Midterm Exam 1
CS 611: Theory of Computation

Feb 21th, 2023 2:45-4:00pm (in class)

Instructions:

1. This is an open-note exam, you can bring a note written on a A4 paper with you, double sided is fine, and you will write down your name and NetID on the note and turned it in together with the exam.
2. You have 75 minutes to solve this exam, scan and submit your answers, you can scan a copy and put to Canvas for a record.
3. Please clearly write down your answers, points deducted due to unreadable writing will be fully your responsibility.
4. Make your answer concise, e.g., when 4 states is enough for a NFA, then no need to draw 5 states.

Name	
NetID	

Problem	Maximum Points	Points Earned
1	20	
2	20	
3	20	
4	30	
Note	10	
Total	100	

Problem 1. Design a DFA for the language $L_1 = \{w \in \{a, b\}^* \mid$ number of as in w is at least 2 and number of bs in w is exactly one$\}$. You can just draw the diagram. **[20 points]**

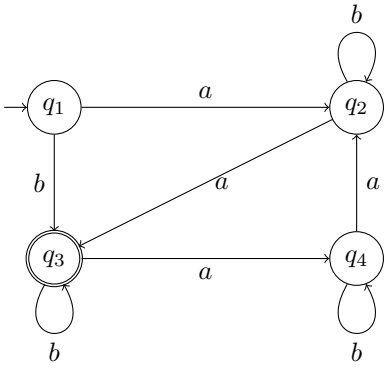
Hint: Think about a DFA accepts strings that has at least two as in it and a DFA accepts strings have exactly one b in it.

Problem 2.

1. Give the NFA for the language defined by the Regular Expression $(aa \cup b)b^*a$. Please follow the steps in the lecture slides, start from the base case, simplify each step's NFAs by removing the ϵ transitions, and then continue on next step. **[10 points]**

2. Convert this NFA to DFA, you can just draw the diagram, you don't need to list the states that are not reachable from initial states. **[10 points]**

Problem 3. Convert the following DFA to the equivalent regular expression, remember to use the approach we discussed in class, that is converting the DFA to a GNFA first, and then eliminate the states one by one. To make things easier, we will just do one step, eliminating q_1 first, then q_2 . **[20 points]**



1. Convert the DFA to GNFA, just draw the diagram.

2. Draw the GNFA after eliminating state q_1.

3. Draw the GNFA after eliminating state q_2.

Problem 4.

1. Write down pumping lemma and the contrapositive of pumping lemma for regular language. **[10 points]**

2. Prove the language $L = \{ a^i b^j c^k, i \leq j \leq k\}$ is not regular. **[20 points]**