

Question-1

18F0139

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Assignment-06

1) $\{a^m b^n \mid m \geq n\}$

Sol:- $S \rightarrow A S_1$

$$S_1 \rightarrow a S_1 b \mid \lambda$$

$$A \rightarrow a A \mid \lambda$$

2) $\{a^m b^n c^p d^q \mid m+n = p+q\}$

Sol:- $S \rightarrow a S d \mid T \mid U$

$$T \rightarrow a T c \mid v$$

$$U \rightarrow b u d \mid v$$

$$V \rightarrow b v c \mid \lambda$$

3) $\{w \in (a+b)^* \mid w \text{ has twice as many } b\text{'s as } a\text{'s}\}$

Sol:-

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

4) $\{u^a w^b : u, w \in (a+b)^*, |u| = |w|\}$

Sol:-

$$S \rightarrow T b$$

$$T \rightarrow a T b \mid b T a \mid a$$

$$T \rightarrow a T a \mid b T b$$

Question # 2

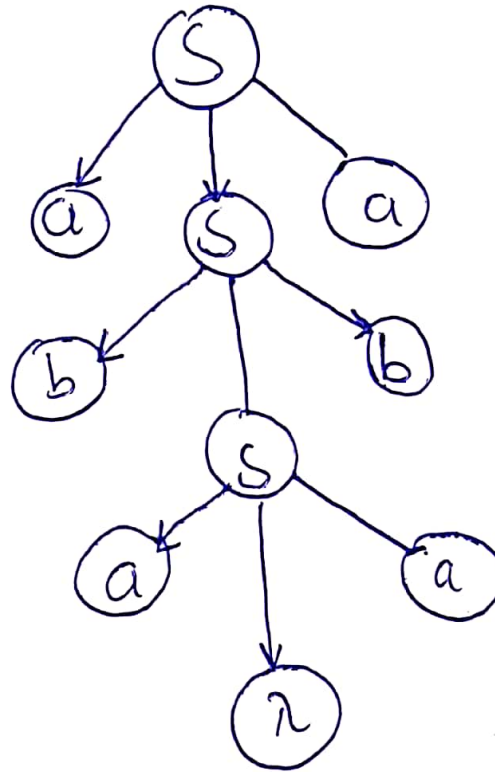
1).

