CONCORDIA UNIVERSITY DEPARTMENT OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

COMP 335 Theoretical Computer Science Winter 2021

Assignment 2 (due Monday, February 22, 11:59 PM)

Show all the steps of your solution for full mark.

Note that in questions below $n_a(w)$ and $n_b(w)$ indicate the number of a's and the number of b's in string w.

1. Find a regular expression for the following languages over $\Sigma = \{a, b\}^*$
   (a) $\{w : w$ does not contain substring $bbb\}$
   (b) $\{w : w$ contains exactly three a's and it ends with $abb\}$
   (c) $\{w : n_a(w) \bmod 3 = 0$ and w begins with $ab\}$
   (d) $\{w : (n_a(w) + n_b(w)) \bmod 3 \geq 2\}$
   (e) $\{w : |w| \bmod 2 = 0\}$
   (f) $L = \{a^m b^n : mn > 4\}$

2. Find an NFA that accepts the language defined by the following regular expression $ab(a + ab)^*(a + aa^*) + (abab)^* + (aaa^* + b)^*$

3. Find a regular expression for the following regular languages
   (a) $\{w : 2n_a(w) + 3n_b(w)$ is even $\}$
   (b) $\{w : (n_a(w) - n_b(w)) \bmod 3 = 1\}$

4. Find a regular grammar for the following languages
   (a) $L(aa^*(ab + a)^*)$
   (b) $L((aab^*ab)^*)$
   (c) $L = \{w : (n_a(w) - n_b(w)) \bmod 3 = 1\}$

5. Prove that the following langauges are not regular
   (a) $L = \{ww : w \in \{a, b\}^*\}$
   (b) $L = \{a^n b^k : n \geq k\}$
   (c) $L = \{a^n b^m c^k : n + m > k > 0\}$
   (d) $L = \{w \in \{a, b\}^* : 2n_a(w) = 3n_b(w)\}$

6. Find context free grammars for the following languages
   (a) $L = \{a^n b^m : n, m \geq 0$ and $n \neq m\}$
   (b) $L = \{a^n b^m c^k : n \geq m \geq 0$ or $m \geq k \geq 0\}$
   (c) $L = \{a^n b^m c^k : n + m > k > 0\}$
   (d) $L = \{w \in \{a, b, c\}^* : n_b(w) = n_a(w) + n_c(w)\}$