(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY SPECIAL/SUPPLEMENTARY EXAMINATIONS 2021/2022 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE OF:
BACHELOR OF SCIENCE IN CIVIL AND STRUCTURAL ENGINEERING
BACHELOR OF TECHNOLOGY IN BUILDING CONSTRUCTION

COURSE CODE: CSE 311

COURSE TITLE: FINITE ELEMENT METHOD

DATE: 25TH JULY 2022 TIME: 2:00 PM – 4:00 PM

INSTRUCTIONS:

1. This paper contains **FIVE** questions
2. Answer **QUESTION ONE** and any other **TWO** Questions
3. Marks for each question are indicated in the parenthesis.
4. Examination duration is **2 Hours**

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 3 Printed Pages. Please Turn Over.

QUESTION ONE (*30 MARKS*)

a) State any FIVE major differences between the classical methods and finite element method in structural analysis. **(5Mks)**

b) In 2-D continua, the size of the elements is vital in determining the accuracy of the analysis. Define the term aspect ratio and illustrate its effect on the accuracy of the approximations. Use a typical 2-D continua of size 12units by 8units. **(10Mks)**

c) Show that the stiffness matrix of a truss element is given by:

$$[\mathbf{k}] = \frac{EA}{l}\begin{bmatrix} c^2 & cs & -c^2 & -cs \\ cs & s^2 & -cs & -s^2 \\ -c^2 & -cs & c^2 & cs \\ -cs & -s^2 & cs & s^2 \end{bmatrix}$$

Where c and s are directional cosines depending on the orientation of the truss element. **(15Mks)**

QUESTION TWO (*20 Marks*)

Define the term shape function and hence derive the shape functions of a two-node beam element using polynomial functions. **(20 Marks)**

QUESTION THREE (*20 Marks*)

Consider a two-bar truss shown in Figure Q3. All members of the truss have identical areas of cross-section, $A = 150\text{mm}^2$, and modulus of elasticity, $E = 210\text{GPa}$. Determine the determine the displacements of node 1 and stress in element 1-3. **(20 Marks)**

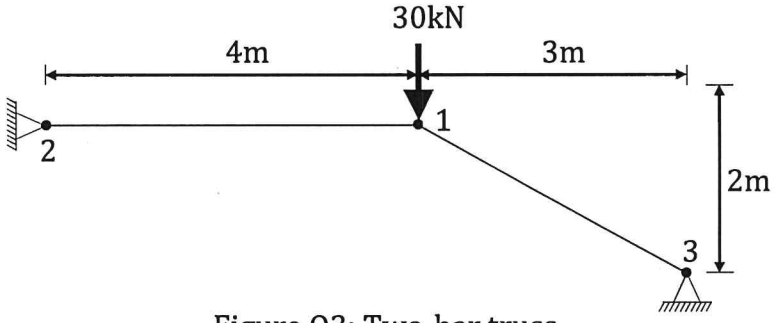

Figure Q3: Two-bar truss

QUESTION FOUR (*20 Marks*)

A triangular finite element in a domain under 2-dimensional analysis is as shown in Figure Q4. The nodal coordinates give the geometry of the element in meters. Under applied loads, the nodal solution gives displacements, in millimeters, at each of the nodes as follows;

$$u_1 = \begin{Bmatrix} 2.5 \\ -6.0 \end{Bmatrix}; \qquad u_2 = \begin{Bmatrix} 4.0 \\ 14.0 \end{Bmatrix}; \qquad u_3 = \begin{Bmatrix} -3.5 \\ -6.5 \end{Bmatrix}$$

Where u_i is the vector of horizontal and vertical displacements at the respective nodes.

a) Calculate the shape functions for the element. **(15 Marks)**

b) Calculate the displacements in point P. **(5 Marks)**

Take: $N_i = \frac{1}{2A}[a_i + b_i x + c_i y]; \quad a_i = x_j y_k - x_k y_j; \quad b_i = y_j - y_k; \; c_i = x_k - x_j$

$$2A = \begin{vmatrix} 1 & x_i & y_i \\ 1 & x_j & y_j \\ 1 & x_k & y_k \end{vmatrix}$$

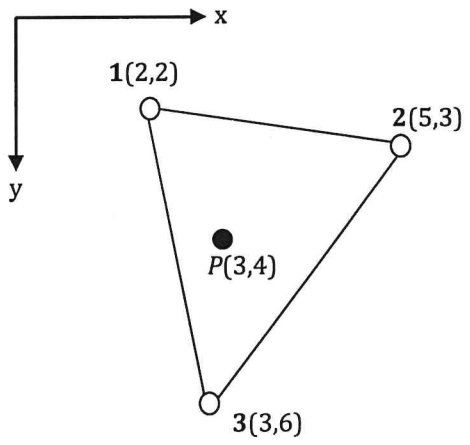

Figure Q4

QUESTION FIVE (*20 Marks*)

(a) State and explain the major steps in solving structural problems using the finite element method. **(11 Marks)**

(b) In the analysis of structures using finite element method, coordinate systems must be defined explicitly. With illustrations, describe the THREE major coordinate systems. **(9Mks)**

======*END OF PAPER*=====