KONGU ENGINEERING COLLEGE, PERUNDURAI 638 060

ODD SEMESTER 2017-2018

CONTINUOUS ASSESSMENT TEST 2 - SEPTEMBER 2017

(Regulations 2014)

Roll No.....

Programme : B.E Branch : CSE Semester : V	Date : 28.09.2017 Time : 9.15am – 10.45am
Course Code :14CST52 Course Name : Theory of Computation	Duration : 1 ½ Hours Max. Marks : 50

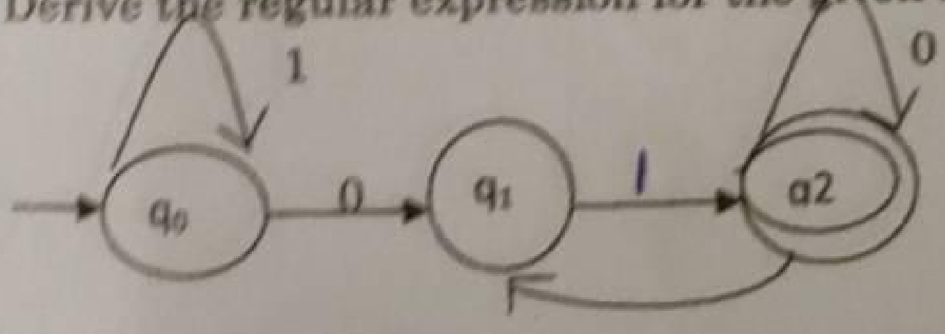
PART - A (10 X 2 = 20 Marks)

ANSWER ALL THE QUESTIONS

1.	Frame the regular expression for the DFA with 'n' states and has i as initial state, 'j' as final state and 'k' as intermediate states.	Co2, Co3	K2
2.	Mention any four closure properties of regular language.	Co2	K1
3.	State pumping lemma with its properties.	Co2	K1
4.	Write the formal definition of CFG.	Co2	K1
5.	Determine the CFL for the CFG S→0S1 / 1S0 /SS/01/10	Co2	K3
6.	Identify the CFG for the CFL L={$a^i b^j$ | i≥ 0}	Co2	K2
7.	Draw the parse tree for the derivation of string id+id*id from grammar E→E+E /E*E/id	Co2	K2
8.	Show that S→aB/ab A→ aAb/a B→ ABb/b is ambiguous.	Co2	K2
9.	State the two ways of acceptance by PDA and define them.	Co3	K1
10.	Identify the useless symbols and simplify the given grammar S→ aAa /aBC A→aS/bD B→ aBa /b C→abb/DD D→ aDa	Co2	K2

PART - B (3 X 10 = 30 Marks)

ANSWER ANY THREE QUESTIONS

11.		Derive the regular expression for the given DFA 	(10)	Co3	K3
12.	a)	Show that L={ a^{n^2} | n>1} is not a regular language.	(10)	Co1	K3

	b)	Design a PDA for L={ ww^R / w∈{0,1} *}	(6)	Co3	K3
13.		Convert the following CFG to CNF S→0A0/1B1/BB A→C B→S/A C→S/∈	(10)	Co2	K2
14.		Convert the following CFG to GNF S→AB A→BS/b B→SA/a	(10)	Co2	K3

Bloom's Taxonomy Level	Remembering (K1)	Understanding (K2)	Applying (K3)	Analysing (K4)	Evaluating (K5)	Creating (K6)
Percentage	26.67	40	33.33	-	-	-

Module Test - II

14CST52 - Theory & Computation

Answer key

Part A (10×2 = 20 marks)

$$R_{ij}^{k} = R_{ij}^{k-1} + R_{ik}^{k-1} (R_{kk}^{k-1})^{*} R_{kj}^{k-1}$$

Closure properties (any four)

(1) Union of two RL is regular
(2) Intersection of " " "
(3) The complement of " " "
(4) Difference of two RL is regular
(5) Reverse of a regular language is regular
(6) Closure of a regular language is regular
(7) Concatenation of " " "
(8) Homomorphism of a " " "
(9) Inverse homomorphism " " "

4) G = (N, T, P, S)

