

Due: Tuesday, March 20<sup>th</sup> by 4:00pm

1. (35 points, 1 point each, unless noted otherwise) With  $\Sigma = \{1, 2, 3\}$ ,  $L_1 = \{111, 222, 333\}$ ,  $L_2 = \{1, 13, 111, 112\}$ ,  $u = 1231$ ,  $v = 2^3$ ,  $r = (1^* | 13^* | 2)^*$ ,  $s = [12][1-3][^1]$  Answer the questions.

- What is  $|u|$ ?
- What is  $vu$ ?
- What are the substrings of  $u$ ?
- What is  $u^R$ ?
- What is  $\Sigma^2$ ?
- What is  $\Sigma^3$ ?
- What is  $L_2L_1$ ?
- What is  $L_1 \cup L_2$ ?
- What is  $L_1 \cap L_2$ ?
- What is  $L_2^R$ ?
- Add parentheses to  $r$  to make its order of precedence clear.
- Provide all strings that would satisfy  $s$ .
- Which members of  $L_1 \cup L_2 \cup u \cup v$  would satisfy  $r$ ?
- Which members of  $L_1 \cup L_2 \cup u \cup v$  would satisfy  $rs$ ?
- (5 points) Provide a state diagram for a finite state automata with a minimal number of states for  $L_1$ .
- (5 points) Provide a state diagram for a finite state automata with a minimal number of states for  $L_2$ .
- (5 points) Provide a formal grammar for  $L_1$  in non Backus-Naur Form.
- (5 points) Provide a formal grammar in Backus-Naur Form for  $L_2$ .
- Provide a derivation tree for  $L_2$ .

2. (8 points, 2 points each) With an alphabet of  $\{0, 1\}$ , and a system that accepts the set of all strings that start with no more than two consecutive 0's, and contain at least two consecutive 1's.

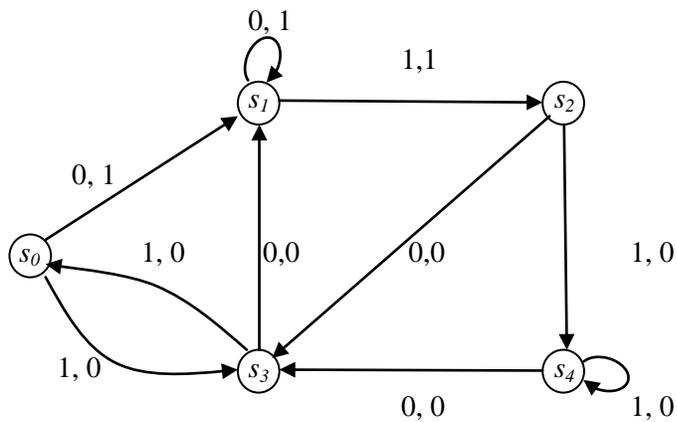
- Draw a state diagram for a finite state automata that accepts only the strings specified.
- Provide a state table for the FSA that you drew in 2a).
- Provide a regular expression that would only accept the strings described.
- Provide a grammar that would create all strings that would satisfy the specification.

3. (1 point) Find a regular expression that defines a language consisting of all strings of 0's and 1's with an odd number of 1's.

4. (3 points) Let  $r$ ,  $s$ , and  $t$  be regular expression over  $\Sigma = \{a, b\}$ . For the following, determine whether the two regular expression define the same language. If they do, describe the language. If they do not give an example of a string that is in one of the languages, but not the other.

- $(r | s)t$  and  $rt | st$
- $(rs)^*$  and  $r^*s^*$
- $(rs)^*$  and  $((rs)^*)^*$

5. (3 points) Given the finite state machine answer below, answer the questions.



a) (2 points) Provide the state table for the FSM.

b) (1 point) What is the output if the input string is 101011?