

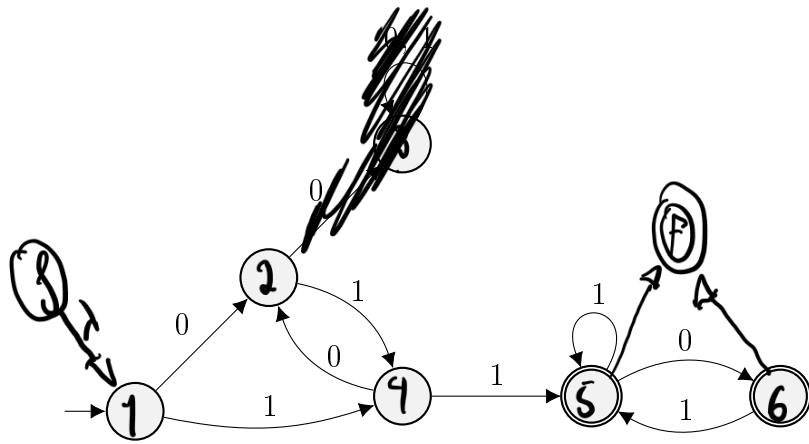


Fundamentos Tóricos da Computação

Lista de Exercícios N.01 (Valor: 1,0 ponto)

Entrega: Quarta-feira, 10 de setembro de 2025 às 23:59

1. Considere o seguinte autômato finito determinístico (AFD) sobre o alfabeto $\Sigma = \{0, 1\}$.



Forneça uma sentença que descreva a linguagem reconhecida por esse AFD. Escreva uma expressão regular (ER) para essa linguagem.

2. Considere as seguintes linguagens sobre o alfabeto $\Sigma = \{0, 1\}$.

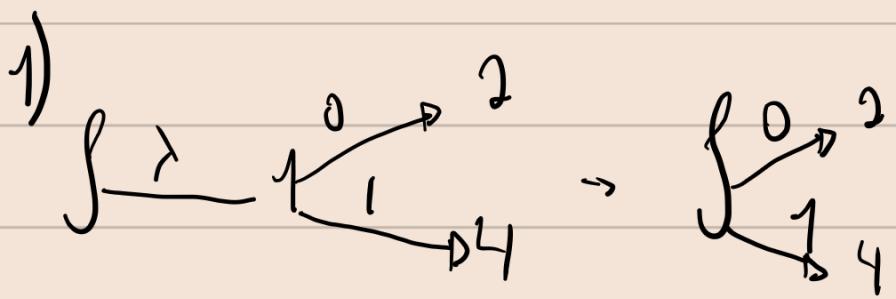
- L_1 : Todas as sentenças que contêm pelo menos dois 0s
- L_2 : Todas as sentenças que contêm pelo menos um 1
- L_3 : Todas as sentenças que contêm pelo menos dois 0s e pelo menos um 1
- L_4 : Todas as sentenças que contêm no máximo um 0 ou nenhum 1s

Forneça AFDs para cada uma das linguagens L_1 , L_2 , L_3 e L_4 .

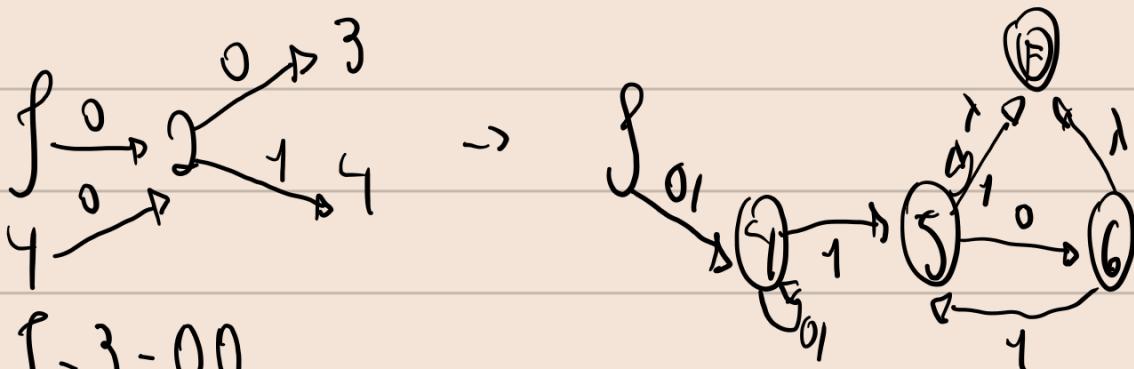
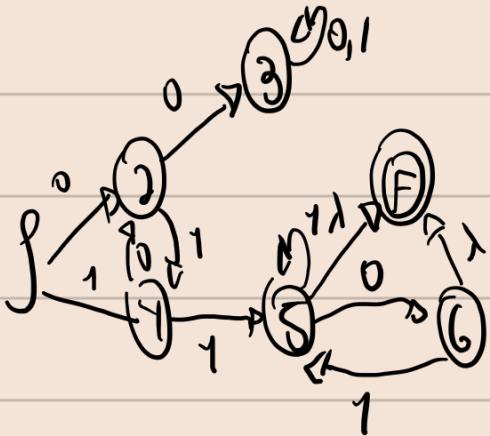
3. Seja E_3 a linguagem sobre o alfabeto $\Sigma = \{a_1, a_2, a_3\}$ definida da seguinte forma.

