



**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**FACULTY OF ENGINEERING**

**DEPARTMENT OF CIVIL AND WATER ENGINEERING**

**STRUCTURAL MECHANICS (ECW 2106)**

**Main Examination Paper**

**December 2024**

**This Examination Paper consists of 8 pages**

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Scientific Calculator

Internal Examiner: Mr. T. Madyangove

External Examiner:

**INSTRUCTIONS**

1. Answer any five (5) questions

**MARK ALLOCATION**

QUESTION	MARKS
1.	20
2.	20
3.	20
4.	20
5.	20
6.	20
<b>TOTAL</b>	<b>100</b>

**QUESTION 1**

a) Locate the centroid of the plane area shown in Fig. 1

[5]

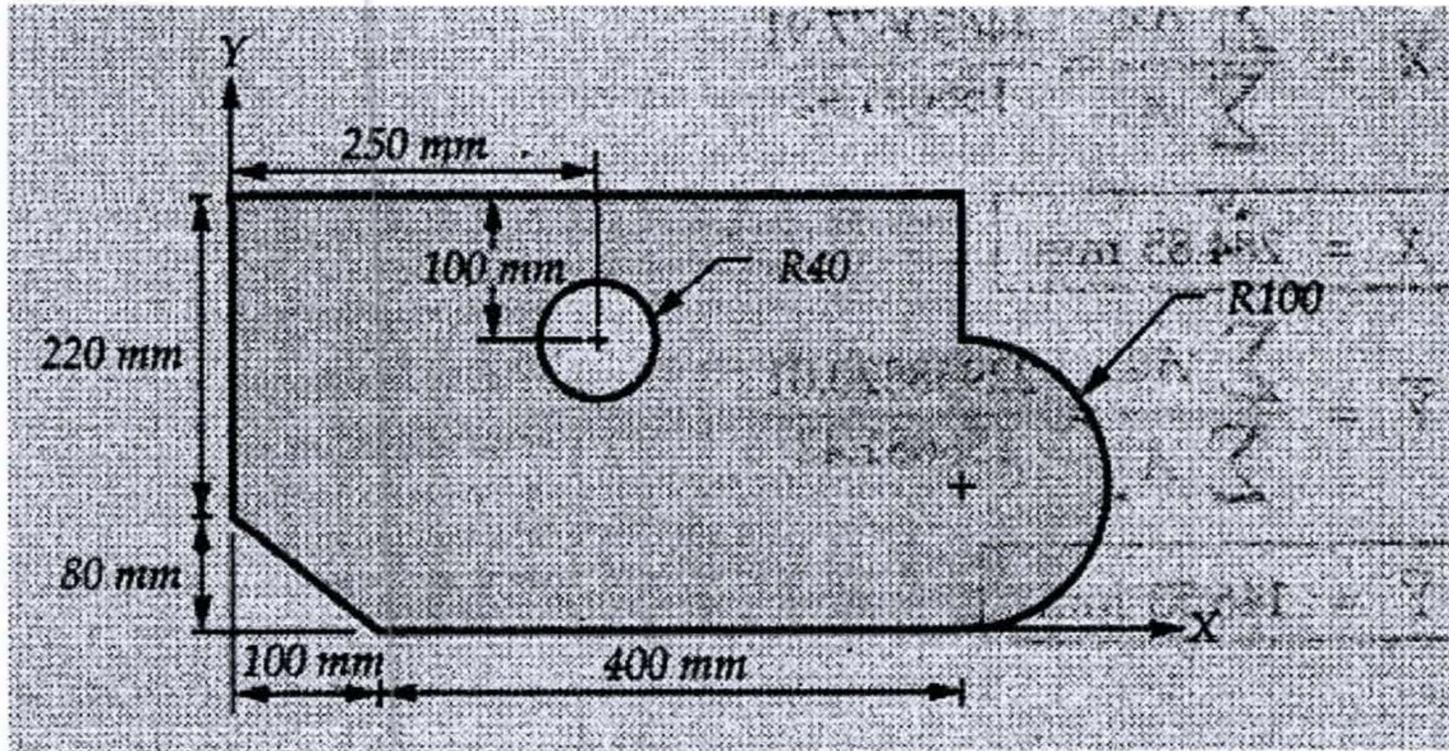


Fig. 1

b) Replace the distributed loading in Fig. 2 with an equivalent resultant force, and specify its location on the beam measured from point A

