1. Suppose we have infinitely many r.e. languages $L_1, L_2, \ldots$. Does it follow that their union $\bigcup_{i=1}^{\infty} L_i$ is also r.e.?

2. Describe in English a TM that halts if and only if the tape contains a nonempty cell. In this question the head can start anywhere on the tape.

3. A marker automaton (MA) is a deterministic 1-tape 1-head machine with input alphabet $\{0, 1\}$. The head can move left or right but is constrained to the input portion of the tape. The machine has the ability to write only one new character to a cell, namely #.
   (a) Give an example of language $D$ that is accepted by an MA but is not context-free. Justify your answer.
   (b) Show that $K_{ma} = \{ \langle M, w \rangle : M$ is an MA accepting $w \}$ is recursive.

4. Show how diagonalization produces a string not on the following list:

   E V E R Y
   S T A I N
   B A C O N
   C L I F F
   K N E A D

5. Determine whether each of the following is True or False. Justify your answer.
   (a) Every infinite set is countable.
   (b) If $N$ is the set $\{ \langle G \rangle : G$ is CFG that does NOT generate all strings $\}$, then $N$ is r.e.
   (c) It is undecidable to determine whether an NFA accepts its own encoding.
   (d) If a language $L$ is context-sensitive, then there is a Printer-TM that prints out $L$ in order.

6. Which of the following is an example of self-reference?
   (a) Rene Magritte’s painting that is not a pipe.
   (b) The Epimedes Paradox
   (c) GNU
   (d) All four answers

Due: Monday November 20