E_3 : Todas as sentenças nas quais a_i ocorre um número par de vezes para algum $i \in \{1, 2, 3\}$

Forneça um autômato finito não-determinístico (AFN) para a linguagem E_3 .



$\int -2 \cdot 0$
 $\int -1 \cdot 1$

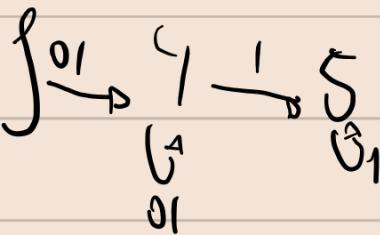


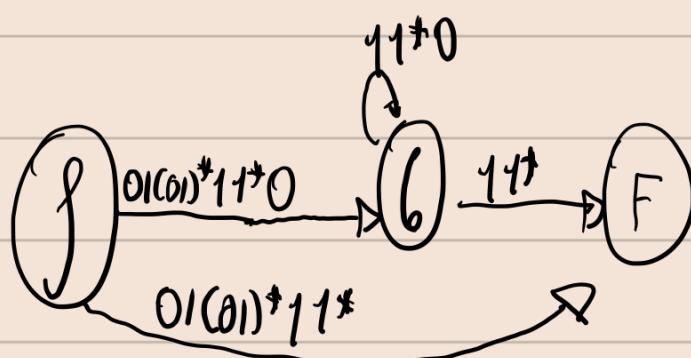
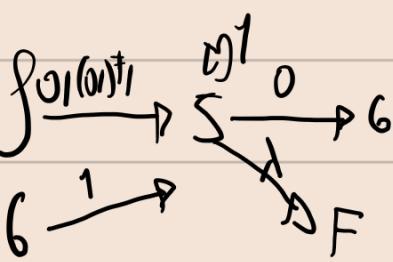
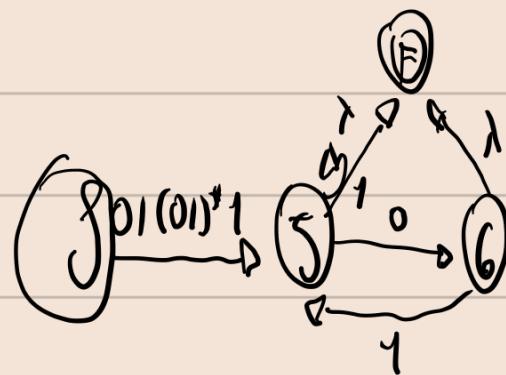
$\int -3 \cdot 00$

