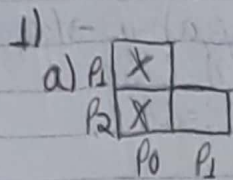
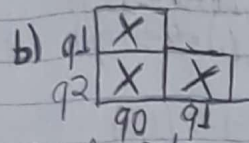
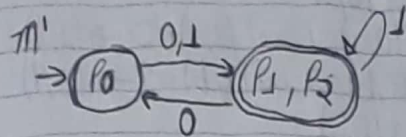


### Atividade 3 LFA



$(p_0, p_1)$

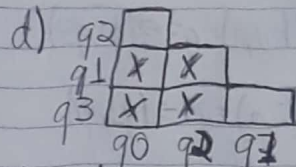
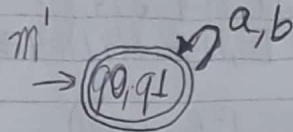
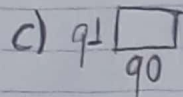
1º par:  $\delta(p_2, 0) = p_0$  e  $\delta(p_2, 1) = p_0 \Rightarrow (p_0, p_0)$   
 $\delta(p_1, 1) = p_1$  e  $\delta(p_1, 1) = p_2 \Rightarrow (p_2, p_1)$



1º par  $(q_0, q_1)$ :

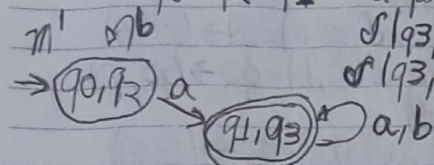
$\delta(q_0, a) = q_2$  e  $\delta(q_1, a) = q_1 \Rightarrow (q_2, q_1)$

O grafo está minimizado



1º par  $(q_0, q_2)$

$\delta(q_0, a) = q_1$  e  $\delta(q_2, a) = q_3 \Rightarrow q_3$   
 $\delta(q_0, b) = q_2$  e  $\delta(q_2, b) = q_2 \Rightarrow (q_2, q_2)$



2)

q2	X		
q1	X	X	
q3	X	X	X
	q0	q2	q1

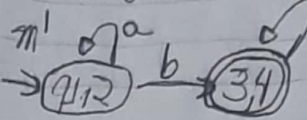
1º par (q0, q2) =  
 $\delta(q0, a) = q0$  e  $\delta(q2, a) = q3 \Rightarrow (q0, q3)$   
 2º par (q1, q3)  
 $\delta(q1, a) = q0$  e  $\delta(q3, a) = q3 \Rightarrow (q0, q3)$

AFD já está minimizado

1)

1	?				
2	?				
3	X	X	X		
4	X	X	X		
	0	1	2	3	a, b

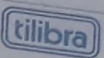
1º par (0, 1)  
 $\delta(0, a) = 1$  e  $\delta(1, a) = 2 \rightarrow (1, 2)$   
 $\delta(0, b) = 3$  e  $\delta(1, b) = 4 \rightarrow (3, 4)$   
 2º par (0, 2)  
 $\delta(0, a) = 1$  e  $\delta(2, a) = 1 \rightarrow (1, 1)$   
 $\delta(0, b) = 3$  e  $\delta(2, b) = 4 \rightarrow (3, 4)$   
 3º par (1, 2)  
 $\delta(1, a) = 2$  e  $\delta(2, a) = 1 \rightarrow (1, 2)$   
 $\delta(1, b) = 4$  e  $\delta(2, b) = 4 \rightarrow (4, 4)$   
 4º par (3, 4)  
 $\delta(3, a) = 4$  e  $\delta(4, a) = 3 \rightarrow (3, 4)$   
 $\delta(3, b) = 3$  e  $\delta(4, b) = 4 \rightarrow (3, 4)$

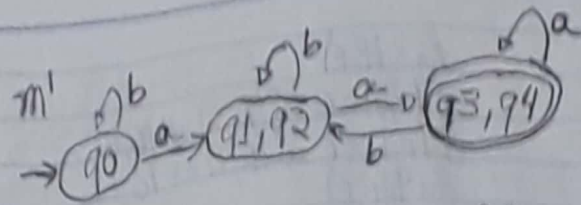


2)

q1	X			
q2	X	?		
q3	X	X	X	
q4	X	X	X	
	q0	q1	q2	q3

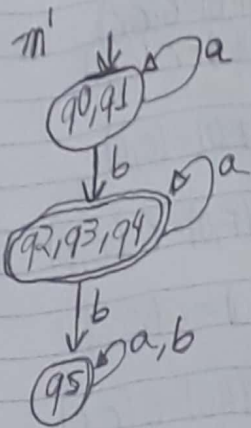
1º par (q0, q1)  
 $\delta(q0, a) = q1$  e  $\delta(q1, a) = q3 \Rightarrow (q1, q3)$   
 2º par (q0, q2)  
 $\delta(q0, a) = q1$  e  $\delta(q2, a) = q4 \Rightarrow (q1, q4)$   
 3º par (q1, q2)  
 $\delta(q1, a) = q3$  e  $\delta(q2, a) = q4 \Rightarrow (q3, q4)$   
 $\delta(q1, b) = q2$  e  $\delta(q2, b) = q2 \Rightarrow (q2, q2)$   
 4º par (q3, q4)  
 $\delta(q3, a) = q3$  e  $\delta(q4, a) = q3 \Rightarrow (q3, q3)$   
 $\delta(q3, b) = q2$  e  $\delta(q4, b) = q2 \Rightarrow (q2, q2)$





1) 

q1	?				
q2	x	x			
q3	x	x	?		
q4	x	x	x	?	
q5	x	x	x	x	x
	q0	q1	q2	q3	q4



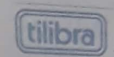
- 1º par (q0, q1)  
 $\delta(q0, a) = q1$  e  $\delta(q1, a) = q0$  (q0, q1)  
 $\delta(q0, b) = q2$  e  $\delta(q1, b) = q3$  (q2, q3)
- 2º par (q0, q5)  
 $\delta(q0, a) = q1$  e  $\delta(q5, a) = q5 \rightarrow (q1, q5)$   
 $\delta(q0, b) = q2$  e  $\delta(q5, b) = q5 \rightarrow (q2, q5)$
- 3º par (q1, q5)  
 $\delta(q1, a) = q0$  e  $\delta(q5, a) = q5 \rightarrow (q0, q5)$   
 $\delta(q1, b) = q3$  e  $\delta(q5, b) = q5 \rightarrow (q3, q5)$
- 4º par (q2, q3)  
 $\delta(q2, a) = q4$  e  $\delta(q3, a) = q4 \rightarrow (q1, q4)$   
 $\delta(q2, b) = q5$  e  $\delta(q3, b) = q5 \rightarrow (q5, q5)$
- 5º par (q2, q4)  
 $\delta(q2, a) = q4$  e  $\delta(q4, a) = q4 \rightarrow (q4, q4)$   
 $\delta(q2, b) = q5$  e  $\delta(q4, b) = q5 \rightarrow (q5, q5)$
- 6º par (q3, q4)  
 $\delta(q3, a) = q4$  e  $\delta(q4, a) = q4$  (q4, q4)  
 $\delta(q3, b) = q5$  e  $\delta(q4, b) = q5$  (q5, q5)

2)

