a) $G = (\{S, A\}, \{0, 1\}, \{A \to AA0 \mid 1 \mid \varepsilon, S \to A1 \mid 1A\}, S)$

b) $G = (\{S, A\}, \{0, 1\}, \{S \to A1A1A1A, A \to 0A \mid 1A \mid \varepsilon\}, S)$

c) $G = (\{S, A\}, \{a, b\}, \{S \to AAS \mid \varepsilon, A \to b \mid a\}, S)$

d) $G = (\{S, A\}, \{a, b\}, \{S \to aA \mid bA, A \to aS \mid bS \mid \varepsilon\}, S)$

e) $G = (\{S, A\}, \{a, b\}, \{S \to bSb \mid A, A \to aA \mid \varepsilon\}, S)$

f) $G = (\{S, A, C\}, \{a, b, c\}, \{S \to AC, A \to abb \mid aAbb, C \to cC \mid c\}, S)$

g) $G = (\{S, A, B\}, \{a, b\}, \{S \to AB \mid \varepsilon, A \to aAb \mid \varepsilon, B \to bBa \mid \varepsilon\}, S)$

2 a) $L = \{w \mid w$ é a palavra $abbb\}$ sobre o alfabeto $\Sigma = \{a, b\}$

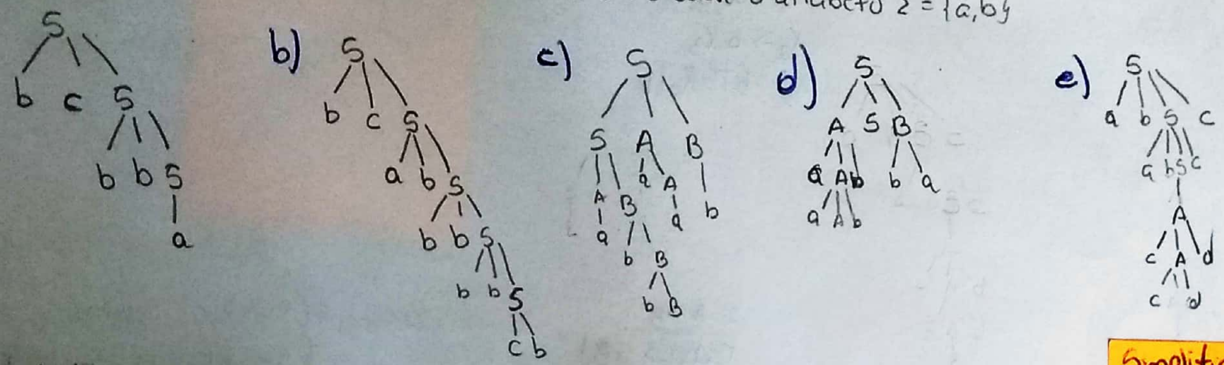
b) $L = \{a^{2n} b^m \mid n, m \geq 0\}$ sobre o alfabeto $\Sigma = \{a, b\}$

c) $L = \{(ab)^n (cd)^m (ba)^m (dc)^n \mid n, m \geq 0\}$ sobre o alfabeto $\Sigma = \{a, b, c, d\}$

d) $L = \{a^n b^{2m} \mid n > 0, m \geq 0\}$ sobre o alfabeto $\Sigma = \{a, b\}$

e) $L = \{w \mid w$ contém o mesmo número de a e b$\}$ sobre o alfabeto $\Sigma = \{a, b\}$

3 a) b) c) d) e)



4 a) $S \to AB \mid SCB$
$A \to aA \mid C$
$B \to bB \mid b$
$C \to cC \mid \varepsilon$

1º $A \to \varepsilon$:
$V_\varepsilon = \{C, A, S\}$
$S \to AB \mid SCB \mid B$
$A \to aA \mid C \mid a$
$B \to bB \mid b$
$C \to cC \mid c$

2º $A \to B$:
Fecho-S = $\{B\}$
Fecho-A = $\{C\}$
Fecho-B = $\varnothing$
Fecho-C = $\varnothing$
$S \to AB \mid SCB \mid SB \mid bB \mid b$
$A \to aA \mid cC \mid a \mid c$
$B \to bB \mid b$
$C \to cC \mid c$

