2.6. $\forall w \# x \mid w$ is a substring of $x$. For $w$ and $y \in \{0,1\}^*$

$\begin{array}{c}
\frac{w \# (01)^* w^r (01)^*}{w \# w^r \mid w \in \{0,1\}^*} \\
S \rightarrow OSO \mid 1S1 \mid #
\end{array}$

$(01)^* \ A \rightarrow OA \mid 1A \mid \varepsilon$

$\begin{array}{c}
\frac{w(01)^* w^r}{w \# OSO \mid 1S1 \mid #A} \\
T \rightarrow SA
\end{array}$

```
011 # 101 110 000
```

Diagram: [Tree representation of the grammar rules and string derivation]
Grammars
\[ a^* \]
\[ A^* \]
\[ (a \cup b) \]
\[ (A \cup B) \]
\[ ab \]
\[ AB \]

Larig start
\[ A \]
\[ B \]
\[ S \rightarrow S_A | S_B \]

\[ w w^r \]
\[ w + w^r \]
\[ \text{palindromes} \]
\[ \{ w | w = w^r \} \]

\[ 1^n01^n \]
2.5

a. \{ w \mid \text{w contains at least 3 1's} \}

b. \{ w \mid \text{w starts and ends w/ same symbol} \}

c. \{ w \mid \text{length of w is odd} \}

d. \{ w \mid \text{length is odd and middle symbol is 0} \}

e. \{ w \mid w = w^2 \}

f. empty
odd palindrome
all palindrome

~0wr