PAPER A

TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING AND CIVIL ENGINEERING
UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN CIVIL ENGINEERING
TCV 4311 : ANALYSIS OF STRUCTURES III
END OF SEMESTER EXAMINATION
SERIES: JANUARY 2025
TIME: 2 HOURS

Instructions to Candidates

You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of five questions.
Attempt question ONE (Compulsory) and any other TWO questions.
Do not write on the question paper.

QUESTION ONE (COMPULSORY) 20 marks

a) Derive the Displacement function and Element stiffness equation for a spring element.

(8 Marks)

b) Consider a spring system shown in **Figure Q1b** below. The applied force at node 3 is 2000N while the applied forces at nodes 2 and 4 are zero. Calculate the nodal displacements and element internal forces, given that;

k_1 =40N/mm, k_2 = 30N/mm, k_3 = 20 N/mm, F_{3x} = 2000 N

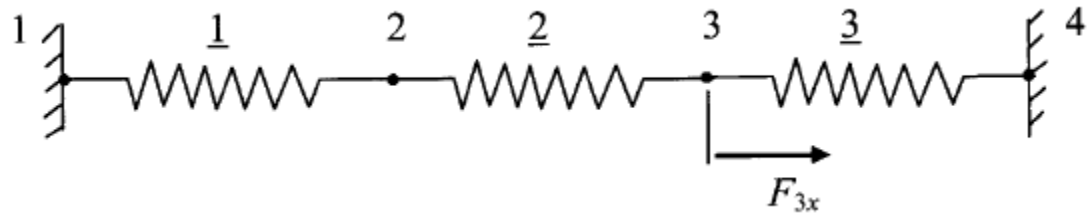

Figure Q1b: Three Spring System

(12 Marks)

QUESTION TWO (20 Marks)

Obtain the nodal displacements, reaction forces and element internal forces of the two-bar truss structure loaded as shown in **Figure Q2** below. For each element, A = 1×10^{-3} m^2 and E = 200,000 Mpa.

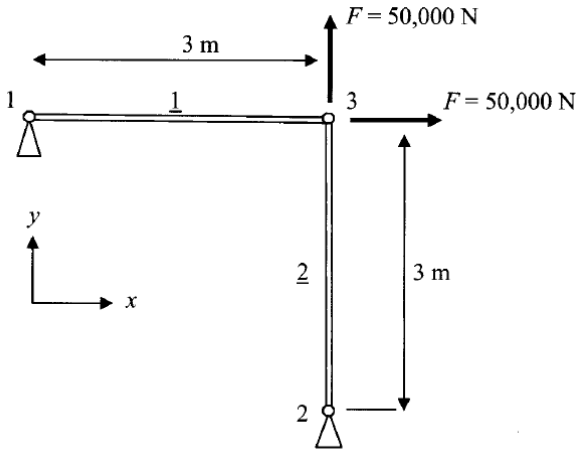

Figure Q2: A two-bar truss structure

(20 Marks)

QUESTION THREE (20 Marks)

Obtain the nodal displacements, reaction forces and element internal forces of the two-bar truss structure loaded as shown in **Figure Q3** below. For each element, A = 1.5 in^2 and E = 35×10^6 psi

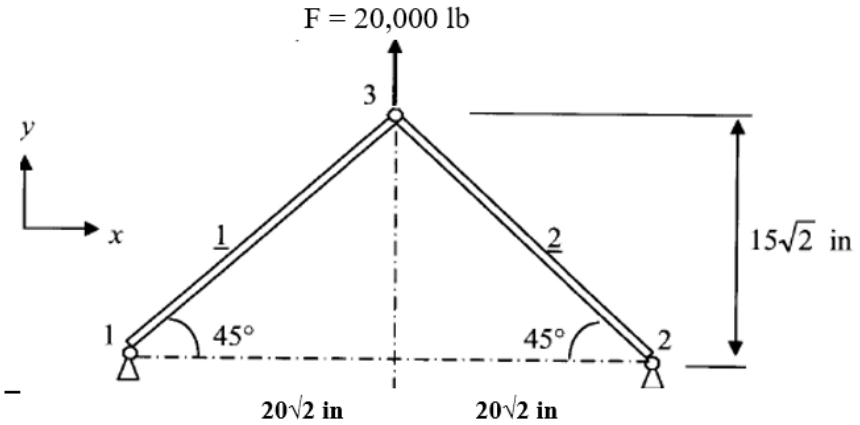

Figure Q3: Truss structure

(20 Marks)

