CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION
JULY 2025 SEMESTER SESSION

SUBJECT CODE	:	**LMB22503**
SUBJECT TITLE	:	**ENGINEERING MATHEMATICS 2**
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	**BACHELOR OF MARINE ENGINEERING TECHNOLOGY WITH HONOURS**
TIME / DURATION	:	**9.00 AM - 12.00 PM (3 HOURS)**
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)** parts; Part A and Part B.
4. Answer **ALL** questions in Part A, and **THREE (3)** questions **ONLY** in Part 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 of black ink except for sketching, graphic and illustration.
8. Formula is appended for your reference.

THERE ARE 7 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

PART A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

With reference to Ratio, Trigonometry, Complex Number and Differentiation:

(a) List any **TWO (2)** applications of each of the following:

i. Complex number in real-world marine problems.

(2 marks)

ii. Differentiation for solving engineering problems on ships.

(2 marks)

iii. Trigonometry in marine engineering.

(2 marks)

(b) Solve $\frac{3+4j}{1-2j}$ and give your answer in algebraic form.

(4 marks)

(c) A ship's engine room uses a mixture of lubricating oil and fuel oil in certain ratios for testing purposes. During a maintenance check, the following data were recorded:

The lubricating oil to fuel oil ratio was **2 : 5**.
The total volume of the mixture in the test tank was **350 litres**.
Later, more lubricating oil was added to improve viscosity.

i. Find the volume of each type of oil in the initial mixture.

(4 marks)

ii. If an additional 50 litres of lubricating oil were added, find the new ratio of lubricating oil to fuel oil.

(2 marks)

iii. To maintain the original ratio of 2 : 5, determine how many litres of fuel oil must be added after in (ii).

(4 marks)

Question 2

With reference to Calculations with Trigonometry and Differentiation:

(a) Figure 1 shows a sinusoidal graph. From the graph, identify:

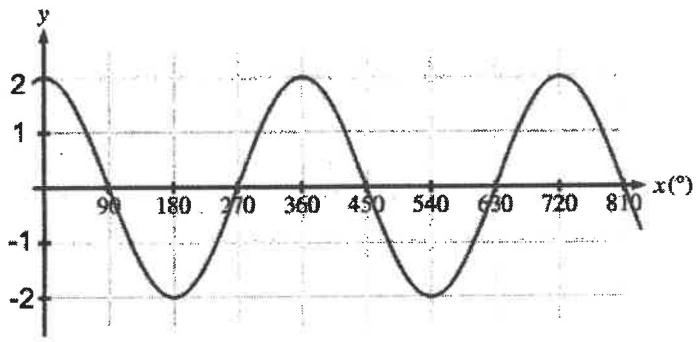

Figure 1

i. Amplitude.

(1 mark)

ii. Period.

(1 mark)

iii. Subinterval.

(1 mark)

iv. Domain.

(1 mark)

(b) Given the expression $\sin A = -\frac{5}{13}$, and A is in Quadrant IV. Express the value of:

i. tan A.

(2 marks)

ii. $\cos A$.

(2 marks)

iii. sec A.

(2 marks)

(c) Differentiate each of the following functions.

i. $y = (-7x^2 + 9)^5$.

(2 marks)

ii. $y = (2x + 5)(1 - x)$.

(4 marks)

iii. $y = \frac{x}{(x^2+1)}$.

(4 marks)

PART B (Total: 60 marks)

INSTRUCTION: Answer THREE questions.
Please use the answer booklet provided.

Question 3

With reference to Calculations with Differential Equations and Differentiation:

(a) Determine the particular solution for the following first order differential equation using the linear differential equation method.

$$\frac{dy}{dx} + 3y = e^{x} \qquad y(0) = 1$$

(8 marks)

(b) Figure 2 shows a closed box in the form of a cuboid, such that the length of its base is twice the width of its base. The volume of the box is 9000 cm^3.

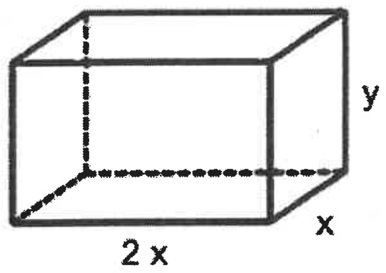

Figure 2: Cuboid

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

$$A = 4x^2 + \left(\frac{27000}{x}\right)$$

(5 marks)

ii. Determine the area of the cuboid showing that it is the minimum.

(7 marks)

Question 4

With reference to Calculations with Integration and Complex Numbers:

(a) Figure 3 shows an area enclosed by the curve $y = 4 - x^2$ and line $y = x^2 - 2x$.

