ZIMBABWE

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

HIGHER EDUCATION EXAMINATIONS COUNCIL (HEXCO)

NATIONAL DIPLOMA

IN

CIVIL ENGINEERING

SUBJECT: Theory of Structures PAPER NO: 578/15/S02

DURATION: 3 hours

MARCH/APRIL 2022 EXAMINATION

REQUIREMENTS

Scientific Calculator

INSTRUCTIONS TO CANDIDATE

1. Answer any five (5) questions.
2. All questions carry equal marks.
3. Start each question on a fresh page.

This paper consists of 5 printed pages.

QUESTION 1

Analyse the following by slope deflection method. Draw the shear force diagram and the bending moment diagram. EI is constant (Fig. 1).

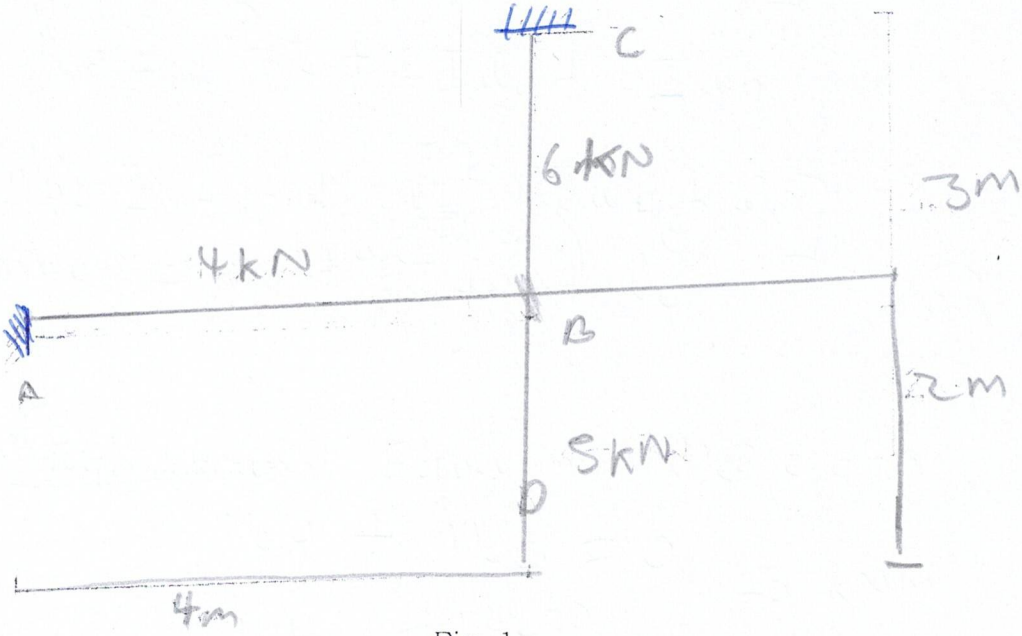

Fig. 1.

QUESTION 2

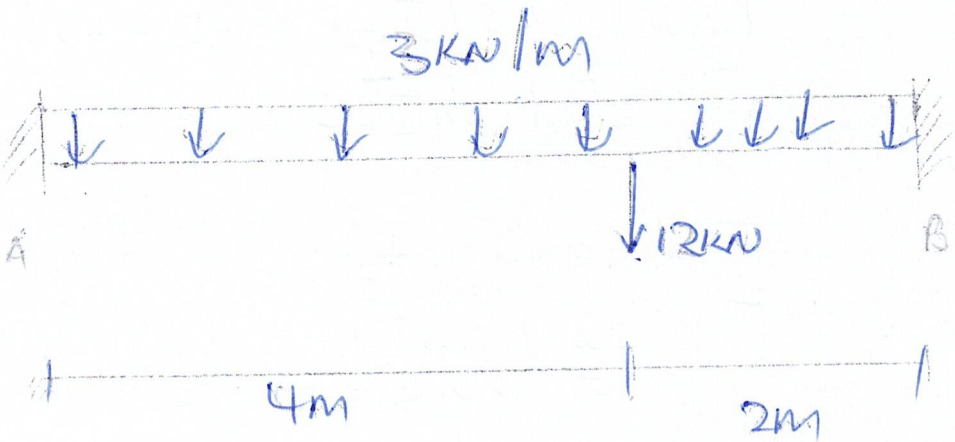

Fig. 2

Determine the maximum deflection for the encastre beam shown in Fig. 2 as an expression of EI. (20 marks)