QUESTION FOUR (20 Marks)

a) Discuss the general methodology followed in analysis of structures using the Matrix Stiffness Method

(5 Marks)

b) Consider a three-element bar structure shown in Figure **Q4b** below. The applied forces at nodes 2 and 3 are 100 KN and 200 KN respectively. Calculate the nodal displacements, reaction forces and element internal forces, given that the member properties are;

Member	Length (mm)	Area (mm^2)	Material, E (KN/mm^2)
1	700	1000	105
2	500	600	150
3	400	200	200

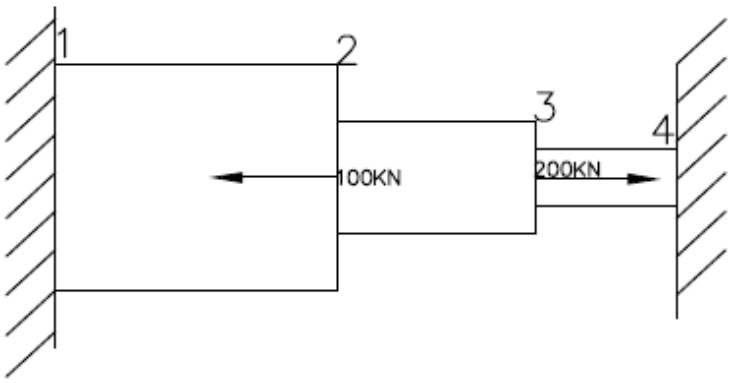

Figure Q4b: Three element bar structure

(15 Marks)

QUESTION FIVE (20 Marks)

Obtain the nodal displacements and reaction forces of the two-member frame structure loaded as shown in **Figure Q5**. Find also the internal forces of element 1. For each member, $E = 25*10^6$ psi, $I = 200$ in^4, and $A = 20$ in^2

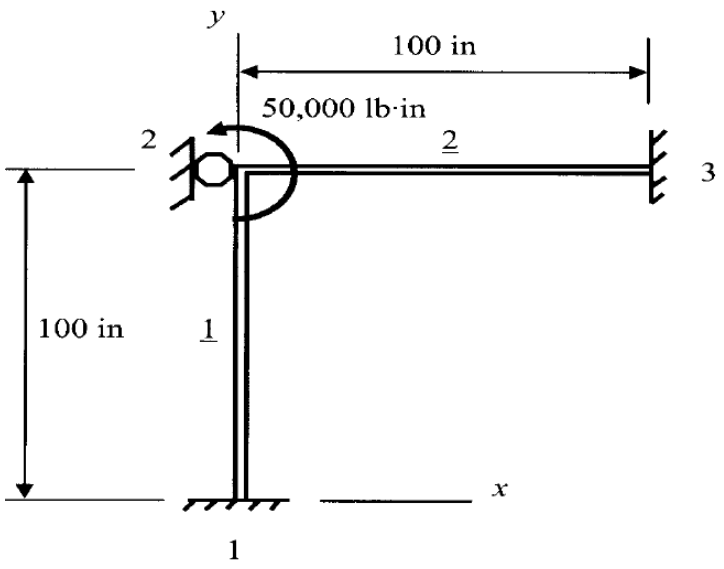

Figure Q5: Two-member frame structure

Given that Element Stiffness matrix [k] is;

$$[k] = (E/L)$$

$$\times \begin{bmatrix} AC^2+\frac{12I}{L^2}S^2 & \left(A-\frac{12I}{L^2}\right)CS & \frac{-6I}{L}S & -\left(AC^2+\frac{12I}{L^2}S^2\right) & -\left(A-\frac{12I}{L^2}\right)CS & \frac{-6I}{L}S \\ & AS^2+\frac{12I}{L^2}C^2 & \frac{6I}{L}C & -\left(A-\frac{12I}{L^2}\right)CS & -\left(AS^2+\frac{12I}{L^2}C^2\right) & \frac{6I}{L}C \\ & & 4I & \frac{6I}{L}S & \frac{-6I}{L}C & 2I \\ & & & AC^2+\frac{12I}{L^2}S^2 & \left(A-\frac{12I}{L^2}\right)CS & \frac{6I}{L}S \\ & \text{Symmetry} & & & AS^2+\frac{12I}{L^2}C^2 & \frac{-6I}{L}C \\ & & & & & 4I \end{bmatrix}$$