Matthew ACS

COT 4420 - Formal Languages and Automata Theory

HW #6

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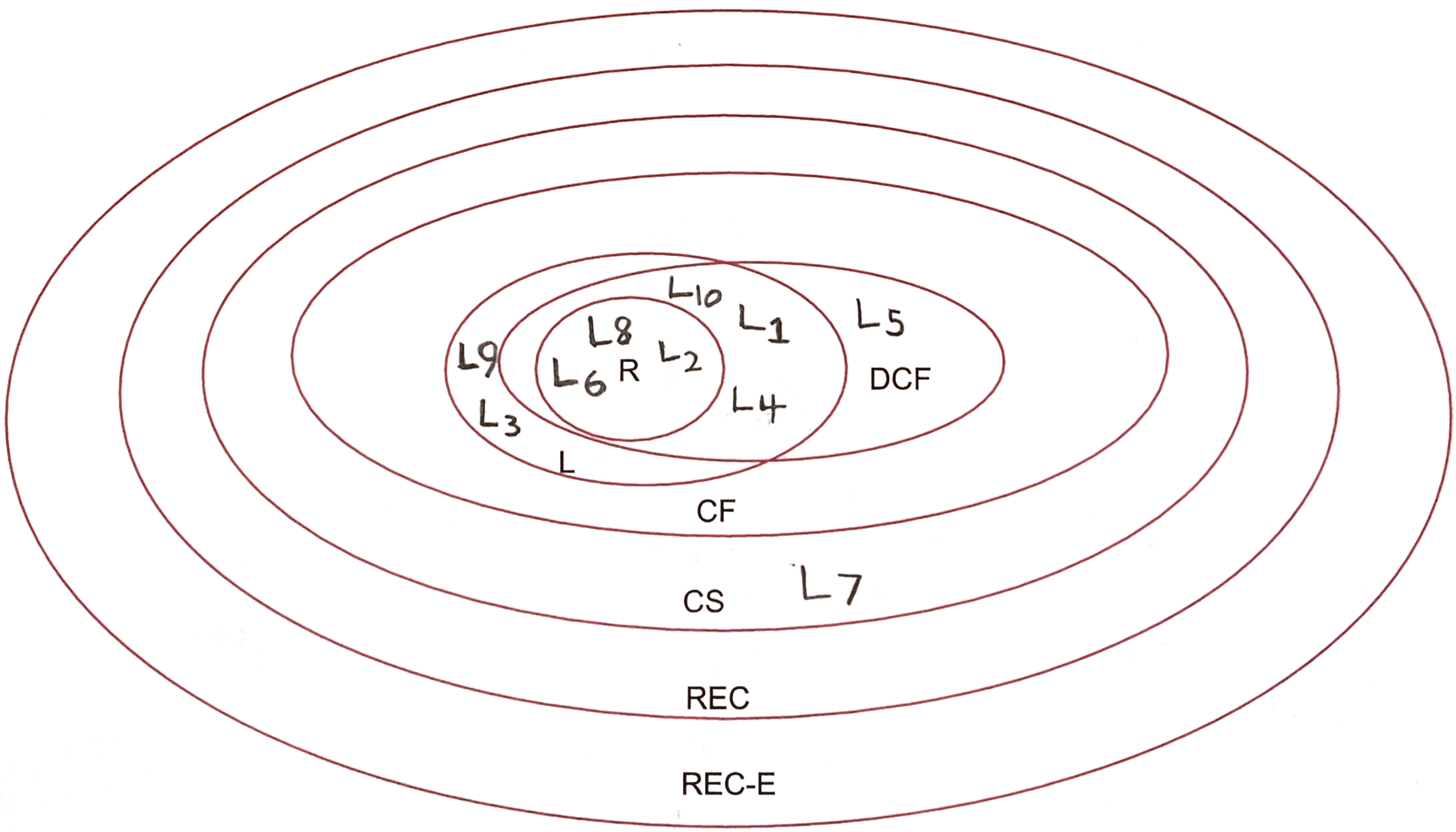
Problem 1 (5 points)

