

FINAL

ALTERNATIVE ASSESSMENT

(COVER PAGE)

Session : January 2021

Programme : Diploma In Mechanical Engineering (DMEN)
Diploma In Electrical and Electronic Engineering (DEEI)

Course : MAT1122/MAT1135 : Engineering Mathematics 2

Date of Examination : March 10, 2021 (Wednesday)

Time : 12:00 pm – 2:15 pm Reading Time : Nil

Duration : 2 hours 15 mins

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer **ALL** the questions. **Write ALL your answers** on A4 paper.

Material permitted : Non-programmable calculator

Materials provided : Nil

Examiner(s) : Dr Chan Kah Yein and Dr Nurulanati Binti Othman

Chief Moderator : Mr Teow Hsien Loong

*This paper consists of **4** printed pages, including the cover page*

DIPLOMA IN ELECTRICAL & ELECTRONIC ENGINEERING PROGRAMME (DEEI)
DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)
MAT1122/MAT1135 : ENGINEERING MATHEMATICS 2
FINAL ALTERNATIVE ASSESSMENT : JANUARY 2021 SESSION

Instructions: This paper consists of **FOUR (4)** questions. Answer **ALL** questions. All questions carry equal marks. Complete working must be shown.

Question 1

- (a) Mechanic A spends a total of 4.5 hours to repair 2 cars, 1 motorcycle and 1 bicycle. Mechanic B spends 7 hours to repair 3 cars, 2 motorcycles and 1 bicycle while Mechanic C spends 6 hours to repair 1 car, 3 motorcycles and 3 bicycles. Assuming the hours taken to repair each vehicle is the same for every mechanic, write a system of linear equations for these statements and a corresponding matrix equation for it. Use Gauss-Jordan Elimination to find the hours needed for repairing each vehicle. (15 marks)
- (b) The pressure P , temperature T , and volume V of a confined gas are related by $P = \frac{kT}{V}$, where k is a constant. Use partial derivatives to approximate the percentage change in pressure if the temperature of a gas is increased 3% and the volume is increased 5%. (10 marks)

Question 2

- (a) The intensity, L , of light x metres beneath the surface of the ocean satisfies the differential equation

$$\frac{dL}{dx} = -kL, \text{ where } k \text{ is a constant.}$$

As a diver, you know from experience that diving to 5 metres in the South China Sea cuts the intensity in half. You cannot work without artificial light when the intensity falls below one-ninth of the surface value. Compute the maximum depth you can expect to work without artificial light.

(15 marks)

- (b) A certain weight stretches a spring beyond its natural length. If the weight is pushed downward from its equilibrium position with a certain initial velocity by a given force, its motion satisfies the equation below.

$$\frac{d^2y}{dt^2} + 13 \frac{dy}{dt} + 36y = 0$$

If y is the displacement of the weight from its equilibrium position at any time t , find a formula for the displacement y if $y = 0$ cm and $\frac{dy}{dt} = -8$ cm/s when $t = 0$ s.

(10 marks)

Question 3

A RC series circuit can be described by the following differential equation

$$RC \frac{dV}{dt} + V = 15e^{-\frac{t}{RC}}$$

where $R = 10 \Omega$, $C = 0.1$ F, V is the voltage and t is time (seconds). If the initial voltage is 1 V, find the voltage V in the circuit at $t = 2$ s by using the methods in (a) and (b). Give your answer in terms of e .

- (a) A method with an integrating factor.

(15 marks)

- (b) Laplace transform.

(10 marks)

Question 4

A mass suspended from a spring performs vertical oscillations and its equation of motion is given by

$$\frac{d^2y}{dt^2} + 8 \frac{dy}{dt} + 15y = e^{-2t}$$

where y is the displacement from the equilibrium position and t is time. Solve the equation using

(a) the method of undetermined coefficients. (11 marks)

(b) Laplace transform, given that when $t = 0$, $y = 1$ and $\frac{dy}{dt} = 3$. (14 marks)

Laplace transforms of differential coefficients

$$L\{y\} = \bar{y}; L\left\{\frac{dy}{dx}\right\} = s\bar{y} - y_0; L\left\{\frac{d^2y}{dx^2}\right\} = s^2\bar{y} - sy_0 - y_1 \text{ where } y_0 \text{ is the value of } y \text{ when } x = 0, \\ y_1 \text{ is the value of } \frac{dy}{dx} \text{ when } x = 0.$$

-THE END-

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