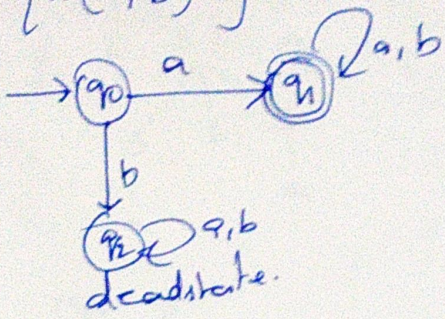
CAT 2 Answer key

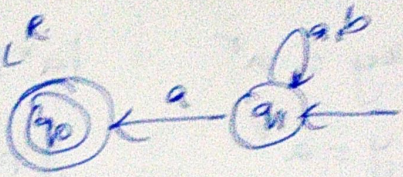
SSN

Part-A

1. $L = \{a(a/b)^*\}$



L^R



$L = \{(a/b)^*a\}$

2. $S \rightarrow aSa \mid bSb \mid a \mid b \mid \varepsilon$

3. CFG

4. $L = \{$number of a's in word = number of b's in $w\}$

5. $A \rightarrow aB \mid a \qquad A_1 \rightarrow BaA_1 \mid Ba$

$A \rightarrow aBA_1 \mid aA_1$

$B \rightarrow b$

6. $M = (Q, \Sigma, \Gamma, q_0, Z, \delta, F)$

details of all $(Q, \Sigma \ldots)$

$\delta: Q \times \Sigma \cup \{\varepsilon\} \times \Gamma^* \rightarrow 2^{Q \times \Gamma^*}$

Part-B

7. Let L be a Regular language. There is a constant n, such that $\forall$ string w in L, such that $|w| \geq n$, we break w into 3 strings, $w = xyz$

$y \neq \varepsilon$ i.e $|y| > 0$

$|xy| \leq n$ &

$\forall i \geq 0$, xy^iz is also in L

$L = \{a^n b^n \mid n \geq 1\}$

$w = a^p b^p$

$xy = a^r \quad |a^r| \leq n$

$y = a^q \quad y \neq \varepsilon$

$z = a^{p-r} b^p$

$xy^i z = xyy^{i-1}z$

$xy^i z = a^r (a^q)^{i-1} a^{p-r} b^p$

<u>$i = 0$</u> $\quad a^{p-q} b^p \notin L$

<u>$i = 1$</u> $\quad a^p b^p \in L$

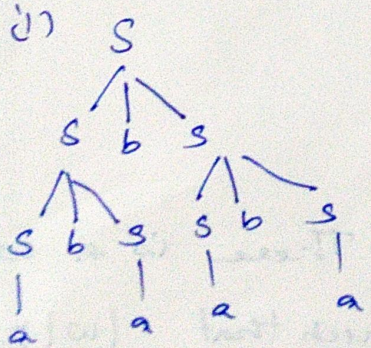
<u>$i = 2$</u> $\quad a^{p+q} b^p \notin L$

$\therefore$ L is not regular.

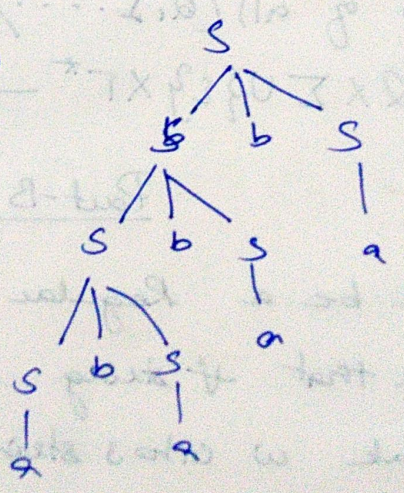
8. $S \rightarrow SbS \mid a$

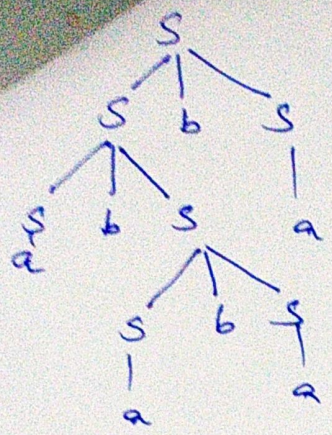
$w = abababa$

(i)

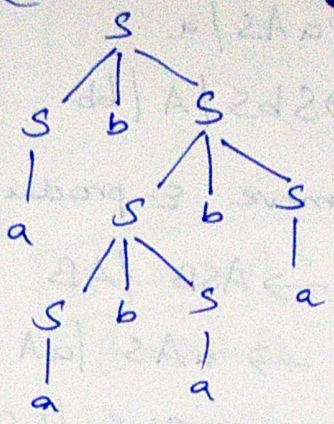


(ii)

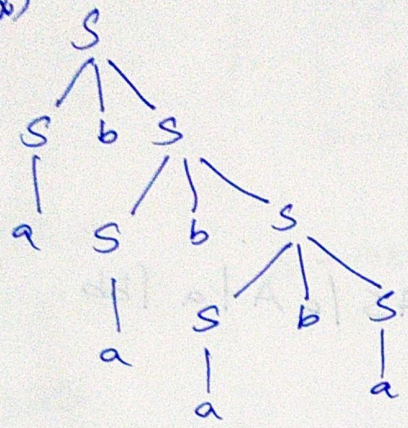




(iv)

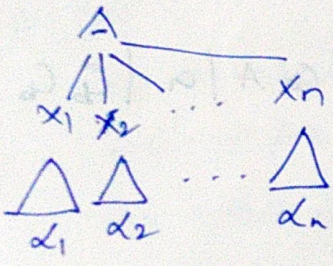


(v)



5 parse trees

9. PT ⟶ Derivation



$A \Rightarrow X_1 X_2 \cdots X_n$

$\overset{*}{\Rightarrow} \alpha_1 X_2 \cdots X_n$

$\vdots$

$\overset{*}{\Rightarrow} \alpha_1 \alpha_2 \cdots \alpha_n$

Part - C

10. $A \to BC$
$A \to a$
$S \to \varepsilon$ is allowed if S does not appear on RHS of any other production.