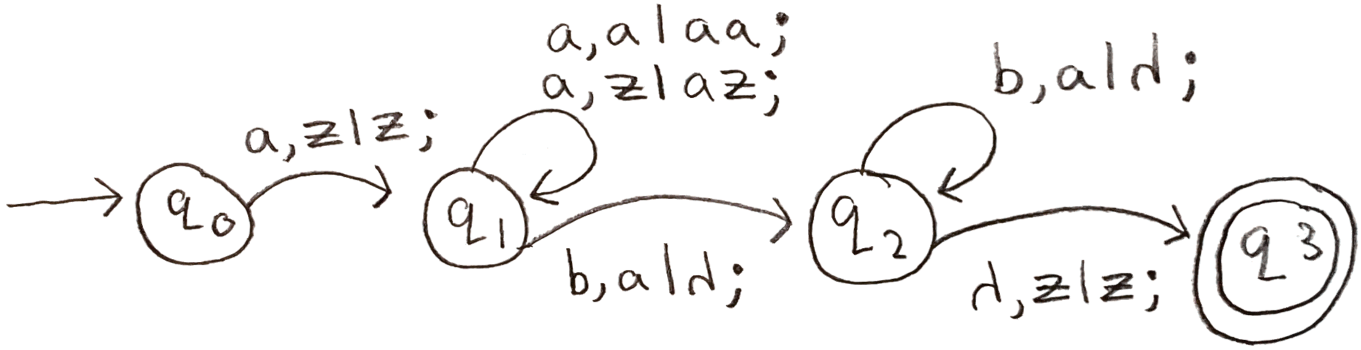
Consider the taxonomy of formal languages below (Chomsky Hierarchy) where R stands for regular, L for linear, DCF for deterministic context-free, CS for context-sensitive, REC for recurscive, and REC-E for recursive enumerable. Place the following languages in their correct location within the taxonomy.
(i) $L_1 = \{a^{n+1}b^n : n \geq 1\}$; (ii) $L_2 = \{a^2b^4, b^7, \lambda\}$; (iii) $L_3 = \{aww^Rb : w \in \{a,b\}\}$; (iv) $L_4 = \{a^{n+1}b^n : n \geq 0\}$; (v) $L_5 = \{w \in \{a,b\}^* : n_a(w) = n_b(w) + 1\}$; (vi) $L_6 = \{w \in \{a,b\}^* :$ w has no pair of consecutive $b's\}$; (vii) $L_7 = \{a^{n+1}b^nc^n : n \geq 1\}$; (viii) $L_8 = \{a^2b^n : n \geq 0\}$; (ix) $L_9 = \{a^{n+1}b^n : n \geq 1\} \cup \{a^{3n}b^{2n} : n \geq 1\}$; (x) $L_{10} = \{a^{n+1}b^n : n \geq 1, n \neq 24\}$.



