CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION

JULY 2025 SEMESTER SESSION

SUBJECT CODE	:	**LMD12803**
SUBJECT TITLE	:	**TECHNICAL MATHEMATICS 2**
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	**DIPLOMA OF ENGINEERING TECHNOLOGY IN MARINE ENGINEERING**
TIME / DURATION	:	**9.00 AM - 11.30 AM (2 HOURS 30 MINUTES)**
DATE	:	**20 DECEMBER 2025**

INSTRUCTIONS TO CANDIDATES

1. Please read **CAREFULLY** the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of **TWO (2)** sections; Section A and Section B.
4. Answer **ALL** question in Section A, and **TWO (2)** questions **ONLY** in Section B.
5. Please write your answers on this answer booklet provided.
6. Answer **ALL** questions in English language **ONLY**.
7. Answer should be written in blue or black ink except for sketching, graphic and illustration.
8. Formula sheet has been appended for your reference.

THERE ARE 10 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

(Total: 100 marks)

SECTION A (60 marks)

INSTRUCTION: Answer ALL questions.

Question 1

With reference to Trigonometry:

(a) Given $f(x) = -3\sin(x - 90^0)$.

i. Find the period and the phase shift of $f(x)$.

(2 marks)

ii. Hence, sketch the graph of function $f(x)$ over two periods.

(6 marks)

iii. Define the domain of f(x) and range of f(x).

(2 marks)

(b) Trigonometry is the branch of mathematics that concerned with specific functions of angles and their application to calculations. State any THREE (3) applications of Trigonometry in engineering field.

(3 marks)

(c) Simplify:

i. $\sec x(\cos x)$.

(2 marks)

ii. $\dfrac{\cos^2 D + \sin^2 D}{\tan D}$.

(2 marks)

iii. $\cos x(\sec x - \cos x)$.

(3 marks)

Question 2

With reference to Geometry:

(a) A horizontal cylindrical fuel tank has a diameter of 250 centimeters and a length of 6 meters. Calculate:

i. the volume of the tank in cubic meters.

(3 marks)

ii. the curved surface area of the tank.

(2 marks)

(b) A marine engineer is tasked with laying a subsea power cable in a sector-shaped area of the ocean. The radius of the area is 20 kilometers, and the central angle of the sector is 135°. Calculate:

i. the area of the sector where the subsea cable will be laid.

(2 marks)

ii. the length of the arc along which the cable will be placed.

(2 marks)

(c) Figure 1 shows a rectangular water container. The container is $\frac{1}{2}$ full of water. Each cup can hold 175 ml of water. Determine number of cups that can be completely filled with water.

(5 marks)

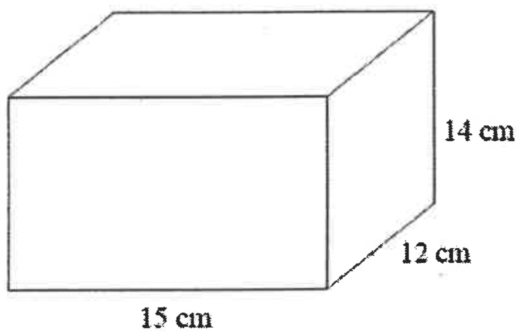

Figure 1: Rectangular Water Container

(d) Figure 2 shows a triangle PQR and a trapezium DEFG. The area of the triangle is equal to the area of the trapezium. Calculate:

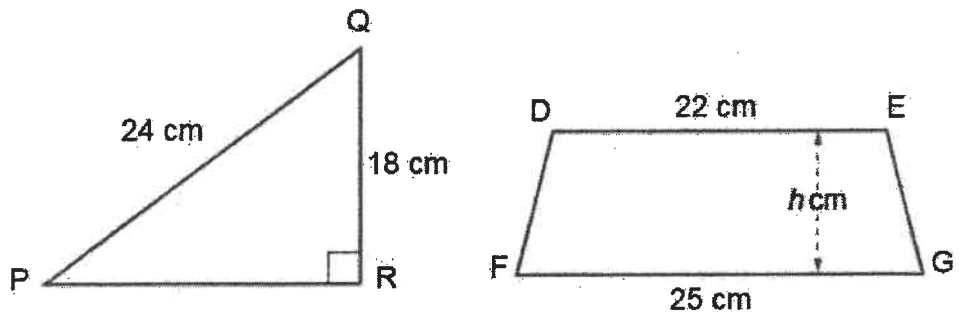

Figure 2: Triangle PQR and Trapezium DEFG

i. the area of the triangle.

