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AT TUTORIAL NO: 6

Q.1] Convert the following grammar to CNF

$$S \rightarrow bA \mid aB$$
$$A \rightarrow bAA \mid aS \mid a$$
$$B \rightarrow aBB \mid bS \mid b$$

Ans: After simplification,

$$S_0 \rightarrow S$$

$$S \rightarrow bA \mid aB$$
$$A \rightarrow bAA \mid aS \mid a$$
$$B \rightarrow aBB \mid bS \mid b$$

After removing RHS with terminal and non-terminal and more than two non-terminals.

$$S_0 \rightarrow S$$

$$P \rightarrow a \qquad Q \rightarrow b$$

$$S \rightarrow QA \mid PB$$

$$A \rightarrow QAA \mid PS \mid a$$
$$B \rightarrow PBB \mid QS \mid b$$

$$S_0 \rightarrow S$$

$$P \rightarrow a \qquad Q \rightarrow b$$

$$T \rightarrow AA \qquad U \rightarrow BB$$

$$A \rightarrow QT \mid PS \mid a$$
$$B \rightarrow PU \mid QS \mid b$$

Q.2] Convert the following grammar to CNF.

$$S \longrightarrow XA \mid BB$$
$$B \longrightarrow b \mid SB$$
$$X \longrightarrow b$$
$$A \longrightarrow a$$

Ans: Let $P \rightarrow a \qquad Q \rightarrow b$

$$S \longrightarrow PAQB$$
$$A \longrightarrow PA \mid a$$
$$B \longrightarrow QB \mid b$$

Let $R \rightarrow PA$, $T \rightarrow QB$

$$S \longrightarrow RT$$
$$A \longrightarrow R \mid a$$
$$B \longrightarrow T \mid b$$
$$R \longrightarrow PA \qquad\qquad T \longrightarrow QB$$

Q.3] Find the CNF equivalent to

$$S \longrightarrow aAbB$$
$$A \longrightarrow aA \mid a$$
$$B \longrightarrow bB \mid b$$

Ans: Let $P \rightarrow a$, $Q \longrightarrow b$

$$S \longrightarrow PAQB$$
$$A \longrightarrow PA \mid a$$
$$B \longrightarrow QB \mid b$$

Let $R \rightarrow PA \qquad T \rightarrow QB$

$$S \longrightarrow RT$$
$$A \longrightarrow R \mid a$$
$$B \longrightarrow T \mid b$$
$$R \longrightarrow PA$$
$$T \longrightarrow QB$$

Q4] Convert given CFG to CNF.

$$S \longrightarrow ASB \mid \epsilon$$
$$B \longrightarrow sbs \mid A \mid bb$$
$$A \longrightarrow aAS \mid a$$

Ans Elimination ϵ production,

$$S \longrightarrow ASB \mid AB$$
$$B \longrightarrow sbs \mid A \mid bb \mid Sb \mid bS \mid b$$
$$A \longrightarrow aAS \mid a \mid aA$$

Eliminating

$$S \longrightarrow ASB \mid AB$$
$$A \longrightarrow aAS \mid a \mid aA$$
$$B \longrightarrow sbs \mid bb \mid sb \mid bS \mid b \mid aAS \mid a \mid aA$$

Simplifying,

$$S_0 \longrightarrow S$$
$$S \longrightarrow ASB \mid AB$$
$$A \longrightarrow aAS \mid a \mid aA$$
$$B \longrightarrow sbs \mid bb \mid Sb \mid bS \mid b \mid aAS \mid a \mid aA$$

Removing unit production:

$$S_0 \longrightarrow ASB \mid AB$$
$$S \longrightarrow ASB \mid AB$$
$$A \longrightarrow aAS \mid a \mid aA$$
$$B \longrightarrow sbs \mid bb \mid sb \mid bS \mid b \mid aAS \mid a \mid aA$$

Let $P \longrightarrow a$ $Q \longrightarrow b$ $R \longrightarrow aA$ $T \longrightarrow bS$ $U \longrightarrow SB$

$$S_0 \longrightarrow AU \mid AB \qquad S \longrightarrow AU \mid AB$$
$$A \longrightarrow RS \mid a \mid PA$$
$$B \longrightarrow ST \mid QQ \mid SQ \mid QS \mid RS \mid b \mid a \mid AA$$