Roll No. - 17103011

ToC Assignment - 5

① $L(G) = \{ w \in (a,b)^* \mid n_a(w) = n_b(w) \}$

③ $G = \{ \{S\}, \{a,b\}, P, S \}$

$P : \{ S \rightarrow asb \mid bsa \mid ss \mid \epsilon \}$

Converting this to CNF

$P' : S \rightarrow AY \mid BX \mid ss \mid \epsilon$

$Y \rightarrow SB$

$X \rightarrow SA$

$A \rightarrow a$

$B \rightarrow b$

$G' = \{ \{S, X, Y, A, B\}, \{a,b\}, P', S \}$

② $L(G) = \{ a^n b^m a^n \mid m, n \geq 1 \}$

$G = \{ \{S, X\}, \{a,b\}, P, S \}$

$P = \{ S \rightarrow asa \mid aXa$

$X \rightarrow bX \mid b \}$

Converting to CNF

$P' : S \rightarrow AC \mid AD$

$X \rightarrow BX \mid b$

$C \rightarrow SA$

$D \rightarrow XA$

$A \rightarrow a$

$B \rightarrow b$

$G = \{\{S, X, A, B, C, D\}, \{a, b\}, P', S\}$

③ $S \rightarrow S+S \mid S*S \mid a \mid b$

Reducing to GNF

Step 1 $S \rightarrow SAS \mid SBS \mid a \mid b$

$A \rightarrow +$

$B \rightarrow *$

Step 2 $S \rightarrow SCa \mid SCb \mid a \mid b$

$C_a \rightarrow AS$

$C_b \rightarrow BS$

$A \rightarrow *$

$B \rightarrow +$

Now convert to GNF

$A_1 \rightarrow AA_2 \mid A_1A_3$

$A_2 \rightarrow A_4A_1$

$A_3 \rightarrow A_5A_1$

$A_4 \rightarrow *$

$A_5 \rightarrow +$

$A_1 \rightarrow a \mid b$

after modification

P: $A_1 \rightarrow aA_2 \mid bA_2 \mid aA_3 \mid bA_3 \mid a \mid b$

$A_2 \rightarrow *A_1$

$A_3 \rightarrow +A_1$

$A_4 \rightarrow *$

$A_5 \rightarrow +$

GNF converted : $G = \{ \{S, A_1, A_2, A_3, A_4, A_5\}, \{*, a, b, +\}, P', A_1 \}$

(4) $S \rightarrow 0S0 \mid 1S1 \mid A$

$A \rightarrow 2B3$

$B \rightarrow 2B3 \mid 3$

Removing unit production $S \rightarrow A$

$S \rightarrow 0S0 \mid 1S1 \mid 2B3$

$B \rightarrow 2B3 \mid 3$

Reducing it to GNF

$S \rightarrow 0SX \mid 1SY \mid 2BZ$

$B \rightarrow 2BZ \mid 3$

$X \rightarrow 0$

$Y \rightarrow 1$

$Z \rightarrow 3$

(5)

$S \rightarrow AB$

$A \rightarrow a$

$B \rightarrow C \mid b$

$C \rightarrow D$

$D \rightarrow E$

$E \rightarrow a$

Removing the unit production $D \rightarrow E$

$S \rightarrow AB$

$A \rightarrow a$

$B \rightarrow C \mid b$

$C \rightarrow D$

$D \rightarrow a$

Removing the unit production $C \rightarrow D$

$S \rightarrow AB$

$A \rightarrow a$

$B \rightarrow C \mid b$

$C \rightarrow a$

Removing the unit production $B \rightarrow C$

$S \rightarrow AB$

$A \rightarrow a$

$B \rightarrow a \mid b$

Reducing to GNF

$S \rightarrow aB$

$B \rightarrow a \mid b$