Exercise 9

Exercise 9.1
Consider the alphabet $\Sigma = \{a, b, c\}$ and the languages

$L_1 = \{c, ca, caac\},$
$L_2 = \{\varepsilon, b, a, ba, ab, bab, aba, bab, \ldots\},$
$L_3 = \{s \in \Sigma^* \mid \exists t \in \Sigma^* \text{ such that } s = tb\},$
$L_4 = \{s \in \Sigma^* \mid \nexists t \in \Sigma^* \text{ such that } s = tb, \text{ and } s \text{ does not contain the sequences } ab, bc, \text{ or } ca\},$
$L_5 = \{\varepsilon\}.$

For each language $L_i$, provide an automaton $A_i$ such that $L_m(A_i) = L_i$ and $L(A_i) = \overline{L}_i.$

Exercise 9.2
Obtain the languages generated and marked by each of the automata shown in Figure 1. Determine whether each automaton is blocking.

Figure 1: Automata for Exercise 9.2.
Exercise 9.3
Consider the alphabet $\Sigma = \{a, b, c, d\}$. Provide nonblocking automata models whose marked languages consist of all words in $\Sigma^*$ that

1. contain the symbol $a$ at least twice;
2. contain the symbol $a$ exactly twice;
3. contain the symbol $a$ at most twice;
4. contain the sequence $aa$;
5. contain the sequence $abcd$;
6. do not contain the sequence $abcd$.

Exercise 9.4
Consider the following languages defined over the alphabet $\Sigma = \{a, b\}$:

$L_1 = \{ s \in \Sigma^* \mid \nexists t, u \in \Sigma^* \text{ such that } s = atbu \}$;
$L_2 = \{ s \in \Sigma^* \mid s \text{ contains } a \text{ an even number of times and contains } b \text{ an odd number of times} \}$.

1. Provide a nonblocking automaton $A_1$ such that $L_m(A_1) = L_1$.
2. Provide a nonblocking automaton $A_2$ such that $L_m(A_2) = L_2$. 