

Q.1. for the following CFG find a leftmost derivation & rightmost derivation with corresponding parse tree.

$$a. \quad S \rightarrow OSO \mid SISI \mid SS \mid d$$

Given the string:

i) 0101101110

Soln: LMD: $S \rightarrow OSO [S \rightarrow OSO] \quad RMD: S \rightarrow OSO [S \rightarrow OSO]$

$$S \rightarrow OISIO [S \rightarrow ISI]$$

$$S \rightarrow OISIO [S \rightarrow ISI]$$

$$S \rightarrow O1SS10 [S \rightarrow SS]$$

$$S \rightarrow O1SS10 [S \rightarrow SS]$$

$$S \rightarrow O1OSOS10 [S \rightarrow OSO]$$

$$S \rightarrow O1SIS110 [S \rightarrow ISI]$$

$$S \rightarrow O1O1S1OS10 [S \rightarrow ISI]$$

$$S \rightarrow O1S1d110 [S \rightarrow d]$$

$$S \rightarrow O1O1d1OS10 [S \rightarrow d]$$

$$S \rightarrow O1O5O1d110 [S \rightarrow OSO]$$

$$S \rightarrow O1O1d1O1S110 [S \rightarrow ISI]$$

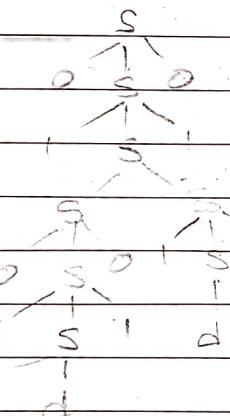
$$S \rightarrow O1O1S1d110 [S \rightarrow ISI]$$

$$S \rightarrow O1O1d1O1d110 [S \rightarrow d]$$

$$S \rightarrow O1O1d1O1d110 [S \rightarrow d]$$

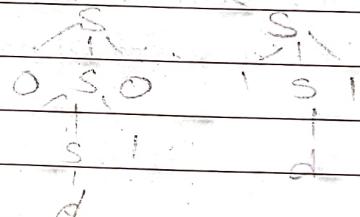
Parse Tree:

LMD:



RMD:

ISO 9001:2015 Certified
NBA and NAAC Accredited



Yield of tree: 0101101110

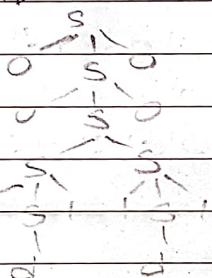
Yield of tree: 0101101110

ii. 0011100

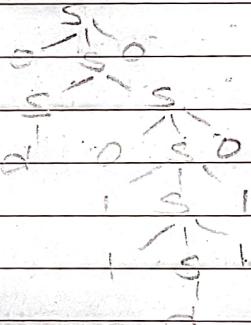
S _{01^n} :	LMD: S → 0S0 [S → 0S0]	RMD: S → 0S0 · [S → 0S0]
	S → 00S00 [S → 0S0]	S → 0SS0 [S → SS]
	S → 00SS00 [S → SS]	S → 0S0S00 [S → 0S0]
	S → 001S1S00 [S → ISI]	S → 0S01S100 [S → ISI]
	S → 001d1S00 [S → d]	S → 0S011S1100 [S → ISI]
	S → 001d1IS100 [S → ISI]	S → 0S011d1p100 [S → d]
	S → 001d1d1d100 [S → d]	S → 0d011d1100 [S → d]

Passe Tree :-

LMD:



RMO:



Yield of tree: 0011100

Yield of tree: 00111100

b. Given the string: i) 1100 ii) 001110 iii) 001101
 $S \rightarrow 0R|IA$ A $\rightarrow 0AS|AA$ B $\rightarrow 1|1S|0BB$

i. for string "1100"

SOM: LMD:

$S \rightarrow IA$ [S → IA]

$$S \rightarrow 11AA \quad [S \rightarrow 1AA]$$

$$S \rightarrow 110A \quad [A \rightarrow 0]$$

$$\zeta \rightarrow 1100 \quad [A \rightarrow 0]$$

RMD:

$s \rightarrow IA$ [$s \rightarrow IA$]