[5]

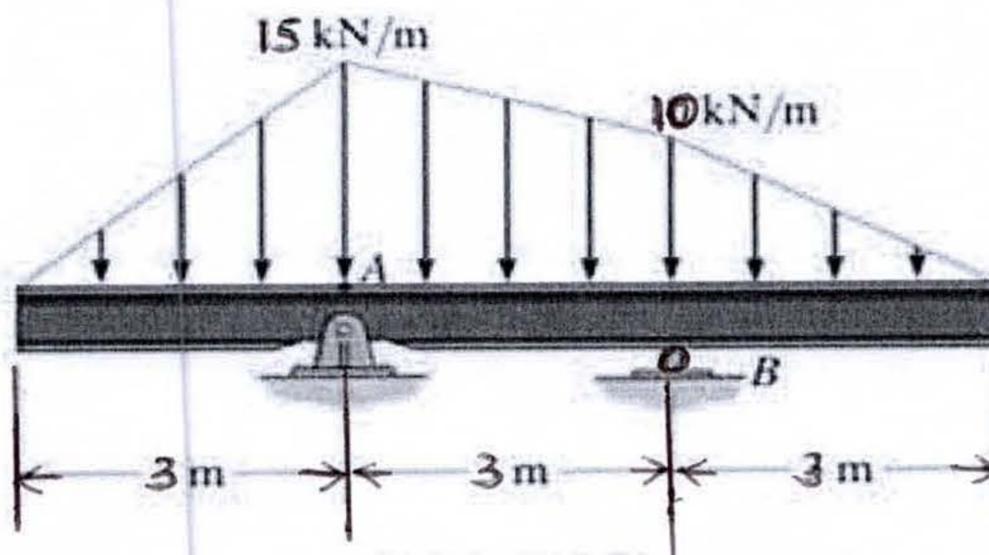


Fig.2

c) Fig .3 shows a simply supported beam

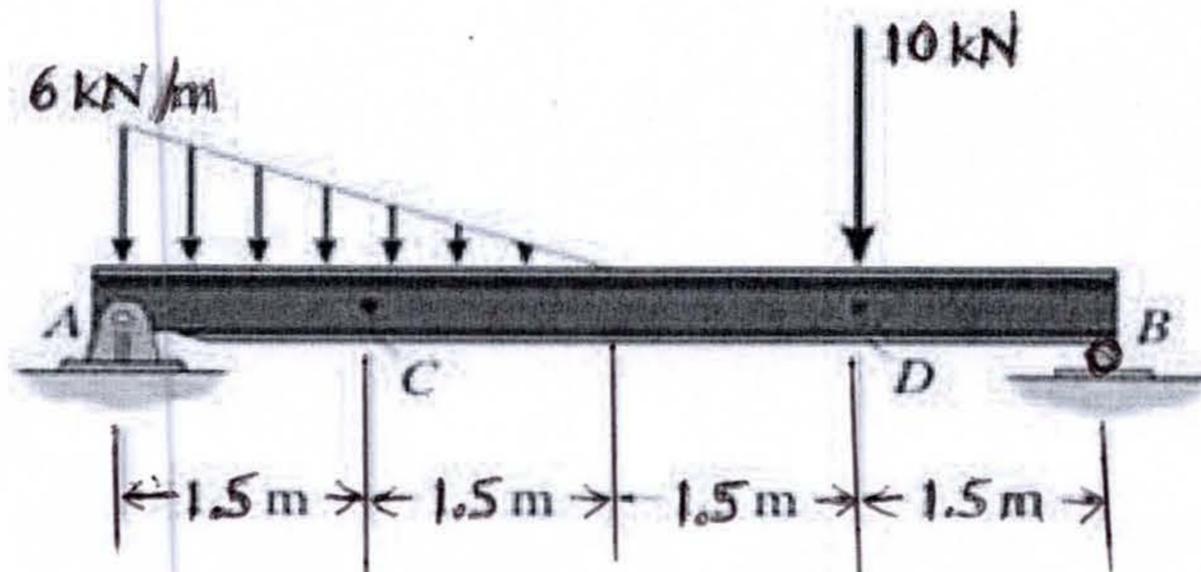


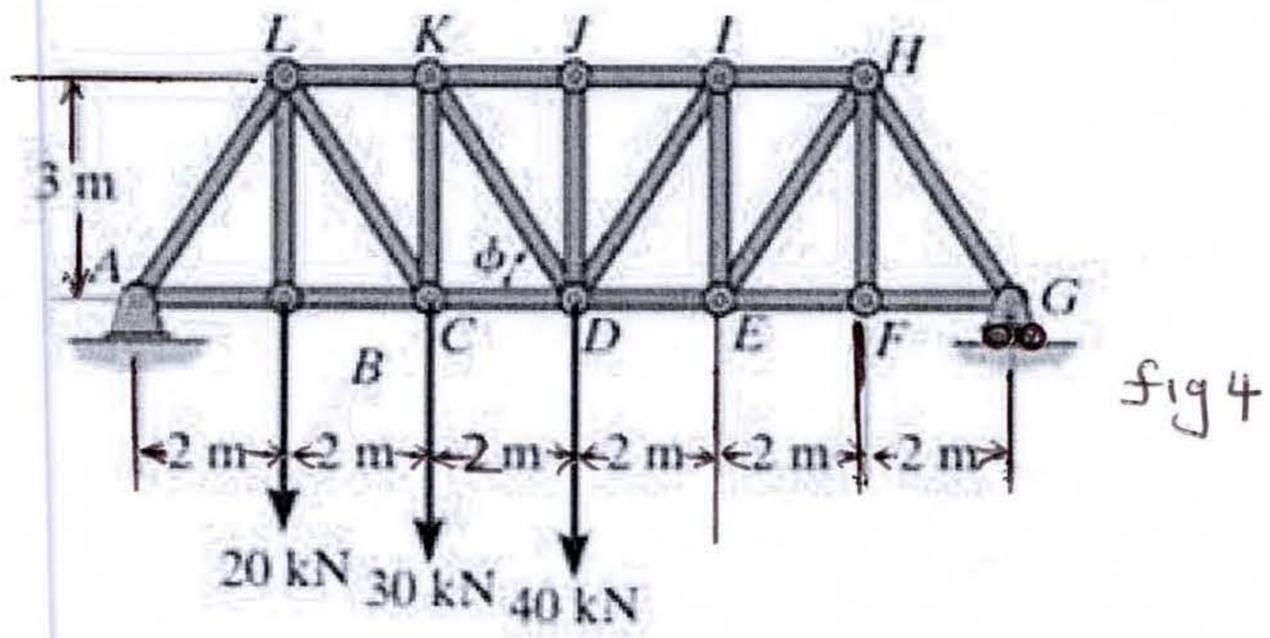
Fig .3

For the given beam structure in **Fig 3**

- i. Determine the reactions at the supports [2]
- ii. Draw the shear force diagram [4]
- iii. Draw the bending moment diagram [4]

### QUESTION 2

- a) State any 3 assumptions in truss analysis [3]
- b) **Fig. 4** shows Pratt truss



- For the given truss structure in Fig 4 .
- i. Calculate the reactions at the supports [4]
  - ii. Determine the forces in members **LK, KC, CD, KJ, and KD**. State whether each member is in tension or compression [13]

**QUESTION 3**

- a) Define deflection and slope in the context of beam bending. How are they related? [3]
- b) Explain the double integration method for determining the deflection of a beam. What are the boundary conditions used in this method? [5]
- c) Fig . 5 shows a cantilever beam