B	X						
C	X	X					
D	X	X	X				
E		X	X	X			
F	X	X	X	X			
G	X	X	X	X	X	X	
H	X		X	X	X	X	X
	A	B	C	D	E	F	G

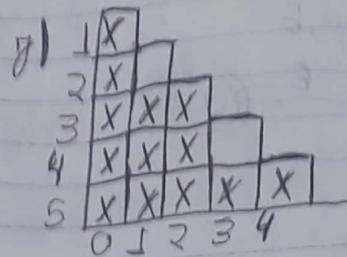
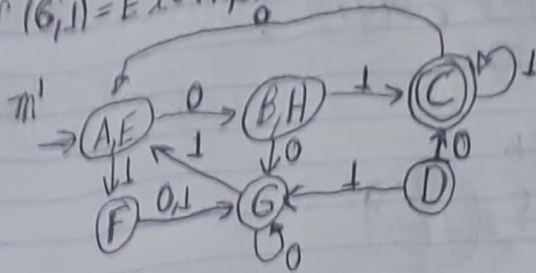
Par 8 (B,E)  
 $\sigma(B,0) = G \times \sigma(E,0) = H(G,H)$   
 $\sigma(B,1) = C \times \sigma(E,1) = F(C,F)$   
 Par 9 (B,F)  
 $\sigma(B,0) = G \times \sigma(F,0) = G(G,G)$   
 $\sigma(B,1) = C \times \sigma(F,1) = G(C,G)$   
 Par 10 (B,G)  
 $\sigma(B,0) = G \times \sigma(G,0) = G(G,G)$   
 $\sigma(B,1) = C \times \sigma(G,1) = E(C,E)$

Par 1 (A,B)  
 $\sigma(A,0) = B \times \sigma(B,0) = G(B,G)$   
 $\sigma(A,1) = F \times \sigma(B,1) = C(F,C)$   
 Par 11 (B,H)  
 $\sigma(B,0) = G \times \sigma(H,0) = G(G,G)$   
 $\sigma(B,1) = C \times \sigma(H,1) = C(C,C)$   
 Par 2 (A,D)  
 $\sigma(A,0) = B \times \sigma(D,0) = C(B,C)$   
 $\sigma(D,0) = C \times \sigma(E,0) = (C,H)$   
 Par 3 (A,E)  
 $\sigma(A,0) = B \times \sigma(E,0) = H(B,H)$   
 $\sigma(A,1) = F \times \sigma(E,1) = F(F,F)$   
 Par 13 (D,F)  
 $\sigma(D,0) = C \times \sigma(F,0) = G(C,G)$   
 Par 4 (A,F)  
 $\sigma(A,0) = B \times \sigma(F,0) = G(B,G)$   
 $\sigma(A,1) = F \times \sigma(F,1) = G(F,G)$   
 Par 14 (D,G)  
 $\sigma(D,0) = G \times \sigma(G,0) = G(C,G)$   
 Par 5 (A,G)  
 $\sigma(A,0) = B \times \sigma(G,0) = G(B,G)$   
 $\sigma(A,1) = F \times \sigma(G,1) = E(F,E)$   
 Par 15 (D,H)  
 $\sigma(D,0) = G \times \sigma(H,0) = G(C,G)$   
 Par 6 (A,H)  
 $\sigma(A,0) = B \times \sigma(H,0) = G(B,G)$   
 $\sigma(A,1) = F \times \sigma(H,1) = C(F,C)$   
 Par 16 (E,F)  
 $\sigma(E,0) = H \times \sigma(F,0) = G(G,H)$   
 $\sigma(E,1) = F \times \sigma(F,1) = G(G,F)$   
 Par 7 (B,D)  
 $\sigma(B,0) = G \times \sigma(D,0) = C(G,C)$   
 $\sigma(E,0) = H \times \sigma(G,0) = G(G,H)$   
 $\sigma(E,1) = F \times \sigma(G,1) = E(F,E)$   
 Par 17 (E,G)  
 $\sigma(E,0) = H \times \sigma(G,0) = G(G,H)$   
 $\sigma(E,1) = F \times \sigma(H,1) = C(F,C)$   
 Par 18 (E,H)  
 $\sigma(E,0) = H \times \sigma(H,0) = G(G,H)$   
 $\sigma(E,1) = F \times \sigma(H,1) = C(F,C)$



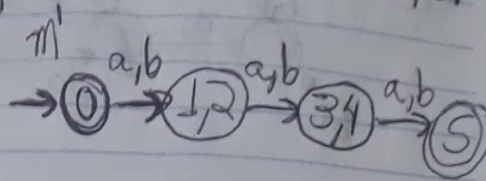


Par 19 (G, F)  
 $\sigma(G, 0) = G \wedge \sigma(F, 0) = G(G, G)$   
 $\sigma(G, 1) = E \wedge \sigma(F, 1) = G(E, G)$   
 Par 20 (F, H)  
 $\sigma(F, 0) = G \wedge \sigma(H, 0) = G(G, G)$   
 $\sigma(F, 1) = G \wedge \sigma(H, 1) = C(H, G)$   
 Par 21 (G, H)  
 $\sigma(G, 0) = G \wedge \sigma(H, 0) = G(G, G)$   
 $\sigma(G, 1) = E \wedge \sigma(H, 1) = C(E, C)$



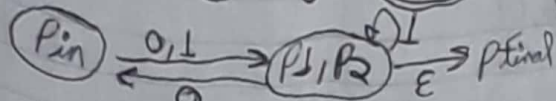
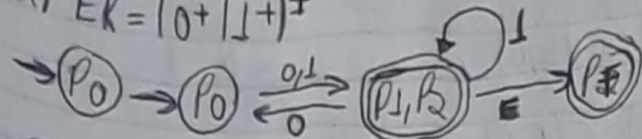
4º Par (2,3)  
 $\sigma(2, a) = 4 \wedge \sigma(3, a) = 5 \Rightarrow (4, 5)$   
 5º Par (2,4)  
 $\sigma(2, a) = 4 \wedge \sigma(4, a) = 5 \Rightarrow (4, 5)$   
 6º Par (3,4)  
 $\sigma(3, a) = 5 \wedge \sigma(4, a) = 5 \Rightarrow (5, 5)$   
 $\sigma(3, b) = 5 \wedge \sigma(4, b) = 5 \Rightarrow (5, 5)$

1º Par (0,1)  
 $\sigma(0, a) = 1 \wedge \sigma(1, 0) = 3 \Rightarrow (1, 3)$   
 2º Par (0,2)  
 $\sigma(0, a) = 1 \wedge \sigma(2, 0) = 4 \Rightarrow (1, 4)$   
 3º Par (1,2)  
 $\sigma(1, 0) = 3 \wedge \sigma(2, a) = 4 \Rightarrow (3, 4)$   
 $\sigma(1, b) = 4 \wedge \sigma(2, b) = 3 \Rightarrow (3, 4)$

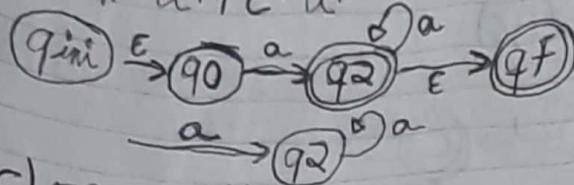


2)