3º Geradores e Atingíveis:
Geradores = $\{S, A, B, C\}$
Geradores = Atingíveis
$P_{Simpl} = \{S \to AB \mid SCB \mid SB \mid bB \mid b,$
$A \to aA \mid cC \mid a \mid c,$
$B \to bB \mid b,$
$C \to cC \mid c\}$

$G_{Simpl} = (\{S, A, B, C\}, \{a, b, c\}, P_{Simpl}, S)$

Simplificação:
Remoção: $A \to \varepsilon$
$A \to B$
Geradores e Atingíveis

FNC: ① Simplificar ✓

FNC: ① Simplificar
② ≥ 2
③ ≥ 3

② ≥ 2
$S \to AB \mid SCB \mid SB \mid T_bB \mid b$
$A \to T_aA \mid T_cC \mid a \mid c$
$B \to T_bB \mid b$
$C \to T_cC \mid c$
$T_a \to a$
$T_b \to b$
$T_c \to c$

③ ≥ 3
$S \to AB \mid SV_1 \mid SB \mid T_bB \mid b$
$A \to T_aA \mid T_cC \mid a \mid c$
$B \to T_bB \mid b$
$C \to T_cC \mid c$
$T_a \to a$
$T_b \to b$
$T_c \to c$
$V_1 \to CB$

$G_{FNC} = (\{S, A, B, C, T_a, T_b, T_c, V_1\}, \{a, b, c\},$
$\{T_a \to a, T_b \to b, T_c \to c, V_1 \to CB, C \to T_cC \mid c,$
$B \to T_bB \mid b, A \to T_aA \mid T_cC \mid a \mid c,$
$S \to AB \mid SV_1 \mid SB \mid T_bB \mid b\}, S)$

③ X_1 ① → menor

④ Renomear
$S = X_1 \to X_2X_3 \mid X_1X_4X_3 \mid X_1X_3 \mid bX_3 \mid b$
$A = X_2 \to aX_2 \mid cX_4 \mid a \mid c$
$B = X_3 \to bX_3 \mid b$
$C = X_4 \to cX_4 \mid c$

③ $A_r \to A_s$ $r \leq s$ OK

④ $X_1 \to X_2X_3 \mid bX_3 \mid b \mid X_2X_3R_1 \mid bX_3R_1 \mid bR_1$
$R_1 \to X_4X_3 \mid X_3 \mid X_4X_3R_1 \mid X_3R_1$
$X_2 \to aX_2 \mid cX_4 \mid a \mid c$
$X_3 \to bX_3 \mid b$
$X_4 \to cX_4 \mid c$

③ $X_1 \to$ menor
④ copiar

5 e 6

$P_{FNG} = \{X_1 \to aX_2X_3 \mid cX_4X_3 \mid aX_3 \mid cX_3 \mid bX_3 \mid b \mid aX_2X_3R_1 \mid cX_4X_3R_1 \mid aX_3R_1 \mid cX_3R_1 \mid bX_3R_1 \mid bR_1,$
$X_2 \to aX_2 \mid cX_4 \mid a \mid c,$
$X_3 \to bX_3 \mid b,$
$X_4 \to cX_4 \mid c,$
$R_1 \to cX_4X_3 \mid cX_3 \mid bX_3 \mid b \mid cX_4X_3R_1 \mid cX_3R_1 \mid bX_3R_1 \mid bR_1\}$

$G_{FNG} = (\{X_1, X_2, X_3, X_4, R_1\}, \{a, b, c\}, P_{FNG}, S)$

Lista A2
Versão final

(b) 1º $A \to \varepsilon$ OK

2º $A \to B$:

Fecho_S = $\emptyset$
Fecho_A = {C}
Fecho_B = $\emptyset$

$S \to AB \mid \varepsilon SB$
$A \to aB \mid$
$B \to bbB \mid b$

$G_{Simpl} = (\{S, A, B\}, \{a, b\}, \{S \to AB, A \to aB, B \to bbB \mid b\}, S)$

