Department of Computer Science
University of Massachusetts Lowell
COMP.3040 Foundations of Computer Science
Fall 2018
Exam 2 [20%]
12/20/2018
2 hours

1. *[20 points]*

   (a) Differentiate between and give an example of each:
      - Turing Decidable
      - Turing Recognizable
      - Turing Undecidable
      - Turing Un-Recognizable

   (b) Differentiate between and give an example of each:
      - Countable
      - Unountable

   (c) Define
      - Decidability
      - Reduciblity

   (d) $REGULAR_{TM} = \{(M) \mid L(M)$ is a regular language$\}$
      $REGULAR_{TM}$ is undecidable
      - True
      - False

   (e) $A_{LBA} = \{(M, w) \mid M$ is an LBA that accepts string w$\}$
      A_{LBA} is
      - Decidable
      - Undecidable

2. *[20 points]* Draw the TM for the following language where

   { a $\oplus$ b, where a and b are 32 bit binary numbers; the result should be the bitwise XOR of the two operands and should be written at the end of the tape; for example, for an input of
   12345678#abcdef90, the output should be 12345678#abcdef90#b9f9b9e8;
   [note that the example shows hexadecimal format for simplicity–the actual data will be in equivalent binary digits]

3. *[20 points]* Let A = $\{\langle M \rangle \mid$ M is a DFA that does not accept any string containing an odd number of 1s$\}$
   Show that A is decidable.

4. *[20 points]*

    (a) Define what is a *computation history*. What is an *accepting computation history* and a *rejecting computation history*?

    (b) What is a *Linear Bounded Automaton*?

    (c) Define the *PCP* problem

    (d) Sketch a proof for *PCP is undecidable*

5. *[20 points]* For the TM shown below, show the sequence of configurations that the machine enters for the input string 110#111

FIGURE 3.10