

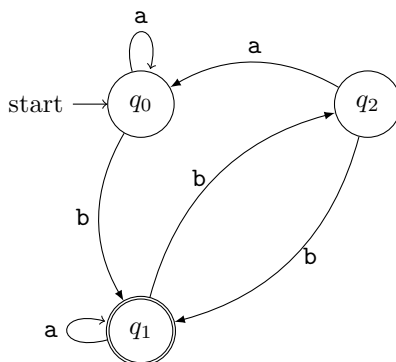
**St. Francis Xavier University**  
**Department of Computer Science**  
**CSCI 356: Theory of Computing**  
**Assignment 1**  
**Due September 20, 2023 at 12:30pm**

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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. Let  $\Sigma = \{a, b\}$ , and consider the regular expressions  $r = (ba + bab)^*a^*$  and  $s = a^*b(a^*ba^*b)^*a^*$ .
- Give two examples of words that belong to both languages  $L(r)$  and  $L(s)$ .
  - Give two examples of words that belong to the language  $L(r)$  but not to the language  $L(s)$ .
  - Give two examples of words that belong to the language  $L(s)$  but not to the language  $L(r)$ .
  - In 1–2 sentences, describe the languages  $L(r)$  and  $L(s)$  in general. What kind of words does either language contain?
- [6 marks] 2. For each of the following languages over the alphabet  $\Sigma = \{0, 1\}$ , show how to define the language using only the empty word  $\epsilon$ , the symbols 0 and 1, and the operations of union ( $\cup$ ), concatenation ( $\cdot$ ), and Kleene star ( $*$ ).
- $L_1 = \{w \mid w \text{ contains both } 000 \text{ and } 111 \text{ as subwords}\}$ .
  - $L_2 = \{w \mid w \text{ has even length and contains } 010 \text{ as a subword}\}$ .
  - $L_3 = \{w \mid w \text{ both begins and ends with the subword } 010\}$ .  
(Note that the beginning and ending occurrences of 010 may overlap with one another.)
- [6 marks] 3. Consider the following finite automaton.



- Give three examples of input words accepted by this finite automaton, and give three examples of input words rejected by this automaton.
- Draw the transition table corresponding to this finite automaton.

(c) What language does this finite automaton recognize?

*Hint.* You may be able to identify a pattern by writing out all words up to a certain length (say, 4) and checking which words are accepted/rejected.

[10 marks] 4. A common feature of programming languages is the ability to write comments within one's code, often between delimiters like `/#` and `#/`. A *valid comment* is one that begins with `/#`, ends with `#/`, and has no other occurrences of `#/` between the delimiters.

Let  $\Sigma = \{\mathbf{a}, \mathbf{b}, /, \#\}$  and consider the language  $L_{\text{comment}} = \{w \mid w \text{ is a valid comment}\}$ .

(a) Give a regular expression that represents the language  $L_{\text{comment}}$ .

(b) Construct a deterministic finite automaton that recognizes the language  $L_{\text{comment}}$ .