UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG (HONS) CIVIL ENGINEERING

SEMESTER ONE EXAMINATIONS 2022/2023

STRUCTURAL ANALYSIS AND DETAILED DESIGN

MODULE NO: CIE5016

Date: Saturday, 07 January 2023 **Time: 2.00 pm to 4.00 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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Module No. CIE5016

SECTION A: STRUCTURAL ANALYSIS

Q1

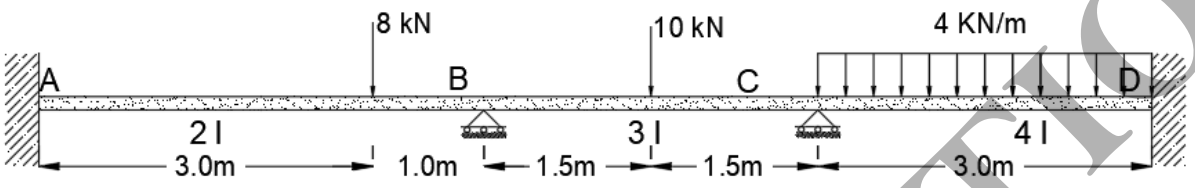

Figure Q1

Figure Q1 shows a 3-span continuous beam ABCD which is simply supported at B and C and fixed to a support at A and D.

i) Find fixed end moments for span AB, BC and CD

(5 marks)

ii) Calculate distribution factors at joint B and C

(5 marks)

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

(10 marks)

iv) Sketch the bending moment diagram for the whole beam, showing values at supports and approximate 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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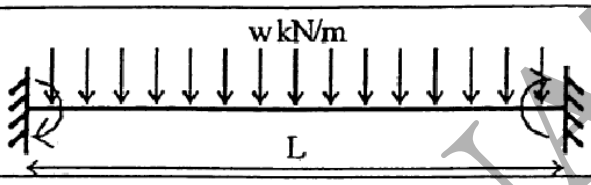
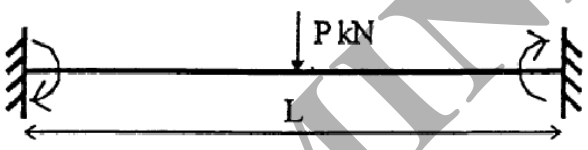
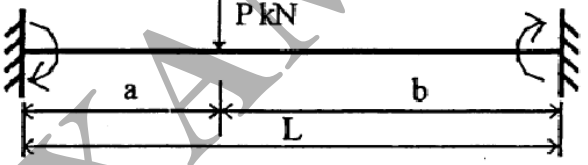
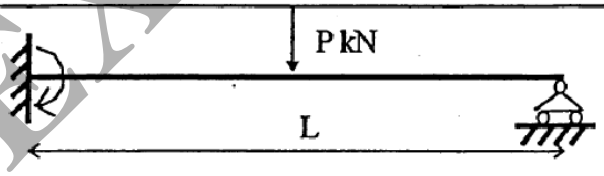
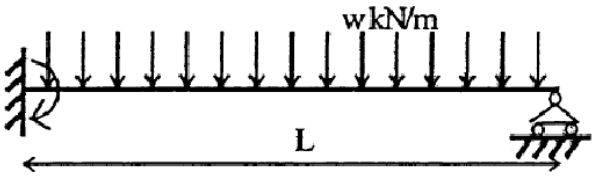
Question 1 continued

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 $\text{Reaction} = \frac{3wL}{8}$

Total 25 marks

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Q2

(a) A cantilever beam 4m long carries a load of 50kN at a distance of 2m from the free end, and a load of W at the free end as shown in Figure Q2 (a). If the deflection at the free end is 25mm. Calculate the magnitude of the load W, and the slope at the free end.

$E = 200kN/mm^2$, $I = 5 \times 10^7\ mm^4$.

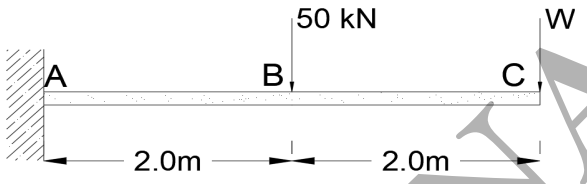

Figure Q2 (a)

(10 marks)

(b) A beam of length 6m is simply supported at its ends and carries two point loads of 48kN at a distance of 1m and 3m respectively from the left support as shown in Figure Q2 (b). The beam has uniform rigidity EI.