N → Non-Terminals

T → Terminals

P → Production

S → Start ~~State~~ Symbol

5) Pumping lemma

→ a tool to test certain languages are regular or not

for every string w splitted as xyz where

a) $y \neq \epsilon$, $|yz| \geq 1$

b) $|xy| \leq n$

c) for all $k \geq 0$, the string $xy^k z$ should be in

where $|w| \geq n$

5. Set of all string with equal number of 0's and

6. CFG for $L = \{a^i b^i \mid i \geq 0\}$

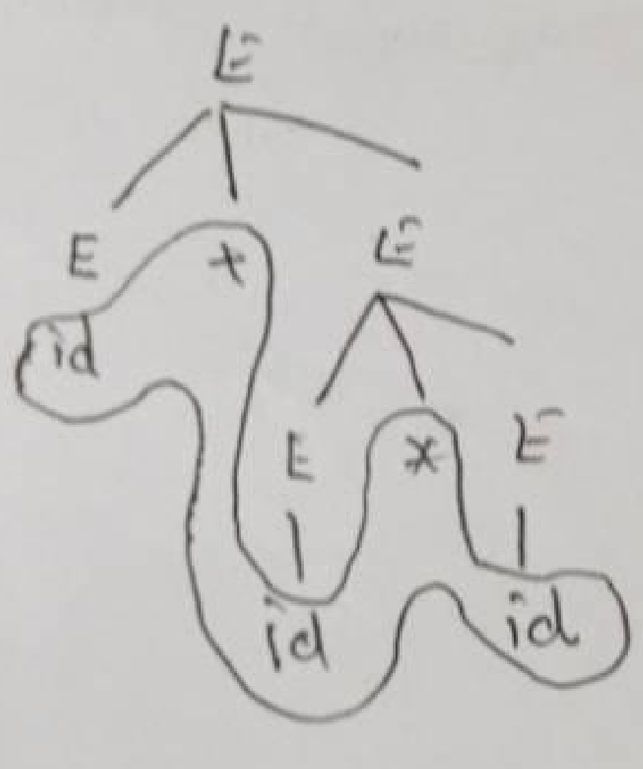
$S \rightarrow aSb$

$S \rightarrow \epsilon$

$S \rightarrow ab$

$S \rightarrow aSb$

7. Parse tree



8. $S \rightarrow aB \mid ab$ $A \rightarrow aAb \mid a$ $B \rightarrow ABb \mid b$ is ambiguous

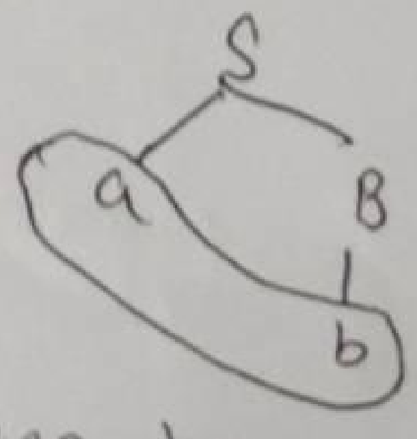
①

$S \rightarrow ab$

②

$S \rightarrow a\overline{B}$

$S \rightarrow a\overline{b}$



Since two different parse tree exists for single string it

9. Two ways of acceptance by PDA

(1) Acceptance by final state

(2) Acceptance by empty stack

8. Useless symbols

Useless symbol is D → because it is not generating

Eliminate D.

S → aAa | aBC

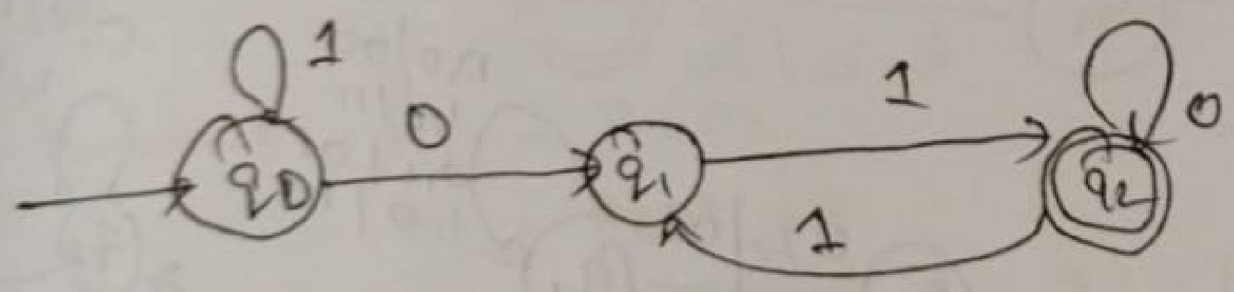
A → aS | b

B → aBa | b

C → abb

Part B (3×10 = 30 marks)

11) Obtain RG from DFA



or State elimination method.

$$R_{ij}^{k} = R_{ij}^{k-1} + R_{ik}^{k-1} (R_{kk}^{k-1})^{*} R_{kj}^{k-1} \quad -(1)$$

$$R_{13}^{3} = R_{13}^{2} + R_{13}^{2} (R_{33}^{2})^{*} R_{33}^{2} \quad -(1)$$

Finding

$R_{13}^{2} \rightarrow 1^{*}01$ → (2)

$R_{33}^{2} \rightarrow (0+\epsilon+11)$ -(3) (4)

