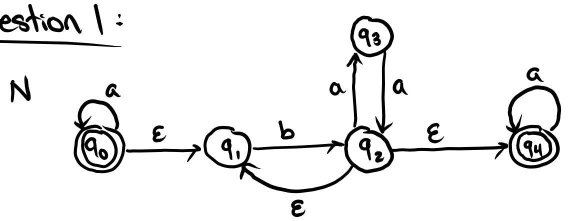
Question 1:

a) N



$N = (\{q_0, q_1, q_2, q_3, q_4\}, \{a,b\}, \delta, q_0, \{q_0, q_4\})$

δ:

δ	a	b	ε
q_0	$\{q_0\}$	$\emptyset$	$\{q_1\}$
q_1	$\emptyset$	$\{q_2\}$	$\emptyset$
q_2	$\{q_3\}$	$\emptyset$	$\{q_4\}$
q_3	$\{q_2\}$	$\emptyset$	$\emptyset$
q_4	$\{q_4\}$	$\emptyset$	$\emptyset$

b) $a^*(b(aa)^*)^*a^*$

Question 2:

$a(a \cup b)^* abb(a \cup b)^* \cup abb(a \cup b)^*$

Question 3:

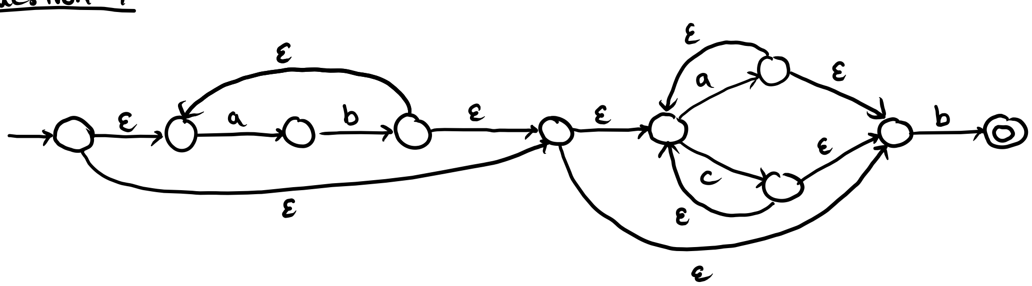
δ_D	a	b
$\emptyset$	$\emptyset$	$\emptyset$
$\{q_0\}$	$\{q_2, q_3\}$	$\{q_1\}$
$\{q_1\}$	$\{q_1, q_3\}$	$\{q_1\}$
$\{q_2\}$	$\emptyset$	$\{q_2, q_3\}$
$\{q_3\}$	$\emptyset$	$\emptyset$
$\{q_0, q_1\}$	$\{q_1, q_2, q_3\}$	$\{q_1\}$
$\{q_0, q_2\}$	$\{q_2, q_3\}$	$\{q_1, q_2, q_3\}$
$\rightarrow \{q_0, q_3\}$	$\{q_2, q_3\}$	$\{q_1\}$
$\{q_1, q_2\}$	$\{q_1, q_3\}$	$\{q_1, q_2, q_3\}$
$\{q_1, q_3\}$	$\{q_1, q_3\}$	$\{q_1\}$
$\{q_2, q_3\}$	$\emptyset$	$\{q_2, q_3\}$
$\{q_0, q_1, q_2\}$	$\{q_1, q_2, q_3\}$	$\{q_1, q_2, q_3\}$
$\{q_0, q_1, q_3\}$	$\{q_1, q_2, q_3\}$	$\{q_1\}$
$\{q_0, q_2, q_3\}$	$\{q_2, q_3\}$	$\{q_1, q_2, q_3\}$
$\{q_1, q_2, q_3\}$	$\{q_1, q_3\}$	$\{q_1, q_2, q_3\}$
$\{q_0, q_1, q_2, q_3\}$	$\{q_1, q_2, q_3\}$	$\{q_1, q_2, q_3\}$

(State diagram not included here)