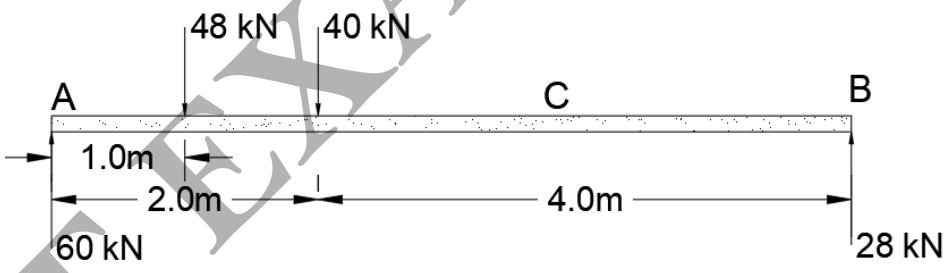

Figure Q2 (b)

i) Determine the general slope and deflection equation using Macaulay's method in terms of EI

(10 marks)

ii) Using derived general deflection equation, calculate the maximum deflection of the beam at B in terms of EI

(5 marks)

Total 25 marks

END OF SECTION A

PLEASE TURN THE PAGE FOR SECTION B

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SECTION B: STRUCTURAL DESIGN

Q3

(a) A connection comprises of 6 bolts, arranged in pairs as shown in **FigureQ3(a)**

i) Which bolt should be checked for tension? (3 marks)

ii) What are the maximum shear and tension loads in the bolts? (10 marks)

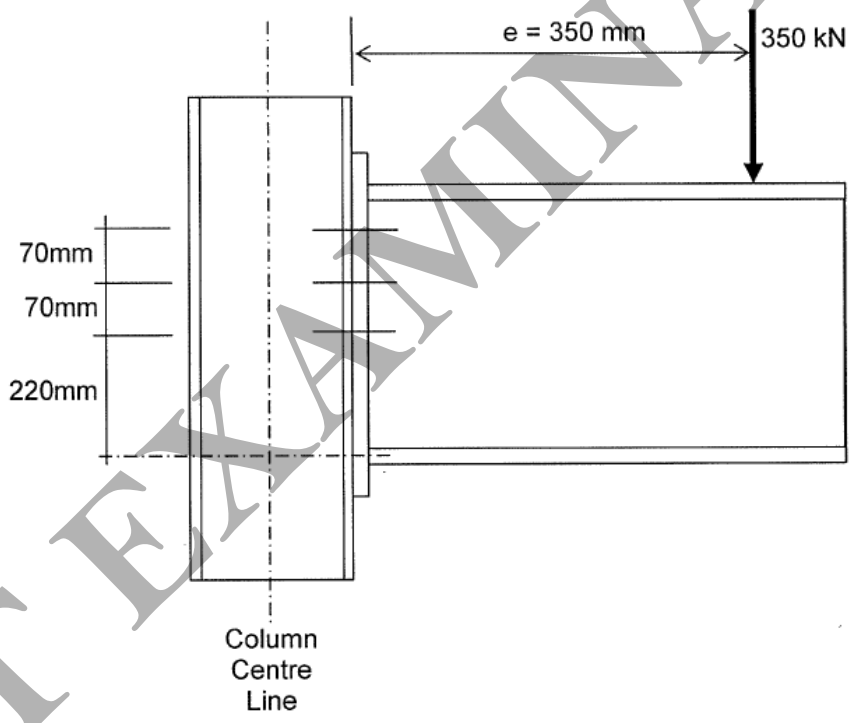

Figure Q3(a)

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 continuous beam as shown in **Figure Q3(b)** has an ultimate bending moment of 675KNm at its supports and 550KNm at its mid span. The shear forces are 550KN at the points of support. The size of the beam is 700mm deep by 500mm wide and it is monolithically cast with a floor slab, making it a T beam. The concrete cover provided is 25mm.It has a fire rating of 1 hour, the grade of concrete is C30/37 and the beam is not directly exposed to water. Yield strength of steel is 500N/mm^2. Determine the tension and shear reinforcement required in the beam. Refer **Table Q3(b)** for Bending Moment and shear coefficients for beam.

