

**CMSC 330 Spring 2011
Practice Problems 2**

1. For each regular expression r below, (i) say whether or not $r \checkmark$ holds and (ii) give the transitions of r .
 - a. $r = a^*$
 - b. $r = (a|ab)^*a$
 - c. $r = a^*(ba^*ba^*)^*$

2. For each regular expression in Question 1
 - i. Reduce the RE to an NFA using the algorithm described in class.
 - ii. Reduce the resulting NFA to a DFA using the subset algorithm.
 - iii. Show whether the DFA accepts / rejects the strings "aba", "aa", "bbabb".

3. Context-Free Grammars
 - a. List the 4 components of a context-free grammar.
 - b. Describe the relationship between terminals, non-terminals, and productions.
 - c. Define ambiguity.
 - d. Describe the difference between scanning & parsing.

4. Describing Grammars
 - a. Describe the language accepted by the following grammar:
 $S \rightarrow abS \mid a$
 - b. Describe the language accepted by the following grammar:
 $S \rightarrow aSb \mid \varepsilon$
 - c. Describe the language accepted by the following grammar:
 $S \rightarrow bSb \mid A \quad A \rightarrow aA \mid \varepsilon$
 - d. Describe the language accepted by the following grammar:
 $S \rightarrow AS \mid B \quad A \rightarrow aAc \mid Aa \mid \varepsilon \quad B \rightarrow bBb \mid \varepsilon$
 - e. Describe the language accepted by the following grammar:
 $S \rightarrow S \text{ and } S \mid S \text{ or } S \mid (S) \mid \text{true} \mid \text{false}$
 - f. Which of the previous grammars are left recursive?
 - g. Which of the previous grammars are right recursive?
 - h. Which of the previous grammars are ambiguous? Provide proof.

5. Creating Grammars
 - a. Write a grammar for $a^x b^y$, where $x = y$
 - b. Write a grammar for $a^x b^y$, where $x > y$
 - c. Write a grammar for $a^x b^y$, where $x = 2y$
 - d. Write a grammar for $a^x b^y a^z$, where $z = x+y$
 - e. Write a grammar for $a^x b^y a^z$, where $z = x-y$
 - f. Write a grammar for all strings of a and b that are palindromes.
 - g. Write a grammar for all strings of a and b that include the substring baa .

- h. Write a grammar for all strings of a and b with an odd number of a 's and an odd number of b 's.
- i. Write a grammar for the set of regular expressions over the alphabet $\{a, b\}$.
- j. Which of your grammars are ambiguous? Can you come up with an unambiguous grammar that accepts the same language?

6. Derivations, Parse Trees, Precedence and Associativity

For the following grammar: $S \rightarrow S \text{ and } S \mid \text{true}$

- a. List 4 derivations for the string "true and true and true".
- b. Label each derivation as left-most, right-most, or neither.
- c. List the parse tree for each derivation
- d. What is implied about the associativity of "and" for each parse tree?

For the following grammar: $S \rightarrow S \text{ and } S \mid S \text{ or } S \mid \text{true}$

- e. List all parse trees for the string "true and true or true"
- f. What is implied about the precedence/associativity of "and" and "or" for each parse tree?
- g. Rewrite the grammar so that "and" has higher precedence than "or" and is right associative