الجامعة الوطنية
National University
Science & Technology للعلوم والتكنولوجيا
كلية عمان البحرية الدولية
International Maritime College Oman

# Final Exam
# DMATH-III: MATH 3
# Fall 2025

**Points of attention:**

- For each question, the maximum earned points are specified in the question.
- Write clearly! Answers that are not readable are not marked and don't earn marks!
- All answers should be written in English using **blue or black pens** only.
- Use the pencil only for diagrams and graphs.
- Show all the calculation steps in the given space.
- When finished, submit the question paper, together with the answer scripts and the signed cover page to the invigilator.
- Any cheating/copying may result in an instant failing of the examination.

**Exam Duration:** 2 hours
**Instructor's Name:** Dr. Rokhsaneh Yousef Zehi & Muhammad Javed
**Exam Date:** 24/12/2025
**Program:** DO

| | |
|---|---|
| | **40** |
| | **10** |

| Student Information | | | |
|---|---|---|---|
| Name: | | ID: | |
| Signature: | | | |

| Invigilator | | | |
|---|---|---|---|
| Initials: | | ☐ Student ID checked | |
| Time received: | | | |

**Question 1** **[4 marks]**

A cube has side length $\boldsymbol{x}$ cm, and the side length $(x)$ is increasing at a rate of 0.5 $cm/min$.

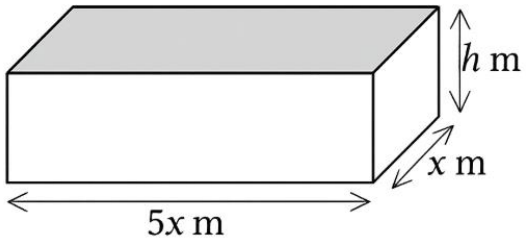
(a) Determine the rate of change of the volume with respect to time when $x = 6$ cm. (2 marks)

(b) Determine the rate of change of the surface area with respect to time when $x = 6$ cm. (2 marks)

**Question 2** **[5 marks]**

A rectangular tank is to be made in the shape of a cuboid. The container has a length of $\mathbf{5}\boldsymbol{x}$ m, a width of $\boldsymbol{x}$ m, and a height of $\boldsymbol{h}$ m. The total external surface area of the container must be $\mathbf{60}\ m^2$. The aim is to construct it with the maximum possible volume.

Determine the value of $x$ that will maximize the tank's volume.



**Question 3** **[6 marks]**

Find all the stationary points of the following function and then determine whether each one is a maximum, minimum, or point of inflection.

$$\boldsymbol{f(x) = x^4 - 8x^2}$$

**Question 4** **[5 marks]**

Calculate the following integrals:

(a) $\int (3x^2 + 6x + 4x^{-2} - 5)\, dx$ (2 marks)

(b) $\int \left(\frac{2}{\sqrt{t}} - 3t^3 + t\sqrt[3]{t}\right) dt$ (3 marks)

**Question 5** **[5 marks]**

Approximate the value of the definite integral

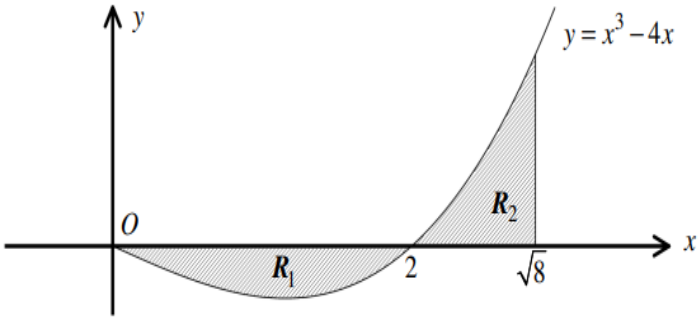
$$\int_{2}^{5} \frac{1}{x^2+1}\, dx$$

using the **Simpson's Rule** with $n = 6$ subintervals. Write your answer correct to 3 decimal places.

**Question 6** **[5 marks]**

The area between the curve $\boldsymbol{y = x^3 - 4x}$ and the $x$-axis from $x = 0$ to $x = \sqrt{8}$ is shown shaded in two parts, $R_1$ and $R_2$, in the diagram below.

Determine the total shaded area $R_1 + R_2$.



**Question 7** **[5 marks]**

A ship's freshwater tank is created by revolving the curve

$$\boldsymbol{y = \frac{1}{2}\sqrt{36 - x^2}}$$

around the **y-axis**, where $y$ is the height (in $m$) and $x$ is the horizontal distance (in $m$).

Using **Disk method**, determine the volume of the tank, formed by revolving this curve from $y = 0$ to $y = 3$.

**Question 8** **[5 marks]**

The time rate of change of displacement (velocity) of a small boat travelling along a river is given by:

$$\frac{ds}{dt} = \frac{50t}{(t^2+1)^3}$$

where $s$ is the displacement (in km) and $t$ is the time (in hours).

Determine the total displacement $(s)$ of the boat between $t = 1$ hour and $t = 3$ hours.

## Formula sheet:

| | |
|---|---|
| Volume of a Cube | $V = x^3$ |
| Surface area of a Cube | $A = 6x^2$ |
| Surface area of a Cuboid | $A = 2(lw + lh + wh)$ |
| Volume of a Cuboid | $V = l \times w \times h$ |
| Simpson's rule | $\int_a^b f(x)dx \approx \frac{h}{3}[y_0 + 4y_1 + 2y_2 + \cdots + 4y_{n-1} + y_n]$ |

**MLO and Bloom's Level of Complexity**

| Q # | MLO Addressed | Complexity Level | Mark | Remark |
|---|---|---|---|---|
| 1 | **2,3** | Application, Analysis | **4** | |
| 2 | **3,4** | Analysis, Evaluate | **5** | |
| 3 | **1,2** | Application | **6** | |
| 4 | **1** | Application | **5** | |
| 5 | **1** | Application | **5** | |
| 6 | **1** | Application | **5** | |
| 7 | **2,3** | Application, Analysis | **5** | |
| 8 | **2,3** | Application, Analysis | **5** | |

**References:**


1. J. Washington, A., 2014. Basic Technical Mathematics with Calculus. 10 ed. Harlow: Pearson Education Limited.
2. Stewart, J., 2008. *Calculus: Early Transcendentals*. 6th ed. Boston: Brooks/Cole.