FNC: ② ≥ 2

$S \to AB$
$A \to TaB$
$B \to TbTbB \mid b$
$Ta \to a$
$Tb \to b$

③ ≥ 3

$S \to AB$
$A \to TaB$
$B \to TbV_1 \mid b$
$V_1 \to TbB$
$Ta \to a$
$Tb \to b$

$G_{FNC} = (\{S, A, B, Ta, Tb, V_1\}, \{a, b\}, \{S \to AB, A \to TaB, B \to TbV_1 \mid b, V_1 \to TbB, Tb \to b, Ta \to a\}, S)$

FNG: ① Simplificação OK

② Renomear

$S = X_1 \to X_2X_3$
$A = X_2 \to aX_3$
$B = X_3 \to bbX_3 \mid b$

③ $A_r \to A_s$ $r \leq s$
④ OK
⑤⑥ $Tb \to b$
$X_1 \to aX_3$
$X_2 \to aX_3$
$X_3 \to bTbX_3 \mid b$

$FNG = (\{X_1, X_2, X_3, Tb\}, \{a, b\}, \{Tb \to b, X_1 \to aX_3, X_2 \to aX_3, X_3 \to bTbX_3 \mid b\})$

FNG:
Renomear
$A_r \to A_s$ $r \leq s$
Recursão esq
5e6

(c) 1º $A \to \varepsilon$:

$V_\varepsilon = \{C, A, S\}$

$S \to AB \mid BCS$
$A \to aA \mid C$
$B \to bbB \mid b$
$C \to cC$

$\Rightarrow$

$S \to AB \mid BCS \mid BS \mid B$
$A \to aA \mid a \mid cC \mid c$
$B \to bbB \mid b$
$C \to cC \mid c$

2º $A \to B$:

Fecho_S = {B}
Fecho_A = $\emptyset$
Fecho_B = $\emptyset$
Fecho_C = $\emptyset$

$S \to AB \mid BCS \mid BS \mid bb \mid B \mid b$
$B \to bbB \mid b$
$C \to cC \mid c$
$A \to aA \mid cC \mid a \mid c$

$G_{Simpl} = (\{S, A, B, C\}, \{a, b, c\}, \{S \to AB \mid BCS \mid BS \mid bb \mid B \mid b, A \to aA \mid cC \mid a \mid c, B \to bbB \mid b, C \to cC \mid C\}, S)$

FNG: $S = X_1 \to X_2X_3 \mid X_3X_4X_1 \mid X_3X_1 \mid bb \mid X_3 \mid b$
$A = X_2 \to aX_2 \mid cX_4 \mid a \mid c$
$B = X_3 \to bbX_3 \mid b$
$C = X_4 \to cX_4 \mid c$

③ OK
④ OK

5e6 $Tb \to b$,
$X_1 \to aX_2X_3 \mid cX_4X_3 \mid aX_3 \mid cX_3 \mid bTbX_3X_4X_1 \mid bX_4X_1 \mid bTbX_3X_1 \mid bX_1 \mid b \mid bTbX_3$,
$X_2 \to aX_2 \mid cX_4 \mid a \mid c$,
$X_3 \to bTbX_3 \mid b$
$X_4 \to cX_4 \mid c$)

$G_{FNG}: (\{X_1, X_2, X_3, X_4, Tb\}, \{a, b, c\}, \{Tb \to b, X_4 \to cX_4 \mid c, X_3 \to bTbX_3 \mid b, X_2 \to aX_2 \mid cX_4 \mid a \mid c, X_1 \to aX_2X_3 \mid cX_4X_3 \mid aX_3 \mid cX_3 \mid bTbX_3X_4X_1 \mid bX_4X_1 \mid bTbX_3X_1 \mid bX_1 \mid b \mid bTbX_3\}, S)$

FNC: ② ≥ 2

$S \to AB \mid BCS \mid BS \mid TbTb \mid B \mid b$
$A \to TaA \mid TcC \mid a \mid c$
$B \to TbTbB \mid b$
$C \to TcC \mid c$
$Tc \to c$
$Ta \to a$
$Tb \to b$

③ ≥ 3

$S \to AB \mid BV_1 \mid BS \mid TbTb \mid B \mid b$
$V_1 \to CS$
$A \to TaA \mid TcC \mid a \mid c$
$B \to TbV_2 \mid b$
$C \to TcC \mid c$
$V_2 \to TbB$
$Tc \to c$
$Ta \to a$
$Tb \to b$

