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

Final Exam
MMATH-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
Exam Date: 29/12/2025
Program: ME

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	10

Student Information

Name: ID:

Signature:

Invigilator

Initials: ☐ Student ID checked

Time received:

Question 1 **[5 marks]**

Given the implicit function

$$\boldsymbol{3x^2y + 2y^3 = x + 4},$$

(a) Determine the slope of the tangent line at the point $(1, 1)$. (3 marks)

(b) Obtain the equation of the normal line to the curve at the point $(1, 1)$. (2 marks)

Question 2 **[3 marks]**

A thin circular metal plate is being heated. It expands such that the radius increases at a rate of 0.04 cm per minute.

(a) Determine the rate of change of the area when the radius is 8 cm. (2 marks)

(b) Determine the rate of change of circumference when the radius is 8 cm. (1 mark)

Question 3 **[7 marks]**

A cylindrical tank is required to have a fixed surface area of $\mathbf{192}\boldsymbol{\pi}\ \boldsymbol{m}^{\mathbf{2}}$. The tank has a radius of $\boldsymbol{r}$ meter and a height of $\boldsymbol{h}$ meter. To maximize the storage capacity of the tank, the aim is to determine the dimensions that give the greatest possible volume.

Determine the dimensions (radius and height) that will maximize the volume of the tank.

Question 4 **[5 marks]**

The rate at which fluid flows through a pipeline is given by

$$\frac{dV}{dt} = \frac{8t^2}{(t^3 + 5)^2}$$

where V is the total volume of fluid (in m^3) and t is the time (in seconds).

Determine the total volume of fluid (V) that passes through the pipeline from $t = 1$s to $t = 3$s.

Question 5 **[5 marks]**

Approximate the value of

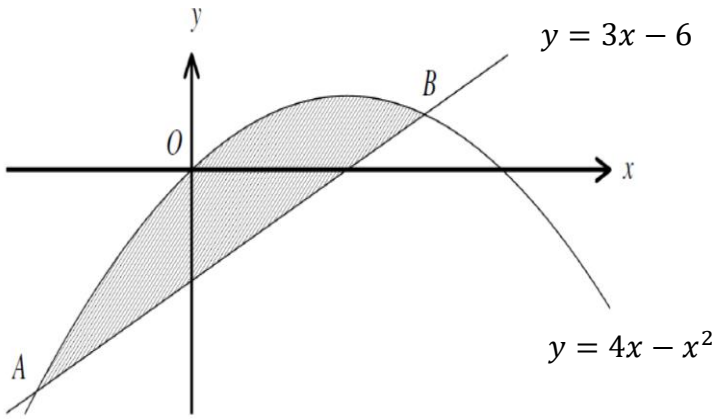
$$\int_2^5 \sqrt{2x + x^2}\,dx$$

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

Question 6 **[5 marks]**

The line $\boldsymbol{y = 3x - 6}$ and the curve $\boldsymbol{y = 4x - x^2}$ intersect at two points, labelled A and B in the below diagram.

Determine the area of the shaded region.



Question 7 **[4 marks]**

A fuel tank on a marine engine boat is formed by revolving the curve

$$\boldsymbol{y = 2\sqrt{9 - x^2}}$$

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

Determine the volume of the tank formed by revolving this curve from $y = 0$ to $y = 6$.

Question 8 **[6 marks]**

During ballasting operations, seawater flows into a tank. The flow rate decreases as the tank fills. Let $V(t)$ be the volume of water (in m^3) in the tank at time t minutes. The process is modeled by the following differential equation:

$$\frac{dV}{dt} = \frac{k}{\sqrt{v}}$$

Where k is a positive constant.

(a) Find the general solution for $V(t)$. (4 marks)

(b) If the tank initially contains $100\ m^3$ of water and $k = 50$, determine the amount of water in the tank after 10 minutes. (2 marks)

This page is for rough work.

Formula sheet:

Product Rule	$(uv)' = u'v + v'u$
Quotient Rule	$\left(\frac{u}{v}\right)' = \frac{u'v - v'u}{v^2}$
Area of a circular tin	$A = \pi r^2$
Circumference of a circular tin	$C = 2\pi r$
Surface area of Cylinder	$A = 2\pi rh + 2\pi r^2$
Volume of Cylinder	$V = \pi r^2 h$
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	**1,2**	Application	**5**	
2	**2,3**	Application, Analysis	**3**	
3	**3, 4**	Analysis, Evaluate	**7**	
4	**1,2**	Application	**5**	
5	**1**	Application	**5**	
6	**1**	Application	**5**	
7	**2,3**	Application, Analysis	**4**	
8	**2,3**	Application, Analysis	**6**	

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.