UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE FZE

BENG(HONS) CIVIL ENGINEERING

TRIMESTER TWO EXAMINATION 2021/2022

ENGINEERING MATHEMATICS AND STRUCTURES

MODULE NO: CIE5004

Date: Tuesday 26th April 2022 **Time: 10:00am – 1:00pm**

INSTRUCTIONS TO CANDIDATES:

There are FOUR questions on 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: STRUCTURES

Q1

a) A three-pin frame is shown in **Figure Q1(a).** The frame is supported by 2 pins at A, G and a third pin is positioned at E. There is a vertical load of 18 kN acting at D and a horizontal load of 12kN at B.

(i) Determine the magnitudes and directions of the support reactions at A and G.

(3 marks)

(ii) Sketch the Axial force, Shear force and Bending Moment Diagrams showing all the necessary supporting calculations

(15 marks)

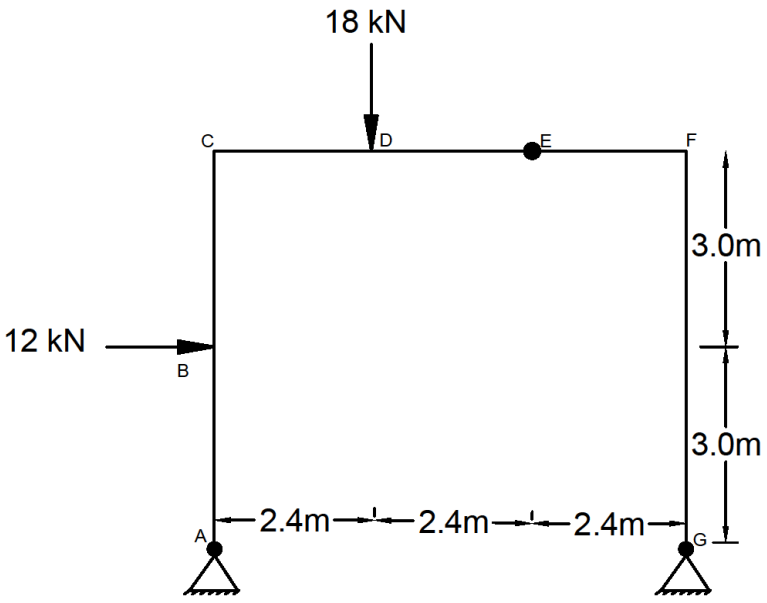

Figure Q1(a) Three-pin frame ABCDEFG

Q1 continued over the page
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Q1 continued

b) **Figure Q1 (b)** shows a very similar frame pinned to supports at A and G with third pin at C (No longer at E). The vertical and horizontal loads remain the same as in **Figure Q1 (a).**

Without doing further calculations, sketch the bending moment diagram (BMD) for the three pin frame shown in **Figure Q1 (b)**. Do not attempt to calculate the values of bending moment of the frame.

(7 marks)

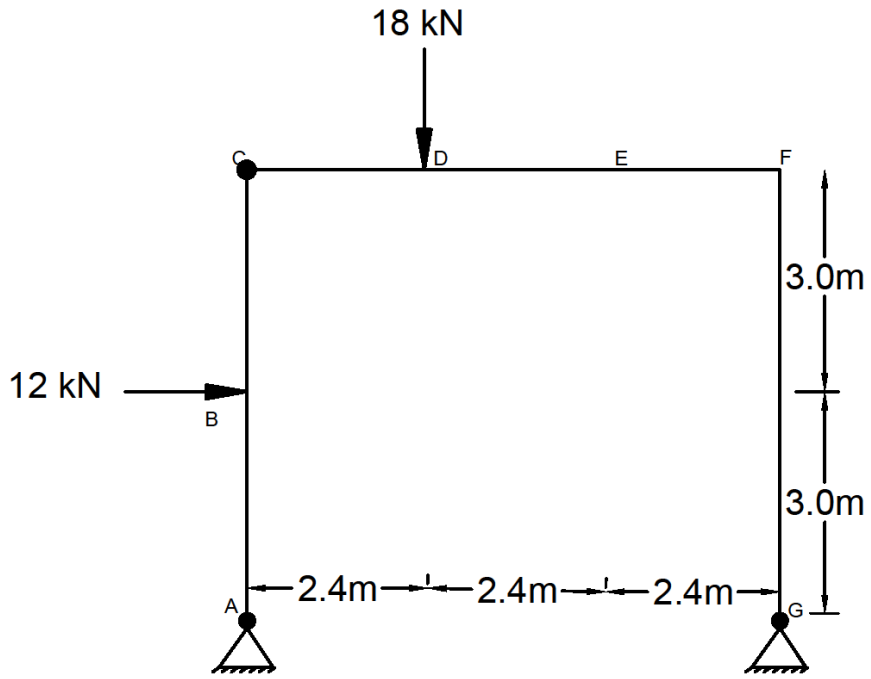

Figure Q1(b) Three-pin frame ABCDEFG

Total 25 marks

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Q2

Figure Q2 shows a beam AB which is simply supported with a span of 5m. The beam carries two point loads 20kN and 50kN acting 1m and 3m away from the left support respectively as shown. The beam also carries a UDL 60kN/m to a length of 2 m from right support. The beam has uniform rigidity EI