$\int -4 \cdot 01$

$\int -3 \cdot 00$

$\int -4 \cdot 01$



$$\int -5 \ 01(01)^* 1$$


$$\int -6 \ 01(01)^* 11^* 0$$

$$\int -F \ 01(01)^* 11^*$$

$$\int -6 \ 11^* 0$$

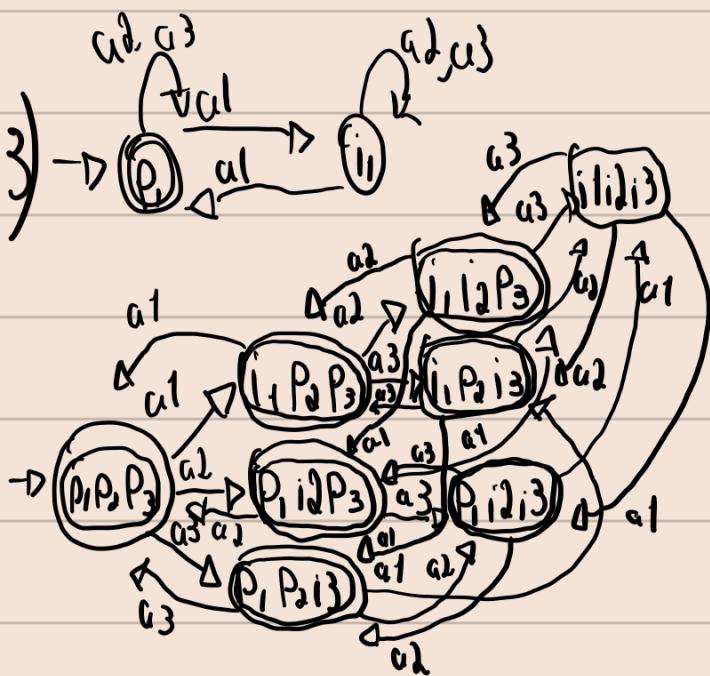
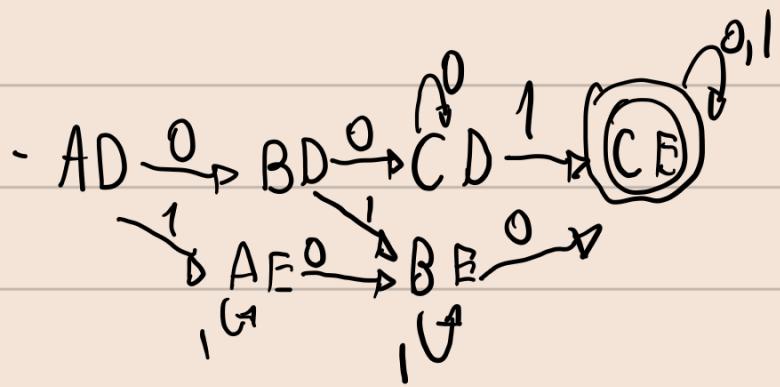
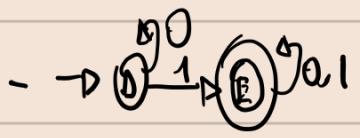
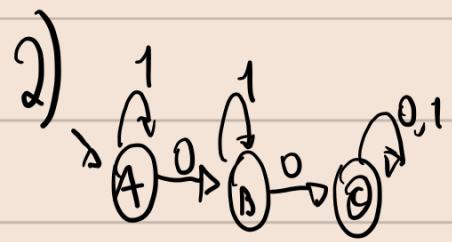
$$\int -F \ 11^*$$

$$11^* 0$$

$$\int \rightarrow 6 \rightarrow F$$

$$\int -F \left\{ (01(01)^* 11^* 0)(11^* 0)(11^*(\lambda)) \right\} \cup (01(01)^* 11^*)$$

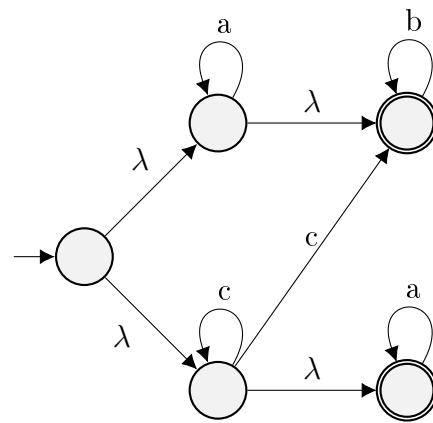
$$\int \underline{\left\{ (01(01)^* 11^* 0)(11^* 0)(11^*(\lambda)) \right\}} \cup (01(01)^* 11^*)$$

4. Forneça ER e gramáticas regulares (GR) para as seguintes linguagens sobre o alfabeto $\Sigma = \{0,1\}$:

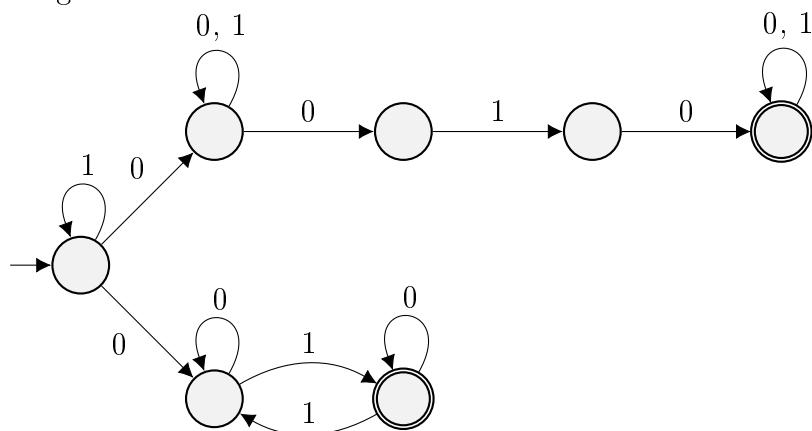
- (a) Todas as sentenças que contêm pelo menos um 0 e pelo menos um 1 e que também terminam com pelo menos dois 1s.
- (b) Todas as sentenças que não iniciam com 01.
- (c) Todas as sentenças que contêm um número ímpar de 1s.

