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

(a) All even-length palindromes from alphabet \{a, b\} that contain abba as a substring.
   \[
P \rightarrow aPa | bPb | abba Q abba | abba \\
Q \rightarrow aQa | bQb | \varepsilon
   \]

(b) The language generated by the RE \((x + y^*)(xyy + yx)\)
   \[
S \rightarrow TU \\
T \rightarrow x \cdot Y \\
Y \rightarrow yY \cdot \varepsilon \\
U \rightarrow xyy \cdot yx
   \]

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

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

(a) Give a derivation tree for the string 01010

(b) Describe in English the language of this grammar.
   all binary strings except 0 and 1
3. Consider the following PDA.

(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.

all even-length binary strings
where first half is of the form 0*1*
and second half is of the form 1*0*