

READ THIS FIRST:

Do your best to answer every question; if you cannot immediately answer a question, go on to others and then come back to it later. If a question has multiple choices, circle your answer to the question to show your selection; else, write your answer neatly and clearly in the space provided. If you are asked to justify your answer, use the space provided or use some other space and make clear to which question it corresponds.

This exam has 10 questions with a total of 46 *regular* points, and 10 *bonus* points. Check to make sure you have all 10 questions.

May the fox be with (your name here): _____

[illegible]

1. Give a regular expression for each of the following languages:

(a) (2 points) $\{ abc \}$

(b) (3 points) $\{ a, b, c \}$

(c) (5 points) $\{ (ab)^n \}$

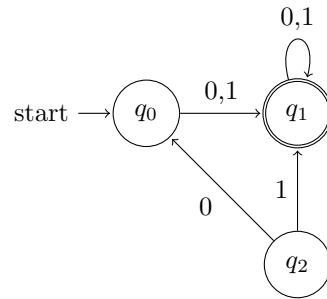
2. (2 points) Give a **grep** regular expression that matches the pattern **exp** only at the beginning of a line.

3. (4 points) Give a **grep** regular expression for matching the patterns **bunk** or **bank** at the end of a line.

4. (4 points) Which two patterns will the **grep** regular expression `[A-Z][a-z].*` match?

- A. 123Stop
- B. 123stop
- C. Stop123
- D. STOP123

5. Answer the questions below regarding the following DFA:



(a) (2 points) Are there any unreachable states? List them if any.

(b) (6 points) What are the languages $L(M, q)$ for each $q \in Q$? List them all. *Hint:* we formally defined $L(M, q) = \{ x \in \Sigma^* \mid \delta^*(q, x) \in F \}$.

(c) (2 points) What is the minimized DFA? Draw below.

6. Give a grammar for each of the following languages. In each case, use S as the start.

(a) (2 points) $L(a^*)$

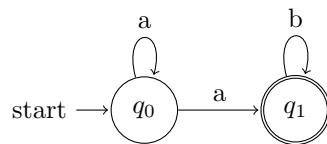
(b) (6 points) $L(a^*b^*c^*)$

7. (4 points) State the following grammar formally as a 4-tuple. (Assume that the terminal alphabet is the set of lowercase letters that appear in productions, the nonterminal alphabet is the set of uppercase letters that appear in productions, and the start symbol is S .)

$$S \rightarrow abS|X$$

$$X \rightarrow baX|\varepsilon$$

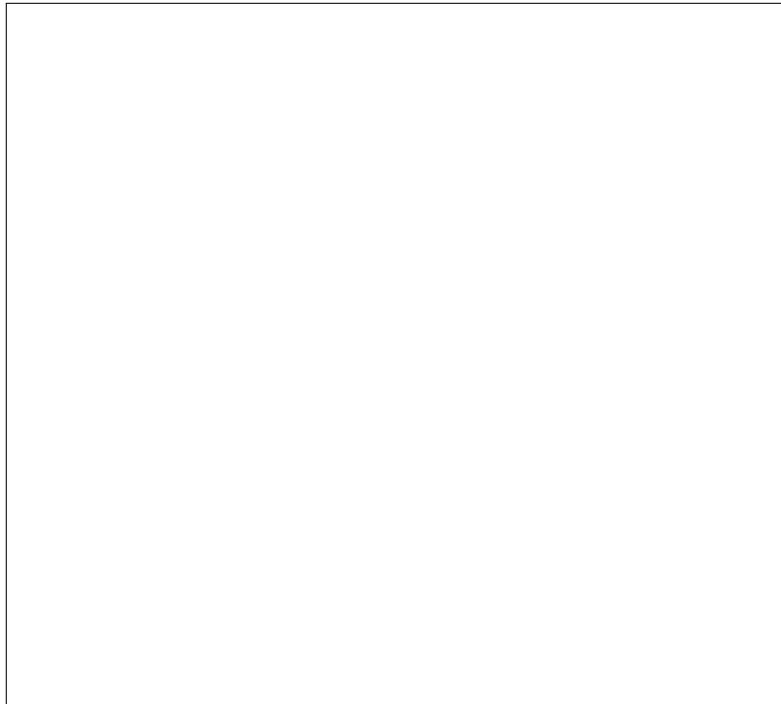
8. (4 points) Make a right-linear grammar that generates the language accepted by the following NFA.



9. A grammar can be formally defined by the following 4-tuple:

$$G = (V, \Sigma, S, P)$$

- (a) (2 points (bonus)) Define V
 - (b) (2 points (bonus)) Define Σ
 - (c) (1 point (bonus)) Define S
 - (d) (3 points (bonus)) Define P
10. (2 points (bonus)) Albert Einstein said “Creativity is intelligence having fun”. You are very smart and talented. That is why you are in this class. With that in mind, and for a chance to be displayed at your professor’s office, draw a cool red fox that is a computer science student at Marist.



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