

MACHAKOS UNIVERSITY
SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT: CIT
BACHELOR OF SCIENCE COMPUTER SCIENCE
UNIT NAME: AUTOMATA THEORY
UNIT CODE: SCO 211
SUPPLIMENTARY EXAM

DATE: _____

TIME: _____

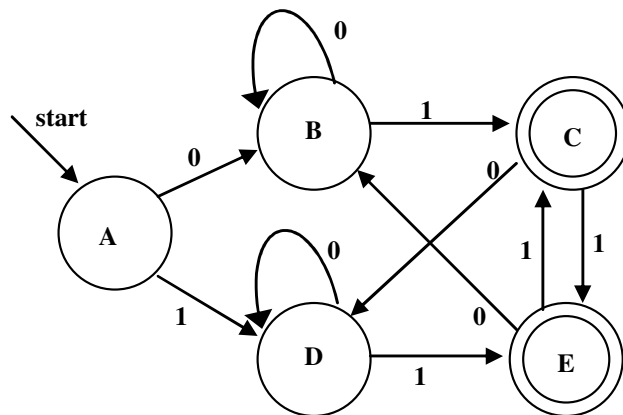
INSTRUCTIONS: Answer Question ONE and Any Other TWO Questions.

INSTRUCTIONS:

ANSWER QUESTION ONE AND ANY OTHER TWO

Question 1 (30 Marks)

a) For the following automaton M



- i. Give the transition function **(3 Marks)**
- ii. Minimize the automaton **(4 Marks)**
- b) Draw a (possibly nondeterministic) FSM that accepts $\{w \in \{a, b\}^* : w \text{ contains at least one instance of } aaba, bbb \text{ or } ababa\}$. **(5 Marks)**
- c) Let $L = \{w \in \{a, b\}^* : w \text{ does not end in } ab\}$
 - i. Show a regular expression that generates L. **(3 Marks)**
 - ii. Show an FSM that accepts L. **(4 Marks)**
- d) Show that the language $L = \{a^n : n \geq 0, n \neq 4\}$ is regular. **(5 Marks)**
- e) Construct complete deterministic automata recognising each of the following languages:

i. $a^2 + (a^3 + a^6 + a^8)(a^6)$

(2 Marks)

ii. $abab(a+b)$

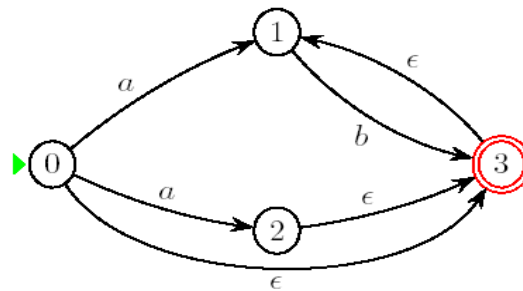
(2 Marks)

iii. $(a+b)^*abab$

(2 Marks)

Question 2 (20 Marks)

- a) Convert the following NFA (Non-deterministic Finite Automata) to DFA (Deterministic Finite Automata) using the subset construction method. (4 Marks)



- b) Consider the following languages over the alphabet $\{a, b\}$.

$$L_1 = \{aba, aab\}$$

$$L_2 = \{\lambda, aab, baa\}$$

$$L_3 = \{\lambda\}$$

Show the languages generated after execution of the following operations:

i. $L_1 \cap L_2$

(2 Marks)

ii. $L_3 \cap L_2$

(2 Marks)

iii. $L_1 \cap L_3$

(2 Marks)

iv. $L_1 \cup L_2$

(2 Marks)

- c) Convert the following NFA to a DFA (8 Marks)



Question 3 (20 Marks)