Final calculation of R_{13}^{3} & result $1^{*}01(0+11)^{*}$

$L = \{a^{n^2} \mid n \geq 1\}$ is not a R_L

$$w = a^{n^2}, \quad |w| = n^2 \geq n \quad -0$$

$$w = xyz = a^{n^2} = |xyz| = n^2 \quad -①$$

$$|xyyz| = |xyz| + y|$$

$$\leq n^2 + n$$

$$|xy^2z| < n^2 + n + (n+1)$$

$$|xy^2z| < n^2 + 2n + 1$$

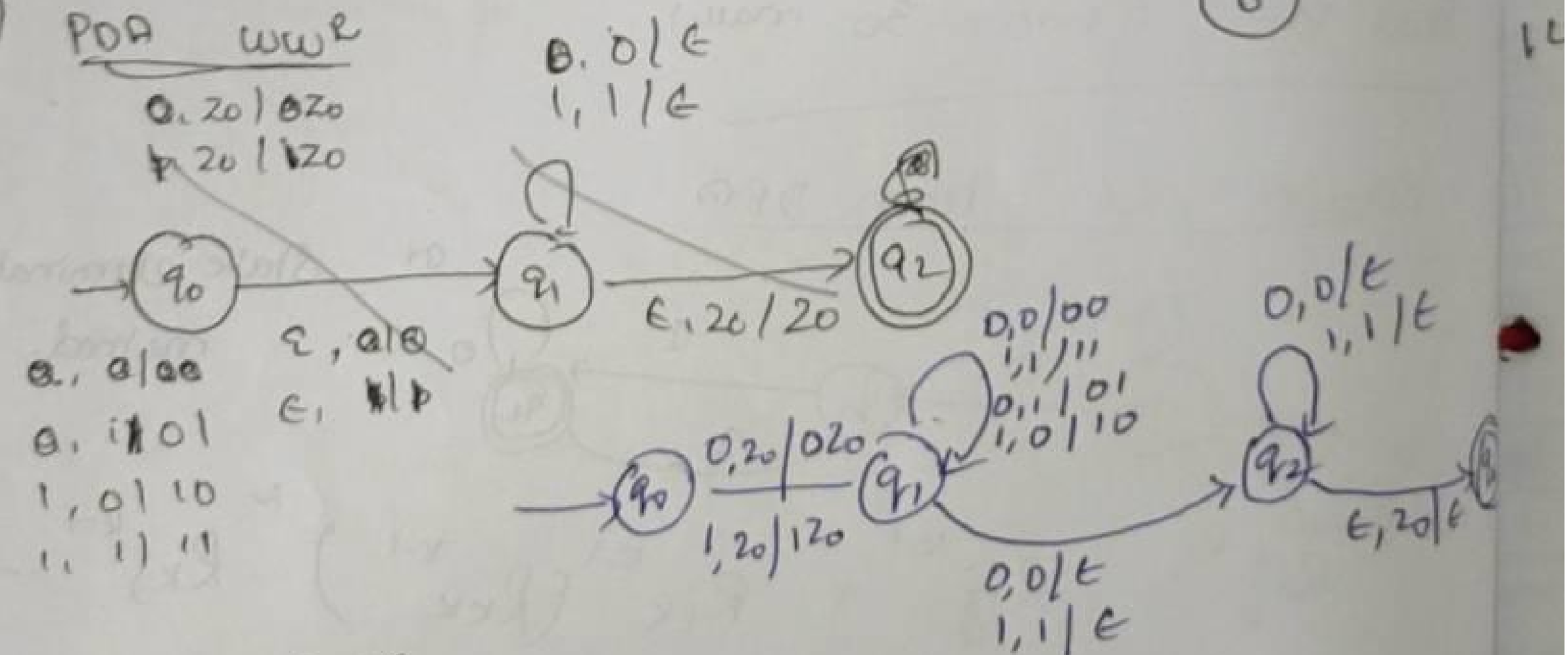
$$< (n+1)^2$$

$|xyz| = n^2$ $|xy^2z|$ $> n^2$ but $< (n+1)^2$

Perfect square cannot be between n^2 & $(n+1)^2$

⑭

(5) PDA ww^R



(6)

(13) CFG to CNF

After simplification

$S \rightarrow 0A0 \mid 00 \mid 1B1 \mid 11 \mid BB \mid B$

CNF →

$S \to D_1 D_1 \mid D_2 D_2$

$D_1 \to 0$

$D_2 \to 1$

14) CFG to GNF

$S \to ABB$

$A \to aBB \mid b$

$B \to SA \mid a$

After terminal $A_1 \to A_2 A_3$

$A_2 \to A_3 A_1 \mid b$

$A_3 \to A_1 A_2 \mid a \to A_3 \to A_3 A_1 A_3 A_2 \mid b A_3 A_2 \mid a$ — (3m)

terminal 2 $A_1 \to A_2 A_3$

$A_2 \to A_3 A_1 \mid b$

$B_1 \to A_1 A_3 A_2 \mid A_1 A_3 A_2 B_1$

$A_3 \to bA_3 A_2 \mid a \mid bA_3 A_2 B_1 \mid aB_1$ — (3m)

Ans (4m)

$A_1 \to bA_3 A_2 A_1 A_3 \mid aA_1 A_3 \mid bA_3 A_2 B_1 A_3 \mid aB_1 A_3 A_1 A_3 \mid bA_3$

$A_2 \to bA_3 A_2 A_1 \mid aA_1 \mid bA_3 A_2 B_1 A_1 \mid aB_1 A_1 \mid b$

$B_1 \to bA_3 A_2 A_1 A_3 A_3 A_2 \mid aA_1 A_3 A_3 A_2 \mid bA_3 A_2 B_1 A_3 A_3 A_2 \mid bA_3 A_3 A_2 \mid (bA_3 A_2 A_1 A_3 A_3 A_2 B_1) \mid aA_1 A_3 A_3 A_2 B_1 \mid bA_3 A_2 B_1 A_3 A_3 A_2 \mid B)$

$A_3 \to bA_3 A_2 \mid a \mid bA_3 A_2 B_1 \mid aB_1 A_1 A_3 A_3 A_2 B_1 \mid bA_3 A_3 A_2 B_1$

DEPT. OF COMPUTER SCIENCE & ENGG.
KONGU ENGINEERING COLLEGE,
THOPPUPALAYAM (PO)
PERUNDURAI (TK), ERODE - 638 060

Hariharan — Name and Signature of Hall Supdt. with Date

Estd : 1984

KONGU ENGINEERING COLLEGE

PERUNDURAI ERODE - 638 060.

(Autonomous)

Name of the Student	G. Raxuen	Register No.	1	5	C	S	R	1	6	9
Programme	B.E	Branch & Semester	CSE-C V							
Course Code and Name	14CST52 Theory Of Computation	Date	28.9.17			No. of Pages Used		15		

MARKS TO BE FILLED IN BY THE EXAMINER

PART - A		PART - B			Grand Total Max. Marks : 50
Question No.	Max Marks : 2	Question No.		Max Marks : 10	
1	2	11	i)	10	46½ / 50
2	2		ii)		
3	0	12	i)		
4	2		ii)		
5	2	13	i)	10	
6	2		ii)		
7	2	14	i)	10	
8	1		ii)		
9	1½				
10	2				
TOTAL	16½	TOTAL		30	

V. good

G. Raxuen.

Total Marks in Words : Forty Six and half

INSTRUCTION TO THE CANDIDATE

1. Check the Question Paper, Programme, Course Code, Branch Name etc., before answering the questions.
2. Use both sides of the paper for answering questions.
3. POSSESSION OF ANY INCRIMINATING MATERIAL AND MALPRACTICE OF ANY NATURE IS PUNISHABLE AS PER RULES.

