1. 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) I made a mistake drawing the state diagram for $M_2$. State 3 is not supposed to be final. The language of all binary strings in which every substring 00 is followed by 1 is not accepted by the original $M_2$, but is if we change state 3 to be non-final.

(b) The language of all strings over $\{a, b\}$ which end in b and which do not contain the substring bb is accepted by $M_1$.

(c) The language of all binary numerals for positive integer $s$ equivalent to 2 modulo 3 is accepted by $M_3$.

(d) The language of all strings over $\{a, b\}$ in which every b is followed by a is not accepted by any of the machines shown.

Construct a DFA which accepts the language $\{b^i a^j : i, j \geq 0\}$, the language of all strings over $\{a, b\}$ which contain exactly one $a$. Your figure need not show the dead state.
2. Recall that $\emptyset$ is the empty language. If $L$ is some language, what is the concatenation $\emptyset L$? Ans: $\emptyset$

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

4. Is concatenation of languages commutative? That is, is the equation $L_1 L_2 = L_2 L_1$ always true? Ans: No.

5. Is it true that, for any language, $L^n L = L^{n+1}$? Ans: Yes.

6. 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! Ans: False, False, True.

7. Does concatenation of languages distribute over union? That is, is $L_1 (L_2 + L_3) = L_1 L_2 + L_1 L_3$ always true? Ans: Yes.

8. What is $\emptyset^*$, the Kleene closure of the empty language? Ans: $\{\lambda\}$.


10. Is the union of two regular languages always regular? Ans: Yes.

11. Is the intersection of two regular languages always regular? Ans: Yes.


14. The DFA $M_1$ shown in Problem 1 is not minimal, that is, it’s equivalent to a DFA with fewer states. Can you draw a state diagram of that DFA? Your figure need not show the dead state.