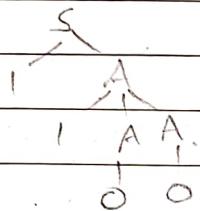
$$S \xrightarrow{A} AA \quad [A \xrightarrow{A} AA]$$

$S \rightarrow 11A_0$ [$A \rightarrow 0$]

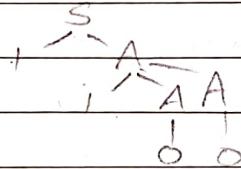
$S \rightarrow 1100$ [$A \rightarrow c$]

Parse Tree:

LMD:



RMD:



Y.O.T: 1100

Y.O.T: 1100

ii. for string "001110"

Sol:

LMD: $S \rightarrow 0B [S \rightarrow 0B]$

$S \rightarrow 00BB [B \rightarrow 0BB]$

$S \rightarrow 001B [B \rightarrow 1]$

$S \rightarrow 0011S [B \rightarrow 1S]$

$S \rightarrow 00111A [S \rightarrow 1A]$

$S \rightarrow 001110 [A \rightarrow 0]$

RMD:

$S \rightarrow 0B [S \rightarrow 0B]$

~~$S \rightarrow 00BB [B \rightarrow 0BB]$~~

$S \rightarrow 001S [B \rightarrow 1S]$

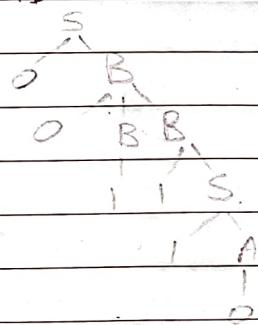
$S \rightarrow 00B11A [S \rightarrow 1A]$

$S \rightarrow 00B110 [A \rightarrow 0]$

$S \rightarrow 001110 [B \rightarrow 1]$

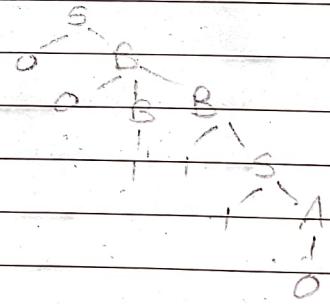
Parse Tree:

LMD:



Y.O.T: 001110

RMD:



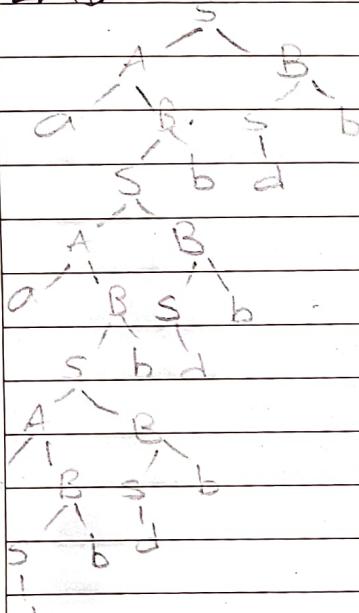
Y.O.T: 001110

$S \rightarrow aaadbd\text{bbSbbR}$ [B \rightarrow Sb]
 $S \rightarrow aaa\text{d bdbbd}\text{bbb}$ [S \rightarrow d]
 $S \rightarrow aaad\text{hdhbdbbSb}$ [B \rightarrow Sb]
 $S \rightarrow aaad\text{bd}\text{bbdbbd}\text{b}$ [S \rightarrow d]

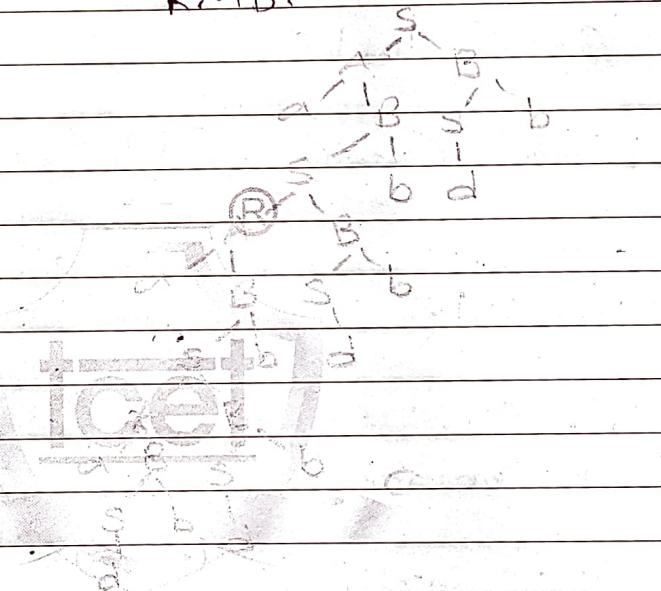
$S \rightarrow aaA\text{d bbbddab}$ [S \rightarrow d]
 $S \rightarrow aaAB\text{bbdbbd}\text{b}$ [A \rightarrow aB]
 $S \rightarrow aaS\text{bd}\text{bbdbbd}\text{b}$ [S \rightarrow Sb]
 $S \rightarrow aaabd\text{bbdbbd}\text{b}$ [S \rightarrow d]

