**CECS 329, Writing Assignment 3, Spring 2024, Dr. Ebert**

**Directions: Turn in handwritten solutions on the morning of the May 16th final exam. Order your solutions by problem number/letter, and do *not* write on the back of any page. Only the front side of each page will be read. Please do *not* staple or fold your pages. Use a paper clip if necessary. Although it's OK to discuss problems with other students, plagiarism will not be tolerated and will result in a final course grade of F. Make sure to describe solutions in your own words. All problems are equally weighted and must be passed in order to pass LO12.**

# Problems

1. Use the union, concatenation, and star closure properties to construct an NFA that accepts the language $L(E)$, where
$$E = (01 \cup 10)(111)^*(01 \cup 10).$$
See Example 26 of the Finite Automata lecture. (5 pts)

2. Provide a DFA that accepts the language $L$ of all binary words that have a number of 1's that is divisible by 3 (yes, 0 is divisible by 3). Then apply the algorithm described in Section 7 of the Finite Automata lecture to determine a regular expression $E$ for which $L = L(E)$. See Example 27 of the Finite Automata lecture. (10 pts)

3. Do the following.

   (a) Provide a context free grammar $G = (V, \Sigma, R, S)$ for which $L(G)$ is the set of binary words that have an odd number of 0's and exactly one 1. Please clearly define $V$, $\Sigma$, and $R$ for your CFG. (10 pts)

   (b) Use $G$ to provide a leftmost derivation of $w = 000100$. (5 pts)

4. Do the following.

   (a) Provide the state diagram of a Turing machine that accept all words of the form $w_1\#w_2$, where $w_1$ and $w_2$ are binary strings, each having the same number of 1's. Hint: words such as #, 00#, and #000 should be accepted. Use the tape alphabet $\Gamma = \{0, 1, \#, x\}$. Test your program at

   `https://turingmachinesimulator.com/`

   (10 pts)

   (b) Show the computations for inputs a) 10#01 and b) 10#11. Verify that the former is an accepting computation, while the latter is a rejecting computation. (5 pts)