CSS 448 Midterm Exam Sample Questions

1. Construct a regular expressions over Σ = {0, 1} to match strings of exactly length 6 with 1 in an odd position, immediately followed by another 1.

2. Construct a regular expression, DFA, and CFG over the alphabet Σ = {0, 1} to match bit strings with odd parity.

3. Construct a regular expression, DFA, and CFG over the alphabet Σ = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9} to match even numbers.

4. Construct a regular expression over the alphabet Σ = {a, b} to match strings with the number of a's divisible by 3.

5. Construct a regular expression to match remote file identifiers of the form **`user@hostname:filename`**, constructed as follows:

> The parts of the identifier are made up of words, which are sequences of one or more letters and digits. You may use **`\w`** extended notation to recognize a word character. The user part contains a single word. A hostname consists of one or more words separated by periods, like www.google.com. A filename consists of one or more words separated by slash character with an optional leading and/or trailing slash (standard Unix conventions). The **`user@`** part is optional and may be omitted. The entire **`user@hostname:`** part may be omitted, including the trailing colon. The **`user@`** part may not appear unless the **`hostname:`** part is also included.

6. Consider the following grammar G:

> S → XY
>
> X → aX | bX | a
>
> Y → Y a | Y b | a

(a) Give a leftmost derivation of abaabb.

(b) Build the derivation tree for the derivation in part (a).

(c) Give an informal description of L(G)?

6. Construct a context-free grammar over terminals {a, b} to match strings with the number of a's divisible by 3. Is the grammar ambiguous? (Hint: to show that it is ambiguous, find a string with two different parse trees or leftmost derivations; to show that it not ambiguous, use mathematical induction on the length of the string).

7. Construct a context-free grammar generating the language $L = \{a^n b^m \mid n < m \text{ or } n = 2m\}$. (Hint: Think of L as the union of two simpler languages). Can you construct a Regular expression?

8. Construct a context-free grammar in Chomsky Normal Form generating the language $L = \{a^n b^m c^{n+m} \mid n > 0, m > 0\}$. (Hint: construct a non-normalized CFG and convert to CNF).

9. Given the following grammar (uppercase letters are nonterminals, lowercase are terminals, and ε is the empty string symbol):

$S \rightarrow A\ B \mid BAB$

$A \rightarrow S\ A \mid y\ x$

$B \rightarrow x \mid \varepsilon$

Compute FIRST and FOLLOW. Is the grammar LL(1)?

10. Construct the LL(1) parse table for the language of the following grammar:

$S \rightarrow aABb$

$A \rightarrow aAc \mid \varepsilon$

$B \rightarrow bB \mid c$

Give an informal description of the language generated (e.g. $a^{n+k}b^m c^k$).

11. True or False (explain or give a counter example):

(a) For every pushdown automaton M there is a regular expression describing L(M).

(b) If L is finite then $\Sigma^* - L$ is regular.

(c) If $L^* \neq \varnothing$ then $L \neq \varnothing$.

(d) If L_1 is context-free and L_2 is regular, then L_1L_2 is context-free.

(e) If L_1L_2 is regular then L_1 and L_2 are both regular.

(f) If R is a regular language and $L \subseteq R$, then L is a regular language.

(g) Every CFL L can be generated by a CFG G in which every rule $A \rightarrow \alpha$ satisfies $|\alpha| \leq 2$