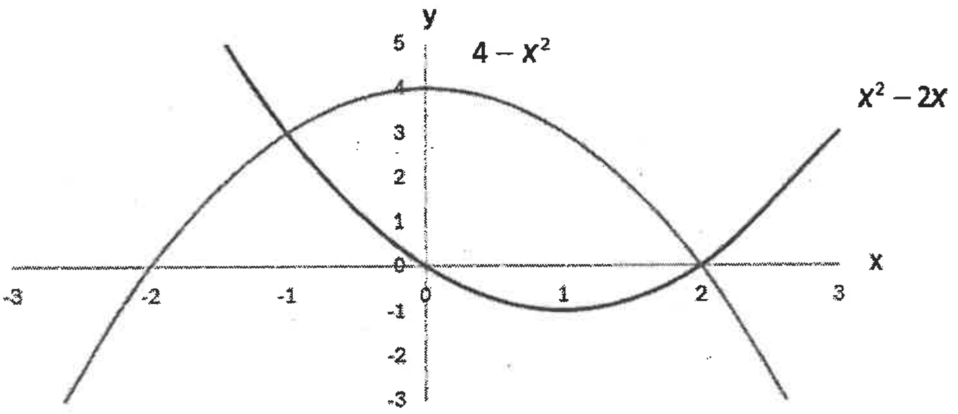

Figure 3: Area Between Curves

i. State the x-intersect between the curves.

(2 marks)

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

(6 marks)

(b) Given $A = 1 + 2i$, $B = 5(\cos 30° + i \sin 30°)$, $C = 4e^{1.5i}$ and $D = 3\angle 35°$, determine the value of $Z = 2A - B + C - D$ in trigonometric form.

(12 marks)

Question 5

With reference to Calculations with Integration and Differential Equations:

(a) Evaluate the given integral using Mid Ordinate Rule method with 6 equal intervals. Give answer correct to 4 significant figures.

$$\int_{0}^{2\pi} \frac{x}{(3 + cosx)} dx$$

(8 marks)

(b) A ship's motion in calm water can be modeled as a damped harmonic oscillator. The vertical displacement x of the ship from its equilibrium position satisfies:

$$\frac{d^2x}{dt^2} + 4\frac{dx}{dt} + 8x = 0$$

where x is measured in meters and t in seconds.

i. Determine the general solution of the differential equation.

(3 marks)

ii. If the ship is initially displaced 0.4 m below equilibrium and released from rest, find the displacement function $x(t)$.

$$x(0) = -0.4\, m, \quad \frac{dx}{dt}(0) = 0.$$

(9 marks)

Question 6

With reference to Calculations with Complex Numbers and Differentiation:

(a) If given $Z_1 = 4 - 2j,\ Z_2 = -2 + 6j$ and $Z_3 = -1 - j$.

i. Calculate $Z_1 Z_3 - Z_2$.

(3 marks)

ii. Convert your answer in (a)i into polar form.

(5 marks)

(b) Given the equation:

$$4y^2 + 2x^5 + x^4y^3 = 20$$

i. Use implicit differentiation method to solve $\frac{dy}{dx}$.

(9 marks)

ii. Then find the value of gradient m, where $m = \frac{dy}{dx}$ if given x = 1 when y = 2.

(3 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
$\sin\dfrac{A}{2} = \pm\sqrt{\dfrac{1-\cos A}{2}}$	$\sin 2A = 2\sin A\cos A$ $\ldots\ldots\ldots\ldots = 1-2\sin^2 A$ $\ldots\ldots\ldots\ldots = 2\cos^2 A - 1$
$\cos\dfrac{A}{2} = \pm\sqrt{\dfrac{1+\cos A}{2}}$	$\cos 2A = \cos^2 A - \sin^2 A$ $\ldots\ldots\ldots\ldots = 1-2\sin^2 A$ $\ldots\ldots\ldots\ldots = 2\cos^2 A - 1$
$\tan\dfrac{A}{2} = \dfrac{1-\cos A}{\sin A} = \dfrac{\sin A}{1+\cos A}$	$\tan 2A = \dfrac{2\tan A}{1-\tan^2 A}$

DIFFERENTIATION

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

EXPONENTIAL FUNCTION

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

LOGARITHMIC FUNCTION

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

INTEGRATION

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

EXPONENTIAL FUNCTION

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

LOGARITHMIC FUNCTION

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

APPROXIMATE INTEGRATION

TRAPEZOIDAL RULE: $Area = \frac{h}{2}[y_1 + y_n + 2(y_2 + y_3 + ... + y_{n-1})]$
SIMPSON'S RULE: $Area = \frac{h}{3}[y_1 + 4y_2 + 2y_3 + 4y_4 + 2y_5 + ... + y_n]$
MID ORDINATE RULE : $\text{Area} = h\sum y_n$

ORDINARY DIFFERENTIAL EQUATIONS FORMULAE

REAL AND DIFFERENT ROOTS: $y = Ae^{m_1 x} + Be^{m_2 x}$
REAL AND SAME ROOTS: $y = (A + Bx)e^{m x}$
COMPLEX ROOTS: $y = e^{\alpha x}(A\cos \beta x + B\sin \beta x)$

VOLUME OF CONE = $\frac{1}{3}\pi r^2 h$

COMPLEX NUMBERS

ALGEBRAIC FORM	$a + bj$
TRIGONOMETRIC FORM	$r(\cos\theta + j\sin\theta)$
POLAR FORM	$r\angle\theta$
EXPONENTIAL FORM	$re^{\theta j}$