



**NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY**

FACULTY OF HEALTH AND APPLIED SCIENCES

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 2019	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
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INSTRUCTIONS
<ol style="list-style-type: none">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 Newton cooling law says that the temperature T at a time t of a material placed in a surrounding medium kept at a constant temperature T_s satisfies $(\Delta T)' = -k(\Delta T)$ with $\Delta T(t) = T(t) - T_s$, and $k > 0$, constant, characterizing the material thermal properties.

1.1.1 Find the solution of Newton's cooling law with initial data $T(0) = T_0$ (5)

1.1.2 A cup with water at 45°C is placed in a cooler held at 5°C . If after 2 minutes the water temperature is 25°C , when will the water temperature be 15°C ? (5)

1.2 Verify that $(xy^2 - 1) dx + x^2y dy = 0$ is exact and hence solve it. (10)

1.3 Solve $\frac{dy}{dx} - y = e^{2x}$, $y(0) = 7$ (5)

Question 2**[25]**

2.1 Solve the equation $y'' + y' - 2y - x^2 = 0$ (10)

2.2 The differential equation of motion of a simple pendulum is given as (15)

$$\frac{d^2x}{dt^2} + \frac{g}{l}x = 0$$

where x is the dependent variable and t is the independent variable.
Find the displacement of the pendulum as a function of time t .

Question 3**[25]**

3.1 Find the values of x, y, z which satisfy the matrix equation (5)

$$\begin{bmatrix} x + 3 & 2y + x \\ z - 1 & 4a - 6 \end{bmatrix} = \begin{bmatrix} 0 & -7 \\ 3 & 2a \end{bmatrix}$$

3.2 Find the inverse of the matrix (10)

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

3.2 Find the eigenvalues and eigenvectors of A , where (10)

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

Question 4

[25]

4.1 Obtain the value of $P_3(x)$ using Rodrigues' formula

(10)

$$P_n(x) = \frac{1}{(2^n)n!} \frac{d^n}{dx^n} (x^2 - 1)^n$$

4.2 Using the Laplace transform find the solution for the following equation

(10)

$$\left(\frac{\partial}{\partial t} y(t)\right) + y(t) = e^t$$

with initial conditions $y(0) = 1$ and $Dy(0) = 0$

4.3 Given $U = 1$; $V = t$, where $t \in (-1,1)$. Verify that U is orthogonal to V .

(5)

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