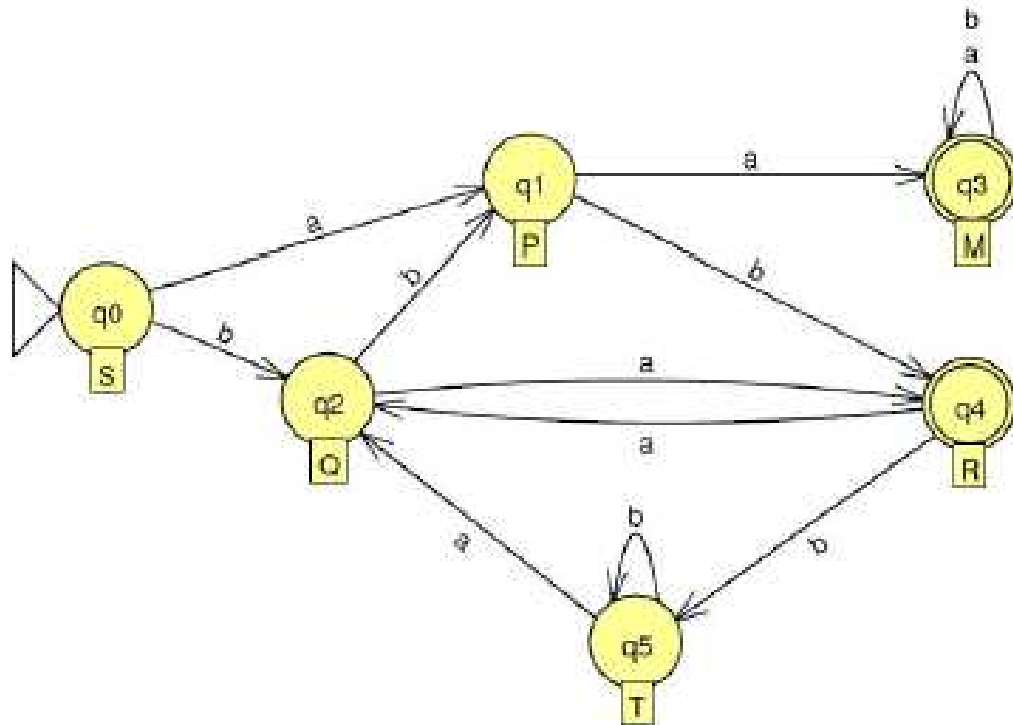
- a) Prove or disprove each of the following statements:
- i. It is possible that the intersection of an infinite number of regular languages is not regular **(2 Marks)**
 - ii. Every subset of a regular language is regular **(2 Marks)**
 - iii. Let $L_4 = L_1L_2L_3$. If L_1 and L_2 are regular and L_3 is not regular, it is possible that L_4 is regular. **(2 Marks)**
 - iv. The union of two regular languages is regular **(2 Marks)**
- b) Define the following terms:
- i. An alphabet **(2 Marks)**
 - ii. A word **(2 Marks)**
 - iii. A language **(2 Marks)**
 - iv. A string **(2 Marks)**
 - v. Finite State Machine **(2 Marks)**
 - vi. Transition function **(2 Marks)**

Question 4 (20 Marks)

- a) Give the formal definition of a Turing machine. Explain briefly what is meant by Turing's Thesis, you should make clear the relationship between 'algorithms' and Turing machines, and between Turing machines and real computers. **(6 Marks)**
- b) Write down a regular expression for the language over the alphabet $\{0, 1\}$ that contains, somewhere, a 0 followed by at least two 1's (not necessarily adjacent). **(4 Marks)**
- c) Differentiate between a Deterministic Finite Automaton (DFA) from a Nondeterministic Finite Automaton (NFA) **(4 Marks)**
- d) Show that if L is a non-empty language, such that any w in L has length at least n , then any dfa accepting L must have at least $n+1$ states. **(6 Marks)**
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QUESTION 5 (20 Marks)

- a) In the automaton diagram below the state labels are below each state (i.e. S, P, Q, . . .). Do not use the names $q_0, q_1, \dots$ to refer to the states. Also note that the loop on state M (the one with both a and b on it) means that there are two loops at M, one labeled a and one labeled b.



For each of the following display the sequence of configurations and state if the word is accepted by the language of the automaton, or not.

- | | |
|---------------|-----------|
| i. abaa | (3 Marks) |
| ii. abbbaaaba | (3 Marks) |
| iii. bbbbbb | (3 Marks) |
| iv. babb | (3 Marks) |
- b) Find dfa's for the following languages $\Sigma = \{a, b\}$
- | | |
|--------------------------------------|-----------|
| i. $L = \{w : w \bmod 3 = 0\}$ | (4 Marks) |
| ii. $L = \{w : w \bmod 5 \neq 0\}$ | (4 Marks) |