UNIVERSITY OF GREATER MANCHESTER

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE, RAS AL KHAIMAH

BENG (HONS) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2025/2026

STRUCTURAL ANALYSIS AND DETAILED DESIGN

MODULE NO: CIE5016

Date: Saturday, 24th January 2026 **Time : 10:00am – 12:00pm**

INSTRUCTIONS TO CANDIDATES:

There are FOUR (4) questions in this paper.

Answer ALL questions.

All questions carry equal marks.

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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Off Campus Division, Western International College – Ras Al Khaimah
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QUESTION 1

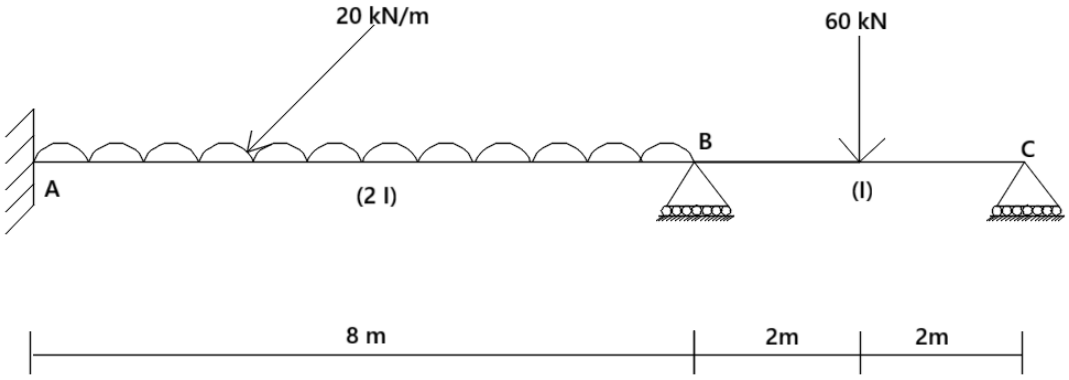

Figure 1: Beam ABC

Figure 1 shows a 2-span continuous beam ABC which is simply supported at B & C and fixed at support A. A point load 60 kN is positioned 2 meters from support B, and a uniformly distributed load (UDL) of 20 kN/m is applied along the span AB.

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

(5 marks)

b) Calculate the distribution factor at joint B

(5 marks)

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

(10 marks)

d) 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 1** on **Page 3.**

[Total 25 marks]

Question 1 continued over the page

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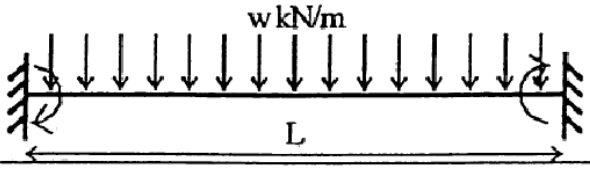
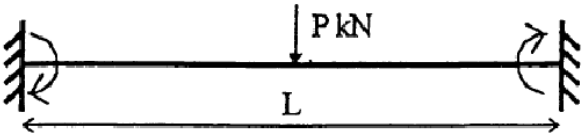
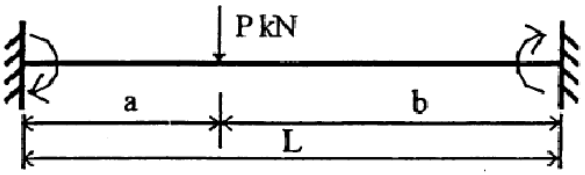
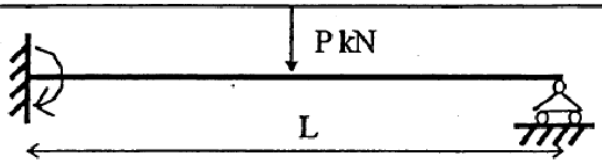
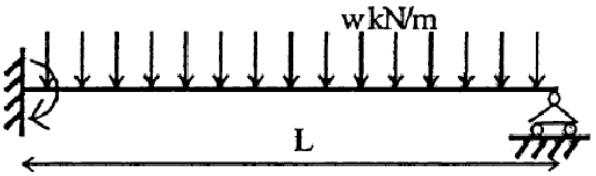
Question 1 continued

Table 1

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 2 shows a simply supported beam (AB) 5 m in length, carrying two point loads of 20 kN and 50 kN at C and D respectively. It also carries a UDL of 60 kN/m over the span DB. Consider E = $200\ GN/m^2$, I = $83\ x\ 10^{-6}\ m^4$.