QUESTION 3

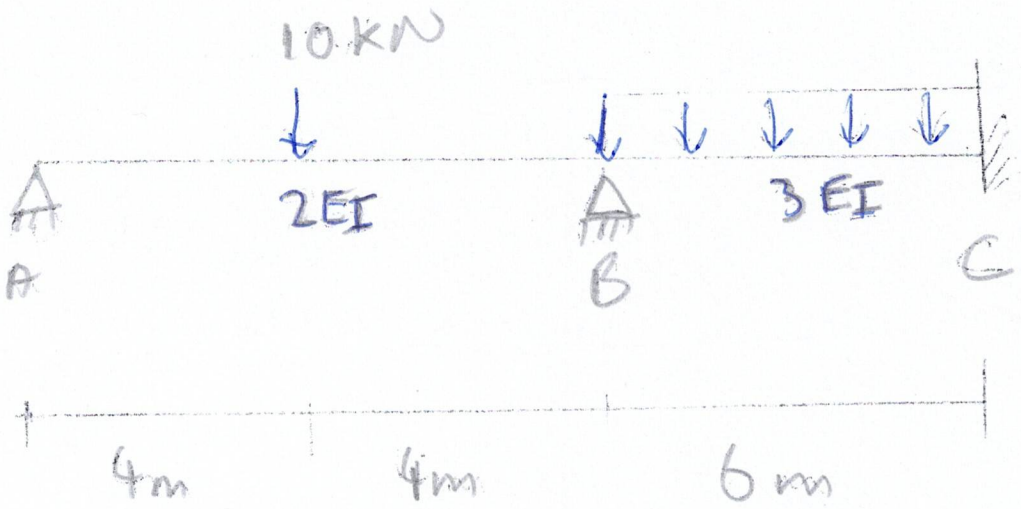

Fig. 3

Use the moment distribution to determine the end moments for the beam shown in Fig. 3. Determine the support reactions. Draw the shear force diagram and bending moment diagram. (20 marks)

QUESTION 4

a) Give Euler's formula for the following cases:

i) Pin ended column

ii) Pinned on one end, fixed on the other

iii) Fixed ended column

iv) Fixed at the bottom, free at the top (8 marks)

b) Find the Rankine critical wad for a strut with an I-section as shown in Fig. 4 given:

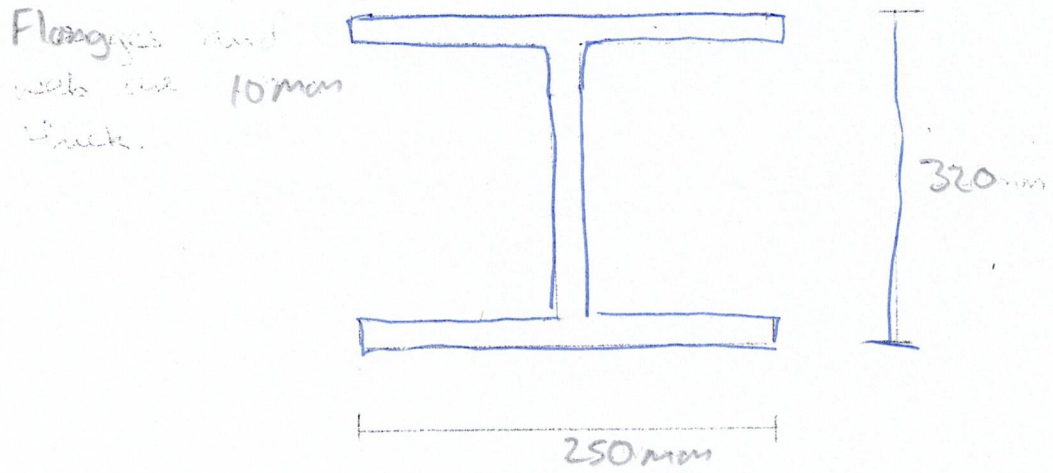

Fig. 4.

$\sigma_n = 325MPa$, E= $205MPa$ and L= $16m$. The strut is built in rapidly at each end. Flanges and web are $10mm$ thick. (12 marks)

QUESTION 5

A 4 meter supply supported beam shown in Fig. 5 is carrying a central 1kN point load. Determine the shear force at the support and draw the shear stress distribution diagram on the supports. (20 marks)

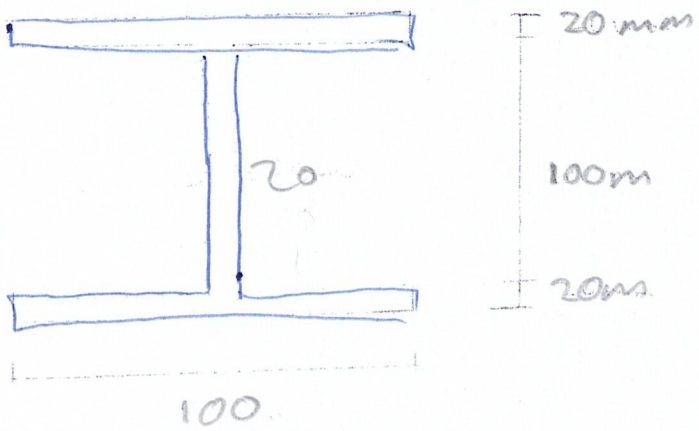

Fig. 5

QUESTION 6

a) What will be the stress induced in a steel bar when it is heated from 15°C to 60°C, all expansion being prevented. For mild steel:

$E = 210GN/m^2$

$\alpha = 11 \times 10^6 \, per \, °C$ (4 marks)

b) A standion is formed by bull welding together four plates of steel to form a square tube of outside cross-section $200mm \times 200mm$. The constant metal thickness is $10mm$. The inside is then filled with concrete.

i) Determine the cross sectional area of the steel and concrete. If E for steel is $250GN/m^2$ and this value is twenty times that for concrete. Find when the standion carries a load of 368.8kN.
ii) The stress in the concrete.
iii) The stress in the steel.
iv) The amount the standion shortens over a length of $2m$. (12 marks)

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