Tutorial No: 05 Student ID: 2SOVD30642
Date: 17/9/24 Student Name: Mosab

**Pre-Tutorial (To be completed by student before attending tutorial session)**

1. What is the language generated by the grammar? $G = \{S \rightarrow aSb \mid SS \mid \varepsilon\}$

**Solution:** $S \rightarrow asb \mid ss \mid \epsilon$

$asb \Rightarrow ab$

$asb$

$aasbb \Rightarrow aabb$

$assb$

$aasbasbb$

$\rightarrow aababb$

language of the given grammar is the combination of a's and b's.

2. Given the production rules of a simple CFG, Use the following grammar to derive the string from the start symbol?

Non-terminals: {S,A}, Terminals: {a,b}, Start Symbol: S

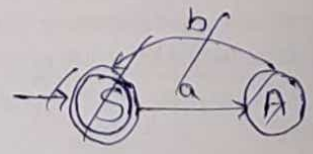
Production Rules:

a. S→aA
b. A→ bS
c. S→ϵ

**Solution:**

$S \rightarrow aA \mid \epsilon$

$A \rightarrow bS$




$S \rightarrow aA$

$abS$

$\rightarrow ab$.

It is not possible to generate 'abb' string from given grammar.

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3. How does a parse tree represent the derivation of a string in a CFG, and why is it useful in understanding the structure of the generated strings? Can you draw a parse tree for the string "(())" using the CFG for balanced parentheses:

Non-terminals: {S}, Terminals: {(,)}, Start Symbol: S

Production Rules:

a. $S \rightarrow SS$

b. $S \rightarrow (S)$

c. $S \rightarrow \epsilon$

**Solution:**

$S \rightarrow (S)$

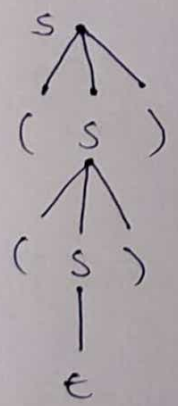
$\rightarrow ((S))$

$\rightarrow$ "(())"

$\rightarrow (S) \Longrightarrow$ S replace with (S)

$((S)) \rightarrow$ S replace with epsilon

"(())"




→ parse tree

∴ "(())"

Tutorial # : 01 | Student ID : 2300030642
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4. What is the difference between leftmost derivation and rightmost derivation in the co
CFGs? Provide an example of each for the string "ab" using the following grammar:

Non-terminals: {S}, Terminals: {a, b}, Start Symbol: S
Production Rules:

c. S→aS
d. S→bS

**Solution:**

S→aS

S→bS

Here, variable on the right most. So, for given grammar there is no variable that leftmost.

So, we can implement right most derivation.

S → aS
abS
abaS, abbS

If S → ∈ then

→ abS
"ab".

Tutorial # 08 Student ID 230080642
Date 17/9/24 Student Name T. Nisitha.

5. Is the following grammar in CNF?

$$S \rightarrow aS \mid Sb \mid AB$$

$$A \rightarrow a \mid \varepsilon$$

$$B \rightarrow b$$

If you find it to be not in CNF, convert it into CNF. Write each step.

**Solution:**

Step1: After simplification of given grammar.

$P' = \{ S \rightarrow aS \mid Sb \mid b \mid AB$

$A \rightarrow a$

$B \rightarrow b \}$

Step2: already CNF $\Rightarrow$ $S \rightarrow b$

$S \rightarrow AB$

$A \rightarrow a$

$B \rightarrow b$

Introduce two new variables $C_a$ & $C_b$. $C_a \rightarrow a$, $C_b \rightarrow b$

$S \rightarrow aS$ $\quad S \rightarrow Sb$

$C_aS \quad \rightarrow SC_b$

$G' = (\{S, A, B, C_a, C_b\}, \{a, b\}, P^{\phi}, S)$

$P = \{ S \rightarrow b \mid AB \mid C_aS \mid SC_b$

$A \rightarrow a$

$B \rightarrow b$

$C_a \rightarrow a$

$C_b \rightarrow b \}$

Tutorial # 05 Student ID 2100030642
Date 12/9/24 Student Name Nikitha

6.Consider the language $L = \{a^n b^m : n \neq 2m\}$. Is it a regular, context-free or both regular, context-free language? Prove it.

**Solution:**

L = { ab, abbb, ···· , aab, aabbb, aabbb, .... }

Check regular:

$z = uvw = aabbb$

i=0 → abb ∈L i=2 → aaabb ∈L

i=1 → aabb ∈L

∵ It is not a regular.

If some condition it possible for $n = 2m$. So, it is not regular by using pumping lemma.

It is a context free grammar because it is derived from a grammar in the form $(V \cup T)^*$.

∵ It is not regular

It is context free grammar.

Tutorial # 05 Student ID 2300030642
Date 17/9/24 Student Name Nirchita

7. Consider the following grammar

$$S \rightarrow aSa \mid bSb \mid \varepsilon$$

Is it in Griebach normal form? If not convert it into Greibach normal form.

