



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF ENGINEERING
DEPARTMENT OF CIVIL AND WATER ENGINEERING
STRUCTURAL ANALYSIS I
ECW 2206

Main Examination Paper
March 2025

This examination question paper consists of **5(five)** pages.

Time Allowed: 3 Hours
Total Marks: 100
Examiner's Name: Eng F. Mudhindi/P. Nkomo

INSTRUCTIONS

1. The paper contains **5(five)** questions
2. Answer any **4(four)** questions of your choice.
3. Use of calculators is permissible.

ADDITIONAL INFORMATION

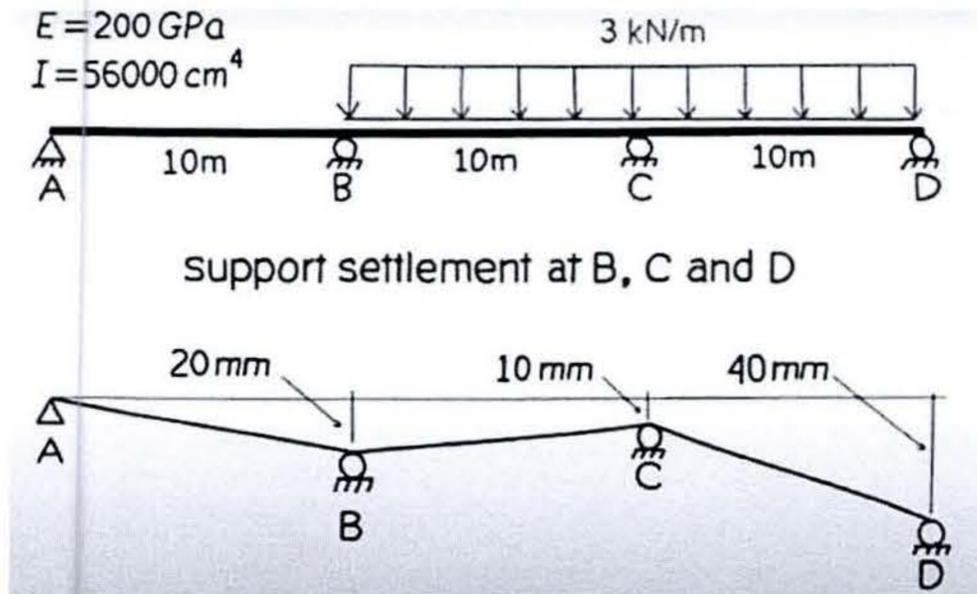
None

MARK ALLOCATION

QUESTION	MARKS
1	25
2	25
3	25
4	25
5	25
TOTAL POSSIBLE MARKS	100

Question 1

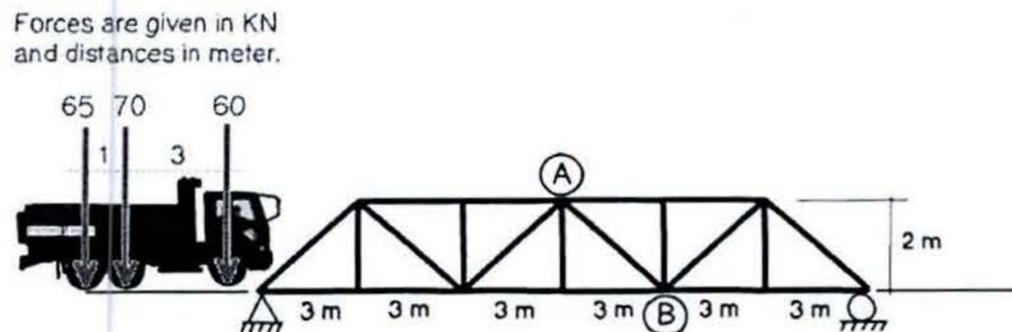
The structure below shows an indeterminate continuous beam taken by Final Year Civil/Structural Engineering students for NUST University Innovation Hub to analyse the structure for its structural integrity. Using the **Slope Deflection Method**, find the member end moments and reactional forces for the beam. [25]



