UNIVERSITY OF BOLTON

WESTERN INTERNATIONAL COLLEGE FZE

BENG (HONS) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2019/2020

MATHEMATICS AND STRUCTURAL ANALYSIS

MODULE NO: CIE4011

Date: Saturday 11th January 2020 **Time: 10.00am - 1.00pm**

INSTRUCTIONS TO CANDIDATES:

There are FOUR questions on this paper.

Answer ALL questions.

All questions carry equal marks.

Marks for parts of questions are shown in the brackets.

This examination paper carries a total of 100 marks.

All working must be shown. A numerical solution to a question obtained by programming an electronic calculator will not be accepted.

University of Bolton
Western International College FZE
BEng (Hons) Civil Engineering
Semester 1 Examination 2019/2020
Mathematics & Structural Analysis
Module No.CIE4011

SECTION A: STRUCTURAL ANALYSIS

Question 1

Figure Q1(a) shows a cross section of a steel beam with a cantilever span of 6.0m in the form of an "I" section.

a. Determine the position of the horizontal neutral axis of the beam. **(5 marks)**

b. What is the value of the second moment of area I_{NA} about the horizontal neutral axis of the beam section? **(6 marks)**

c. Determine the distribution of shear force in the beam given in **Figure Q1(b).** Draw a neat hand drawn diagram of its distribution (SFD) along the beam length, indicating the values of Shear force at A, B and C. **(5 marks)**

d. For the loading configuration shown in **Figure Q1(b)**, sketch the bending moment diagram, indicating the values of bending moment at significant points along the beam. **(5 marks)**

e. Compute the maximum bending stress in the cantilever beam and sketch the stress distribution along the depth of the cross section**.** **(4 marks)**

Total 25 marks

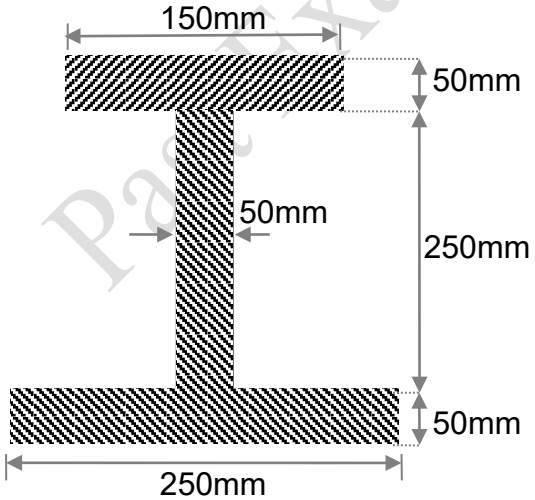

Figure Q1(a)
Section through the Cantilever Beam ABC

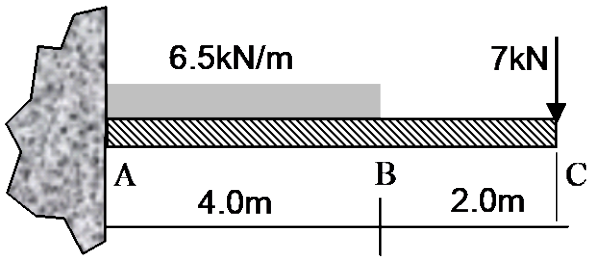

Figure Q1(b)
Loading on Cantilever Beam ABC

University of Bolton
Western International College FZE
BEng (Hons) Civil Engineering
Semester 1 Examination 2019/2020
Mathematics & Structural Analysis
Module No.CIE4011

Question 1 continued over the page

Question 1 continued

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

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

Question 2

A Warren 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 40kN at joint C, 10kN at joint B and 30kN at Joint D

a. Prove that the given pin-jointed truss is statically determinate. Determine the magnitude and direction of the support reactions at A and E. **(5 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. **(15 marks)**

c. Summarise your answer on a diagram of the truss layout. **(5 marks)**

Total 25 marks

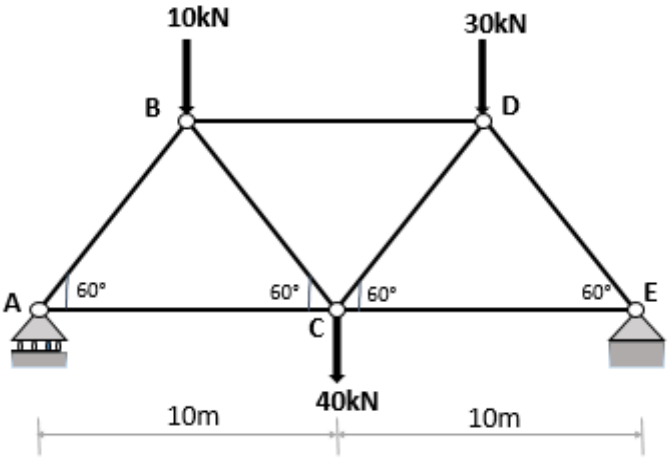

Figure Q2: Warren Truss

END OF SECTION A

University of Bolton
Western International College FZE
BEng (Hons) Civil Engineering
Semester 1 Examination 2019/2020
Mathematics & Structural Analysis
Module No.CIE4011