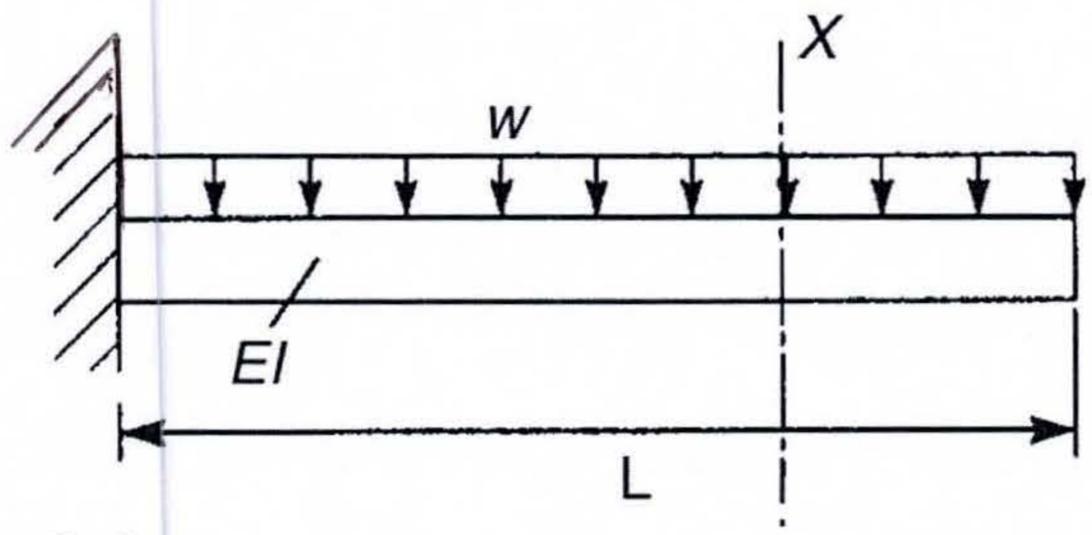


Fig .5

Determine the deflection curve of the cantilever beam [12]

#### QUESTION 4.

Fig.6 shows a truss, the cross-sectional area of each member is  $1700 \text{ mm}^2$  and Young's modulus,  $E$ , for the material of the members is  $190\,000 \text{ N/mm}^2$

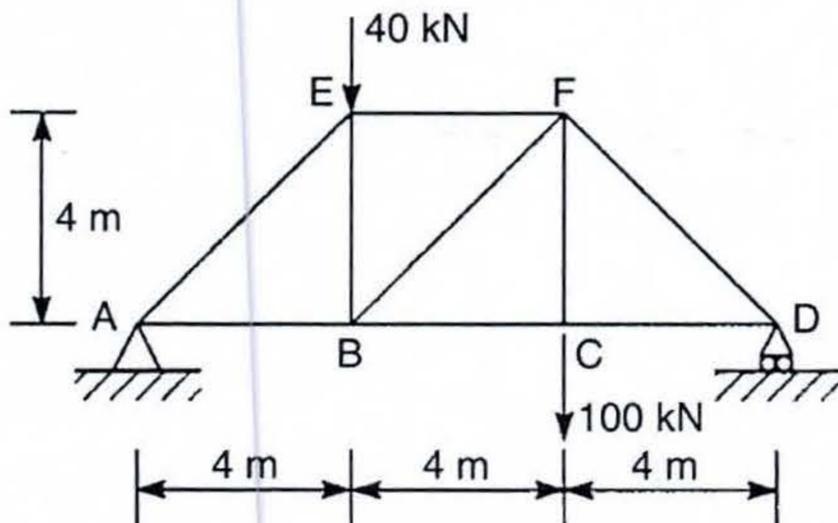


Fig.6

- Calculate the vertical deflection of the joint B [10]
- The horizontal movement of the support D in the truss shown in 6 . [10]

#### QUESTION 5

- Define stress and strain. [2]
- State Hooke's law with equation. [2]
- A tensile test was conducted on a mild steel bar. The following data was obtained from the test:

Diameter of the steel bar = 3 cm  
Gauge length of the bar = 20 cm  
Load at elastic limit = 250 kN  
Extension at a load of 150 kN = 0.21 mm  
Maximum load = 380 kN  
Total extension = 60 mm  
Diameter of the rod at the failure = 2.25 cm.

