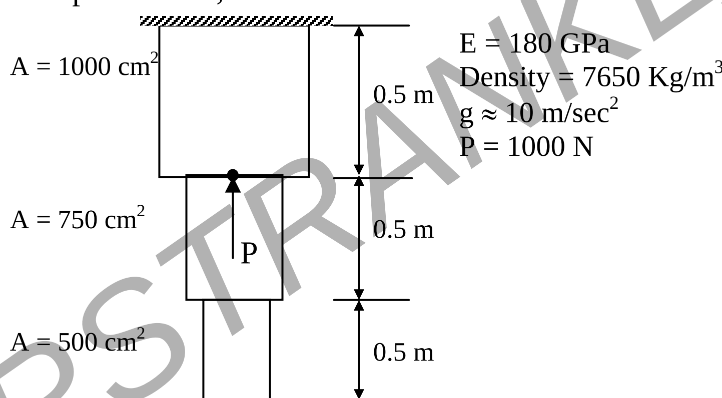

Fig. 1

3.a) Formulate global stiffness matrix and global load vector for the beam shown in fig.2

b) State the boundary conditions. [16]

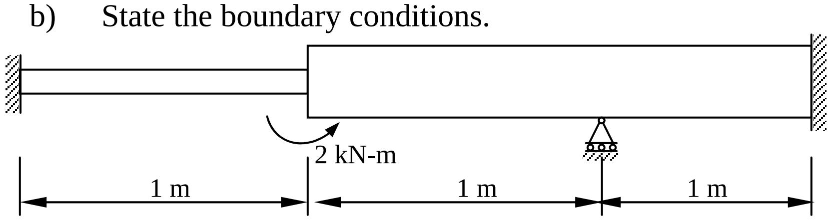

Fig. 2

FIRSTRANKER

www.firstranker.com

4.a) Explain about constant strain triangle element. What are the limitations in using CST element.

b) For the triangular element shown in fig.3, obtain the shape functions at point P (2, 2) within the element.

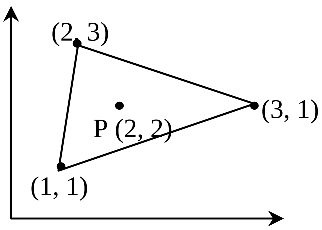

Fig. 3

c) Derive the Jacobian matrix for a 3 noded triangular element. [4+6+6]

5.a) Differentiate between strain matrix for a plane strain problem and axisymmetric problem.

b) The calculated displacements for an axisymmetric element with E = 110GPa and ν = 0.20 are given below:
u_i=0.01; u_j = 0.04; u_k = 0.02; w_i = -0.02; w_j = 0 and w_k= 0.02
The nodal coordinates in mm :
r_i = 5; r_j = 1; r_k= 3; z_i = 5; z_j = 5 and z_k= 2
Calculate the resultant element stresses at the centroid of the element. [6+10]

6. The coordinates of each node of a four-node quadrilateral element are 1(3, 1); 2(4, 1); 3(5, 5) and 4(2, 4). The displacement vector of the element is given as
$\{q\} = \{0.20 \;\; 0 \;\; 0.10 \;\; 0 \;\; 0.12 \;\; 0.15 \;\; 0 \;\; 0.06\}^T$
Find
i) The x, y coordinates of a point whose location in the master element is given by ξ= 0.2 and η = 0.4
ii) The *u*, *v* displacement of point P
iii) The Jacobian [J] at ξ= η = 0.4. [16]

