CECS 329 MW, LO Assessment 2 Solutions, Fall 2026, Dr. Ebert

IMPORTANT: For each problem (LO1,LO2,GK,Advanced, All LO Makeups) write your solution using a **SINGLE** and **SEPARATE SHEET OF PAPER (BOTH FRONT AND BACK)**. Write your **FIRST NAME**, **ALPHABETIZING NAME** and **PROBLEM CODE** on each sheet.

25 Points Each

LO3 Do the following.

a. Let A denote the language of binary words of length four that have exactly two 0's. Let B denote the language consisting of all binary words of length four and (when viewed as a binary number) that are divisible by 3. Use set list notation to write the members of $A - B$. Hint: 0011 and 1001 are both in set B since, as binary numbers, 0011 evaluates to 3, while 1001 evaluates to 9. (6 pts)

Solution. We have

$$A = \{0011, 0101, 0110, 1001, 1010, 1100\}$$

and

$$B = \{0000, 0011, 0110, 1001, 1100, 1111\}$$

and

$$A - B = \{0101, 1010\}.$$

b. For the language A described in part a, is 1100010101001100 a member of A^*? Justify your answer. (6 pts)

Solution. the word is not a member of A^* since $w[9:12] = 0100 \notin A$.

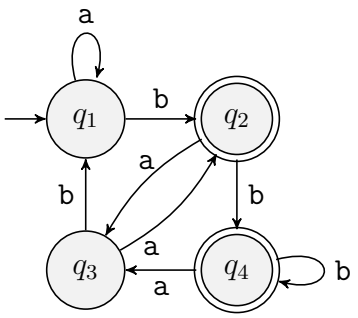
c. Provide a regular expression that describes the language consisting of all words over the alphabet {a,b} that have an even number of a's, and begin with an a, and end with a b. Words in the language include aab, ababaab, and aababababaab.

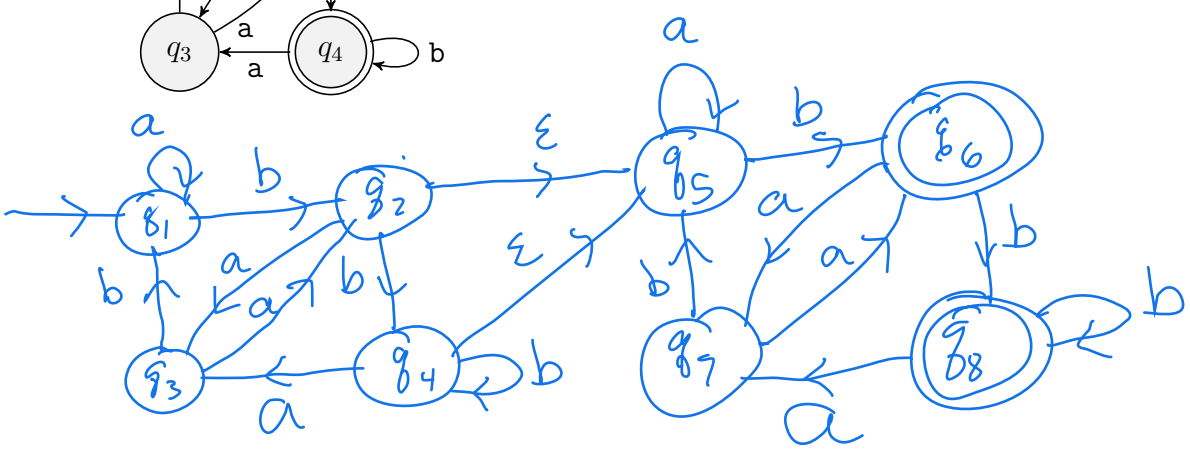
Solution. $ab^*a(b^*ab^*a)^*b^+$ (13 pts)

LO4 Do the following

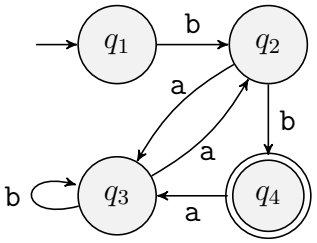
Solution.