5. Obtenha uma GR que gere a linguagem reconhecida pelo seguinte AFD:



6. Forneça um AFD e GR para cada uma das seguintes linguagens sobre o alfabeto $\Sigma = \{0,1\}$.

- (a) A linguagem do seguinte AFN:



- (b) A linguagem dada pela expressão regular $(0 + 01)^*1^*$.

7. Seja $L_5 = \{0^{n^2} \mid n \geq 0\}$ e $L_6 = \{0\}^k \{0\}^*$, em que k é uma constante. Responda para cada uma das seguintes linguagens se ela é ou não regular, justificando sua resposta com uma prova.

4) $(0 \cup 1)^* 0 (0 \cup 1)^* 1 (0 \cup 1)^* 1 1$

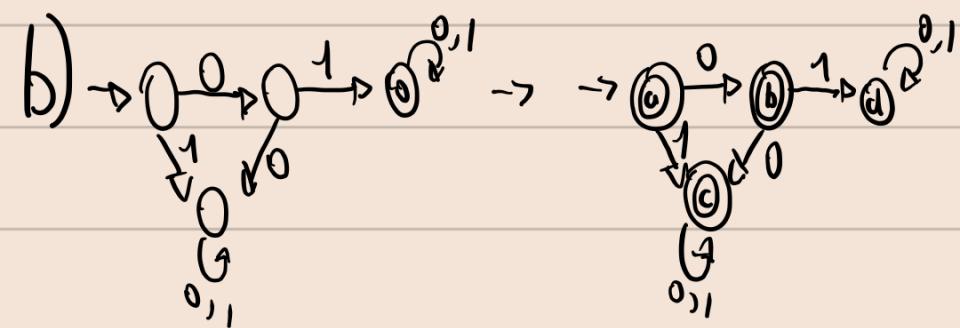
6: A → OA | 1A | OB

B → 0B|1B|1C

C → OCl1C1D

D → 1 E

$E \rightarrow X$

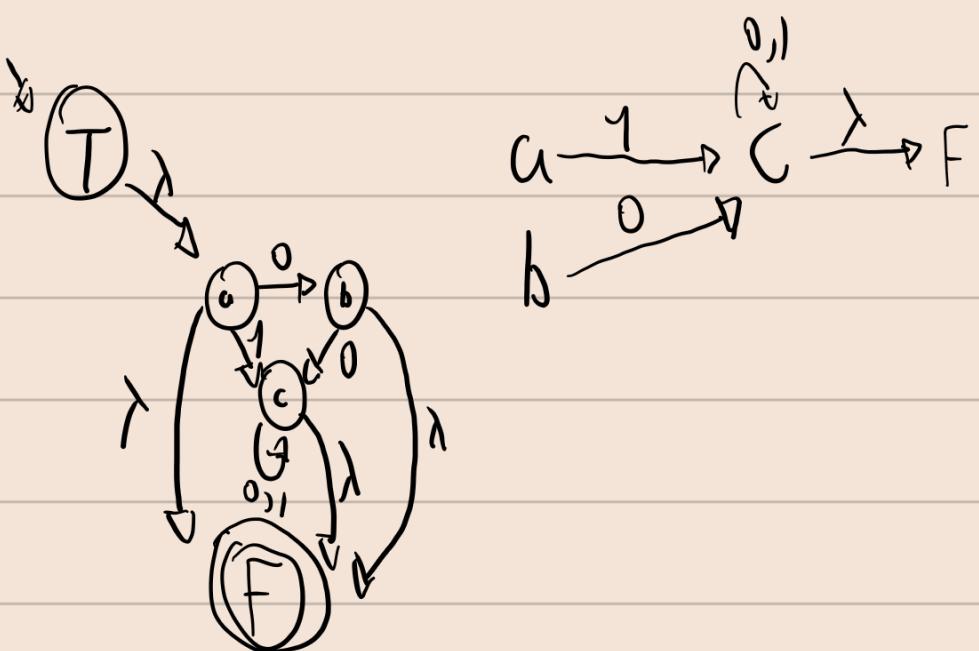


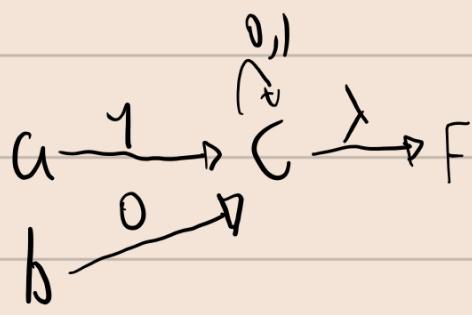
$G : A \rightarrow OB | 1c | \lambda$

$$B \rightarrow D^+ \bar{D}^- \pi^+ \pi^-$$

(→ OCH₂Cl)

