OCD013

UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG (HONS) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2024/2025

MATHEMATICAL METHODS FOR CIVIL ENGINEERING

MODULE NO: CIE4022

Date: Saturday, 4 January 2025 **Time: 2:00 pm – 4:00 pm**

INSTRUCTIONS TO CANDIDATES:

There are SIX (6) questions on this paper.

Answer any FIVE (5) 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 2024/2025
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Module No: CIE4022

QUESTION 1

(a) A cantilever beam is fixed at one end and supports a uniformly distributed load (UDL) of 1.2 kN/m over its entire length. The beam is made of steel with a Young's modulus E=200 kN/mm^2. The maximum deflection δ at the free end of the cantilever is given by the formula:

$$\delta = \frac{WL^4}{8EI}$$

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

(3 marks)

ii) If the deflection of the beam (δ) is 311 mm, and the second moment of area (I) is 490 cm^4, what is the length of the beam (L) in (m)?

(8 marks)

(b) Evaluate $(1.002)^9$ correct to 3 decimal places using the binomial theorem

(5 marks)

(c) The relationship between the temperature on a Fahrenheit scale and that on a Celsius scale is given by $F = \frac{9}{5}c + 32$. Express C in terms of F and express 113^0F in degrees Celsius.

(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 2024/2025
Mathematical Methods for Civil Engineering
Module No: CIE4022

QUESTION 2

(a) Evaluate

$$\frac{(log\ 25 - log\ 125 + \ ½\ log\ 625)}{3log5}$$

(7 marks)

(b) Solve the simultaneous equations:

$$3p = 2q$$
$$4p + q + 11 = 0$$

(5 marks)

(c) The total surface area 'A' of a solid cone is given by the formula, $A = \pi rl\ + \pi r^2$, where 'l' is the slant height and 'r' is the base radius. Given that the total surface area of the cone, A, is 486.2 cm^2 and the slant height is 15.3 cm, determine its base diameter using the quadratic formula.

(8 marks)

[TOTAL 20 MARKS]

University of Bolton
Off Campus Division – Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2024/2025
Mathematical Methods for Civil Engineering
Module No: CIE4022

QUESTION 3

A simply supported beam made of concrete is tested under increasing point loads at its midpoint. The deflection y at the midpoint is measured for each load P as shown in **Table Q3.**

Table Q3

Load P (kN)	Deflection y (mm)
5	0.25
10	0.5
15	0.8
20	1.1
25	1.3
30	1.6

(i) Plot the data from **Table Q3** on the graph paper provided, with the Load 'P' values on the Y- axis and the deflection 'y' values on the X-axis using an appropriate scale.

(7 marks)

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

(6 marks)

(iii) Determine from the graph

- The deflection at a load of 12 kN.

(2 marks)

- The load at a deflection of 1.0 mm.

(2 marks)

- The equation of the trend line for load versus deflection.

(3 marks)

[TOTAL 20 MARKS]

Please turn the page

QUESTION 4

University of Bolton
Off Campus Division – Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2024/2025
Mathematical Methods for Civil Engineering
Module No: CIE4022

(a) Show that the differential equation If $\frac{d^2y}{dx^2} + 6\frac{dy}{dx} + 9y = 0$ is satisfied when $y = 2xe^{-3x}$

(8 marks)

(b) The Volume, 'V' cubic metres, of water in a reservoir varies with time 't', in minutes. When a valve is opened the relationship between 'V' and 't' is given by $V = 2 \times 10^4 - 20t^2 - 10t^3$. Calculate the rate of change of water volume at the time when t = 3 minutes.

(4 marks)

(c) The distance s metres travelled by a car in t seconds after the brakes are applied is given by $s = 25t - 2.5t^2$. Find

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

(4 marks)

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

(4 marks)

[TOTAL 20 MARKS]

Please turn the page

QUESTION 5

University of Bolton
Off Campus Division – Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2024/2025
Mathematical Methods for Civil Engineering
Module No: CIE4022

(a) Evaluate

(i) $\int_{6}^{5} x^3 \, dx$

(2 marks)

(ii) $\int (2+\theta)^2 \, d\theta$

(2 marks)

(b) Evaluate

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

(2 marks)

(ii) $\int_{0}^{2} 3 \, sint \, dt$

(2 marks)

(c) Determine the area enclosed between the curves

$$y = x^2 + 3 \; and \; y = 7 - 3x$$

(12 marks)

[TOTAL 20 MARKS]

Please turn the page

QUESTION 6

University of Bolton
Off Campus Division – Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2024/2025
Mathematical Methods for Civil Engineering
Module No: CIE4022

(a) Evaluate $= cos\ cos\ 3x\ sin\ sin\ 4y$. Find

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

(1.5 marks)

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

(1.5 marks)

(b) 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) $\frac{\partial V}{\partial h}$

(2.5 marks)

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

(2.5 marks)

(c) Determine the stationary values of the function $z = x^3 - xy + y^3$

and distinguish between them.

(12 marks)

[TOTAL 20 MARKS]

END OF QUESTIONS

PLEASE TURN THE PAGE FOR FORMULA SHEET

FORMULA SHEET

University of Bolton
Off Campus Division – Western International College
BEng (Hons) Civil Engineering
Semester One Examination 2024/2025
Mathematical Methods for Civil Engineering
Module No: CIE4022

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

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

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

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

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

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

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

END OF PAPER