CSE596, Fall 2008　　　　Problem Set 5　　　　Due Wed. Oct. 8

The **First Prelim Exam** is on **Wed. Oct. 15**, in class period. This the last problem set before it, and Problem Set 6 will be due on Wed. Oct. 22.

　　Reading. For next week, grapple with Sections 3.7, 3.9, and 3.10. These are *not* on the first prelim exam, which covers up thru 3.6 (not 1.7) and 3.8 (with the proof in lecture by reductions, not the text's proof via the Recursion Theorem). Please don't put them off just because they're not on the exam—there's a whole week to focus on them before the weekend of focusing on the exam.

(1) Text, "Homework 3.23" on page 70. (18 pts.)

(2) Prove that the following decision problem CRASH is undecidable, by reduction from the Acceptance Problem or Halting Problem:

INSTANCE: A Turing machine M' with a single one-way-infinite tape, as in the text;
QUESTION: Is there an input x such that $M'(x)$ 'crashes' by attempting to move its head off
　　　　　　the left end of the tape?

Also answer whether the language of this decision problem is computably enumerable or not. *Hint:* It is AOK for the machines M' you target in the reduction to have routines that "commit suicide by crashing." You may cite some facts from the past two problem sets without having to re-state the details of your answers. $(12 + 3 = 15$ pts.)

(3) Text, "Homework 3.28" on page 71. $(9+9 = 18$ pts.)

(4) Consider the following decision problem:

　　PRIMETIME
　　INSTANCE: A Turing machine M.
　　QUESTION: Does $L(M)$ equal the set of (binary strings encoding) prime numbers?

Prove that this problem is not only undecidable, but also that its language is *neither c.e. nor co-c.e.* Use reductions from K and from D—or from other languages that are respectively RE-complete and co-RE-complete. (That this language is undecidable follows immediately from Rice's Theorem—for 3 pts. briefly explain why—but the "neither c.e. nor co-c.e." part does not entirely follow from it, and is 21 pts. for 24 total on the problem and 75 regular-credit points on the set.)

　　(Extra credit option: The non-c.e. language in Homework 3.28 is not co-c.e. either, i.e. it's "neither-nor." Prove this for 12 pts. extra.)