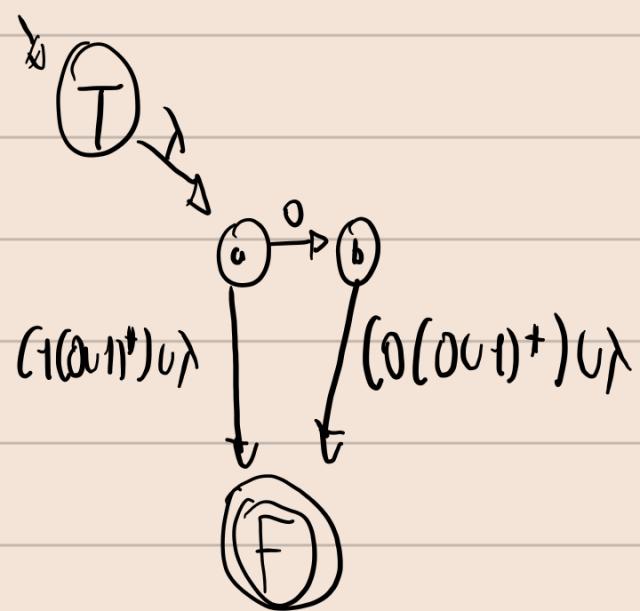
D → OD | 1D



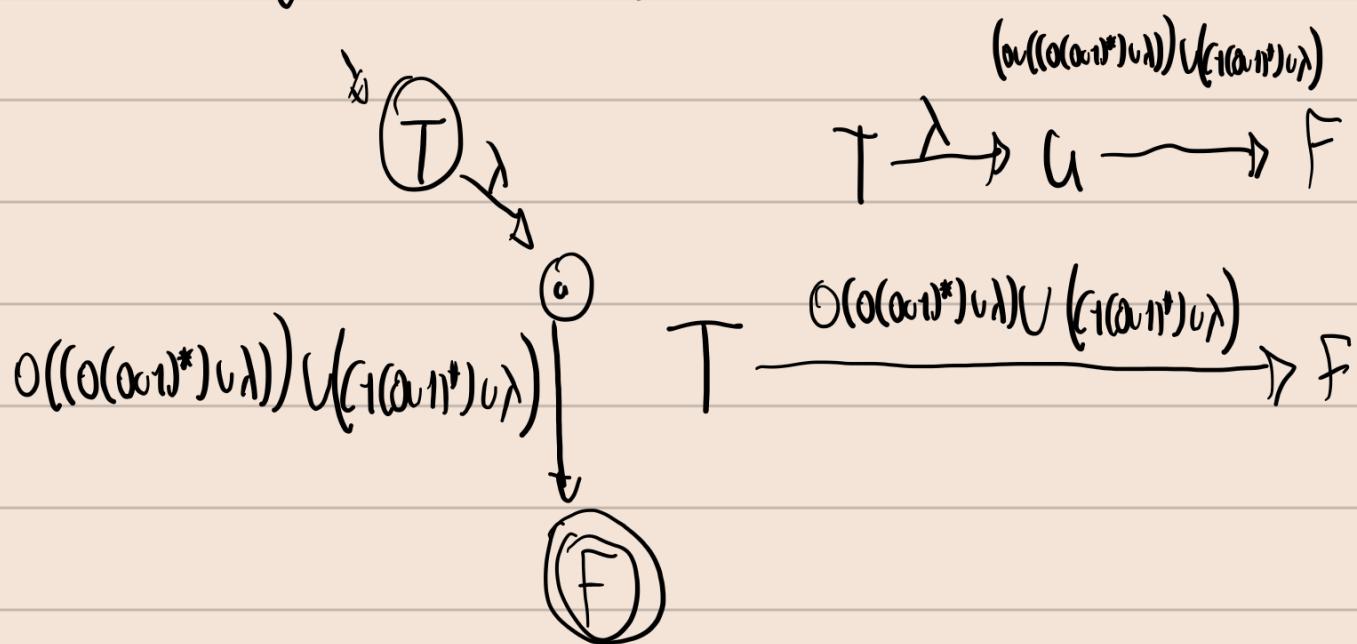


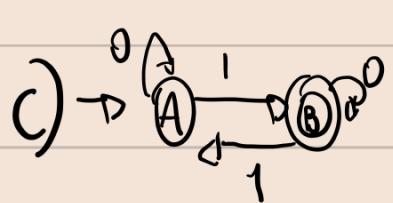
$$a \rightarrow F = (\Gamma(0\cup 1)^*)$$

