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Exam Date: February 12, 2025
Academic Year and Term: Term 2, A.Y. 2024 - 2025
Total Points: 100
REMINDERS. READ BEFORE YOU START ANSWERING!

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1. This is an open notes exam. Only non-digital notes are allowed.
2. This exam is worth 100 points.
3. Show your solution as detailed as possible because partial credits will be given when appropriate. Clearly indicate the final answer for each item (you may box the final answer to indicate it when applicable).
4. When a question asks for a deterministic machine, any nondeterministic answer will receive **ZERO** points.
5. For state diagrams and transition tables, failure to indicate the start state will automatically result in a score of **ZERO** for that item. For items with a state limit, exceeding the state limit will also result in a score of **ZERO**.
6. Cheating in any form is punishable with a grade of 0.0 for the course and a disciplinary offense. This includes but is not limited to passing notes during the exam or communicating with other people.

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1. Design a Mealy machine that takes as input $\omega \in \{a, b, c\}^*$ and outputs 0 if the last two symbols read are different and 1 if they are the same. (10 points)

   Sample runs:

Input	Output
$abcba$	00000
$caaaabbb$	00111011
$abbaacc$	0010101

Table 1: Sample Test Cases for Exam #1, Item #1

2. Create a deterministic finite automaton (DFA) that accepts binary strings ($\omega \in \{0, 1\}^*$) with the following properties:

   - If it starts with a 0, the string must be of even length,
   - If it starts with a 1, the string must be of odd length, and
   - It should not start and end with the same symbol. (10 points)

   Sample strings
   Accepted: $01, 100, 0111, 10100$
   Rejected: $001, 1100, 0100, 10011$

3. Given the alphabet $\Sigma = \{a, b, c, d, e, f\}$, design a DFA that accepts all strings whose last four symbols are identical. This machine is expected to have a very large number of states and transitions. (10 points)

   To express it efficiently, provide the mathematical definition of the DFA, i.e.,

   $M = (Q, S, \delta, q_I, F)$
   Q - finite set of states
   S - finite input alphabet
   $\delta : Q \times S \to Q$ - transition function
   q_I - initial state
   F - finite set of final states. $F \subseteq Q$

   Accepted: $acbefadddd, aaaa, afdbceeedeeee, bbacccc$
   Rejected: $a. \lambda, fcdacbfd, eadcfeab, bbb$

4. Create a non-deterministic finite automaton (NFA), possibly with ϵ-moves/λ-moves, that accepts the language L over the alphabet (a, b, c), such that all b's are immediately preceded by an a and all c's are possibly preceded by a's and/or b's. (NOTE: You cannot construct a DFA and argue that DFAs are special cases of NFAs.) (10 points)

   Sample strings
   Accepted: $aab, cc, aacabc, caab$
   Rejected: $abba, cabcb, babaa$

5. Code-switching is the use of two languages in a sentence. Juan dela Cruz created a DFA that accepts word sequences conforming to the structure of proficiency-driven code-switching.

   Specifically, the DFA they created accepts sequences where all English words (e) are succeeded by at least three Filipino words (f). The definition of code-switching requires at least one English (e) word and at least one Filipino (f) word to be present. Design a regular expression that models the language accepted by the DFA created by Juan dela Cruz.

Additional requirement: The regular expression MUST include a Kleene star (*). (10 points)

Accepted: $efff, fefff, efffefffefffffffff$
Rejected: $f, e, ef, fe, eefff$

6. Maria asked Juan to create a Moore machine that takes English words (e) as input and converts every second input symbol into a Filipino word (f). She also mentioned that the first output symbol can be arbitrary. Example:

   Input: $eeeeee$
   Output: $eefefef$

   Juan created a Moore machine; the transition and output are provided below:

	e
$\rightarrow Q1 : e$	Q2
$Q2 : e$	Q3
$Q3 : f$	Q2

Table 2: Moore Machine for Exam #1, Item #6

   Convert this Moore machine into its equivalent Mealy machine using the process discussed in class. (10 points)

7. Provide the transition table for the reduced and connected machine that is equivalent to the following DFA. (10 points)

	a	b	c
$\rightarrow A$	~~A~~	D	G
B	~~A~~	F	A
C	~~G~~	F	D
D^*	~~A~~	C	F
E	~~G~~	F	H
F^*	C	A	D
G	~~G~~	D	A
H^*	B	C	F
I^*	E	G	D

Table 3: Exam #1, Item #7

8. Show whether the following two DFAs are equivalent or not. Show your complete solution. (10 points)

	0	1
$\rightarrow A$	A	C
B^*	C	B
C	B	A
D	B	C
E	B	D
F	F	E

Table 4: Transition Table for M1 for Exam # 1, Item # 8

	0	1
$\rightarrow G$	H	K
H^*	G	H
I	H	J
J	H	G
K	K	G
L	L	I

Table 5: Transition Table for M2 for Exam # 1, Item # 8

9. Convert the DFA below into RegEx. The input involves English (e) and Filipino (f) words. (10 points)

Accepted: $fffeee$ (siya sa kanto is eating apples)
Rejected: $fefefe$ (siya there sa mall ay eating)

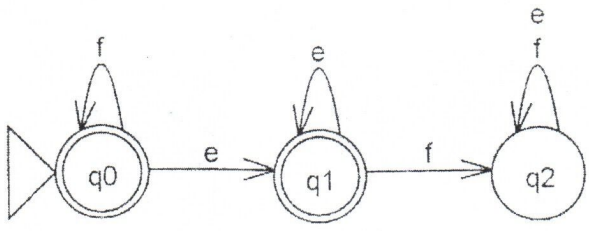

Figure 1: DFA for Exam # 1, Item #9

10. Convert the following λ-NFA into its equivalent DFA. Provide the transition table. (10 points)

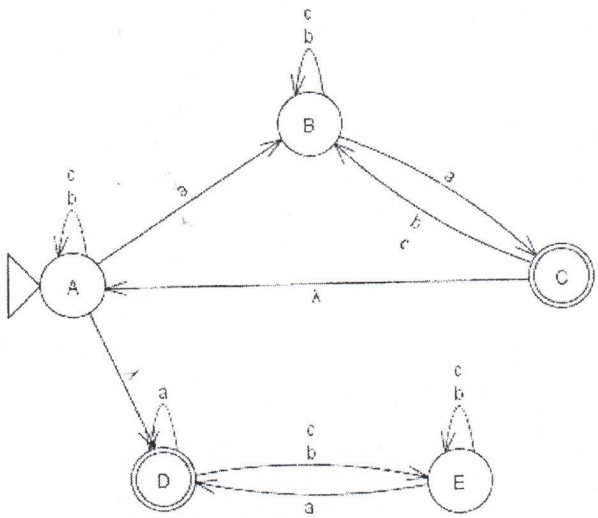

Figure 2: λ-NFA for Exam #1, Item #10

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