1. Given a string $x$, an expansion of $x$ is any string obtained by repeating some of the letters some number of times. For example, each of CCAATT, CAT and CCCCCCAAT are expansions of CAT. Given a language $L$, the expansion of $L$ is all possible expansions of strings in $L$. Show that the regular languages are closed under expansion.

2. For each language, give 3 strings that are pairwise distinguishable with respect to that language:
   (a) The set of all binary strings whose first and last bit are the same
   (b) The set of all binary strings that contain 101 as substring
   (c) The set of all binary strings of odd length.

3. Give a CFG for the set of all even-length palindromes from alphabet $\{a, b\}$ that contain abba as a substring.

4. 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 0101
   (b) Describe in English the language of this grammar.