CS154 (sec 1), Spring 2015

**Final Exam**

**Instructions**

No communication is allowed during the exam except with the instructor. This includes copying, sending messages, receiving messages, and other forms of signaling.

However, access to non-human resources is permitted. This includes web sites, local files, programs, books, and notes.

Although exams are different, please do not discuss the exam with students from other sections until everyone has finished.

Attach files containing your answers to an email and send it to the instructor within five minutes after the end of the exam. Submissions later than this will not be accepted.

My email: [jon.pearce@sjsu.edu](mailto:jon.pearce@sjsu.edu)

**Problem 1 [10 points]**

Write an unambiguous context-free grammar for formulas, where:

       A formula consists of two terms separated by either = or <.

       A term is a number (int or double), variable, or function call.

       A function call is the name of the function followed by an operands list.

       An operands list is a comma-separated list of zero or more terms bracketed with parentheses.

       Any alphanumeric string beginning with a letter can be a variable or function name.

**Problem 2 [5 points]**

Using your grammar from problem 1, find a left-most derivation of the formula:

sin(cos(x)) = tan(3.14)

**Problem 3 [10 points]**

Use a diagonalization construction to define a recursive set of binary numbers that is not in CFL. Clearly explain why your set is recursive yet not a CFL.

**Problem 4 [10 points]**

Let PL' = PL – {loop} + {if} where if commands have the form:

if x == y then  
   C1  
   C2  
   ...  
end

Assume C1, C2, and C3 are PL' commands. Show how the following loop command could be implemented in PL':

loop x  
   C1  
   C2  
   C3  
end

**Problem 5 [3 points each]**

True or false:

a.     Assume a PL program P cannot be implemented in LOOP. Then for some x, P(x) diverges. – T - F

b.     10n2 + 25n + 50 = O(n2) T

c.     ack(3) = hyper2(hyper2(2)) T

d.     {0i10j| i != j} is regular F

e.     Every regular language can be recognized by a LOOP program T

f.      {i | Pi(i) diverges} is RE T

g.     All C – {goto} programs halt on all inputs F

**Problem 6 [10 points]**

Write a Turing Machine program that implements integer division by 3. For example, your program might convert the input 1111111000... into the  output 00100100000...

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