



MACHAKOS UNIVERSITY

University Examinations for 2018/2019

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: 18/4/2019

TIME: 2.00-4.00 PM

INSTRUCTIONS

Answer **question ONE** and any other **TWO** questions.

QUESTION ONE (30 MARKS)

- a) Design a context-free grammar (CFG) for the language $\{a^n b^n : n \geq 0\}$. (6 marks)
- b) Discuss the Application areas of Context Free Grammars as it applies in computing (6 marks)
- c) Explain the following terms as used in automata theory (4 marks)
 - i. Deterministic
 - ii. Non-Deterministic
- d) Describe Time and Space Complexity as it applies to complexity theory (4 marks)
- e) Let $A = \{1, 2, 3, 4\}$. Which ordered pairs are in the relation $R = \{(a, b) \mid a < b\}$? (4 marks)
- f) List and explain THREE variants of Turing Machine (6 marks)

QUESTION TWO (20 MARKS)

- a) Based on the top-down parsing, list and explain the FOUR types of transitions as it applies to Push Down Automaton (8 marks)
- b) Explain three traditional areas of theory of computation (6 marks)
- c) Construct a Push Down Automaton that accepts $L = \{ww^R \mid w = (a+b)^*\}$ (6 marks)

QUESTION THREE (20 MARKS)

- a) With help of examples, discuss the following set operations (8 marks)
 - i. Union
 - ii. Intersection

- iii. Set difference
- iv. Complement
- b) Describe THREE different cases of complexities as it applies to complexity theory (6 marks)
- c) Construct finite state automata that recognizes all possible strings over the alphabet $\{0,1\}$ ending with two consecutive zeros. (6 marks)

QUESTION FOUR (20 MARKS)

- a) Automata Theory deals with definitions and properties of different types of “computation models”. List and explain some examples of such models (6 marks)
- b) Let a non-deterministic finite automaton be as shown below with the 5-tuples. Draw a finite state diagram showing the next possible states after an input 0 and 1 is applied to the present state; then generate a table showing the next possible states (10 marks)
 - ✓ $Q = \{a, b, c\}$
 - ✓ $\Sigma = \{0, 1\}$
 - ✓ $q_0 = \{a\}$
 - ✓ $F = \{c\}$
 - ✓ The transition function δ as
- c) Describe the following sets by regular expression (4 marks)
 - i. $\{01,10\}$
 - ii. $\{101\}$
 - iii. $\{\lambda, 1, 11, 111, \dots\}$
 - iv. $\{1, 11, 1111, \dots\}$

QUESTION FIVE (20 MARKS)

- a) Describe the following terms as it applies to theory of computation giving examples in each case (10 marks)
 - i. Alphabet
 - ii. String
 - iii. Kleene star
 - iv. Kleene closure / plus
 - v. 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. (6 marks)
- c) State four important components in a grammatical description of a language in context free grammar (4 marks)