



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
INNOVATION, SCIENCE AND TECHNOLOGY DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

HIGHER NATIONAL DIPLOMA

IN

CIVIL ENGINEERING

SUBJECT: Theory of Structures

**PAPER NO: 778/17/S04
778/16/S04**

DURATION: 3 hours

OCTOBER/NOVEMBER 2024 EXAMINATION

REQUIREMENTS

1. Scientific calculator
2. Graph paper

INSTRUCTIONS TO CANDIDATE

Answer any five (5) questions.

QUESTION 1

- a) A steel transmission shaft is 510mm long and 50mm external diameter. For part of its length, it is bored to a diameter of 25mm and for the rest to 38mm diameter. Find the maximum power that may be transmitted at a speed of 210rev/min if the shear stress is not to exceed 70MN/m^2 . (12 marks)
- b) If the angle of twist in the length of 25mm bore is equal to that in the length of 38mm bore, determine the length bored to 38mm diameter. (8 marks)

QUESTION 2

A material is subjected to two mutually perpendicular direct stress of 80MN/m^2 tensile and 50MN/m^2 compressive, together with a shear stress of 30MN/m^2 . The shear couple acting on planes carrying the 80MN/m^2 stress is clockwise in effect.

Calculate:

- a) the magnitude and nature of the principal stresses (10 marks)
- b) the magnitude of the maximum shear stresses (5 marks)
- c) the directions of the planes on which these stresses act (5 marks)

[HINT: Take the 50MN/m^2 stress as σ_x]

QUESTION 3

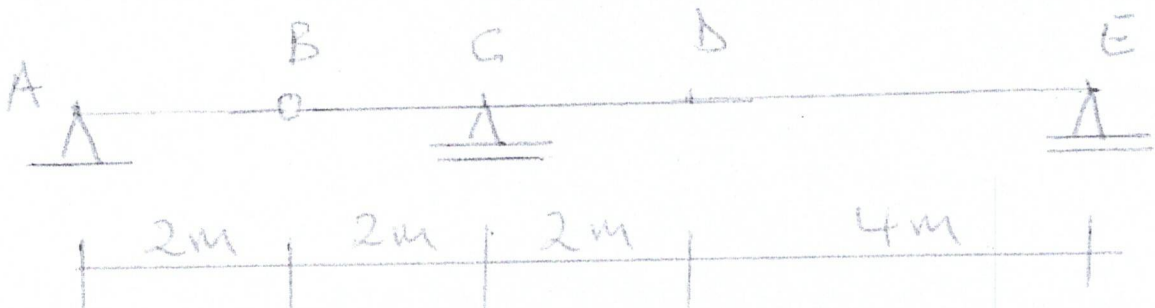


Fig. Q3

For the beam shown in Fig. Q3:

- draw the influence line for the moment development at point D. (8 marks)
- determine the maximum positive moment at point D due to a concentrated moving load of $16kN$, a uniform moving load of $3kN/m$ and a beam weight of $2kN/m$. (12 marks)