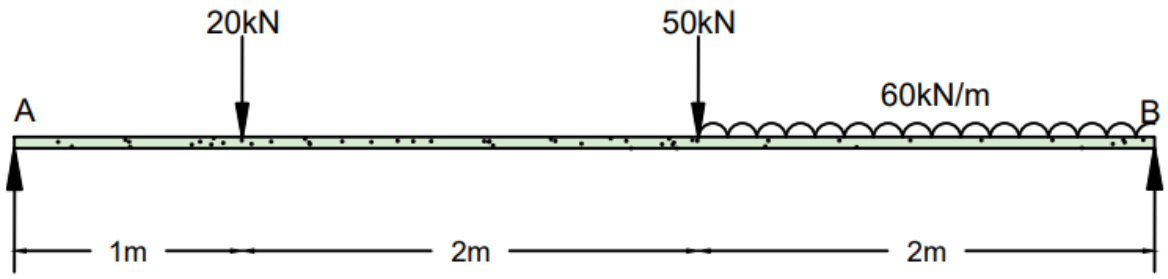

Figure Q2: Simply supported beam AB

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

(14 marks)

(ii) Using derived general slope and deflection equations, calculate the slope and deflection of the beam at 3 m away from the left support in terms of EI

(5 marks)

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

(6 marks)

Formula for the deflection of beam is $EI.\frac{d^2y}{dx^2} = -M$

Total 25 marks

END OF SECTION A
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SECTION B: ENGINEERING MATHEMATICS

Q3

Part of a reinforced concrete structure comprises of a concrete column connected to a slab which provides a rigid support at its base. A point load of 40KN is applied to its free end as shown in **Figure Q3** and is represented by the stiffness matrix below.

$$\begin{bmatrix} P_{XA} \\ P_{YA} \\ M_A \\ P_{XB} \\ P_{YB} \\ M_B \end{bmatrix} = \begin{bmatrix} \frac{EA}{L} & 0 & 0 & -\frac{EA}{L} & 0 & 0 \\ 0 & \frac{12EI}{L^3} & \frac{6EI}{L^2} & 0 & -\frac{12EI}{L^3} & \frac{6EI}{L^2} \\ 0 & \frac{6EI}{L^2} & \frac{4EI}{L} & 0 & -\frac{6EI}{L^2} & \frac{2EI}{L} \\ -\frac{EA}{L} & 0 & 0 & \frac{EA}{L} & 0 & 0 \\ 0 & -\frac{12EI}{L^3} & -\frac{6EI}{L^2} & 0 & \frac{12EI}{L^3} & -\frac{6EI}{L^2} \\ 0 & \frac{6EI}{L^2} & \frac{2EI}{L} & 0 & -\frac{6EI}{L^2} & \frac{4EI}{L} \end{bmatrix} \mathbf{x} \begin{bmatrix} \delta_{XA} \\ \delta_{YA} \\ \theta_A \\ \delta_{XB} \\ \delta_{YB} \\ \theta_B \end{bmatrix}$$

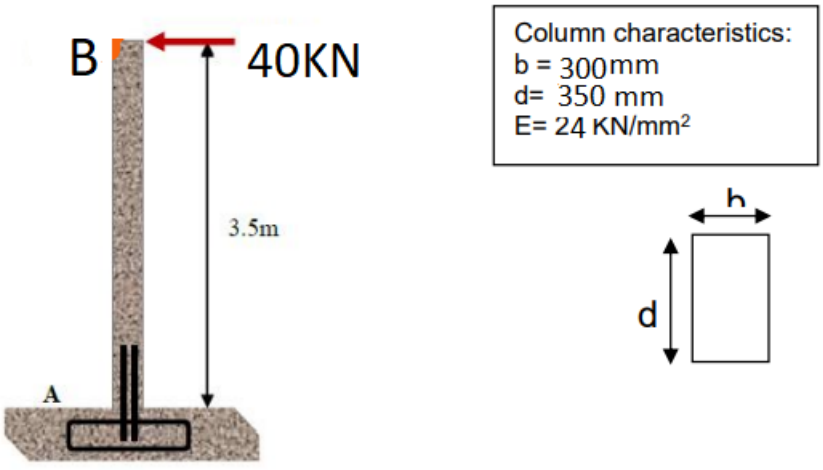

Figure Q3

Q3 continued over the page
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Q3 continued

(i) Find the reduced stiffness matrix required for the beam

(7 marks)

(ii) Determine the inverse of the stiffness matrix and determine the deflection at the tip of the column.

(18 marks)

Total 25 marks

Q4

(a) The probability of a person having a road accident in a certain period is 0.0003. For a population of 7500 people, draw a histogram showing the probabilities of 0,1,2,3,4,5 and 6 people having an accident in this period.

(10 marks)

(b) If 3% of the tiles produced by a company are defective, determine the probabilities that in a sample of 80 tiles

(i) two are defective

(ii) more than two are defective.

(7.5 marks)

(c) A package contains 50 similar hollow blocks and inspection shows that four have been damaged during transit. If six hollow blocks are drawn at random from the package. Determine the probabilities that in this sample

(i) one is damaged and

(ii) fewer than three are damaged. **(7.5 marks)**

Total 25 marks

END OF SECTION B

END OF QUESTIONS

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Formula Sheet for Section B

1 . Binomial expansion

$$(q+p)^n = q^n + nq^{n-1}p + \frac{n(n-1)q^{n-2}p^2}{2!} + \frac{n(n-1)(n-2)q^{n-3}p^3}{3!} + \ldots.$$

2. Poisson Distribution

$$\Pr(x) = e^{-\lambda}(1+\lambda+\frac{\lambda^2}{2!}+\frac{\lambda^3}{3!}+\cdots)$$

END OF FORMULA SHEET

END OF PAPER