Carleton University
COMP 3803, Fall 2025, Test 1

Thursday October 9, 2025

Student Name:

Student Number:

40 marks total

Question 1: (**10 marks**) In class, you have seen a deterministic finite automaton (DFA) that accepts the set A of binary strings defined as

$$A = \{w \in \{0,1\}^* \mid \ w \text{ has a 1 at the third position from the right}\}.$$

This DFA has eight states q_{ijk}, where i, j, and k are zero or one. The idea is that the DFA is in state q_{ijk} if the last three bits read are ijk. For example, the DFA is in state q_{110} if the last three bits read are 110.

Since at the start, no bits have been read, we have to be careful in defining the start state. In class, you have seen that we *imagine* that the input string has three dummy bits 000 to its left. Based on this, the start state is q_{000}.

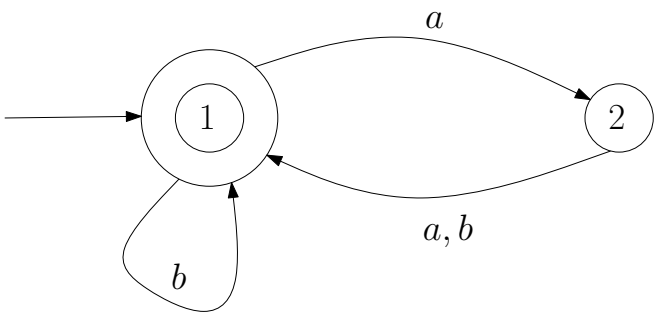
Here is the question: If we take q_{001} to be the start state, is the DFA still correct, i.e., is the language accepted still equal to A? As always, justify your answer.

Question 2: (**10 marks**) Give the state diagram of a nondeterministic finite automaton (NFA) that accepts the set A of binary strings defined as

$$A = \{w \in \{0,1\}^* \mid \ w \text{ contains both 00 and 11 as substrings}\}.$$

Explain why your NFA is correct.

Question 3: (**10 marks**) Use the method introduced in class to convert the following deterministic finite automaton (DFA) to a regular expression. The alphabet is $\{a, b\}$. Show your work.



Question 4: (**10 marks**) Let A be a regular language. We have shown in class that there exists a regular expression R that describes the language A.

Assume that you are given the regular expression R. Explain how to obtain a regular expression that describes the complement $\overline{A}$ of A. (Recall that $\overline{A}$ is the set of all strings that are not in A.) You may use any result that was proven in class.

EXTRA PAGE FOR ANSWERS

EXTRA PAGE FOR ANSWERS