is converted into Chomsky normal form (CNF), one can easily answer whether a particular string is generated by the grammar or not. A polynomial time algorithm called CYK algorithm can be constructed to check this. For a CFG converted into CNF, the parse tree generated from the CNF is always a binary tree. Similarly, if a CFG is converted into Greibach normal form (GNF), then a PDA accepting the language generated by the grammar can easily be designed. In this section we shall leam mainly two types of normal forms: (a) CNF and (b) GNF.

6.7 .1 Chomsky Normal Form

A CFG is said to be in CNF if all the productions of the grammar are in the following form

$$\text{Non-terminal} \rightarrow \text{String of exactly two non-terminals}$$
$$\text{Non-terminal} \rightarrow \text{Single terminal}$$

A CFG can be converted into CNF by the following process.

Step I:
1. Eliminate all the ϵ -production.
2. Eliminate all the unit production.
3. Eliminate all the useless symbols.

Step II:
1. **if** (all the productions are in the form NT $\rightarrow$ string of exactly two NTs or NT $\rightarrow$ Single terminal) Declare the CFG is in CNF. And stop.
2. **else** (follow step III and/or IV and/or V).

Step III: (Elimination of terminals on the RHS of length two or more.)
Consider any production of the form

$$\mathrm{NT} \rightarrow \mathrm{T}_1\ \mathrm{T}_2 \ldots . \mathrm{T}_n$$

where n $\geq$ 2 (T means terminal and NT means noo-terminal). For a terminal T, introduce a new variable (non-terminal) say NT, and a corresponding production NT, $\rightarrow$ T, Repeat this for every terminal on the RHS so that every production of the grammar has either a single terminal or two or more variables.

Step Iv: (Restriction of the number of variables on the RHS to two.)
Consider any production of the form

$$\mathrm{NT} \rightarrow \mathrm{NT}_1\mathrm{NT}_2 \ldots \mathrm{NT}_n$$

where n $\geq$ 3.
The production $\mathrm{NT} \rightarrow \mathrm{NT}_1\mathrm{NT}_2 \ldots \mathrm{NT}_n$ is replaced by new productions

$$\mathrm{NT} \rightarrow \mathrm{NT}_1\ \mathrm{A}_1$$
$$\mathrm{A}_1 \rightarrow \mathrm{NT}_2\ \mathrm{A}_2$$
$$\mathrm{A}_2 \rightarrow \mathrm{NT}_3\ \mathrm{A}_3$$
$$\ldots\ldots\ldots\ldots\ldots\ldots$$
$$\ldots\ldots\ldots\ldots\ldots\ldots$$
$$\mathrm{A}_{\mathrm{a}-2} \rightarrow \mathrm{NT}_{\mathrm{n}-1}\mathrm{NT}_{\mathrm{n}}$$

Here the A_1 's are new variables.