St. Francis Xavier University
Department of Computer Science

CSCI 356: Theory of Computing
Assignment 1
Due September 26, 2022 at 1:15pm

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.

[4 marks] 1. For each of the following languages over the alphabet $\Sigma = \{\mathtt{0}, \mathtt{1}\}$, show how to define the language using only the empty word ϵ, the symbols `0` and `1`, and the operations of union ($\cup$), concatenation ($\cdot$), and Kleene star (*).

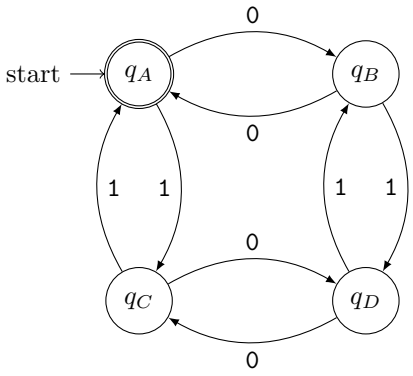
(a) $L_1 = \{w \mid w$ starts with `000` or ends with `111`$\}$.

(b) $L_2 = \{w \mid w$ contains `00100` as a subword$\}$.
(A subword is a "word within a word"; the given symbols must appear together and in order within any word of L_2.)

[6 marks] 2. (a) Let $\Sigma = \{\mathtt{0}, \mathtt{1}\}$. Consider the languages $A = \{\mathtt{1}, \mathtt{10}, \mathtt{010}\}$ and $B = \{\mathtt{1}, \mathtt{01}\}$.
Write down all words in the language AB and write down all words in the language BA. Are these two concatenation languages the same?

(b) Let $\Sigma = \{\mathtt{a}, \mathtt{b}\}$. Consider the regular languages $R = (\mathtt{ab} \cup \mathtt{aab})^*\mathtt{a}^*$ and $S = (\mathtt{a}^*\mathtt{ba}^*\mathtt{b})^*\mathtt{a}^*$.
Give one example each of a word that (i) is in R but not S; (ii) is in S but not R; and (iii) is in both R and S.

[8 marks] 3. Consider the following finite automaton.



(a) Give each part of the tuple $(Q, \Sigma, \delta, q_0, F)$ specifying this finite automaton. Write the transition function δ as a transition table.

(b) Give two examples each of words that (i) are accepted by this finite automaton and (ii) are not accepted by this finite automaton.

[7 marks] 4. Given the following nondeterministic finite automaton $\mathcal{M}$ with epsilon transitions, convert it to an equivalent (non)deterministic finite automaton $\mathcal{M}'$ without epsilon transitions. Show all your work in addition to giving the converted finite automaton.