1. For each of the following regular expressions:
   i. \( \{a, b\}^*a\{a, b\}^* \).
   ii. \((\lambda \cup a)b^*\).

Answer the following questions:
(a) Give two strings in the language represented by the regular expression.
(b) Give two strings not in the language represented by the regular expression.
(c) Describe in English the language represented by the regular expression.

2. Using the method of Lemma 1 from *Finite Automata, Part 4*, give an NFA to recognize the language represented by regular expression \((a \cup bb)^*(aba)\).

3. Using the method of Lemma 4 from *Finite Automata, Part 4*, give a regular expression representing the language recognized by the following NFA.

4. Use the Pumping Lemma to show that the following languages are not regular.
   (a) \( A = \{a^ibai \mid i \geq 0\} \).
   (b) \( B = \{ww \mid w \in \{a, b\}^*\} \).
   (c) Let \( \Sigma = \{(, )\} \). Show \( C \) is non-regular, where \( C \) is the language of legal balanced parentheses: i.e., for each left parenthesis there is a matching right parenthesis to its right, and pairs of matched parentheses do not interleave. For example, the following are in \( C \): \( (\), ()), (((()()))) \), and the following are not in \( C \): \( )((())), (\).
   (d) \( D = \{a^{2i} \mid i \geq 0\} \), strings with \( a \) repeated \( 2^i \) times for some \( i \).

Challenge problem (not for credit). Let \( E = \{a^ib^jc^k \mid i, j, k \geq 0 \text{ and if } i = 1 \text{ then } j = k\} \).

a. Show that \( E \) observes the Pumping Lemma. That is, show that there is an integer \( p \geq 1 \), such that for all \( s \in E \) with \( |s| \geq p \), \( s \) can be written as \( s = xyz \) with the three conditions of the Pumping Lemma being true.
b. Nonetheless, show that $E$ is not regular. Two approaches are possible. One is to prove a small variant of the Pumping Lemma and then use the variant to show that $E$ is not regular; the second is to argue that if $E$ were regular, then so is a language $F$ and then to apply the Pumping Lemma to $F$ ($F$ is not obtained by applying the standard set operations).