$$b \rightarrow F = (\emptyset(0\cup 1)^*)$$



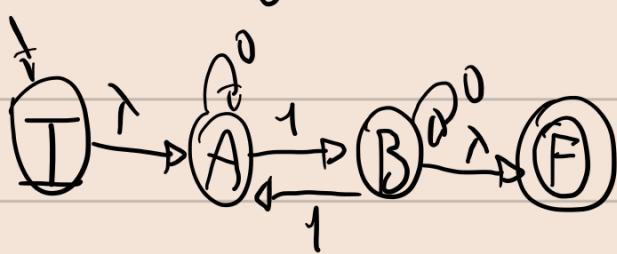
$$a \rightarrow F = \emptyset((\emptyset(0\cup 1)^*) \cup \lambda)$$





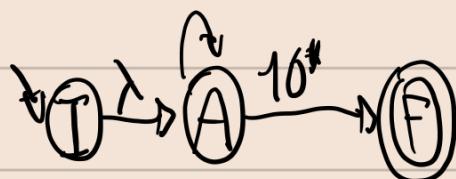
$G: A \rightarrow 0A \mid 1B$

$B \rightarrow 0B \mid 1A \mid \lambda$



$A \xrightarrow{1} B \xrightarrow{0} F$
 $\quad\quad\quad \downarrow \quad\quad\quad \uparrow$
 $\quad\quad\quad F \xrightarrow{1} A$

$(10^*1) \cup 0$



$A \rightarrow F = 10^*$

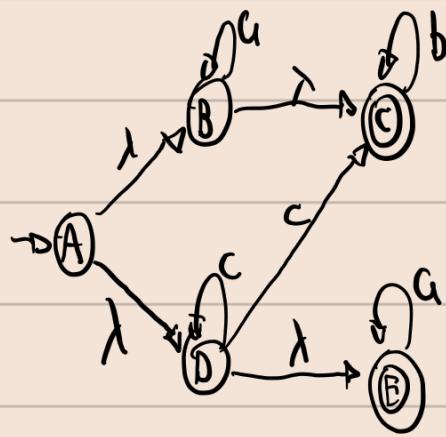
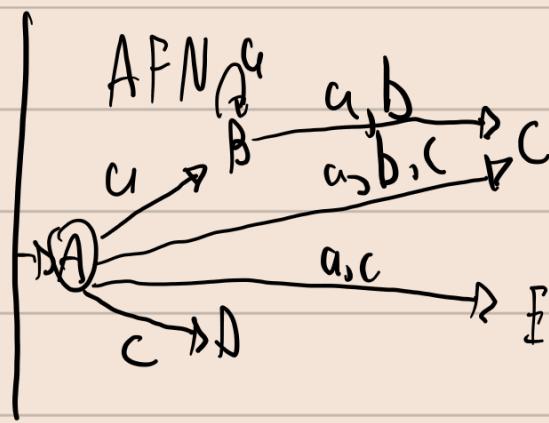
$A \rightarrow A = 10^*1$

$(10^*1) \cup 0$

$I \xrightarrow{0} A \xrightarrow{10^*} F$

$I \rightarrow F = ((10^*1) \cup 0)^* 10^*$

5)

AFN- λ 

$$F\lambda(A) = \{A, B, C, D, E\}, F\lambda(B) = \{B, C\}, F\lambda(D) = \{D, E\}, \\ F\lambda(C) = \{C\}, F\lambda(E) = \{E\}$$

$$\dot{\lambda}(A, a) = \bigcup_{r \in \{A, B, C, D, E\}} F\lambda(\lambda(r, a)) = F\lambda(\emptyset) \cup F\lambda(B) \cup F\lambda(C) \cup F\lambda(D) \cup F\lambda(E) \\ Q \cup \{B, C\} \cup Q \cup Q \cup \{E\} = \{B, C, E\}$$