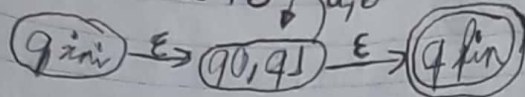
a) ER =  $(0+1)^+$



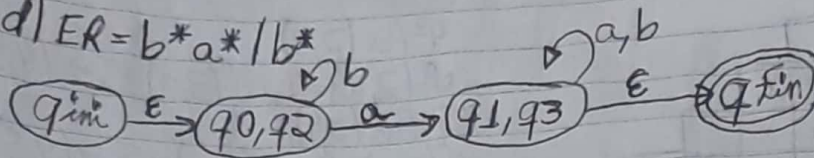
b) ER =  $a^+ | c^+ a^*$



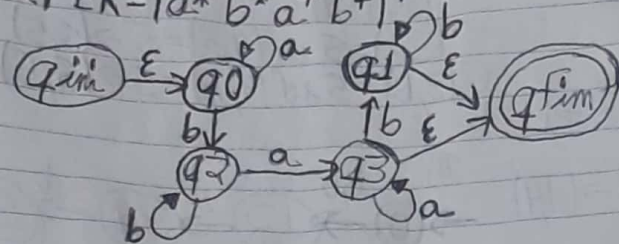
c) ER =  $a^* | b^*$

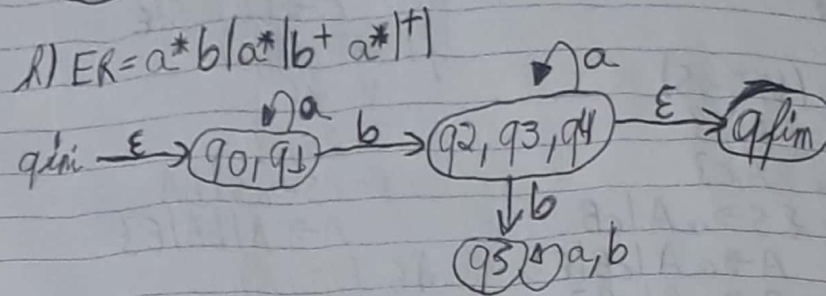
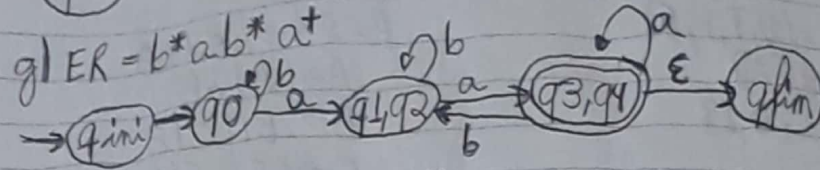
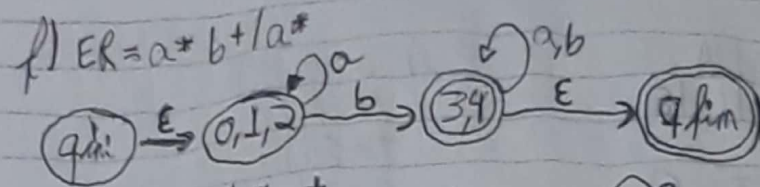


d) ER =  $b^* a^* | b^*$

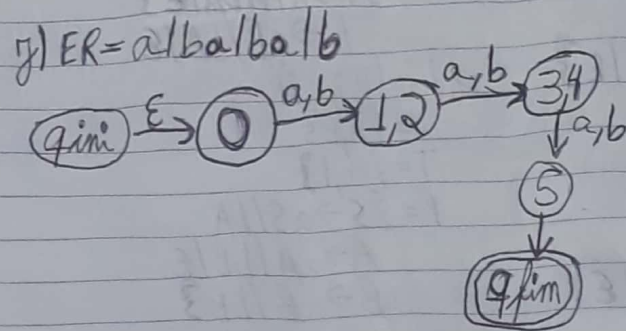


e) ER =  $(a^* b^* a^+ b^+)^+$





i)  $ER = |01^+0|^*|10^+1|^*|00^+1|^*$



3)

$$a) S \rightarrow aA \mid \lambda$$

$$A \rightarrow aA \mid \lambda \mid \epsilon$$

$$G = (V, T, P, S)$$

$$V = \{A\}$$

$$T = \{a, \lambda\}$$

$$P = \{S \rightarrow aA, A \rightarrow aA, A \rightarrow \lambda, A \rightarrow \epsilon\}$$

$$b) G = (V, T, P, S)$$

$$V = \{A, B\}$$

$$T = \{a, c\}$$

$$P = \{S \rightarrow aA \mid cB, A \rightarrow aA \mid cB \mid \epsilon, B \rightarrow aB \mid cB\}$$

$$c) G = (V, T, P, S)$$

$$V = \{S\}$$

$$T = \{a, b\}$$

$$P = \{S \rightarrow aS \mid bS \mid \epsilon\}$$

$$d) G = (V, T, P, S)$$

$$V = \{A\}$$

$$T = \{a, b\}$$

$$P = \{S \rightarrow bS \mid aA, A \rightarrow aA \mid bA \mid \epsilon\}$$

$$e) G = (V, T, P, S)$$

$$V = \{A, B, C\}$$

$$T = \{a, b\}$$

$$P = \{S \rightarrow aS \mid bA, A \rightarrow bA \mid aB, B \rightarrow aB \mid bC \mid \epsilon, C \rightarrow bC \mid aS \mid \epsilon\}$$

$$f) G = (V, T, P, S)$$

$$V = \{A\}$$

$$T = \{a, b\}$$

$$P = \{S \rightarrow aS \mid bA, A \rightarrow aA \mid bA \mid \epsilon\}$$

$$g) G = (V, T, P, S)$$

$$V = \{A, B\}$$

$$T = \{a, b\}$$

$$P = \{S \rightarrow aS \mid bA, A \rightarrow bA \mid aB, B \rightarrow aB \mid bA \mid \epsilon\}$$

$$h) G = (V, T, P, S)$$

$$V = \{A, B\}$$

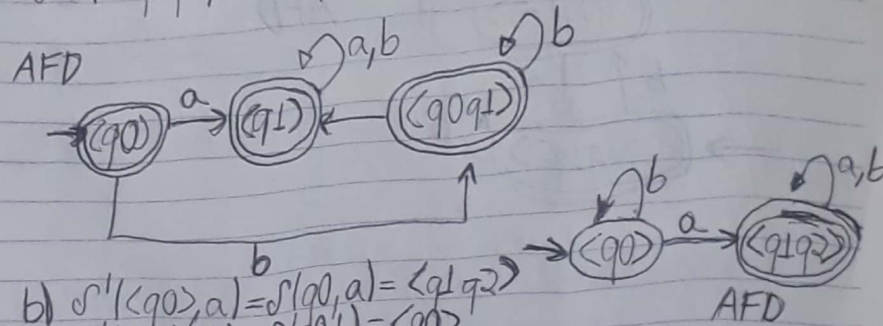
$$T = \{a, b\}$$

$$P = \{S \rightarrow aS \mid bA, A \rightarrow aA \mid bB \mid \epsilon, B \rightarrow aB \mid bB\}$$



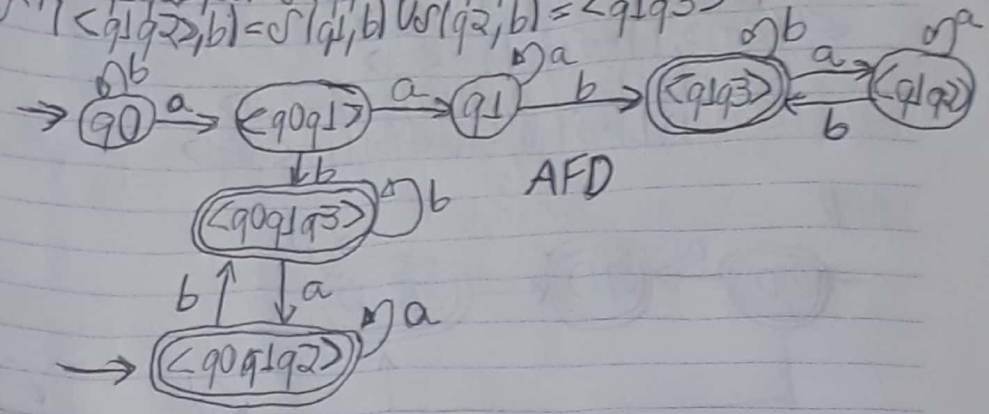
$\lambda) G = (V, T, P, S)$   
 $V = \{A, B, C, D, E\}$   
 $T = \{0, 1\}$   
 $P = \{S \rightarrow 0A \mid 1C$   
 $A \rightarrow 0D \mid 1B$   
 $B \rightarrow 0S \mid 1B \mid E$   
 $C \rightarrow 0D \mid 1D$   
 $d \rightarrow 0D \mid 1S$   
 $E \rightarrow 0B \mid 1D\}$

