1. For each of the following languages, give a CFG that generates it.

   (a) All even-length palindromes from alphabet \{a, b\} that contain \texttt{abba} as a substring.
   (b) The language generated by the RE \((x + y^*)(xyy + yx)\)

2. Consider the following CFG with start variable \(S\):

   \[ S \rightarrow 0T0 \mid 1T1 \mid 0T1 \mid 1T0 \mid \varepsilon \]
   \[ T \rightarrow 0S \mid 1S \mid \varepsilon \]

   (a) Give a derivation tree for the string \texttt{01010}
   (b) Describe in English the language of this grammar.

3. Consider following PDA.

   \[
   \begin{align*}
   &\text{START} \\
   \downarrow &\text{READ} \quad \text{READ} \\
   &\text{PUSH}x \quad \varepsilon \\
   0 &\text{READ} \quad \varepsilon \\
   \downarrow &\text{POP} \\
   \varepsilon &\text{READ} \\
   1 &\text{PUSH}x \\
   \downarrow &\text{READ} \quad \varepsilon \\
   &\text{READ} \\
   \downarrow &\text{POP} \\
   \varepsilon &\text{READ} \\
   &\text{POP} \\
   \downarrow &\text{READ} \quad \Delta \\
   \downarrow &\text{READ} \\
   &\text{ACCEPT} \\
   \downarrow &\text{READ} \\
   \Delta &\text{POP} \\
   \end{align*}
   \]

   (a) Give two strings of length 4 accepted by the PDA.
   (b) Give two strings of length 4 NOT accepted by the PDA.
   (c) Describe in succinct-ish English the language of this PDA. Be precise.