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UNIVERSITY OF NAMIBIA

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| **Faculty** | Agriculture, Engineering and Natural Sciences | | |
| **School** | Science | | |
| **Department** | Computing, Mathematical and Statistical Sciences | | |
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## FIRST OPPORTUNITY EXAMINATION

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**Moderator: Dr. W. Nangolo, University of Namibia**

This question paper consists of six pages (including this front page).

**Instructions**

- **Answer all the questions in Section A**
- **And any three questions in Section B.**

## UNIVERSITY OF NAMIBIA EXAMINATIONS

# Section A (40 Marks)

**Answer ALL questions.**

**A1.**

Let

$$C = \{\emptyset,\ \{1\},\ \{1,\emptyset\},\ \{\{1\}\},\ \{1,\{1\}\},\ \{\emptyset,\{1\}\}\}$$

Determine whether the following statements are true or false, and justify your answers.

(a) $\emptyset \in C$ [1]

(b) $\{1,\emptyset\} \in C$ [1]

(c) $\{1,\emptyset\} \subseteq C$ [1]

(d) $\{1,\{1\}\} \subseteq C$ [1]

(e) $\left|\{x \in C : x \text{ is a set containing } 1\}\right| = 3$ [2]

(f) $C$ has exactly 2 elements that are not subsets of $C$ [2]

(g) $\mathcal{P}(\{1\}) \subseteq C$ [2]

**A2.**

Given $A = \{2,4,6,8,10\}$, $B = \{1,2,3,4,5\}$, $U = \{1,2,\ldots,10\}$.

Find:

(a) $A \cap B$ [1]

(b) $A \cup B$ [1]

(c) $A \setminus B$ [1]

(d) $A^c$ [1]

**A3.**

Solve the inequality and write the solution in interval notation:

$$|x-3| \leq 10$$

[2]

**A4.**

Given $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$, $B = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$.

Find:

1. $A + B$ [2]

2. $3A$ [2]

**A5.**

Solve the system:

$$\begin{cases} x + 2y = 5 \\ 3x - y = 1 \end{cases}$$

[3]

**A6.**

If $f(x) = \dfrac{x+1}{x-2}$, find the domain of $f$. [2]

**A7.**

Let $A = \{1, 2, 3\}$, $B = \{a, b\}$. Write $A \times B$. [3]

**A8.**

Determine whether the function $f(x) = x^3 - x$ is even, odd, or neither. Justify. [3]

**A9.**

Find $|A \cup B|$ if $|A| = 12$, $|B| = 17$, and $|A \cap B| = 5$. [2 2]

**A10.**

Write the following interval in set-builder notation: $(-3, 5]$. [2]

**A11.**

Given $f(x) = 2x + 1$ and $g(x) = x^2$, find $f(g(2))$. [3]

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# Section B (60 Marks)

**Answer ANY THREE questions.**

*(Each question carries 20 marks.)*

## Question B1

B1.1 Let the universal set be

$$U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

and define

$$T = \{2, 4, 6, 8, 10\}, \quad S = \{1, 2, 3, 5, 8\}, \quad V = \{2, 3, 5, 7, 9\}, \quad W = \{1, 4, 6, 8, 10\}$$

Find:

(a) $(T \Delta S) \Delta V$ [2]

(b) $(T \cap S^c) \cup (V \Delta W)$ [2]

(c) $(T \cup S)^c \setminus (V \cap W)^c$ [3]

B1.2 (a) Solve $|x+4| > 3$ and express the solution in interval notation. [2]

(b) Find the interval(s) where $x^2 - 9 \geq 0$. [2]

(c) Given $C = (-\infty, -1]$ and $D = (-3, 2)$, compute $C \setminus D$ (set difference). [3]

B1.3 Using Venn diagrams and clear mathematical reasoning, prove the following, where $A$, $B$, and $C$ are sets (in the context of a universal set $U$):

$$A \setminus B = A \cap B^c$$

[6]

## Question B2

(a) Given that

$$A = \begin{pmatrix} 2 & -1 & 1 \\ 1 & 0 & 2 \\ 3 & 1 & 0 \end{pmatrix}, \quad B = \begin{pmatrix} -2 & 4 \\ -7 & 0 \\ 1 & 3 \end{pmatrix},$$

(i) If $\det(A) \neq 0$, find $A^{-1}$. [5]

(ii) Compute the product $AB$. [2]

(b) Find $x$, $y$, $z$ and $w$ if

$$3\begin{pmatrix} x & y \\ z & w \end{pmatrix} - \begin{pmatrix} x & 6 \\ -1 & 2w \end{pmatrix} = \begin{pmatrix} 4 & x+y \\ z+w & 3 \end{pmatrix}$$

[4]

(c) Consider the system of linear equations,

$$\begin{cases} 2x + y - z = 0 \\ 2z + 3y + x = 12 \\ 3x + z + 2y = 7. \end{cases}$$

Using Cramer's Rule, find the values of $x$, $y$ and $z$. [6]

(d) Use the Gaussian elimination method, solve the system:

$$\begin{cases} 3x - 2y = 4, \\ 6x - 4y = 9. \end{cases}$$

State whether the system has a unique solution, no solution, or infinitely many solutions. [3]

## Question B3

(a) State whether each of the following statement is true or false:

(i) If $A - B = \emptyset$, then $B \subseteq A$ [2]

(ii) If $|x| \leq 3$, then $-3 \leq -x \leq 3$

(b) Express $[1, \infty) \setminus [2, 5)$ in the set builder notation. [2]

(c) Let

$$A = \begin{pmatrix} 2 \\ 3 \\ -1 \end{pmatrix}, \quad B = \begin{pmatrix} 6 & -4 & 5 \end{pmatrix}.$$

(i) Compute $AB$, and give the order of the product $AB$. [3]

(ii) Find the determinant of $AB$ obtained in (i). [2]

(d) Consider the following sets

$$A = \{-1, 2, 3\}; \quad B = \{-6, 4\}.$$

(i) Find the cartesian product $A \times B$, and determine its cardinality. [2]

(ii) Come up with two relations $\mathcal{R}$, such that $\mathcal{R} = \{(a, b) \mid a \text{ divides } b\}$ of your choice from $A \times B$. [2]

(e) Solve the system of linear equations, using Gaussian elimination [7]

$$\begin{cases} x + 4y - 8z - 2 = 0 \\ 7y + 5x - 2z + 4 = 0 \\ 6z + 2y - 3x = 3 \end{cases}$$

## Question B4

B4.1 Given the functions $f(x) = \sqrt{9 - x^2}$, and $g(x) = x^2 - 3$.

(i) Determine the domain of $f$. [3]

(ii) Find the composite function $g \circ f$. [2]

(iii) Determine whether $g$ is one-one. [2]

B4.2 Let $h(x) =$

$$\begin{cases} 1 - x, & x < 1, \\ \sqrt{x - 1}, & x \geq 1. \end{cases}$$

(i) Find the domain of $h$. [2]

(ii) Evaluate $h(1 - x)$, if $x > 0$. [2]

(iii) Sketch a clear and well-labelled graph of $h(x)$. [4]

B4.3 Consider functions $g(x) = x^2$ and $f(x) = -2(x - 3)^2 + 5$.

(i) Describe, step by step, the sequence of transformations (such as shifts, reflections, stretches, or compressions) applied to the graph of $y = g(x)$ to obtain the graph of $y = f(x)$. [3]

(ii) Write down the coordinates of the vertex of $f$ and state whether it is a maximum or a minimum. [2]

**END**