Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II (OLD) – • EXAMINATION – SUMMER 2016

Subject Code: 1720901 **Date: 17/05/2016**

Subject Name: Finite Element Method

Time:10:30 am to 01:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Formulate the finite element model for a bar fixed at one end and subjected to axial load at the other end. Assume that the bar is discretized into two elements and the axial rigidity of the bar is constant. **07**

(b) Apply Castigliano's first theorem to the system of four spring elements depicted in Fig. 1 to obtain the system stiffness matrix. The vertical members at nodes 2 and 3 are to be considered rigid. **07**

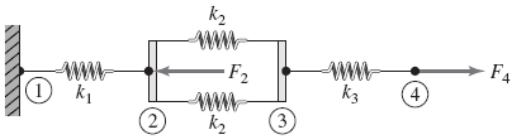

Fig.1

Q.2 **(a)** Explain the minimum potential energy approach and derive the FEM model for the spring system shown in Fig.1. **07**

(b) Figure 2 shows material properties, geometry, loads and boundary conditions of the two-bar structure. Element 1 is oriented at 90^0 while the element 2 is located at 45^0 with respect to positive *x* axis. **07**

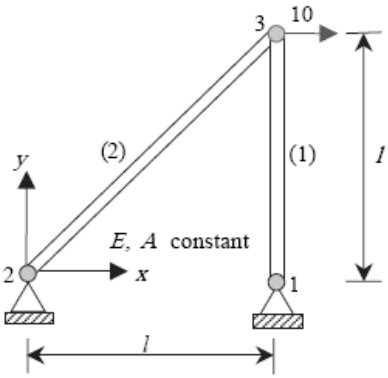

Fig.2

Write the final FE model and apply the boundary conditions.

OR

(b) Find out the perimeter of a circle using finite element method. **07**

Q.3 **(a)** Discuss the order and type of the shape functions in global coordinates used for flexural element. **07**

(b) Derive the FEM model for the beam shown in Fig. 3 along with the appropriate boundary conditions. Write the reduced FE equation in matrix form after applying the boundary conditions. **07**

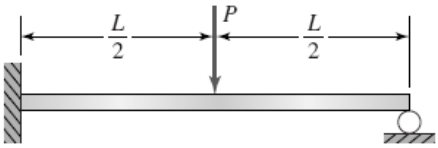

Fig.3

OR

Q.3 **(a)** Write the properties of the stiffness matrix. **07**

(b) Using the work equivalence method find the nodal forces for the beam element shown in Fig. 4. **07**

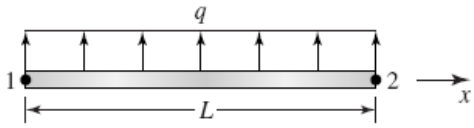

Fig.4

Q.4 **(a)** Explain Galerkine finite element method using suitable example. **07**

(b) Derive the element stiffness matrix for a bar element using Galerkine finite element method. **07**

OR

Q.4 **(a)** Discuss the requirements for selecting the polynomial function for one dimension element. **07**

(b) Discuss *p*, *h* and *ph* refinement methods with suitable example. **07**

Q.5 **(a)** Figure 5 shows a quadrilateral element in global coordinates. Show that the mapping function correctly describes the line connecting nodes 2 and 3 and determine the (x , y) coordinates corresponding to (r, s) = (1, 0.5)

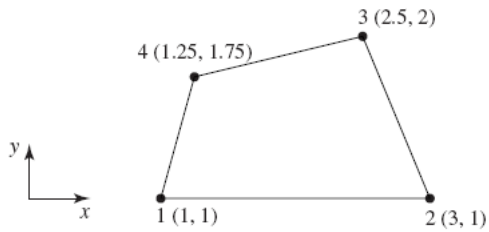

Fig.5

(b) Determine the Jacobian matrix for a four-node, two-dimensional quadrilateral element. **07**

OR

Q.5 **(a)** Formulate the plane quadrilateral element used for solid mechanics using Isoparametric approach. **07**

(b) Which element will be used to model the bending of a cantilever beam and why? Give proper justification. **07**

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