OCD019

UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG(HONS) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2022/2023

MATHEMATICAL METHODS FOR CIVIL ENGINEERING

MODULE NO: CIE4022

Date: Thursday, 12 January 2023 **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
Off Campus Division, Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2022/2023
Mathematical Methods for Civil Engineering
Module No. CIE4022

Q1

(a) Solve the following equation

$\log x^4 - \log x^3 = \log 5x - \log 2x$

(5 marks)

(b) In an engineering process, two variables 'C' and 'T' are related by the equation;

C = a + bT, where 'a' and 'b' are constants

If, T =100 when C=52, and T =400 when C=172

Determine the values of 'a' and 'b'.

(7 marks)

(c) The stress 'f' (N/mm^2) in a material of a thick cylinder can be obtained from the equation,

$$\frac{D}{d} = \sqrt{\frac{(f+p)}{(f-p)}}$$

Calculate the stress (f), given that D=20mm, d =10mm and p=1800 N/mm^2

(8 marks)

Total 20 marks

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division, Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2022/2023
Mathematical Methods for Civil Engineering
Module No. CIE4022

Q2

(a) The deflection of a simply supported beam with a uniform load across the span is given by:

$$y = \frac{5wL^4}{384EI}$$

Where,

w- Uniform load (kN/m)

L- Length in meters,

E- Modulus of elasticity (kN/m^2)

I- Moment of Inertia (m^4)

(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 uniform load (W) is 25 kN/m , the elastic modulus (E) is 200 kN/mm^2, and the second moment of area (I) is 2350 cm^4 , what is the length of the beam (L) in (m) correct to 2 decimals?

(8 marks)

(b) The sag 'l' metres in a cable stretched between two supports, distance 'x' m apart is given by:

$$lx = 12 + x^2$$

Using 'quadratic formula' Determine the distance between supports(x) in mm, when the sag is 20 m.

(6 marks)

(c) Evaluate $(3.039)^4$, correct to 6 significant figures using the binomial theorem

(4 marks)

Total 20 marks

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division, Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2022/2023
Mathematical Methods for Civil Engineering
Module No. CIE4022

Q3

A structural metal specimen is tested in the laboratory within its elastic range. The stress- strain data obtained from the test is shown in **Table 1.**

Table 1. Stress – Strain Data

Strain $(\times 10^{-5})$	Stress N/mm^2
0	0
7	4.9
13	8.7
21	15.0
27	18.4
31	24.2
39	27.3

(a) Plot the data from **Table 1** 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)

(b) Draw an appropriate trend-line through the points and find the Young's Modulus of Elasticity which is given by the gradient of the graph

(8 marks)

(c) Find the value of the strain at a stress of 25 N/mm^2

(4 marks)

Total 20 marks

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division, Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2022/2023
Mathematical Methods for Civil Engineering
Module No. CIE4022

Q4

(a) If $f(t) = \frac{2}{5}\,t^2 - \frac{1}{t^3} + \frac{3}{t} - \sqrt{t} + 1$

(i) Determine $f''(t)$

(3 marks)

(ii) Evaluate $f''(t)$ when t = 1

(2 marks)

(b) The distance 's' metres travelled by a car in t seconds after the brakes are applied is given by $s = 25t - 2.5t^2$

Determine

(i) The speed of the car (in km/hr) when the brakes are applied.

(3 marks)

(ii) The distance the car travels before it stops.

(3 Marks)

(c) Determine

(i) $\int \frac{(2+3x)^2}{\sqrt{x}}\,dx$

(5 marks)

(i) $\int \frac{3}{4x^4}\,dx$

(4 marks)

Total 20 marks

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division, Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2022/2023
Mathematical Methods for Civil Engineering
Module No. CIE4022

Q5

(a) Evaluate

(i) $\int_{-1}^{2}(3-x^2)dx$

(2 marks)

(ii) $\int_{1}^{3}(x^2-4x+3)\,dx$

(2 marks)

(b) If $z = cos3x\ sin4y$ find

(i) $\frac{\partial z}{\partial x}$

(2 marks)

(ii) $\frac{\partial z}{\partial y}$

(2 marks)

(c) Determine the area enclosed by the three straight lines

$y = 3x; \qquad 2y = x; \qquad y + 2x = 5$

(12 marks)

Total 20 marks

Q6

(a) The volume of a cone of height h and base radius r is given by $v = \frac{1}{3}\pi r^2 h$. Determine

(i) $\frac{\partial v}{\partial h}$

(1.5 marks)

(ii) $\frac{\partial v}{\partial r}$

(1.5 marks)

Q6 continued over the page

PLEASE TURN THE PAGE

University of Bolton
Off Campus Division, Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2022/2023
Mathematical Methods for Civil Engineering
Module No. CIE4022

Q6 continued

(b) If $y = 4sin3x\ cos2t$,find

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

(2.5 marks)

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

(2.5 marks)

(c) Find the stationary values of the function $f(x,y) = x^3 - 6xy + y^3$ and determine their nature.

(12 marks)

Total 20 marks

END OF QUESTIONS

PLEASE TURN THE PAGE FOR FORMULA SHEET

University of Bolton
Off Campus Division, Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2022/2023
Mathematical Methods for Civil Engineering
Module No. CIE4022

Formula Sheet

$$x = \frac{-b \mp \sqrt{(b^2 - 4ac)}}{2a}$$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \frac{n(n-1)(n-2)}{3!}x^3 + \cdots$$

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

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

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

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

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

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

END OF PAPER