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06ME63

Sixth Semester B.E. Degree Examination, June-July 2009
Modeling and Finite Element Analysis

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Explain the principle of minimum potential energy and principle of virtual work. **(06 Marks)**

b. Evaluate the integral $I = \int_{-1}^{+1}(3\xi^3 + 2\xi^2 + \xi + 2)d\xi$ by using 2 point and 3 point Gauss quadrature. **(06 Marks)**

c. Solve the following system of simultaneous equations by Gauss Elimination method:
$x_1 - 2x_2 + 6x_3 = 0$
$2x_1 + 2x_2 + 3x_3 = 3$
$-x_1 + 3x_2 = 0$ **(08 Marks)**

2 a. Explain briefly about node location system. **(06 Marks)**
b. Explain preprocessing and preprocessing in FEM. **(06 Marks)**
c. Explain the basic steps involved in FEM. **(08 Marks)**

3 a. What are the considerations for choosing the order of polynomial functions? **(06 Marks)**
b. Explain convergence requirements of a polynomial displacement model. **(06 Marks)**
c. Derive the linear interpolation polynomial in terms of natural co-ordinate for 2-D triangular elements. **(08 Marks)**

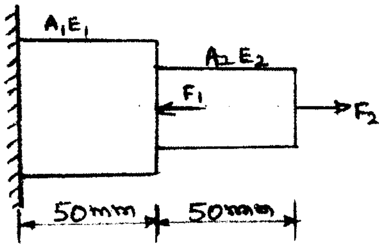
4 a. What are Hermite shape functions of beam element? **(06 Marks)**
b. Derive the shape function for a quadratic bar element using Lagrangian method. **(06 Marks)**
c. Derive the shape function for a nine noded quadrilateral element. **(08 Marks)**

PART – B

5 a. Derive the element stiffness matrix for truss element. **(10 Marks)**
b. Derive the Jacobian matrix for 2D triangular element. **(10 Marks)**

6 a. Explain the types of boundary conditions in heat transfer problems. **(10 Marks)**
b. Discuss the Galerkin approach for 1-D heat conduction problem. **(10 Marks)**

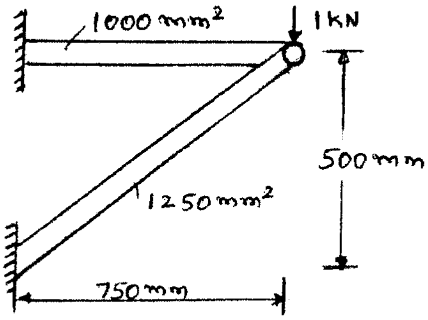
7 a. Using the direct stiffness method, determine the nodal displacements of stepped bar shown in figure Q7 (a). **(10 Marks)**



$E_1 = 200$ GPa
$E_2 = 70$ GPa
$A_1 = 150\ mm^2$
$A_2 = 100\ mm^2$
$F_1 = 10$ kW
$F_2 = 5$ kW

Fig. Q7 (a)

7 b. For the truss shown in figure Q7 (b), find the assembled stiffness matrix. **(10 Marks)**



$E_1 = E_2 = 200$ GPa

Fig. Q7 (b)

8 a. Determine the temperature distribution through the composite wall subjected to convection heat loss on the right side surface with convective heat transfer coefficient shown if figure Q8 (a). The ambient temperature is -5°C. **(10 Marks)**

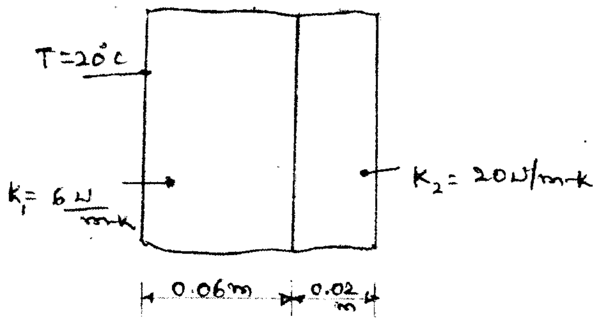
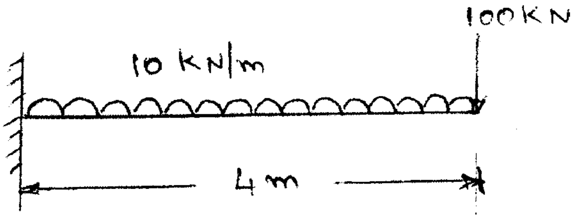


Fig. Q8 (a)

b. Determine the maximum deflection in the uniform cross section of Cantilever beam shown in figure Q8 (b) by assuming the beam as a single element. **(10 Marks)**



$E = 7\times10^9\ N/m^2$

$I = 4\times10^{-4}\ m^4$

Fig. Q8 (b)

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Sixth Semester B.E. Degree Examination, May/June 2010

Modeling and Finite Element Analysis

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO from each part.***

PART - A

1 a. Using Rayleigh Ritz method, find the maximum deflection of a simply supported beam with point load at center. **(10 Marks)**

b. Solve the following system of simultaneous equations by Gaussian elimination method.

