1. 5.1.7.

2. Write a CFG for following languages. Give clear explanations/intuitions about your grammar.
   
   (a) \( w \in (a+b)^*, \#a(w) = \#b(w) \).
   
   (b) Let \( b(n) \) denote the binary representation of \( n \geq 1 \), leading zeros omitted. For example, \( b(5) = 101 \) and \( b(12) = 1100 \). Let \( \text{rev}(w) \) be the reverse of the string \( w \). For example, \( \text{rev}(b(12)) = 0011 \). \$ is a symbol not in \( \{0,1\} \). Write a CFG for the following language
   
   \[ \{ \text{rev}(b(n))\$b(n+1) \mid n \geq 1 \} \]

3. A symmetric linear grammar is one for which the productions are of the following form. \( A, B, C \) and \( X \) are non-terminals, \( a \) and \( b \) are terminals (that may or may not be distinct).
   
   \[
   \begin{align*}
   A & \rightarrow \varepsilon \\
   B & \rightarrow aXb \\
   C & \rightarrow a
   \end{align*}
   
   A language \( L \) is a symmetric linear language if \( L = L(G) \) for some symmetric linear grammar \( G \).
   
   (a) Give a symmetric linear language that is not regular.
   
   (b) Show that all regular languages are symmetric linear languages. \textit{Hint:} This might be trickier than you think. Remember that non-terminals can represent set (or ...) of states.
   
   (c) Show that all symmetric linear languages over a single letter alphabet are regular.

4. Write down a CFG for the complement of the following language \( \{(1^i0^j) \mid i, j \geq 0 \} \). Here \( w^n \) is a string of \( n \) consecutive \( w \)'s.