NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES

SCHOOL OF NATURAL AND APPLIED SCIENCES

DEPARTMENT OF BIOLOGY, CHEMISTRY AND PHYSICS

QUALIFICATION : BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	**LEVEL:** 7
COURSE CODE: MMP701S	**COURSE NAME:** MATHEMATICAL METHODS IN PHYSICS
SESSION: JULY 2023	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SUPPLEMENTARY/SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	Prof Dipti Ranjan 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 The law of decay states that the rate of decay for a radioactive material is proportional to the number of atoms present.

1.1.1 Formulate the differential equation and determine the amount of radioactive material left at any time, t by solving the differential equation. (5)

1.1.2 Determine the half-life of a radioactive material using solution of differential equation. (5)

1.1.3 In two years, 3 g of a radioisotope decay to 0.9 g. Determine both the half-life T and the decay rate k. (5)

1.2 Solve the equation,

$$\frac{dx}{dt} + t^2 x = Cost$$ (5)

1.3 Solve the differential equation $(2xy-3x^2)\,dx + (x^2-2y)\,dy = 0$ (5)

Question 2 **[25]**

2.1 Suppose that a car is going 76 m/s when brakes are applied at t = 2 s. Suppose that the nonconstant deceleration is known to be $a = -12t^2$. Formulate the differential equation and determine the distance the car travels. (10)

2.2 Find the particular solution of $x' + x = e^{-t}$ (10)

2.3 Solve the equation: $5y'' + 2y' + 2y = 0$. (5)

Question 3 **[25]**

3.1 Find the eigenvalues and eigenvector of the matrix A given by (10)

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

3.2 Solve the following system of equations using Gauss-Jordan Elimination: (10)

$$-3x - 2y + 4z = 9$$
$$3y - 2z = 5$$
$$4x - 3y + 2z = 7$$

3.3 If $\begin{bmatrix} 2x & 3 \end{bmatrix} \begin{bmatrix} 1 & 2 \\ 0 & -3 \end{bmatrix} \begin{bmatrix} x \\ 8 \end{bmatrix} = 0$, find the value of x (5)

Question 4 **[25]**

4.1 Let v be a vector in an inner product space V over R. (10)
Suppose that $\{u_1,\ldots,u_n\}\{u_1,\ldots,u_n\}$ is an orthonormal basis of V.
Let θ_i be the angle between v and u_i for i=1,...,n.. Prove that $\cos^2\theta_1+\cdots+\cos^2\theta_n=1$

4.2 Verify if the vectors $V_1 = \begin{pmatrix}1\\0\\0\end{pmatrix}$; $V_2 = \begin{pmatrix}0\\2\\1\end{pmatrix}$; $V_3 = \begin{pmatrix}0\\3\\5\end{pmatrix}$ are linearly independent. (5)

4.3 Express first two Legendre Polynomials $P_0(x)$ and $P_1(x)$ using the given function (4)

$$P_n(x) = \frac{(2n)!}{2^n(n!)^2}\left[x^n - \frac{n(n-1)}{2(2n-1)}x^{n-2} + \frac{n(n-1)(n-2)(n-3)}{2\times4(2n-1)(2n-3)}x^{n-4} - \ldots\right]$$

4.4 Using the Laplace transform find the solution for the following equation (6)

$$\frac{\partial y(t)}{\partial t} = e^{-3t}$$

with initial conditions y (0) = 4 and Dy (0) = 0

.... END...