a. Consider the DFA M below which recognizes/accepts language A. Use it provide an NFA that recognizes $A \circ A = A^2$. (9 pts)

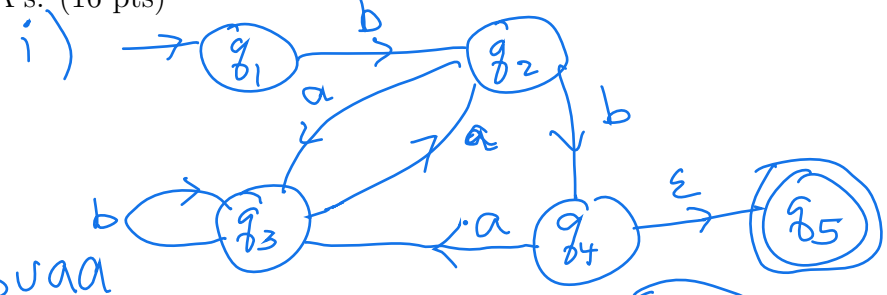




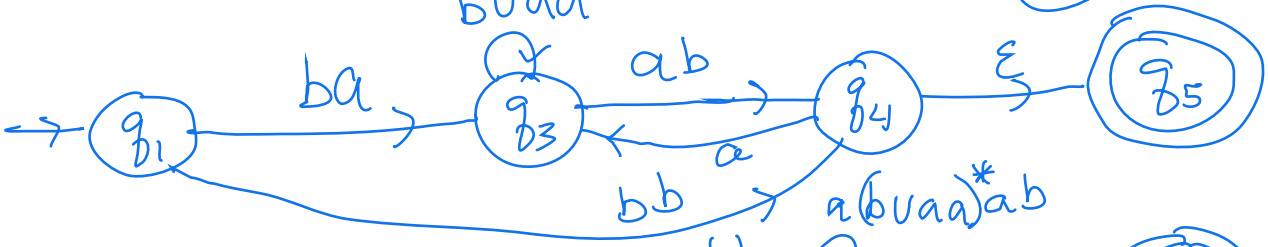
b. The DFA M shown below accepts some regular language L. Demonstrate each of the following steps of the GNFA-to-Regular-Expression algorithm to compute a regular expression that describes L: i) create a new accepting state and label it q_5, ii) remove state q_2, iii) remove state q_3, iv) remove state q_4. Redraw the GNFA after each step. Therefore, you must draw four different NFA's. (16 pts)



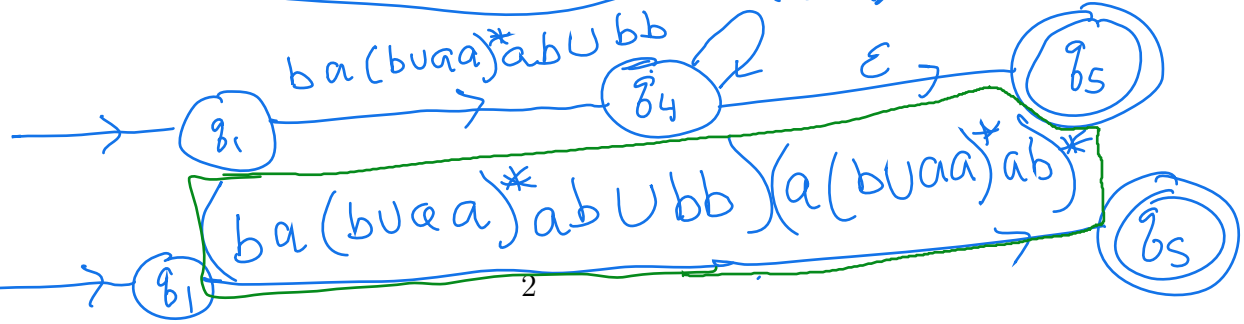
i)



ii)



iii)



iv)