Solution: After simplification of given grammar,

Step 1:

$S \rightarrow aSa \mid aa \mid bSb \mid bb$

Step 2: (somewhat CNF)

$S \rightarrow aSa$

$S \rightarrow aa$

$S \rightarrow bSb$

$S \rightarrow bb$

Introduce two new variables $C_a, C_b$, $C_a \rightarrow a$, $C_b \rightarrow b$

$S \rightarrow aSC_a \mid aC_a$

$S \rightarrow bSC_b \mid bC_b$

$P' = \{ S \rightarrow aSC_a \mid aC_a \mid bSC_b \mid bC_b \}$

$G' = (\{S, C_a, C_b\}, \{a, b\}, P', S)$

Tutorial # 05 Student ID 2300030642
Date 19/9/24 Student Name Nikhita.

**IN-TUTORIAL (To be carried out in presence of faculty in classroom)**

1. Consider the following grammar

$$S \rightarrow ASB \mid c$$

$$A \rightarrow \epsilon \mid aA$$

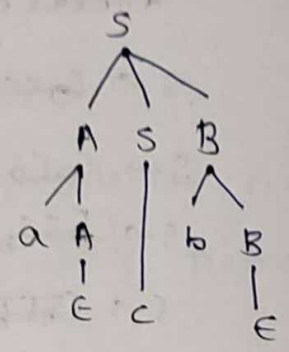
$$B \rightarrow \epsilon \mid bB$$

Derive the string $acb$ using leftmost and rightmost derivation. Show the parse trees for your derivation.

**Solution:**

$S \rightarrow ASB$ (leftmost derivation)

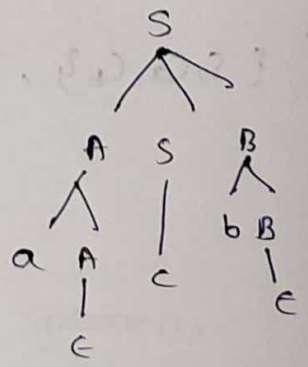
$S \rightarrow aASB$
$\rightarrow aSB$
$\rightarrow acB$
$\rightarrow acbB$
$\rightarrow 'acb'$




acb

(Right most derivation)

$S \rightarrow ASB$
$\rightarrow ASbB$
$\rightarrow Asb$
$\rightarrow Acb$
$\rightarrow aAcb$
$\rightarrow 'acb'$



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17/9/24

Student ID 2300010642
Student Name Nikhil C.

ven the language consisting of strings with equal numbers of a's and b's (e.g., 'ab', 'aabb', 'abab'). truct a CFG that generates this language. What challenges do you face in ensuring that the numbers of a's b's are equal?

tion: $L = \{ab, aabb, abba, abab, abbbaa, \ldots\}$

from given language the base case is 'ϵ'

$S \rightarrow \epsilon$

for 'ab':

$S \rightarrow asb$

for 'ba':

$S \rightarrow bsa$

for mixing of same number of a's and b's:

$S \rightarrow SS$

So, the CFG is

$P: \{ S \rightarrow \epsilon | asb | bsa | SS \}$

Experiment #: 05 | Student ID: 2300030642
Date: 19/9/24 | Student Name: Mrs Code

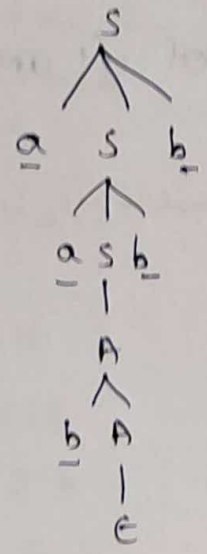
3. Draw the parse tree for the string "aabbb" using the following CFG:
Non-terminals: {S,A}, Terminals: {a, b}, Start Symbol: S
Production Rules:

i) S→aSb
ii) S→A
iii) A→bA
iv) A→ε

**Solution:**

$S \rightarrow aSb$

$\rightarrow aaSbb$ ($\because S \rightarrow aSb$)
$\rightarrow aaAbb$ ($\because S \rightarrow A$)
$\rightarrow aabAbb$ ($\because A \rightarrow bA$)
$\rightarrow$ "aabbb" ($\because A \rightarrow \epsilon$)




"aabbb".

