ZIMBABWE

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

HIGHER EDUCATION EXAMINATIONS COUNCIL (HEXCO)

NATIONAL DIPLOMA

IN

CIVIL ENGINEERING

SUBJECT: Strength of Materials and Civil Engineering Calculations

PAPER NO: 578/23/M04

DURATION: 3 hours

MAY/JUNE 2024 EXAMINATION

REQUIREMENTS

Calculator

INSTRUCTIONS TO CANDIDATE

1. Answer questions one and two and any other two of your choice.
2. Question one and two carry 30 marks each.
3. Question 3, 4 and 5 carry 20 marks each.
4. Start each question on a new page.
5. Do not tear pages from booklets.

This paper consists of 4 printed pages.

PAPER NO: 578/23/M04 – STRENGTH OF MATERIALS AND CIVIL ENGINEERING CALCULATIONS

QUESTION 1

a) Differentiate the function $y = \frac{x^3 e^x \sin x}{(1+x)^2}$ with respect to x, using logarithmic differentiation or otherwise. (5 marks)

b) Resolve $\frac{x^2-2x}{(x+1)(2+x^2)}$ into partial fractions. (5 marks)

c) Solve for x correct to 2 decimal place: $3\cosh x - 5\sin x = 30$ (5 marks)

d) Evaluate $\int_1^2 x^2 \, lnx \, dx$, correct to 3 significant figures. (5 marks)

e) Expand $xln\,(1+x)$ as a series of ascending powers of x up to the term in x^4, using Maclaurin's theorem. (5 marks)

f) Find the centre of gravity of a uniform lamina whose area is branded by $y = x^2$, $x = 2, x = 6$ and the *x-axis*. (5 marks)

QUESTION 2

a) Compare and contrast encastre and simply supported beams. (4 marks)

b) An encastre beam carries a central point load of 10kN and a uniformly distributed load of 2kN/m for the entire span of the beam. The beam spans 8m. Determine the following:

i) The reactions at the supports (4 marks)
ii) Sketch the shear force and bending moment diagram. (4 marks)
iii) The deflection under the point load in terms of EI. (4 marks)

c) State the assumptions made when deriving the Euler formula for a strut with pin-jointed ends. (4 marks)

d) Derive the Euler crippling load for such a strut. (4 marks)

e) A straight steel rod 350mm long and 6mm diameter is loaded axially in compression until it buckles. Assuming that the ends are pin-jointed, find the critical load using the Euler formula. Also calculate the maximum central deflection when the material reaches a yield stress of 300MN/m^2 compression. Take E= 200GN/m^2. (6 marks)

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QUESTION 3

a) Explain the principle of the moment-area method in the analysis of structures. (4 marks)

b) Analyse the continuous beam shown in Fig. A3(b) using the 3-moment equation method. Draw the shear force and bending moment diagrams.

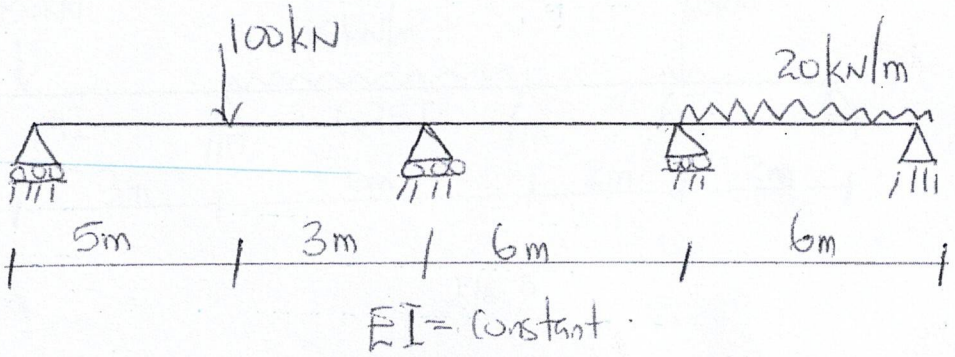

Fig. Q3(b)

(16 marks)

QUESTION 4

Determine the end moments for the portal frame shown below using the moment distribution method then draw the bending moment and shear force diagram (Fig. 4).

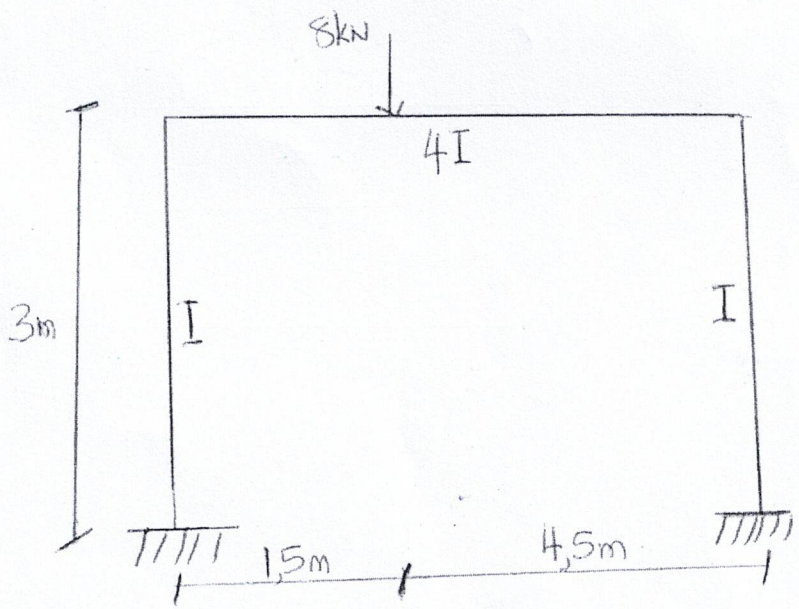

Fig. 4

(20 marks)

QUESTION 5

Analyse the beam below using the slope deflection method and draw the bending moment and shear force diagram (Fig. 5).

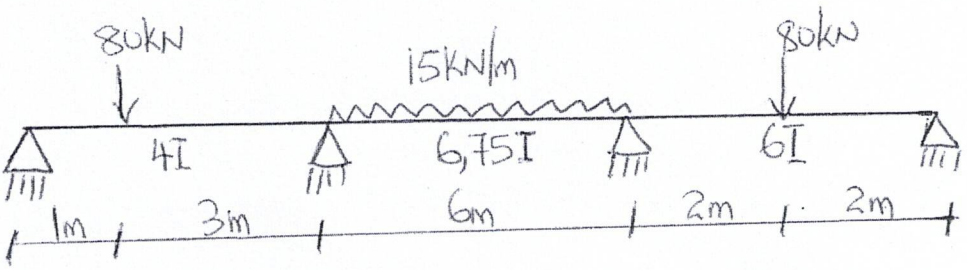

Fig. 5

(20 marks)

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