UNIVERSITY OF BOLTON ENG37

SCHOOL OF ENGINEERING

B.Eng. (Hons) MECHANICAL ENGINEERING

SEMESTER 1 EXAMINATIONS 2018/19

ENGINEERING PRINCIPLES 1

MODULE NO: AME4062

Date:Tuesday January 15th **Time:10.00-12.00**

INSTRUCTIONS TO CANDIDATES: 1. There are FOUR questions.

2. Answer all questions.

3. Maximum marks for each part/question are shown in brackets.

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School of Engineering
B.Eng (Hons) Mechanical Engineering
Semester 1 Examinations 2018/19
Engineering Principles 1
AME4062

1. (a) The expression $12\cos x + 5\sin x$ can be written in the form $R\cos(x-\alpha)$ with $-\pi \leq \alpha \leq \pi$. Determine the values of R and α (in radians) correct to 3 decimal places.

(5 marks)

(b) With the aid of suitable diagrams, find all of the solutions of the following equations in the given interval to two decimal places:

(i) $\sin x = \frac{\sqrt{3}}{2}$ for $0 \leq x < 2\pi$ (2 marks)

(ii) $\tan x + 3\cot x = 5\sec x$ for $0 \leq x < 2\pi$

(6 marks)

(c) Solve the following equations giving your answer to two decimal places:

(i) $5^x = 7$ (3 marks)

(ii) $2^{x+2} = 5^x$ (4 marks)

(iii) $3^{2x} \times 4^{x+1} = 5$ (5 marks)

Please turn the page

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School of Engineering
B.Eng (Hons) Mechanical Engineering
Semester 1 Examinations 2018/19
Engineering Principles 1
AME4062

2. (a) Given that $\boldsymbol{a} = \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix}$ and $\boldsymbol{b} = \begin{pmatrix} 4 \\ -1 \\ -1 \end{pmatrix}$ find

(i) $3\boldsymbol{a} + 2\boldsymbol{b}$ (2 marks)

(ii) $|\boldsymbol{a}|$ and $|\boldsymbol{b}|$ (4 marks)

(iii) $\boldsymbol{a} \bullet \boldsymbol{b}$ (2 marks)

(iv) The angle between $\boldsymbol{a}$ and $\boldsymbol{b}$ (2 marks)

(v) $\boldsymbol{a} \times \boldsymbol{b}$ (5 marks)

(b) Given that $\boldsymbol{a} = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$, $\boldsymbol{b} = \begin{pmatrix} y \\ z \\ x \end{pmatrix}$, $\boldsymbol{a} \times \boldsymbol{b} = \begin{pmatrix} 3 \\ 1 \\ 5 \end{pmatrix}$ and $|\boldsymbol{a}| = 3$, show that

$$\boldsymbol{a} \bullet \boldsymbol{b} = 18$$

(10 marks)

Please turn the page

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School of Engineering
B.Eng (Hons) Mechanical Engineering
Semester 1 Examinations 2018/19
Engineering Principles 1
AME4062

3. (a) If $\boldsymbol{A} = \begin{pmatrix} 1 & 3 \\ -2 & 5 \end{pmatrix}$ and $\boldsymbol{B} = \begin{pmatrix} 3 & 4 \\ -1 & 5 \end{pmatrix}$ find

(i) $2\boldsymbol{A} - 3\boldsymbol{B}$ (2 marks)

(ii) $\boldsymbol{AB}$ (3 marks)

(iii) $|\boldsymbol{A}|$ (2 marks)

(iv) $\boldsymbol{A}^{-1}$ (2 marks)

Hence solve the set of simultaneous equations

$$\begin{aligned} x + 3y &= 7 \\ -2x + 5y &= 8 \end{aligned}$$

(4 marks)

(b) Solve $x^2 - 4x + 13 = 0$.

(4 marks)

In parts (c) and (d) below, $z_1 = 2 + j11$ and $z_2 = 3 - j4$.

(c) Find

(i) $2z_1 - 3z_2$ (2 marks)

(ii) $z_1 z_2$ (2 marks)

(iii) $\bar{z}_2$ (1 marks)

(d) Find $|z_2|$ and $\arg(z_2)$ and hence write z_2 in polar **and** exponential form.

(3 marks)

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4. (a) Use Pascal's Triangle to expand each of the following:

(i) $(a+b)^4$

(4 marks)

(ii) $(x-2)^5$

(6 marks)

(b) Using the binomial theorem, write down the binomial expansion for the following, up to and including the term x^4:

(i) $\sqrt[5]{1+x}$ (6 marks)

(ii) $\dfrac{\sqrt{1+x}}{(1-x)^4}$ (9 marks)

END OF QUESTIONS

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School of Engineering
B.Eng (Hons) Mechanical Engineering
Semester 1 Examinations 2018/19
Engineering Principles 1
AME4062

Formula Sheet

1. Quadratic Equation

For the equation $ax^2 + bx + c = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

2. Laws of Logarithms

$$\begin{aligned} \log AB &= \log A + \log B \\ \log \tfrac{A}{B} &= \log A - \log B \\ \log A^p &= p \log A \end{aligned}$$

3. Trigonometry

$$\tan\theta \equiv \frac{\sin\theta}{\cos\theta}$$

$$\cos^2\theta + \sin^2\theta \equiv 1$$

$$\tan^2\theta + 1 \equiv \sec^2\theta$$

$$\cot^2\theta + 1 \equiv \operatorname{cosec}^2\theta$$

$$\sin(A \pm B) \equiv \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) \equiv \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) \equiv \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B}$$

$$\sin 2A \equiv 2 \sin A \cos A$$

$$\cos 2A \equiv \cos^2 A - \sin^2 A \equiv 2\cos^2 A - 1 \equiv 1 - 2\sin^2 A$$

$$\tan 2A \equiv \frac{2\tan A}{1 - \tan^2 A}$$

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4.

$$If \;\; R\cos(x-\alpha) = a\cos(x) + b\sin(x) \;\; then$$

$$\alpha = \tan^{-1}\left(\frac{b}{a}\right), \quad R = \sqrt{a^2 + b^2}$$

5. Complex Numbers

$$re^{j\theta} = r(\cos\theta + j\sin\theta)$$

$$\cos\theta = \frac{e^{j\theta} + e^{-j\theta}}{2} \qquad \sin\theta = \frac{e^{j\theta} - e^{-j\theta}}{2j}$$

De Moivre's Theorem

$$(r(\cos\theta + j\sin\theta))^n = r^n(\cos n\theta + j\sin n\theta)$$

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