University of Nevada, Las Vegas Computer Science 456/656 Fall 2021
## Assignment 2. Due 11:59 PM Wednesday September 8, 2021

Name:_____

You are permitted to work in groups, get help from others, read books, and use the internet. Post your answers on Canvas as instructed by the graduate assistant, Mr. Singh, by 11:59 PM on the due date.

In each case, the identical problem is in both fifth and sixth editions of your textbook.

1. Write a regular expression for the language consisting of all strings over $\{a, b\}$ which contain the substring *aaa*.
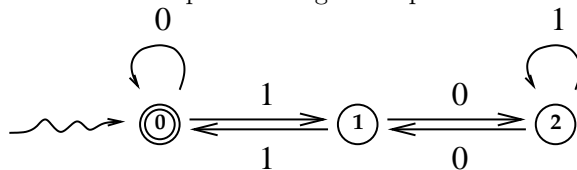
$(a + b)^*aaa(a + b)^*$

2. Find a regular expression equivalent to the following NFA.
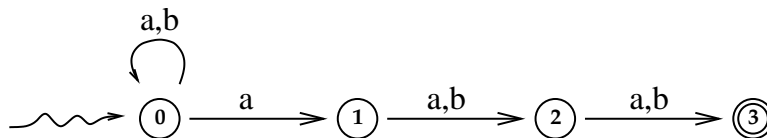
$(a + b)^*a(a + b)(a + b)$

3. The following DFA accepts the language consisting of all binary numerals for positive multiples of three, where a leading 0 is allowed. Find an equivalent regular expression.

$(0 + 1(01^*0)^*1)^*$

4. State the pumping lemma for regular languages.

For any regular language L there exists a positive integer p, called the *pumping length* of L, such that for any $w \in L$ if $|w| \geq p$ there exist strings x, y, z such that the following four conditions hold:
1. $w = xyz$
2. $|xy| \leq p$
3. $|y| \geq 1$
4. For any integer $i \geq 0$ $xy^iz \in L$

5. True or False. T = true, F = false, and O = open, meaning that the answer is not known science at this time. In the questions below, $\mathcal{P}$ and $\mathcal{NP}$ denote $\mathcal{P}$-TIME and $\mathcal{NP}$-TIME, respectively.

(a) **F** Every language generated by an unambiguous context-free grammar is accepted by some DPDA.

(b) **F** Let L be the language over $\{a, b, c\}$ consisting of all strings which have more a's than b's and more b's than c's. There is some PDA that accepts L.

(c) **T** The language $\{a^n b^n \mid n \geq 0\}$ is context-free.

(d) **F** The language $\{a^n b^n c^n \mid n \geq 0\}$ is context-free.

(e) **T** The language $\{a^i b^j c^k \mid j = i + k\}$ is context-free.

(f) **T** The intersection of any two regular languages is regular.

(g) **T** If L is a context-free language over an alphabet with just one symbol, then L is regular.

(h) **T** The set of strings that your high school algebra teacher would accept as legitimate expressions is a context-free language.

(i) **T** The problem of whether a given string is generated by a given context-free grammar is decidable.