R. Saganthi
Name of the Examiner

3/10/17
Signature of the Examiner with Date

1. Regular Expression:

Regular Expression for DFA with n states and k intermediate with i as initial state and j as final state is given as,

$$R_{ij}^{K} = R_{ij}^{K-1} + (R_{iK})^{K-1} (R_{KK}^{K-1})^{*} \cdot (R_{Kj})^{K-1}$$

2 Closure properties:-

Union of two regular language is also regular.

Intersection of two regular language is also regular.

Difference of two regular language is also regular.

Complement of a regular language is also regular.

Homomorphism of a regular language is also regular.

3 Pumping lemma:-

It is used to state that the language is not accepted by the DFA.

Properties:-

power is always $\geq n$

xy^kz where $k = 0, 1, 2 \ldots$

4. CFG:-

Content Free Grammar is defined as,

$G = \{V, T, P, S\}$

V - finite set of nonterminals
T - finite set of Terminals
P - Production
S - starting state.

S → 0S1 / 1S0 / SS / 01 / 10.

Language for the Grammar is

$L = \{$ Set of all strings with equal number of 0's and equal number of 1's $\}$
i.e., no. of 0's = no. of 1's.

6. $L = \{a^i b^j \mid i \geq 0\}$

CFG is,

$G = \{V, T, P, S\}$

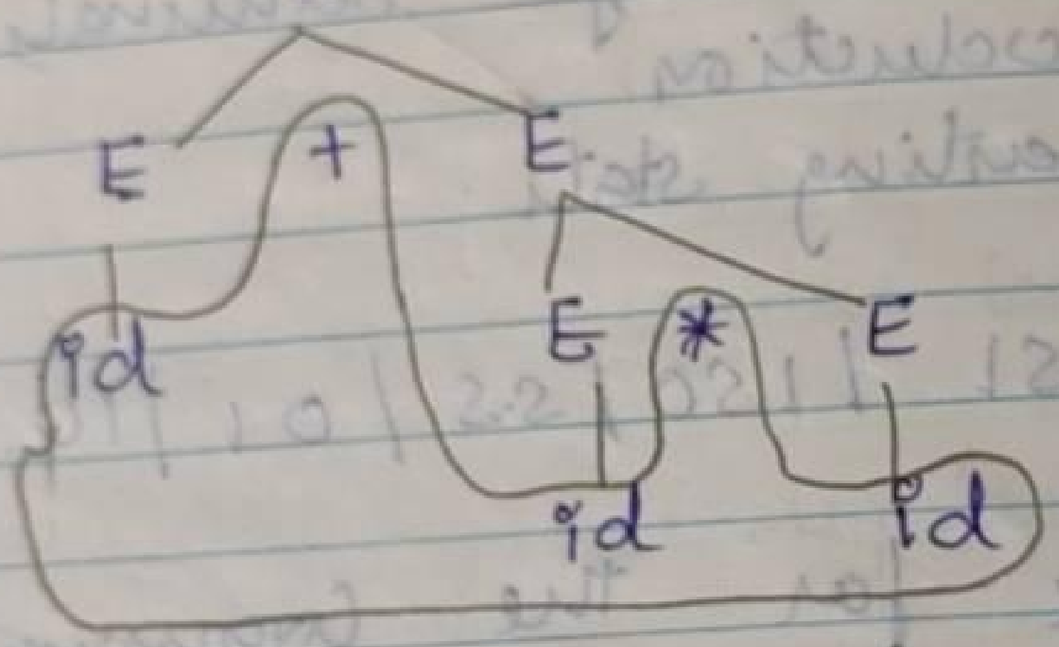
P: $S \rightarrow aSb \mid \in$

$G = \{\{S\}, \{a, b\}, P, S\}$

1. $E \rightarrow E+E$
   $E \rightarrow E*E$
   $E \rightarrow id$

String id+id*id.

Parse Tree:



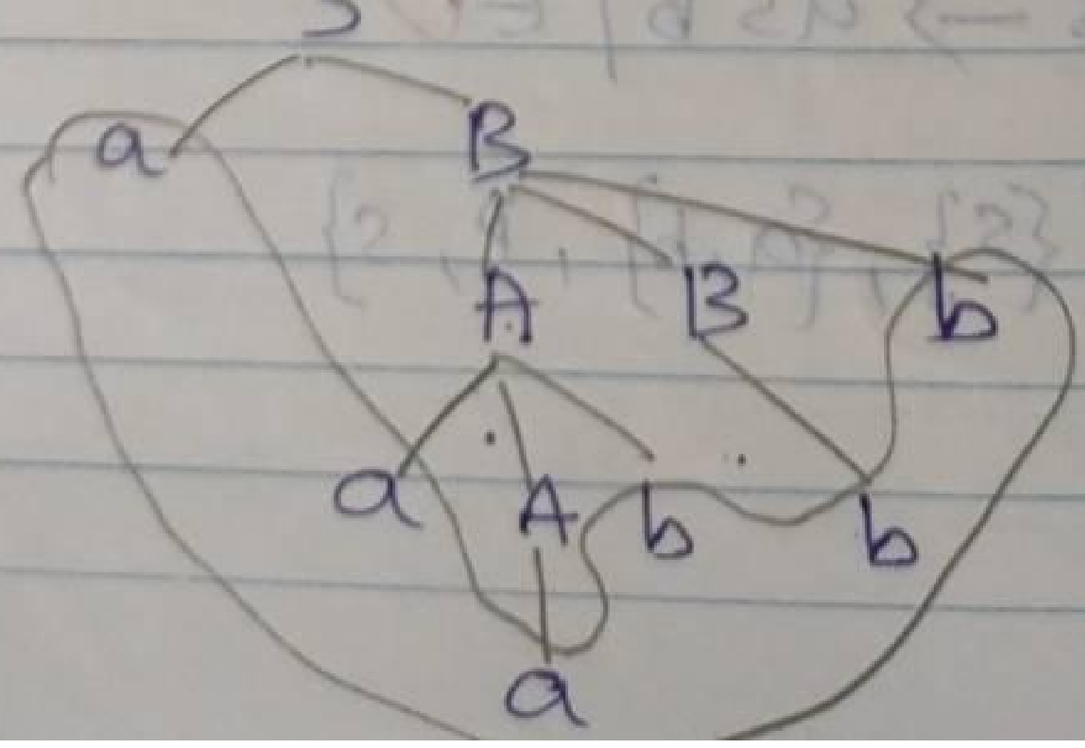
String : id+id*id

2. $S \rightarrow aB/ab$
   $A \rightarrow aAb/a$
   $B \rightarrow ABb/b$

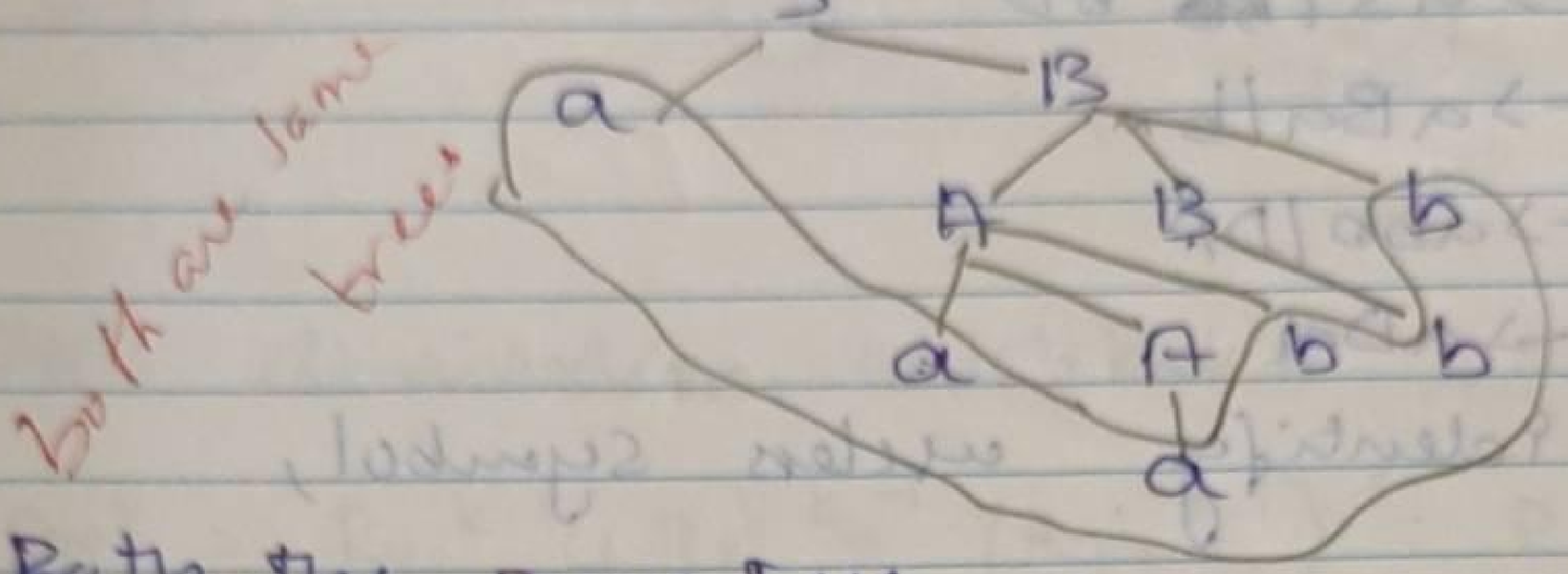
is ambigious.

Let us consider the string,
aa abbb.

Parse Tree.



Parse Tree 2.



Both the parse Tree gives same string, So the given production is ambiguous.

9. Two ways of acceptance by PDA.
   Accepting by final state
   Accepting by empty stack.

Accepting by final state :-
Here the PDA has the final state as,

$\epsilon, Z_0 / \epsilon$.

Z_0 is the final element in the stack. So if Z_0 is reached the string is accepting.

Accepting by empty stack :-
The entire stack is removed including Z_0.