4) a)  $\sigma^1(\langle q_0 \rangle, a) = \sigma(q_0, a) = \langle q_1 \rangle$   
 $\sigma^1(\langle q_0 \rangle, b) = \sigma(q_0, b) = \langle q_0, q_1 \rangle$   
 $\sigma^1(\langle q_1 \rangle, a) = \sigma(q_1, a) = \langle q_1 \rangle$   
 $\sigma^1(\langle q_1 \rangle, b) = \sigma(q_1, b) = \langle q_1 \rangle$   
 $\sigma^1(\langle q_0, q_1 \rangle, a) = \sigma(q_0, a) \cup \sigma(q_1, a) = \langle q_1 \rangle$   
 $\sigma^1(\langle q_0, q_1 \rangle, b) = \sigma(q_0, b) \cup \sigma(q_1, b) = \langle q_0, q_1 \rangle$

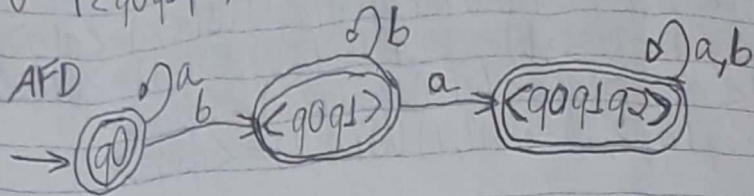


b)  $\sigma^1(\langle q_0 \rangle, a) = \sigma(q_0, a) = \langle q_1, q_2 \rangle$   
 $\sigma^1(\langle q_0 \rangle, b) = \sigma(q_0, b) = \langle q_0 \rangle$   
 $\sigma^1(\langle q_1, q_2 \rangle, a) = \sigma(q_1, a) \cup \sigma(q_2, a) = \langle q_1, q_2 \rangle$   
 $\sigma^1(\langle q_1, q_2 \rangle, b) = \sigma(q_1, b) \cup \sigma(q_2, b) = \langle q_1, q_2 \rangle$

- c)  $\delta^r(\langle q_0, a \rangle) = \delta^r(q_0, a) = \langle q_0 q_1 \rangle$   
 $\delta^r(\langle q_0, b \rangle) = \delta^r(q_0, b) = \langle q_0 \rangle$   
 $\delta^r(\langle q_0 q_1, a \rangle) = \delta^r(q_0, a) \cup \delta^r(q_1, a) = \langle q_1 \rangle$   
 $\delta^r(\langle q_0 q_1, b \rangle) = \delta^r(q_0, b) \cup \delta^r(q_1, b) = \langle q_0 q_1 q_3 \rangle$   
 $\delta^r(\langle q_1, a \rangle) = \delta^r(q_1, a) = \langle q_1 \rangle$   
 $\delta^r(\langle q_1, b \rangle) = \delta^r(q_1, b) = \langle q_1 q_3 \rangle$   
 $\delta^r(\langle q_0 q_1 q_3, a \rangle) = \delta^r(q_0, a) \cup \delta^r(q_1, a) \cup \delta^r(q_3, a) = \langle q_0 q_1 q_2 \rangle$   
 $\delta^r(\langle q_0 q_1 q_3, b \rangle) = \delta^r(q_0, b) \cup \delta^r(q_1, b) \cup \delta^r(q_3, b) = \langle q_0 q_1 q_3 \rangle$   
 $\delta^r(\langle q_1 q_3, a \rangle) = \delta^r(q_1, a) \cup \delta^r(q_3, a) = \langle q_1 q_2 \rangle$   
 $\delta^r(\langle q_1 q_3, b \rangle) = \delta^r(q_1, b) \cup \delta^r(q_3, b) = \langle q_1 q_3 \rangle$   
 $\delta^r(\langle q_0 q_1 q_2, a \rangle) = \delta^r(q_0, a) \cup \delta^r(q_1, a) \cup \delta^r(q_2, a) = \langle q_0 q_1 q_2 \rangle$   
 $\delta^r(\langle q_0 q_1 q_2, b \rangle) = \delta^r(q_0, b) \cup \delta^r(q_1, b) \cup \delta^r(q_2, b) = \langle q_0 q_1 q_3 \rangle$   
 $\delta^r(\langle q_1 q_2, a \rangle) = \delta^r(q_1, a) \cup \delta^r(q_2, a) = \langle q_1 q_2 \rangle$   
 $\delta^r(\langle q_1 q_2, b \rangle) = \delta^r(q_1, b) \cup \delta^r(q_2, b) = \langle q_1 q_3 \rangle$

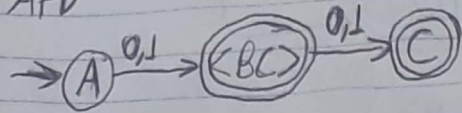


$$\begin{aligned}
 d) \sigma^1(\langle q_0 \rangle, a) &= \sigma^1(q_0, a) = \langle q_0 \rangle \\
 \sigma^1(\langle q_0 \rangle, b) &= \sigma^1(q_0, b) = \langle q_0 q_1 \rangle \\
 \sigma^1(\langle q_0 q_1 \rangle, a) &= \sigma^1(q_0, a) \cup \sigma^1(q_1, a) = \langle q_0 q_1 q_2 \rangle \\
 \sigma^1(\langle q_0 q_1 \rangle, b) &= \sigma^1(q_0, b) \cup \sigma^1(q_1, b) = \langle q_0 q_1 \rangle \\
 \sigma^1(\langle q_0 q_1 q_2 \rangle, a) &= \sigma^1(q_0, a) \cup \sigma^1(q_1, a) \cup \sigma^1(q_2, a) = \langle q_0 q_1 q_2 \rangle \\
 \sigma^1(\langle q_0 q_1 q_2 \rangle, b) &= \sigma^1(q_0, b) \cup \sigma^1(q_1, b) \cup \sigma^1(q_2, b) = \langle q_0 q_1 q_2 \rangle
 \end{aligned}$$

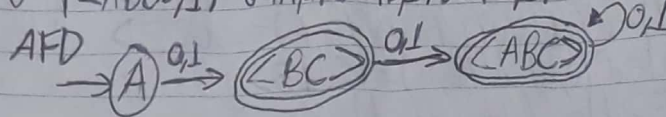


$$\begin{aligned}
 1) \sigma^1(\langle A \rangle, 0) &= \sigma^1(A, 0) = \langle BC \rangle \\
 \sigma^1(\langle A \rangle, 1) &= \sigma^1(A, 1) = \langle BC \rangle \\
 \sigma^1(\langle BC \rangle, 0) &= \sigma^1(B, 0) \cup \sigma^1(C, 0) = \langle C \rangle \\
 \sigma^1(\langle BC \rangle, 1) &= \sigma^1(B, 1) \cup \sigma^1(C, 1) = \langle C \rangle
 \end{aligned}$$

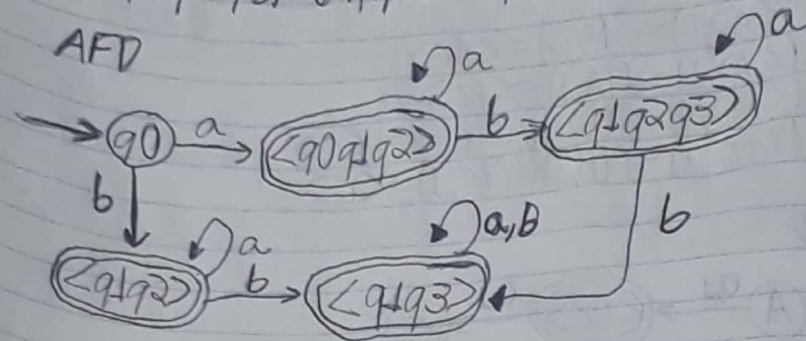
AFD



$$\begin{aligned}
 2) \sigma^1(\langle A \rangle, 0) &= \sigma^1(A, 0) = \langle BC \rangle \\
 \sigma^1(\langle A \rangle, 1) &= \sigma^1(A, 1) = \langle BC \rangle \\
 \sigma^1(\langle BC \rangle, 0) &= \sigma^1(B, 0) \cup \sigma^1(C, 0) = \langle ABC \rangle \\
 \sigma^1(\langle BC \rangle, 1) &= \sigma^1(B, 1) \cup \sigma^1(C, 1) = \langle ABC \rangle \\
 \sigma^1(\langle ABC \rangle, 0) &= \sigma^1(A, 0) \cup \sigma^1(B, 0) \cup \sigma^1(C, 0) = \langle A, B, C \rangle \\
 \sigma^1(\langle ABC \rangle, 1) &= \sigma^1(A, 1) \cup \sigma^1(B, 1) \cup \sigma^1(C, 1) = \langle ABC \rangle
 \end{aligned}$$



