TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY
Department of Building & Civil engineering
UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN CIVIL ENGINEERING
ECV 4505: THEORY OF STRUCTURE V

END OF SEMESTER EXAMINATION
SERIES: AUGUST 2024
TIME: 2 HOURS

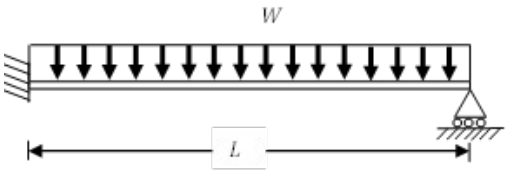
Instructions to Candidates:

1. You should have an answer booklet for this examination.
2. This paper contains FOUR questions.
3. Answer question ONE or any TWO questions.
4. Marks for each question are indicated in the parenthesis.
5. Examination duration is **2 Hours.**

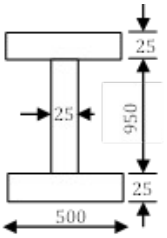
Question One (30 marks)

a) State any THREE fundamental differences between elastic analysis and plastic analysis of structures.
(6mks)

b) A steel beam shown in **Figure Q1b** is to be used in the construction of a bridge of length, L = 5m. Determine the shape factor of the structure and explain its significance (**6mks)**



a) Support and loading conditions



b) Beam cross-section (dimensions in mm)

Figure Q1b

c) For the spring system with arbitrarily numbered nodes and elements, is as shown in **Figure 1Qc**. Find the global stiffness matrix.

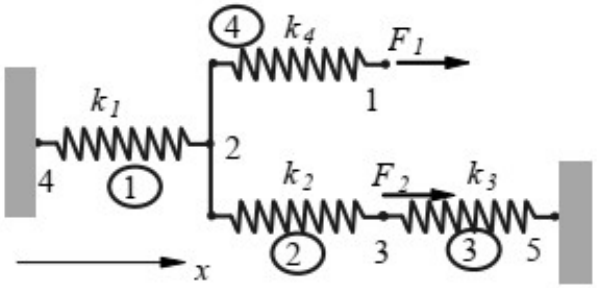


Figure 1Qc.

(6 marks)

d) Find the stresses in the two bar assembly which is loaded with force P, and constrained at the two ends, as shown in the **Figure 1Qd.**

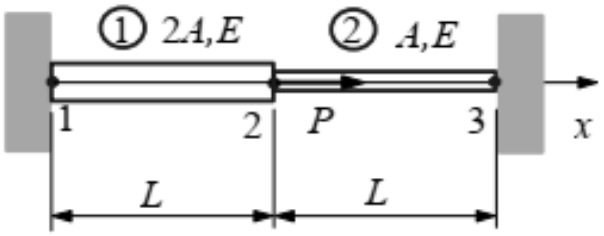


Figure 1Qd. **(12 marks)**

Question Two (20 marks)

For the plane truss shown in **Figure Q2**,

P = 1000 kN, L = 1m, E = 210 GPa

A = 6.0 x 10 ^-4 m^2 for elements 1 and 2

A = 6 $\sqrt{2}$ x 10^ -4 m^2 for element 3

Determine the displacements and reaction forces.

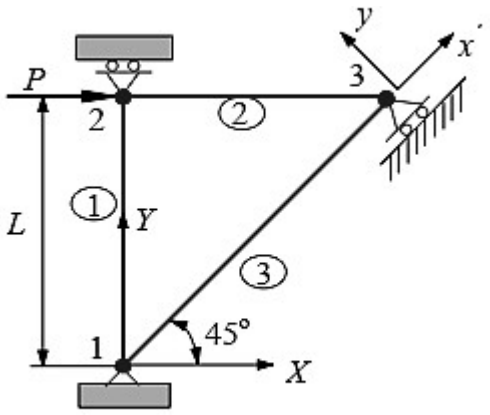


Figure Q2 **(20 marks)**

Question Three (20 marks)

a) Postulate the collapse mechanisms of the structures under the influence of monotonically increasing static load configurations given in **Figure Q3(a). (4mks)**