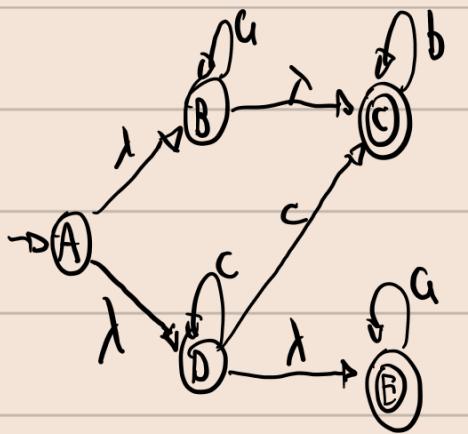
$$\dot{\lambda}(A, b) = \bigcup_{r \in \{A, B, C, D, E\}} F\lambda(\lambda(r, b)) = F\lambda(\emptyset) \cup \dots \cup F\lambda(C) = \{C\}$$

$$\dot{\lambda}(A, c) = \bigcup_{r \in \{A, B, C, D, E\}} F\lambda(\lambda(r, c)) = F\lambda(D, C) = \{D, E, C\}$$

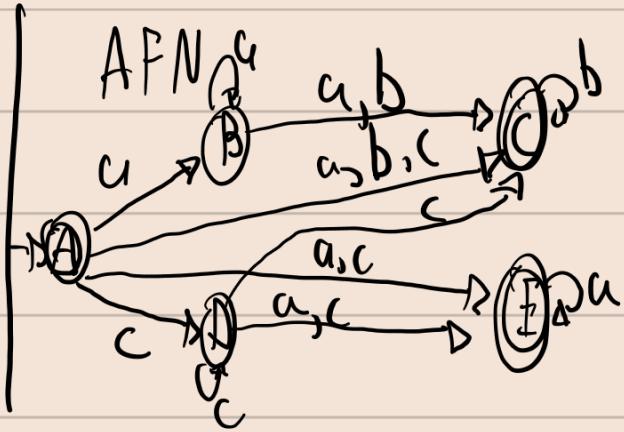
$$\dot{\lambda}(B, a) = \bigcup_{r \in \{B, C\}} F\lambda(\lambda(r, a)) = F\lambda(B) = \{B, C\}$$

$$\dot{\lambda}(B, b) = \bigcup_{r \in \{B, C\}} F\lambda(\lambda(r, b)) = F\lambda(C) = \{C\}$$

$$\dot{\lambda}(B, c) = \bigcup_{r \in \{B, C\}} F\lambda(\lambda(r, c)) = F\lambda(\emptyset) = \emptyset$$



AFN- λ



$$\delta(D, a) = \bigcup_{r \in \{D, E\}} \delta(r, a) = F\lambda(E) = \{E\}$$

$$\delta(D, b) = \bigcup_{r \in \{D, E\}} \delta(r, b) = F\lambda(D) = D$$

$$\delta(D, c) = \bigcup_{r \in \{D, E\}} \delta(r, c) = F\lambda(D, c) \rightarrow$$

$$\delta(E, a) = \bigcup_{r \in \{E\}} \delta(r, a) = F\lambda(E) = E$$

$$G: A \rightarrow aB \mid aC \mid bC \mid cC \mid aE \mid cE \mid cD \mid \lambda$$

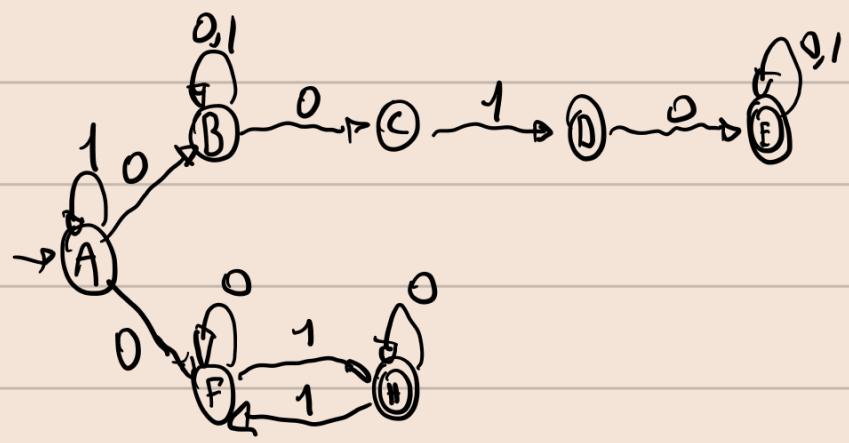
$$B \rightarrow aB \mid aC \mid bC$$

$$C \rightarrow bC \mid \lambda$$

$$D \rightarrow cD \mid aE \mid cB \mid cC$$

$$E \rightarrow aE \mid \lambda$$

6)