(4 marks)

ii. the length h in cm.

(2 marks)

Question 3

With reference to Geometry:

(a) Figure 3 shows a rhombus whose one side measures 5 cm and one diagonal as 8 cm. Compute the:

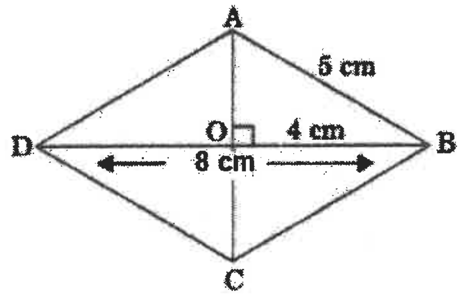

Figure 3: Rhombus ABCD

i. perimeter of the rhombus.

(2 marks)

ii. area of the rhombus.

(4 marks)

(b) Figure 4 shows an isosceles triangular prism with the given dimensions. The triangular faces of the prism are isosceles.

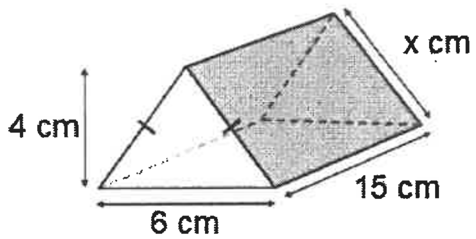

Figure 4: Isosceles Triangular Prism

i. Calculate x, the length of the two identical sides of each triangular face.

(2 marks)

ii. Hence, find the surface area of the prism.

(7 marks)

(c) The surface area of a sphere is 452.39 cm^2. Calculate:

i. the radius of the sphere.

(2 marks)

ii. Hence, calculate the volume of the sphere.

(3 marks)

SECTION B (Total: 40 marks)

INSTRUCTION: Answer ONLY TWO (2) questions.

Please use the answer booklet provided.

Question 4

With reference to Differentiation:

(a) Find the derivative of the following functions:

i. $y = e^{3z} - \dfrac{3}{6z^2}$.

(3 marks)

ii. $y = \sqrt{2x^3 - 8x + 5}$.

(3 marks)

iii. $y = \dfrac{5\sin(2w)}{w+3}$.

(4 marks)

(b) A shipping company wants to design a cylindrical water tank with **no top** as shown in Figure 5. The volume of the tank must be 32 m^3.

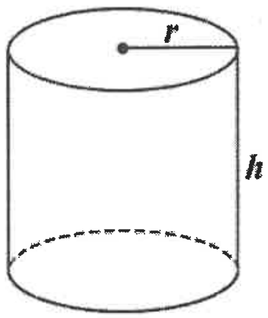

Figure 5: Cylindrical Water Tank

i. Show that the surface of the tank, A m^2 is given by

$$A = \pi r^2 + \left(\frac{64}{r}\right)$$

(4 marks)

ii. Determine the dimensions (radius and height) that will minimize the surface area.

(6 marks)

Question 5

With reference to Differentiation and Integration:

(a) Solve the following integrals by using suitable integration method.

i. $\int 6x^2(2x^3+1)^7\ dx.$

(4 marks)

ii. $\int \frac{x}{(x+4)(x-1)} dx.$

(8 marks)

(b) Given $x^2 + y + y^4 = 10$.

i. Find dy/dx by implicit differentiation.

(6 marks)

ii. Hence, calculate the gradient at point (2,1) .

(2 marks)

Question 6

With reference to Integration:

(a) Integrate the following:

i. $\int \left(6x^5 - 3x + 2\right) dx$

(2 marks)

ii. $\int \frac{6}{2x+1} dx$

(2 marks)

iii. $\int \left(e^{3z} - \frac{3}{6z^2}\right) dz$

(3 marks)

iv. $\int \left(\sec^2 4\theta + \sin 3\theta + 2\right) d\theta$

(3 marks)

(b) Figure 6 shows an area enclosed by the curve $y = 4x - x^2 - 1$ and line $y = x + 1$.