(12 marks)

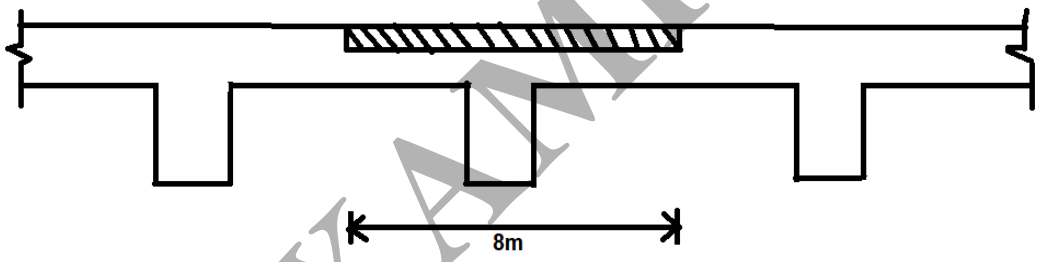

Figure Q3 (b)

Note: $beff = b_w + \sum beff, i$

Table Q3(b): Bending Moment and shear coefficients for a beam with uniform bending and spans

Location	Outer Support	End Span	First Interior Support	Typical Mid Span	Interior Support
Bending Moment	0	0.09Fl	-0.11Fl	0.07Fl	0.1Fl
Shear	0.45F	-	0.6F	-	0.55F

Total 25 Marks

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Q4

(a) Summarize the difference between Embodied Carbon and Embodied Energy?

(8 marks)

(b) Evaluate the preliminary sizing of Slab and Beam shown in **Figure Q4 (b)** and calculate the embodied carbon in the structure. Imposed load on the slab V_A is 4KN/m^2.

(17 marks)

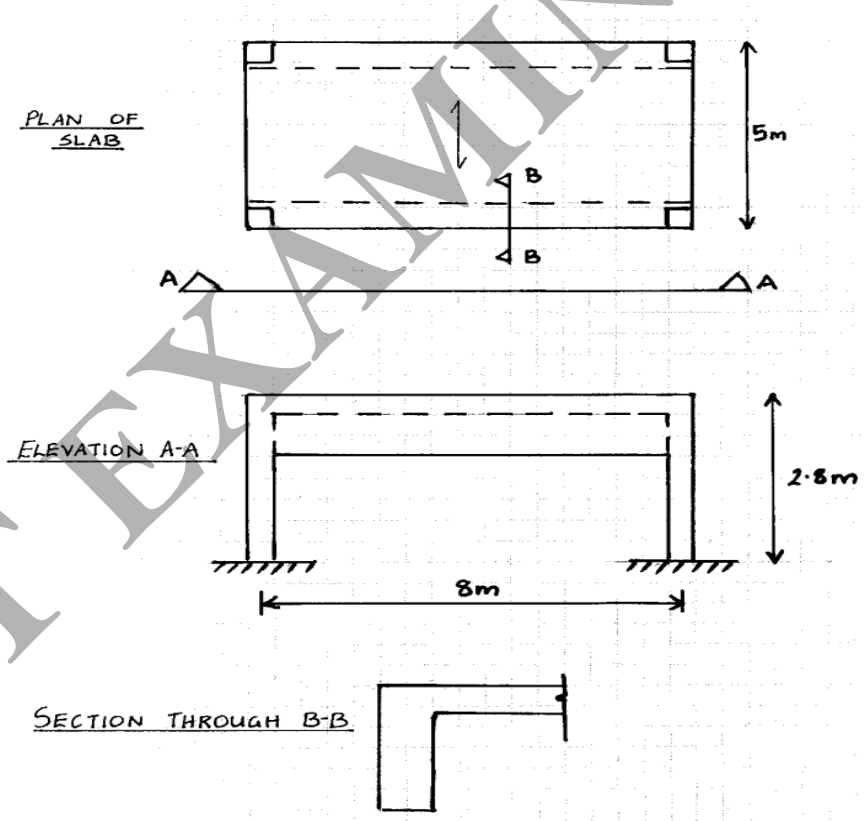

Figure Q4(b)

Total 25 Marks

END OF QUESTIONS

END OF PAPER