CECS 329, Learning Outcome 12 Assessment, Due December 14th, 2023, Dr. Ebert

Directions: Turn in handwritten solutions before the start of the final exam on December 14th. Order your solutions by problem number/letter, and do *not* write on the back of any page. Only the front side of each page will be read. Staple all pages (no folding of corners). Although it's OK to discuss problems with other students, plagiarism will not be tolerated and will result in a final course grade of F. Make sure to describe solutions in your own words. All problems are equally weighted and must be passed in order to pass LO12.

Problems

1. Solve the following problems.

   (a) Provide the state diagram of a DFA M_1 that accepts each word $w \in \{a, b\}^*$ for which the number of a's in w is a multiple of 3.

   (b) Provide the state diagram of a DFA M_2 that accepts each word $w \in \{a, b\}^*$ for which bab does not appear in w.

   (c) Use the Intersection construction described in the proof of Proposition 2 (page 28 of the Finite Automata lecture) and uses your M_1 and M_2 from parts a and b to provide the state diagram of a DFA M that accepts each word $w \in \{a, b\}^*$ for which i) the number of a's in w is a multiple of 3 and ii) bab does not appear in w. Please follow these rules when drawing the DFA: i) include *all* possible states $(q, q') \in Q_1 \times Q_2$, where Q_i is the state set for M_i, $i = 1, 2$, ii) use a "matrix node layout" where, assuming $Q_1 = \{q_1, \ldots, q_r\}$ and $Q_2 = \{q'_1, \ldots, q'_s\}$ state (q_i, q'_j) is drawn in cell (i, j) of the matrix.

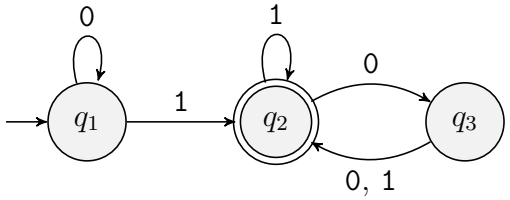
2. Solve the following problems.

   (a) Provide a regular expression that represents the set of all words in $w \in \{a, b, 0, 1\}^*$ that have the form $w =$ ab$v$ba, where $v \in \{a, b, 0, 1\}^*$ is any word for which neither ab nor ba appear. For example, $w =$ abb10a0bba is one such word, while $w =$ abb10abbba should *not* be represented by the regular expression. Note: this kind of language is akin to the set of all legal long-form comments in a program file, where ab and ba serve as the beginning and ending delimiters, and these delimiters must not appear in the body of the comment.

   (b) Provide an NFA that accepts the language described in part a and uses *at most* seven states.

3. Use the closure methods from Sections 4.2-4.4 of Finite Automata lecture to provide an NFA that accepts the language represented by the regular expression $(a \cup b^*)a^*b^+$. See Example 26 of the lecture. Hint: concatenate together two or three different NFA's.

4. For the DFA M shown below, do the following.



(a) Describe in one or two sentences the type of words that are accepted by M and formalize your description by providing a regular expression for the accepted language.

(b) Use the GNFA algorithm (see pages 44-46 of the Finite Automata lecture) to convert M to a regular expression. Remove the states one by one and redraw the GNFA after each state removal.

(c) Write a paragraph that convinces the grader that the regular expressions from parts a and b are representing the same language.