University of Nevada, Las Vegas Computer Science 456/656 Spring 2026

Assignment 1: Due Saturday January 31, 2026, 11:59:59 PM

Name:_____

You are permitted to work in groups, get help from others, read books, and use the internet. Turn in the assignment as instruced by the Graduate Assistant, Shubhashish Kar, `shubhashish.kar@unlv.nevada.edu`

1. Work Exercises 1-6 on page 2 of the handout introduction.pdf.

   (1) A

   (2) A

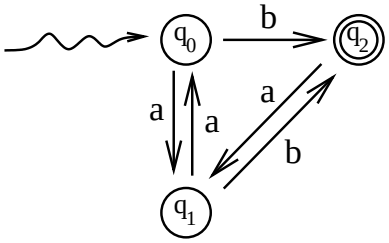
   (3) $\{aa, aba, abba\}$

   (4) $\emptyset$

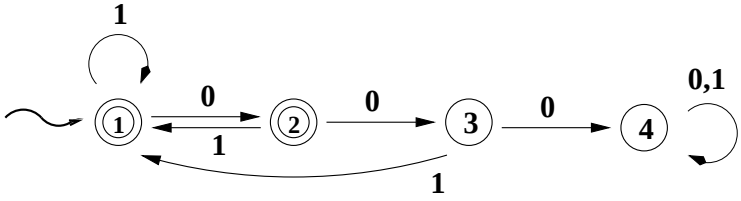
   (5) $\{\lambda\}$

   (6) $\{\lambda\}$

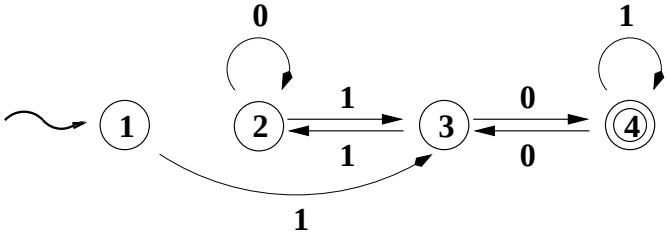
2. Let M_1 be the DFA shown below.



   Let M_2 be the DFA shown below.



   Let M_3 be the DFA shown below.



   Which of the following languages is accepted by M_1? By M_2? By M_3?

   (a) The language of all binary strings in which every substring 00 is followed by 1.

   (b) All strings over $\{a, b\}$ which end in b and which do not contain the substring bb.

(c) The language of all binary numerals for positive integers equivalent to 2 modulo 3.

(d) The language of all strings over $\{a, b\}$ in which every a is followed by b.

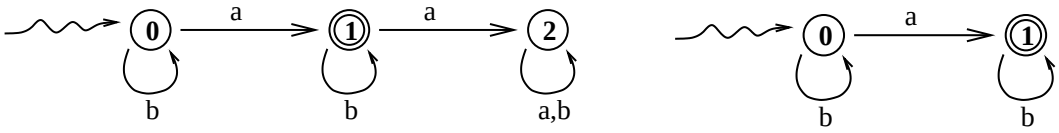
M_1 accepts (b).

M_2 accepts (a).

M_3 accepts (c).

3. Construct a DFA which accepts the language $\{b^i a b^j : i, j \geq 0\}$, the language of all strings over $\{a, b\}$ which contain exactly one a. Your figure need not show the dead state.

   With and without the dead state:



4. Recall that $\emptyset$ is the empty language. If L is some language, what is the concatenation $\emptyset L$?

   The empty language, $\emptyset$.

5. Let $L_1 = \{\lambda\}$. the language consisting of only the empty string. If L_2 is some other language, what is the concatenation $L_1 L_2$?

   L_2

6. Is concatenation of languages commutative? That is, is the equation $L_1 L_2 = L_2 L_1$ always true?

   No, not always.

7. Which of the following is true:

   (a) If L is any language, $L^0 = L$.

   (b) If L is any language, $L^0 = \emptyset$.