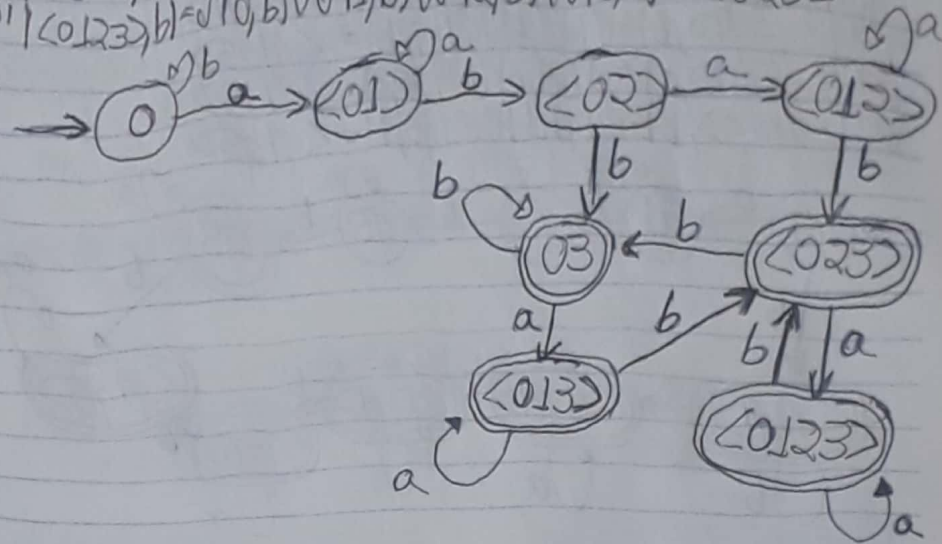
$$\begin{aligned}
 g) \sigma^1(\langle q_0 \rangle, a) &= \sigma(q_0, a) = \langle q_0 q_1 q_2 \rangle \\
 \sigma^1(\langle q_0 \rangle, b) &= \sigma(q_0, b) = \langle q_1 q_2 \rangle \\
 \sigma^1(\langle q_0 q_1 q_2 \rangle, a) &= \sigma(q_2, a) \cup \sigma(q_1, a) \cup \sigma(q_0, a) = \langle q_0 q_1 q_2 \rangle \\
 \sigma^1(\langle q_0 q_1 q_2 \rangle, b) &= \sigma(q_2, b) \cup \sigma(q_1, b) \cup \sigma(q_0, b) = \langle q_1 q_2 q_3 \rangle \\
 \sigma^1(\langle q_1 q_2 \rangle, a) &= \sigma(q_2, a) \cup \sigma(q_1, a) = \langle q_1 q_2 \rangle \\
 \sigma^1(\langle q_1 q_2 \rangle, b) &= \sigma(q_2, b) \cup \sigma(q_1, b) = \langle q_1 q_3 \rangle \\
 \sigma^1(\langle q_1 q_2 q_3 \rangle, a) &= \sigma(q_3, a) \cup \sigma(q_2, a) \cup \sigma(q_1, a) = \langle q_1 q_2 q_3 \rangle \\
 \sigma^1(\langle q_1 q_2 q_3 \rangle, b) &= \sigma(q_3, b) \cup \sigma(q_2, b) \cup \sigma(q_1, b) = \langle q_1 q_3 \rangle \\
 \sigma^1(\langle q_1 q_3 \rangle, a) &= \sigma(q_3, a) \cup \sigma(q_1, a) = \langle q_1 q_3 \rangle \\
 \sigma^1(\langle q_1 q_3 \rangle, b) &= \sigma(q_3, b) \cup \sigma(q_1, b) = \langle q_1 q_3 \rangle
 \end{aligned}$$



$$\begin{aligned}
 a) \sigma^1(\langle 0 \rangle, a) &= \sigma(0, a) = \langle 01 \rangle \\
 \sigma^1(\langle 0 \rangle, b) &= \sigma(0, b) = \langle 0 \rangle \\
 \sigma^1(\langle 01 \rangle, a) &= \sigma(1, a) \cup \sigma(0, a) = \langle 01 \rangle \\
 \sigma^1(\langle 01 \rangle, b) &= \sigma(1, b) \cup \sigma(0, b) = \langle 02 \rangle \\
 \sigma^1(\langle 02 \rangle, a) &= \sigma(2, a) \cup \sigma(0, a) \cup \sigma(1, a) = \langle 012 \rangle \\
 \sigma^1(\langle 02 \rangle, b) &= \sigma(2, b) \cup \sigma(0, b) \cup \sigma(1, b) = \langle 03 \rangle \\
 \sigma^1(\langle 012 \rangle, a) &= \sigma(2, a) \cup \sigma(1, a) \cup \sigma(0, a) = \langle 012 \rangle \\
 \sigma^1(\langle 012 \rangle, b) &= \sigma(2, b) \cup \sigma(1, b) \cup \sigma(0, b) = \langle 023 \rangle \\
 \sigma^1(\langle 03 \rangle, a) &= \sigma(3, a) \cup \sigma(0, a) \cup \sigma(1, a) = \langle 013 \rangle \\
 \sigma^1(\langle 03 \rangle, b) &= \sigma(3, b) \cup \sigma(0, b) \cup \sigma(1, b) = \langle 03 \rangle
 \end{aligned}$$

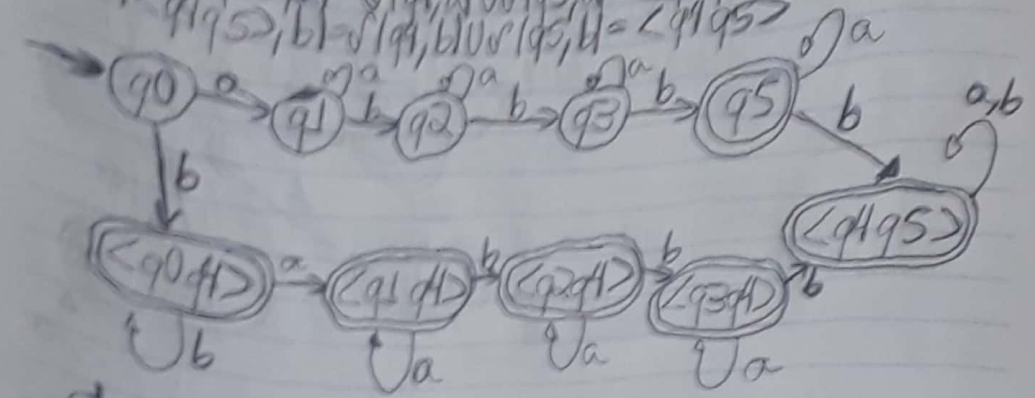


$$\begin{aligned} \delta^1(\langle 023 \rangle, a) &= \delta^1(0, a) \cup \delta^1(2, a) \cup \delta^1(3, a) = \langle 0123 \rangle \\ \delta^1(\langle 023 \rangle, b) &= \delta^1(0, b) \cup \delta^1(2, b) \cup \delta^1(3, b) = \langle 03 \rangle \\ \delta^1(\langle 013 \rangle, a) &= \delta^1(0, a) \cup \delta^1(1, a) \cup \delta^1(3, a) = \langle 013 \rangle \\ \delta^1(\langle 013 \rangle, b) &= \delta^1(0, b) \cup \delta^1(1, b) \cup \delta^1(3, b) = \langle 023 \rangle \\ \delta^1(\langle 0123 \rangle, a) &= \delta^1(0, a) \cup \delta^1(1, a) \cup \delta^1(2, a) \cup \delta^1(3, a) = \langle 0123 \rangle \\ \delta^1(\langle 0123 \rangle, b) &= \delta^1(0, b) \cup \delta^1(1, b) \cup \delta^1(2, b) \cup \delta^1(3, b) = \langle 023 \rangle \end{aligned}$$