7. Find the temperature distribution in the one dimensional fin shown in fig. 4. [16]

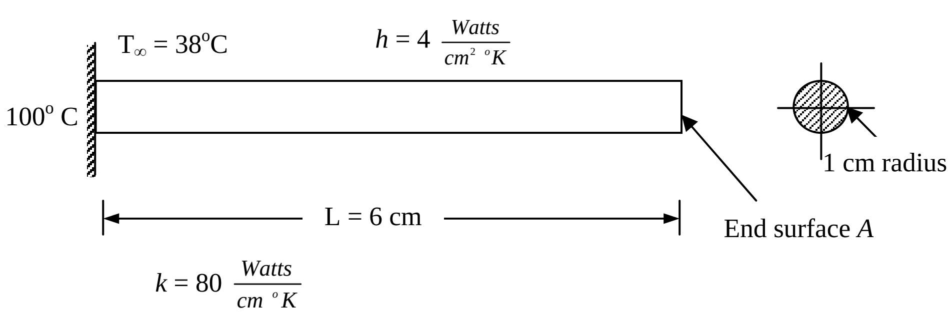

Fig. 4

8. Find the approximate first two natural frequencies of a simply supported beam using one element. [16]

--ooOoo--

FIRSTRANKER

www.firstranker.com

Code.No: 07A51402

R07

SET-3

III B.TECH – I SEM EXAMINATIONS, NOVEMBER - 2010
FINITE ELEMENT METHODS
(MECHANICAL ENGINEERING)
(MECHATRONICS)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) If displacement field is described by
$u = (3x^2 + y^2 + 2xy)\ 10^{-4}$, $v = (4x - 6y^2 + 4y)\ 10^{-4}$
Determine the value of ε_x, ε_y and γ_{xy} at the point (x, y) = (1.2, 1.6).

b) Consider the following state of stress and strain:
$\sigma_{xx} = x^2$, $\sigma_{yy} = y^2$, $\varepsilon_{xy} = -3xy$, $\sigma_{zz} = \varepsilon_{xz} = \varepsilon_{yz} = 0$
Determine whether the compatibility equations are satisfied. [6+10]

2.a) Calculate the element load vector due to uniform temperature change $\Delta T = 110^o$ C, for a one dimensional linear element with the following data:
E = 180 Gpa, a = 300 mm^2 and $\alpha = 8 \times 10^{-6}$ per ^{o}C.

b) Derive the shape function for a 1-D quadratic element in terms of global and natural coordinates. [6+10]

3. For the beam shown in fig. 1, determine the beam deflection and member end loads. [16]

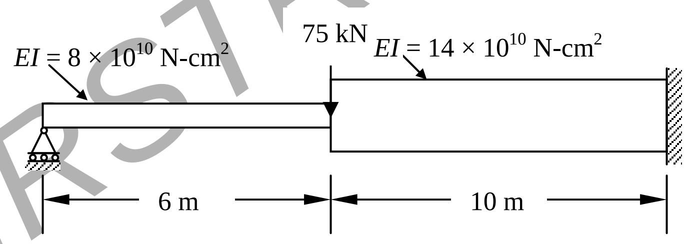

Fig. 1

4.a) Calculate the jacobian matrix for a triangular element with nodal coordinates as (1, 1), (6, 4) and (3, 5).

b) Calculate the element stresses for the element shown in fig. 2 for plane stress condition when nodal displacements are as given below:
$q_1 = 0$, $q_2 = 0$, $q_3 = 0.001$mm, $q_4 = 0.002$mm, $q_5 = -0.003$mm and $q_6 = 0.002$mm
E = 200GPa, ν=0.25, thickness = 20mm. [6+10]

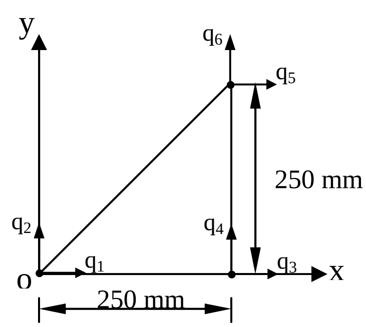

Fig.2

www.firstranker.com

FIRSTRANKER

www.firstranker.com

5.a) Derive the material property matrix for a axisymmetric element.

b) Formulate element equations for the axisymmetric element shown in fig.3. [6+10]

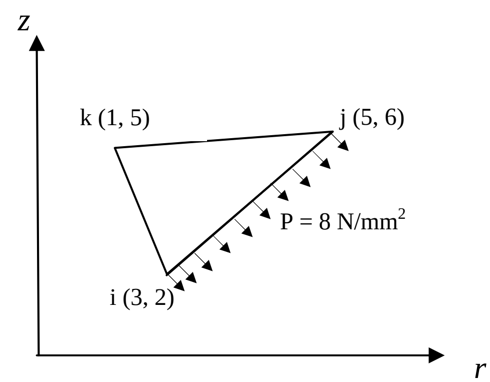

Fig. 3

6.a) Evaluate the integral $\int_{-1}^{+1}(6\xi^3 + 3\xi^2)d\xi$ using two point Gaussian quadrature methods.

