LAIKIPIA UNIVERSITY

UNIVERSITY EXAMINATIONS

FIRST SEMESTER 2025/2026 ACADEMIC YEAR

FIRST YEAR EXAMINATION FOR THE DEGREES OF BACHELOR OF SCIENCE IN COMPUTER SCIENCE, BACHELOR OF INFORMATION COMMUNICATION & TECHNOLOGY AND BED (SCIENCE)

COMP 114: DISCRETE STRUCTURES I

STREAM: R ***TIME: 2 HRS***

DAY: WEDNESDAY [11.30 – 13.30 P.M] ***DATE: 28/01/2026***

THIS QUESTION PAPER CONSISTS OF THREE (3) PAGES

PLEASE DO NOT OPEN UNTIL THE INVIGILATOR SAYS SO.

INSTRUCTIONS: ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS

SECTION A .

QUESTION ONE COMPULSORY (30 MARKS)

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You are hired as a junior data scientist in a financial technology company that uses algorithmic decision-making for loan approvals.

a) Construct a logical representation (using propositional logic and truth tables) for validating client identity. **(6 Marks)**

b) Apply proof by contradiction to demonstrate that the eligibility verification process always terminates. **(4 Marks)**

c) Use mathematical induction to show correctness in repeated loan risk checks. **(4 Marks)**

d) Apply set theory concepts (Cartesian products, equivalence relations) to model risk classification of customers. **(6 Marks)**

e) Explain how the pigeonhole principle applies when assigning customers to limited risk categories. **(4 Marks)**

f) Evaluate how Boolean algebra and De Morgan's laws help optimize circuit-based decision processes. **(6 Marks)**

SECTION B.

SECTION TWO CHOOSE ANY TWO QUESTIONS 4O MARKS. ALL QUESTIONS CARRY EQUAL MARKS (20 MARKS EACH)

QUESTION TWO (20 MARKS)

A university is implementing a biometric-based library access system.

a) Elaborate how functions (injections, surjections, bijections) ensure each student is uniquely mapped to a biometric ID. **(6 Marks)**

b) Evaluate risks when the mapping function is not bijective, using practical examples. **(6 Marks)**

c) Describe how inverse and composition of functions would work in case of multiple verification layers. **(4 Marks)**

d) Discuss how relations (reflexivity, symmetry, transitivity) can be applied to model student-to-resource authentication. **(4 Marks)**

QUESTION THREE (20 MARKS)

During a network security audit, encrypted keys are generated using prime numbers and modular arithmetic.

a) Describe the role of Euclid's algorithm in computing secure encryption parameters. **(4 Marks)**

b) Elaborate the importance of greatest common divisor (GCD) in cryptographic key generation. **(4 Marks)**

c) Apply the concept of least common multiple (LCM) in ensuring compatibility of cryptographic cycles. **(4 Marks)**

d) Interpret how modular arithmetic secures message confidentiality with a worked example. **(6 Marks)**

e) Apply permutations, combinations, or binomial coefficients to calculate the number of possible key arrangements among servers. **(2 Marks)**

QUESTION FOUR (20 MARKS)

A software engineering team is designing a fault-tolerant distributed database using graph-based replication.

a) Discuss how connectivity in graphs ensures redundancy in database nodes. **(6 Marks)**

b) Describe the role of paths and cycles in identifying communication bottlenecks. **(4 Marks)**

c) Interpret how spanning trees can be used to optimize replication. **(6 Marks)**

d) Evaluate potential weaknesses of relying solely on connectivity for fault tolerance. **(4 Marks)**

QUESTION FIVE (20 MARKS)

An AI-powered chatbot must choose valid responses from multiple contradictory inputs.

a) Explain how logical connectives are used to model chatbot decision-making. **(4 Marks)**

b) Construct a truth table to resolve contradictions between two statements. **(6 Marks)**

c) Interpret how probability logic helps the chatbot choose the most likely response. **(4 Marks)**

d) Discuss the implications of using CNF and DNF for ensuring logical validity. **(6 Marks)**