COMP 314 Homework Assignment 3

1. (a) (10 points) Using a reduction from a problem that has already been proved undecidable in this class, prove that the following problem is undecidable. Given a Turing machine T, and input I, and a particular state s in T's set of states, does T ever enter state s on input I?

   (b) (5 points) Give an informal argument that the following problem is undecidable. Given a Python program P, an input I, and a positive integer n, does P execute line n of the source code when given input I? Hint: explain how to reduce the problem in part (a) to the executes-line-n problem. Details are not required. A few sentences should be sufficient.

2. (5 points) Give an informal argument that the following problem is undecidable. Given a Python program P that employs an integer variable `num`, is there any input I that causes `num` to have the value 314 at some point during the P's execution? Hint: explain how to reduce part (b) of the previous question to this problem. Again, details are not required – a few sentences should be sufficient.

3. (5 points) Use Rice's Theorem to prove the following problem is undecidable. Given a Python program P, does P output "`yes`" on all inputs that represent prime numbers (e.g. "`23`", "`71`"), and "no" otherwise?

4. (5 points) Which of the following problems can be proved undecidable using our version of Rice's Theorem? Give a one-sentence explanation for each answer; detailed reasoning is not required.

   (a) Given a Python program P, determine whether P halts on the input "`Green Devils`".

   (b) Given a Python program P, determine whether P contains any `for` loops.

   (c) Given a Python program P, determine whether P executes at least 20 lines of code on all inputs.

   (d) Given two Python programs P_1, P_2, determine whether P_1 and P_2 compute the same function.

   (e) Determine whether a Python program decides `Yes` on all inputs containing the string "`wombat`" (and otherwise decides `No`).

5. (5 points) (The point of this question is to memorize Rice's Theorem and its meaning. Consult your notes before answering the question, then type or write your answer without consulting anything other than your own brain. If you get stuck, consult your notes again, then start again from the beginning.) State the simplified variant of Rice's Theorem discussed in class. Your statement of the theorem should include

brief definitions of the key concepts involved. In one or two additional sentences, explain the significance of Rice's Theorem.