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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:	**Engineering Maths 101**
Module Code:	**MATH6005**
Programme Title(s):	BEng Hons Chem&Biopharm Eng Y1 BEng (Hons) Structural Eng Y1 BEng (Hons) Mechanical Eng Y1 BEng Hons Biomedical Eng Y1 Cmn Entry Engineering Lvl 8 Y1
Block Code(s):	**ECPEN_8_Y1** **CSTRU_8_Y1** **EMECH_8_Y1** **EBIOM_8_Y1** **EOMNI_8_Y1**
External Examiner(s):	**Prof. Brien Nolan**
Internal Examiner(s):	Dr. Violeta Morari, Dr. Clodagh Carroll, Ms. Marie Nicholson
Instructions:	Answer All Questions
Duration:	2 Hours
Required Items:	Calculator, Log/Formulae Tables

1. (a) Given the matrices

$$A = [0, -1, 2],\ B = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix},\ C = \begin{bmatrix} 4 & 1 & 1 \\ -1 & 7 & -3 \\ -1 & 3 & 5 \end{bmatrix} \text{ and } I = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix},$$

find the matrix X such that $(AB)I + C^T = C^2 + X$.

[7 marks]

(b) Using Gaussian Elimination find all values of the number a for which the following system has:

$$\begin{array}{rcrcrcl} x & + & 2y & + & z & = & 1 \\ 2x & + & 5y & + & 3z & = & a \\ 3x & + & 4y & + & a^2 z & = & 9 \end{array}$$

(i) No solutions.
(ii) Infinitely many solutions.
(iii) A unique solution.

[10 marks]

Obtain the solution in (ii).

[4 marks]

(c) Use the inverse matrix method to solve the following linear system:

$$\begin{array}{rcrcrcl} x & + & 3y & - & 2z & = & 9 \\ 3x & - & 6y & + & 2z & = & 1 \\ x & + & 6y & - & 3z & = & 13 \end{array}$$

[13 marks]

[P.T.O]

Winter 2018

2. (a) Find the complex number $z = a + bi$ if

$$\frac{3z}{1+i} - \frac{zi}{2-i} = \frac{32-74i}{5+5i}.$$

[8 marks]

(b) Let $z = -2 + 2i$ and $w = 3 - \sqrt{3}\,i$.

(i) Convert z and w to polar form.

[7 marks]

(ii) Use your answers from part (i) to find $z^4 \cdot w^2$, giving your answer in polar form.

[4 marks]

(iii) Find $\dfrac{z^6}{w^4}$, giving your answer in polar from.

[4 marks]

(iv) Write z in exponential form.

[2 marks]

(c) Find all roots of the equation $z^3 = \sqrt{2} + \sqrt{2}\,i$. Both polar and cartesian forms of the roots are required. Represent all roots on an Argand diagram.

[8 marks]

[P.T.O]

Winter 2018

3. (a) Consider the vectors $\overline{a} = \overline{i} + 2\overline{j} + 3\overline{k}$ and $\overline{b} = 2\overline{i} + 3\overline{j} + 5\overline{k}$.

(i) Find $(\overline{a} + \overline{b}) \cdot (\overline{a} - \overline{b})$.

[4 marks]

(ii) Find the angle between the vectors $\overline{a}$ and $\overline{b}$.

[7 marks]

(iii) Find two unit vectors which are perpendicular to the plane spanned by $\overline{a}$ and $\overline{b}$.

[6 marks]

(b) Find the volume of the parallelepiped with adjacent edges $\overrightarrow{PQ}$, $\overrightarrow{PR}$, $\overrightarrow{PS}$ where $P(1, 1, 1)$, $Q(2, 0, 3)$, $R(4, 1, 7)$ and $S(3, -1, -2)$ are 4 points.

[8 marks]

(c) The force $\overrightarrow{F} = 5\overline{i} - 6\overline{j} + 7\overline{k}$ is applied at the point $P(1, 2, -3)$.

(i) Find the moment of this force about the origin.

[4 marks]

(ii) Find the moment of this force about the point $Q(3, 2, -1)$.

[4 marks]

Winter 2018