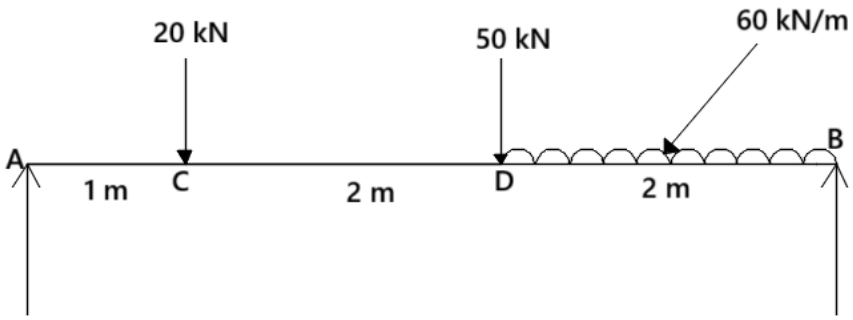

Figure 2 : Beam AB

a) Find the support reactions.

(4 marks)

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

(6 marks)

c) Calculate the slope and deflection at D

(10 marks)

d) Calculate the magnitude of maximum deflection.

(5 marks)

[Total 25 marks]

Please turn the page

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QUESTION 3

a) A steel connection consists of six bolts arranged in three pairs, as shown in **Figure 3**. The connection is subjected to an eccentric load acting at a certain distance from the centroid of the bolt group, causing both direct shear and additional tensile forces due to the moment created by the eccentricity. Based on this arrangement, identify which bolt is expected to experience the maximum tensile force, and determine the maximum shear and tensile forces developed in the bolts by considering both the direct shear from the applied load and the moment-induced forces about the bolt group centroid.

(12 marks)

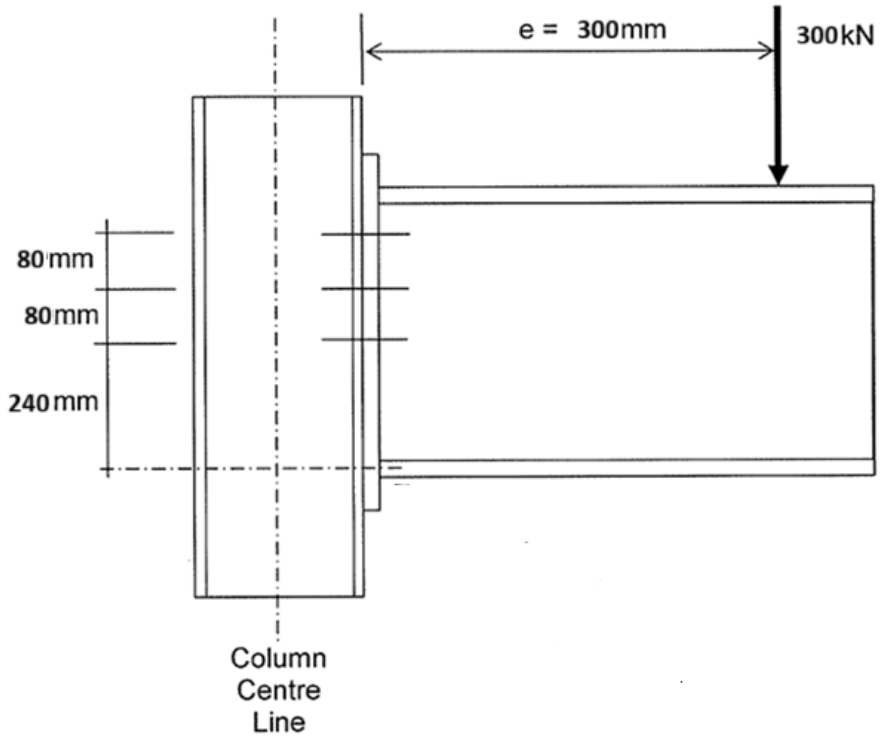

Figure 3 Bolted Connection

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

Question 3 continued over the page

Question 3 continued

b) A 400mm × 400mm reinforced concrete column carries an axial load of 700kN and a bending moment of 35 kNm. It is supported by a square pad footing 1.85m × 1.85m on soil with an allowable bearing capacity of 250 kN/m². Using basic bearing-pressure theory, determine whether the footing is adequate to support the applied load and verify whether the load eccentricity lies within the middle third of the footing dimension. Include a clear, labelled sketch showing the column position, applied load, moment, eccentricity 'e', and the linear pressure diagram.

(13 marks)

[Total 25 marks]

QUESTION 4

a) A reinforced concrete beam measuring 6m in length, 0.30 m in width, and 0.50 m in depth is constructed using C40/50 concrete with an embodied carbon intensity of 0.138 kg CO_2e/kg of concrete. The density of concrete is taken as 2400 kg/m³. Using this information, calculate the total embodied carbon associated with the concrete used in the beam, expressing your answer in kgCO_2e. Assume that the embodied carbon contribution from reinforcement and formwork is negligible.

(7 marks)

b) Discuss the key sustainability challenges associated with the use of concrete in construction and explain the strategies that can be adopted to reduce the embodied carbon of concrete structures without compromising strength and durability.

(18 marks)

[Total 25 marks]

END OF PAPER