13

B. Sc. Engg. (CEE)/ 8th Sem. 11 March 2024(Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Mid Semester Examination **Summer Semester: 2022-2023**
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 describe Well-Conditioned Mesh and Ill-Condition Mesh in finite element method. (6) (CO1) (PO1)

1(b). Derive the shape functions of 4-nodal elements for the one-dimensional condition in the local coordinate system using the Lagrange Polynomials. Draw also the curves for all four shape functions. (13) (CO1) (PO1)

1(c). Briefly describe the limitations of the Jacobian Matrix in mapping between the local and global coordinate systems. (6) (CO1) (PO1)

2(a). Derive the shape functions and Jacobian matrix of a 3-nodal triangular element in the two-dimensional condition for the local coordinate system. (11) (CO1) (PO1)

2(b). Answer the following question regarding a triangular element having coordinates of (0,0), (4, 0), and (2, 3) - (14) (CO2) (PO2)

(i) Determine the coordinates of a point in the global coordinate system corresponding to the local coordinate (0.3, 0.5).

(ii) Determine Jacobian matrix.

3(a). Derive strain displacement matrix [B] for three-dimensional condition. (12) (CO1) (PO1)

3(b). Derive general stiffness matrix using the principle of virtual work. (13) (CO1) (PO1)

4. Calculate axial forces at both nodes of a truss element for the nodal displacements of 5.0 mm at node 1 and 3.0 mm at node 2. Show the calculations of the Jacobian matrix, strain-displacement matrix [B], and stiffness matrix [K] for elastic condition. The cross section of the truss is circular having a diameter of 50 mm, and the length is 8.0 m. Here, the elastic modulus of the truss material, E = 200 GPa. (25) (CO2) (PO2)