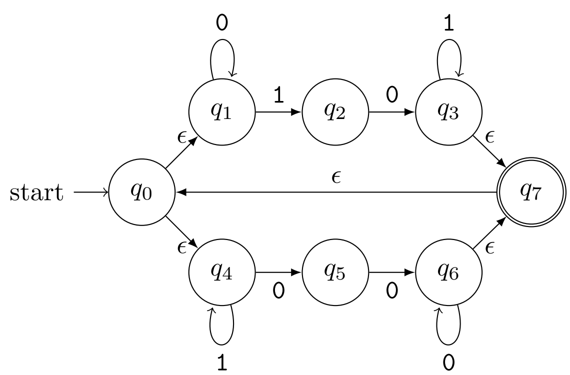
St. Francis Xavier University
Department of Computer Science

CSCI 356: Theory of Computing
Assignment 2
Due October 11, 2023 at 12:30pm

Assignment Regulations.

- This assignment must be completed individually.
- Please include your full name and email address on your submission.
- You may either handwrite or typeset your submission. If your submission is handwritten, please ensure that the handwriting is neat and legible.

[12 marks] 1. Consider the following nondeterministic finite automaton $\mathcal{M}$ with epsilon transitions:



(a) Convert $\mathcal{M}$ to a nondeterministic finite automaton without epsilon transitions. Show all your work in addition to giving the final nondeterministic finite automaton.

(b) Using your nondeterministic finite automaton from part (a), use the subset construction to complete the table corresponding to the transition function for the equivalent deterministic finite automaton. You do not need to draw the deterministic finite automaton, although you may do so if you wish.

[8 marks] 2. Consider the following regular expression over the alphabet $\Sigma = \{\mathtt{0}, \mathtt{1}\}$:

$$(\mathtt{01}^* + \mathtt{10})^*.$$

Convert this regular expression to a finite automaton recognizing the same regular language. Show all your work in addition to giving the finite automaton. You do not need to remove epsilon transitions or determinize the finite automaton.

[6 marks] 3. Let $\Sigma = \{\mathtt{(}, \mathtt{)}\}$. A word w over Σ contains balanced parentheses if every opening parenthesis is matched by a closing parenthesis and each pair of parentheses is correctly nested. For example, the words `()`, `()(())`, and `((()())())` all contain balanced parentheses, but the words `(()()(()` and `()))(())((())` do not.

Using the pumping lemma for regular languages, prove that the following language is not regular:

$$L_{()} = \{w \mid w \text{ contains balanced parentheses}\}.$$

[4 marks] 4. As we well know, 0^*1^* is a regular language. However, one of your friends who goes to Dalhousie is unconvinced, and gave you the following "proof" that 0^*1^* is not regular.

> Assume by way of contradiction that 0^*1^* is regular, and let p denote the pumping constant given by the pumping lemma. We choose the word w = 0^p1^p. Clearly, w is in the language and w has length at least p, but everybody knows w can't be pumped. Therefore, the language isn't regular.

What is the error in this "proof"? Give as much detail as necessary.