**University of Nevada, Las Vegas Computer Science 456/656 Spring 2020**

**Assignment 4: Due Tuesday March 24, 2020**

**Name:**_____

You are permitted to work in groups, get help from others, read books, and use the internet. But the handwriting on this document must be your own. Print out the document, staple, and fill in the answers. You may attach extra sheets. ~~Turn in the pages to the graduate assistant at the beginning of class, March 24.~~

**We will not meet in the classrom on Tuesday. I will post instructions for turning in your homework on the assignments page.**

1. True or False. T = true, F = false, and O = open, meaning that the answer is not known to science at this time.

   (a) _____ Every language accepted by an NFA is accepted by some DFA.

   (b) _____ Every language accepted by an NPDA is accepted by some DPDA.

   (c) _____ Every language accepted by an NTM is accepted by some TM.

   (d) _____

   (e) _____ The class of PDAs which accept by final state is equivalent to the class of PDAs which accept by empty stack.

   (f) _____ The class of 2-PDAs, that is, automata with 2 stacks, is equivalent to the class of PDAs with just one stack.

   (g) _____ The class of C++ programs is equivalent to the class of Turing machines.

   (h) _____ The class of Turing machines with a 2-way infinite tape is equivalent to the class of Turing machines with a semi-infinite tape.

   (i) _____ The complement of any recursive language is recursive.

   (j) _____ The complement of any recursively enumerable language is recursive.

2. Prove that a language $L$ is recursive if and only if there is a machine which enumerates $L$ is canonical order.

3. Prove that a language $L$ is accepted by some machine if and only if there is a machine which enumerates $L$.

4. Prove that the halting problem is undecidable. Hint: the proof given in our textbook looks quite different from the proof I gave in class, but it is essentially the same. You might find yet another proof in another textbook or on the internet.

5. Give an unrestricted grammar which generates $L = \left\{ a^{n^2} \ : \ n \geq 0 \right\}$.