

UNIVERSITY OF GREATER MANCHESTER
OFF CAMPUS DIVISION
WESTERN INTERNATIONAL COLLEGE, RAS AL
KHAIMAH
BENG(HONS) CIVIL ENGINEERING
SEMESTER ONE EXAMINATION 2025/2026
MATHEMATICAL METHODS FOR CIVIL
ENGINEERING
MODULE NO: CIE4022

Date: Tuesday, 13th January 2026

Time: 1:00pm – 3:00pm

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.

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Question 1

- a) The stopping sight distance (SSD) required for a vehicle to come to a complete

stop is given by:
$$SSD = \frac{V^2}{2g(G+f)}$$

Where

SSD = stopping sight distance (m), G = longitudinal grade of road (m/m)

g = acceleration due to gravity (9.81 m/s^2), V = design speed (m/s)

f = coefficient of friction (dimensionless)

- (i) Rearrange the equation by transposition to find an expression for V. (3 marks)

- (ii) For a downhill section of the highway:

Available stopping sight distance: $SSD = 105 \text{ m}$

Coefficient of friction: $f = 0.34$

Road grade: $G = -0.05$

Use your formula to determine the maximum safe design speed V in km/h.

(9 marks)

b)

- (i) Factorize $5ax - 10ay + 3bx - 6by$ (4 marks)

- (ii) Simplify $\frac{(2x27)^3}{(6^2x3^3)^2}$, expressing the answers in index form and with positive indices.

(4 marks)

[Total 20 marks]

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Question 2

- a) Expand the log expression

$$\log_3(27\sqrt{x} \cdot \sqrt[3]{y})$$

(6 marks)

- b) $y = mx + c$ is the equation of a straight line, where m is the slope and c is the y -axis intercept.

If the line passes through the below points:

- when $x = 1$, $y = 3$

- when $x = 4$, $y = 9$

Find the slope m and the y -axis intercept c of the straight line by forming simultaneous equations.

(6 marks)

- c) The cross-sectional area A of a trapezoidal open channel is given by the formula: $A = By + zy^2$

where: A = cross-sectional wetted area (m^2), B = bottom width of the channel (m), y = depth of flow (m) and z = side slope

If a stormwater drainage channel is designed with Bottom width $B = 6.0$ m, Side slopes $z = 2.0$ and Wetted flow area, $A = 18.0$ m^2 , determine the flow depth 'y' using the quadratic formula.

(8 marks)

[Total 20 marks]

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Question 3

A smooth PVC pipe is tested in the hydraulics lab under different flow rates. For each flow rate Q , the corresponding head loss h over a fixed pipe length is measured, as shown in **Table Q3**.

Table Q3

Flow rate Q (L/s)	Head loss h (m)
2	18
4	37
6	55
8	73
10	91
12	108

- a) Plot the data from **Table Q3** on the graph paper provided, with the **head loss h** values on the **Y-axis** and the **flow rate Q** values on the **X-axis**, using an appropriate scale. (7 marks)
- b) Draw an appropriate trend-line through the points and determine the slope of the graph, m . (6 Marks)
- c) Determine from the graph
- The head loss at a flow rate of 9 L/s. (2 marks)
 - The flow rate corresponding to a head loss of 60 m (2 marks)
 - The equation of the trend line for head versus flow rate. (3 marks)

[Total 20 marks]

Please turn the page

Question 4

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

(8 marks)

- b) A moving object travels along a straight line, and its displacement at any time t seconds is given by $S = 30t + 27t^2 - 3t^3$ metres. Determine the time at which the acceleration will be zero.

(4 marks)

- c) A wheel rotates with its angular displacement given by $\theta = 10\pi + 24t - 3t^2$, where θ is in radians and t is in seconds. Find the time at which the wheel comes to rest and determine the angle it rotates through during its final second of motion.

(8 marks)

[Total 20 marks]

Please turn the Page

Question 5

- a) Evaluate

(i) $\int \frac{4}{3x^2} dx$

(2 marks)

(ii) $\int 5\sin 2\theta d\theta$

(2 marks)

b) Evaluate

$$(i) \int_{-1}^1 -\frac{3}{4}t^2 dt$$

(2 marks)

$$(ii) \int_1^2 4e^{2x} dx$$

(2 marks)

c) Determine the area enclosed between the curves

$$y = x^2 + 1 \text{ and } y = 7 - x$$

(12 marks)

[Total 20 marks]

Please turn the page

Question 6

a) Evaluate $z = x^3 - 2xy + y^2$. Find

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

(1.5 marks)

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

(1.5 marks)

b) Evaluate $z = 2x^2y^3 - 3x^3 + 4y^2$. Find

$$(i) \frac{\partial^2 z}{\partial x \partial y}$$

(2.5 marks)

$$(ii) \frac{\partial^2 z}{\partial y \partial x}$$

(2.5 marks)

- c) Determine the stationary values of the function $f(x, y) = x^3 - 6x^2 - 8y^2$ and distinguish between them.

(12 marks)

[Total 20 marks]

END OF QUESTIONS

Please turn the Page for the Formula sheet

Formula Sheet

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

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

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

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

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

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

END OF PAPER

PAST EXAMINATION