$4x_1 + 2x_2 + 3x_3 = 4$

$2x_1 + 3x_2 - 5x_3 = 2$

$2x_1 + 7x_2 = 4$ **(10 Marks)**

2 a. Explain the descretization process. Sketch the different types of elements 1D, 2D, 3D elements used in the finite element analysis. **(06 Marks)**

b. Considering for element, obtain the element stiffness matrix by direct stiffness approach. Comment on its characteristics. **(09 Marks)**

c. Define a shape function. What are the properties that the shape function should satisfy? **(05 Marks)**

3 a. Explain the convergence criteria with suitable examples and compatibility requirements in FEM. **(08 Marks)**

b. Explain simplex, complex and multiplex elements using element shapes. **(06 Marks)**

c. Explain linear interpolation, polynomials in terms of global coordinates for one dimensional simplex element. **(06 Marks)**

4 a. Explain the concept of isoparametric, sub parametric and super parametric elements and their uses. **(06 Marks)**

b. Derive the shape functions for a CST element and also the displacement matrix. **(08 Marks)**

c. Derive the Hermite shape functions for a beam element. **(06 Marks)**

PART - B

5 a. Find the shape functions at point P for the CST element shown in fig. Q5(a). Also find the area and Jacobian matrix for the element. **(10 Marks)**

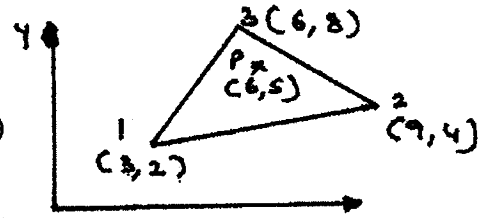


Fig.Q5(a)

b. Derive the stiffness matrix for a 2 – dimensional truss element. **(10 Marks)**

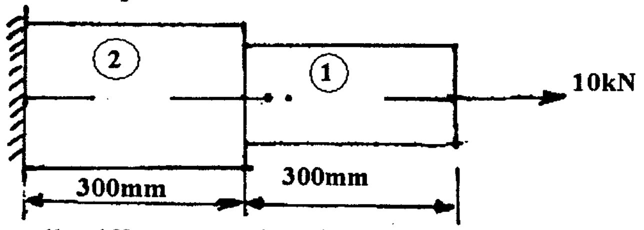
6 a. Discuss the various steps involved in the finite element analysis of a one dimensional heat transfer problem with reference to a straight uniform fin. **(10 Marks)**

b. Explain the finite element modeling and shape functions for linear interpolation of temperature field (one – dimensional heat transfer element). **(10 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

7 a. Determine the nodal displacement and stresses in the element shown in fig. Q7(a). **(10 Marks)**

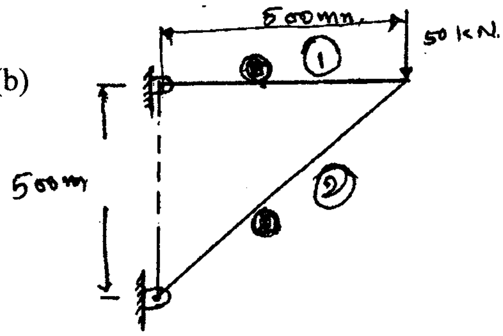
Fig.Q7(a)



$A_1 = 500\ mm^2$
$A_2 = 2000 mm^2$
$E_1 = 100$ GPa
$E_2 = 200$ GPa

b. Obtain the overall stiffness matrix of the truss elements shown in fig. Q7(b). All the elements have an area of $200 mm^2$ and elements (1) and (2) are 500mm long. E = 200 GPa. **(10 Marks)**

Fig.Q7(b)



8 A composite wall consists of three materials as shown in fig. Q8. The outer temperature $T_0 = 20^0C$. Convective heat transfer takes place on the inner surface of the wall with $T_{00} = 800^0C$ and $h = 25\ W/m^2\ ^0C$. Determine the temperature distribution on the wall. **(20 Marks)**

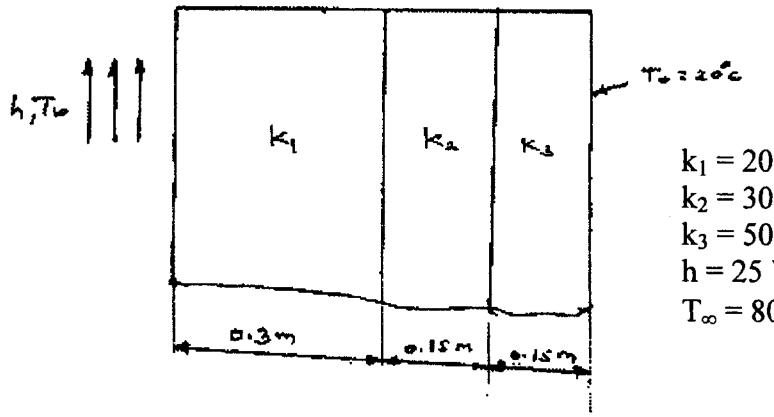


Fig.Q8

$k_1 = 20\ W/m^0C$
$k_2 = 30\ W/m^0C$
$k_3 = 50\ W/m^0C$
$h = 25\ W/m^2\ ^0C$
$T_\infty = 800^0C$

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