OCD051

UNIVERSITY OF BOLTON

WESTERN INTERNATIONAL COLLEGE FZE

BEng (HONS) CIVIL ENGINEERING

SEMESTER TWO EXAMINATION 2018/2019

MATHEMATICS AND STRUCTURAL ANALYSIS

MODULE NO: CIE4011

Date: Friday 24th May 2019 **Time: 1:00pm – 4:00pm**

INSTRUCTIONS TO CANDIDATES:

There are five 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 brackets.

This examination paper carries a total of 100 marks.

Formula sheet for Section B is attached on this 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(a) shows a 10m long simply supported beam with a pinned support at A and a roller support at F. The beam is carrying a uniformly distributed load (UDL) of 2kN/m in the direction of gravity between C and D, and two vertical point loads of 4kN at B and 8kN at E. The beam has an asymmetrical I-shape cross section as shown in Figure Q1(b)

(a) Determine the position of the Neutral Axis

(5 marks)

(b) Determine the value of the second moment of area about the neutral axis of the beam section

(5 marks)

(c) Determine the distribution of shear force in the beam given in Figure 1(a). Draw a neat hand drawn diagram of its distribution (SFD) along the beam length, indicating the values of Shear force at A, B, C, D ,E and F.

(6 marks)

(d) Determine the distribution of bending moment in the beam given in Figure 1(a). Draw a neat hand drawn diagram of its distribution (BMD) along the beam length, indicating the values of bending moment at A, B, C, D, E and F. Also determine the maximum Bending moment.

(9 marks)

(e) Compute the maximum bending stress developed in the beam and sketch the stress variation along the beam depth, clearly indicating regions of tension and compression.

(5 marks)

[Total 30 marks]

NOTE :

The moment of Inertia of Unsymmetrical section is given by $I = I_o + Ah^2$

The bending moment equation is given by $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$

Question 1 continued over the page

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Question 1 continued.