$$S \rightarrow aSa$$

$$S \rightarrow bSa$$

$$S \rightarrow \lambda$$

Sol:-



Question #3

$$L = \{uvw^R : u, v, w \in \{a, b\}^+; |u| = |w| = 2\}$$

Sol:-

$$S \rightarrow AB$$

$$A \rightarrow aa|ab|ba|bb$$

$$B \rightarrow aBa|bBb|aAa|bAb$$

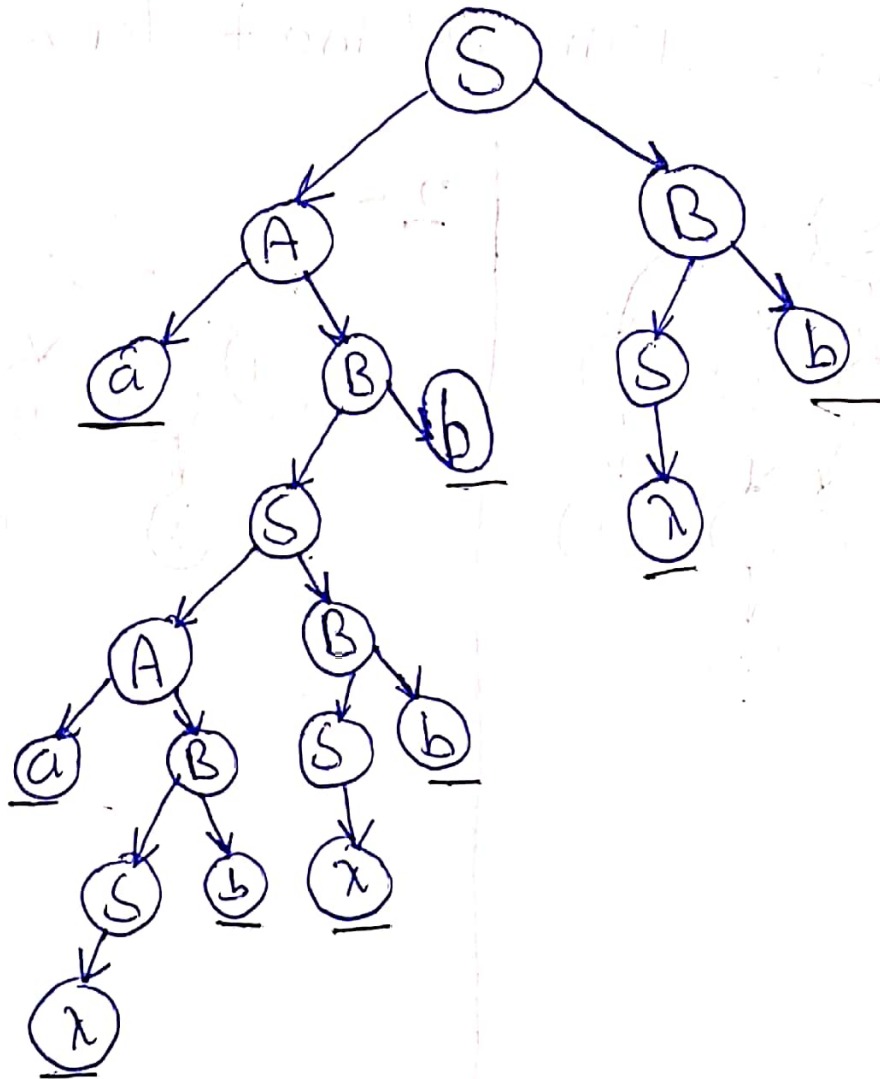
Question #4

aabbbb :-

from:-

$$S \rightarrow AB \mid \lambda$$
$$A \rightarrow aB$$
$$B \rightarrow Sb$$

Sol:-



Underlined Nodes are the final states.

Question # 5

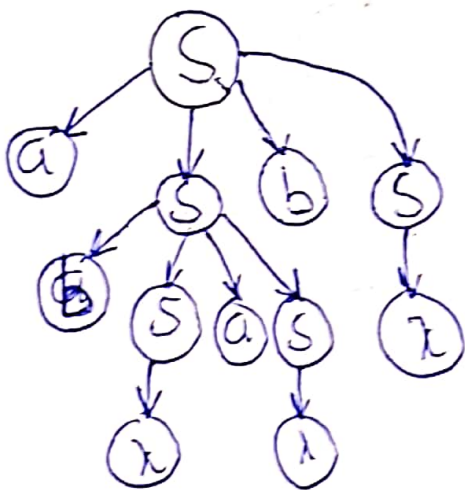
$S \rightarrow aSbS \mid bSaS \mid \lambda$ is ambiguous?

Sol:- Grammar is said to be ambiguous only if there exists multiple left or right most derivation on same string.

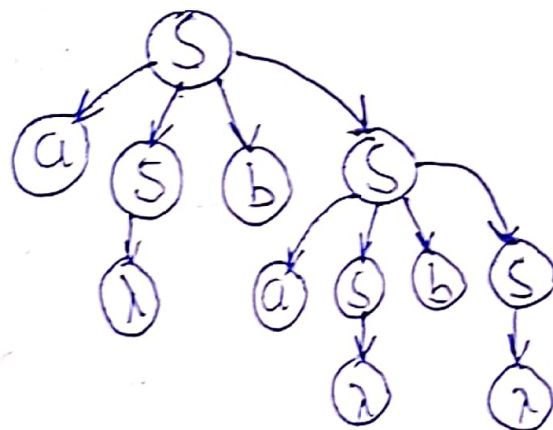
Let: take example string for test:

$S \Rightarrow abab$ using left most derivation

1-



2-



So, grammar is ambiguous

Question: 6

$$S \rightarrow AaB/aaB$$

$$A \rightarrow \lambda$$

$$B \rightarrow bbA/\lambda$$

Sol:-

A & B are Nullable

therefore Putting value of $A \rightarrow \lambda$

$$S \rightarrow AaB/aaB/ab$$

$$B \rightarrow bbA/\lambda/bb$$

$$A \rightarrow \lambda$$

Now Putting value of $B \rightarrow \lambda$

$$S \rightarrow AaB/aaB/aB/Aa/aa/a$$

$$B \rightarrow bbA/bb$$

~~A~~ Removal of A as it doesn't exist.