Parse Tree:

LMD:



RMD:



ISO 9001:2015 Certified

Y.O.T: aaabbhbbbbb N.B.A and N.A.Y.O.T. aaabbhbbbbb

Q.2. Write a context free grammars for each of &c.e.

i) a*

Ans $S \rightarrow aS|E$

iii) a.(a+b)*

Ans $S \rightarrow aA$

$A \rightarrow aA|bA|E$

ii)

Ans $(a+b)^*$

$L = \{E, a, b, ab, ba, \dots\}$

$\therefore S \rightarrow aS|bS|E$

iv) (aa+ba)(a+b)*

$S \rightarrow aaA|baA$

$A \rightarrow aA|bA|d$

5) $a^{2n} b^n$ Ay $S \rightarrow aab|bd$ 7) $(0+1)^* 10$ Ay $S \rightarrow 0s11s10$ 7) $(0+1)^* 011 (0+1)^*$ Ay $S \rightarrow A011A$
 $A \rightarrow 0A1|1A1E$

Q.3) Write C.F.G. for each language.

1. $a^n b^n, n \geq 1$ Ay $S \rightarrow aSb|ab$ 4. $a^n b^{n+1}, n \geq 1$ Ay $S \rightarrow aSb|abb$ 2. $a^n b^{2n}, n \geq 1$ Ay $S \rightarrow aSbb|abb$ 5. $a^n b^{n-3}, n \geq 1$ Ay $S \rightarrow aaa|aaaA$ 3. $a^{3n} b^n, n \geq 1$ Ay $S \rightarrow aaasb|aaab$ $A \rightarrow aAb|ab$ 6. $a^n b^n c^m, n, m \geq 1$ Ay $S \rightarrow aSbTcE$ $T \rightarrow ctE$

Q.4. Convert the CFG to CNF form.

a) $S \rightarrow ABA$ $A \rightarrow aA1d$ $B \rightarrow bB1d$ Solⁿ Step 1: Removed Null production. $S \rightarrow ABAB|ABA|AA|AB|A|B|1$ $A \rightarrow aA1a$ $B \rightarrow bB1b$

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Step 2 : Remove Unit production

$$S \rightarrow A, S \rightarrow B$$

$$S \rightarrow ABA | BA | AA | AB | Aa | aB | bB | b | \lambda$$

$$A \rightarrow aAa$$

$$B \rightarrow bB | b$$

Step 3 : Let $x \rightarrow AB, y \rightarrow b, R \rightarrow a$

$$S \rightarrow xA | BA | AA | AB | RA | a | yB | b | \lambda$$

$$A \rightarrow RA | a$$

$$B \rightarrow yB | b$$

is the CNF form.

b. $S \rightarrow 11S | 00$

$$S \rightarrow 00S | 11$$

$$S \rightarrow 00 | E$$

$\therefore S$ on RHS $S' \rightarrow S$

Step 1 :-

$$S \rightarrow 11S | 00 | 11$$

$$S \rightarrow 00S | 11 | 00$$

$$S \rightarrow 00 | E$$

Step 2 :-

$$Let x \rightarrow 1, y \rightarrow 0$$

$$S \rightarrow xxS | yy | xx$$

$$S \rightarrow yyS | xx | yy$$

$$S \rightarrow yx | E$$

Step 3 :-

$$R \rightarrow xS, T \rightarrow yS, S' \rightarrow xR | yy | xx | yT | E$$

$$S \rightarrow xR | yy | xx | yT | E$$

$$x \rightarrow 1$$

$$y \rightarrow 0$$

is the CNF form.