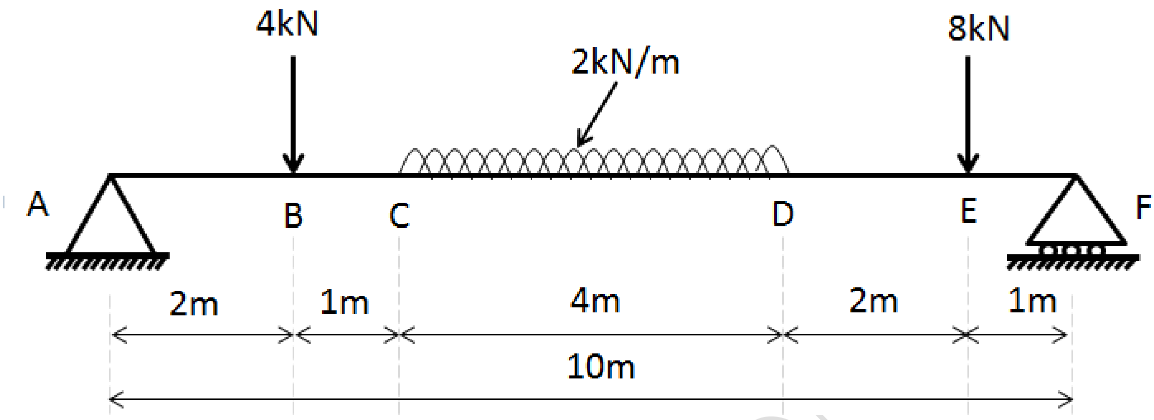

Figure Q1(a): Simply supported beam

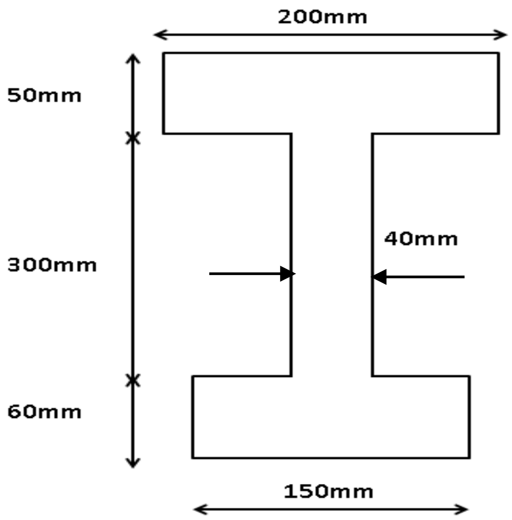

Figure Q1(b): Cross section of the beam

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Question 2

A pin-jointed truss as shown in **Figure Q2**, having a roller support at end A and pinned support at end E is subjected to a vertical force of 8kN at joint C and horizontal force of 6kN at joint B,

(a) Prove that the given pin-jointed truss is statically determinate. Determine the magnitude and direction of the support reactions at A and E.

(4 marks)

(b) Using the method of resolution at joints, calculate the axial forces in the members of this truss and state whether each axial force is in tension or in compression.

(12 marks)

(c) Summarise your answer on a diagram of the truss layout.

(4 marks)

[Total 20 marks]

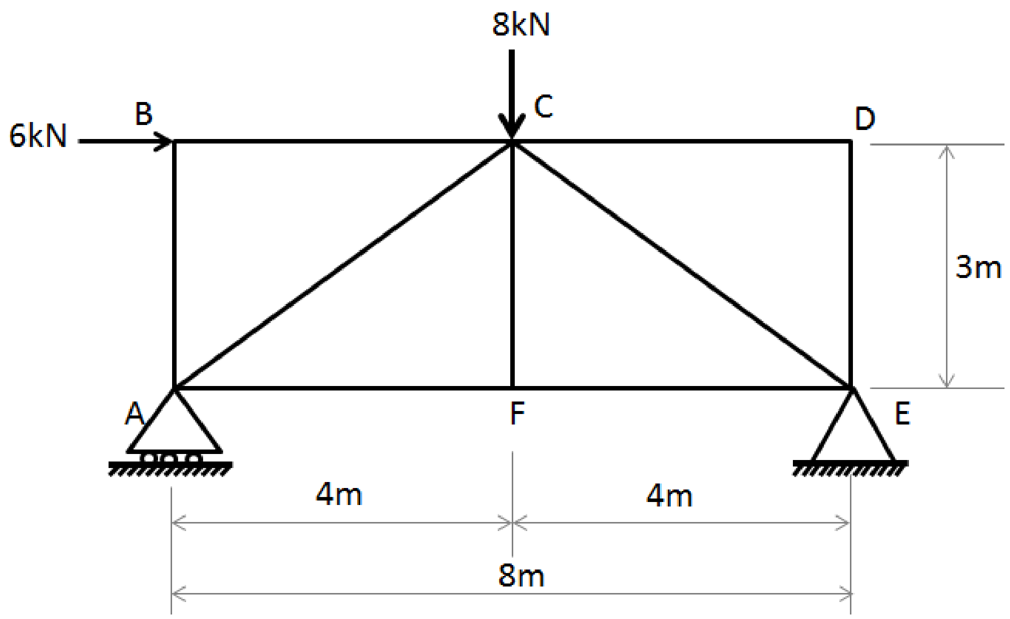

Figure Q2: Truss Layout

END OF SECTION A

Please turn over for Section B

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SECTION B: MATHEMATICS

Question 3

(a) **Table Q3** below gives the slenderness of a steel strut, λ, for corresponding values of stress, σ using trigonometric ratios. Linear Interpolation is permitted between values.