$$S \rightarrow aB/aaB/aB/a/aa/a$$

$$B \rightarrow bb/bb$$

Removing duplicates:-

$$\begin{aligned} S &\rightarrow aB/aaB/a/aa \\ B &\rightarrow bb \end{aligned}$$

→ final grammar after
eliminating all λ
~~empty~~ production

Question: 7

$$S \rightarrow a|aA|B|c$$

$$A \rightarrow aB|\lambda$$

$$B \rightarrow Aa$$

$$C \rightarrow cCD$$

$$D \rightarrow ddd$$

Eliminate all unit Production:-

Sol:- here unit Production are

$$S \rightarrow B, S \rightarrow C$$

apply Transitive Property

$$S \rightarrow B \rightarrow Aa, S \rightarrow C \rightarrow cCD$$

Now

$$S \rightarrow a|aA|Aa|cCD$$

$$A \rightarrow AB|\lambda$$

$$C \rightarrow cCD$$

$$B \rightarrow Aa$$

$$D \rightarrow ddd$$

is the final grammar.

Question-8

$$S \rightarrow abAB$$

$$A \rightarrow bAB/\lambda$$

$$B \rightarrow BAa/A/\lambda$$

Sol:-

Removing λ Productions
 λ variables $\rightarrow \{A, B\}$

Removing A

$$S \rightarrow abAB/abB$$

$$A \rightarrow bAB/bB$$

$$B \rightarrow BAa/A/\lambda/Ba$$

Removing B

$$S \rightarrow abAB/abB/abA/ab$$

$$A \rightarrow bAB/bB/bA/b$$

$$B \rightarrow BAa/A/Ba/Aa/a$$

Removing unit Production:-

Removing : $B \rightarrow A$

$$S \rightarrow abB/abAB/abA/ab$$

$$A \rightarrow bAB/bAB/bB/bA/b$$

$$B \rightarrow bAB/bB/BAa/bA/b/Ba/Aa/a$$

Converting to chomsky normal form:

Using $S_a \rightarrow a$, $S_b \rightarrow b$

$$S \rightarrow S_a S_b A B \mid S_a S_b B \mid S_a S_b A \mid S_a S_b$$

$$A \rightarrow S_b A B \mid S_b B \mid S_b A \mid S_b$$

$$B \rightarrow B A S_a \mid S_b A B \mid S_b B \mid S_b A \mid S_b \mid B S_a \mid A S_a \mid S_a$$

$$S_a \rightarrow a$$

$$S_b \rightarrow b$$

Now adding additional variables

$$V \rightarrow AB, U \rightarrow S_b V, X \rightarrow S_b V, X \rightarrow S_b B, Y \rightarrow S_b A \\ Z \rightarrow A S_a$$

$$S \rightarrow S_a U \mid S_a X \mid S_a Y \mid S_a S_b$$

$$A \rightarrow S_b V \mid S_b A \mid S_b B \mid S_b$$

$$B \rightarrow B Z \mid A S_a \mid B S_a \mid S_a \mid S_b V \mid S_b A \mid S_b B \mid S_b$$

$$S_a \rightarrow a$$

$$S_b \rightarrow b$$

Converted to chomsky Normal form:

Question #9

$$S \rightarrow aA | aBB$$

$$A \rightarrow aaA | \lambda$$

$$B \rightarrow bB | bbc$$

$$C \rightarrow B$$

Sol: Removing λ production

$$A \rightarrow \lambda$$

$$S \rightarrow aA | aBB | a$$

$$A \rightarrow aaA | aa$$

$$B \rightarrow bB | bbc$$

$$C \rightarrow B$$

Removing unit production:

$$C \rightarrow B$$

$$S \rightarrow aA | aBB | a$$

$$A \rightarrow aaA | aa$$

$$B \rightarrow bB | bbc$$

$$C \rightarrow bB | bbc$$

Removing useless Production

C, B :- As its a loop

$S \rightarrow aA|a$
 $A \rightarrow aaA|aa$

→ final resultant grammar.

