



UNDERGRADUATE UNIVERSITY EXAMINATIONS

SCHOOL OF EDUCATION (SOE)

DEGREE BACHELOR OF EDUCATION ARTS

MTH 212: DISCRETE MATHEMATICS

DATE: 31ST JULY 2026

DURATION: 2 HOURS

MA

XIMUM MARKS: 70

INSTRUCTIONS:

1. Write your registration number on the answer booklet.
2. **DO NOT** write on this question paper.
3. This paper contains **SIX (6)** questions.
4. Question **ONE** is compulsory.
5. Answer any other **THREE** questions.
6. Question **ONE** carries **25 MARKS** and the rest carry **15 MARKS** each.
7. **Write all your answers in the Examination answer booklet provided.**

QUESTION ONE

a) Let U denote the universal set $\{a, b, c, d, e, f\}$ and that set

$A = \{b, c, f\}$ and set $B = \{a, c, e\}$ are subsets of

U . Verify that: i) $(A \cup B)' = A' \cap B'$

ii) $(A \cap B)' = A' \cup B'$

(7**marks)**

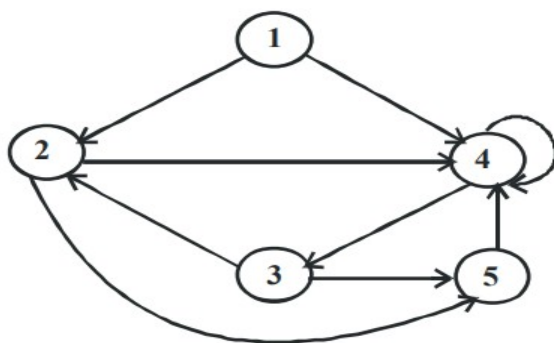
b) Let the function $f: x \rightarrow R$ be defined by $f(x) = x^3 - 3x^2 - x + 3$, If $x = \{-2, -1, 0, 1, 2, 3\}$ find the range of the function f

(6 marks)

c) Consider the relation $R = \{(1, a), (1, b), (3, b), (3, d), (4, d)\}$ from $X = \{1, 2, 3, 4\}$ to $Y = \{a, b, c, d\}$. Find (i) $E = \{X: xRb\}$ and $F = \{X: xRd\}$ ii) $G = \{Y: yRx\}$ and $H = \{Y: yRy\}$

(4 marks)

d) Consider the following diagram R



i) Represent the above diagram in In-degree and Out-degree form **(5 marks)**

ii) Compute a matrix M_R

(3 marks)

QUESTION TWO

a) In a survey of 80 customers of beverages, it was found that 45 like tea, 40 like coffee, 30 like juice, 15 like both tea and coffee, 12 like tea and juice, 10 like coffee and juice, 5 like all the three drinks.

Determine: i) Like tea only ii) Like exactly two drinks iii) Like at least one drink

(11 marks)

b) Let $A = \{1, 2, 3, 4, 5\}$ and $B = \{x, y\}$. Find (i) $A \times B$ (ii) $B \times A$

(4 marks)

QUESTION THREE

a) Given $A = \{1, 2, 3, 4\}$ and $B = \{a, b, c\}$. Let R be the following relation from A to B .

$$R = \{(1, b), (2, b), (3, a), (4, c)\}$$

i) Determine the matrix M_R of the relation

(4

marks)

ii) Draw an arrow diagram of R

(4

marks)

iii) Find the inverse relation R^{-1} of R (1

mark)

iv) Determine the domain and range of R (2

marks)

b) Let $A = B = \{x, y, z\}$ and $R = \{(x, x), (x, y), (y, z), (z, x)\}$. Draw a
diagraph of R (4

marks)

QUESTION FOUR

a) i) Write implication for p and q for each of the following

1. P : I have headache q : I will take aspirin.

2. P : I take a walk q : I will reach late.

3. P : 2 divides 10 q : Joseph will go to movie (3

marks)

ii) Draw the truth table for $p \rightarrow q$ (4

marks)

b) Give contra-positive and converse of the following statements.

i. If I am hungry then I will eat.

ii. If today is Sunday, then I am going for a movie (4

marks)

c) Form the conjunction of p and q for each of the following

i. P : I will drive my car q : I will reach the office in time.

- ii. P: 2 is even q: 11 is odd.
- iii. P: $2 + 3 + 1 = 6$ q: $2 + 3 > 4$
- iv. P: Nairobi is capital of Kenya q: Chemistry is a science subject.

**(4
marks)**

QUESTION FIVE

a) Let $A = \{1, 2, 3\}$, $B = \{a, b, c\}$ and $C = \{x, y, z\}$. Consider the following relation R from A to B and relation S from B to C : $R = \{(1, b), (2, a), (2, c)\}$ and $S = \{(a, y), (b, x), (c, y), (c, z)\}$.

i) Find the composition relation $R \circ S$ **(3
marks)**

ii) Find the matrices M_R , M_S , and $M_{R \circ S}$ of the respective relations R , S , and $R \circ S$

**(4
marks)**

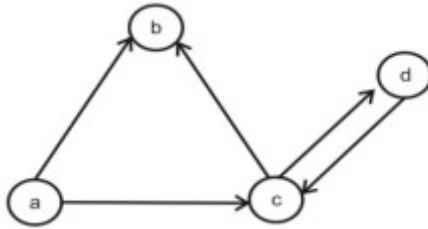
iii) Compare $M_{R \circ S}$ to the product $M_R M_S$ **(3
marks)**

d) Let $f: \mathbb{R} \rightarrow \mathbb{R}$ be defined by $f(x) = x^2 + 2x$. Find a formula for $[f \circ f(x)]$ and hence find $[(f \circ f)(3)]$

(5 marks)

QUESTION SIX

Consider the following diagraph



a) i) List all paths of length '2' (5

marks)

ii) List all paths of length '3' (2

marks)

iii) list all cycles (2

marks)

b) Use Warshall's Algorithm

to find the:

i) Relation R of adjacency and hence compute the adjacency matrix

(3 marks)

ii) Relation R of transitive closure hence compute the transitive closure matrix

(3 marks)