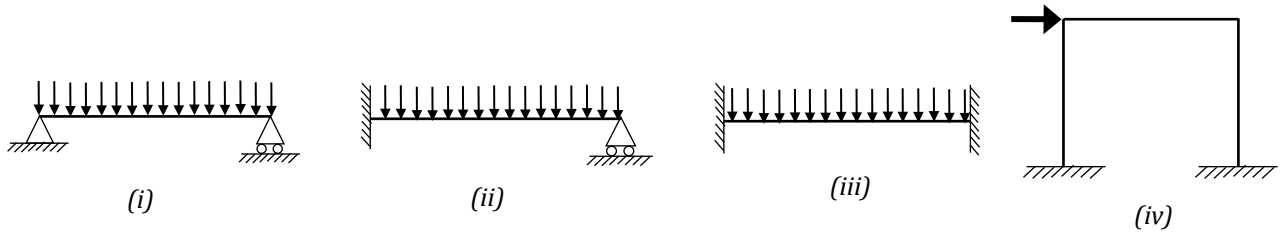


Figure Q3(a)

b) Evaluate using virtual work method, the ultimate load, W_c, required to cause collapse of a beam loaded as shown in **Figure Q3(b).** The material making the beam has plastic moment, M_p = 120 kNm. **(16mks)**

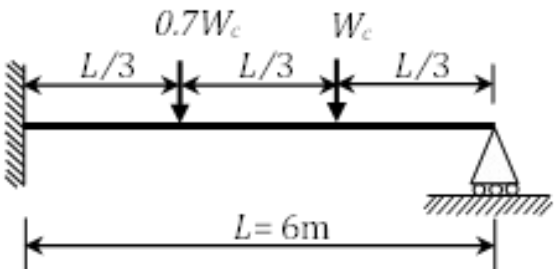


Figure Q3(b)

Question Four (20 marks)

For the frame shown, use the stiffness method to:

i. Determine the **deflection** and **rotation** at ***B***.
ii. Determine all the reactions at supports.
iii. Draw the **quantitative shear** and **bending moment diagrams.**

E = 200 GPa, I = 60(10^6) mm4, A = 600 mm^2

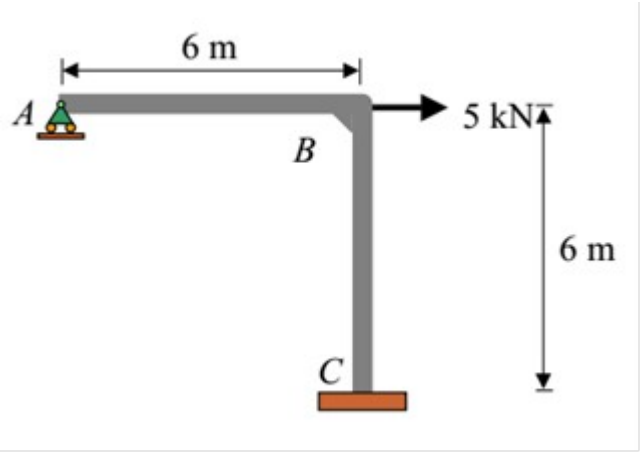


Figure Q4

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Hint

$$\frac{EA}{L}\begin{bmatrix} l^2 & lm & -l^2 & -lm \\ lm & m^2 & -lm & -m^2 \\ -l^2 & -lm & l^2 & lm \\ -lm & -m^2 & lm & m^2 \end{bmatrix}$$

$l = \cos\theta$

$m = \sin\theta$

$$\begin{bmatrix} \frac{EA}{l_e} & 0 & 0 & -\frac{EA}{l_e} & 0 & 0 \\ 0 & \frac{12EI}{l_e^3} & \frac{6EI}{l_e^2} & 0 & -\frac{12EI}{l_e^3} & \frac{6EI}{l_e^2} \\ 0 & \frac{6EI}{l_e^2} & \frac{4EI}{l_e} & 0 & -\frac{6EI}{l_e^2} & \frac{2EI}{l_e} \\ -\frac{EA}{l_e} & 0 & 0 & \frac{EA}{l_e} & 0 & 0 \\ 0 & -\frac{12EI}{l_e^3} & -\frac{6EI}{l_e^2} & 0 & \frac{12EI}{l_e^3} & -\frac{6EI}{l_e^2} \\ 0 & \frac{6EI}{l_e^2} & \frac{2EI}{l_e} & 0 & -\frac{6EI}{l_e^2} & \frac{4EI}{l_e} \end{bmatrix} \begin{bmatrix} l & m & 0 & 0 & 0 & 0 \\ -m & l & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & l & m & 0 \\ 0 & 0 & 0 & -m & l & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

FIXED END FORCES

At A $\quad M_A = -\frac{Wab^2}{L^2} \qquad R_A = -\frac{Wb}{L^3}(l^2 + ab - a^2)$

At B $\quad M_B = -\frac{Wa^2b}{L^2} \qquad R_B = -\frac{Wa}{L^3}(l^2 + ab - b^2)$

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