**Determine:**

- The Young's modulus, [2]
- The stress at elastic limit, [2]
- The percentage elongation, and [2]
- The percentage decrease in area [2]

c ) A member ABCD in Fig .7 is subjected to point loads P1, P2, P3 and P4

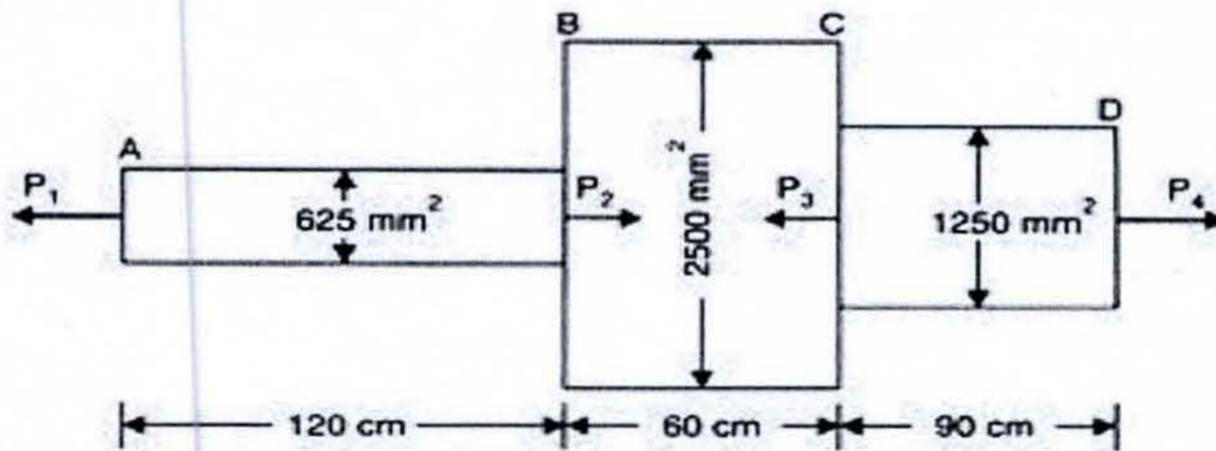


Fig.7

If  $P_1 = 45 \text{ kN}$ ,  $P_2 = 365 \text{ kN}$ ,  $P_3 = 450 \text{ kN}$ ,  $P_4 = 130 \text{ kN}$ .

Determine the total elongation of the member. Assuming the modulus of elasticity is  $2.1 \times 10^5 \text{ N/mm}^2$  [8]

**QUESTION 6**

a ) A cantilever in Fig.8 of length 3 m carries two-point loads of 2 kN at the free end and 4 kN at a distance of 1 m from the free end.

