Middle East Technical University　　　Department of Computer Engineering

CENG 280

Formal Languages and Abstract Machines

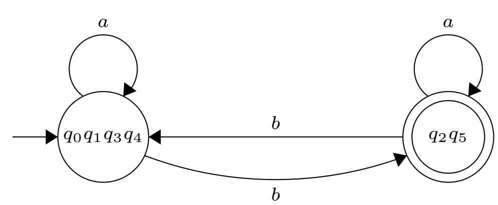
Spring 2022-2023

Homework 3

Name Surname: Burak YILDIZ
Student ID: 2449049

Answer for Q1

1)
0 - Equivalence $\equiv \{q_0, q_1, q_3, q_4\}$, $\{q_2, q_5\}$
1 - Equivalence $\equiv \{q_0, q_1, q_3, q_4\}$, $\{q_2, q_5\}$
Since they are same we stop and the resulting DFA is as follows:



2)
$E_{q_0q_1q_3q_4} = a^* \cup Lb$
$E_{q_2q_5} = bLa^*$

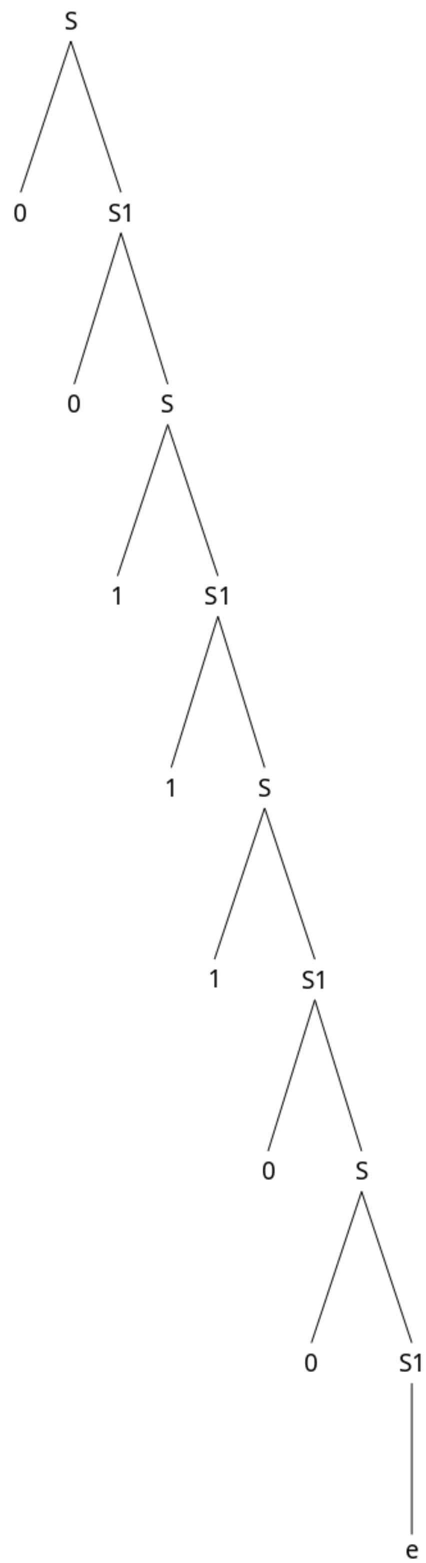
3)
No two strings d^i and d^j, with $i \neq j$, are equivalent under L'. Simply because there is a string (namely $a^k b^{2i} c^k$) which when affixed d^i gives a string in L', but when affixed to d^j produces a string not in L'. Hence it has infinitely many equivalence classes. So by the Myhill-Nerode Theorem this language is not regular.

Answer for Q2

1)
$S \rightarrow Bb \mid MS \mid SMB$
$B \rightarrow Bb \mid \epsilon$
$M \rightarrow \epsilon \mid MM \mid aMb \mid bMa$

2)
Let L be the language given in the question and $L_1 = \{a^i b^i \mid i \geq 0\}$, $L_2 = \{b^k c^k \mid k \geq 0\}$.
So that $L = L_1 L_2$
The CFG for L_1 is $S_1 \rightarrow aS_1b \mid \epsilon$ and
the CFG for L_2 is $S_2 \rightarrow bS_2c \mid \epsilon$
Sor for L the CFG is:
$S_3 \rightarrow S_1 S_2$
$S_1 \rightarrow aS_1b \mid \epsilon$
$S_2 \rightarrow bS_2c \mid \epsilon$

3)
$S \rightarrow 0S_1 \mid 1S_1$
$S_1 \rightarrow 0S \mid 1S \mid \epsilon$



Answer for Q3

1) This is the language: $(0(0+1)^*0) + (1(0+1)^*1) + e$

2) This CFG generates the language that has at leas two 1's in it we can show the language as: $(0+1)^*1(0+1)^*1(0+1)^*$