CS 4810 Homework Assignment 3 due Friday class Sept 20, 2019

**Please place your net ID in upper right corner of your homework**

1. Write regular expressions for the following sets of strings.
   (a) All strings in $\{a, b, c\}^*$ with at least one $a$ and at least one $b$.
   (b) All strings of 0's and 1's where the $5^{th}$ symbol from end is a 1.
   (c) All strings of 0's and 1's with an odd number of 1's.
   (d) All strings of 0's and 1's where every pair of adjacent 0's appears before any pair of adjacent 1's.

2. Let $L$ be the set of all strings of 0's and 1's with an odd number of 0's and a number of 1's divisible by three.
   (a) Try to write a regular expression denoting the set $L$. You do not need to hand this work in. Just see how hard it is.
   (b) Construct a deterministic finite automaton $M$ that accepts $L$.
   (c) Convert the deterministic finite automaton $M$ to a regular expression.

3. The shuffle of two strings $x$ and $y$ is a string in which the symbols of $x$ appear in the order they are in $x$ and the remaining symbols are the the symbols of $y$ in the order they occur in $y$. The shuffle of two languages $L_1$ and $L_2$ is the set $\{\text{shuffle}(x, y) | x \in L_1, y \in L_2\}$. Prove that the class of regular sets is closed under shuffle using a machine construction.

4. Let $L = (0+10)^*$, $h(a) = 00$, and $h(b) = 01$. What is $h^{-1}(L)$?

5. Given a regular set over the alphabet $\{0, 1\}$ remove all even blocks of 1's and reduce all odd blocks of 1's to one 1 using using homomorphisms and intersection with regular sets. The string 011011100 becomes 00100.