$G_{FNC} = (\{V_1, V_2, S, A, B, C\}, \{a, b, c\}, \{S \to AB \mid BV_1 \mid BS \mid TbTb \mid B \mid b, V_1 \to CS, V_1 \to TbB, A \to TaA \mid TcC \mid a \mid c, B \to TbV_2 \mid b, C \to TcC, Ta \to a, Tb \to b, Tc \to c\}, S)$

d) $S \to aAd \mid A$
$A \to Bc \mid \varepsilon$
$B \to Ac \mid a$

1º $A \to \varepsilon$
$S \to aAd \mid A \mid ad$
$A \to Bc$
$B \to Ac \mid a \mid c$

2º $A \to B$:
Fecho_S = {A}
Fecho_A = ∅
Fecho_B = ∅
P_{Simpl} = {$S \to aAd \mid Bc \mid ad$,
$A \to Bc$,
$B \to Ac \mid a \mid c$}

G_{Simpl} = ({S, A, B}, {a, b, c}, P_{Simpl}, S)

FNC: ① Simplificar

② ≥ 2
$S \to T_a A T_d \mid B T_c \mid T_a T_d$
$A \to B T_c$
$B \to A T_c \mid a \mid c$

③ ≥ 3
$S \to T_a V_1 \mid B T_c \mid T_a T_d$
$V_1 \to A T_d$
$A \to B T_c$
$B \to A T_c \mid a \mid c$
$T_a \to a$
$T_b \to b$
$T_c \to c$

G_{FNC} = ({S, A, B, T_a, T_b, T_c, V_1}, {a, b, c}
{$T_a \to a$, $T_b \to b$, $T_c \to c$, $A \to BT_c$,
$V_1 \to AT_d$, $S \to T_a V_1 \mid BT_c \mid T_a T_d$}
S)

FNG: $S = X_1 \to a X_2 d \mid X_3 c \mid ad$
$A = X_2 \to X_3 c$
$B = X_3 \to X_2 c \mid a \mid c$

③ OK
④ OK

⑤ e ⑥

P_{FNG}: {$X_1 \to a X_2 T_d \mid a T_d \mid a T_c \mid c T_c \mid a R_1 T_c \mid c R_1 T_c$,
$X_2 \to a T_c \mid c T_c \mid a R_1 T_c \mid c R_1 T_c$},
$X_3 \to a \mid c \mid a R_1$,
$R_1 \to c T_c \mid c T_c R_1$,
$T_c \to c$, $T_d \to d$}

e) $S \to A \mid ABa \mid AbA$
$A \to Aa \mid \varepsilon$
$B \to Bb \mid BC$
$C \to CB \mid CA \mid bB$

1º $A \to \varepsilon$:
V_ε = {A, S, ...}
$S \to AB \mid AbA \mid Ba \mid Ab \mid Aa \mid a$
$A \to Aa \mid a$
$B \to Bb \mid BC$
$C \to CB \mid bB \mid CA$

2º $A \to B$
Fecho_S = ∅
Fecho_A = ∅
Fecho_B ∅
Fecho_C ∅

3º Geradores = {S, A}

G_{simpl} = {{S, A}, {a, b}, {$S \to AbA \mid Ab \mid bA \mid b \mid Aa \mid a \mid \varepsilon$, $A \to Aa \mid a$}, S)

FNG: $S = X_1 \to X_2 b X_2 \mid X_2 b \mid b X_2 \mid b \mid X_2 a \mid a$
$A = X_2 \to X_2 a \mid a$

③ $A_r \to A_s$ $r \leq s$ OK

④ $X_2 \to a \mid a R_1$
$R_1 \to a \mid a R_1$

⑤ e ⑥

P_{FNG}: {$X_1 \to b X_2 \mid a b \mid a T_b X_2 \mid a R_1 T_b X_2 \mid a T_b \mid a R_1 T_b \mid a R_1 T_a \mid a T_a$,
$X_2 \to a \mid a R_1$,
$R_1 \to a \mid a R_1$,
$T_a \to a$,
$T_b \to b$}

G_{FNG} = ({X_1, X_2, R_1, T_a, T_b}, {a, b}, P_{FNG}, S)

