

MODULE 3

1. prove the following grammar is ambiguous $s \rightarrow aSbS \mid bSaS \mid \epsilon$.
2. Construct CFG to generate the language $L = \{a^i b^j c^k \mid k=i+j, i, j \geq 1\}$
3. The grammar G is $S \rightarrow aB \mid bA, A \rightarrow aS \mid bAA, B \rightarrow b \mid bS \mid aBB$ Derive using Left Most Derivation(LMD) and Rightmost Derivation (RMD) for the following string “aaabbb”. Draw Parse Tree.
4. Consider following CFG. Is it already simplified ? Explain your answer. Convert it to CNF form. $S \rightarrow ASB \mid a \mid bb, A \rightarrow aSA \mid a, B \rightarrow SbS \mid bb$.
5. Simplify the given grammar $S \rightarrow ASB \mid \epsilon, A \rightarrow aAS \mid a, B \rightarrow SbS \mid A \mid bb$.
6. i) Construct CFG for given language. $L = \{0^i 1^j 0^k \mid j > i+k\}$
ii) The grammar G is $S \rightarrow aB \mid bAA, A \rightarrow aS \mid bAA, B \rightarrow b \mid bS \mid aBB$ Obtain parse tree for the following string “aababb” and check if the grammar is ambiguous.
7. find GNF FORM GIVEN CFG.

S \rightarrow AA \mid a

A \rightarrow SS \mid b

8.

3. Consider following grammar :

$S \rightarrow iCtS \mid iCtSeS \mid a$

$C \rightarrow b$

corrected

For string “ibraeibta” find the following :

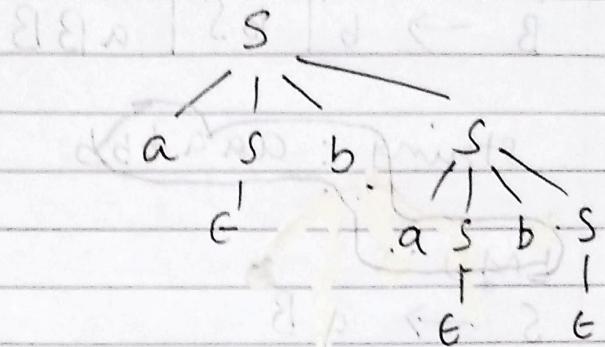
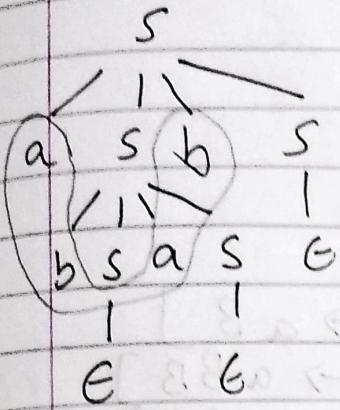
- (i) Leftmost derivation
- (ii) Rightmost derivation
- (iii) Parse tree

ibtaeibta

Mod 3 PYQ

(Q1)

Let's suppose we want to derive the string abab



$$(Q2) L = \{ a^i b^j c^k \mid k = i+j, i, j \geq 1 \}$$

$$\Rightarrow a^i b^j c^{i+j} \\ a^i b^j c^{i+j} \\ a^i b^j c^i c^j \\ \overbrace{\quad \uparrow \quad \uparrow \quad \uparrow \quad \uparrow \quad} \quad \overbrace{\quad \uparrow \quad \uparrow \quad \uparrow \quad \uparrow \quad} \\ L = \{ abcc, aabbccc, aaabbccs, \dots \}$$

$$S \rightarrow a^i S_c \mid a^i X_c \\ X \rightarrow b^j X_c \mid b^j c$$

a * EMR

Q3)

$$\Rightarrow S \rightarrow aB \mid bA$$

$$A \rightarrow a \mid aS \mid bAA$$

$$B \rightarrow b \mid bS \mid aBB$$

string : aaaabb

LMD :

$$S \rightarrow aB \quad [S \rightarrow aB]$$

$$S \rightarrow a a BB \quad [B \rightarrow a BB]$$

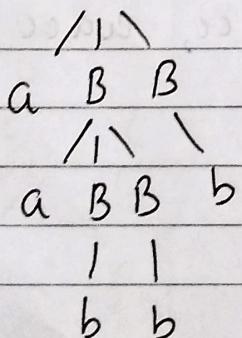
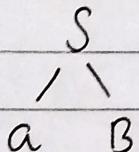
$$S \rightarrow a a a B B B \quad [B \rightarrow a BB]$$

