This is a $2\frac{1}{2}$ hour in class closed book exam. All questions are straightforward and you should have no trouble doing them. Please show all work and write legibly. Thank you.

1. Is it decidable for regular sets R_1 and R_2 whether $R_1 \subseteq R_2$? Justify your answer.

2. Write a context-free grammar for the compliment of $\{ww \mid w \in (a+b)^*\}$.

3. Let $L \subseteq (a+b)^*$ be a context-free language. In each string interchange the order of a and b in each occurrence of ab. Is the resulting language context free? Give a proof of your answer.

Examples

$$aabb \rightarrow abab$$
$$ababab \rightarrow bababa$$
$$bababa \rightarrow bbabaa$$

4. If one can list the elements of a set in order, then must the set be recursive? Prove your answer.

5. Is the class of Turing machines that accept the empty set recursive, r.e. or not r.e.? Justify your answer.