QUESTION 4

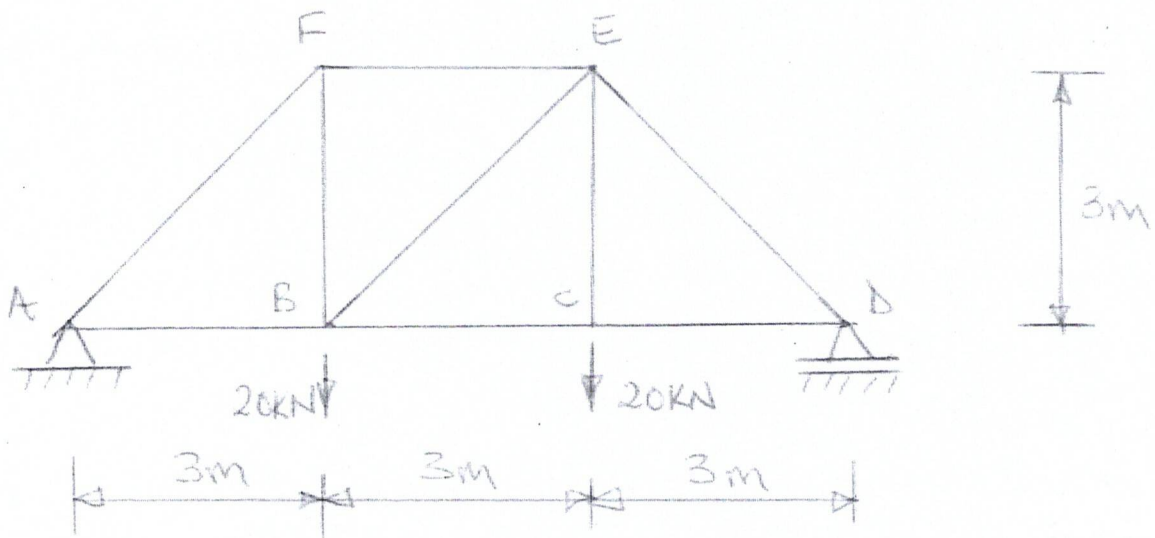


Fig.Q4

Use the method of virtual work to determine the vertical displacement of joint C of the steel truss shown in Fig.Q4. The cross sectional area of each member is $A = 300mm^2$ and $E = 200GPa$. (20 marks)