$$S \rightarrow a a a b B B \quad [B \rightarrow b]$$

$$S \rightarrow a a a b b B \quad [B \rightarrow b]$$

$$S \rightarrow a a a b b b \quad [B \rightarrow b]$$

parse tree



RMD

$$S \rightarrow aB \quad [S \rightarrow aB]$$

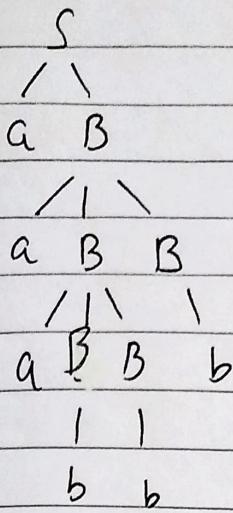
$$S \rightarrow a a B B \quad [B \rightarrow a BB]$$

$$S \rightarrow a a B . b \quad [B \rightarrow b]$$

$$S \rightarrow a a a B B b \quad [B \rightarrow a BB]$$

$$S \rightarrow a a a B b b \quad [B \rightarrow b]$$

$$S \rightarrow a a a b b b \quad [B \rightarrow b]$$



Q4) $S \rightarrow ASB \mid a \mid bb$

$A \rightarrow aSA \mid a$

$B \rightarrow SbS \mid bb$

Let $G = (V, T, P, S)$ be given CFG
 $V = \{S, A, B\}$

capital letters

$T = \{a, b\}$

small letters and symbols

$P = S \rightarrow ASB \mid a \mid bb$

$A \rightarrow aSA \mid a$

$B \rightarrow SbS \mid bb$

S = start variable

Step 1 : Simplification of CFG
 Already simplified

Step 2 : Conversion of simplified CFG to CNF

$S \rightarrow A \times \mid a \mid yy$

$A \rightarrow ZW \mid a$

$B \rightarrow SY \mid yy$

$X \rightarrow SB$
 $Y \rightarrow b$
 $Z \rightarrow a$
 $W \rightarrow SA$
 $V \rightarrow SY$

Q5)

$\rightarrow S \rightarrow ASB | \epsilon$
 $A \rightarrow aAS | a$
 $B \rightarrow SbS | A|bb$

Step 1: Elimination of useless variable
 No useless variable

Step 2: Elimination of null production
 $S \rightarrow \epsilon$

$S \rightarrow ASB | AB$
 $A \rightarrow aAS | a | aA$
 $B \rightarrow SbS | A | bb | Sb | bS | b$

Step 3: Elimination of unit production
 $B \rightarrow A$ is unit production

$S \rightarrow ASB | AB$
 $A \rightarrow aAS | a | aA$
 $B \rightarrow SbS | aAS | a | aA | bb | Sb | bS | b$

$$(g6) axL = \{ 0^i 1^j 0^k \mid j > i+k \}$$

$$\Rightarrow L = \{ 01110, 0011110, 0111100, \dots \}$$

$$\frac{01}{i} \quad \frac{1}{j} \quad \frac{10}{k}$$

$$S \rightarrow X Y Z$$

$$X \rightarrow 0 \quad X \mid \epsilon$$

$$Y \rightarrow 1 \quad Y \mid \epsilon$$

$$Z \rightarrow 1 \quad Z \mid \epsilon$$

$$b) S \rightarrow aB \mid bA$$

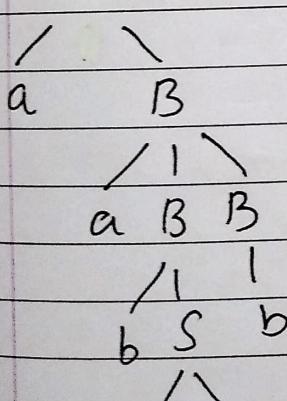
$$A \rightarrow a \mid aS \mid bAA$$

$$B \rightarrow b \mid bs \mid aBB$$

String: aababb

Parse tree

S



LMD

$$S \rightarrow aB \quad [S \rightarrow aB]$$

$$S \rightarrow a a B B \quad [B \rightarrow a B B]$$

$$S \rightarrow a a b s B \quad [B \rightarrow b s]$$

$$S \rightarrow a a b a B B \quad [S \rightarrow a B]$$

$$S \rightarrow a a b a b \quad [B \rightarrow b]$$

$$S \rightarrow a a b a b b \quad [B \rightarrow b]$$

a a B B

- i. Using this production rule, all derivations for "aababb" lead to the same parse structure.
- ii. The grammar is not ambiguous.

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Rules
non-terminal
or A → Terminal
Non-terminal → Terminal, T NT → TM
 $A \rightarrow a, aA, aB$

$$Q7) S \rightarrow AA | a$$

$$A \rightarrow SS | b$$

$$S \rightarrow a$$

$$A \rightarrow b$$

both of the above are already in GNF

(1) $S \rightarrow AA$

(i) $S \rightarrow bA$

(ii) $S \rightarrow SS A$
 $S \rightarrow bSA$

(iii) $S \rightarrow ASS$
 $S \rightarrow bSS$

(2) $A \rightarrow SS$

(i) $A \rightarrow aS$

(ii) $A \rightarrow AAS$
 $A \rightarrow aAS$

(iii) $A \rightarrow SAA$
 $A \rightarrow aAA$

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the string is given wrong in the Q
the string should be 'ibtaeibta'

