UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG (HONS) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2024/2025

STRUCTURAL ANALYSIS AND DETAILED DESIGN

MODULE NO: CIE5016

Date: Saturday, 11 January 2025 **Time: 10:00 am – 12:00 pm**

INSTRUCTIONS TO CANDIDATES:

There are FOUR (4) questions in this paper.

Answer ANY THREE (3) 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 75 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

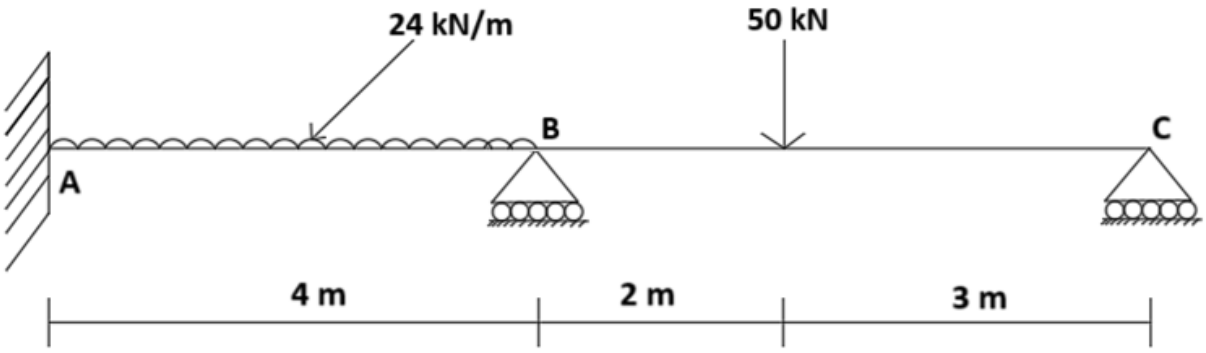

Figure Q1

Figure Q1 shows a 2-span continuous beam ABC which is simply supported at B & C and fixed at support A. A point load 50 kN is positioned 3 meters from support C, and a uniformly distributed load (UDL) of 24 kN/m is applied along the span AB.

i) Find the fixed end moments for spans AB, BC

(5 marks)

ii) Calculate the distribution factor at joint B

(5 marks)

iii) Using the method of **Moment Distribution**, calculate the bending moments at A, B and C

(10 marks)

iv) Sketch the bending moment diagram for the whole beam, showing values at supports and values around mid-spans.

(5 marks)

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

[TOTAL 25 MARKS]

Question 1 continued over the page…

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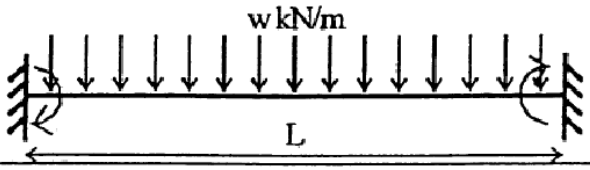
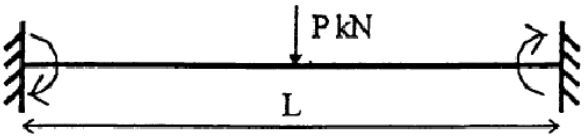
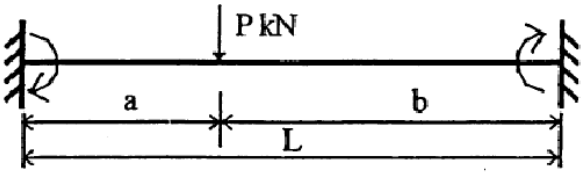
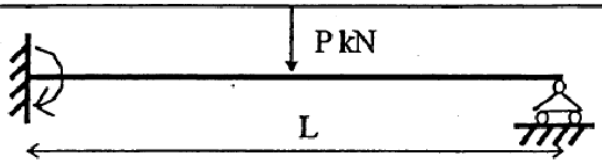
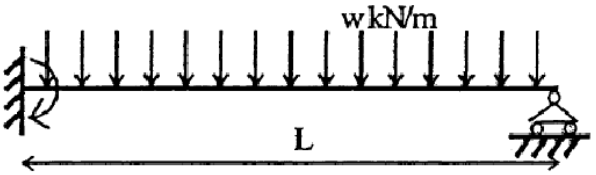
Question 1 continued…

Table Q1

Fixed End Moments

FIXED-END MOMENTS		
FEM_{AB}	A B	FEM_{BA}
$-\frac{wL^2}{12}$		$\frac{wL^2}{12}$
$-\frac{PL}{8}$		$\frac{PL}{8}$
$-\frac{Pab^2}{L^2}$		$\frac{Pa^2b}{L^2}$
$-\frac{3PL}{16}$ $\text{Reaction} = \frac{11P}{16}$		0 $\text{Reaction} = \frac{5P}{16}$
$-\frac{wL^2}{8}$ $\text{Reaction} = \frac{5wL}{8}$		0 $\text{Reaction} = \frac{3wL}{8}$

Please turn the page

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QUESTION 2

Figure Q2 shows a simply supported beam (AB) 8m in length, carrying a uniformly distributed load (UDL) of intensity 10 kN/m over the span DB and a concentrated load of 48 kN load at C.

