[ENG20]

# UNIVERSITY OF BOLTON

# NATIONAL CENTRE FOR MOTORSPORT ENGINEERING

# BEng (HONS) AUTOMOTIVE PERFORMANCE ENGINEERING (MOTORSPORT)

# SEMESTER 1 EXAMINATION 2023/2024

# ENGINEERING MATHEMATICS II

# MODULE NUMBER MSP5017

**Date: Wednesday 10th January 2024** **Time: 14:00 – 16:00**

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**INSTRUCTIONS TO CANDIDATES**

**This is an OPEN BOOK examination.**

**This paper has FIVE questions.**
**Answer ALL FIVE questions.**

**The maximum marks possible for each question and part question are shown in brackets. Note- not all questions carry equal marks.**

**Electronic calculators may be used if data and program storage memory is cleared prior to the examination.**

**Mobile phones or tablets may-not be used as calculators.**

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Engineering Mathematics II
Module No. MSP5017



**Question 1**

Consider the following equation:

$$x - \cos(2x) = 0$$

a) Show that the interval $[0..1]$ contains a root of this equation.

(4 marks)

b) Use the Newton Raphson method to find this root correct to 5 decimal places.

(8 marks)

**Total for Question 1 (12 marks)**

**Question 2**

The following Ordinary Differential Equation represents the one quarter model for a car suspension system in the usual notation:

$$m\ddot{x} + c\dot{x} + kx = c\dot{y} + ky \quad (1)$$

In what follows, use values: $m = 1, c = 2, k = 37, y = t$.

The General Solution to (1) comprises a complementary function and a particular integral.

a) Find the complementary function.

(8 marks)

b) Find the particular integral and hence write down the general solution.

(8 marks)

c) If the vertical displacement and velocity are zero at $t = 0$, write down the initial conditions, and use these to find the particular solution.

(12 marks)

**Total for Question 2 (28 marks)**

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**Question 3**

a) The Laplace Transform of a function $f(t)$ is found using the following integral:

$$\mathcal{L}\big(f(t)\big) = \int_0^\infty f(t)e^{-st}dt$$

Using this definition, find the Laplace Transform of:

i) $f(t) = e^{2t}$ (4 marks)

ii) $f(t) = t$ (6 marks)

b) Use the method of Laplace Transforms to solve the following Ordinary Differential Equation:

$$\dot{x}(t) + 6x(t) = 12e^{6t}$$

given that $x(0) = 0$.

(12 marks)

**Total for Question 3 (22 marks)**

**Question 4**

Find and classify the stationary points of the surface defined by:

$$z = 2y^3 - 24y + x^3 - 3x + 27$$

(20 marks)

**Total for Question 4 (20 marks)**



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**Question 5**

For the following double integral:

$$\int_{x=0}^{1}\int_{y=-x}^{x}(x^2+y^2)\,dydx$$

a) Sketch the region of integration.

(5 marks)

b) Evaluate the double integral.

(13 marks)

**Total for Question 5 (18 marks)**

**END OF QUESTIONS**