UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG (HONS) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2023/24

STRUCTURAL ANALYSIS AND DETAILED DESIGN

MODULE NO: CIE5016

Date: Tuesday, 09 January 2024   **Time : 10:00 AM – 12:00 PM**

INSTRUCTIONS TO CANDIDATES:

There are **FOUR questions** in this paper.

Answer **ALL** questions.

Answer Section A and Section B questions in separate answer books.

Marks for parts of questions are shown in the brackets.

This examination paper carries a total of 100 marks.

Formula sheet / supplementary information is provided at the end of question paper.

All working must be shown. A numerical solution to a question obtained by programming an electronic calculator will not be accepted.

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SECTION A: STRUCTURAL ANALYSIS
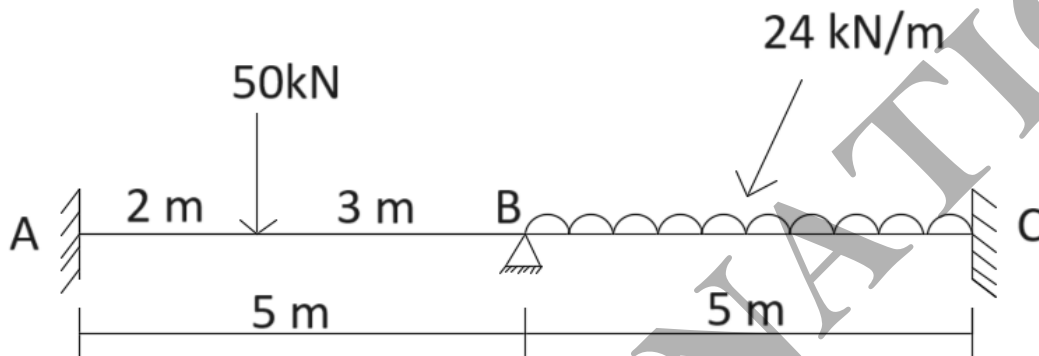
Question 1

Figure Q1

Figure Q1 shows a 2-span beam ABC which is simply supported at B and fixed at support A and C. Analyse the beam by Moment Distribution Method.

i) Find fixed end moments for span AB and BC.

(4 marks)

ii) Calculate Stiffness factors and distribution factors at joint B.

(4 marks)

iii) Calculate the bending moments at A, B & C.

(10 marks)

iv) Sketch the bending moment diagram for the whole beam.

(7 marks)

A table of Fixed-End Moments is provided in **Table Q1** on **Page 3.**

Total 25 marks

Question1 continued over…

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Question 1 continued…

Table Q1
Fixed End Moments

FIXED-END MOMENTS			
FEM_{AB}	A	B	FEM_{BA}
$-\dfrac{wL^2}{12}$	w kN/m, L		$\dfrac{wL^2}{12}$
$-\dfrac{PL}{8}$	P kN, L		$\dfrac{PL}{8}$
$-\dfrac{Pab^2}{L^2}$	P kN, a, b, L		$\dfrac{Pa^2b}{L^2}$
$-\dfrac{3PL}{16}$ $Reaction = \dfrac{11P}{16}$	P kN, L		0 $Reaction = \dfrac{5P}{16}$
$-\dfrac{wL^2}{8}$ $Reaction = \dfrac{5wL}{8}$	w kN/m, L		0 $Reaction = \dfrac{3wL}{8}$

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Question 2

(a) **Figure Q2 (a)** shows a simply supported beam of span 6m that carries a UDL of 5 kN/m over a length of 3 m from left end. By using Macaulay's Method, calculate deflection at C.

$E = 2 \times 10^5 \, \text{N/mm}^2$, $I = 6.2 \times 10^6 \, \text{mm}^4$.
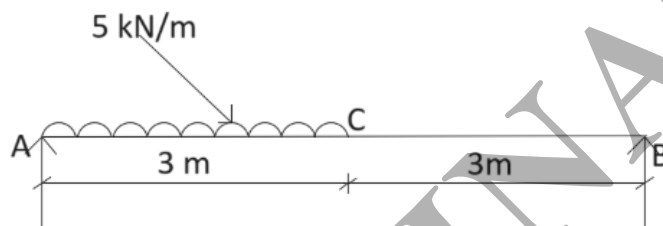
Figure Q2 (a)

(10 marks)

(b) **Figure Q2 (b)** shows a steel girder simply supported at the ends A and B. It carries two concentrated loads of 90 kN and and 60 kN at 3m and 4.5m from the two ends A & B respectively. The beam has uniform rigidity EI. Use Macaulay's method and calculate the deflection of the girder at the points C & D under the two loads.
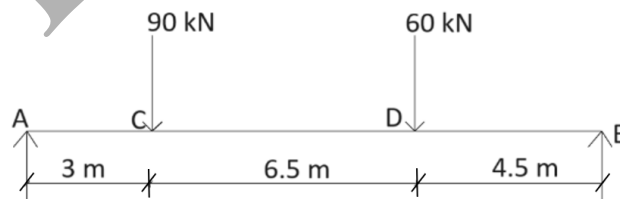
Figure Q2 (b)

