

**St. Francis Xavier University**  
**Department of Computer Science**  
**CSCI 356: Theory of Computing**  
**Assignment 2**  
**Due October 17, 2022 at 1:15pm**

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**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.
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- [8 marks] 1. Consider the following regular expression over the alphabet  $\Sigma = \{a, b, c\}$ :

$$(ab^*(a + c))^*.$$

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.

- [5 marks] 2. Let  $\Sigma = \{a, b, c\}$ . Using the pumping lemma for regular languages, prove that the following language is not regular:

$$L = \{a^{4i+2}b^k c^{2i+1} \mid i \geq 0 \text{ and } k \geq 0\}.$$

- [7 marks] 3. Let  $\Sigma = \{a, b, c, d\}$ . Give a context-free grammar that generates the language

$$L = \{a^i b^{2k} c^k d^{3i} \mid i \geq 1, k \geq 1\} \cup \{a^r b^{2r} c^s d^{3s} \mid r \geq 1, s \geq 1\}.$$

For each of the rules of your grammar, give a brief ( $\sim 1$  sentence) description of the purpose/function of that rule.

- [5 marks] 4. Let  $\Sigma = \{x, y\}$ . Consider the following context-free grammar  $G$ :

$$\begin{aligned} S &\rightarrow A \\ A &\rightarrow AA \mid B \\ B &\rightarrow xBy \mid xy \end{aligned}$$

- (a) Describe the language  $L(G)$  generated by this context-free grammar.
- (b) Is the context-free grammar  $G$  ambiguous? If so, give an example of one word in the language  $L(G)$  having two different parse trees. If not, explain why not.