[ESS06]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

BENG (HONS) AUTOMOTIVE PERFORMANCE ENGINEERING

SEMESTER ONE EXAMINATION 2019/2020

ENGINEERING MATHEMATICS

MODULE NO: MSP4017

Date: Tuesday 14th January 2020 **Time: 2:00pm – 4:00pm**

INSTRUCTIONS TO CANDIDATES:

There are FIVE questions.

Answer ALL FIVE questions.

The maximum marks possible for each part is shown in brackets

The examination is open-book

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1. Let f denote the quadratic function defined by:

$$f(x) = x^2 - 12x + 45.$$

(a) Show that $x_1 = 6 + 3i$ and $x_2 = 6 - 3i$ are roots of $f(x) = 0$. (6 marks)

(b) Plot the complex numbers x_1, x_2 and $x_1 - x_2$ on an Argand diagram. (6 marks)

(c) Simplify $\dfrac{1}{x_2}$ and write it in the form $a + bi$ for some real numbers a and b. (6 marks)

(d) Convert $x_1 = 6 + 3i$ to polar form. (6 marks)

2. Let $\underline{u}$, $\underline{v}$ be vectors in $\mathbb{R}^3$ defined by

$$\underline{u} \equiv \begin{pmatrix} 2 \\ 6 \\ 3 \end{pmatrix} \quad \text{and} \quad \underline{v} \equiv \begin{pmatrix} \lambda \\ 5 \\ 4 \end{pmatrix}$$

with respect to the standard Cartesian basis vectors, for some $\lambda \in \mathbb{R}$.

(a) Find the value of λ for which the vectors $\underline{u}$ and $\underline{v}$ are *orthogonal*. (6 marks)

(b) With $\lambda = 1$, find a unit vector in $\mathbb{R}^3$ that is perpendicular to both $\underline{u}$ and $\underline{v}$. (8 marks)

(c) With $\lambda = 2$, find the angle between the vectors $\underline{u}$ and $\underline{v}$ to 3 decimal places. (8 marks)

3. Let f be the function defined by $f(x) = 3x^2 + 6x - 10$. Find the derivative of f with respect to x *from first principles*. (8 marks)

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4. Testing of the tensile strength of a composite material yields the following results:

Tensile strength (Pa)					
220	234	244	219	256	211
231	232	216	250	244	227

(a) Find the mean, median and mode of the tensile strength data. (6 marks)

(b) Find the standard deviation of the tensile strength data. (8 marks)

(c) Draw a box-and-whiskers plot displaying the tensile strength data. (8 marks)

5. (a) The probability that a tyre on a car will burst whilst racing on a particular circuit is 0.06. Find the probability that amongst 22 drivers:

(i) exactly one tyre will burst; (6 marks)

(ii) three or more will burst. (6 marks)

(b) The lifetime of a particular car tyre is known to follow a normal distribution with mean $\mu = 41000$ miles and standard deviation $\sigma = 1600$ miles. Find the probability that such a car tyre chosen at random will:

(i) last between 39000 and 45000 miles; (6 marks)

(ii) last more than 45400 miles. (6 marks)

END OF PAPER