



**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: JUNE 2022	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 100

FIRST 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 A battery giving a constant voltage of $E(t) = 40V$ is connected in series to a resistor of resistance 20Ω and an inductor of inductance $1H$. If the initial current in the circuit, is $I(0) = 3A$.
- 1.1.1 Write the differential equation satisfying above condition (2)
- 1.1.2 Solve the formulated differential equation and find the current after t seconds. (8)
- 1.2 Find the particular solution of $(\cos x - x \sin x + y^2) dx + 2xy dy = 0$ that satisfies the initial conditions $y = 1$ when $x = \pi$ (10)
- 1.3 Solve $(y^2 - 1) y' = 4xy^2$ (5)

Question 2**[25]**

- 2.1 Solve $y'' - 4y = xe^x + \cos 2x$ (15)
- 2.2 A spring with a mass of 2 kg has natural length 0.5 m. A force of 25.6 N is required to maintain it stretched to a length of 0.7 m. If the spring is stretched to a length of 0.7 m and then released with initial velocity zero
- 2.2.1. What is the value of spring constant (2)
- 2.2.2. Formulate the differential equation and find the position of the mass at any time t . (8)

Question 3**[25]**

- 3.1 Given the system

$$x - 2y + 3z = 3$$

$$4x + y - z = 2$$

$$2x + 3y - 5z = -1$$

- 3.1.1. Identify the column vectors as V_1, V_2, V_3 (3)
- 3.1.2. Find the the superposition coefficients. (5)
- 3.1.3 Express column vectors as a superposition of the V 's. (2)
- 3.2 Find the eigenvectors of the matrix A given as (10)

$$A = \begin{pmatrix} 5 & 4 \\ 1 & 2 \end{pmatrix}$$

- 3.3 Find the adjoint of matrix A (5)

$$A = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 3 & 1 \\ 0 & 1 & 2 \end{bmatrix}$$

Question 4**[25]**

4.1 Verify that the functions $f_1(x) = 1$, $f_2(x) = \sin x$, and $f_3(x) = \cos x$ are orthogonal in $[-\pi, \pi]$, and use them to construct an orthonormal set of functions in $[-\pi, \pi]$ (10)

4.2 Determine the first three Hermite polynomials from the generating formula (5)

$$H_n(y) = (-1)^n e^{+y^2} \frac{d^n}{dy^n} e^{-y^2}$$

4.3 What is Gram-Schmidt Orthogonalization Process, explain it mathematically (10)

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