Table Q3

λ	σ (N/mm^2)
35	273.503
55	262.134
75	245.782
95	228.736
115	183.384
135	162.589
155	146.545
175	117.898
195	84.7362
215	65.607
235	36.448

i. Calculate the value of σ if $\lambda = 105$

(2 marks)

ii. Calculate the value of σ if $\lambda = 167.475$

(5 marks)

iii. Calculate the value of λ if $\sigma = 88.393$

(5 marks)

(b) Use Pascal's triangle to expand the following expression

$$(2x-3)^4$$

(3 marks)

(c) Use binomial theorem to expand the expression $(3-2x)^4$

(5 marks)

[Total 20 marks]

Please turn the page

Question 4

(a) Express the following into partial fractions

i. $\dfrac{10x+3}{x^2+3x-28}$

(4 marks)

ii. $\dfrac{35x+17}{(5x+2)^2}$ (6 marks)

(b) A structural glass specimen is tested in the laboratory in a 3- point bending arrangement within its elastic range. The stress- strain data obtained from the test is shown in **Table Q4.b**

Table Q4.b: Stress-strain Data

Stress N/mm^2	Strain $(\times 10^{-6})$
0	0
2.473	40.312
4.792	74.016
6.502	99.302
8.696	131.773
15.038	225.739
21.306	316.215
33.113	490.928
38.772	575.411
46.839	693.021
52.17	771.839
59.564	880.665
68.131	1022.911

i. Plot the data from Table Q4.b on the graph paper provided, with the stress values on the Y- axis and the strain values on the X-axis using an appropriate scale. (8 marks)

ii. In the above plot, draw an appropriate trend-line through the points. (2 marks)

iii. Use the plot from (i) to generate the linear function for the data set.

(4 marks)

Question 4 continued over to the page

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Question 4 continued.

(c) A surveyor measures the angle of elevation of the top of a building as 19° from a **Point C** as shown in **Figure Q5**. He moves 120m nearer to the building and finds that the angle of elevation is now 47°. Determine the height of the building AB. **Figure Q5 is provided with details.**

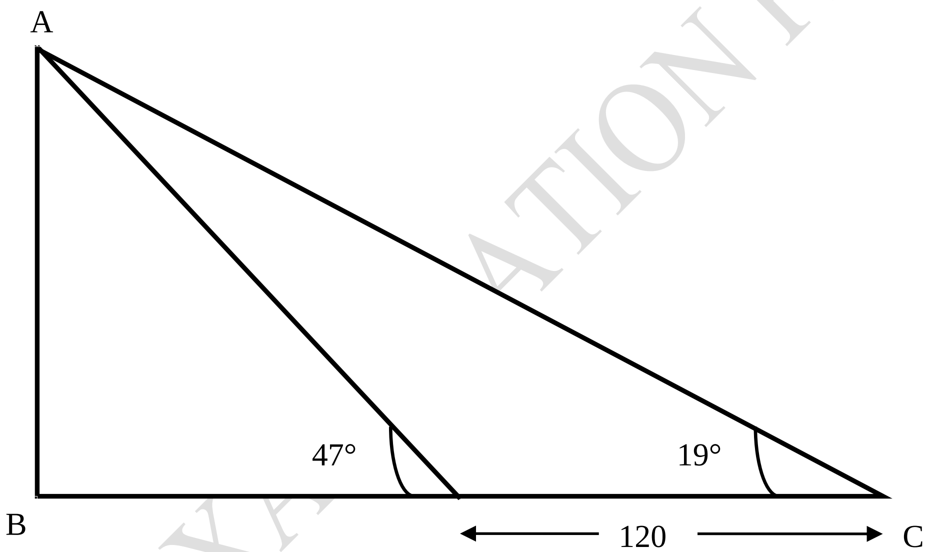

Figure Q5

(6 marks)

[Total 30 marks]

END OF SECTION B

END OF QUESTIONS

Please turn the page for Formula sheet

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Formula Sheet

Coefficients in the expansion														
							1							
						1		1						
					1		2		1					
				1		3		3		1				
			1		4		6		4		1			
		1		5		10		10		5		1		
	1		6		15		20		15		6		1	

$$(a + b)^n = a^n + na^{n-1}b + \frac{n(n-1)}{2!} a^{n-2}b^2 + \frac{n(n-1)(n-2)}{3!} a^{n-3}b^3 + \ldots\ldots\ldots\ldots + b^n$$

END OF PAPER