UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG(HONS) CIVIL ENGINEERING

TRIMESTER ONE EXAMINATION 2021/2022

MATHEMATICAL METHODS FOR CIVIL ENGINEERING

MODULE CIE4022

Date: Tuesday 11th January 2022   **Time: 10:00 – 12:00**

INSTRUCTIONS TO CANDIDATES: There are SIX questions on this paper.

Answer **ANY FIVE** questions.

All questions carry equal marks.

Marks for parts of questions are shown in 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.

University of Bolton
Western International College
BEng (Hons) Civil Engineering
Trimester 1 Examination 2021/2022
Mathematical Methods for Civil Engineering
Module No. CIE4022

Q1

a) The deflection of a simply supported beam with a point load in mid-span is given by:

$$y = \frac{PL^3}{48EI}$$

 i. Rearrange the equation by transposition to find an expression for L.

(2 marks)

 ii. If the deflection of the beam (y) is limited to 10 mm, the magnitude of the uniformly varying load (P) is 200 kN , the elastic modulus (E) is 210 kN/mm^2 , and the second moment of area (I) is 2356 cm^4 , what is the length of the beam (L) in (m)?

(6 marks)

b) According to the effective area approach used for column base design, A$_{eff}$ is given by the equation:

$$A_{eff} = 4c^2 + 2(h + b)c + hb$$

If Effective area (A$_{eff}$)= 369000 mm^2, the depth of column(h) = 365.3 mm the and the width of column(b)= 322.2 mm,

 (i) Formulate the final equation for A$_{eff}$ for the given conditions

(4 marks)

 (ii) Estimate the Projection width 'c' in mm using 'quadratic formula'

(4 marks)

Q1 continues over the page…

PLEASE TURN THE PAGE…..

University of Bolton
Western International College
BEng (Hons) Civil Engineering
Trimester 1 Examination 2021/2022
Mathematical Methods for Civil Engineering
Module No. CIE4022

Q1 continued….

    c) Write down and simplify the first four terms of the binomial expansion for:

$$(3 + x)^{1/2}$$

(4 marks)

Total 20 marks

Q2
    a) Using logarithms, solve the following simultaneous equations:

$$2^{(x+y)} = 32$$
$$x - y = 3$$

(7 marks)

    b) Expand the log expression

$$\log_{10} \left(\sqrt[3]{\frac{m}{5yk}} \right)$$

(4 marks)

    c) Water flows through a 225mm diameter pipeline. The pipeline has surface roughness coefficient 'Ks' of 0.9mm. Using Barr's equation, determine the value for the Darcy friction factor, λ if Reynold's number is given as 12752.

$$\frac{1}{\sqrt{\lambda}} = -2\log\left[\frac{k_s}{3.7d} + \frac{5.1286}{R_e^{0.89}}\right]$$

(9 marks)

Total 20 marks

PLEASE TURN THE PAGE…..

University of Bolton
Western International College
BEng (Hons) Civil Engineering
Trimester 1 Examination 2021/2022
Mathematical Methods for Civil Engineering
Module No. CIE4022

Q3

While calibrating a Venuti meter, the following values were obtained for heads for different Q values as shown in Table 1.

Table 1

Discharge Q(m³/s)	$H_v^{1/2}$ (m$^{1/2}$)
0.1 E-02	0.11
0.70E-02	0.7
0.8E-03	0.75
0.9E-03	0.85
1.00E-02	1
1.10E-02	1.1
1.20E-02	1.25
1.30E-02	1.35

i.   Using the graph paper provided, plot Q Vs $H^{1/2}$ for the Venturi meter on an appropriately scaled axis.

(8 marks)

ii.   Draw an appropriate trend-line through the points and determine the slope of the graph, m.

(8 marks)

iii.   Determine a value of C$_d$ for venturi meter using the below equation

$$C_d = \frac{m}{k\sqrt{2g}}, \text{ if the value of } k = 2.37 x 10^{-3} \text{ and g= 9.81 m/s}^2$$

(4 marks)

Total 20 marks
PLEASE TURN THE PAGE.....

University of Bolton
Western International College FZE
BEng (Hons) Civil Engineering
Semester One Examination 2021/2022
Mathematical Methods for Civil Engineering
Module No. CIE4022

Q4

a) If $f(x) = 2x^2 - 4x^3 + 3x - 5$, find $f''(x)$

(3 marks)

b) The distance x metres moved by a car in a time 't' seconds is given by

$$x = 3t^3 - 2t^2 + 4t - 1$$

Determine the velocity and acceleration when

    i.   t=0

    ii.   t=1.5 s

(5 marks)

c) Evaluate $\int (\frac{\theta+2}{\sqrt{\theta}}) d\theta$ taking positive square roots only

(12 marks)

Total 20 marks

Q5

a) Determine

    (i) $\int x \cos x \, dx$ **(2 marks)**

    (ii) $\int 3\sqrt{x} \, dx$ **(3 marks)**

b) If $z = \sin xy$ show that $\quad \frac{1}{y} \frac{\partial z}{\partial x} = \frac{1}{x} \frac{\partial z}{\partial y}$

(3 marks)

c) Determine the area of triangular plot which is bounded by the three straight lines

$$y = 4 - x; \qquad y = 3x; \qquad 3y = x$$

(12 marks)

Total 20 marks

PLEASE TURN THE PAGE…..

Q6

a) Determine

    (i) $\int 2t^3 dt$

    (ii) $\int 5x^2\, dx$

(3 marks)

b) Given $y = 4\sin 3x \cos 2t$, find

    (i) $\dfrac{\partial y}{\partial x}$

    (ii) $\dfrac{\partial y}{\partial t}$

(5 marks)

c) Determine the stationary values of the function

$f(x, y) = x^4 + 4x^2y^2 - 2x^2 + 2y^2 - 1$ and distinguish between them.

(12 marks)

Total 20 marks

END OF QUESTIONS

F

PLEASE TURN THE PAGE FOR FORMULA SHEET…..

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		

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

Velocity v = $\dfrac{dx}{dt}$

Acceleration a = $\dfrac{d^2x}{dt^2}$

$\int u\, dv = uv - \int v\, du$

$\int ax^n\, dx = \dfrac{ax^{n+1}}{n+1} + c$

$\sqrt[n]{a^m} = a^{\frac{m}{n}}$

END OF FORMULA SHEET

END OF PAPER