Constructing Context-free Grammars

Consider the problem of constructing a context-free grammar for the language described in Sipser Exercise 2.6 (c):

$$\left\{ w\#x \mid w^R \text{ is a substring of } x \text{ for } w, x \in \{0,1\}^* \right\}$$

Solution: All strings in this language are of the form $w\#\Sigma^* w^R \Sigma^*$. We can construct a context-free grammar for this language as follows.

$$
\begin{aligned}
S &\;\to\; CB &&\triangleright \text{ Generates } w\#\Sigma^* w^R \Sigma^*. \\
C &\;\to\; 0C0 \mid 1C1 \mid \#B &&\triangleright \text{ Generates } w\#\Sigma^* w^R. \\
B &\;\to\; AB \mid \varepsilon &&\triangleright \text{ Generates } A^* = \Sigma^*. \\
A &\;\to\; 0 \mid 1 &&\triangleright \text{ Generates } \Sigma.
\end{aligned}
$$