



**PES UNIVERSITY, Bangalore**  
(Established under Karnataka Act No. 16 of 2013)  
**Department of Computer Science & Engineering**

**Automata Formal Languages & Logic**

**Unit 3**

**Chomsky Normal Norm**

- 1) Convert the following CFG into an equivalent CFG in Chomsky normal form

$$S \rightarrow ASA \mid B \mid \lambda$$

$$A \rightarrow 00 \mid \lambda$$

- 2) Convert the following grammar to Chomsky Normal Form

$$S \rightarrow X \mid XYa \mid XbX$$

$$X \rightarrow Xa \mid \lambda$$

$$Y \rightarrow Yb \mid YZ$$

$$Z \rightarrow ZY \mid ZX \mid bY$$

- 3) If G is the grammar in CNF, then fill the following table

w	w	Length of derivation	Max depth of the tree	Min depth of the tree
$\lambda$				
$a_1$				
$a_1a_2$				
$a_1a_2a_3$				
$a_1a_2a_3a_4$				
$a_1a_2a_3a_4a_5$				
$a_1a_2a_3a_4a_5a_6$				

4) Convert the following CFG to CNF

$S \rightarrow aAa \mid bBb \mid BB$

$A \rightarrow C$

$B \rightarrow S \mid A$

$C \rightarrow S \mid \lambda$

5) Design a CNF grammar for the set of strings of balanced parentheses.

### CYK

1) Determine whether the string 00111 is the member of the language generated by the grammar

$S \rightarrow XY$

$X \rightarrow YY \mid 0$

$Y \rightarrow XY \mid 1$

2) Determine whether the string 0011 is the member of the language generated by the grammar

$S \rightarrow XY$

$X \rightarrow YY \mid 0$

$Y \rightarrow XY \mid 1$

3) Determine whether the string 11000 is the member of the language generated by the grammar

$S \rightarrow PQ \mid QR$

$P \rightarrow QP \mid 0$

$Q \rightarrow RR \mid 1$

$R \rightarrow PQ \mid 0$

4) Determine whether the string 00000 is the member of the language generated by the grammar

$S \rightarrow PQ \mid QR$

$P \rightarrow QP \mid 0$

$Q \rightarrow RR \mid 1$

$R \rightarrow PQ \mid 0$

5) Determine whether the string aabbbcc is the member of the language generated by the grammar

$S \rightarrow AB$

$A \rightarrow CD \mid CF$   
 $B \rightarrow c \mid EB$   
 $C \rightarrow a$   
 $D \rightarrow b$   
 $E \rightarrow c$   
 $F \rightarrow AD$

### Greibach Normal Form

- 1) Give the relationship between the length of a string and the length of its derivation if the grammar is given in GNF?

- 2) Convert the grammar into Greibach normal form.

$S \rightarrow XY1 \mid 0$   
 $X \rightarrow 00X \mid Y$   
 $Y \rightarrow 1X1 \mid \lambda$

- 3) Convert the following grammar G into Greibach Normal Form (GNF)

$S \rightarrow CA \mid BB$   
 $B \rightarrow b \mid cB$   
 $C \rightarrow b$   
 $A \rightarrow a$

- 4) Consider the following CFG, find the number of productions in the grammar after it is converted into Greibach normal form.

$S \rightarrow XX \mid a$   
 $X \rightarrow aaS \mid b$

- 5) Convert the grammar

$S \rightarrow XY1 \mid 0$   
 $X \rightarrow 00X \mid 1$   
 $Y \rightarrow 1X1 \mid 1YY \mid XYY \mid 0$

### CFG to PDA

- 1) Construct PDA for the following grammar

$S \rightarrow 00S1 \mid 0S01 \mid 01S0 \mid 0S10 \mid 10S0 \mid 1S00 \mid \lambda$

- 2) Give an instantaneous description to show that the grammar below accepts the string 000010101000100011

$$S \rightarrow 00S1 \mid 0S01 \mid 01S0 \mid 0S10 \mid 10S0 \mid 1S00 \mid \lambda$$

3) Construct PDA for the following grammar

$$S \rightarrow 0AB1$$

$$A \rightarrow BAS \mid \lambda$$

$$B \rightarrow 0 \mid 1$$

4) Construct PDA for the following

$$S \rightarrow 0XYX \mid 0YY$$

$$X \rightarrow 1X \mid 1$$

$$Y \rightarrow 2Y \mid 2$$

5) Construct PDA for the following

$$S \rightarrow aSb \mid a \mid b \mid \lambda$$