1. (10 points)
   a. Use Pumping Lemma to prove that $DOUBLE(\{0^n1^n \mid n \geq 0\})$ is nonregular.
   b. Explain the problem in the following attempted proof that $STUTTER(\{0^n1^n \mid n \geq 0\})$ is nonregular:
      “Proof”: In class, we proved that the language $\{0^n1^n \mid n \geq 0\}$ is nonregular. In GroupHW1 we proved that the class of regular languages is closed under the operation $STUTTER$. Applying the contrapositive of this closure claim, we see that $STUTTER(\{0^n1^n \mid n \geq 0\})$ must be nonregular as well.
      
      Extension (not for credit): How would you prove that $STUTTER(\{0^n1^n \mid n \geq 0\})$ is nonregular?
   c. Let $L$ be any nonregular set and $L_F$ be any finite set. Prove that $L \cup L_F$ is nonregular too.
      Hint: do not use Pumping Lemma.
   d. Prove that you can’t replace union with intersection in the claim above. That is, give an example of a specific nonregular set and a specific finite set whose intersection is regular.

2. (10 points) For this problem, assume $L$ is a regular language with pumping length 5. Briefly justify your answers to each of the following True/False questions.
   a. True / False: $L$ has pumping length 10.
   b. True / False: All strings in $L$ have length less than or equal to 5.
   c. True / False: If there is a string in $L$ with length equal to 4, then $L$ is finite.
   d. True/ False: If there is a string in $L$ with length equal to 6, then $L$ is infinite.
3. (10 points) Design a PDA over the alphabet \( \{a, b, c\} \) that recognizes the set of all palindromes. In other words, the language of your PDA should be

\[
\{w \in \{a, b, c\}^*: \ w = w^R\}
\]

Draw the state diagram of your PDA in JFLAP, export the image as a png or jpg file, and include it as part of your submission. You do not need to justify your construction for credit, but if you describe how your state diagram works by briefly describing the role of each state and the transitions between them we may be able to award partial credit if your answer is incorrect.

*Hint: Make sure to take into account both odd and even length palindromes; you might find Example 2.18 in the book helpful, as well as question 3 in the Individual HW.*