

**CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ**

Semester 2 Examinations 2010/11

Module Title: Technological Mathematics 1

Module Code: MATH 6014

School: School of Building & Civil Engineering
School of Mechanical & Process Engineering
School of Biomedical Engineering

Programme Title:

Bachelor of Engineering in Mechanical Engineering – Year 1
Bachelor of Engineering in Biomedical Engineering – Year 1
Bachelor of Engineering in Building Services Engineering – Year 1
Bachelor of Engineering(Honours) in Sustainable Engineering – Year 1

Programme Code: EMECH_7_Y1
EBIME_7_Y1
EBSen_7_Y1
ESent_8_Y1

External Examiner(s): Dr. P. Robinson
Internal Examiner(s): Mr. J. P. McCarthy Dr. V. Morari, Dr. S. O Rourke

Instructions: Answer QUESTION 1 (worth 40 marks) and TWO other questions (worth 30 marks each)

Duration: 2 HOURS

Sitting: Summer 2011

Requirements for this examination: Mathematics Tables

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

1. (a) Transpose the formula

$$y = \frac{T}{\sqrt{rx - \frac{1}{p}}}$$

to make x the subject.

(5 marks)

- (b) Solve for x

$$4^{3x+7}16^{2x+1} = 8^{5x}$$

(5 marks)

- (c) Express the following as the sum of two partial fractions.

$$\frac{5(x+2)}{(x+1)(x+6)}$$

(5 marks)

- (d) Solve the quadratic equation

$$\frac{2}{2x+3} + \frac{1}{x} = 1.$$

(5 marks)

- (e) Two variables are related by the equation $R = k + \frac{h}{d^2}$. Use the following table to solve for k and h .

R	183	198
d	0.3	0.9

(5 marks)

- (f) Given that $y = 3e^{-\frac{t}{200}}$ find the value of t for which $y = 9$.

(5 marks)

- (g) Solve for A :

$$2 \cos^2 A - \sin A = 1, \quad 0^\circ \leq A \leq 360^\circ.$$

(5 marks)

- (h) State the amplitude, period, frequency and phase angle of the following function.

$$f(t) = 5 \sin \left(3\pi t - \frac{3\pi}{4} \right)$$

Sketch one cycle of the function.

(5 marks)

2. (a) Simplify

$$\frac{5^x 8^{x-2}}{4^{x-3} 10^{x-1}}$$

(6 marks)

(b) Simplify

$$\frac{360 \times 10^{-5} \times 0.001}{0.09 \times 0.006 \times 0.01}$$

and give your answer in standard form.

(6 marks)

(c) The size N of the population of a particular bacteria after t hours is given by

$$N = 500e^{0.01t}$$

Determine when does the size of the population reach 2000.

(6 marks)

(d) Solve for x , correct to two decimal places:

(i)

$$7^{2x+1} = 3^{x-1}$$

(ii)

$$3 \log x^5 - 2 \log x^7 = \log 7x - \log 2x$$

(8 marks)

(e) Transpose the formula

$$y = \sqrt{1 - \left(\frac{x-1}{x+2}\right)}$$

to make x the subject.

(4 marks)

3. (a) The forces F_1 , F_2 and F_3 are related by the equations

$$\begin{aligned} F_1 + F_2 - F_3 &= 0.9 \\ 3F_1 + 2F_2 + F_3 &= 0.7 \\ F_2 + 2F_3 &= -0.1. \end{aligned}$$

Find the forces and check your answer.

(10 marks)

- (b) Show that $x = 3$ is a root for the cubic equation

$$3x^3 - 11x^2 + 10x - 12 = 0$$

Does this equation have any other real roots?

(10 marks)

- (c) A shed is 4.0 m long and 2.0 m wide. A concrete path of constant width is laid all the way around the shed. If the area of the path is 9.5 m^2 , calculate its width.

(10 marks)

4. (a) Express each of the following equations in linear form, indicating what you would plot on each axis and how each constant might be evaluated.

i.

$$P = RI^n \quad \text{where } R, n \text{ are constants}$$

ii.

$$S = \frac{a}{b\sqrt{T} + T} \quad \text{where } a, b \text{ are constants}$$

(10 marks)

- (b) In an experiment a pendulum was allowed to oscillate through a small angle in a horizontal plane. The periodic times for a range of different lengths of the pendulum were determined and a summary of the results is given in the following table:

Length of pendulum (cm) l	22.3	30.9	45.7	64.6	98.0
Periodic time (s) T	0.940	1.109	1.352	1.603	1.981

It is believed that the relationship between T and l is of the form $T = kl^m$ where k and m are constants. By plotting a suitable linear graph show that the data obeys the given law and calculate the values of the constants k and m .

(20 marks)

5. (a) Find all angles $0^\circ \leq A \leq 180^\circ$ such that

$$4 \cos(2A - 15^\circ) = -0.5$$

- (b) Let ABC be a triangle such that $|AB| = 20 \text{ cm}$, $\angle A = 30^\circ$ and $\angle B = 100^\circ$. Solve the triangle.

- (c) The current i (amperes) flowing in a circuit at any given time t (seconds) is given by the equation:

$$I = 4 \sin \left(3\pi t - \frac{\pi}{2} \right)$$

Find the

- i. value of the current at $t = 0$ seconds.
- ii. value of the current at $t = 0.4$ seconds.
- iii. time when the current first reaches 1 ampere, and
- iv. time when the current is first a maximum.