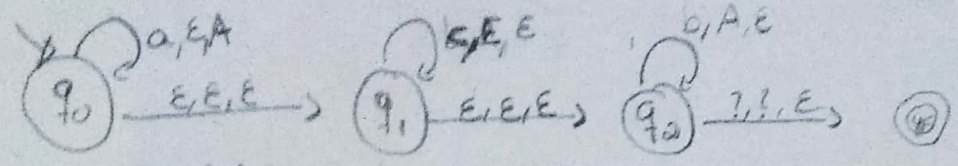
FNC: ② $S \to AT_bA \mid AT_b \mid T_bA \mid b \mid AT_a \mid a$
$A \to AT_a \mid a$

③ $S \to A V_1 \mid A T_b \mid T_b A \mid b \mid A T_a \mid a$
$A \to A T_a \mid a$
$V_1 \to T_b A$

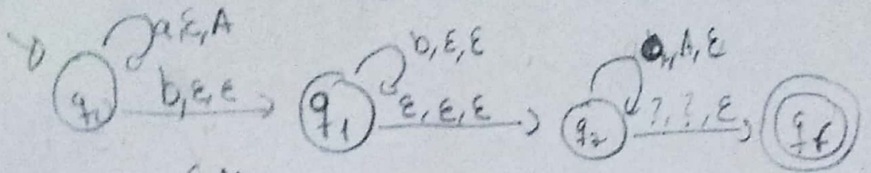
G_{FNC} = {(S, A, V_1}, {a, b}, {$S \to AV_1 \mid AT_b \mid T_bA \mid b \mid AT_a \mid a$, $A \to AT_a \mid a$, $V_1 \to T_bA$}, S)

5

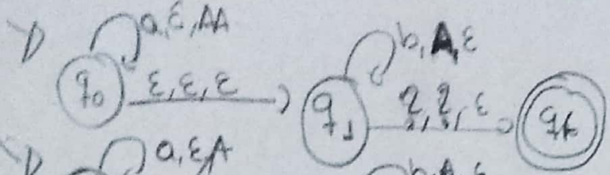
a)



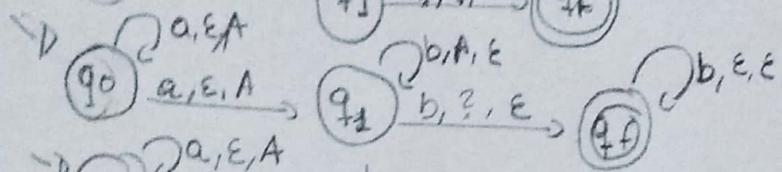
b)



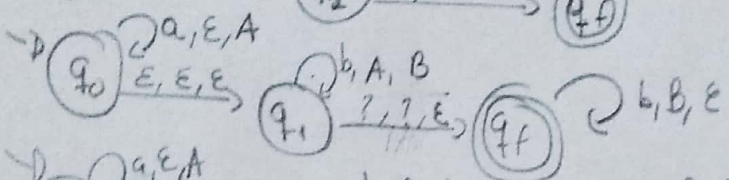
c)



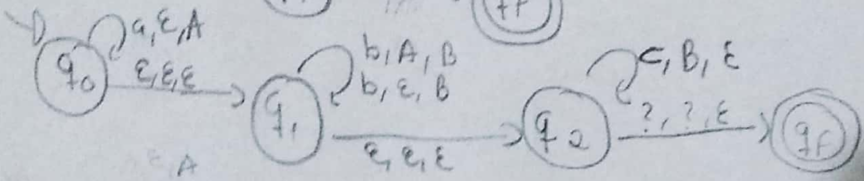
d)



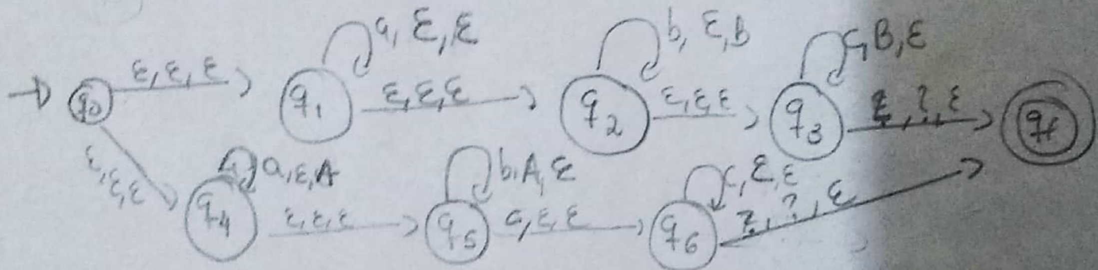
e)



f)