10 S -> aAa | aBC

A -> aS | bB | bD

B -> aBa | b

C -> abb | DD

D -> aDa

To identify useless symbol,

Reachable Symbol = {S, A, B, C, a, b, D}

Generating Symbol = {a, b, S, B, C, A}

The useless symbol is D

eliminating all the production for D, we get

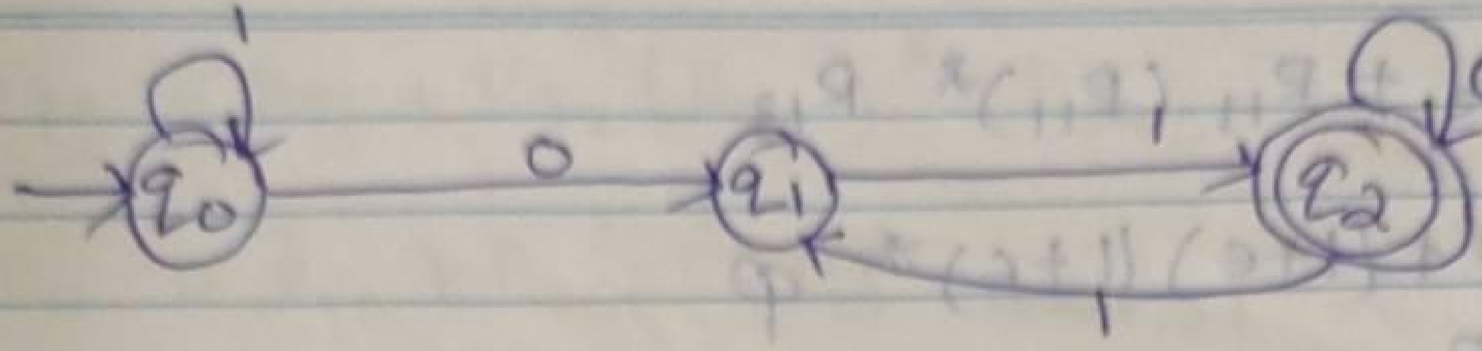
S -> aAa | aBC

A -> aS

B -> aBa | b

C -> abb

11



State elimination method:

$$R_{ij}^{k} = R_{ij}^{k-1} + R_{ik}^{k-1} \left(R_{kk}^{k-1}\right)^{*} R_{kj}^{k-1}$$

K=0.

$R_{11} = 1 + \epsilon$ $\quad R_{21} = \phi$ $\quad R_{31} = \phi$

$R_{12} = 0$ $\quad R_{22} = \epsilon$ $\quad R_{32} = 1$

$R_{13} = \phi$ $\quad R_{23} = 1$ $\quad R_{33} = 0 + \epsilon$.

K = 1.

$$R_{ij}^{0} = R_{ij} + R_{01} (R_{11})^{*} R_{1j}$$

$$R_{11} = R_{11} + R_{11} (R_{11})^{*} R_{11}$$

$$= 1+\epsilon + (1+\epsilon)(1+\epsilon)^{*} (1+\epsilon)$$

$$= 1+\epsilon + (1+\epsilon)^{*}$$

$R_{11} = 1+\epsilon$.

$$R_{12} = R_{12} + R_{11} (R_{11})^{*} R_{12}$$

$$= 0 + (1+\epsilon)(1+\epsilon)^{*} . 0$$

$$= 0 + (1+\epsilon)^{*} . 0$$

$$= 0 + 1^{*} . 0$$

$$= 1^{*} . 0$$

$$R_{13} = R_{13} + R_{11}(R_{11})^* R_{13}$$

$$= \varphi + (1+\epsilon)(1+\epsilon)^* \varphi$$

$$R_{13} = \varphi$$

$$R_{21} = R_{21} + R_{21}(R_{11})^* R_{11}$$

$$= \varphi + \varphi (1+\epsilon)^* \varphi (1+\epsilon)$$

$$= \varphi$$

$$R_{22} = R_{22} + R_{21}(R_{11})^* R_{12}$$

$$= \epsilon + \varphi (1+\epsilon)^* \varphi$$

$$= \epsilon$$

$$R_{23} = R_{23} + R_{21}(R_{11})^* R_{13}$$

$$= 1 + \varphi (1+\epsilon)^* \varphi$$

$$R_{23} = 1$$

$$R_{31} = R_{31} + R_{31}(R_{11})^* R_{11}$$

$$= \varphi + \varphi (1+\epsilon)^* (1+\epsilon)$$

$$= \varphi$$

$$R_{32} = R_{32} + R_{31}(R_{11})^* R_{12}$$

$$= 1 + \varphi (1+\epsilon)^* \varphi$$

$$= 1$$

$$R_{33} = R_{33} + R_{31}(R_{11})^* R_{13}$$

$$= \varphi + \epsilon + \varphi (1+\epsilon)^* \varphi$$

$$= \varphi + \epsilon$$

k=2.

$R_{ij} = R_{ij} + R_{i2}(R_{22})^* R_{2j}$

$R_{11} = R_{11} + R_{12}(R_{22})^* R_{21}$

$= (1+\epsilon) + 0 \cdot \epsilon^* \cdot (1+\epsilon)\ \varphi$

$= 1+\epsilon + 0 \cdot \epsilon^* \cdot (1+\epsilon) = (1+\epsilon) \cdot (1+\epsilon) = 1+\epsilon$

$R_{12} = R_{12} + R_{12}(R_{22})^* R_{22}$

$= 0 + 0\ \epsilon^* \cdot \epsilon$

$= 0 + 0 \cdot \epsilon$

$= 0 \cdot (\epsilon)$

$R_{13} = R_{13} + R_{12}(R_{22})^* R_{23}$

$= \varphi + 0\ \epsilon^* \cdot 1$

$= 0 \epsilon 1$

$R_{21} = R_{21} + R_{22}(R_{22})^* R_{21}$

$= \varphi + \epsilon(\epsilon^*)\varphi = \varphi$

$R_{22} = R_{22} + R_{22}(R_{22})^* R_{22}$

$= \epsilon + \epsilon\ \epsilon^* \cdot \epsilon = \epsilon \cdot$

$R_{23} = R_{23} + R_{22}(R_{22})^* R_{23}$

$= 1 + \epsilon \cdot \epsilon^* \cdot 1 \cdot$

$= 1 + \epsilon \cdot 1$

$R_{31} = R_{31} + R_{32}(R_{22})^* R_{21}$

$= \varphi + 1\ \epsilon^* \varphi = \varphi \cdot$

$R_{32} = R_{32} + R_{32}(R_{22})^* R_{22}$

$= 1 + 1\ \epsilon^* \cdot \epsilon = 1+1$

$R_{33} = R_{33} + R_{32}(R_{22})^* R_{23}$

$= 0 + \epsilon + 1 \cdot \epsilon^* \cdot 1 = 0 + \epsilon + 1 \cdot \epsilon \cdot 1$

