CS 3120 Exam 1

This packet contains exam 1. This **cover sheet** is here to provide instructions, and to cover the questions until the quiz begins. **do not open this quiz packet** until your proctor instructs you to do so.

You will have 1 hour and 45 minutes to complete this exam. Each quiz is two pages (front and back of one sheet of paper) worth of questions. Make sure to **write your name and computing id at the top of each individual page**.

When you are finished, simply submit this packet at the front of the classroom.

This quiz is CLOSED text book, closed-notes, closed-calculator, closed-cell phone, closed-computer, closed-neighbor, etc. Questions are worth different amounts, so be sure to look over all the questions and plan your time accordingly. Please sign the honor pledge below.

A crash reduces
Your expensive computer
To a simple stone.

Module 1: Computers and Cardinality

Name ______________________________

1. [6 points] Answer the following True/False questions.

$\lvert\{0,1\}^\infty\rvert > \lvert\mathbb{N}\rvert$	**True**	**False**
Computers (as we defined them) can only understand *binary strings*	**True**	**False**
For a computing model, it is allowed that $\Sigma = \mathbb{Z}$	**True**	**False**
It is not possible to implement every function (from strings to strings) in *python*	**True**	**False**
All finite sets have an *injection* to $\mathbb{N}$	**True**	**False**
All finite sets have a *surjection* to $\mathbb{N}$	**True**	**False**

2. [2 points] In class we said the following: For any set A, $|A| < |\mathbb{N}|$ if there is a bijection between A and $[k] = \{n : n \in \mathbb{N} \wedge n < k\}$. Explain what this means in your own words.

3. [2 points] Suppose I take an uncountably infinite set A and a countably infinite set B. What can I say about the size of $A \cap B$? Explain your answer.

Module 2: Regular Languages

Name

4. [6 points] Answer the following True/False questions.

$\{1^*0^n1^n0^* \mid n \geq 0\}$ is a regular language because we can always set $n = 0$, reducing the language to just 1^*0^*	**True**	**False**
It is possible for a *DFA* to have at least one accept state ($\|F\| > 0$) and for the language of that *DFA* to be the empty set ($\emptyset$)	**True**	**False**
The *regular languages* are closed under *intersection*	**True**	**False**
Any *regular language* can be expressed using an *NFA*, but some *regular languages* cannot be expressed with a *DFA* (an *NFA* is required)	**True**	**False**
All regular expressions can be represented using only the *union*, *concatenation*, and *star* operators	**True**	**False**
*DFA*s are required to have a *finite* number of states ($\|Q\| < \|\mathbb{N}\|$)	**True**	**False**

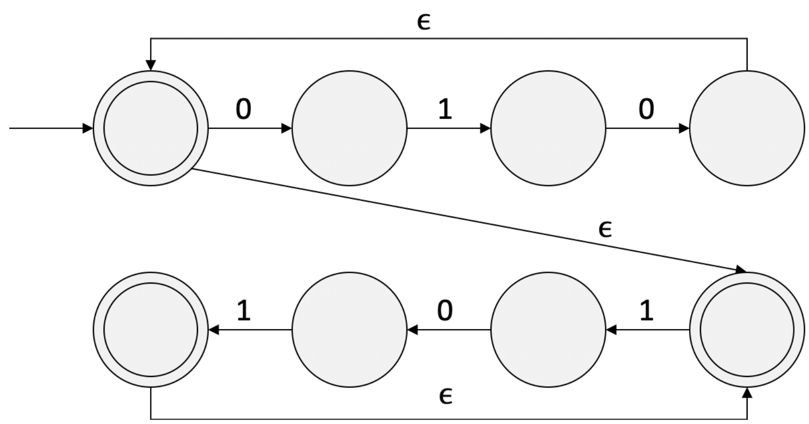
5. [2 points] Draw a working *DFA* or *NFA* for the language represented by the following regular expression: $0^*110^* \cup 1^*001^*$

6. [2 points] Prove that the regular languages are closed under complement. Recall that if A is a language of strings, then $\bar{A} = \{w \in \Sigma^* \mid w \notin A\}$

Miscellaneous

7. [3 points] Consider the following claim regarding the pummping lemma: *If a language A is regular then it has some pumping length p. Given a string $w \in A$ such that $|w| > p$, any substring of w that has length p must contain a substring y that can be pumped.*. Is this claim *true* or *false*. Explain your answer.

8. [3 points] Look at the follwing *NFA* and give a *regular expression* for the language recognized by this *NFA*.



9. [3 points] Consider the following set: *The Real numbers strictly between 0 and 1*. Is this set countably or uncountably infinite? If the former, show a bijection to $\mathbb{N}$. If the latter, prove by diagonalization.