$$\begin{aligned} i) \delta^1(\langle q0 \rangle, a) &= \delta^1(q0, a) = \langle q1 \rangle \\ \delta^1(\langle q0 \rangle, b) &= \delta^1(q0, b) = \langle q0q4 \rangle \\ \delta^1(\langle q1 \rangle, a) &= \delta^1(q1, a) = \langle q1 \rangle \\ \delta^1(\langle q1 \rangle, b) &= \delta^1(q1, b) = \langle q2 \rangle \\ \delta^1(\langle q0q4 \rangle, a) &= \delta^1(q0, a) \cup \delta^1(q4, a) = \langle q1q4 \rangle \\ \delta^1(\langle q0q4 \rangle, b) &= \delta^1(q0, b) \cup \delta^1(q4, b) = \langle q0q4 \rangle \\ \delta^1(\langle q2 \rangle, a) &= \delta^1(q2, a) = \langle q2 \rangle \\ \delta^1(\langle q2 \rangle, b) &= \delta^1(q2, b) = \langle q3 \rangle \\ \delta^1(\langle q3 \rangle, a) &= \delta^1(q3, a) = \langle q3 \rangle \\ \delta^1(\langle q3 \rangle, b) &= \delta^1(q3, b) = \langle q5 \rangle \\ \delta^1(\langle q5 \rangle, a) &= \delta^1(q5, a) = \langle q5 \rangle \end{aligned}$$

$\delta^*(q_0, b) = \delta(q_0, b) = \langle q_0 q_0 \rangle$   
 $\delta^*(q_1, a) = \delta(q_1, a) \cup \delta^*(q_0, a) = \langle q_1 q_1 \rangle$   
 $\delta^*(q_1, b) = \delta(q_1, b) \cup \delta^*(q_0, b) = \langle q_2 q_1 \rangle$   
 $\delta^*(q_2, a) = \delta(q_2, a) \cup \delta^*(q_1, a) = \langle q_2 q_2 \rangle$   
 $\delta^*(q_2, b) = \delta(q_2, b) \cup \delta^*(q_1, b) = \langle q_3 q_2 \rangle$   
 $\delta^*(q_3, a) = \delta(q_3, a) \cup \delta^*(q_2, a) = \langle q_3 q_3 \rangle$   
 $\delta^*(q_3, b) = \delta(q_3, b) \cup \delta^*(q_2, b) = \langle q_4 q_3 \rangle$   
 $\delta^*(q_4, a) = \delta(q_4, a) \cup \delta^*(q_3, a) = \langle q_4 q_4 \rangle$   
 $\delta^*(q_4, b) = \delta(q_4, b) \cup \delta^*(q_3, b) = \langle q_5 q_4 \rangle$



$$\delta^*(p, a) = F \cup \delta^*(p, a) \cup \delta^*(q, a)$$

$$= \{p\} \cup \{q\} \cup \emptyset$$

$$= \{p, q\}$$

$$F \cup \{q\} = \{q\} \cup \delta^*(q, a)$$

$$= \{q\} \cup \emptyset$$

$$\delta^*(p, a) = F \cup \delta^*(p, a) \cup \delta^*(q, a)$$

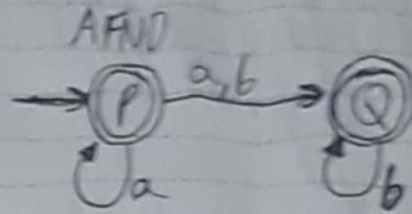
$$F \cup \{p\} = F \cup \{p\} = \{p, q\}$$

$$\delta^*(p, b) = F \cup \delta^*(p, b) \cup \delta^*(q, b)$$

$$F \cup \emptyset = F \cup \{q\} = \{q\}$$



$$\begin{aligned} \delta^*(Q, a) &= F \cup \delta^*(Q, a) \\ F \cup \delta^*(Q, a) &= F \cup \delta^*(Q, a) \\ \delta^*(Q, a) &= F \cup \delta^*(Q, a) \\ F \cup \delta^*(Q, a) &= F \cup \delta^*(Q, a) \end{aligned}$$

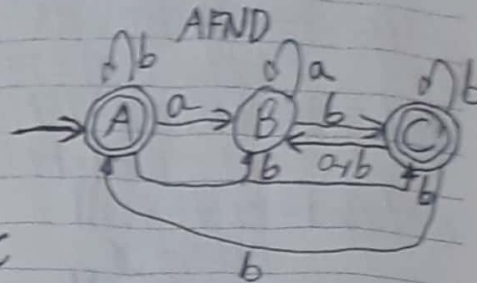


$$\begin{aligned} F(A) &= \{A\} \cup \delta^*(A, \epsilon) \cup \delta^*(\delta^*(A, \epsilon), \epsilon) \\ &= \{A\} \cup \{B\} \cup \emptyset \\ &= \{A, B\} \end{aligned}$$

$$\begin{aligned} F(B) &= \{B\} \cup \emptyset \\ &= \{B\} \end{aligned}$$

$$\begin{aligned} F(C) &= \{C\} \cup \delta^*(C, \epsilon) \cup \delta^*(\delta^*(C, \epsilon), \epsilon) \\ &= \{C\} \cup \{A\} \cup \{B\} \\ &= \{A, B, C\} \end{aligned}$$

$$\begin{aligned} \delta^*(A, a) &= F \cup \delta^*(A, a) \cup \delta^*(B, a) \\ F \cup \delta^*(A, a) \cup \delta^*(B, a) &= F \cup \delta^*(A, a) \cup \delta^*(B, a) \\ \delta^*(A, b) &= F \cup \delta^*(A, b) \cup \delta^*(B, b) \\ F \cup \delta^*(A, b) \cup \delta^*(B, b) &= F \cup \delta^*(A, b) \cup \delta^*(B, b) \end{aligned}$$



$$\delta^*(B, a) = B$$

$$\delta^*(B, b) = C$$

$$\begin{aligned} \delta^*(C, a) &= F \cup \delta^*(A, a) \cup \delta^*(B, a) \cup \delta^*(C, a) \\ F \cup \delta^*(A, a) \cup \delta^*(B, a) \cup \delta^*(C, a) &= F \cup \delta^*(A, a) \cup \delta^*(B, a) \cup \delta^*(C, a) \end{aligned}$$

$$\begin{aligned} \delta^*(C, b) &= F \cup \delta^*(A, b) \cup \delta^*(B, b) \cup \delta^*(C, b) \\ F \cup \delta^*(A, b) \cup \delta^*(B, b) \cup \delta^*(C, b) &= F \cup \delta^*(A, b) \cup \delta^*(B, b) \cup \delta^*(C, b) \end{aligned}$$

$$\begin{aligned}
 C) F_E(q_1) &= \{q_1\} \cup \{q_1, a\} \cup \dots \\
 &= \{q_1\} \cup q_2 \cup q_3 \cup q_4 \\
 &= \{q_1, q_2, q_3, q_4\}
 \end{aligned}$$

$$\begin{aligned}
 F_E(q_2) &= \{q_2, q_3, q_4\} \\
 F_E(q_3) &= \{q_3, q_4\} \\
 F_E(q_4) &= \{q_4\}
 \end{aligned}$$

$$\begin{aligned}
 \sigma^1(q_1, a) &= F_E(\delta(q_1, a) \cup \delta(q_2, a) \cup \delta(q_3, a) \cup \delta(q_4, a)) \\
 &= F_E(\{q_1, q_2, q_3\}) = \{q_1, q_2, q_3, q_4\}
 \end{aligned}$$

$$\begin{aligned}
 \sigma^1(q_1, b) &= F_E(\delta(q_1, b) \cup \delta(q_2, b) \cup \delta(q_3, b) \cup \delta(q_4, b)) \\
 &= F_E(\{q_2, q_3, q_4\}) = \{q_2, q_3, q_4\}
 \end{aligned}$$

$$\begin{aligned}
 \sigma^1(q_2, a) &= F_E(\delta(q_2, a) \cup \delta(q_3, a) \cup \delta(q_4, a)) \\
 &= F_E(\{q_2, q_3\}) = \{q_2, q_3, q_4\}
 \end{aligned}$$

