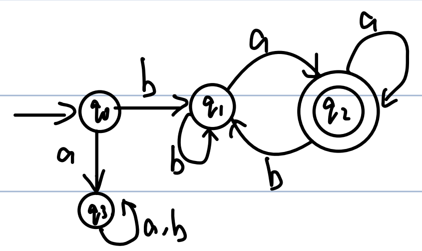
Q1.



Symbolic description: $M = \{Q, \Sigma, \delta, q, F\}$

The set of states is $Q = \{q_0, q_1, q_2, q_3\}$

The alphabet $\Sigma = \{a, b\}$

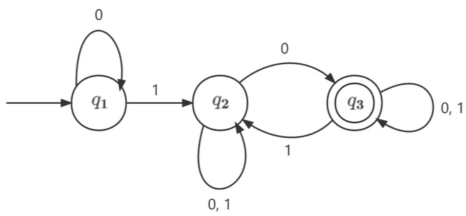
The start state q is q_0

The accept state is $F = \{q_2\}$

The transition function δ is shown by the transition table below:

	a	b
q_0	q_3	q_1
q_1	q_2	q_1
q_2	q_2	q_1
q_3	q_3	q_3

Q2.



$move(q, a) = \{\delta(q, a)\}$

$E(\{q_1\}) = \{q_1\} = A$

$E(move(q_1, 0)) = E(\{q_1\}) = \{q_1\} = A$

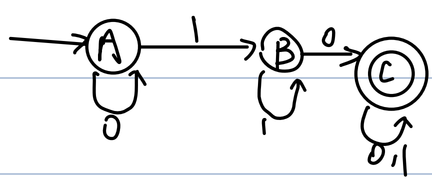
$E(move(q_1, 1)) = E(\{q_2\}) = \{q_2\} = B$

$E(move(B, 0)) = E(\{q_2, q_3\}) = \{q_2, q_3\} = C$

$E(move(B, 1)) = E(\{q_2\}) = \{q_2\} = B$

$E(move(C, 0)) = E(\{q_2, q_3\}) = \{q_2, q_3\} = C$

$E(move(C, 1)) = E(\{q_2, q_3\}) = \{q_2, q_3\} = C$



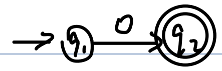
$A: \{q_1\}$

$B: \{q_2\}$

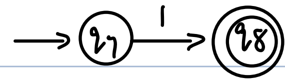
$C: \{q_2, q_3\}$

Q3.

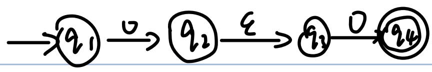
0 :



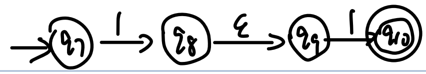
1 :



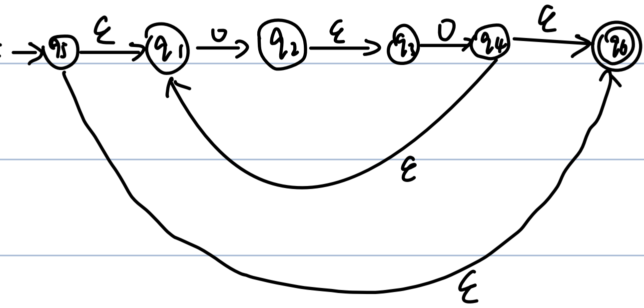
00 :



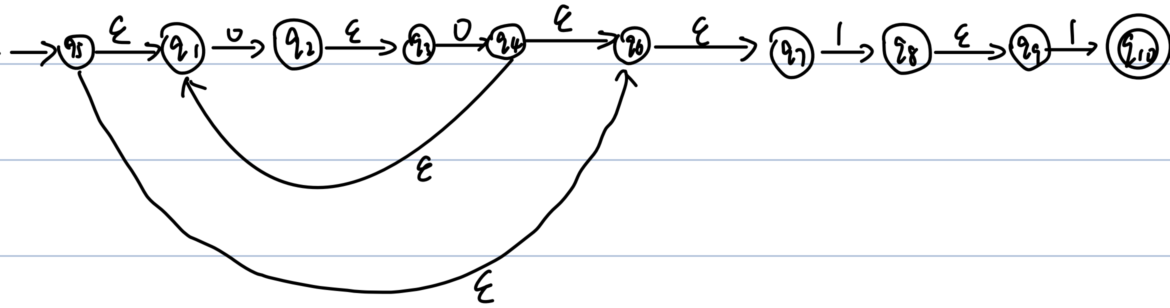
11 :



(00)* :



(00)* 11 :



Q4.

Suppose A_1 is regular, then it should satisfy pumping lemma.

Let p be the "pumping length" of the Pumping Lemma. Consider $w = a^p b$ then $s = www = a^p b a^p b a^p b$.

And $|s| = 3p + 3 > p$, so the Pumping lemma will hold. Thus we can split the string s into 3 parts $s = xyz$ satisfying the conditions:

$xy^i z \in A_1$ for each $i \geq 0$ (1)

$|y| > 0$ (2)

$|xy| \leq p$ (3)

Because $|xy| \leq p$, and first p symbols of s are a, so we can say that:

$x = a^m$ for some $m \geq 0$

$y = a^n$ for some $n \geq 1$

$z = a^{p-m-n} b a^p b a^p b$

By condition (3), when $i = 0$, $xy^i z = xz = a^m a^{p-m-n} b a^p b a^p b = a^{p-n} b a^p b a^p b$

since $n \geq 1$, $p - n < p$

so $a^{p-n} b \neq a^p b$, which means $xy^0 z \notin A$, this contradicts to pumping lemma.

Hence our consumption that A_1 is regular is false. Therefore A_1 is nonregular