$D = (P(Q), \{a,b\}, \delta_D, q_D, F_D)$ where

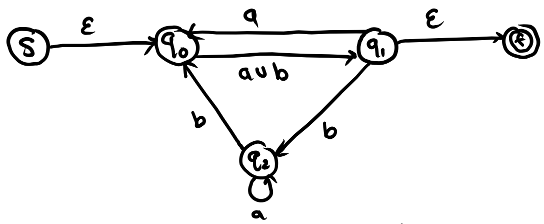
- $Q = \{q_0, q_1, q_2, q_3\}$
- $q_D = \{q_0, q_3\}$
- $F_D = \{\{q_3\}, \{q_0, q_3\}, \{q_1, q_3\}, \{q_2, q_3\}, \{q_0, q_1, q_3\}, \{q_0, q_2, q_3\}, \{q_1, q_2, q_3\}, \{q_0, q_1, q_2, q_3\}\}$

Question 4



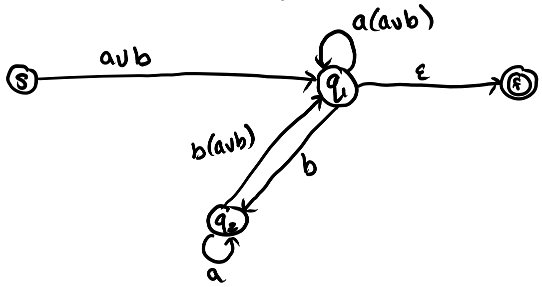
Question 5

GNFA :

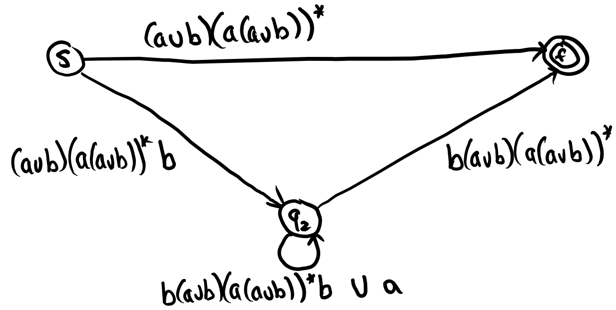


∅ - transitions omitted

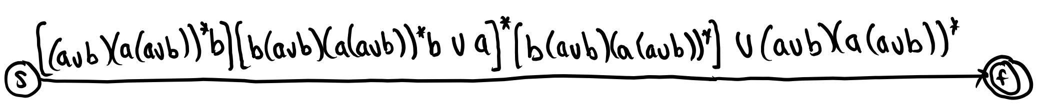
$q_{rip} = q_0$



$q_{rip} = q_1$



$q_{rip} = q_2$



$$R = [(a \cup b)(a(a \cup b))^* b][b(a \cup b)(a(a \cup b))^* b \cup a]^* [b(a \cup b)(a(a \cup b))^*] \cup (a \cup b)(a(a \cup b))^*$$

Question 6:

$\cancel{\{q_0, q_1\}}$ $\cancel{\{q_1, q_2\}}$ $\{q_2, q_3\}$ $\cancel{\{q_3, q_4\}}$

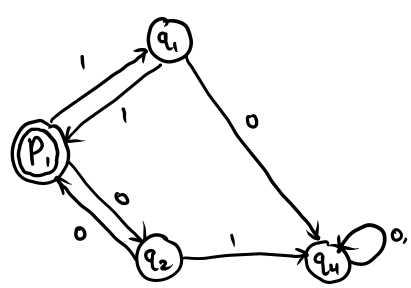
$\cancel{\{q_0, q_2\}}$ $\cancel{\{q_1, q_3\}}$ $\cancel{\{q_2, q_4\}}$

$\{q_0, q_3\}$ $\cancel{\{q_1, q_4\}}$

$\cancel{\{q_0, q_4\}}$

$P_1 : q_0 \sim q_3$

D'



Question 7:

Assume for a contradiction that L is regular. Let p be the pumping length of L.

Choose $s = 0^p 1^{2p}$. Since $s \in L$ and $|s| \geq p$, we can rewrite $s = xyz$ such that

1) $y \neq \varepsilon$
2) $|xy| \leq p$
3) $xy^iz \in L$ for each $i \geq 0$

By property 2), xy consists of only 0's

By property 1), y is a non-empty substring of 0's. Let y be 0^k for some $k \geq 1$

Consider the string xy^2z. $xy^2z = 0^{p+k} 1^{2p}$ since we are concatenating y somewhere in the beginning 0's.

Since $k \geq 1$, xy^2z does not have at least twice as many 1's as 0's, which violates property 3) of the pumping lemma.

We cannot rewrite $s = xyz$ such that all properties of the pumping lemma hold

Therefore, L is not regular.