# COMP 3803 — Assignment 2

**Due:** Thursday February 14, before 11:55pm.

**Assignment Policy:**

- Your assignment must be submitted as one single PDF file through cuLearn.
- Late assignments will not be accepted.
- You are encouraged to collaborate on assignments, but at the level of discussion only. When writing your solutions, you must do so in your own words.
- Past experience has shown conclusively that those who do not put adequate effort into the assignments do not learn the material and have a probability near 1 of doing poorly on the exams.
- When writing your solutions, you must follow the guidelines below.
  - You must justify your answers.
  - The answers should be concise, clear and neat.
  - When presenting proofs, every step should be justified.

**Question 1:** Give regular expressions describing the following languages. In all cases, the alphabet is $\{0, 1\}$. Justify your answers.

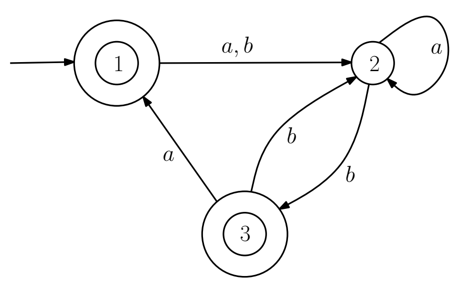
- $\{w : w$ contains an even number of 0s and each 0 is followed by at least one 1$\}$.
- $\{w : w$ contains exactly two 0s and at least two 1s$\}$.
- $\{w :$ every odd position in $w$ is 1$\}$.

**Question 2:** Use the construction given in class to convert the regular expression

$$((0 \cup 1)(11)^* \cup 0)^*$$

to an NFA. The alphabet is $\{0, 1\}$.

**Question 3:** Use the construction given in class to convert the following DFA to a regular expression.



**Question 4:** Let $R$ be a regular expression and let $A$ be the language described by $R$. Explain how to obtain a regular expression that describes the complement $\overline{A}$ of $A$. You may use any result that was proven in class and Assignment 1.

**Question 5:** Prove that the following languages are not regular.

1. $\{a^n b^n c^{2n} : n \geq 0\}$.
2. $\{a^{3^n} : n \geq 0\}$. (Remark: $a^{3^n}$ is the string consisting of $3^n$ many $a$'s.)
3. $\{uvu : u \in \{a,b\}^*, u \neq \epsilon, v \in \{a,b\}^*\}$.
4. $\{a^m b^n : m \geq 0, n \geq 0, m \neq n\}$. (Using the Pumping Lemma for this one is a bit tricky. You can avoid using the Pumping Lemma by combining results about the closure under regular operations.)

**Question 6:** Let $A$ be a language consisting of finitely many strings.

1. Prove that $A$ is a regular language.
2. Let $n$ be the maximum length of any string in $A$. Prove that *every* deterministic finite automaton (DFA) that accepts $A$ has at least $n+1$ states. (*Hint:* How is the pumping length chosen in the proof of the Pumping Lemma?)