b) In a quadrilateral element, the nodal coordinates in cm are given below:
$x_1 = 6$; $x_2 = 2$; $x_3 = 3$; $x_4 = 9$
$y_1 = 8$; $y_2 = 5$; $y_3 = 2$; $y_4 = 5$
Determine the global coordinates corresponding to $\xi = -1.0$ $\eta = 0.75$ on the parent element. [6+10]

7. For the composite wall shown in fig. 4. Determine the temperature distribution. [16]

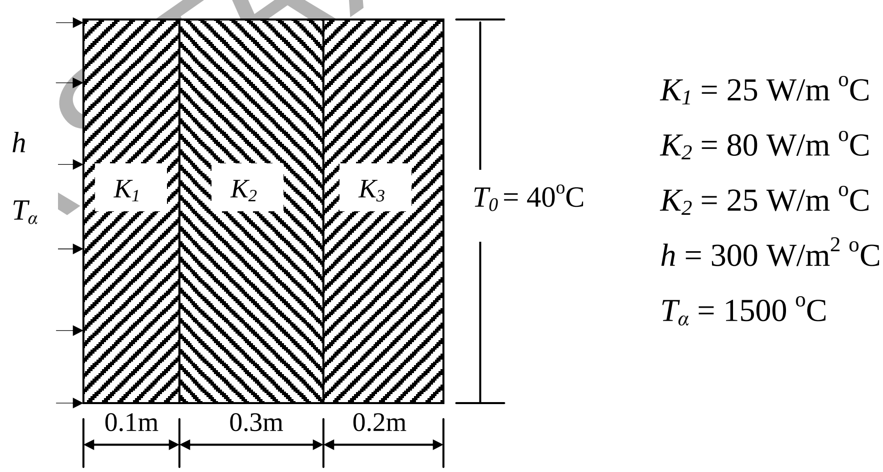

Fig. 4

8.a) State the method used for obtaining natural frequencies and corresponding eigen vectors.

b) Determine the natural frequencies of a cantilever beam shown in shown in Fig. 5. using 2 beam elements with consistent mass matrix. [6+10]

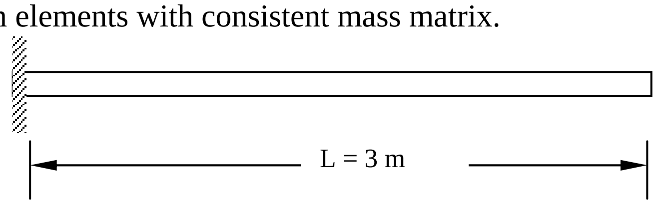

Fig. 5

--ooOoo--

FIRSTRANKER

www.firstranker.com

www.firstranker.com

Code.No: 07A51402

R07

SET-4

III B.TECH – I SEM EXAMINATIONS, NOVEMBER - 2010
FINITE ELEMENT METHODS
(MECHANICAL ENGINEERING)
(MECHATRONICS)

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

Answer any FIVE questions
All questions carry equal marks
- - -

1.a) Explain the various steps involved in solving a problem using finite element method.
b) Determine whether the following state of strain is physically realizable:

$$\varepsilon_{xx} = c(x^2 + y^2), \quad \varepsilon_{yy} = cy^2, \; \varepsilon_{xy} = 3cxy, \; \varepsilon_{zz} = \varepsilon_{xz} = \varepsilon_{yz} = 0.$$ [6+10]

2. For the two stepped bar shown in fig. 1, which is at room temperature is fixed at one end and a rigid wall at the other end. The temperature is then raised by 50^o C. Determine the displacements at nodes 2 and 3, stresses in the two sections. [16]

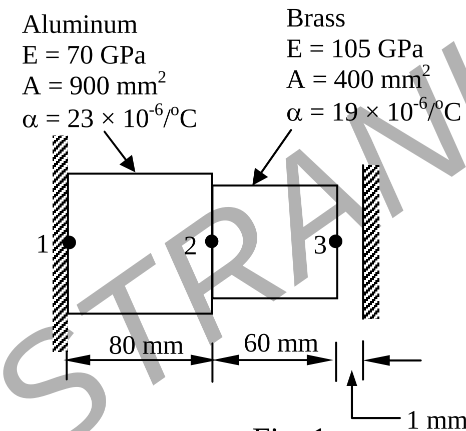

Fig. 1

3.a) Distinguish between essential and natural boundary conditions in beam problems.
b) Find the nodal displacements and slope at the mid-point of element (2) of the shaft shown in fig.2. The shaft is assumed to be supported in bearings regarded as fixed support at A and B. $E = 210$ GPa; $I = 4 \times 10^6$ N-m^2. [6+10]

