NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, APPLIED SCIENCES AND NATURAL RESOURCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION : BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 7
COURSE CODE: MMP701S	**COURSE NAME:** MATHEMATICAL METHODS IN PHYSICS
SESSION: JULY 2022	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SUPPLEMENTARY/SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	Prof Dipti R Sahu
MODERATOR:	Prof. S. C. Ray

INSTRUCTIONS
1. Answer ALL the questions. 2. Write clearly and neatly. 3. Number the answers clearly.

PERMISSIBLE MATERIALS

Non-programmable Calculators

THIS QUESTION PAPER CONSISTS OF 3 PAGES (Including this front page)

Question 1 **[25]**

1.1 Newton's law of cooling states that the rate of cooling of a body is directly proportional to the temperature difference between the body and the surroundings

1.1.1 Formulate the differential equation and determine the temperature of the body at any time, t. (10)

1.1.2 A body at a temperature of 80^0C cools to 60^0C in 30min in a room temperature environment of 30oC. Find the temperature of the body after 16 min. (5)

1.2 Solve the equation

$$x\frac{dy}{dx} + y\,(x+1) = 9x\,;y(1) = 15 \quad (5)$$

1.3 Solve the initial value problem $ty' + 3y = 0$, $y(1) = 2$, assuming $t > 0$ (5)

Question 2 ***[25]***

2.1 A series circuit consists of a resistor with R = 40 Ω, an inductor with L= 1 H, a capacitor with C = 16 x 10^{-4} F are connected with E(t) =100 cos10t. The circuit initial charge and current are both zero.

2.1.1 Find the charge and current at time (t) in the circuit using the differential equation of the above circuit (15)

2.1.2 Write down the steady state solution of the equation. (5)

2.2 Solve $y'' + 4y = e^{3x}$ (10)

Question 3 ***[25]***

3.1 (5)

$$\text{If } A = \begin{bmatrix} 3 & 1 & 2 \\ 1 & 0 & 1 \end{bmatrix} \text{ and } B = \begin{bmatrix} 1 & -1 \\ 2 & 1 \\ 3 & 1 \end{bmatrix}, \text{ find } AB$$

3.2 Solve the system of equations using Gauss-Jordan elimination method (10)

2x-3y = -21

3x- 2y = 1

8x-5y = -49

3.3 Find the eigenvalues and eigenvectors of the 3 × 3 matrix (10)

$$A = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix}$$

Question 4 *[25]*

4.1 Find the first three Laguerre polynomials from the Rodrigues formula (5)

$$L_n(x) = \frac{1}{n!} e^x \frac{d^n}{dx^n}(x^n e^{-x})$$

4.2 Determine the inner product of the following functions in [0, 1] (10)

(a) f (x) = 8x,

(b) g(x) = $x^2 - 1$.

(c) Also find ||f || and ||g||.

4.3 Given the independent set of vectors: $V_1 = \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \end{pmatrix}$; $V_2 = \begin{pmatrix} 0 \\ 1 \\ 1 \\ 1 \end{pmatrix}$; $V_3 = \begin{pmatrix} 0 \\ 0 \\ 1 \\ 1 \end{pmatrix}$ and (10)

the corresponding orthonormal set

$$e_1 = \frac{1}{2}\begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \end{pmatrix}; \quad e_2 = \frac{1}{2\sqrt{3}}\begin{pmatrix} -3 \\ 1 \\ 1 \\ 1 \end{pmatrix}; \quad e_3 = \frac{\sqrt{3}}{3\sqrt{2}}\begin{pmatrix} 0 \\ -2 \\ 1 \\ 1 \end{pmatrix}$$

express the vector

$$B = \begin{pmatrix} 3 \\ 3 \\ 1 \\ -5 \end{pmatrix}$$ as a superposition of (i) V (ii) and e

.....**END**.....