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CIT Semester 1 Examinations 2018/19

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

Module Title: **Technological Mathematics 1**

Module Code: **MATH6014**

Programme Title(s): BEng Mechanical Engineering Y1
BEng Hons Sustainable Energy Y1
BEng Hons Electronic Eng Y1
BEng Electronic Engineering Y1
BEng Biomedical Engineering Y1
BEng Electrical Engineering Y1
BEng Hons Electrical Eng Y1

Block Code(s): **EMECH_7_Y1** **ESENT_8_Y1** **EELES_8_Y1**
EELXE_7_Y1 **EBIME_7_Y1** **EELEC_7_Y1**
EEPSY_8_Y1

External Examiner(s): **Dr. James Cruickshank**

Internal Examiner(s): Dr. Catherine Palmer, Ms. Hannah Lordan, Mr. Donal O Shea

Instructions: Answer all four questions.
Please show all your calculations and workings.

Duration: 2 Hours

Required Items: Log/Formulae Tables

1. (a) (i) Express the following in index form, giving your answer with positive indices:

$$8\sqrt[3]{x} + \frac{4}{5\sqrt{x}} + \frac{1}{x^{-2}}$$

- (ii) Use the laws of indices to simplify the following expression.
Give your final answer with positive indices.

$$\frac{(x^3y^2z)^3}{x^4y^{-6}z^5}$$

- (iii) Solve the following equation for x .

$$4^{x+2} = 8^{2x-3}$$

[10 marks]

- (b) Solve for x in each of the following equations.

(i) $\log_x 27 = 3$

(ii) $\log_{10}(x + 2) + \log_{10}(x - 3) = 2\log_{10}(x - 1)$

(iii) $7 = 10(1 - e^{-0.8x})$

[11 marks]

- (c) Given

$$x = \frac{2.9 \times 4.2}{5.8}$$

- (i) Use your calculator to find the exact value of x .
- (ii) By rounding each number correct to the nearest whole number, find an approximate value for x .
- (iii) Calculate the relative percentage error in the approximation.

[4 marks]

- 2 (a) Express as two single fractions:

$$\frac{5x - 19}{(x + 5)(4x - 2)}$$

[7 marks]

- (b) Solve for W , X and Y in the following system of simultaneous equations:

$$3W + 4X - 5Y = 3$$

$$2W - 3X + Y = 9$$

$$5W + 6X = -2$$

[7 marks]

- (c) Given the formula:

$$V = \frac{Er}{R + r}$$

- (i) Evaluate V when $E = 4.5 \times 10^3$, $r = 3 \times 10^{-2}$, $R = 5 \times 10^2$

- (ii) Make R the subject of the formula.

[6 marks]

- (d) Make u the subject of the following formula:

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

[5 marks]

3 (a) Write the following equations in linear form, indicating clearly what would be plotted on each axis and what each constant represents:

(i) $R = aV^b$ where a and b are constants.

(ii) $p = \frac{a}{\sqrt{d}} + b\sqrt{d}$ where a and b are constants. [9 marks]

(b) A solid cylinder has a total surface area of $486\pi \text{ cm}^2$ and a height of 18 cm. Calculate the radius of this cylinder.

[Note: the total surface area of a cylinder = $2\pi rh + 2\pi r^2$] [5 marks]

(c) (i) Verify that $x = 2$ is a root of: $4x^3 - 21x + 10 = 0$.

(ii) Hence, find the other roots, if any.

(ii) Draw a rough sketch of the function, $f(x) = 4x^3 - 21x + 10$, clearly labelling the points where the function crosses both axes.

[11 marks]

- 4 (a) Convert:
- (i) 150° to radians.
 - (ii) 3.5 radians to degrees.
 - (iii) $\frac{5\pi}{12}$ radians to degrees. [3 marks]
- (b) Find all the values of $0^\circ \leq \theta < 360^\circ$ that satisfy the following equations:
- (i) $\sin(2\theta) = -0.5$
 - (ii) $5\cos(\theta + 20^\circ) = 4$ [8 marks]
- (c) The current i (amperes) flowing in a circuit at any time t seconds is given by:
 $i = 15\sin(40\pi t - 0.2\pi)$. Find:
- (i) The amplitude, the periodic time, the frequency and the phase time
 - (ii) The current when $t = 0$.
 - (iii) The current when $t = 12$ milliseconds.
 - (iv) The time when the current first reaches its maximum.
 - (v) Sketch the curve for one cycle showing the relevant points. [14 marks]