QUESTION 5

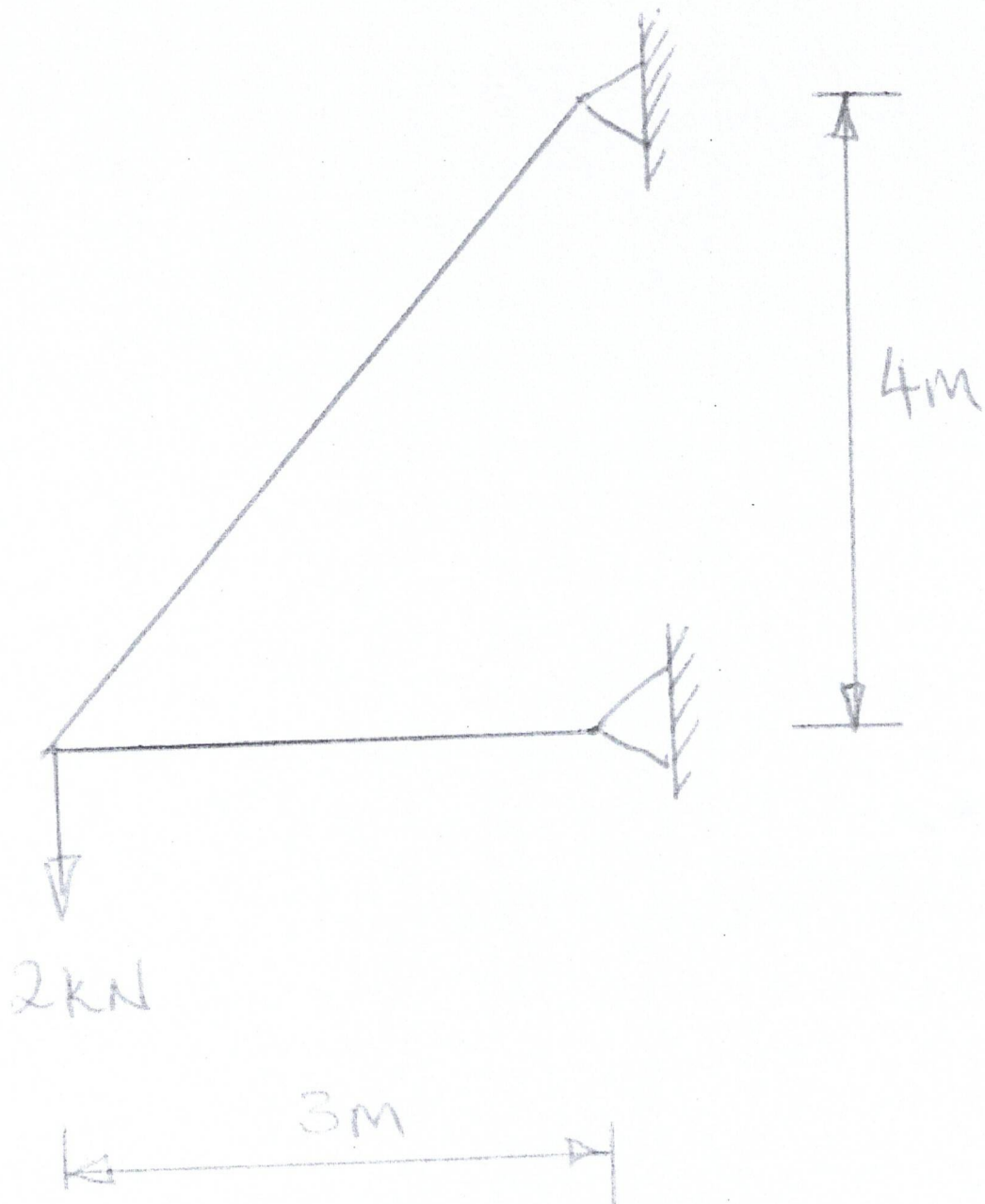


Fig. Q5

Determine the force in each member of the truss shown in Fig. Q5. Use the matrix stiffness method. Assume AE is constant. (20 marks)

QUESTION 6

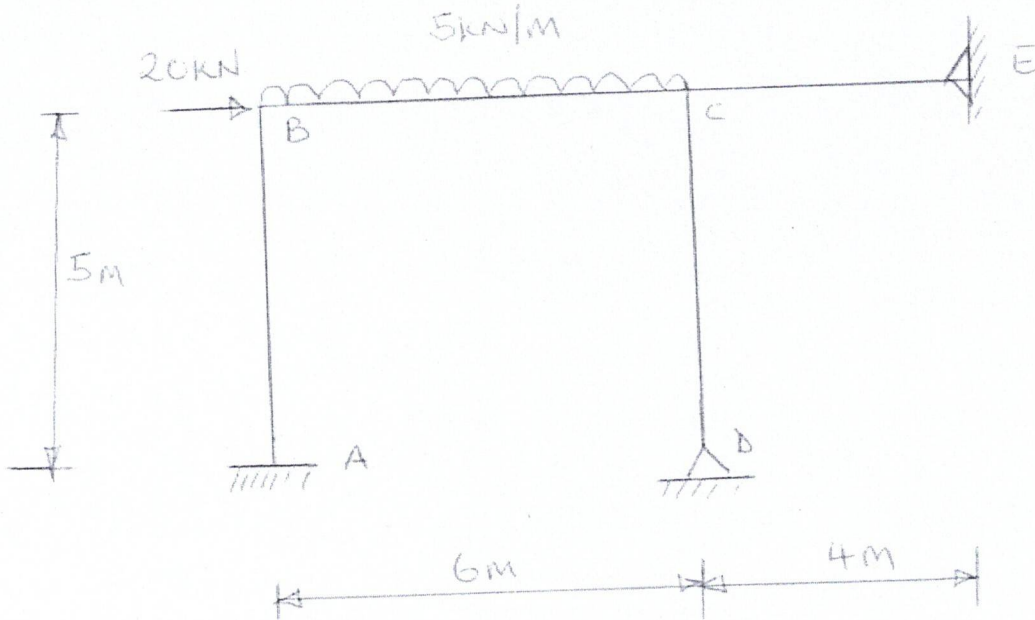


Fig. Q6

Determine all the reactions at the supports for the frame shown in Fig. Q6. Sketch the shear force and bending moment diagrams. Assume EI is constant for all members. (20 marks)