ComSS 331 Fall 2017 Name:_____

HW 12 Due 1 dec 2017

1. You are employed as a programmer, and you are asked to write a program that:

   (a) receives in input a generic C program x, and counts the number of statements in x.

   (b) receives in input a generic C program x and an input string w, and counts the number of statements executed at least once when x runs on input w.

   (c) receives in input a generic C program x and an input string w, and counts the number of statements never executed when x runs on input w.

   (d) receives in input a generic C program x and decides whether x is syntactically correct.

   (e) receives in input two natural numbers and computes a specific function $f : \mathbb{N}^2 \to \mathbb{N}$.

   (f) receives in input a generic arithmetic expression e composed of integers and the four arithmetic operators, and computes its value.

   (g) halts on the empty string.

   (h) receives in input a generic C program x and decides whether x halts only on the empty string.

   (i) receives in input two generic regular expressions and decides whether they are equivalent.

   (j) receives in input a generic C program x and the name of one of its functions, f, and decides whether x can ever call f.

   (k) receives in input a generic C program x, an input string w, and the name of one of its functions, f, and decides whether x calls f when runnning on input w.

   (l) receives in input two generic C programs x_1 and x_2 and an input string w, and decides whether x_1 and x_2 produce the same output when running on input w.

   (m) receives in input two generic C programs x_1 and x_2, and decides whether x_1 and x_2 produce the same output when running on every possible input.

   (n) receives in input two generic C programs x_1 and x_2, and decides whether x_1 and x_2 produce the same output when running on at least one input.

   (o) receives in input a generic C program x, an input string w, and a natural number n, and decides whether x uses less than n bytes of memory when running on input w. *

   (p) receives in input a generic C program x, an input string w, and decides whether there is $n \in \mathbb{N}$ such that x uses less than n bytes of memory running on input w. *

   For each case, write "Y" close to the question if the program can be written, i.e., if the corresponding problem is solvable in general (semi-solvable is not enough), "N" otherwise. Do not concern yourself with memory limitations, that is, asssume that the computer used to run your program has a large, effectively unbounded, amount of memory. Cases marked with a "*" are particularly challenging. 160

2. Use reduction to prove that the language

   $$L = \{\rho(M)\rho(w) : \text{the TM } M \text{ never enters its initial state again when running on } w\}$$

   is undecidable. 100