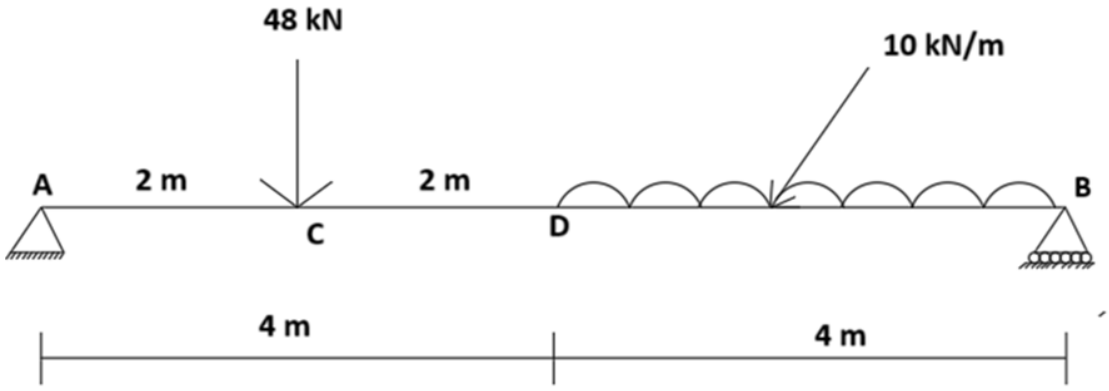

Figure Q2

i) Find the support reactions.

(4 marks)

ii) By using **Macaulay's method** derive the equations for both slope and deflection.

(6 marks)

iii) Calculate the slope at A and B.

(10 marks)

iv) Calculate the deflection at C.

(5 marks)

[TOTAL 25 MARKS]

Please turn the page for section B

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SECTION B: STRUCTURAL DESIGN

QUESTION 3

(a) A connection comprises 8 bolts, arranged in pairs as shown in **Figure Q3(a).** The flange thickness is 13.2 mm, and the beam's overall depth is 528.3mm. What is the tension and shear in the hardest working bolt?

(10 marks)

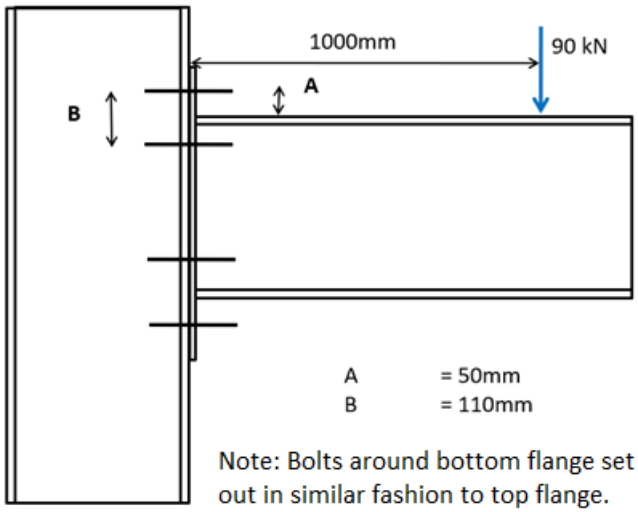

Figure Q3(a): Bolted Connection

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

Question 3 continued over the page…

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Question 3 continued…

(b) A reinforced concrete beam section has limited dimensions due to architectural constraints, requiring it to carry a bending moment larger than the capacity of a singly reinforced section. Given that the section must withstand both positive and negative bending moments due to an applied eccentric load, explain why a doubly reinforced section would be preferred over a singly reinforced section. Discuss how the inclusion of compression steel in a doubly reinforced beam contributes to increased moment resistance, deflection control, and structural resilience in seismic regions.

(15 marks)

[**TOTAL 25 MARKS]**

QUESTION 4

(a) A concrete slab with dimensions 6m X 4m X 0.25m is used in a construction project. The concrete used has a carbon intensity of 300kg CO_{2e}/m^3. Calculate the embodied carbon for the concrete slab.

(5 marks)

(b) A construction company wants to reduce the environmental impact of a new building project. The team is considering different system boundaries to guide choices on materials and design.

i) Define the system boundaries Cradle-to-Gate, Cradle-to-Grave, and Cradle-to-Cradle.

(15 marks)

ii) Which boundary would best help the team understand the full environmental impact, including material disposal or recycling? Explain your reasoning.

(5 marks)

[**TOTAL 25 MARKS]**

END OF QUESTIONS