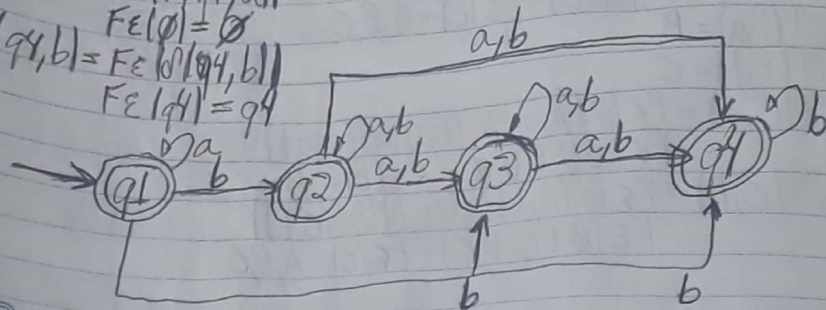
$$\begin{aligned}
 \sigma^1(q_2, b) &= F_E(\delta(q_2, b) \cup \delta(q_3, b) \cup \delta(q_4, b)) \\
 &= F_E(\{q_3, q_4\}) = \{q_3, q_4\}
 \end{aligned}$$

$$\begin{aligned}
 \sigma^1(q_3, a) &= F_E(\delta(q_3, a) \cup \delta(q_4, a)) \\
 &= F_E(\{q_3\}) = \{q_3, q_4\}
 \end{aligned}$$

$$\begin{aligned}
 \sigma^1(q_3, b) &= F_E(\delta(q_3, b) \cup \delta(q_4, b)) \\
 &= F_E(\{q_4\}) = \{q_4\}
 \end{aligned}$$

$$\begin{aligned}
 \sigma^1(q_4, a) &= F_E(\delta(q_4, a)) \\
 &= F_E(\emptyset) = \emptyset
 \end{aligned}$$

$$\begin{aligned}
 \sigma^1(q_4, b) &= F_E(\delta(q_4, b)) \\
 &= F_E(\{q_4\}) = \{q_4\}
 \end{aligned}$$





$$d) FE(q_0) = \{q_0\} \cup \delta(q_0, \epsilon) \\ = \{q_0\} \cup \{q_1\} = \{q_0, q_1\}$$

$$FE(q_1) = \{q_1\}$$

$$FE(q_2) = \{q_2\} \cup \delta(q_2, \epsilon) \\ = \{q_2\} \cup \{q_3\} = \{q_2, q_3\}$$

$$FE(q_3) = \{q_3\}$$

$$\delta''(q_0, a) = FE(\delta(q_0, a) \cup \delta(q_1, a)) \\ FE(q_0 \cup q_1) = FE(q_0, q_1) = q_0, q_1$$

$$\delta''(q_0, b) = FE(\delta(q_0, b) \cup \delta(q_1, b)) \\ FE(q_0 \cup q_1) = FE(q_0, q_1) = q_0, q_1$$

$$\delta''(q_1, a) = q_1$$

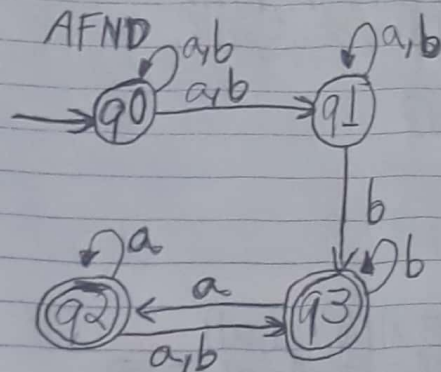
$$\delta''(q_1, b) = q_1, q_3$$

$$\delta''(q_2, a) = FE(\delta(q_2, a) \cup \delta(q_3, a)) \\ FE(q_2 \cup q_3) = FE(q_2) = q_2, q_3$$

$$\delta''(q_2, b) = FE(\delta(q_2, b) \cup \delta(q_3, b)) \\ FE(\emptyset \cup q_3) = FE(q_3) = q_3$$

$$\delta''(q_3, a) = q_2$$

$$\delta''(q_3, b) = q_3$$



$$2) F_{\epsilon}(X) = \{X\} \cup \{X, \epsilon\} \cup \{X, \epsilon, \epsilon\} \dots$$

$$= \{X\} \cup \{A\} \cup \{B\} = X, A, B$$

$$F_{\epsilon}(A) = \{A, B\}$$

$$F_{\epsilon}(B) = \{B\}$$

$$\sigma^1(X, A) = F_{\epsilon}(\sigma(X, a) \cup \sigma(A, a) \cup \sigma(B, a))$$

$$F_{\epsilon}(B \cup \emptyset \cup \emptyset) = F_{\epsilon}(B) = B$$

$$\sigma^1(X, b) = F_{\epsilon}(\sigma(X, b) \cup \sigma(A, b) \cup \sigma(B, b))$$

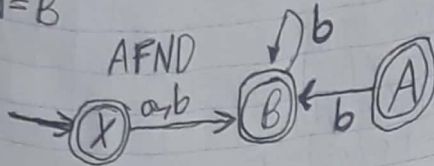
$$F_{\epsilon}(\emptyset \cup \emptyset \cup B) = F_{\epsilon}(B) = B$$

$$\sigma^1(A, a) = F_{\epsilon}(\sigma(A, a) \cup \sigma(B, a) \cup \sigma(\emptyset, a)) = F_{\epsilon}(B \cup \emptyset) = B$$

$$\sigma^1(A, b) = F_{\epsilon}(\sigma(A, b) \cup \sigma(B, b) \cup \sigma(\emptyset, b)) = F_{\epsilon}(B \cup \emptyset) = B$$

$$\sigma^1(B, a) = \emptyset$$

$$\sigma^1(B, b) = B$$



$$6) F_{\epsilon}(q_0) = \{q_0\}$$

$$F_{\epsilon}(q_1) = \{q_1\}$$

$$F_{\epsilon}(q_2) = \{q_2\} \cup \{q_2, \epsilon\} \cup \{q_2, \epsilon, \epsilon\} \dots$$

$$\{q_2\} \cup \{q_3\} \cup \{q_1\} = \{q_2, q_3, q_1\}$$

$$F_{\epsilon}(q_3) = \{q_3\} \cup \{q_3, \epsilon\}$$

$$\{q_3\} \cup \{q_1\} = \{q_3, q_1\}$$

$$\sigma^1(q_0, a) = \{q_0, q_1, q_2\}$$

$$\sigma^1(q_0, b) = \{q_1, q_2\}$$

$$\sigma^1(q_1, a) = \{q_1\}$$

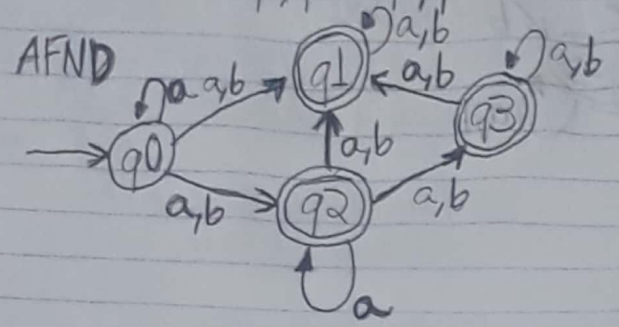
$$\sigma^1(q_1, b) = \{q_1\}$$

$$\sigma^1(q_2, a) = F_{\epsilon}(\sigma(q_2, a) \cup \sigma(q_3, a) \cup \sigma(q_1, a))$$