GK Answer the following.

a. Consider the problem of searching through a file system in order to locate text files that possess some **regular pattern**, meaning that the set of hypothetical text files (when viewed as words over the ASCII alphabet) that have the pattern forms a regular language. Explain the role that an i) NFA, ii) regular expression, and iii) DFA could play in locating all the text files in the system that possess the given pattern. Hint: the order in which you answer these may be of help. (15 pts)

Solution. The regular text pattern that a file should possess can be described by a regular expression. This expression can then be converted to an NFA, which in turn can be converted to a DFA which can decide if a given file has the pattern, and using a number of steps that is proportional to the file's size.

b. What does it mean to be an "atomic" regular expression and (based on the lecture notes) what are the different ways that one can build a compound expression out of atomic ones? (10 pts)

Solution. See Regular Expressions lecture notes.

ADV Answer the following.

a. Suppose L is a regular language over some alphabet Σ. Provide a solid argument for why $\overline{L}$, the complement of L, is also regular. (10 pts)

Solution. Since L is regular, there is a DFA $M = (Q, \Sigma, \delta, q_0, F)$ that decides L. Thus, $w \in \Sigma^*$ belongs to $\overline{L}$ iff the computation of M on input w terminates in some state in $Q - F$. Therefore, the DFA $\overline{M} = (Q, \Sigma, \delta, q_0, Q - F)$ accepts $\overline{L}$.

b. Based on part a and the fact that regular languages are closed under the set union operation, prove that regular languages are also closed under both the intersection and set-difference (i.e. $A - B$) operations. (15 pts)

Solution. If A and B are regular, then by De Morgan's rule so is

$$A \cap B = \overline{\overline{A} \cup \overline{B}}$$

since it is the complement of the union of two regular langauges (the complements of A and B) and regular languages are closed under both union and complement. Therefore, regular languages are also closed under intersection, which means that

$$A - B = A \cap \overline{B}$$

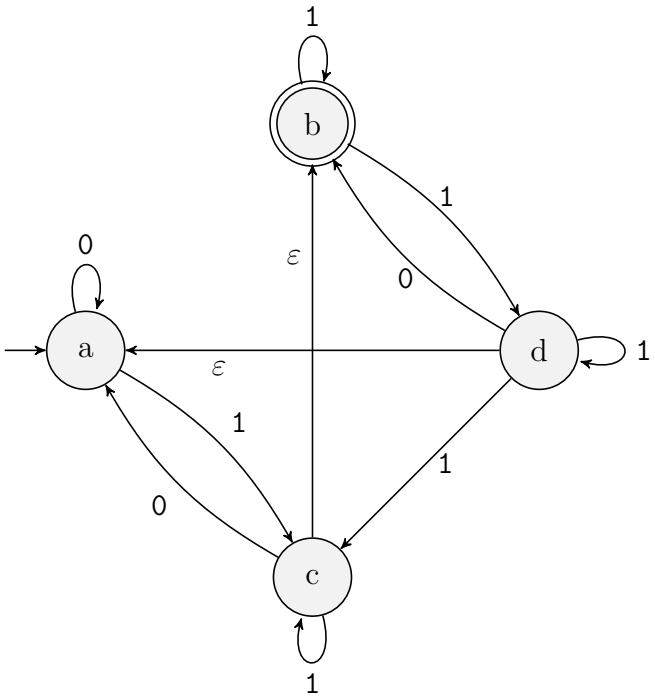
is also regular.

Makeup LO's (Pass/No Pass)

LO1. Consider the language L consisting of all words in {a,b}* that begin with an a and end with bb. Provide the state diagram of a DFA M that accepts L and show the computation of M on inputs $w_1 =$ ababb and $w_2 =$ abab.

LO2. Do the following.

(a) For the NFA N whose state diagram is shown below, provide a table that represents N's δ transition function.



(b) Use the table from part b to convert N to an equivalent DFA M using the method of subset states. Draw M's state diagram.