$G : A \rightarrow 1A | 0B | 0F$

$B \rightarrow 0B | 1B | 0C$

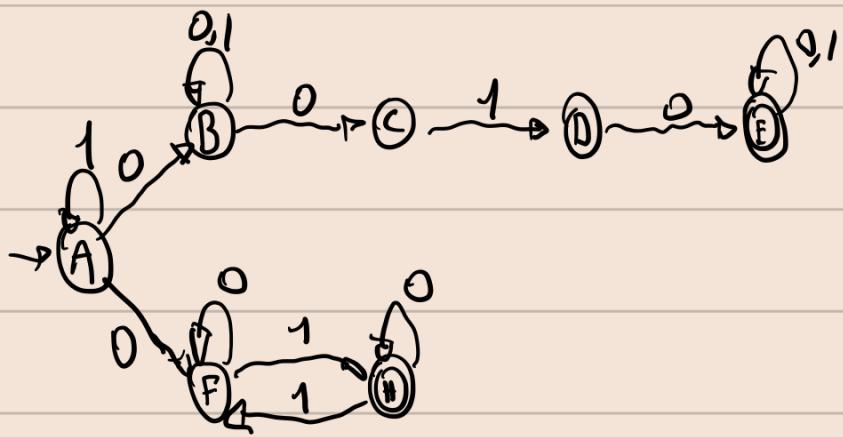
$C \rightarrow 1D$

$D \rightarrow 0E$

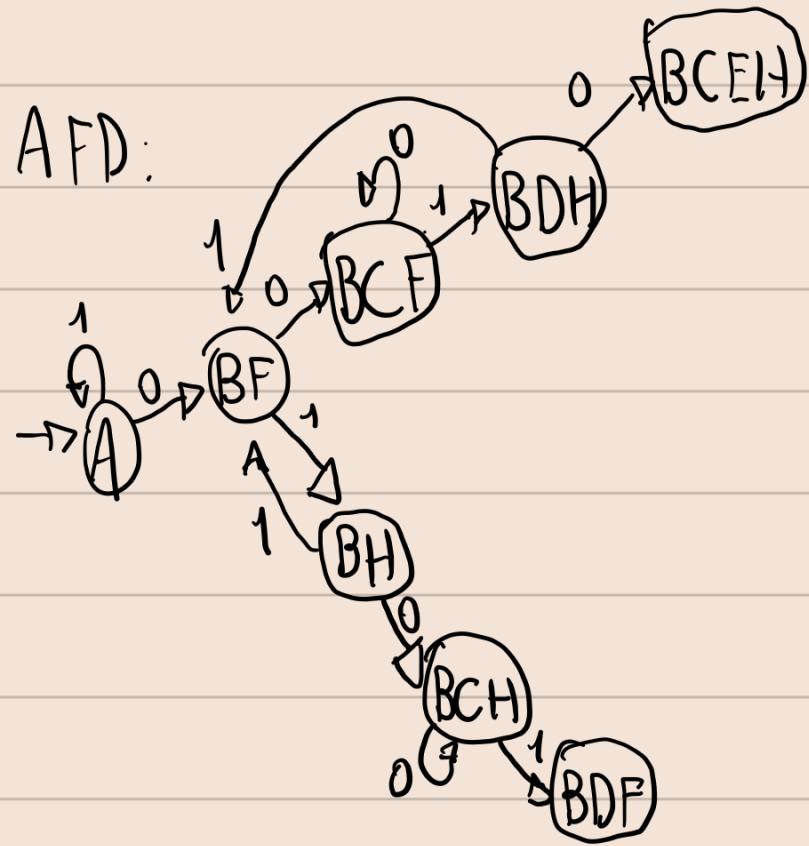
$E \rightarrow 0E | 1E | \lambda$

$F \rightarrow 0F | 1H$

$H \rightarrow 0H | 1F | \lambda$



AFD:



- (a) $L_5 - L_6$
- (b) $L_5 \cap L_6$
- (c) $L_5 \cup L_6$

8. Prove para cada uma das seguintes linguagens se ela é ou não regular.

- (a) $C_n = \{x \mid x \text{ representa um número binário múltiplo de } n\}$, para todo $n \geq 1$
- (b) $L_k = (\{0\}^k \{00, 01, 10, 11\}^* \{1\}^k) \cap \{0^n 1^n \mid n \geq 0\}$, para todo $k \geq 1000$