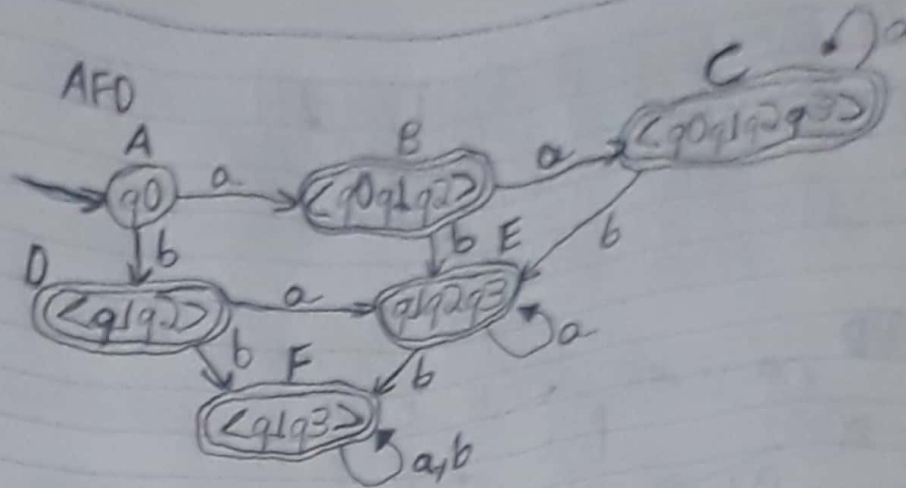
$$F_{\epsilon}(q_2 \cup q_3 \cup q_1) = F_{\epsilon}(q_2, q_3, q_1) = \{q_1, q_2, q_3\}$$



$$\begin{aligned} \delta^*(q_2, b) &= FE \delta^*(q_2, b) \cup \delta^*(q_3, b) \cup \delta^*(q_1, b) \\ &= FE \emptyset \cup \delta^*(q_3, b) \cup \delta^*(q_1, b) = FE \delta^*(q_3, q_1) = \{q_1, q_3\} \\ \delta^*(q_3, a) &= FE \delta^*(q_3, a) \cup \delta^*(q_1, a) \\ &= FE \delta^*(q_3, q_1) = \{q_1, q_3\} \\ \delta^*(q_3, b) &= FE \delta^*(q_3, b) \cup \delta^*(q_1, b) \\ &= FE \delta^*(q_3, q_1) = \{q_1, q_3\} \end{aligned}$$



$$\begin{aligned} \delta^*(\langle q_0 \rangle, a) &= \delta^*(q_0, a) = \langle q_0 q_1 q_2 \rangle \\ \delta^*(\langle q_0 \rangle, b) &= \delta^*(q_0, b) = \langle q_1 q_2 \rangle \\ \delta^*(\langle q_0 q_1 q_2 \rangle, a) &= \delta^*(q_0, a) \cup \delta^*(q_1, a) \cup \delta^*(q_2, a) = \langle q_0 q_1 q_2 q_3 \rangle \\ \delta^*(\langle q_0 q_1 q_2 \rangle, b) &= \delta^*(q_0, b) \cup \delta^*(q_1, b) \cup \delta^*(q_2, b) = \langle q_1 q_2 q_3 \rangle \\ \delta^*(\langle q_1 q_2 \rangle, a) &= \delta^*(q_1, a) \cup \delta^*(q_2, a) = \langle q_1 q_2 q_3 \rangle \\ \delta^*(\langle q_1 q_2 \rangle, b) &= \delta^*(q_1, b) \cup \delta^*(q_2, b) = \langle q_1 q_3 \rangle \\ \delta^*(\langle q_0 q_1 q_2 q_3 \rangle, a) &= \delta^*(q_0, a) \cup \delta^*(q_1, a) \cup \delta^*(q_2, a) \cup \delta^*(q_3, a) = \langle q_0 q_1 q_2 q_3 \rangle \\ \delta^*(\langle q_0 q_1 q_2 q_3 \rangle, b) &= \delta^*(q_0, b) \cup \delta^*(q_1, b) \cup \delta^*(q_2, b) \cup \delta^*(q_3, b) = \langle q_1 q_2 q_3 \rangle \\ \delta^*(\langle q_1 q_2 q_3 \rangle, a) &= \delta^*(q_1, a) \cup \delta^*(q_2, a) \cup \delta^*(q_3, a) = \langle q_1 q_2 q_3 \rangle \\ \delta^*(\langle q_1 q_2 q_3 \rangle, b) &= \delta^*(q_1, b) \cup \delta^*(q_2, b) \cup \delta^*(q_3, b) = \langle q_1 q_3 \rangle \\ \delta^*(\langle q_1 q_3 \rangle, a) &= \delta^*(q_1, a) \cup \delta^*(q_3, a) = \langle q_1 q_3 \rangle \\ \delta^*(\langle q_1 q_3 \rangle, b) &= \delta^*(q_1, b) \cup \delta^*(q_3, b) = \langle q_1 q_3 \rangle \end{aligned}$$



B	X				
C	X				
D	X				
E	X				
F	X				
A	B	C	D	E	

1º Par (B, D)  
 $\delta(B, a) = C$  e  $\delta(D, a) = E \rightarrow (C, E)$   
 $\delta(B, b) = E$  e  $\delta(D, b) = F \rightarrow (E, F)$

2º Par (B, E)  
 $\delta(B, a) = C$  e  $\delta(E, a) = E \rightarrow (C, E)$   
 $\delta(B, b) = E$  e  $\delta(E, b) = F \rightarrow (E, F)$

3º Par (B, F)  
 $\delta(B, a) = C$  e  $\delta(F, a) = F \rightarrow (C, F)$   
 $\delta(B, b) = E$  e  $\delta(F, b) = F \rightarrow (E, F)$



5º par (C, D)

$$\delta(C, a) = C \wedge \delta(D, a) = E \rightarrow (C, E)$$

$$\delta(C, b) = F \wedge \delta(D, b) = F \rightarrow (E, F)$$

6º par (C, E)

$$\delta(C, a) = C \wedge \delta(E, a) = E \rightarrow (C, E)$$

$$\delta(C, b) = E \wedge \delta(E, b) = F \rightarrow (E, F)$$

7º par (C, F)

$$\delta(C, a) = C \wedge \delta(F, a) = F \rightarrow (C, F)$$

$$\delta(C, b) = E \wedge \delta(F, b) = F \rightarrow (E, F)$$

8º par (D, E)

$$\delta(D, a) = E \wedge \delta(E, a) = E \rightarrow (E, E)$$

$$\delta(D, b) = F \wedge \delta(E, b) = F \rightarrow (F, F)$$

9º par (D, F)

$$\delta(D, a) = E \wedge \delta(F, a) = F \rightarrow (E, F)$$

$$\delta(D, b) = F \wedge \delta(F, b) = F \rightarrow (F, F)$$

10º par (E, F)

$$\delta(E, a) = E \wedge \delta(F, a) = F \rightarrow (E, F)$$

$$\delta(E, b) = F \wedge \delta(F, b) = F \rightarrow (F, F)$$

m'