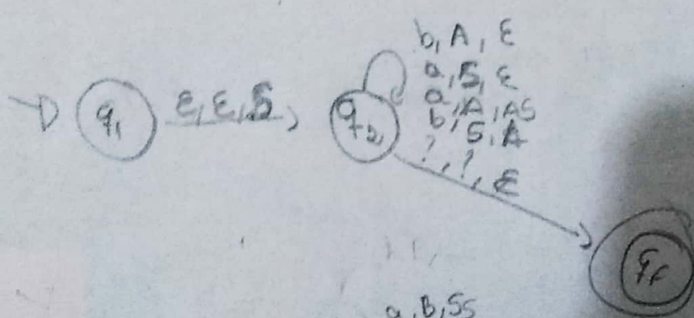


g)

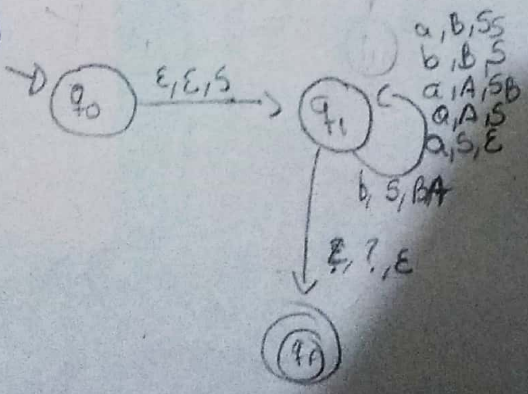


6

a)



b)



7 a) Seja L livre de contexto e p o comprimento do bombeamento.

$w = a^p b^p c^p d^p$

$w \in L$ e $|w| \geq p$

Decompondo w em $\Rightarrow w = uxvyz$ tq $|xvy| \leq p$, $|xy| \geq 1$

$\forall i \in \mathbb{N}$, $ux^ivy^iz \in L$

w∈L e |w|≥p
Decompor w.
$|xvy| \leq p$
$|xy| \geq 1$

Caso 1: xvy possui combinações: $a^r b^s$ ou $b^r c^s$ ou $c^r d^s$, $0 < r+s \leq p$.
Se bombear ux^2vy^2z temos um aumento no comprimento bombeado, nessa situação tem um desbalanceamento as proporções de a, b, c e d, gerando palavras fora da linguagem. Logo $ux^2vy^2z \notin L$.

Chega-se em uma contradição e L não é livre do contexto.

b) Seja L livre de contexto; p o comprimento do bombeamento.

Seja: $w = a^p (bb)^p a^p$

$w \in L$ e $|w| \geq p$

Decompondo w em: $w = uxvyz$ tq $|xvy| \leq p$, $|xy| \geq 1$ e $\forall i \in \mathbb{N}$, $ux^ivy^iz \in$

Caso 1: xyz possui apenas o primeiro conjunto de a's ou apenas (bb)'s ou o conjunto de a's apenas. Ao bombear ux^2vy^2z, em qualquer uma das situações, haverá aumento no comprimento bombeado. Teremos o desbalanceamento das proporções de a's, (bb)'s e a's, gerar palavras que não estão na linguagem, então $ux^2vy^2z \notin L$.

Caso 2: xvy possui apenas uma combinação dos primeiros a's com os (bb)'s ou combinação dos (bb)'s com os segundos a's, sendo assim, $a^r(bb)^s$ ou $(bb)^r a^s$, $0 < r+s \leq p$. Como $|xvy| \leq p$, não pode haver a's em ambos os lados de (bb)'s, teremos palavras que não pertencem na linguagem, nesse caso $ux^2vy^2z \notin L$.