c) $S \rightarrow aS | A | C$

$$A \rightarrow a$$

$$B \rightarrow aa$$

$$C \rightarrow acb | c$$

$\therefore S$ on RHS $S' \rightarrow S$

Step 1 :-

$$S \rightarrow aS | A | C$$

$$S \rightarrow Aa, S \rightarrow C, C \rightarrow c$$

NBA and NAAC $C \rightarrow acb | acb \therefore C \rightarrow acb$

$$S \rightarrow a$$

$$S \rightarrow acb$$

Step 2 :-

$$S \rightarrow acb, C \rightarrow acb$$

$\because C$ doesn't derive any terminal string.

$$B \rightarrow a a \therefore T \text{ is unreachable}$$

\therefore final grammar :-

$$S \rightarrow aS | a$$

$$Let x \rightarrow a$$

$$\therefore S \rightarrow xS | a, S' \rightarrow xs | a$$

is the CNF form.

$$d) S \rightarrow abAB$$

$$A \rightarrow bAB | \lambda$$

$$B \rightarrow BAa | Aa\lambda$$

Solⁿ: Step 1:-

$$S \rightarrow abAB | abB | abA | ab$$

$$A \rightarrow bAB | bB | bAb$$

$$B \rightarrow BAa | Ba | Aala$$

Step 2:-

$$\text{Let } x \rightarrow a, y \rightarrow b$$

$$S \rightarrow XYAB | XYB | XYA | XY$$

$$A \rightarrow YAB | YB | YA | b$$

$$B \rightarrow BAX | BX | Ax | a$$

$$\text{Let } R \rightarrow XY, T \rightarrow AB, M \rightarrow AX$$

$$S \rightarrow RT | RB | RA | XY$$

$$A \rightarrow YT | YB | YA | b$$

$$B \rightarrow BM | BX | Ax | a$$

is the CNF form

$$e) S \rightarrow aslAc$$

$$A \rightarrow a$$

$$B \rightarrow aa$$

$$C \rightarrow aCb$$

Solⁿ: ∵ S is on RHS ∴ S' → S

Step 1:-

$$S \rightarrow A, S \rightarrow C$$

$$\therefore S \rightarrow aslAc$$

Step 2:-

$$A \rightarrow a, B \rightarrow aa, C \rightarrow aCb$$

∴ All these symbols are
unreachable.

final Grammar:-

$$S \rightarrow aslAc$$

Step 3:-

$$\text{Let } x \rightarrow a, y \rightarrow c, z \rightarrow b$$

$$\therefore S \rightarrow xs | a | xyz, S' \rightarrow xs | a | xyz$$

Step 4: Let M → xyz

$$\therefore S \rightarrow xs | a | Mz, S' \rightarrow xs | a | Mz$$

$$x \rightarrow a, y \rightarrow c, z \rightarrow b$$

is the CNF form.

f) $S \rightarrow aB|bA$

$$A \rightarrow a|as|baA$$

$$B \rightarrow b|bs|aBB$$

Soln. :- S on RHS $\therefore S' \rightarrow S$

Step 1 :- Let $x \rightarrow a, y \rightarrow b$

$$S \rightarrow XB|YA$$

$$A \rightarrow a|xS|R_A, B \rightarrow b|yS|T_B$$

$$R_A \rightarrow b|ys|XB$$

Step 2 :- Let $R \rightarrow YA, T \rightarrow XB$

$$S \rightarrow XB|YA, S' \rightarrow XB|YA$$

$$A \rightarrow a|xS|R_A, B \rightarrow b|yS|T_B$$

is the CNF form.

g) $S \rightarrow aABR$

$$A \rightarrow aAa$$

$$B \rightarrow bB|b$$

Soln. Step 1 :-

Let $x \rightarrow a, y \rightarrow b$

$$S \rightarrow XAYB$$

$$A \rightarrow xA|a$$

$$B \rightarrow yB|b$$

Step 2 :-

Let $R \rightarrow XA, T \rightarrow YB$

$$S \rightarrow RT$$

$$A \rightarrow xA|a$$

$$B \rightarrow yB|b$$

is the CNF form.