DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)/
DIPLOMA IN ELECTRICAL & ELECTRONIC ENGINEERING (DEEI)
MAT1122 / MAT1135: ENGINEERING MATHEMATICS 2
FINAL EXAMINATION: JANUARY 2020 SESSION

**Instructions:** This paper consists of **FOUR (4)** questions. Answer **ALL** questions in the answer booklet provided. All questions carry equal marks. Working must be shown.

**Question 1**

(a) Express $z = -1 - i$ in polar form. Use De Moivre's Theorem to find the cube roots of z. Leave your answers in polar form. (11 marks)

(b) Find the determinant of $\mathbf{A} = \begin{pmatrix} 3 & 5 & -2 \\ 1 & -6 & 7 \\ -2 & 1 & 3 \end{pmatrix}$. (5 marks)

(c) Solve the following system of linear equations using elementary row operations:

$$\begin{aligned} 2x + 2y + 5z &= 7 \\ x + y + 3z &= 6 \,. \\ y + 4z &= 8 \end{aligned}$$

(9 marks)

**Question 2**

(a) The voltage V = IR where I is the current and R, the resistance. Use partial derivatives to estimate the percentage change in I when the percentage changes in V and R are 3% and 4% respectively. (8 marks)

(b) Find the following integrals:

(i) $\int x \sin 3x \, dx$. (3 marks)

(ii) $\int \frac{1}{\sqrt{4+25x^2}} \, dx$. (5 marks)

(iii) $\int \frac{7x-16}{6x^2-7x-5} \, dx$. (5 marks)

(c) Derive Taylor series for $f(x) = \ln x$ at $x = 4$ up to the third non-zero term. (4 marks)

**Question 3**

(a) Solve the following first-order differential equations.

(i) $\frac{dy}{dx} = \frac{x\sqrt{1+y^2}}{y\,e^x}$ (7 marks)

(ii) $\frac{dy}{dx} - y\tan x = \cos x$ (8 marks)

(b) Solve the following homogeneous second-order differential equations.

(i) $3\frac{d^2y}{dx^2} - 7\frac{dy}{dx} + 2y = 0$ (3 marks)

(ii) $\frac{d^2y}{dx^2} + 6\frac{dy}{dx} + 9y = 0$ (3 marks)

(iii) $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 10y = 0$ (4 marks)

**Question 4**

(a) Solve the second-order differential equation $\frac{d^2y}{dx^2} - 5\frac{dy}{dx} = x$, using the method of undetermined coefficients. (12 marks)

(b) Solve the following differential equation using Laplace transform:
$\frac{d^2y}{dt^2} - 6\frac{dy}{dt} + 8y = e^{3t}$ , given that when t = 0, y = 0, $\frac{dy}{dt} = 2$. (13 marks)

Laplace transforms of differential coefficients

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

**-THE END-**

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