MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING, APPLIED SCIENCES AND TECHNOLOGY

DEPARTMENT: COMPUTER SCIENCE AND INFORMATION SYSTEMS

MODULE: THEORY OF COMPUTATION

CODE: BCOS212

SESSIONAL EXAMINATIONS
JUNE 2024

DURATION: 3 HOURS

EXAMINER: MS. C. KATSANDE

INSTRUCTIONS

1. Answer **Any 4** questions
2. Each question carries 25 marks
3. Start a new question on a fresh page
4. Total marks 100

Additional material(s): None

Question 1

a) Outline the three pillars of Theory of Computation.   **[9 Marks]**

b) Using examples, define the following concepts:
    i.   Sequence;   **[2Marks]**
    ii. Tuple;   **[2 Marks]**
    iii. String; and   **[2 Marks]**
    iv. Language.   **[2 Marks]**

c)   Prove that

   the √2 is irrational using a proof by contradiction.   **[8 Marks]**

Question 2

a) Given the following the transition graph **M**, provide a formal description of **M**.
                                                                           [9 Marks]
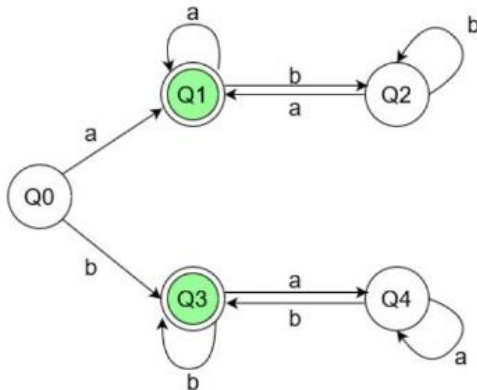
b) Give regular expressions that generate each of the following languages. In all cases,
    the alphabet is $\Sigma = \{0, 1\}$.

   i.   The language $\{w \in \Sigma*: w$ contains at least two 0s$\}$.   **[3 Marks]**
   ii. The language $\{w \in \Sigma^*: w$ has an odd number of 1's$\}$.   **[3 Marks]**

c) Construct a Deterministic Finite Automata (DFA) that accepts a language L over input

    alphabet $\Sigma = \{a, b\}$ such that L is the set of all strings starting with 'aba'. **[10 Marks]**

Question 3

a) Design a Non-deterministic Finite Automata (NFA) with $\sum = \{0, 1\}$ in which a substring "double '1' is followed by single '0' must exist. **[8 Marks]**

b) Provide any five applications of context-free grammar. **[5 Marks]**

c) Convert the given grammar to Chomsky Normal Form (CNF). **[12 Marks]**

  S → ASA | aB

  A → B | S
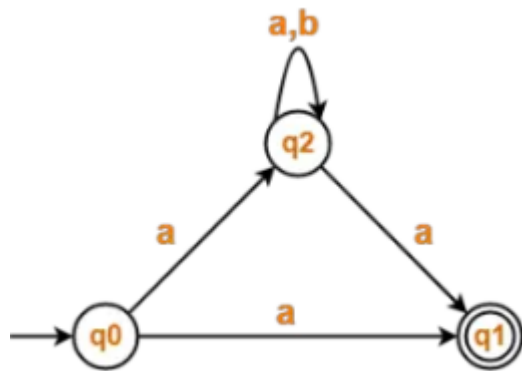
  B → b | ε

Question 4

a) Enumerate three (3) key differences between Finite Automata and Turing machines. **[3 Marks]**

b) Show how the given Non-deterministic Finite Automaton (NFA) can be converted to its equivalent Deterministic Finite Automaton (DFA). **[12 Marks]**

c) Consider the following production rules for the grammar (G):

  S → xB / yA

  S → xS / yAA / x

B → yS / xBB / y

String W = **xxxyyxyyyx**

Show that given string belongs to Given Grammar (G) using the leftmost derivation tree.

[10 Marks]

Question 5

a) Given a language $L = a^N b^N c^N$ where N>0.

   i) Give an implementation-level algorithm of a Turing Machine that decides the language. **[4 Marks]**

   ii) Design a Turing Machine which recognizes the given language. **[12 Marks]**

b) Explain any three (3) problems that belong to class NP. **[9 Marks]**

END OF EXAMINATION