(g) $S \rightarrow iCtS \mid iCtSeS \mid a$

For string ibtaeibta

LMD

$S \rightarrow iCtSeS$
 $S \rightarrow ibtSeS$
 $S \rightarrow ibtaeS$
 $S \rightarrow ibtae iCtS$
 $S \rightarrow ibtaeibtS$
 $S \rightarrow ibtaeibta$

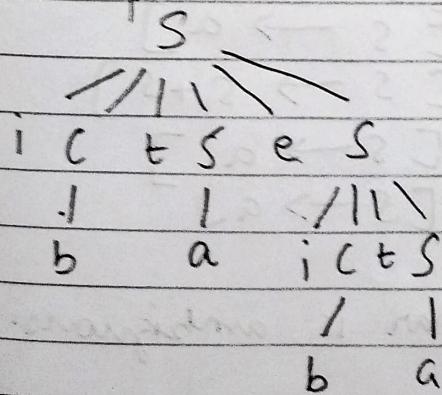
$[S \rightarrow iCtSeS]$
 $[C \rightarrow b]$
 $[S \rightarrow a]$
 $[S \rightarrow iCtS]$
 $[C \rightarrow b]$
 $[S \rightarrow a]$

RMD

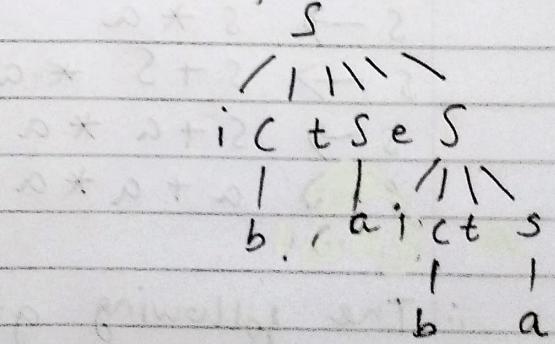
$S \rightarrow iCtSeS$
 $S \rightarrow iCtSe \cdot iCtS$
 $S \rightarrow iCtSe i(ta)$
 $S \rightarrow iCtSeibta$
 $S \rightarrow iCtSeibta$
 $S \rightarrow ibtaeibta$

$[S \rightarrow iCtSeS]$
 $[S \rightarrow iCtS]$
 $[S \rightarrow a]$
 $[C \rightarrow b]$
 $[S \rightarrow a]$
 $[C \rightarrow b]$

LMD parse tree



RMD parse tree



(Q9) Show that the following grammar is ambiguous

$$S \rightarrow aSbS \mid bSAS \mid \epsilon$$

\Rightarrow Refer Q1 and write

As there are two parse trees, therefore the grammar is ambiguous.

(Q10) Check if the following grammar is ambiguous or not?

$$S \rightarrow S + S \mid S - S \mid S^* S \mid S/S \mid (S) \mid a$$

\Rightarrow for string $a+a^*a$

LMD

$$S \rightarrow S + S \quad [S \rightarrow S + S]$$

$$S \rightarrow a + S \quad [S \rightarrow a]$$

$$S \rightarrow a + S * S \quad [S \rightarrow S * S]$$

$$S \rightarrow a + a * S \quad [S \rightarrow a]$$

$$S \rightarrow a + a * a \quad [S \rightarrow a]$$

RMD

$$S \rightarrow S * S \quad [S \rightarrow S * S]$$

$$S \rightarrow S * a \quad [S \rightarrow a]$$

$$S \rightarrow S + S * a \quad [S \rightarrow S + S]$$

$$S \rightarrow S + a * a \quad [S \rightarrow a]$$

$$S \rightarrow a + a * a \quad [S \rightarrow a]$$

\therefore The following grammar is ambiguous.

Q1) Construct CR for following

- (i) Alternate sequence of 0 and 1 starting with 0
- (ii) Does not contain 3 consecutive a over $\{a, b\}$
- (iii) $L = \{x \in \{0, 1\}^* \mid x \text{ has equal number of } 0's \text{ and } 1's\}$

$$\Rightarrow \text{(i) P: } S \rightarrow 0A \mid 1B$$

$$A \rightarrow 1B \mid E$$

$$B \rightarrow 0A \mid E$$

$$G = (\{S, A, B\}, \{0, 1\}, P, S)$$

$$L(G) = \{01, 010, 0101, \dots\}$$

$$\text{(ii) } S \rightarrow aA \mid bB \mid a \mid b$$

$$A \rightarrow aC \mid bB \mid a \mid b$$

$$B \rightarrow aA \mid bB \mid a \mid b$$

$$C \rightarrow bB \mid b$$

$$\text{(iii) } S \rightarrow 0B \mid 1A$$

$$A \rightarrow 0 \mid 0S \mid 1A \mid A$$

$$B \rightarrow 1 \mid 1S \mid 0B \mid B$$