Homework Assignment #8
Due: Tuesday July 10, 2012 at 7:00 p.m.

You may submit your solution to this assignment as a hardcopy to me or as a pdf file using the submit command.

1. Let $EQ_{TM} = \{\langle M_1, M_2\rangle : M_1 \text{ and } M_2 \text{ are Turing machines and } L(M_1) = L(M_2)\}$.
Let $SUB_{TM} = \{\langle M_1, M_2\rangle : M_1 \text{ and } M_2 \text{ are Turing machines and } L(M_1) \subseteq L(M_2)\}$.

(a) If you had an algorithm $A(\langle M_1, M_2\rangle)$ that decided SUB_{TM}, show how you could use A as a subroutine to design an algorithm $B(\langle M_1, M_2\rangle)$ that decides EQ_{TM}.

(b) Use Theorem 5.4 of the textbook to prove SUB_{TM} is undecidable.

(c) Assume there is an algorithm $E(\langle M_1, M_2\rangle)$ that recognizes SUB_{TM}.

$F(\langle M, w\rangle)$ % Here, M is a Turing machine and w is an input string for M
  Construct a Turing machine M_2 that accepts every string over M's alphabet *except* w
  run $E(\langle M, M_2\rangle)$ and output whatever E outputs
end F

Show that $F(\langle M, w\rangle)$ outputs "accept" if and only if M does not accept w.

(d) Is SUB_{TM} recognizable? Prove your answer is correct.