



MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTING AND INFORMATION TECHNOLOGY

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MATHEMATICS)

SMA 394: THEORY OF COMPUTATION

DATE: 13/11/2020

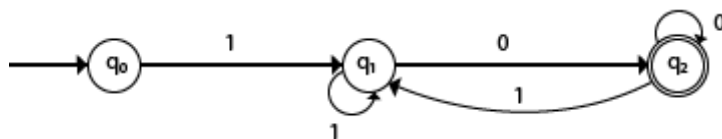
TIME: 11:00 – 1:00 PM

INSTRUCTIONS

Answer question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

- a) Explain the following terms as used in automata theory (4 marks)
- i. Deterministic finite automata
 - ii. Non-Deterministic finite automata
- b) State the language denoted by following finite automaton over the alphabet $\{0, 1\}$. (2 marks)



- c) Design a context-free grammar (CFG) for the language $\{a^n b^n : n \geq 0\}$. (4 marks)
- d) Let $A = \{1, 2, 3, 4\}$. Which ordered pairs are in the relation $R = \{(a, b) \mid a < b\}$? (6 marks)
- e) Write the regular expression for the following language (6 marks)
- i. The set of strings over $\{0,1\}$ that end in 3 consecutive 1's.
 - ii. The set of strings over $\{0,1\}$ that have at least one 1.
 - iii. The set of strings over $\{a,b\}$ that start with a but not having consecutive b 's.

- f) Design a NFA for the transition table over $\Sigma = \{0,1\}$ as given below: (4 marks)

State	0	1
$\rightarrow q_0$	q_0, q_1	q_0, q_2
q_1	q_3	ε
q_2	q_2, q_3	q_3
$\rightarrow q_3$	q_3	q_3

- g) A soda dispensing machine has the following characteristics: (4 marks)

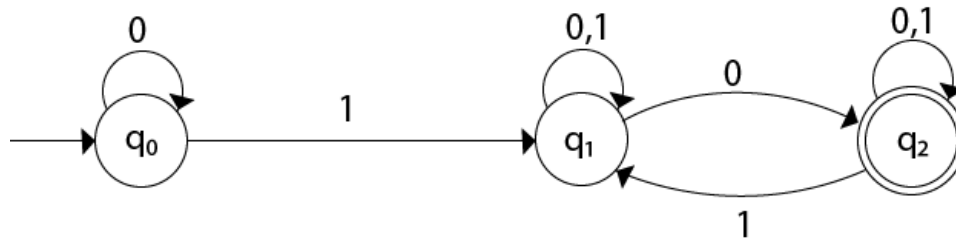
- Drinks cost 20 shillings.
 - The only coins accepted by the machine are the Five, Ten- and Twenty-shillings coins abbreviated E, N and Y respectively. The machine accepts any combination of these coins, in any order, that add up to 20 shillings.
 - If the buyer puts in too much money, the dispenser returns appropriate change.
 - If the user enters a partial sum, e.g. one five shilling coin (E) and one ten shilling coin (N) and then enters too much money e.g. one twenty shilling coin (Y), the machine will accept the input, move into the final state and return appropriate change.
- Ignoring the selection or delivery of drinks, *draw a finite-state model* of the soda dispensing machine that returns appropriate change when the buyer enters too much money.

QUESTION TWO (20 MARKS)

- a) Describe the following terms as it applies to automata theory and languages giving examples in each case (10 marks)
- Alphabet
 - String
 - Kleene star
 - Kleene closure / plus
 - Length of a string
- b) Design a Turing Machine that reads a string representing a binary number and erases all leading 0's in the string. However, if the string comprises of only 0's, it keeps one 0. You can use a table to show the results (10 marks)

QUESTION THREE (20 MARKS)

a) Convert the given NFA to DFA. (8 marks)



- b) Discuss two application areas of Context Free Grammars as it applies in automata theory and languages (4 marks)
- c) Construct a Turing machine which accepts the language of aba over $\Sigma = \{a, b\}$. (4 marks)
- d) List the four components used to form a context free grammar. (4 marks)

QUESTION FOUR (20 MARKS)

- a) Using a table, design and explain a Turing Machine that can be used to recognize all strings consisting of an odd number of a 's. (6 marks)
- b) With help of examples, discuss the following operations on regular expression (6 marks)
- Union
 - Intersection
 - Kleen closure
- c) Automata Theory deals with definitions and properties of different types of "computation models". List and explain three examples of such models (6 marks)
- d) Explain the pumping Lemma (2 marks)

QUESTION FIVE (20 MARKS)

- a) Describe the language denoted by following regular expression (4 marks)
- r.e. = $(b^* (aaa)^* b^*)^*$
 - r.e = $1 (0+1)^* 0$
- b) Design an NFA with $\Sigma = \{0, 1\}$ accepts all string ending with 01. (4 marks)
- c) Based on the top-down parsing, list and explain the FOUR types of transitions as it applies to Push Down Automaton (8 marks)
- d) Describe Time and Space Complexity as it applies to complexity theory (4 marks)