UNIVERSITY OF BOLTON

OFF CAMPUS DIVISION

WESTERN INTERNATIONAL COLLEGE

BENG (HONS) CIVIL ENGINEERING

SEMESTER ONE EXAMINATION 2023/24

MATHEMATICAL METHODS FOR CIVIL ENGINEERING

MODULE NO: CIE4022

Date: Saturday 13 January 2024 **Time: 10:00 AM – 12:00 PM**

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.

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Question 1

a) The deflection of a cantilever beam of a rectangular cross-section subjected to point load at its free end is given by,

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

(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 5 mm, the magnitude of the load (W) is 60 kN, the elastic modulus (E) is 210 kN/mm^2, and the second moment of area (I) is 33750 cm^4, what is the length of the beam (L) in (m)?

(6 marks)

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

(5 marks)

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

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

Express p in terms of D, d and f.

(7 marks)

Total 20 marks

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Question 2

a) Solve the equation for *x*

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

(7 marks)

b) Solve the simultaneous equations:

$$x-3y=0$$
$$\frac{x}{3}+y=4$$

(5 marks)

c) Solve the following using quadratic formula

$$2x\,(5x-2)=39$$

(4 marks)

d) Evaluate the below expression,

$$(\log_2 64-\log_2 128+\log_2 32)$$

(4 marks)

Total 20 marks

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Question 3

The velocity 'v' of a body after varying time intervals 't' was measured as shown in **Table 1.**

Table 1

Stress N/mm^2	Strain $(\times 10^{-6})$
16.9	0
19	40.3
21.1	74
23.2	99.3
26	131.8
28.1	225.7

(i) Plot the data from **Table 1** on the graph paper provided, with the velocity 'v' values on the Y- axis and the time 't' 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

a) the velocity at 10s

(2 marks)

b) the time at 20 m/s

(2 marks)

c) the equation of the graph

(3 marks)

Total 20 marks

Please turn the page

Question 4

(a) Show that the differential equation If $\frac{d^2y}{dx^2} - 4\ \frac{dy}{dx} + 4y = 0$ is satisfied

when $y = xe^{2x}$

(5 marks)

(b) The displacement of the slide valve of an engine is given by

$x = 2.2\ cos5\pi t + 3.6\ sin5\pi t$. Evaluate the velocity in m/s when time t=30s

(5 Marks)

(c) Determine $\int \frac{(1+\theta)^2}{\sqrt{\theta}}\, d\theta$

(10 marks)

Total 20 marks

Question 5

(a) Evaluate

(i) $\int_1^3 (x^2 - 4x + 3)\ dx$

(2 marks)

(ii) $\int_{-1}^2 \frac{2}{3e^{2x}}\ dx$

(2 marks)

Q5 continued over the page…
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Question 5 continued…

(b) If $z = \cos 3x \sin 4y$ 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

$$y = 3x, \qquad 2y = x \qquad and \qquad y + 2x = 5$$

(12 marks)
Total 20 marks

Question 6

(a) If $z = sin\, xy$ show that $\frac{1}{y}\frac{\partial z}{\partial x} = \frac{1}{x}\frac{\partial z}{\partial y}$

(3 marks)

(b) Pressure 'p' of a mass of gas is given by $pV = mRT$, where m and R are constants, V is the volume and T the temperature. Find the expressions for $\frac{\partial p}{\partial T}$ and $\frac{\partial p}{\partial V}$

(5 marks)

(c) Determine the stationary values of the function $z = 12x^2 + 6xy + 15y^2$ and distinguish between them.

(12 marks)
Total 20 marks

END OF QUESTIONS

Please Turn the Page for Formula sheet

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Formula Sheet

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

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

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

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

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

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

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

END OF PAPER