K=3.

$$R^{0}_{ij} = R_{ij}{}^{2} + R_{i3}{}^{2}\,(R_{33}{}^{2})^{*}\,R_{3j}{}^{2}$$

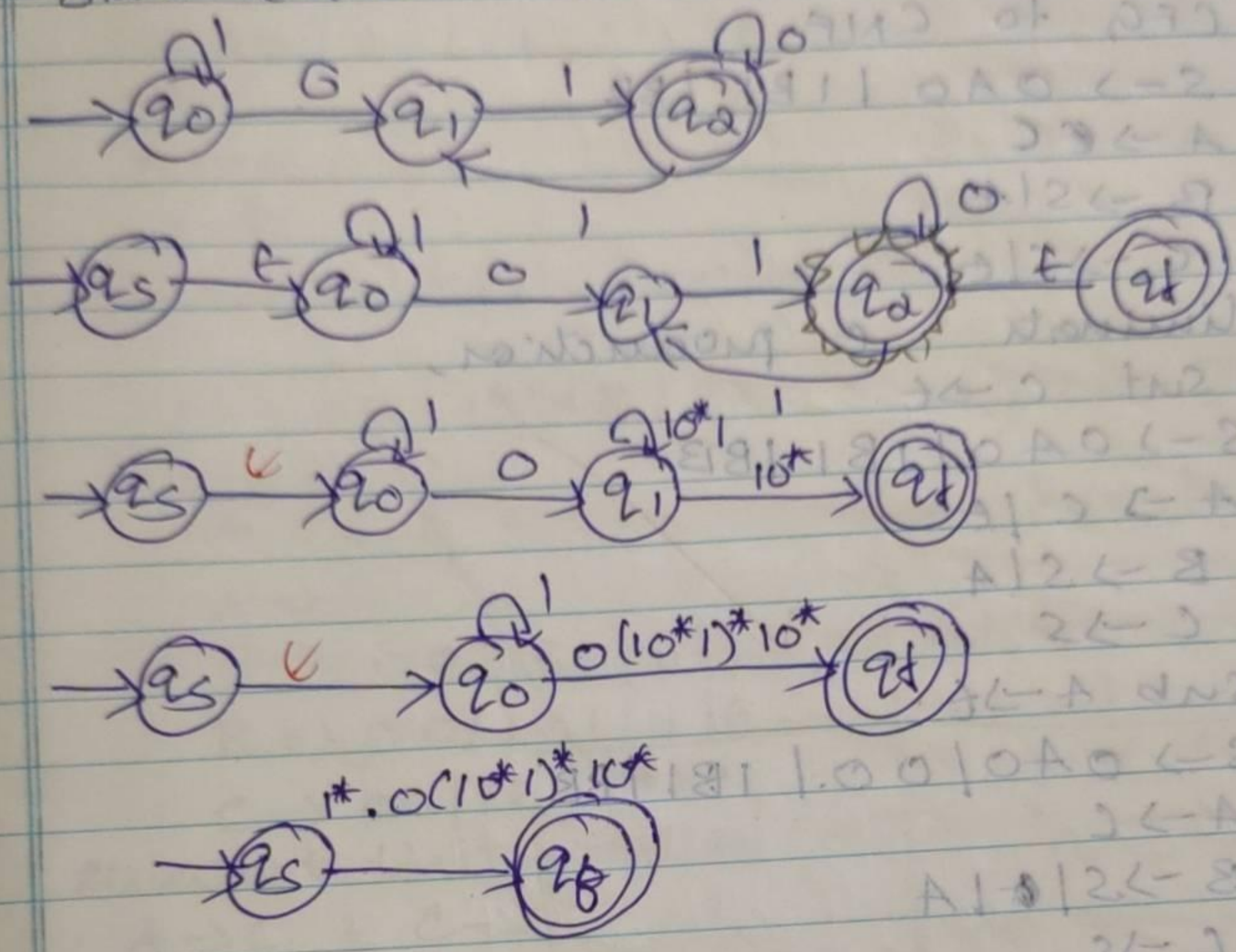
$$R_{13} = R_{13}{}^{2} + R_{13}{}^{2}\,(R_{33})^{*}\,R_{33}{}^{2}$$

$$= \phi + \phi(\phi+\epsilon)(\phi+\epsilon)$$

the Regular Expression. RE.

$$RE = 1^{*}.0\,(10^{*}1)^{*}\,10^{*}$$

State Elimination method.



R.E = $1^*.0(10^*1)^*10^*$

13. CFG to CNF

S -> OAO | 1B1 | BB

A -> C

B -> S | A

C -> S | ε

Eliminate ε production,

Sut C -> ε.

S -> OAO | 1B1 | BB

A -> C | ε

B -> S | A

C -> S

Sub A -> ε.

S -> OAO | OO | 1B1 | BB

A -> C

B -> S | ε | A

C -> S

Sub B -> ε

S -> OAO | OO | 1B1 | 11 | B | ε

A -> C

B -> S | A

C -> S

Sub S -> ε

S -> OAO | OO | 1B1 | 11 | B

A -> C

B -> S | A | ε

C -> S.

Sub B -> ε.

S -> OAO | OO | 1B1 | 11 | B

C -> ε.