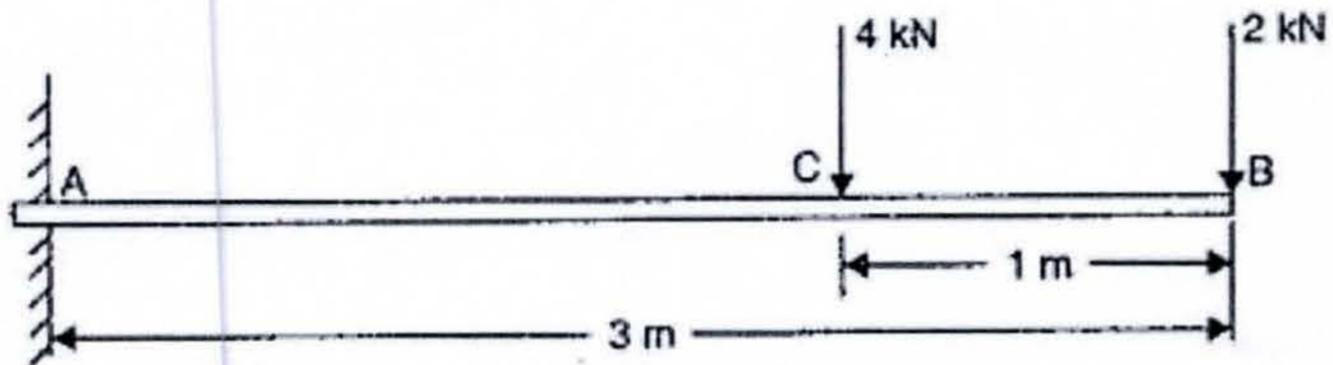


Fig .8

Find the deflection at the free end. Take  $E = 2 \times 10^5 \text{ N/mm}^2$  and  $I = 108 \text{ mm}^4$  [14]

b) The cable shown in Fig. 9 is pinned to supports at A and B, and carries a concentrated load of 10 kN at a point C.

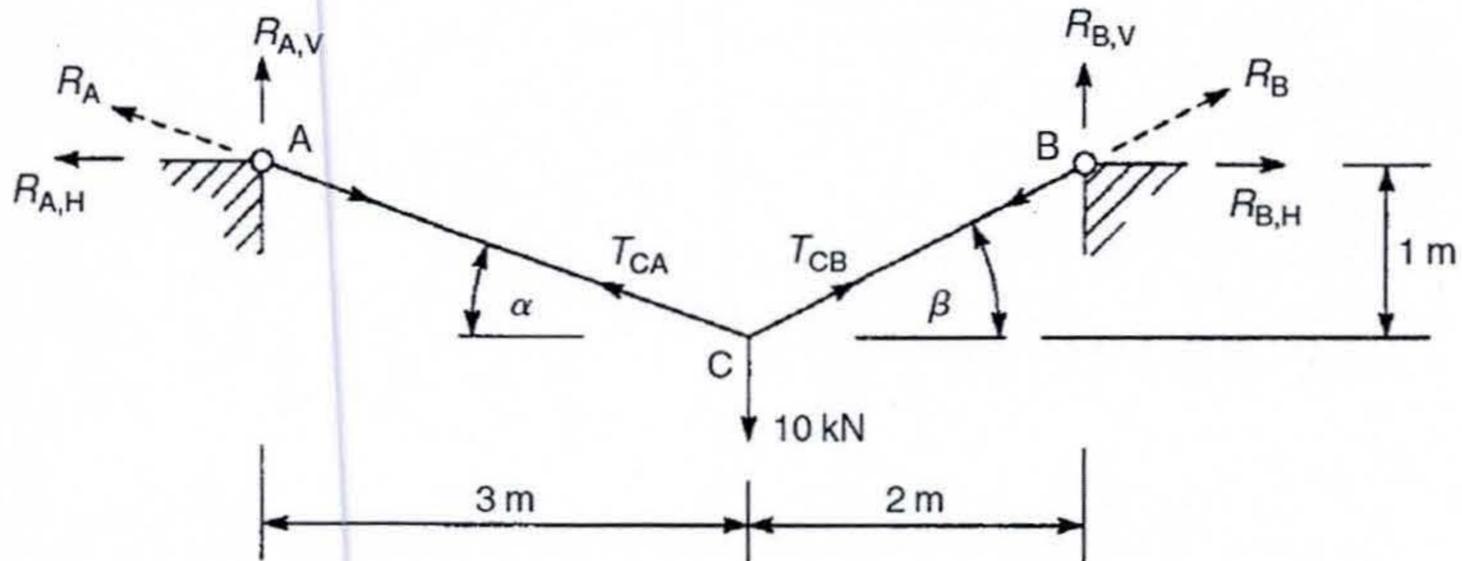


Fig .9

- i. Reactions at the supports A and B [2]
- ii. Calculate the tension in each part of the cable and the reactions at the supports [4]

**THE END**