



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

DURATION: 3 Hours

MARCH / APRIL 2022 EXAMINATION

REQUIREMENTS

Scientific calculator, answer booklet

INSTRUCTIONS TO CANDIDATE

- 1) Answer any four (4) questions in three (3) hours.
- 2) Show all working and formulae.
- 3) Each question carries 25 marks.
- 4) Start each question on a fresh page.

This paper consists of 4 printed pages.

QUESTION 1

A vertical column of 8m height is to carry a crane girder load of 50kN applied at an eccentricity of 0,2m. Calculate the moments at A(top support) and B (bottom support) due to this load assuming both ends are fixed. The load is applied at a point 2m below the top support at the aforementioned eccentricity.
(25 marks)

QUESTION 2

a) Consider a cylinder attached to a fixed wall, with constant diameter $d=4\text{cm}$ and length $L=2\text{m}$ and a torque of 8Nm is applied. Use Castiglianos Theorem to find displacement of the cylinder assuming $G=120\text{GPa}$.
(10 marks)

b) Find the principal stresses in a body under the stress state

$$\delta x = 10, \delta y = 8, \sigma_z = -5$$

$$\tau_{yz} = \tau_{zy} = 5$$

$$\tau_{zx} = \tau_{xz} = -4$$

$$\tau_{xy} = \tau_{yx} = -8$$

Where all stresses are in MPa.

(10 marks)

c) Distinguish between an influence coefficient and an influence line.

(5 marks)

QUESTION 3

a) i) Define a fully plastic moment of a section.
(2 marks)

ii) State any five assumptions used for finding the plastic moment of a section.
(5 marks)

b) Consider a three span continuous beam, in Fig Q3b, of uniform section throughout. Use the kinematic method to determine the collapse load.
(13 marks)

c) Distinguish between the static theorem and the kinematic theorem.

(5 marks)

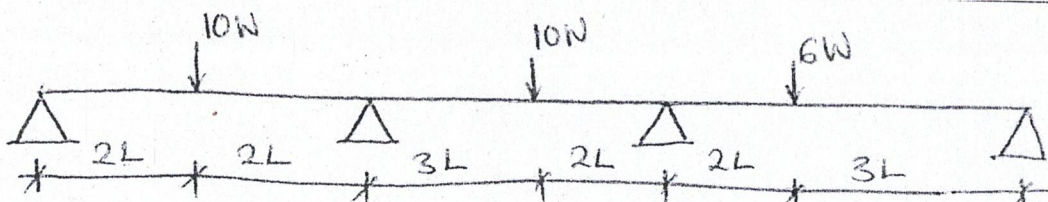


Fig Q3b

QUESTION 4

Use the matrix stiffness method to determine the rotation of the joints and the bending moment diagram for the frame in fig Q4. Neglect axial deformations and take $EI=1 \times 10^3$.

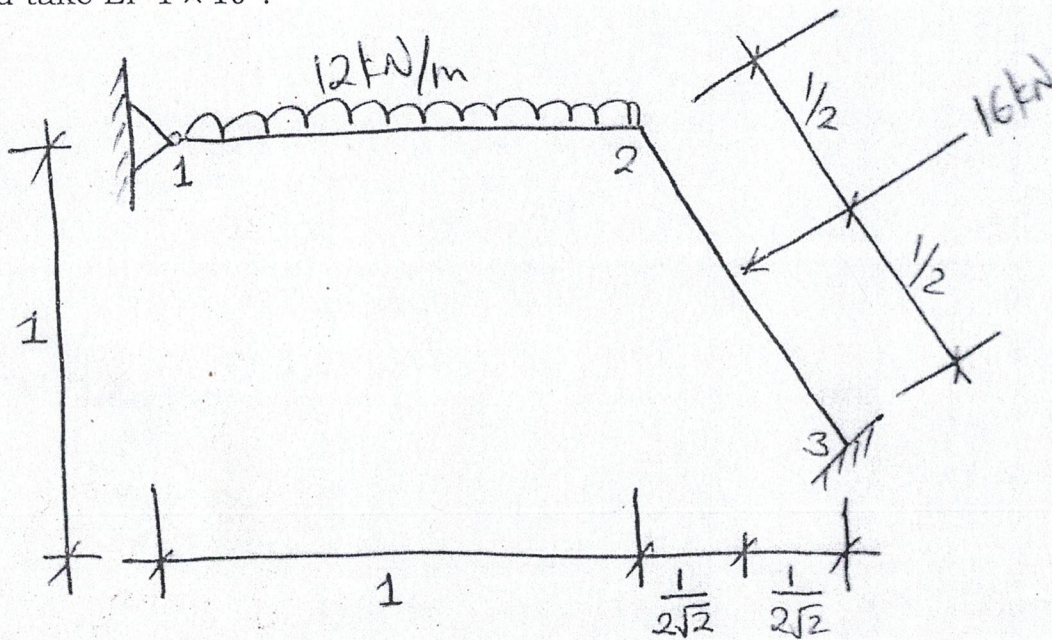


Fig Q4

QUESTION 5

- Find the vertical deflection of joint B in the pin pointed frame of Q5a. Members AB and BC are timber with $E=5\text{KN/mm}^2$, the others steel with $E=200\text{KN/mm}^2$. The sections are solid square with sides 300mm and 50mm respectively. (10 marks)
- What additional deflection would be produced by drying out of the timber members assuming that shrinkage is 0.1% of their length. (5 marks)
- A beam ABC is simply supported at A and B, with AB 8m and BC 4m. Sketch the influence lines for the reactions at A and B and the shear force and bending moment at a point D midway between A and B. Use the influence lines to determine the maximum positive bending moment when a uniformly distributed load longer than AB and of intensity 20kN/m crosses the beam. (10 marks)

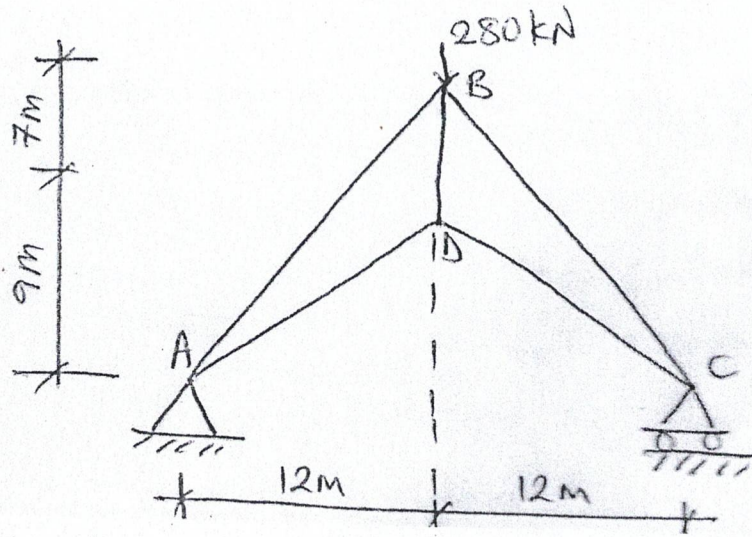


Fig Q5a.

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