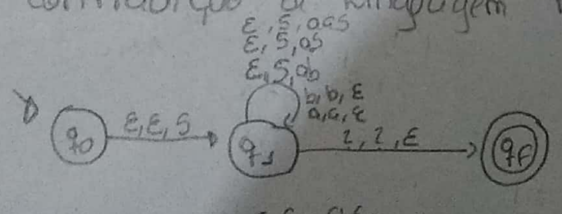
Por contradição a linguagem L não é LLC.

c) Seja L livre de contexto; p o comprimento do bombeamento. $w = a^p(bb)^p(aa)^p b^p$ então $w \in L$, $|w| \geq p$. Portanto w pode ser decomposto em $w = uxvyz$ tq $|xvy| \leq p$, $|xy| \geq 1$ e $\forall i \in \mathbb{N}$, $ux^ivy^iz \in L$.
xvy possui apenas uma combinação de a's e (bb)'s ou (bb)'s e (aa)'s ou (aa)'s e b's, ou seja, $a^r(bb)^s$ ou $(bb)^r(aa)^s$ ou $(aa)^r b^s$, $0 < r+s \leq p$. Em qualquer uma das situações ao bombear ux^2vy^2z haverá aumento desproporcional no número de a's, (bb)'s, (aa)'s e b's, gerando palavras que não estão na linguagem, então $ux^2vy^2z \notin L$.

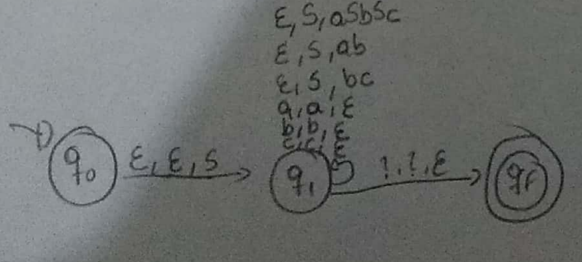
Por contradição a linguagem não é Livre de Contexto.

Pilha Descendente
1. Empilha símbolo inic
2. topo = variável: substitui por todas as prod
3. topo = terminal

8 a)



b)



Scanned by CamScanner

9) a)

S			
—	A,B		
S	—	A	
A	B	B	A
a	b	b	a

Aceita a palavra abba.

b)

—		
S,B	—	
A,C	B	A
a	b	a

Não aceita a palavra aba.

c)

S,B				
A	S,B			
S,B	A	S,B		
—	S,B	A	A	
A	A	B	B	B
a	a	b	b	b

Aceita a palavra aabbb

d)

S,C				
S,A,C	S,C			
—	S,C,A	B		
S,A	B	B	S,C	
B	A,C	A,C	A,C	B
b	a	a	a	b

Aceita a palavra baaab.

10) a) D0: S → •BC/0
B → •b/0
C → •c/0
⇒ D1: B → b•/0
S → B•C/0
C → •c/1
⇒ D2: C → c•/1
S → BC•/0
⇒ Aceita a palavra bc.

b) D0: E → •T+id/0
E → •id/0
T → •E/0
⇒ D1: E → id•/0
T → E•/0
E → T•+id/0
⇒ D2: E → T+•id/0
⇒ D3: E → T+id•/0
T → E•/0
E → T•+id/0
Aceita a palavra id+id

c) D0: S → •aSb/0
S → •aB/0
S → •a/0
B → •bB/0
B → •b/0
⇒ D1: S → a•Sb/0
S → a•B/0
S → a•/0
S → •aSb/1
S → •aB/1
S → •a/1
B → •bB/1
B → •b/1
⇒ D2: S → a•Sb/1
S → a•B/1
S → a•/1
S → •aSb/2
S → •aB/2
S → •a/2
B → •bB/2
B → •b/2
S → aS•b/0
D3: B → b•B/2
B → b•/2
S → aSb•/0
B → •bB/3
B → •b/3
S → aB•/1
Aceita palavra aab

d) D0: S → •aBSb/0
S → •aB/0
B → •bB/0
B → •b/0
⇒ D1: S → a•BSb/0
S → a•B/0
B → •bB/1
B → •b/1
⇒ D2: B → b•B/1
B → b•/1
B → •bB/2
B → •b/2
S → aB•Sb/0
S → aB•/0
S → •aBSb/2
S → •aB/2
⇒ D3: S → a•BSb/2
S → a•B/2
B → •bB/3
B → •b/3

D4: B → b•/3
B → b•B/3
S → aB•Sb/2
S → aB•/2
S → aBS•b/0
S → •aBSb/4
S → •aB/4