PRINT NAME: _____

$\mathcal{SIGN}$: _____

1. (4 pts) Let G be the grammar defined below. Convert to an equivalent grammar with no left recursion.

$$G : \begin{aligned} S &\rightarrow AB \mid BC \mid \lambda \\ A &\rightarrow aa \mid bb \mid A\underline{AA} \mid A\underline{AB} \mid A\underline{BB} \\ B &\rightarrow bb \mid cc \mid B\underline{AA} \mid B\underline{A} \\ C &\rightarrow cc \mid ccc \mid c \end{aligned}$$

BAA is unnecessary.

$$G' : \begin{aligned} S &\rightarrow AB \mid BC \mid \lambda \\ A &\rightarrow aa \mid bb \mid aaX \mid bbX \\ X &\rightarrow AA \mid AB \mid BB \mid AAX \mid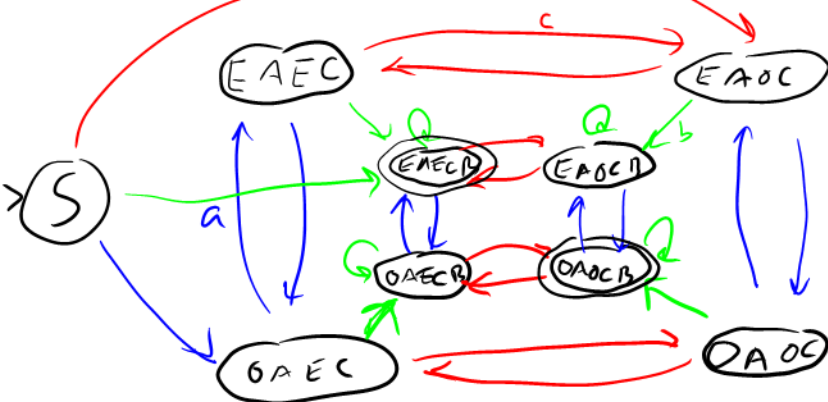 ABX \mid BBX \\ B &\rightarrow bb \mid cc \mid bbY \mid ccY \\ Y &\rightarrow AA \mid A \mid AAY \mid AY \end{aligned}$$

$\hookrightarrow$ unnecessary.

2. (6 pts) Let L be the language of all strings $w \in \{a,b,c\}^*$ with $n_a(w) + n_c(w)$ even and $n_b(w) > 0$. Draw the state diagram of a deterministic finite automaton M such that $L(M) = L$.

Give a short description of the role of each state.

It can be done with four states, but I'll use 9.

S   Start

EAEC – n_a even, n_c even, $n_b = 0$
EA 0C
DA EC   etc
O A O
EAEC B – n_a even, n_c even, $n_b > 0$
EADC B
OAEC B   etc
OAOC B

E ~ even
O ~ odd

	a	b	c
S	P	Q	P
P	S	R	S
Q	R	Q	R
R	Q	R	Q

Bonus. (2 pts) Draw the transition table of your machine in question 2 on the back of this page.

(four state machine,