$S \rightarrow ASB \mid \varepsilon$

$A \rightarrow aAS \mid a$

$B \rightarrow SbS \mid A \mid bb$

I

(i) Remove ε- productions

$S \rightarrow ASB \mid AB$

$A \rightarrow aAS \mid aA \mid a$

$B \rightarrow SbS \mid bS \mid Sb \mid b \mid A \mid bb$

(ii) Remove Unit productions

$S \rightarrow ASB \mid AB$

$A \rightarrow aAS \mid aA \mid a$

$B \rightarrow SbS \mid bS \mid Sb \mid b \mid aAS \mid aA \mid a \mid bb$

(iii) No Useless symbols.

II

$S \rightarrow ASB \mid AB$

$A \rightarrow C_aAS \mid C_aA \mid a$

$B \rightarrow SC_bS \mid C_bS \mid SC_b \mid b \mid C_aAS \mid C_aA \mid a \mid C_bC_b$

$C_a \rightarrow a$

$C_b \rightarrow b$

III

$S \rightarrow ASB$

$S \rightarrow AD_1$

$D_1 \rightarrow SB$

$S \rightarrow AB$

$C_a \rightarrow a$

$C_b \rightarrow b$

$A \to aA \mid a$

$A \to aA$
$A \to aD_2$
$D_2 \to AS$

$B \to SbS$
$B \to SD_3$
$D_3 \to bS$

$B \to bS$
$B \to Sb$
$B \to b$
$B \to aA$

$B \to aAS$
$B \to aD_4$
$D_4 \to AS$

11. $A \to a\alpha$ $\quad S \to \varepsilon$ ....
$\alpha \in N^*$

$S \to AB$
$A \to BS \mid b$
$B \to SA \mid a$.

(i) CNF.

$A_1 \to A_2 A_3$
$A_2 \to A_3 A_1 \mid b$
$A_3 \to A_1 A_2 \mid a$

(ii) $A_i \to A_j \gamma \quad j > i$

$A_3 \to A_1 A_2 \mid a$
$A_3 \to A_2 A_3 A_2 \mid a$
$A_3 \to A_3 A_1 A_3 A_2 \mid b A_3 A_2 \mid a$.

∴ New production

$A_1 \to \cdots$
$A_2 \cdots$ $A_3 \to A_3 A_1 A_3 A_2 \mid b A_3 A_2 \mid a$

(iii) Eliminate Left Recursion.

(i) $A_i \rightarrow A_j \gamma$

$A_3 \rightarrow bA_3A_2 \mid a \mid bA_3A_2B_3 \mid aB_3$ ——— (3)

$B \rightarrow A_1A_3A_2 \mid A_1A_3A_2B_3$

(iv) Modify A_i productions

$A_2 \rightarrow bA_3A_2A_1 \mid aA_1 \mid bA_3A_2B_2A_1 \mid aB_3A_1 \mid b$ (2)

$A_1 \rightarrow bA_3A_2A_1A_3 \mid aA_1A_3 \mid bA_3A_2B_3A_1A_3 \mid$

$aB_3A_1A_3 \mid bA_3$ ——— (1)

(v) Modify B_i productions

$B_3 \rightarrow bA_3A_2A_1A_3A_3A_2 \mid aA_1A_3A_3A_2 \mid bA_3A_2B_2A_1A_3A_3A_2$

$\mid aB_3A_1A_3A_3A_2 \mid bA_3A_3A_2$ ——— (4)

$B_3 \rightarrow bA_3A_2A_1A_3A_3A_2B_3 \mid aA_1A_3A_3A_2B_3 \mid$

$bA_3A_2B_2A_1A_3A_3A_2B_3 \mid aB_3A_1A_3A_3A_2B_3 \mid$

$bA_3A_3A_2B_3$ ——— (5)

12. a.

FA	PDA
1) No memory.	Stack
2) Type 2 CFG.	Type 3 RG
3) CFL	RL

eptance by reaching
the final state &
employing the stack.

Acceptance by reaching the final state.

b) ID

(q_1, w, γ)

q current state

w remaining input symbols

γ current stack contents

$\vdash$ (turnstile symbol) to connect 2 ID's

$(p, b\gamma T) \vdash (q, w, \gamma\gamma)$

a) $\delta(q_0, a, Z) = \{(q_0, aaaZ)\}$

$\delta(q_0, a, a) = \{(q_0, aaaa)\}$

NPDA $\delta(q_0, \varepsilon, a) = \{(q_1, a)\}$ (or) DPDA $\delta(q_0, b, a) = \{(q_1, \varepsilon)\}$

$\delta(q_1, b, a) = \{(q_1, \varepsilon)\}$

$\delta(q_1, \varepsilon, Z) = \{(q_2, Z)\}$

TD , All tuples.