B. Sc. Engg. (CEE)/ 8th Sem. 20 February 2023

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Mid Semester Examination **Summer Semester: 2021-2022**
Course No.: CEE 4815 **Full Marks: 75**
Course Title: Introduction to Finite Element Method **Time: 1.5 Hours**

There are 4 (Four) questions. Answer 3 (Three) questions. Questions 2 and 4 are compulsory. Answer 1 question from questions 1 and 3. The figures in the right margin indicate full marks.

1(a). Briefly explain the steps of the finite element method. (10) (CO1) (PO1)

1(b). Derive the shape functions of 2-nodal and 3-nodal truss elements for the local coordinate system and verify with the Lagrange Polynomials. (15) (CO1) (PO1)

2(a). Derive the shape functions and Jacobian matrix of a 4-nodal square element in the two-dimensional condition for the local coordinate system. (11) (CO1) (PO1)

2(b). Answer the following question regarding a quadrilateral element having coordinates of (0,0), (5, 1), (5, 3), and (0,4) - (14) (CO2) (PO2)
(i) Determine the coordinates of a point in the global coordinate system corresponding to the local coordinate (0.5, 0.7).
(ii) Determine Jacobian matrix.

3(a). Derive strain displacement matrix [B] for plane strain condition. (10) (CO1) (PO1)

3(b). Derive general stiffness matrix using the principle of virtual work. (15) (CO1) (PO1)

4. Calculate axial forces at both nodes of a truss element for the nodal displacements of 2.0 mm at node 1 and 10 mm at node 2. Show the calculations of the Jacobian matrix, strain-displacement matrix [B], and stiffness matrix [K] for elastic condition. The cross-sectional area of the truss is 100 mm^2, and the length is 5.0 m. Here, the elastic modulus of the truss material, $E = 200$ GPa. (25) (CO2) (PO2)