CECS 329 Friday, 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 *at most* four that are palindromes (i.e. read the same forward as backwards). Let B denote the language of all binary words of length *at most* four that represent prime numbers. Use set list notation to write the members of $A \cap B$. Hint: 010 and 1111 are examples of palindromes, while 0011 and 0101 both represent prime numbers, since 0011 evaluates to 3, while 0101 evaluates to 5. (6 pts)

Solution. We have

$$A \cap B = \{010, 11, 101, 111\}.$$

b. For the languages A and B described in part a, is 1011101 a member of BA? Justify your answer. (6 pts)

Solution. Yes. 1011 is prime while 101 is a palindrome. Therefore, $1011101 \in BA$.

c. Provide a regular expression that describes the language consisting of all words over the alphabet {a,b} that have at least three a's, and at most one b.

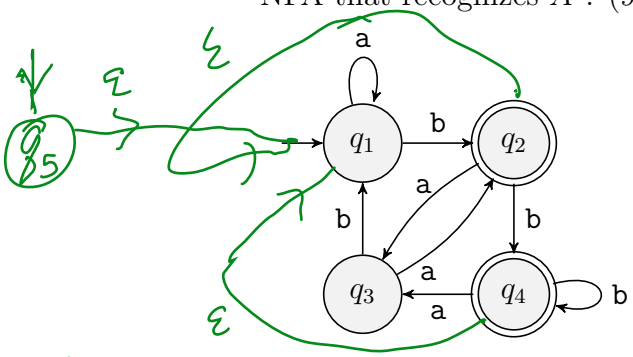
Solution. We have

$$a^3a^* \cup a^3a^*ba^* \cup a^2a^*ba^+ \cup a^+ba^2a^* \cup a^*ba^3a^*.$$

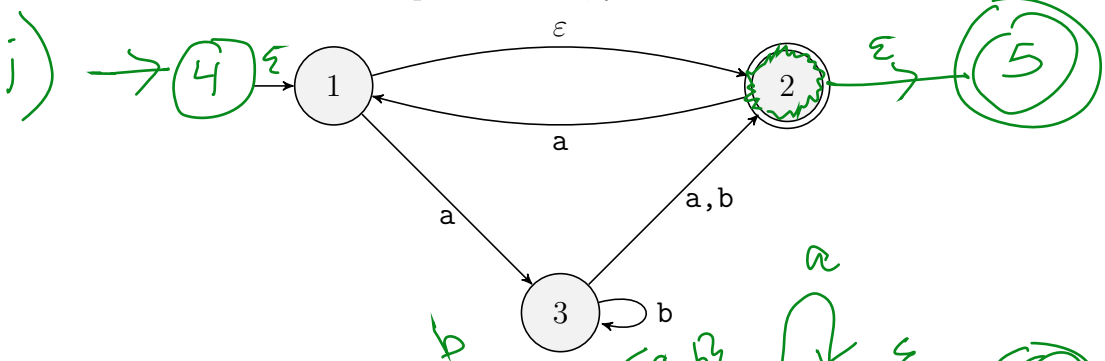
(13 pts)

LO4 Do the following

a. Consider the DFA M below which recognizes/accepts language A. Use it to provide an NFA that recognizes A^*. (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 initial state labeled as 4 and create a new accepting state labeled as 5, ii) remove state 1, iii) remove state 3, iv) remove state 2. Redraw the GNFA after each step. Therefore, you must draw four different GNFA's. (16 pts)



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. Provide a regular expresion that describes the language of all words w over the alphabet $\{-1, +1\}$ for which, for all $k = 1, \ldots, |w|$,

$$\sum_{i=1}^{k} w_i \leq 3,$$

and for which $w_1 + \cdots + w_{|w|} = 0$. In other words, when reading w, the sum of its letters always remains nonnegative but never exceeds 3, and the entire word sums to 0. For the sake of readability, please use the letter **a** to represent $+1$, and the letter **b** to represent -1. (15 pts)

Solution. We have

$$(a(a(ab)^*b)^*b)^*.$$

b. Consider the alphabet

$$\Sigma = \left\{ \begin{matrix} 0 \\ 0 \end{matrix} , \begin{matrix} 0 \\ 1 \end{matrix} , \begin{matrix} 1 \\ 0 \end{matrix} , \begin{matrix} 1 \\ 1 \end{matrix} \right\}$$

where each symbol is a column vector of two bits. Provide a regular expression that describes the language of all words over Σ for which the top-layer binary word u is greater than the bottom-layer word v when both are viewed as binary numers. For example, one such word in the language is

$$\begin{matrix} 01111 \\ 00110 \end{matrix}$$

since $u = 01111$ represents 15, while $v = 00110$ represents 6. (10 pts)

Solution. We have

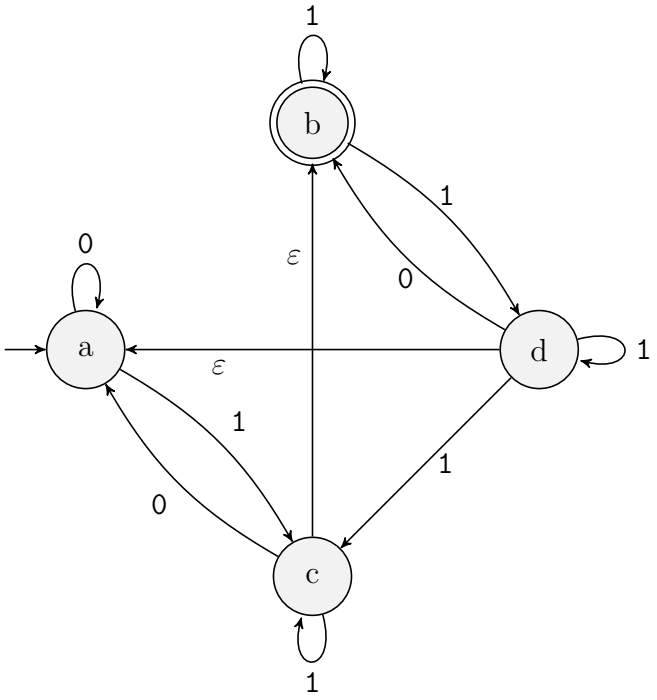
$$\left\{ \begin{matrix} 0 \\ 0 \end{matrix} , \begin{matrix} 1 \\ 1 \end{matrix} \right\}^* \begin{matrix} 1 \\ 0 \end{matrix} \left\{ \begin{matrix} 0 \\ 0 \end{matrix} , \begin{matrix} 0 \\ 1 \end{matrix} , \begin{matrix} 1 \\ 0 \end{matrix} , \begin{matrix} 1 \\ 1 \end{matrix} \right\}^* .$$

Makeup LO's (Pass/No Pass)

LO1. Consider the language L consisting of all words in {a,b}* that do *not* have the pattern abab. Provide the state diagram of a DFA M that accepts L and show the computation of M on inputs $w_1 =$ abbba 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.