**COT 4210 Exam #2: Turing Machines and Decidability**

**Date: 11/1/2011**

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1) (15 pts) A 3R2L Turing Machine is one where the two possible moves on each transition are 3R or 2L. 3R represents moving right 3 spaces and 2L represents moving left 2 spaces. Prove that anything computable on this model is computable on a regular Turing Machine. Show that all computations on a regular Turing Machine that DON’T attempt to move left off the left end of the tape are computable on a 3R2L Turing Machine. (Note: The models are equivalent, but there’s a snag in simulating the behavior of a regular TM when the tape head attempts to move left off the left end of the tape. This can be fixed, but I wanted to make this question easier and don’t want you to worry about that detail.)

2) (15 pts) Let FINITECFG = { <G> | G is a Context Free Grammar such that the number of strings it contains is finite.} Prove that FINITECFG is a decidable language.

3) (15 pts) Let FINITETM = { <M> | M is a Turing Machine such that the number of strings it accepts is finite.} Prove that FINITETM is an undecidable language.

4) (15 pts) Is the set of regular languages countable? Prove your answer.

5) (20 pts) In this question you’ll write a verifier for the post-correspondence problem. Namely, you will be write a method (in Java) that takes in an array of tiles describing the valid tiles for the problem instance and a second array that takes in a potential solution, and simply return true if the solution is correct. In order for the solution to be correct, each tile listed in it must be valid and the top and bottom of all the tiles read in sequence must be the same string. Fill in the missing method in the code below:

import java.util.\*;

import java.io.\*;

class Tile {

 private String top;

 private String bottom;

 public Tile(String t, String b) {

 top = t;

 bottom = b;

 }

 public boolean equals(Tile other) {

 return top.equals(other.top) && bottom.equals(other.bottom);

 }

 public String getTop() {

 return top;

 }

 public String getBottom() {

 return bottom;

 }

 public String toString() {

 return top + "/" + bottom;

 }

}

public class PCPChecker {

 /\*\*\* FILL IN THIS METHOD.

 list is the list of valid tiles.

 sol is the solution you are checking.

 \*\*\*/

 public static boolean isMatch(Tile[] list, Tile[] sol) {

 }

 public static boolean inSet(Tile t, Tile[] list) {

 for (Tile thistile: list)

 if (thistile.equals(t))

 return true;

 return false;

 }

}

6) (15 pts) A useless state in a Turing machine is one that is never entered on any input string. Let USELESSTM = { <M, q> | M is a Turing machine that contains a useless state q }. Prove that USELESSTM is undecidable.

7) (5 pts) From what city will the UCF Knights football opponents, the Tulsa Golden Hurricane be traveling when they come here this Thursday?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Scratch Page – Please clearly label any work on this page that you would like graded.**