CS 530 Theory of Computation	**Spring Semester, 2022**

Homework 1

Assigned: Jan 25 | *Due: Feb 8*

1. Construct DFAs that recognize the following languages over the alphabet $\{a, b\}$:

1. $\{w \mid; \; w$ contains at least two as and at most one $b\}$
2. $\{w \mid w$ does not contain the substring $bba\}$
3. $\{w \mid w$ contains at least three bs$\}$
4. $D = \{w \mid w$ has an equal number of occurrences of ab and ba as substrings$\}$. Thus $bab \in D$ because bab contains a single ab and a single ba, but $baba \notin D$ because $baba$ contains two bas and one ab.

Draw the state diagram for all; add a formal description of the DFA for **2)**.

2. For the NFA in Figure 1, convert it to a DFA using the method of Theorem 21 from the notes.

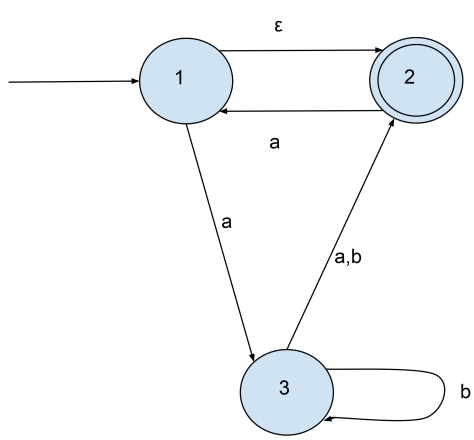

Figure 1: NFA for Problem 2.

3. Give regular expressions generating the languages of Exercise **1**.

4. For each of the following give two strings that are members of the language, and two strings that are not members of the language. Assume the alphabet $\Sigma = \{0, 1\}$.

1. 0^*1^*.

2. $1(01)^*0$.

3. $\Sigma^*0\Sigma^*1\Sigma^*0\Sigma^*$.

4. $(0110^* \cup 0 \cup 10)^*$.

5. $1^* \cup 0^*$.

5. Obtain the regular expression that describes the same language as the automaton in Figure 2, using the method of Lemma 30 from the notes. Show your intermediate steps.

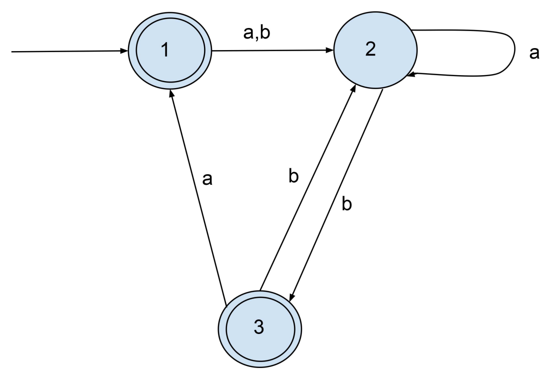

Figure 2: Finite Automaton for Problem 5.

6. Prove that the following languages over $\{0, 1\}$ are not regular:

1. $\{0^{p-1} \mid p \text{ is a prime}\}$

2. $\{0^n1^m0^n \mid n, m \geq 0\}$

3. $\{0^n1^m \mid n \neq m\}$