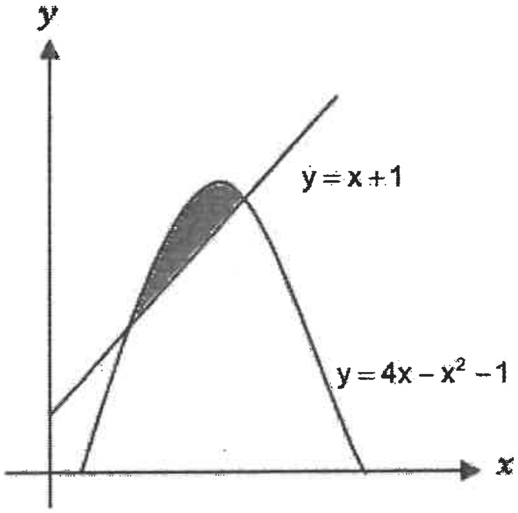

Figure 6: Area Between Curves

Compute:

i. the x-intersect between the curves.

(4 marks)

ii. the area under the region enclosed by the line and the curve.

(6 marks)

END OF EXAMINATION PAPER

TRIGONOMETRY IDENTITIES

FUNDAMENTAL IDENTITIES	FORMULAS FOR NEGATIVES
$\csc\theta = \dfrac{1}{\sin\theta}$	$\sin(-\theta) = -\sin\theta$
$\sec\theta = \dfrac{1}{\cos\theta}$	$\cos(-\theta) = \cos\theta$
$\cot\theta = \dfrac{1}{\tan\theta} = \dfrac{\cos\theta}{\sin\theta}$	$\tan(-\theta) = -\tan\theta$
$\cos^2\theta = \dfrac{1}{2}(1+\cos 2\theta)$	$\csc(-\theta) = -\csc\theta$
$\sin^2\theta + \cos^2\theta = 1$	$\sec(-\theta) = \sec\theta$
$1+\tan^2\theta = \sec^2\theta$	$\cot(-\theta) = -\cot\theta$
$1+\cot^2\theta = \csc^2\theta$	$\sin^2\theta = \dfrac{1}{2}(1-\cos 2\theta)$

ADDITION FORMULAS	SUBTRACTION FORMULAS
$\sin(A+B) = \sin A\cos B + \cos A\sin B$	$\sin(A-B) = \sin A\cos B - \cos A\sin B$
$\cos(A+B) = \cos A\cos B - \sin A\sin B$	$\cos(A-B) = \cos A\cos B + \sin A\sin B$
$\tan(A+B) = \dfrac{\tan A + \tan B}{1-\tan A\tan B}$	$\tan(A-B) = \dfrac{\tan A - \tan B}{1+\tan A\tan B}$

HALF-ANGLE FORMULAS	DOUBLE-ANGLE FORMULAS
$\sin\dfrac{\theta}{2} = \pm\sqrt{\dfrac{1-\cos\theta}{2}}$	$\sin 2\theta = 2\sin\theta\cos\theta$
$\cos\dfrac{\theta}{2} = \pm\sqrt{\dfrac{1+\cos\theta}{2}}$	$\cos 2\theta = \cos^2\theta - \sin^2\theta$ $\ldots\ldots\ldots = 1-2\sin^2\theta$ $\ldots\ldots\ldots = 2\cos^2\theta - 1$
$\tan\dfrac{\theta}{2} = \dfrac{1-\cos\theta}{\sin\theta} = \dfrac{\sin\theta}{1+\cos\theta}$	$\tan 2\theta = \dfrac{2\tan\theta}{1-\tan^2\theta}$

PRODUCT-TO-SUM FORMULAS	SUM-TO-PRODUCT FORMULAS
$\sin\alpha\cos\beta = \dfrac{1}{2}[\sin(\alpha+\beta)+\sin(\alpha-\beta)]$	$\sin\alpha + \sin\beta = 2\sin\dfrac{\alpha+\beta}{2}\cos\dfrac{\alpha-\beta}{2}$
$\cos\alpha\sin\beta = \dfrac{1}{2}[\sin(\alpha+\beta)-\sin(\alpha-\beta)]$	$\sin\alpha - \sin\beta = 2\cos\dfrac{\alpha+\beta}{2}\sin\dfrac{\alpha-\beta}{2}$
$\cos\alpha\cos\beta = \dfrac{1}{2}[\cos(\alpha+\beta)+\cos(\alpha-\beta)]$	$\cos\alpha + \cos\beta = 2\cos\dfrac{\alpha+\beta}{2}\cos\dfrac{\alpha-\beta}{2}$

