

# **CSci 370**

## **Second Hour Exam**

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

Friday, Oct. 19  
100 points.

I. (10 points) Sketch a NFA corresponding to the regular expression  $(0 \cup 1)^* 01(0 \cup 1)^+$ .

II. Pumping Lemma.

1. (5 points) State the pumping lemma for regular languages.

2. (5 points) Where does the pumping length (of the pumping lemma) come from?

3. (15 points) Use the pumping lemma to show that the language  $L = \{a^n b^{2^n} a^n \mid n \geq 0\}$  is not regular.

### III. Context-Free Grammars

1. (5 points) Give a formal definition of a context-free grammar.
2. (5 points) What form must the productions / re-write rules take for a context-free grammar to be in Chomsky Normal Form?

Given our favorite grammar for a subset of arithmetic expressions:

$$E \rightarrow E+T \mid T$$
$$T \rightarrow T * F \mid F$$
$$F \rightarrow ( E ) \mid a \mid b \mid c$$

3. (5 points each)

a. What are the variables (non-terminals)?

b. What are the terminals?

c. What is the start symbol?

4. (10 points). Give a complete (no skipping steps) derivation of the expression  $a*(b+c)$

5. (5 points) Sketch the parse tree for the derivation in the preceding problem (problem 4)

6. (5 points) We have examined how, given a context-free grammar, we can construct a push-down automata to recognize the language defined by the context-free grammar. Sketch the contents of the stack in the first four steps of the push-down automata associated with the derivation done in problem 4 above.

IV Pushdown automata

1. (10 points) Give a formal definition of a push-down automaton.

2. (10 points) Using the conventions described in the textbook, sketch a push-down automaton that recognizes balanced parenthesis. By this we understand that the language consists of a left paren '(' and a right paren ')', and that strings such as "((()))" and (()) should both be accepted. (Some partial credit for a written description of what the automaton does.)