Question 2

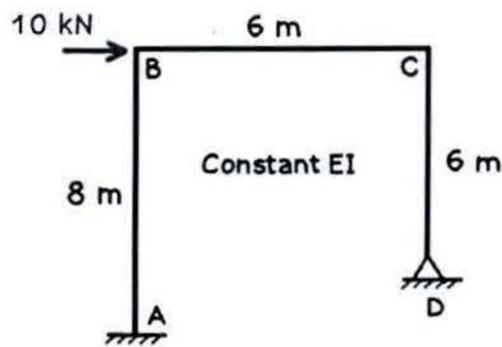
The structure below shows a truss steel overbridge proposed along Harare-Marondera highway road. Using the truck shown below as the design vehicle:

- Draw the **influence line** for the truss member **AB**. [15]
- Determine the **maximum positive** force for the truss member **AB** as the truck moves across the bridge in both directions. [5]
- Determine the **maximum negative** force for the truss member **AB** as the truck moves across the bridge in both directions. [5]



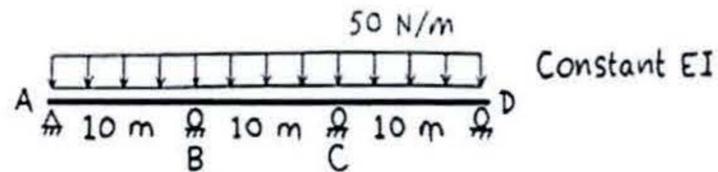
Question 3

Using the **Moment distribution Method**, analyse the frame shown below for the deflected shape, bending moment diagram, and reactional forces. [25]



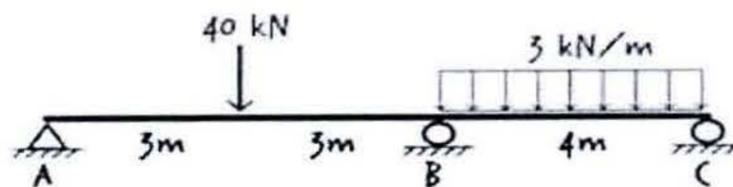
Question 4

Using the Force Method, determine the reactional forces at **A, B, C, and D** taking support at **B** and **C** as redundant forces. [25]