Please Turn the Page for Section B

SECTION B: MATHEMATICS

Question 3

a. An approximate relationship between the number of teeth, T, on a miller cutter, the diameter of the cutter, D, and the diameter of the cut, d, is given by

$$T = \frac{12.50D}{D + 4d}$$

Determine the value of D, when T=10 and d=4mm

. **(4 marks)**

b. Solve the equation for *x*

$$\log(x-1) + \log(x+8) = 2\log(x+2)$$

(4 marks)

c. To estimate the amount of earth to be removed when constructing a cutting, the cross sectional area at intervals of 8m intervals were estimated as follows

Cross- Sectional Area(m^2)	0	2.80	3.70	4.50	4.10	2.6	0

Estimate the volume to be excavated in cubic metres.

(5 marks)

d. In a chemical reaction of sewage treatment plant, the amount of concentration 'C' in cm^3 left after 't' minutes is given by

$$C = 40e^{-0.006t}$$

i. Plot a graph concentration 'C' against time 't' **(6 marks)**
ii. Determine the concentration C after 1 hour **(3 marks)**
iii. The time taken for concentration to decrease by half **(3 marks)**

Total 25 marks

University of Bolton
Western International College FZE
BEng (Hons) Civil Engineering
Semester 1 Examination 2019/2020
Mathematics & Structural Analysis
Module No.CIE4011

Please Turn the Page

Question 4

a. Each cable joining the two towers on the Golden Gate Bridge in San Fransico, California can be modelled by the function

$$y = \frac{1}{9000}x^2 - \frac{7}{15}x + 500,$$

where x and y are measured in metres. What is the height h above the road of the cable at its lowest point?

(5 marks)

b. The length of a bar, l at a temperature θ is given by, $l = l_0 e^{\alpha\theta}$, where l_0 and α are constants. Evaluate l, correct to 4 significant figures, when $l_0 = 2.587m, \theta = 321.7K$ and $\alpha = 1.771 \times 10^{-4}\ perK$. **(4 marks)**

c. Evaluate $(0.97)^6$ correct to 4 significant figures using the binomial theorem.

(7 marks)

d. A vertical tower AB is situated on the lower edge of a ramp, as shown in **Figure Q4**

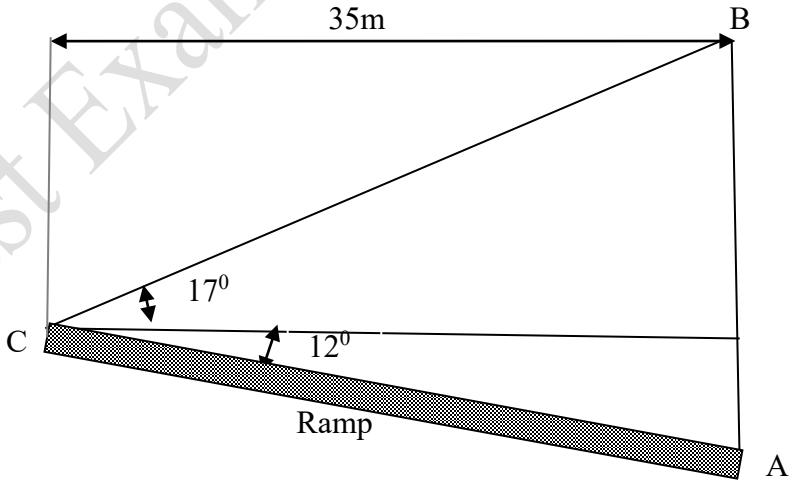

Figure Q4

From 'C', the angle of elevation to the top of the tower is 17°; the angle of depression to the foot of the tower is 12°. If C is located at 35m away from the tower, estimate the height of the tower.

(5 marks)

. **Question 3 continued over the page**

Question 3 continued

e. Prove that $\frac{1+\cot\theta}{1+\tan\theta} = \cot\theta$

(4 marks)

Total 25 marks

END OF SECTION B

END OF QUESTIONS

Please Turn the Page for Formula sheet

University of Bolton
Western International College FZE
BEng (Hons) Civil Engineering
Semester 1 Examination 2019/2020
Mathematics & Structural Analysis
Module No.CIE4011

Formula sheet

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

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	

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

Trapezium rule

$$\text{Area} = b\left[\tfrac{1}{2}\left(y_{first} + y_{last}\right) + y_2 + y_3 + y_4 + \ldots\ldots\right]$$

Mid-ordinate rule

$$\text{Area} = b\left(y_{m1} + y_{m2} + y_{m3} + \ldots\ldots\right)$$

Simpson's rule

$$\text{Area} = \tfrac{1}{3}b\left[y_1 + y_7 + 4\left(y_2 + y_4 + y_6\right) + 2\left(y_3 + y_5\right)\right]$$