

**CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ**

Autumn Examinations 2017/18

Module Title: Technological Mathematics 1 (C.A.)

Module Code: MATH 6016

School(s): National Maritime College of Ireland
School of Engineering: Building and Civil Engineering

Programme Titles: Bachelor of Engineering in Marine & Plant Engineering – Stage 1
Bachelor of Engineering in Marine Electrotechnology– Stage 1
Bachelor of Engineering in Civil Engineering – Stage 1
Bachelor of Engineering in Environmental Engineering – Stage 1

Programme Codes: EMARE_7_Y1, EMAEL_7_Y1
CCIVL_7_Y1 , CENVI_7_Y1

External Examiner: Dr James Cruickshank

Internal Examiners: Dr T. Creedon

Ms H. Lordan

Instructions: Answer QUESTION 1 (compulsory - 40 marks)
and TWO other questions (30 marks each)
All numerical answers should be displayed correct to five decimal places.

Duration: 2 Hours

Sitting: Autumn 2018

Requirements for this examination: Mathematical Tables

Note to Candidates: Please check the Programme Title and the Module Title to ensure that you have received the correct examination paper. If in doubt please contact an Invigilator.

Q1. Answer all parts:

(a) Evaluate h given that $h = \frac{0.03Lv^2}{2dg}$ when

$$v = 9.65 \times 10^{-1}, L = 1.5 \times 10^2, d = 3 \times 10^{-1} \text{ and } g = 9.81.$$

(5 marks)

(b) Transpose the formula $\frac{x}{y} = \sqrt{\frac{p+2q}{p-2q}}$ to make q the subject.

(5 marks)

(c) The temperature θ °C of an object at time t seconds is given by

$$\theta = 15 + 85e^{-0.002t}.$$

Determine (i) the temperature θ °C when $t = 120$ seconds

(ii) the time t when the temperature is 40 °C .

(5 marks)

(d) The equation of a line is $y = mx + c$ where m is the slope and c is the y -axis intercept. If the line passes through (1, -1) and (2, 4), find the slope and the y -axis intercept and write down the equation of the line.

(5 marks)

(e) Express the following as the sum of two partial fractions:

$$\frac{2x-1}{(x+1)(x-2)}$$

(5 marks)

(f) Find the roots of the equation $3x^2 + 4x = 5$.

(5 marks)

(g) Given the triangle ABC with $C = 92^\circ$, $a = 15.4$ cm and $b = 9.6$ cm, determine side c .

(5 marks)

(h) Determine the amplitude, periodic time, frequency and phase angle of the function

$$f(t) = 13\sin(25t + 0.26)$$

State whether the phase angle is lagging or leading.

(5 marks)

Q2. (a) Solve the following simultaneous equations:

$$\begin{aligned}3x + 2y - z &= 8 \\x - 2y + 3z &= -6 \\2x + y - 2z &= 6\end{aligned}$$

(10 marks)

(b) Show that $x = 1$ is a root of the cubic equation

$$3x^3 + 7x^2 - 7x - 3 = 0$$

and use the Remainder Theorem to find the other two roots.

(10 marks)

(c) The area of a rectangle is 35.4 cm^2 and the length is 2.2 cm more than the width. Show that this gives rise to a quadratic equation and solve this equation to find the length and width of the rectangle.

(10 marks)

Q3. (a) Using the laws of indices simplify the following, giving your final answers with only positive exponents.

(i) $\frac{2^{2n+3}4^{2n+4}}{8^{2n-2}}$

(ii) $\sqrt{\frac{25x^4y^4z^6}{36x^{-2}y^{-2}z^2}}$

(8 marks)

(b) Solve for x :

(i) $\log_5 25 = 4x$

(ii) $\log_5(2x - 4) - \log_5(x - 3) = 2$

(iii) $3^{x+1} = 4^{x+2}$

(15 marks)

(c) Transpose the formula $f = \frac{1}{2\pi} \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$ to make C the subject.

(7 marks)

Q4. (a) Express each of the following in the form $Y = mX + c$, indicating what you would plot along each axis and what each constant represents.

(i) $C = \frac{T}{A + kT}$ (A and k are constants)

(ii) $y = Ae^{bx}$ (A and b are constants)

(10 marks)

(b) The current flowing in, and the power dissipated by, a resistor are measured experimentally for various values and the results are shown below.

Current I (amps)	2.2	3.6	4.1	5.6	6.8
Power P (watts)	116	311	403	753	1110

- (i) By plotting a suitable linear graph show that the equation $P = RI^n$ is satisfied by the variables I and P .
- (ii) Estimate the values of the constants R and n .
- (iii) Calculate the power dissipated when the current is 6.1 amperes.

(20 marks)

Q5. (a) Find all values of x in the range $0 \leq x \leq 360^\circ$ for which

$$4 \cos(2x - 20^\circ) = 3.62$$

(8 marks)

(b) Find the values of A in the range $0 \leq A \leq 360^\circ$ for which

$$\cos^2 A - 2 \sin A - 2 = 0$$

(8 marks)

ANSWER either C or D

(c) The value of voltage in a circuit at any time t seconds is given by

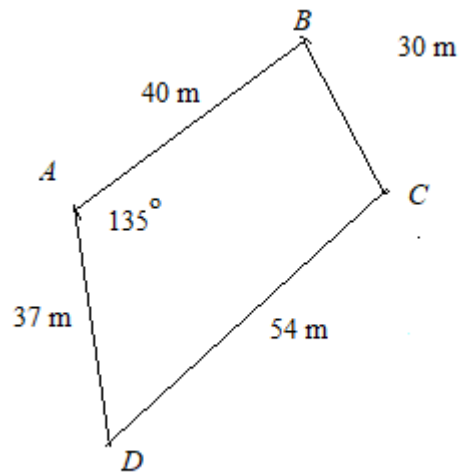
$$v(t) = 220 \sin(30\pi t + 0.68) \text{ volts.}$$

Determine the

- (i) value of $v(t)$ when $t = 0$
- (ii) value of $v(t)$ after 20 ms
- (iii) time (in ms) when $v(t)$ is first a maximum
- (iv) time (in ms) when $v(t)$ first reaches 200 volts

(14 marks)

(d) Figure shows a quadrilateral (not drawn to scale)



Using the cosine rule find

- (i) the length of $|BD|$
- (ii) the angle BCD

Find the area of the quadrilateral.

(14 marks)