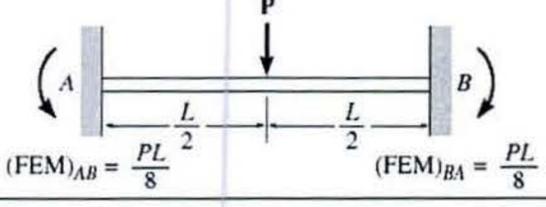
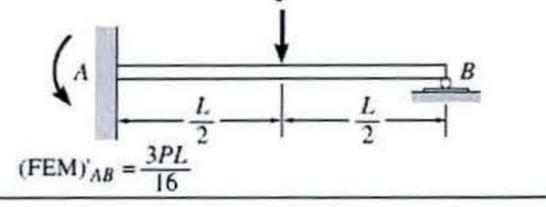
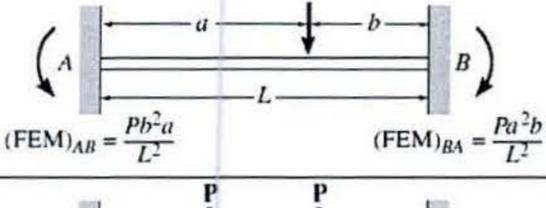
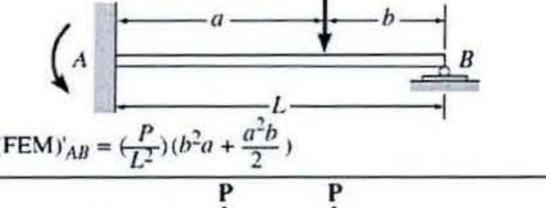
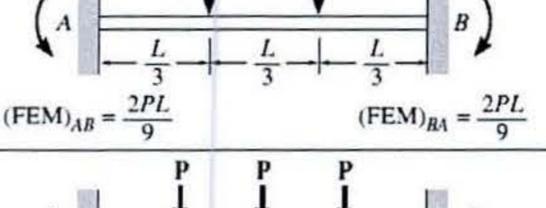
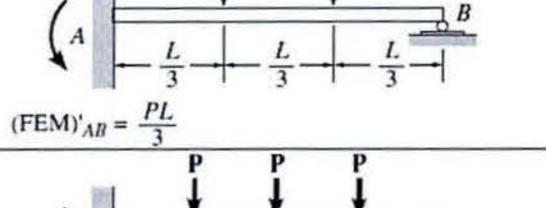
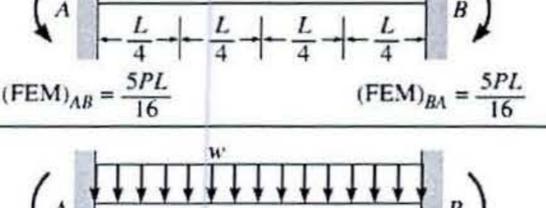
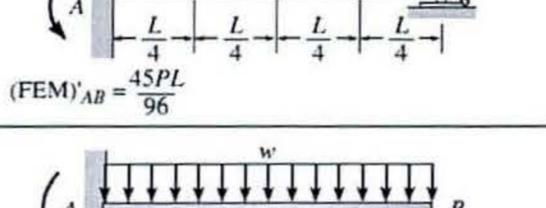
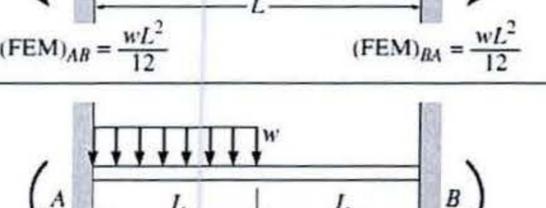
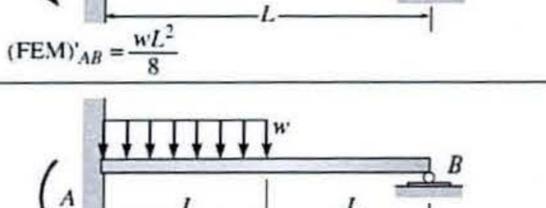
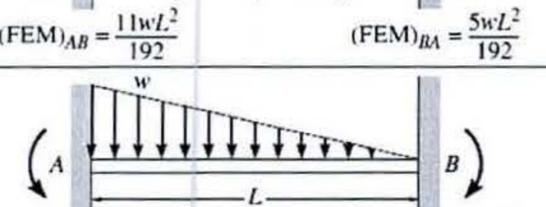
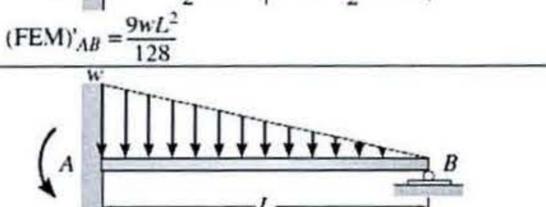
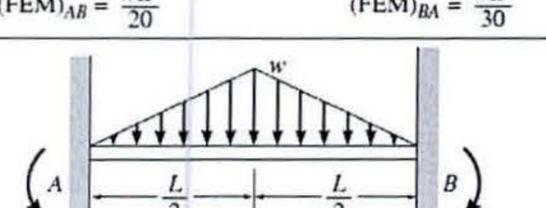
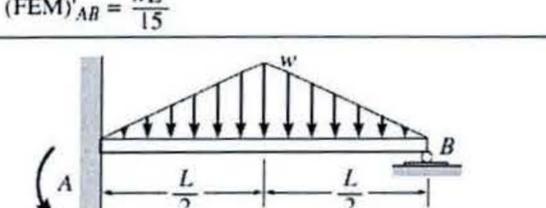
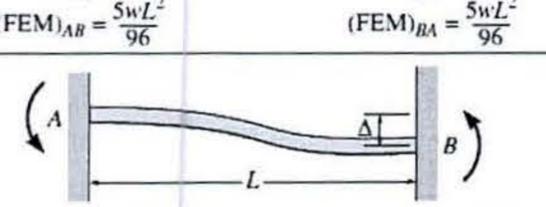
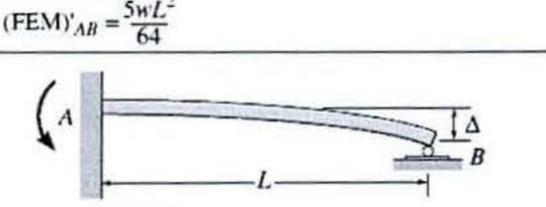
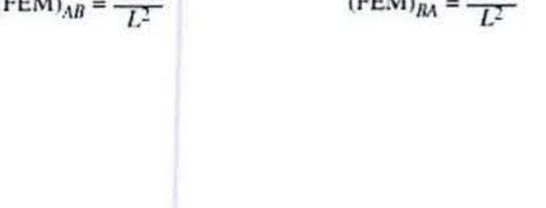