DIFFERENTIATION

STANDARD FORM	GENERAL FORM
$\frac{d}{dx}(\sin x) = \cos x$	$\frac{d}{dx}(\sin f(x)) = f'(x)\cos f(x)$
$\frac{d}{dx}(\cos x) = -\sin x$	$\frac{d}{dx}(\cos f(x)) = -f'(x)\sin f(x)$
$\frac{d}{dx}(\tan x) = \sec^2 x$	$\frac{d}{dx}(\tan f(x)) = f'(x)\sec^2 f(x)$
$\frac{d}{dx}(\csc x) = -\csc x \cot x$	$\frac{d}{dx}(\csc f(x)) = -f'(x)\csc f(x)\cot f(x)$
$\frac{d}{dx}(\sec x) = \sec x \tan x$	$\frac{d}{dx}(\sec f(x)) = f'(x)\sec f(x)\tan f(x)$
$\frac{d}{dx}(\cot x) = -\csc^2 x$	$\frac{d}{dx}(\cot f(x)) = -f'(x)\csc^2 f(x)$

EXPONENTIAL FUNCTION

STANDARD FORM	GENERAL FORM
$\frac{d}{dx}e^x = e^x$	$\frac{d}{dx}e^{f(x)} = f'(x)e^{f(x)}$

LOGARITHMIC FUNCTION

STANDARD FORM	GENERAL FORM
$\frac{d}{dx}\ln x = \frac{1}{x}$	$\frac{d}{dx}\ln f(x) = \frac{f'(x)}{f(x)}$

INTEGRATION

STANDARD FORM	GENERAL FORM Where : $f(x) = ax + b$
$\int \cos x\, dx = \sin x + c$	$\int \cos f(x) dx = \frac{\sin f(x)}{f'(x)} + c$
$\int \sin x\, dx = -\cos x + c$	$\int \sin f(x) dx = \frac{-\cos f(x)}{f'(x)} + c$
$\int \sec^2 x\, dx = \tan x + c$	$\int \sec^2 f(x) dx = \frac{\tan f(x)}{f'(x)} + c$
$\int \sec x \tan x\, dx = \sec x + c$	$\int \sec f(x) \tan f(x) dx = \frac{\sec f(x)}{f'(x)} + c$
$\int \csc x \cot x\, dx = -\csc x + c$	$\int \csc f(x) \cot f(x) dx = \frac{-\csc f(x)}{f'(x)} + c$
$\int \csc^2 x\, dx = -\cot x + c$	$\int \csc^2 f(x) dx = \frac{-\cot f(x)}{f'(x)} + c$
$\int \tan x\, dx = \ln\lvert\sec x\rvert + c$	$\int \tan x\, dx = \frac{\ln\lvert\sec f(x)\rvert}{f'(x)} + c$
$\int \sec x\, dx = \ln\lvert\sec x + \tan x\rvert + c$	$\int \sec x\, dx = \frac{\ln\lvert\sec f(x) + \tan f(x)\rvert}{f'(x)} + c$
$\int \cot x\, dx = \ln\lvert\sin x\rvert + c$	$\int \cot x\, dx = \frac{\ln\lvert\sin f(x)\rvert}{f'(x)} + c$
$\int \csc x\, dx = -\ln\lvert\csc x + \cot x\rvert + c$	$\int \csc x dx = \frac{-\ln\lvert\csc f(x) + \cot f(x)\rvert}{f'(x)} + c$

EXPONENTIAL FUNCTION

STANDARD FORM	GENERAL FORM Where : $f(x) = ax + b$
$\int e^x dx = e^x + c$	$\int e^{f(x)}\, dx = \frac{e^{f(x)}}{f'(x)} + c$

LOGARITHMIC FUNCTION

STANDARD FORM	GENERAL FORM Where : $f(x) = ax + b$
$\int \frac{1}{x} dx = \ln\lvert x\rvert + c$	$\int \frac{1}{f(x)} dx = \frac{\ln\lvert f(x)\rvert}{f'(x)} + c$

SURFACE AREA

CIRCLE	πr^2
SPHERE	$4\pi r^2$
CYLINDER	$2\pi rh + 2\pi r^2$
CONE	$\pi rs + \pi r^2$
TRAPEZIUM	$\frac{1}{2}(a+b)h$

VOLUME

SPHERE	$\frac{4}{3}\pi r^3$
CONE	$\frac{1}{3}\pi r^2 h$
CYLINDER	$\pi r^2 h$