

Institute Of Technology, Nirma University
B.Tech. (CE) Sem VI
2CS601 Theory of Computation

Tutorial 6

Q-1 Design CFG for the following languages:

- a. $\{a^i b^j c^k \mid i = j + k\}$
- b. $\{a^i b^j c^k \mid j = i + k\}$
- c. $\{a^i b^j c^k \mid j = i \text{ or } j = k\}$
- d. $\{a^i b^j c^k \mid i = j \text{ or } i = k\}$
- e. $\{a^i b^j c^k \mid i < j \text{ or } i > k\}$
- f. $\{a^i b^j \mid i \leq 2j\}$
- g. $\{a^i b^j \mid i < 2j\}$
- h. $\{a^i b^j \mid i \leq j \leq 2i\}$

Q.2 In each case, what languages are generated for the following CFGs:

1. $S \rightarrow aSa \mid bSb \mid \Lambda$
2. $S \rightarrow aSa \mid bSb \mid a \mid b$
3. $S \rightarrow aSb \mid bSa \mid \Lambda$
4. $S \rightarrow aSa \mid bSb \mid aAb \mid bAa$
 $A \rightarrow aAa \mid bAb \mid a \mid b \mid \Lambda$
5. $S \rightarrow aS \mid bS \mid a$
6. $S \rightarrow SS \mid bS \mid a$
7. $S \rightarrow SaS \mid b$
8. $S \rightarrow aT \mid bT \mid \Lambda$
 $T \rightarrow aS \mid bS$

Q.3 Consider the CFG with productions $S \rightarrow aSbScS \mid aScSbS \mid bSaScS \mid bScSaS \mid cSaSbS \mid cSbSaS \mid \Lambda$. Does this generate the language $\{x \in \{a,b,c\}^* \mid n_a(x) = n_b(x) = n_c(x)\}$? Prove your answer.

Q:4 Convert the following CFG to Chomsky Normal Form:

1. $S \rightarrow aAbB$
 $A \rightarrow Ab \mid b$
 $B \rightarrow Ba \mid a$
2. $S \rightarrow aA \mid bB$
 $A \rightarrow bAA \mid a$
 $B \rightarrow BBa \mid b$
3. $S \rightarrow aAC$
 $A \rightarrow aB \mid bAB$

do not consider this :
 $S \rightarrow \text{null}$
 $A \rightarrow S$

$B \rightarrow b$

$C \rightarrow c$

4. $S \rightarrow 0X1Y$

$X \rightarrow 0X \mid 0$

$Y \rightarrow 1Y \mid 1$

5. $S \rightarrow abSab \mid a \mid aAAb$

$A \rightarrow bS \mid aAAb \mid c$

Q:5 Explain the term ambiguity and prove that the following grammar is ambiguous grammar.

$S \rightarrow S+S \mid S-S \mid S*S \mid S-S|a$

Q:6 Remove unit productions from the following grammar and generate equivalent grammar:

1. $S \rightarrow ABC \mid 0$

$A \rightarrow 1$

$B \rightarrow C \mid 0$

$C \rightarrow D$

$D \rightarrow E$

$E \rightarrow 2$

2. $S \rightarrow ABCD \mid 0$

$A \rightarrow BC \mid 1$

$B \rightarrow C$

$C \rightarrow D$

$D \rightarrow d$