(15 marks)

Total 25 marks

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SECTION B: STRUCTURAL DESIGN

Question 3

(a) A connection comprises of 6 bolts, arranged in pairs as shown in **Figure Q3(a).**
The plate thickness is 6mm and column thickness is 11mm.

i) Determine the direct shear and bending shear acting on each bolt   (6 marks)

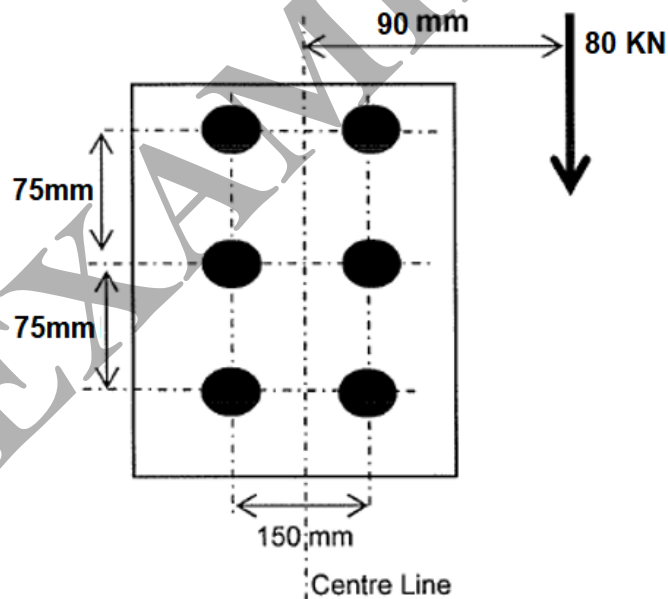ii) Determine the resultant shear in the hardest working bolt   (6 marks)

Figure Q3(a) Bolted Connection

Note: Engineers Bending Equation is $\dfrac{M}{I} = \dfrac{\sigma}{y} = \dfrac{E}{R}$

Question 3 continued over…

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Question 3 continued…

(b) Design a singly reinforced concrete beam, Using the following data:

Height of the section, h =425mm

Width of the section, b = 200mm

Cover to reinforcement= 25mm

Bending Moment, M = 55 kN/m

Cylinder Strength, fck = 20 N/mm^2

Reinforcement strength= 500 N/mm^2

Assume bar diameter as 20mm and link diameter as 10mm for calculating the effective depth (d).

(13 marks)

Total 25 marks

Question 4

(a) Explain in detail the schematic representation of different system boundaries in a building's life cycle

(8 marks)

(b) Evaluate the preliminary sizing of the beam shown in **Figure Q4 (b)** and calculate the embodied carbon in the beam. The grade of concrete is C30. The imposed load on the slab V$_A$ is 4.5 KN/m^2.

(17 marks)

Total 25 marks

Question 4 continued over…

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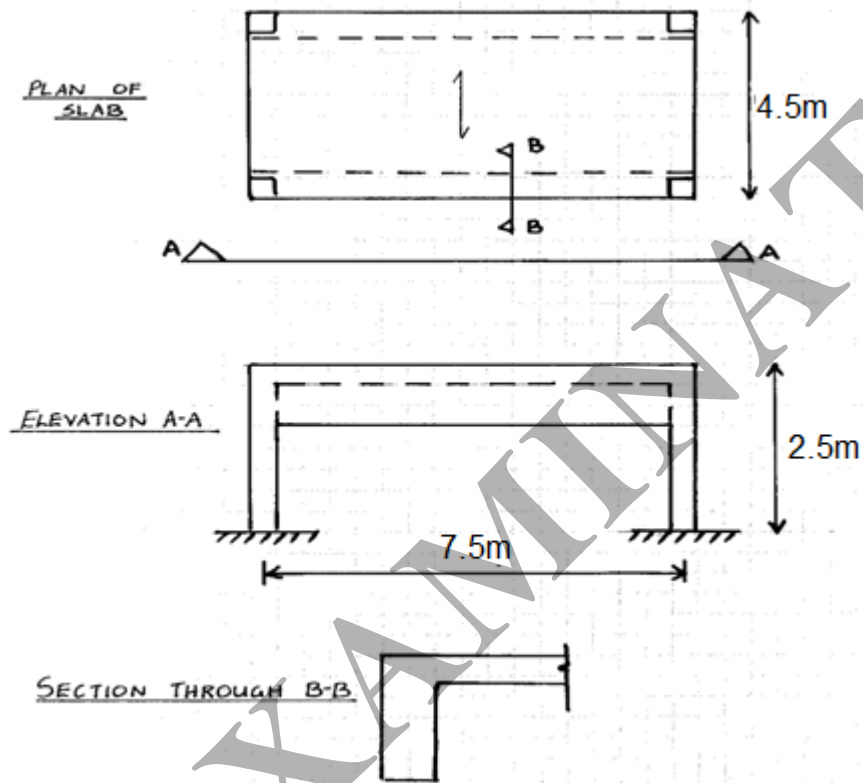Module No. CIE5016

Question 4 continued…

Figure Q4(b)

END OF QUESTIONS