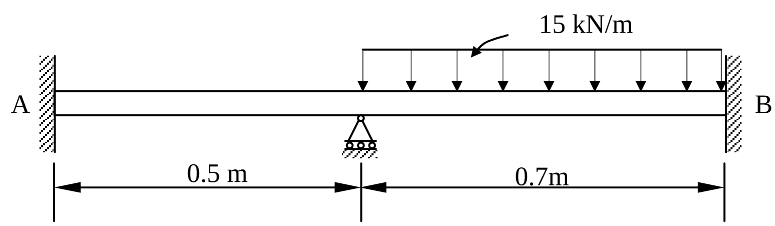

Fig. 2

FIRSTRANKER

www.firstranker.com

www.firstranker.com

4. For the two-dimensional loaded plate shown in fig. 3 determine the displacements of nodes 1 and 2 and the element stresses using plane stress condition. [16]

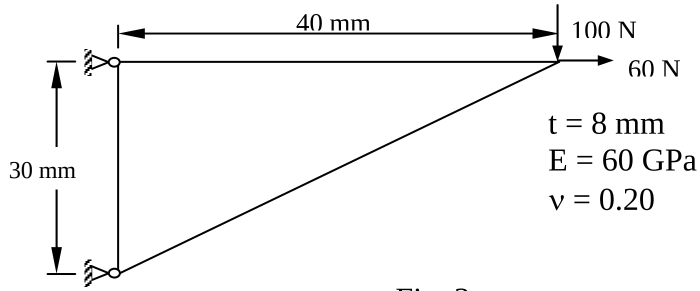

Fig. 3

5. A long cylinder with outside diameter 140mm is fitted on to a shaft of outside diameter of 100 mm. The cylinder is raised to a temperature of 60°C. Using two elements of 20 mm length, formulate the element matrices for the cylinder taking E = 210 GPa; ν = 0.25 and $\alpha = 5\times 10^{-6}$ per °C. Also find nodal displacements. [16]

6. For the quadratic, isoprametric triangular element shown in fig. 4 map the point ξ= 0.4 and η = 0.3 on the parent element to the corresponding point on the distorted element. [16]

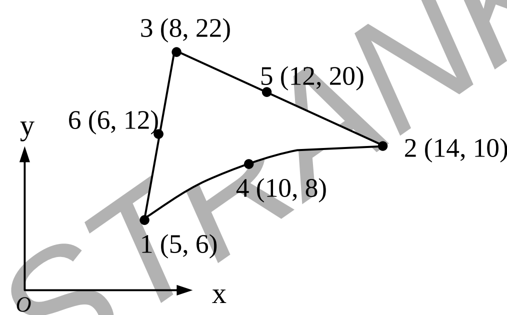

Fig. 4

7.a) What are essential and natural boundary conditions in steady state heat transfer problems.

b) Formulate the finite element equations for triangular torsion element shown in fig.5 [6+10]

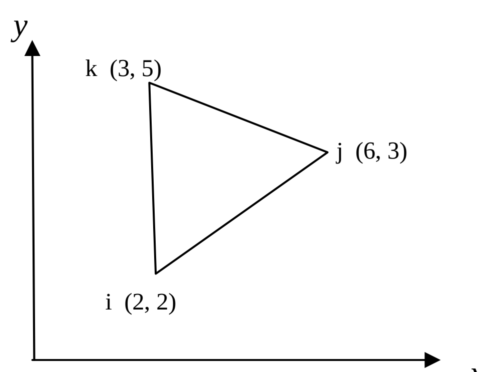

Fig. 5

FIRSTRANKER

www.firstranker.com

8.a) Derive the consistent mass matrix and lumped mass matrices for a one dimensional bar element.

b) Consider the eigen value problem where

$$[K] = \begin{bmatrix} 6 & -1 & 4 \\ -3 & 8 & -2 \\ 4 & -2 & 6 \end{bmatrix}; \qquad [M] = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 4 & 0 \\ 0 & 0 & 6 \end{bmatrix}$$

Compute the eigen values and eigen vectors. [8+8]

--ooOoo--

FIRSTRANKER