Question 5

Using the Matrix (Displacement) method of analysing indeterminate structures, calculate the member **reactional forces** and draw the **Shear Force** and **Bending Moment Diagram** for the structure shown below assuming a constant EI [25]



Fixed End Moments

 <p> $(FEM)_{AB} = \frac{PL}{8}$ $(FEM)_{BA} = \frac{PL}{8}$ </p>	 <p> $(FEM)'_{AB} = \frac{3PL}{16}$ </p>
 <p> $(FEM)_{AB} = \frac{Pb^2a}{L^2}$ $(FEM)_{BA} = \frac{Pa^2b}{L^2}$ </p>	 <p> $(FEM)'_{AB} = \left(\frac{P}{L^2}\right)(b^2a + \frac{a^2b}{2})$ </p>
 <p> $(FEM)_{AB} = \frac{2PL}{9}$ $(FEM)_{BA} = \frac{2PL}{9}$ </p>	 <p> $(FEM)'_{AB} = \frac{PL}{3}$ </p>
 <p> $(FEM)_{AB} = \frac{5PL}{16}$ $(FEM)_{BA} = \frac{5PL}{16}$ </p>	 <p> $(FEM)'_{AB} = \frac{45PL}{96}$ </p>
 <p> $(FEM)_{AB} = \frac{wL^2}{12}$ $(FEM)_{BA} = \frac{wL^2}{12}$ </p>	 <p> $(FEM)'_{AB} = \frac{wL^2}{8}$ </p>
 <p> $(FEM)_{AB} = \frac{11wL^2}{192}$ $(FEM)_{BA} = \frac{5wL^2}{192}$ </p>	 <p> $(FEM)'_{AB} = \frac{9wL^2}{128}$ </p>
 <p> $(FEM)_{AB} = \frac{wL^2}{20}$ $(FEM)_{BA} = \frac{wL^2}{30}$ </p>	 <p> $(FEM)'_{AB} = \frac{wL^2}{15}$ </p>
 <p> $(FEM)_{AB} = \frac{5wL^2}{96}$ $(FEM)_{BA} = \frac{5wL^2}{96}$ </p>	 <p> $(FEM)'_{AB} = \frac{5wL^2}{64}$ </p>
 <p> $(FEM)_{AB} = \frac{6EI\Delta}{L^2}$ $(FEM)_{BA} = \frac{6EI\Delta}{L^2}$ </p>	 <p> $(FEM)'_{AB} = \frac{3EI\Delta}{L^2}$ </p>

Slope Deflection Equations

$$M_N = 2Ek(2\theta_N + \theta_F - 3\psi) + (FEM)_N$$

$$M_N = 3Ek(\theta_N - \psi) + (FEM)_N$$

Beam Element Stiffness Matrix

$$[\mathbf{k}] = \begin{bmatrix} \frac{12EI}{L^3} & \frac{6EI}{L^2} & -\frac{12EI}{L^3} & \frac{6EI}{L^2} \\ \frac{6EI}{L^2} & \frac{4EI}{L} & -\frac{6EI}{L^2} & \frac{2EI}{L} \\ -\frac{12EI}{L^3} & -\frac{6EI}{L^2} & \frac{12EI}{L^3} & -\frac{6EI}{L^2} \\ \frac{6EI}{L^2} & \frac{2EI}{L} & -\frac{6EI}{L^2} & \frac{4EI}{L} \end{bmatrix}$$