Branch : CSE & IT **Batch : Hinglish**

Theory of Computation

Push Down Automata

Context Free Grammar

DPP 01

[MCQ]

1. Consider the following grammar:

$S \rightarrow abSba|bSb|aSa|a|b|\in$

What is the language generated by above grammar?

(a) CFG that generates all palindromes over alphabet (a, b).

(b) CFG that generates all palindromes over alphabet (a, b) that do not contain substring "ab".

(c) CFG that generates all palindromes over alphabet (a, b) that contain substring "aa".

(d) CFG that generates all palindromes over alphabet (a, b) that do not contain substring "aa".

[MCQ]

2. Consider the following grammars:

G_1: $S \rightarrow aSc \mid \$\ B$

$B \rightarrow bBc \mid \$$

G_2: $S \rightarrow aaScc \mid \$\ B$

$B \rightarrow bBc \mid \$$

G_3: $S \rightarrow aSc \mid \$\ B$

$B \rightarrow bbBcc \mid \$$

Which of the following is true regarding G_1, G_2 and G_3?

(a) $L(G_1) \subseteq L(G_2), L(G_2) \subseteq L(G_3)$

(b) $L(G_2) \subseteq L(G_3), L(G_1) \subseteq L(G_3)$

(c) $L(G_1) \subseteq L(G_3), L(G_3) \subseteq L(G_2)$

(d) $L(G_2) \subseteq L(G_1), L(G_3) \subseteq L(G_1)$

[MCQ]

3. Consider the following context free grammar:

$S \rightarrow aA \mid aBB$

$A \rightarrow aaA \mid \in$

$B \rightarrow bB \mid bbC$

$C \rightarrow B$

What will be the equivalent simplified CFG for the given grammar?

(a) $S \rightarrow aA \mid a$

$A \rightarrow aaA \mid aa \mid b$

(b) $S \rightarrow aA \mid a$

$A \rightarrow aaA \mid aa$

(c) $S \rightarrow aAa \mid B$

$A \rightarrow aaA \mid aa$

$B \rightarrow bB \mid bb$

(d) $S \rightarrow aAa \mid B$

$A \rightarrow aA \mid b$

$B \rightarrow bB \mid bb \mid a$

[MSQ]

4. Consider the following grammar:

$S \rightarrow AB$

$A \rightarrow BaB \mid a$

$B \rightarrow bbA$

Which of the following is true regarding given grammar?

(a) Every string of the above grammar have at least two a's.

(b) Every string have three consecutive a's.

(c) Every string have alternate a and b.

(d) Every string have b's in multiple of 2.

[NAT]

5. Consider the following grammar G:

$S \rightarrow XA \mid BB$

$B \rightarrow b \mid SB$

$X \rightarrow b$

$A \rightarrow a$

After converting above grammar into GNF how many productions are there in the grammar?

[MSQ

6. Which of the following is true

(a) A grammar is called ambiguous if
(No. of parse tree's = No. of left most derivation = Number of Right most derivation) > 1

(b) Production of the form $A \rightarrow a$ is known as unit production.

(c) CNF is also known as binary standard form.

(d) In left-most derivation, right most non-terminal is substituted with its production to derive a string.

[MCQ]

7. Given the following two grammars:

G_1: $S \rightarrow AB \mid aaB$
$A \rightarrow a \mid Aa$
$B \rightarrow b$

G_2: $S \rightarrow aSbS \mid bSaS \mid \in$

What is true regarding above grammars?

(a) Both G_1 and G_2 are ambiguous.

(b) Both G_1 and G_2 are unambiguous.

(c) Only G_1 is ambiguous.

(d) Only G_1 is unambiguous.

[MCQ]

8. Consider the following languages

$L_1 = \{a^n b^{n+m} c^m \mid n, m \geq 0\}$

$L_2 = \{a^p b^q c^{p+q} \mid p, q \geq 0\}$

Which of the following is true?

(a) Only L_1 is Regular.

(b) Only L_2 is Regular.

(c) Both L_1 and L_2 are Regular.

