CSE3064 - Midterm Study Questions – Spring 2021

(Q-M): Study question for both the midterm and midterm quiz.
(M): Study question for the midterm.

1. (Q-M) Give the state diagram of a DFA recognizing the following language (Σ={a,b}):

   L = {w | w contains at least three **b**s and at most one **a**}

2. (Q-M) Construct an NFA recognizing the language of the following regular expression:
$$(01){*}(1{*} \cup 0000){*}(0101 \cup \varepsilon)$$

3. (Q-M) Design an NFA for the following language over an alphabet Σ = {0,1,2}:
   L = { y2z | y, z $\in$ {0, 1}*, the last symbols of both y and z are 1, and both y and z contain 010 as substring}

4. (Q-M) Given two regular languages L_1 and L_2 over an alphabet Σ = {0,1,2}, prove or disprove that the following languages are regular:
   a. L_3 = { w $\in$ Σ* | w $\in$ L_1 but w $\notin$ L_2}
   b. L_4 = { w $\in$ Σ* | w is in exactly one of L_1 and L_2}

5. (Q-M) Convert the following NFA to an equivalent DFA following the steps described in class (see Theorem 1.39 in Sipser).
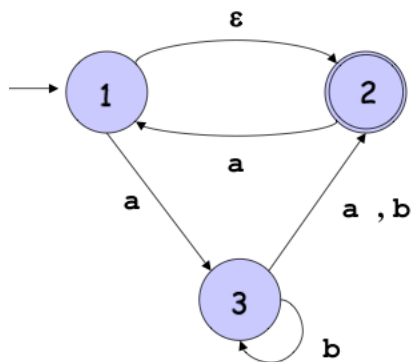
6. (Q-M) Convert the following DFA to an equivalent regular expression following the steps described in class (see Lemma 1.60 in Sipser).
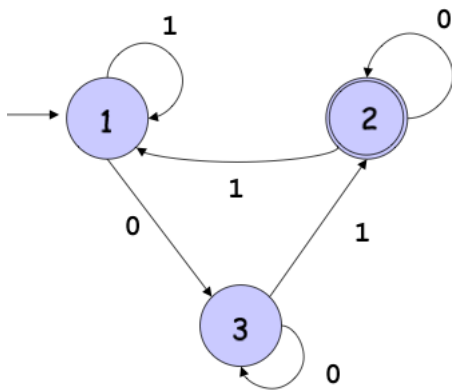
7. (Q-M) Convert the regular expression $(0+(11^*))(01)^*$ to an equivalent NFA following the steps described in class (see Lemma 1.55 in Sipser).

8. (Q-M) Prove or disprove that the intersection of a regular language and a non-regular language is always a regular language.

9. (Q-M) Prove or disprove that the union of two non-regular languages is always non-regular.

10. (M) Over the alphabet Σ={a,b}, prove or disprove that the language {w|w contains equal number of substrings **ab** and **ba**} is a regular language.

11. (M) Prove that the following language is not a regular language:
    $L = \{ 0^x 1^y \mid x, y \geq 1, (x \geq y) \text{ or } (x < y \text{ and } y \text{ modulus } x = 0) \}$

12. (M) Write the context-free grammars which generate the following language:

    a. $L_1 = \{w \in \{a, b\}^* \mid \text{the middle symbol of } w \text{ is } b \text{ and the length of } w \text{ is odd}\}$
    b. $L_2 = \{ 0^a 1^b 2^c \mid a, b, c \geq 0 \text{ and } a + 2b = c \}$

a) $S \rightarrow aSa \mid aSb \mid bSa \mid bSb \mid b$

b) $S \rightarrow 0S2 \mid X$
$X \rightarrow 1X22 \mid \varepsilon$