Question # 10

a) $S \rightarrow SS | AAA | \lambda$

$$A \rightarrow aA | Aa | b$$

$$L = \{w, w \in (a+b)^*\}$$

b) Left Most derivation of
"abbaba"

Sol:-

$$S \rightarrow AAA$$

Using $S \rightarrow AAA$

$$S \rightarrow aAAA$$

using $A \rightarrow aA$

$$S \rightarrow abAA$$

Using $A \rightarrow b$

$$S \rightarrow abAaA$$

Using $A \rightarrow Ab$

$$S \rightarrow abbaA$$

Using $A \rightarrow b$

$$S \rightarrow abbaAa$$

Using $A \rightarrow Aa$

$$S \rightarrow abbaba$$

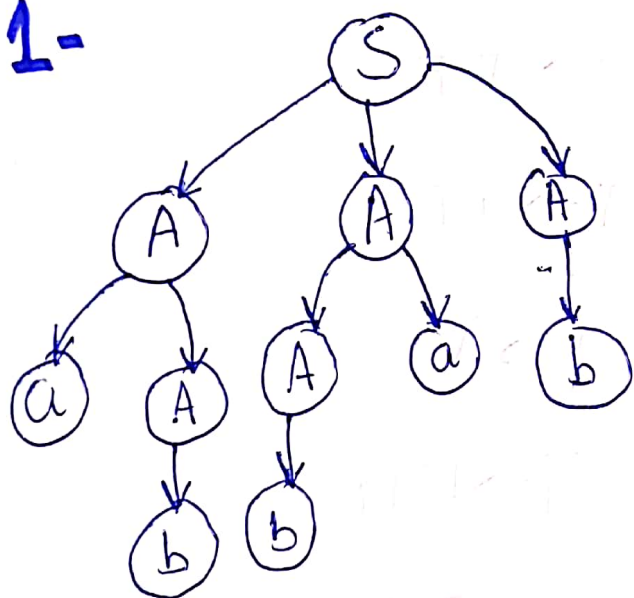
Using $A \rightarrow b$

c)

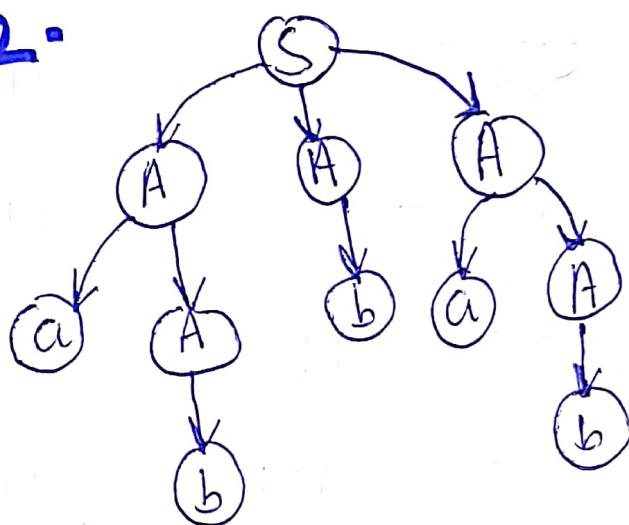
Sol:- S is said to be ambiguous if it has multiple left or right derivation tree on specific String

Using : abbab :- Using left derivation tree

1-



2-



So, grammar is ambiguous.

Question #11

$$S \rightarrow T b T$$

$$T \rightarrow a T b \mid b T a \mid T T \mid \lambda$$

String:- a b b a b a b

Sol:- Left Most derivation:-

$$S \rightarrow T b T$$

Using $S \rightarrow T b T$

$$S \rightarrow a T b b T$$

Using $T \rightarrow a T b$

$$S \rightarrow a b b a T b$$

Using $T \rightarrow \lambda$

$$S \rightarrow a b b a b T a b$$

Using $T \rightarrow b T a$

$$S \rightarrow a b b a b a b$$

Using $T \rightarrow \lambda$

Tree:-

