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.

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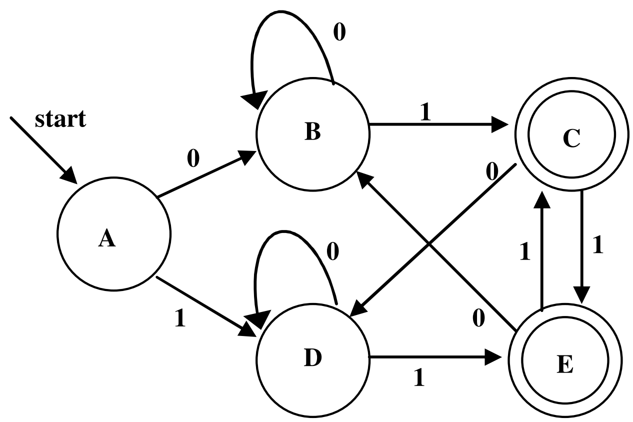
ANSWER QUESTION ONE AND ANY OTHER TWO

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 ∈ {a, b}* : w contains at least one instance of aaba, bbb or ababa}. **(5 Marks)**

c) Let L = {w ∈ {a, b}* : w 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:

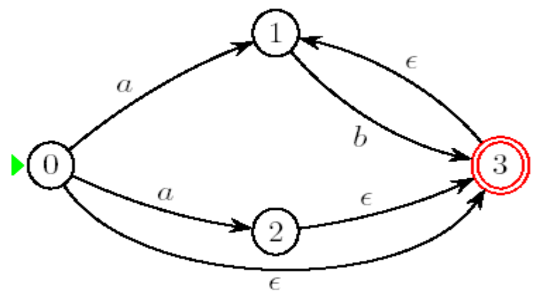
i. $a^2+(a^3+a^6+a^8)(a^6)$ **(2 Marks)**

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= {λ, aab, baa}

L_3= {λ}

Show the languages generated after execution of the following operations:

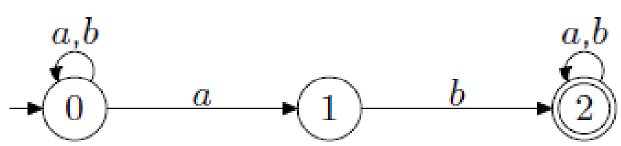
i. $L_1 \cap L_2$ **(2 Marks)**

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 regula **(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)**

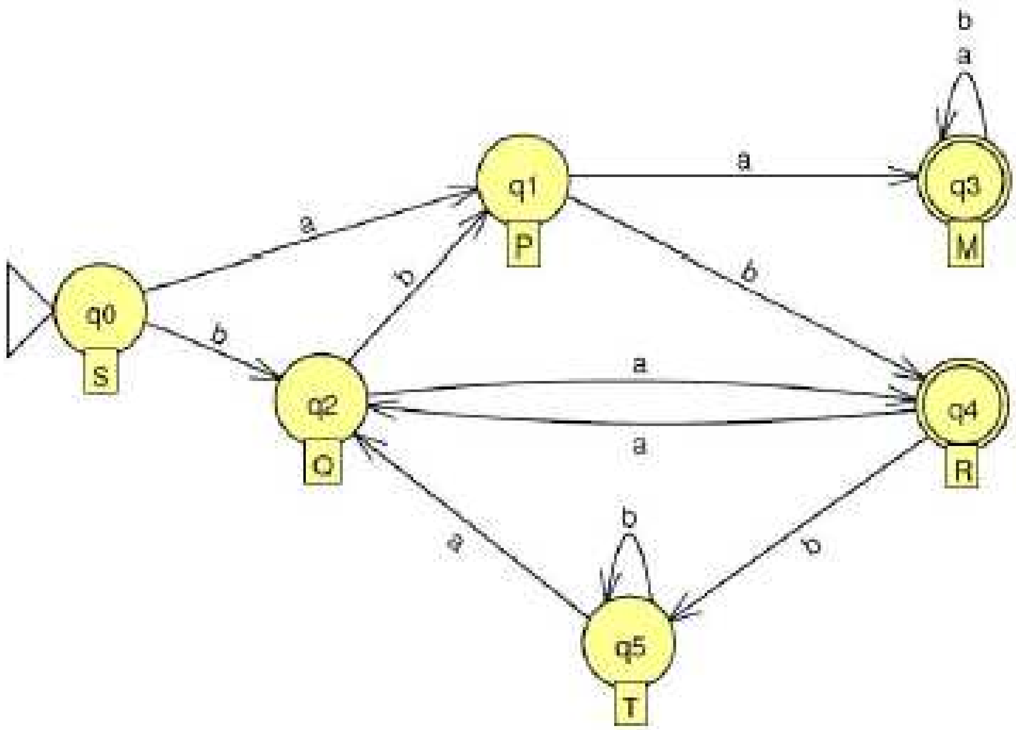
b) Write down a regular expression for the language over the alphabet {0, 1} that contains, somewhere, a 0 followed by at least two 1's (not necessarily adjacent). **(4 Marks)**

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 rnust have at least n+1 states. **(6 Marks)**

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 q0, q1,. . . 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 on 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. bbbbb **(3 Marks)**

iv. babb **(3 Marks)**

b) Find dfa's for the following languages $\sum = \{a, b\}$

i. $L = \{w: |w| \bmod 3 = 0\}$ **(4 Marks)**

ii. $L = \{w: |w| \bmod 5 \neq 0\}$ **(4 Marks)**