Experiment: 05 Student ID: 2100080642
Date: 19/9/24 Student Name: N. Nikhila

2. Using the following CFG, perform both a leftmost and a rightmost derivation for the string "aab":
Non-terminals: {S,A}, Terminals: {a, b}, Start Symbol: S,
Production Rules:
S→aS, S→A, A→aA, A→b

Solution:

S → aS

S → A

A → aA

A → b

Left most derivation:

S → aS

→ aA

→ aaA

→ "aab"

Right most-derivation:

S → aS

→ aA

→ aaA

→ "aab".

| Experiment # | 01 | Student ID | 230003064 |
|---|---|---|---|
| Date | 17/9/24 | Student Name | Mirlde |

5.Consider the CFG for simple arithmetic expressions involving addition and multiplication:

Non-terminals: {E, T, F}, Terminals: {+, *, (, ), id}, Start Symbol: E

Production Rules:

E→E+T, E→T, T→T*F, T→F, F→(E), F→id

Parse the expression "id + id * id" and draw the corresponding parse tree. Explain each step in t process and how the CFG handles operator precedence.

**Solution:**

$E \rightarrow E+T$

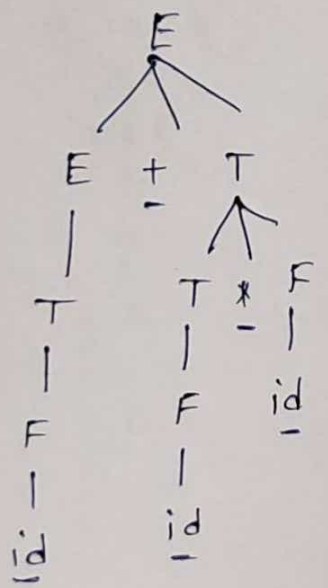
$\rightarrow E+T*F$

$\rightarrow E+F*F$

$\rightarrow T+F*F$

$\rightarrow F+F*F$

$\rightarrow$ "id + id * id"




"id + id * id"

Experiment # 5 Student ID 2100010642

Date 17/9/24 Student Name S.Nikhil Re.

**Post-Tutorial (To be carried out by student after attending tutorial session)**

1. Consider the grammar G = (V, Σ, R, S), where V = {a, b, S, A}, Σ = {a, b}, R = { S → AA, A → AAA, A → a, A → bA, A → Ab }.
   (1) List the set of strings that can be produced by derivations of four or fewer steps using G
   (2) (b) Give any four distinct derivations for the string "babbab" using G

**Solution:**

(1) $S \to AA$
$\to aA$
$\to$ "aa"

$S \to AA$
$\to bAA$
$\to bbAA$
$\to$ "bbaa"

$S \to bbAA$
$\to$ "bbbaa"

$S \to AA$
$\to AbAb \to$ "abab"

(2)
$S \to AA$
$\to bAA$
$\to baA$
$\to babA$
$\to babbAb$
$\to$ "babbab"

$S \to AA$
$\to AAA$
$bAAA$
$baAA$
$babAA$
$babbAA$
"babbab"

(1) : "aa", bbaa, bbbaa, abab

2. Design CFG for a language which accepts palindrome over an alphabet Σ = {a,b}

**Solution:**

$L = \{ aa, aba, bab, \ldots \}$

for empty:

$S \to \epsilon$

$\therefore P' = \{ S \to \epsilon \mid aSa \mid bSb \mid a \mid b \mid SS \}$

for aa

$S \to aSa$

for aba:

$S \to b$

for bab

$S \to bSb \mid a$

for mixing : $S \to SS$

Experiment # 05 Student ID 2100057

Date 17/9/24 Student Name S.Nalini

3. Check whether the given grammar is ambiguous or not: S → SS, S → a, S → b. Expla

**Solution:**

$S \rightarrow SS$

$S \rightarrow a$

$S \rightarrow b$

Leftmost:

$S \rightarrow SS$

$\rightarrow aS$

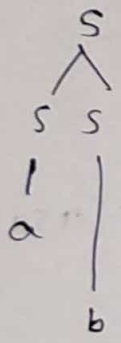
$\rightarrow$ "ab"

Rightmost:

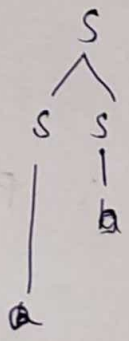
$S \rightarrow SS$

$\rightarrow Sa$

$\rightarrow$ "ba"




"ab"




"aba"

∴ It is ambiguous.

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| Date | 12/9/24 | Student ID | 23000306 42 |
| | | Student Name | Nischitha |

Viva Questions

1. What is the role of non-terminal and terminal symbols in a CFG?

Answer:

Terminals symbols are alphabets, digits, special symbols

Eg: a, b, (, ), *, 2, 1, ---

Non-terminals means variables (uppercase letters)

Eg: A, S, B, ---

2. Provide an example of a production rule and explain its significance.

Answer:

Production is the form of $\alpha \rightarrow \beta$

where

$\alpha \in V$

$\beta \in V^* | T^* | (VUT)^*$

Eg: 1) $A \rightarrow asa$

2) $B \rightarrow b$

3) $S \rightarrow SA$

(For Evaluator's use only)

| Comment of the Evaluator (if Any) | Evaluator's Observation |
|---|---|
| | Marks Secured: out of 50 |
| | Full Name of the Evaluator: |
| | Signature of the Evaluator Date of Evaluation: |