(d) None of these

Answer Key

1. **(a)**
2. **(d)**
3. **(b)**
4. **(a, d)**
5. **(18)**
6. **(a, b, c)**
7. **(a)**
8. **(d)**

Hints & Solutions

1. (a)

Given

$S \rightarrow abSba \mid bSb \mid aba \mid a \mid b \mid \in$

Strings formed using above grammar are:

{∈, a, b, aa, bb, ...}

This is the CFG that generates all palindromes over alphabet (a, b).

So, option (a) is correct answer.

2. (d)

$L(G_1) = \{a^m \$ b^n \$ c^{m+n} \mid m, n \geq 0\}$

$L(G_2) = \{a^{2m} \$ b^n \$ c^{2m+n} \mid m, n \geq 0\}$

$L(G_3) = \{a^m \$ b^{2n} \$ c^{m+2n} \mid m, n \geq 0\}$

$\therefore$ It is clear,

$L(G_2) \subseteq L(G_1)$, and

$L(G_3) \subseteq L(G_1)$

Therefore, option d is correct.

3. (b)

Simplified CFG is a CFG without any null productions, unit-productions and useless symbol.

1. Elimination of NULL Productions:

   $A \rightarrow \in$

   Keep all the productions as it is and substitute ∈ in place of A.

   $S \rightarrow aA \mid aBB \mid a$

   $A \rightarrow aaA \mid aa$

   $B \rightarrow bB \mid bbC$

   $C \rightarrow B$

2. Eliminate Unit Productions: If the productions is of the form $A \rightarrow B$, the production is known as unit production. Eliminate unit production by replacing equivalent derivations.

   $S \rightarrow aA \mid aBB \mid a$

   $A \rightarrow aaA \mid aa$

   $B \rightarrow bB \mid bbB$

3. Eliminate useless symbol: The variables that are not involved the derivation of any string is known as useless symbol.

   In this question B is deriving bB | bbB which is entering into infinite loop. So, eliminating all productions of B.

   $S \rightarrow aA \mid a$

   $A \rightarrow aaA \mid aa$

Hence, options (b) is the correct answer.

4. (a, d)

The string produced by given grammar is

{abba, abbaabba, ……}

So option (a) and (d) are the true statements.

5. (18)

After converting the given grammar to GNF.

The final grammar will be.

$S \rightarrow bA \mid bB'B \mid bABB'B \mid bB \mid bABB$

$B \rightarrow bB' \mid bABB' \mid b \mid bAB$

$B' \rightarrow bB'BB' \mid bABB'\,BB' \mid bBB' \mid bABBB' \mid bB'B \mid bABB'B \mid bB \mid bABB$

$A \rightarrow a$

So, the total productions are 18.

6. (a, b, c)

According to definition of Ambiguous grammar, if there exist more than are parse tree for a string, then it is ambiguous grammar, option a is correct.

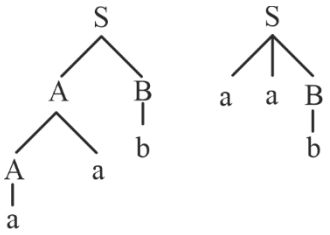
Production of the form $A \rightarrow a$ is known as unit production.

CNF is also known as binary standard form because the parse tree in CNF is always a binary tree.

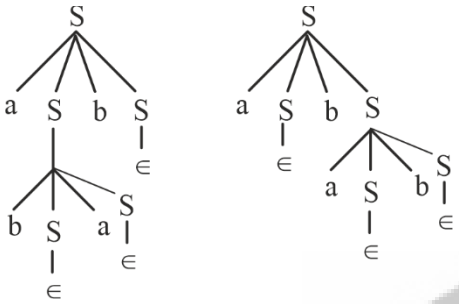
7. (a)

Both G_1 and G_2 are ambiguous, as both have multiple parse tree for same string.

G_1: aab



G_2: abab



8. (d)

$L_1 = \{\in, ab, bc, aabb, bbcc, \ldots\ldots\}$

$L_2 = \{\in, ac, bc, aacc, bbcc, \ldots\ldots\}$

Both the languages are CFL not regular.

Therefore option (d) is correct.