1. Provide a regular expression to describe the language of the following NFA

![NFA Diagram]

2. For each of the two regular expressions below, (i) write two strings that are members of the language described by that expression and (ii) draw an NFA or DFA (your choice) to accept that string. Use the language \( \Sigma = \{4,5,6\} \)

a. \(5^*(64^* \cup 5)6\)

b. \((5 \cup 64)^*456^*\)

3. Use the pumping lemma to show that the following languages are not regular.

a. \(A_1=\{x^k5yx^k \mid k \geq 1\}\)

b. \(A_2=\{b^n1^n \mid n \geq 1\}\) (Note \(b^1=b, b^2=b^2=bb, b^3=b^6=bbbbbb, b^4=b^{12} \ldots\))

c. \(A_3=\{a^n b^m c^o \mid o, n, m \geq 0 \text{ and } o = n-m\}\)

d. \(A_4=\{0110^R \mid w \in \{0,1\}^* \}\) Note, \(w^R\) is the reverse of \(w\), if \(w = 01001\), \(w^R=10010\)
4. Provide a regular expressions generating each of the languages below, presuming the alphabet $\Sigma = \{+, -, <, >\}$
   a. $\{w | w \text{ contains less than 2 symbols}\}$
   b. $\{w | w \text{ does not contain the substring } \rightarrow\}$
   c. $\{w | \text{ each } < \text{ is followed by } + \text{ in } w\}$
   d. $\{w | \text{ the length of } w \text{ is exactly 6}\}$

5. The pumping lemma says that every regular language has a pumping length $p$, such the every string in the language can be pumped if it has length $p$ or more. If $p$ is a pumping length for language $A$, so is any length $p' \geq p$ that is a pumping length for $A$. For Example, if $A = 01^*$, the minimum pumping length is 2. The reason is that the string $s = 0$ is in $A$ and has length 1 yet $s$ cannot be pumped; but any string in $A$ of length 2 or more contains a 1 and hence can be pumped by dividing it so that $x=0$, $y=1$, and $z$ is the rest. For each of the following languages, give the minimum pumping length and justify you answer.
   a. $(010)^*01$
   b. $01^*$
   c. $11^*(00^*)1$
   d. $10011$

6. Convert the following grammar to be in Chomsky Normal Form.

   \[
   S \to Boo \mid SC \\
   B \to mB \mid \epsilon \\
   C \to oCo \mid n
   \]