

## Sixth Semester B.E. Degree Examination, June 2012

### Modelling and Finite Element Analysis

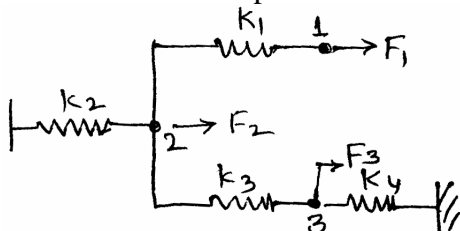
Time: 3 hrs.

Max. Marks:100

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

#### PART – A

- 1 a. Differentiate between plane stress and plane strain problems. Also state the stress-strain relations for both. (05 Marks)
- b. State the principle of minimum (stationary) potential energy and apply the same to determine nodal displacement of the spring system shown in Fig.Q1(b). (10 Marks)



$$\begin{aligned}
 k_1 &= 50 \text{ N/mm} \\
 k_2 &= k_3 = 60 \text{ N/mm} \\
 k_4 &= 80 \text{ N/mm} \\
 F_1 &= 100 \text{ N}, F_2 = 150 \text{ N}, F_3 = 200 \text{ N},
 \end{aligned}$$

Fig.Q1(b)

- c. Evaluate the following integral using two point Gauss quadrature formula.

$$I = \int_1^3 \left( \frac{1}{x} \right) dx \quad (05 \text{ Marks})$$

- 2 a. What is FEM? What are the advantages and limitations of the method? (08 Marks)
- b. Derive the element stiffness matrix of linear bar element and list the properties of stiffness matrix. (12 Marks)
- 3 a. What do you understand by  $C^0$  and  $C^1$  shape functions? State the properties of  $C^0$  shape functions. Derive shape functions of a 3-noded bar element in natural coordinates. Show the variation of each shape function over the element. (12 Marks)
- b. Discuss the various convergence criteria and geometric isotropy as regards to finite element models. (08 Marks)
- 4 a. What do you understand by Hermitian shape functions? Derive Hermite shape functions of a beam element and show the variation of the shape functions over the element. (10 Marks)
- b. Explain the sub-super and isoparametric finite elements. (05 Marks)
- c. Write a note on higher order elements used in FEM. (05 Marks)

#### PART – B

- 5 a. Derive a stiffness matrix for 2D truss element. (10 Marks)
- b. Derive strain-displacement [B] matrix for a 3-noded CST element. (10 Marks)
- 6 a. Write a note on application of FEM in solving scalar field problems. (04 Marks)
- b. Write the governing differential equations for one dimensional heat transfer and discuss the various types of boundary conditions used in solving heat transfer problems. (06 Marks)
- c. Derive element conductivity matrix for one dimensional heat flow 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 at node 2, the stresses in the elements at support reactions for the stepped bar shown in Fig.Q7(a). (10 Marks)

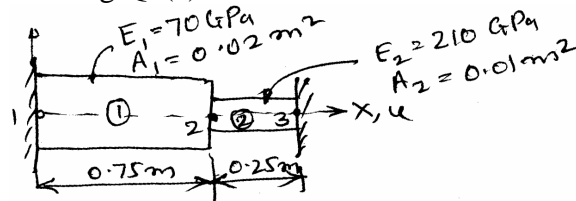
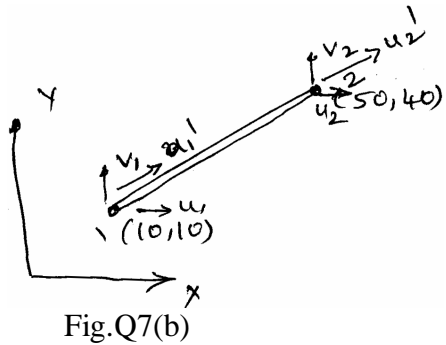


Fig.Q7(a)

- b. For the truss element shown in Fig.Q7(b), (x, y) co-ordinates of the element are indicated near nodes 1, 2. The element displacement dof vector is given by  $\{u\} = [1.5 \ 1.0 \ 2.1 \ 4.3]^T \times 10^{-2} \text{ mm}$ . Take  $E = 300 \times 10^3 \text{ N/mm}^2$ ,  $A = 100 \text{ mm}^2$ , determine the following:  
 i) Element displacement dof in local coordinates ( $u_1^1$  &  $u_2^1$ )  
 ii) Stress in the element  
 iii) Stiffness-matrix of the element. (10 Marks)



$E = 300 \times 10^3 \text{ N/mm}^2$   
 $A = 100 \text{ mm}^2$

$$\begin{Bmatrix} u_1 \\ v_1 \\ u_2 \\ v_2 \end{Bmatrix} = \begin{Bmatrix} 1.5 \\ 1.0 \\ 2.1 \\ 4.3 \end{Bmatrix} \times 10^{-2} \text{ mm}$$

Fig.Q7(b)

- 8 a. For the brick wall shown in Fig.Q8(a), the inner surface temperature is  $28^\circ\text{C}$  and outer surface is exposed to cold air at  $-15^\circ\text{C}$ . Determine the temperature distribution in steady state, within the wall, by considering 2 elements, one dimensional heat flow elements. What is heat flux through the wall? (10 Marks)

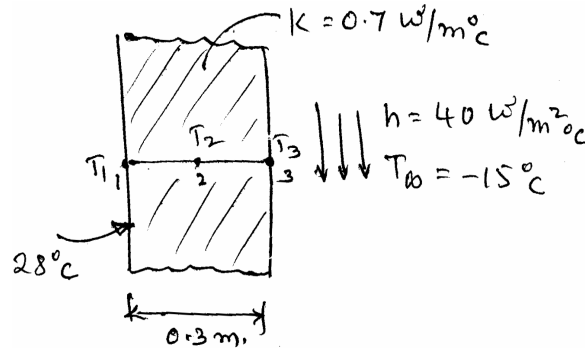
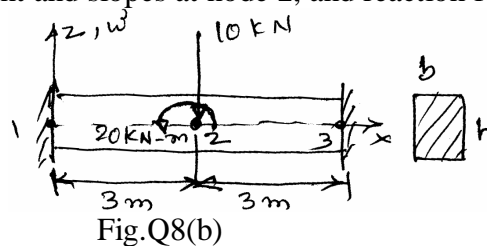


Fig.Q8(a)

- b. For the beam fixed at both ends and loaded as shown in Fig.Q8(b), determine the displacement and slopes at node 2, and reaction force at node 1 only. (10 Marks)



$E = 210 \text{ GPa}$   
 $b = 0.2 \text{ m}$   
 $h = 0.4 \text{ m}$

Fig.Q8(b)

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