Sub $B \to \epsilon$

$S \to OAO \mid OO \mid 1B1 \mid 11 \mid B$

$A \to C$

$B \to S \mid A$

$C \to S.$

Eliminate Unit production.

$S \to OOO \mid 1B1 \mid 11 \mid B$

~~$B \to S.$~~

$A \to C$

$A \to S$

$A \to OOO \mid 1B1 \mid 11 \mid B.$

$B \to OOO \mid 1B1 \mid 11 \mid B.$

$C \to OOO \mid 1B1 \mid 11 \mid B.$

Eliminate Unit Production.

$A \to C.$ $C \to S.$

$S \to OSO \mid OOO \mid 1B1 \mid BB$

$A \to OSO \mid OOO \mid 1B1 \mid BB$

$B \to OSO \mid OOO \mid 1B1 \mid BB$

$C \to OSO \mid OOO \mid 1B1 \mid BB$

Useless Symbol.

Reachable symbol $= \{S, O, 1, B\}$

Generating symbol $= \{O, 1, S, A, B, C\}$.

useless symbol are A and C.

$S \to OSO \mid OOO \mid 1B1 \mid BB.$

$B \to OSO \mid OOO \mid 1B1 \mid BB.$

$C_1 \to O$ $C_2 \to 1$ $C_3 \to C_1S$ $C_4 \to C_2B$

$S \to C_1SC_1 \mid C_1C_1 \mid C_2BC_2 \mid BB.$

$S \to C_3C_1 \mid C_1C_1 \mid C_4C_2 \mid BB.$

The CNF is.

$S \to C_3C_1 \mid C_1C_1 \mid C_4C_2 \mid BB$

$C_1 \to O$

$C_2 \to 1$

$C_3 \to C_1S$

$C_4 \to C_2B.$

14. CFG to GNF

$S \to AB$

$A \to BS \mid b$

$B \to SA \mid a$

The given production is not in GNF.

Sub $S = A_1$, $A = A_2$, $B = A_3$.

$A_1 \to A_2 A_3$

$A_2 \to A_3 A_1 \mid b$

$A_3 \to A_1 A_2 \mid a$

$A_1 \to A_2 A_3$ $\quad i < j$

$A_2 \to A_3 A_1 \mid b$ $\quad i < j$

$A_3 \to A_1 A_2 \mid a$ $\quad i \geq j$

Sub A_1 in A_3.

$A_3 \to A_2 A_3 A_2 \mid a$ $\quad i < j$.

Sub A_2 in A_3.

$A_3 \to A_3 A_1 A_3 A_2 \mid b A_3 A_2 \mid a$. Left recursion

Introduce B_3.

$B_3 \to A_1 A_3 A_2 \mid A_1 A_3 A_2 B_3$.

Sub B_3 in A_3

$A_3 \to A_3 B_3 \mid b A_3 A_2 \mid a$.

Sub other rule of A_3 in A_3

$A_3 \rightarrow bA_3A_2A_1A_3A_2 \mid bA_3A_2 \mid a$

Sub A_3 in A_2.

$A_2 \rightarrow bA_3A_2A_1A_3A_2A_1 \mid bA_3A_2A_1 \mid aA_1 \mid b$

Sub A_2 in A_1.

$A_1 \rightarrow A_2A_3$.

$A_1 \rightarrow bA_3A_2A_1A_3A_2A_1$

Sub other rule of A_3 in A_3.

$A_3 \rightarrow bA_3A_2B_3 \mid aB_3 \mid bA_3A_2 \mid a$.

Sub A_3 in A_2.

$A_2 \rightarrow bA_3A_2B_3A_1 \mid aB_3A_1 \mid bA_3A_2A_1 \mid aA_1 \mid b$.

Sub A_2 in A_1

$A_1 \rightarrow bA_3A_2B_3A_1A_3 \mid aB_3A_1A_3 \mid bA_3A_2A_1A_3 \mid aA_1A_3 \mid b$

Sub A_1 in B_3.

$B_3 \rightarrow bA_3A_2B_3A_1A_3A_3A_2 \mid aB_3A_1A_3A_3A_2 \mid b$
$bA_3A_2A_1A_3A_3A_2 \mid aA_1A_3A_3A_2 \mid bA_3A_3A_2 \mid$
$bA_3A_2B_3A_1A_3A_3A_2B_3 \mid aB_3A_1A_3A_3A_2B_3 \mid bA_3A_2A_1A_3A_3A_2B_3 \mid$
$aA_1A_3A_3A_2B_3 \mid bA_3A_3A_2B_3$

The Grammar in GNF is

$A_1 \rightarrow bA_3A_2B_3A_1A_3 \mid aB_3A_1A_3 \mid bA_3A_2A_1A_3 \mid aA_1A_3 \mid bA_3$.

$A_2 \rightarrow bA_3A_2B_3A_1 \mid aB_3A_1 \mid bA_3A_2A_1 \mid aA_1 \mid b$.

$A_3 \rightarrow bA_3A_2B_3 \mid aB_3 \mid bA_3A_2 \mid a$

$B_3 \rightarrow bA_3A_2B_3A_1A_3A_3A_2 \mid aB_3A_1A_3A_3A_2 \mid$

$bA_3A_2A_1A_3A_3A_2 \mid aA_1A_3A_3A_2 \mid bA_3A_3A_2 \mid$

$bA_3A_2B_3A_1A_3A_3A_2B_3 \mid aB_3A_1A_3A_3A_2B_3 \mid$

$bA_3A_2A_1A_3A_3A_2B_3 \mid aA_1A_3A_3A_2B_3 \mid$

$bA_3A_3A_2B_3$