3. Grammar

Def^n:- The <u>set</u> of all the <u>rules</u> which are <u>used</u> to generate the <u>strings</u> is called as <u>Grammar</u>.

(or)

Grammar is <u>4-tuple</u> $G = \{V, T, P, S\}$

where, $V \Rightarrow$ Set of all variables & nonterminals

$T \Rightarrow$ Set of all terminals.

$P \Rightarrow$ Set of all productions $(\rightarrow)$

$S \Rightarrow$ Start symbol.

$\Rightarrow$ Grammar is <u>generating</u> device & automata is <u>accepting</u> device.

Ex:-
$$S \rightarrow aS$$
$$S \rightarrow \epsilon$$

terminal $\Rightarrow a$

Non-terminal $\Rightarrow S$

$\rightarrow$ Production (P)

$L(G) = a^*$

$V = \{S\}$; $T = \{a\}$

Set of terminals
$$T = \begin{cases} = (a, b, \ldots z) \\ = (0, 1, \ldots 9) \\ = (+, -, @, *, (,) \ldots) \end{cases}$$

Ex:-

1) $S \rightarrow ABC$ (r_1)
   $A \rightarrow a$ (r_2)
   $B \rightarrow b$ (r_3)
   $C \rightarrow c$ (r_4)

$\Rightarrow$

$V = \{ S, A, B, C \}$

$T = \{ a, b, C \}$

$P = \{ r_1, r_2, r_3, r_4 \}$

$S = \{ S \}$

$S \rightarrow \underline{A}BC$

$\rightarrow \underline{a} \underline{\underline{B}}C$ ($\because$ $A \rightarrow a$)

$\rightarrow ab\underline{C}$ ($\because$ $B \rightarrow b$)

$\rightarrow \underline{\underline{abc}}$ ($C \rightarrow c$)

$L(G) = \{ abc \}$

② $E \rightarrow E + E$
$E \rightarrow E - E$
$E \rightarrow E = E$ ⎫
$E \rightarrow (E)$ ⎬ P
$E \rightarrow id$ ⎭

$V = \{E\}$

$T = \{+, -, =, (,), id\}$

$S = \{*E\}$

Note:—

1) Grammar is generating device

2) If G is grammar then L(G) is the language generated by G.

3) Every grammar has only one start symbol & the derivation of a string always starts with start symbol.

4) If S is start symbol of grammar G then w ∈ L(G)

Derivation:-

The process of deriving a string is called as derivation & geometrical representation is called as derivation tree (or) Parse tree.

Derivation	Derivation/Parse Tree

Derivation

$S \rightarrow ABC$
$A \rightarrow a$
$B \rightarrow b$
$C \rightarrow c$

$S \rightarrow ABC$ ⎫
$\rightarrow aBC$ ⎪
$\rightarrow abC$ ⎬ Sentential Form
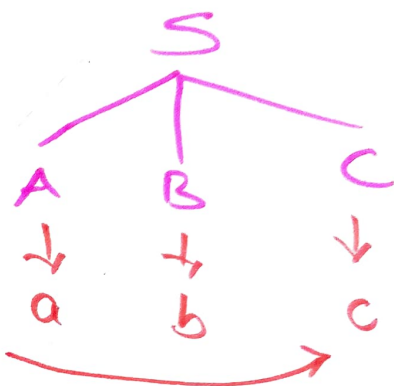$\rightarrow abc$ ⎭

$L(G) = \{abc\}$

Derivation/Parse Tree

S
├── A → a
├── B → b
└── C → c

Always take the string from left to right.

Sentential Form:- Every intermediate step involved in the derivation is called as Sentential form.

$S \rightarrow ABC$ ⎫
$\rightarrow aBC$ ⎪
$\rightarrow abC$ ⎬ Sentential Form
$\rightarrow abc$ ⎭