

061306T4CPM

COMPUTER PROGRAMMING LEVEL 6

IT/OS/CP/CR/02/6

Apply Discrete Mathematical Concepts

March/April 2026



**TVET CURRICULUM DEVELOPMENT, ASSESSMENT AND CERTIFICATION
COUNCIL (TVET CDACC)**

WRITTEN ASSESSMENT

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATE

1. This paper consists of **TWO** sections: **A** and **B**.
2. Answer **ALL** questions in section A and **ANY THREE** (3) questions in section B.
3. Marks for each question are indicated in the brackets.
4. Candidates are provided with a separate answer booklet
5. Do not write on the question paper.

This paper consists of FOUR (4) printed pages

**Candidate should check the question paper to ascertain that all pages are printed as
indicated and that no questions are missing.**

SECTION A: (40 Marks)*(Answer ALL questions in this section)*

1. Given that $A=\{a, b\}$, $B=\{3,2\}$ and $C=\{4,3\}$, determine $A \times (B \cup C)$ (2 marks)
2. Use truth tables to prove that the propositions $(p \wedge) \vee (\neg p \wedge \neg q)$ and $p \leftrightarrow q$ are logically equivalent (5 marks)
3. Let $t_1=2$, $t_2=4$, $t_3=8$ and for ≥ 1 , $t_{n+3} = t_{n+2} + t_{n+1} + 2t_n$. Find a pattern for t_n and prove your answer. (4 marks)
4. Given that $f(x)=3x+2$ and $g(x)=x^2$. Find $f(x) - g(2x)$ (2 marks)
5. Find the sum of the first 12 terms of the arithmetic series:
 $3 + 7 + 11 + \dots$ (4 marks)
6. Given the matrix:

$$M = \begin{bmatrix} 2 & 1 \\ 5 & 3 \end{bmatrix}$$

Determine M^{-1} (6 marks)

7. Simplify the Boolean expression using algebraic methods:
 $F = (A + B) (A' + C)$ (6 marks)
8. A recursive sequence is defined as:
 $a_0 = 4$
 $a_{n+1} = 2a_n + 1$ for $n \geq 0$

Find:

- a. a_1
- b. a_2
- c. a_3 (3 marks)
9. Given the adjacency matrix below, draw the corresponding graph: (4 marks)

$$\begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ 1 & 0 & 1 & 0 \end{bmatrix}$$

10. The product of two consecutive positive integers is 72. Find the integers. (4 marks)

SECTION B: (60 Marks)*(Answer Any THREE questions in this section)*

11. A transport network consists of four towns: A, B, C, and D.
- A is connected to B and C
 - B is connected to A and D
 - C is connected to A and D
 - D is connected to B and C
- a. Draw the undirected graph representing the network. (4 marks)
- b. Write the adjacency matrix for the graph using the order A, B, C, D. (8 marks)
- c. Explain FOUR advantages of using graphs to model transport networks. (8 marks)
12. a. Simplify the following Boolean function using K-Map. (10 marks)

$$F = X'Y'Z + X'YZ + X'YZ' + X'Y'Z'$$

- b. A water filtration system releases 500 litres of clean water on the first day. Due to gradual clogging of the filters, the amount of water released each day becomes 75% of the previous day's output. Determine the total amount of water the system will release before it becomes ineffective. (4 marks)
- c. Write a recursive relation for the sequence:
1, 4, 9, 16, ... (6 marks)
13. a. Using 2's complement, perform the following calculations (10 marks)
- i. $F9_{16} - 102_8$
 - ii. $11011011_2 - 11010101_2$
- b. Given the relation: $R = \{(1,1), (2,2), (3,3), (1,2), (2,1)\}$
- i. Determine whether R is reflexive (1 mark)
 - ii. Determine whether R is symmetric (1 mark)
 - iii. Determine whether R is transitive (2 marks)
- c. Given the function:

$$f(x) = \sqrt{x-1}$$

- i. State the domain of f. (3 marks)
 - ii. State the range of f. (3 marks)
14. a. The sum of three consecutive terms in an arithmetic progression is 36, and the product of the three terms is 1,716. Find the three numbers. (10 marks)

- b. A survey shows that 90 employees use Email (E), 60 use Cloud Storage (C), and 40 use both.
- i. Draw a Venn diagram to represent the information (6 marks)
 - ii. Find the number of employees who use only Email (2 marks)
 - iii. Find the number who use at least one service (2 marks)