   (c) If L is any language, $L^0 = \{\lambda\}$.

   Hint: Think!

   (c) is true, the others are false.

8. What is $\emptyset^*$, the Kleene closure of the empty language?

   $\{\lambda\}$

9. True(T) or False(F).

   i **F** Every subset of a regular language is a regular languge.

   ii **F** Every language is generated by a grammar.

   iii **F** Every language is finite.

iv **F** 'Every language is infinite.

v **F** Concatenation is commutative. That is, $L_1L_2 = L_2L_1$ for any languages L_1 and L_2.

vi **T** Concatenation is associative. That is, $(L_1L_2)L_3 = L_1(L_2L_3)$ for any languages L_1, L_2, and L_3.

vii **T** The intersection of any two regular languages is regular.

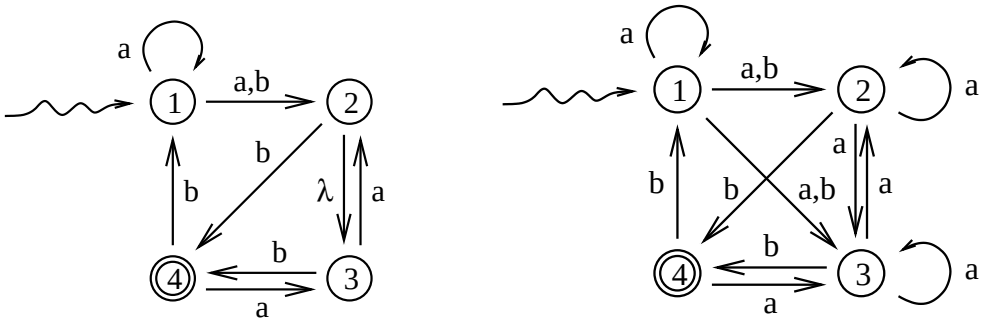
viii **T** The complement of any regular languages is regular.

ix **T** The Kleene closure of any regular languages is regular.

x **T** $\{\lambda\} + A = A$

xi **T** Concatenation of languages distributes over union. That is, $L_1(L_2 + L_3) = L_1L_2 + L_1L_3$ for any languages L_1, L_2, L_3.

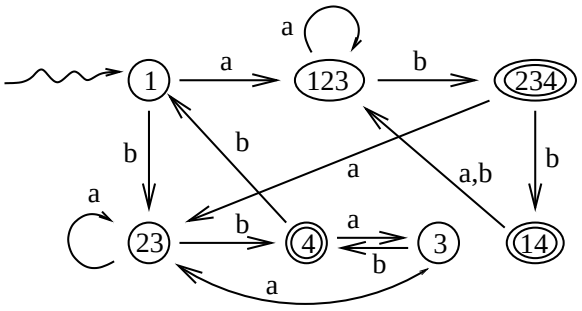
10. Construct a DFA equivalent to the following NFA. We first construct the λ closure.



Now build the transition table. I start with the singleton sets: $\{1\}$, $\{2\}$, $\{3\}$, $\{4\}$, then fill in all remaining subsets that are reachable. Note that $\{2\}$ is unreachable, but I'll keep it in the table, since it's a singleton. Only seven of the sixteen subsets of Q are reachable. We obtain the DFA of seven states shown below.

Note that *braced*3 is equivalent to $\{2, 3\}$. No two of the remaining reachable subsets are equivalent, hence we have the minimal DFA shown below. Since the question did not ask for a minimal DFA, it would be correct to not collapse $\{3\}$ with $\{2, 3\}$. The resulting DFA has seven states and is not minimal.

	a	**b**
1	**123**	**23**
2	**23**	**4**
3	**23**	**4**
4	**3**	**1**
23	**23**	**4**
123	**123**	**234**
234	**23**	**14**
14	**123**	**123**



$\{3\}$ is equivalent to $\{2, 3\}$. There are no other equivalences. Here is the minimal DFA.