ACHARYA INSTITUTE OF TECHNOLOGY
Bangalore - 560090

USN | | | | | | | | | | |

10AE64

Sixth Semester B.E. Degree Examination, Dec.2016/Jan.2017
Finite Element Analysis

Time: 3 hrs. Max. Marks:100

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

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.

PART – A

1 a. Derive an expression for the potential energy functional for a three–dimensional body subjected to body forces, surface forces and point loads. **(06 Marks)**

b. Determine the nodal displacements for the spring system shown in the Fig. Q1(b) using the principle of minimum potential energy. **(06 Marks)**

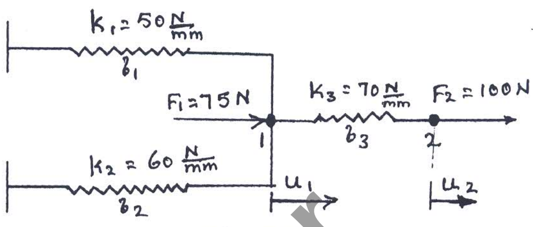

Fig. Q1(b)

c. Derive an expression for the displacement at the free end of the cantilever bar subjected to uniaxial as shown in the Fig. Q1(c). Also find the expression for stress. Consider the cross sectional area as A and elastic modulus as E. **(08 Marks)**

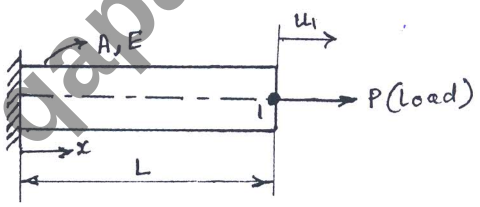

Fig. Q1(c)

2 a. Derive an expression for the shape function for 1–D bar element in natural co-ordinates. **(07 Marks)**

b. Explain the convergence requirements in finite element formulation using Pascal 2D triangle. **(07 Marks)**

c. Explain the co-ordinate systems used in finite element formulation. **(06 Marks)**

3 a. Derive the elemental stiffness matrix for a plane truss element. **(10 Marks)**

b. Determine the nodal displacement, elemental stresses and support reaction of the bar shown in the Fig. Q3(b). Take $E_{steel} = 200$ GPa ; $E_{copper} = 100$ GPa. **(10 Marks)**

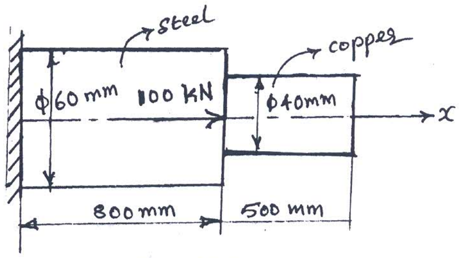

Fig. Q3(b)

4 a. Derive the shape function for a none noded quadrilateral element in natural co-ordinates. **(10 Marks)**

b. Derive the Jacobian matrix for 2–D CST element and thus determine the Jacobian for the triangular stiffness element shown in the Fig. Q4(b). **(10 Marks)**

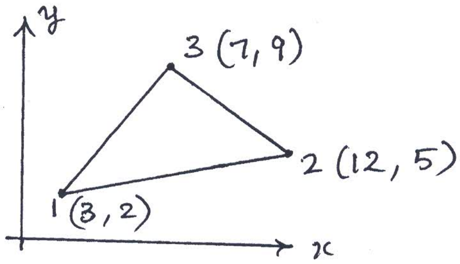

Fig. Q4(b)

PART – B

5 a. Derive the shape function for 4 noded tetrahedral elements. **(10 Marks)**

b. Differentiate between Lagrange and serendipity family of elements with neat sketches. **(10 Marks)**

6 a. Explain the three phases in finite element analysis. **(06 Marks)**

b. What are ISO–parametric, sub parametric and super parametric elements? Explain with suitable sketches. **(08 Marks)**

c. Explain the different schemes of node numbering and thus explain half band width. **(06 Marks)**

7 a. Derive the shape function for 8 noded hexahedral elements. **(12 Marks)**

b. What are axisymmetric elements? Explain the finite element analysis of ax symmetric quadrilateral element. **(08 Marks)**

8 a. Derive the governing differential equation for 1–D heat conduction. **(06 Marks)**

b. A composite wall consists of three materials as shown in the Fig. Q8(b). The outer surface temperature is 20°C. Convective heat transfer takes place on the inner surface with T_∞ = 800°C and h = 25 W/m^2 °C. Determine the temperature distribution in the inner wall. **(14 Marks)**

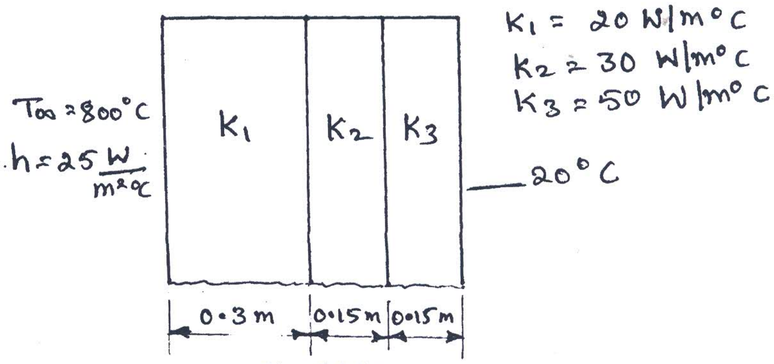

Fig. Q8(b)

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