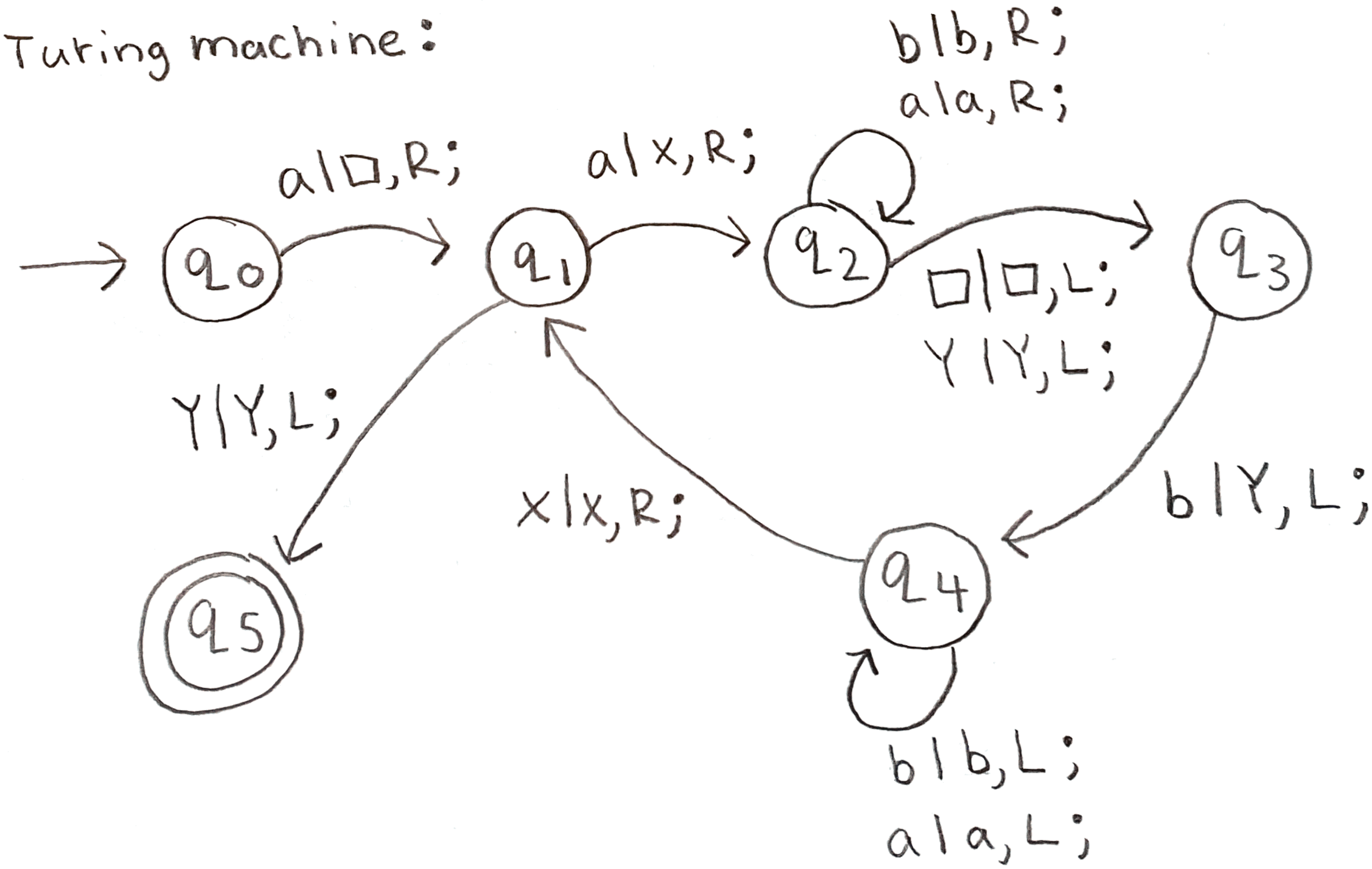
Problem 2:

A DFA can not be created for L_1 because it is not in the regular language portion of the Chompsky Hierarchy and only regular languages have DFA representations. However, L_1 is linear and DCF, which means a pushdown automaton and a turing machine can be created.

Pushdown automaton:



Turing machine:



Problem 3:

The turing machine above accepts the language $L_7 = \{a^{n+1} b^n c^n : n \geq 1\}$. It does this by removing an a from the leftmost side of the input and feeding the result to M_L. M_L then decides the acceptance or rejection of a String. This is because M_L is designed to decide the acceptance or rejection of $L = \{a^n b^n c^n : n \geq 1\}$, So by removing an a from the String and then feeding it to M_L, the new String (if part of the language) would be of the form $a^n b^n c^n$, which M_L would accept. If the String is not part of the language it will get Stuck on a non-final State of M_L, rejecting it.