

1) (10 points) Give the formal definition of the DFA M_1 given in Figure 1

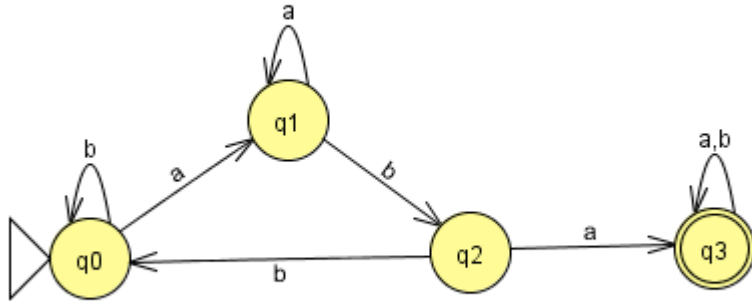


Figure 1: Machine M_1

- 2) (10 points) Give a regular expression for the language generated by the DFA shown in Figure 2. Describe the Language.

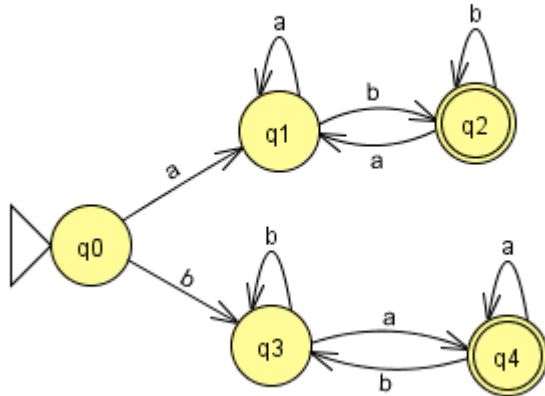


Figure 2:
Description

REGEX: _____

- 3) (10 points) Draw the state diagram for the following NFA

$$M_2 = \{Q = \{1, 2, 3, 4, 5\}, \Sigma = \{a, b\}, \delta, 1, \{1, 3\}\}$$

where δ is given by the following table:

$\delta(1, a) = \{2, 3\}$	$\delta(1, b) = \emptyset$	$\delta(1, c) = \{3\}$
$\delta(2, a) = \emptyset$	$\delta(2, b) = \{2, 4\}$	$\delta(2, c) = \emptyset$
$\delta(3, a) = \{5, 2\}$	$\delta(3, b) = \emptyset$	$\delta(3, c) = \emptyset$
$\delta(4, a) = \emptyset$	$\delta(4, b) = \emptyset$	$\delta(4, c) = \{3\}$
$\delta(5, a) = \emptyset$	$\delta(5, b) = \{3, 5\}$	$\delta(5, c) = \emptyset$

4) (10 pts) Draw a transition diagram for a DFA machine M_3 that accepts any and only binary string that start with **bab**.

5) (20 points) Write a regular expression that describes formally the following informally described languages. Assume $\Sigma = \{a, b\}$.

a) **w** contain a **b** in the third symbol from the left.

b) **w** contain a **b** in the third symbol from the left.

c) **w** contain both **aaa** or **bbb** as a substring.

d) **w** contain either **aaa** or **bbb** as a substring.

6) (10 points) Write a context-free grammar that generates the following languages. Assume $\Sigma = \{a, b, \#\}$.

$\{ \#a^{2^n}\#b^n\# \mid n > 0 \}$ this language has two a's for each b.

7) (10 points) Use the pumping lemma to show that the following language is not regular. Assume $\Sigma = \{a, b\}$.

a) $\{a^n b^{2^n} \mid n > 0\}$ this language has two b's for each a.