COMPUTER ENGINEERING DEPARTMENT

SUBJECT: THEORY OF COMPUTER SCIENCE

COURSE: T.E. **Year: 2020-2021** **Semester: V**

DEPT: Computer Engineering

SUBJECT CODE: CSC504 **EXAMINATION DATE: 14/01/2021**

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THEORY OF COMPUTER SCIENCE ANSWER SHEET

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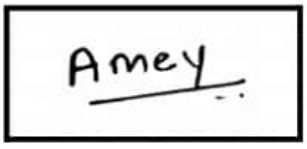
Exam : SEMESTER V

Subject : THEORY OF COMPUTER SCIENCE

Date : 14/01/2021

Day : THURSDAY

Student Signature: 

Q.2. A)

Let G be the grammar

$S \rightarrow aB \mid bA$

$A \rightarrow a \mid aS \mid bAA$

$B \rightarrow b \mid bS \mid aBB$

Find leftmost derivation, rightmost derivation and parse tree for the string 'bbaaabbaba'.

① Leftmost derivation.

$S \rightarrow bA$
$\rightarrow bbAA$ ($A \rightarrow bAA$)
$\rightarrow bbaA$ ($A \rightarrow a$)
$\rightarrow bbaaS$ ($A \rightarrow aS$)
$\rightarrow bbaaaB$ ($S \rightarrow aB$)
$\rightarrow bbaaabS$ ($B \rightarrow bS$)
$\rightarrow bbaaabbA$ ($S \rightarrow bA$)
$\rightarrow bbaaabbaS$ ($A \rightarrow aS$)
$\rightarrow bbaaabbabA$ ($S \rightarrow bA$)
$\rightarrow bbaaabbaba$ ($A \rightarrow a$)

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② Rightmost Derivation

$S \rightarrow bA$
$\rightarrow bbAA$ ($A \rightarrow bAA$)
$\rightarrow bbAaS$ ($A \rightarrow aS$)
$\rightarrow bbAaaS$ ($S \rightarrow aB$)
$\rightarrow bbAaabS$ ($B \rightarrow bS$)
$\rightarrow bbAaabbA$ ($S \rightarrow bA$)
$\rightarrow bbAaabbaS$ ($A \rightarrow aS$)
$\rightarrow bbAaabbabA$ ($S \rightarrow bA$)
$\rightarrow bbAaabbaba$ ($A \rightarrow a$)
$\rightarrow bbaaabbaba$ ($A \rightarrow a$)

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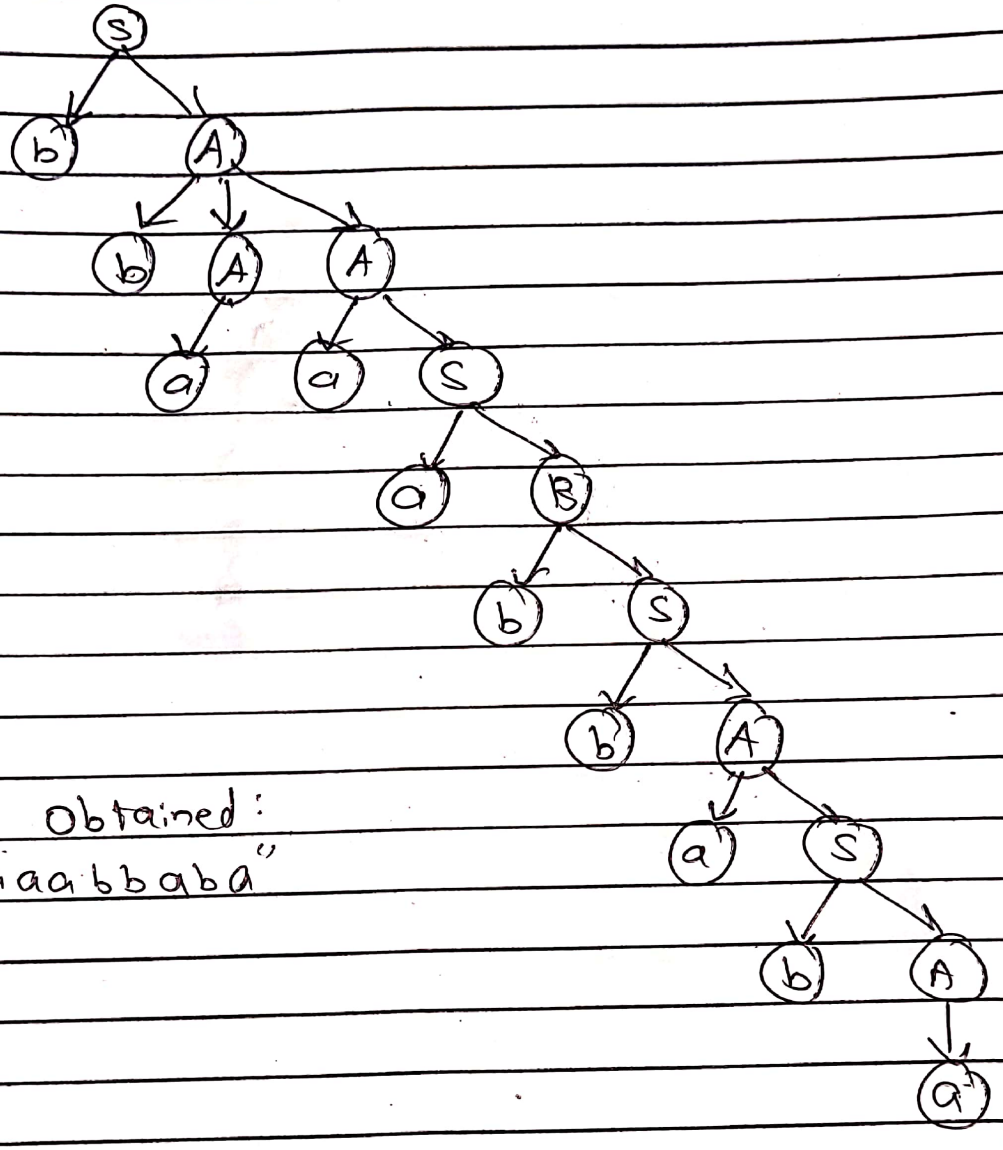
(3) Parse Tree for the Leftmost Derivation



String Obtained:
"bbaaaabbaba"

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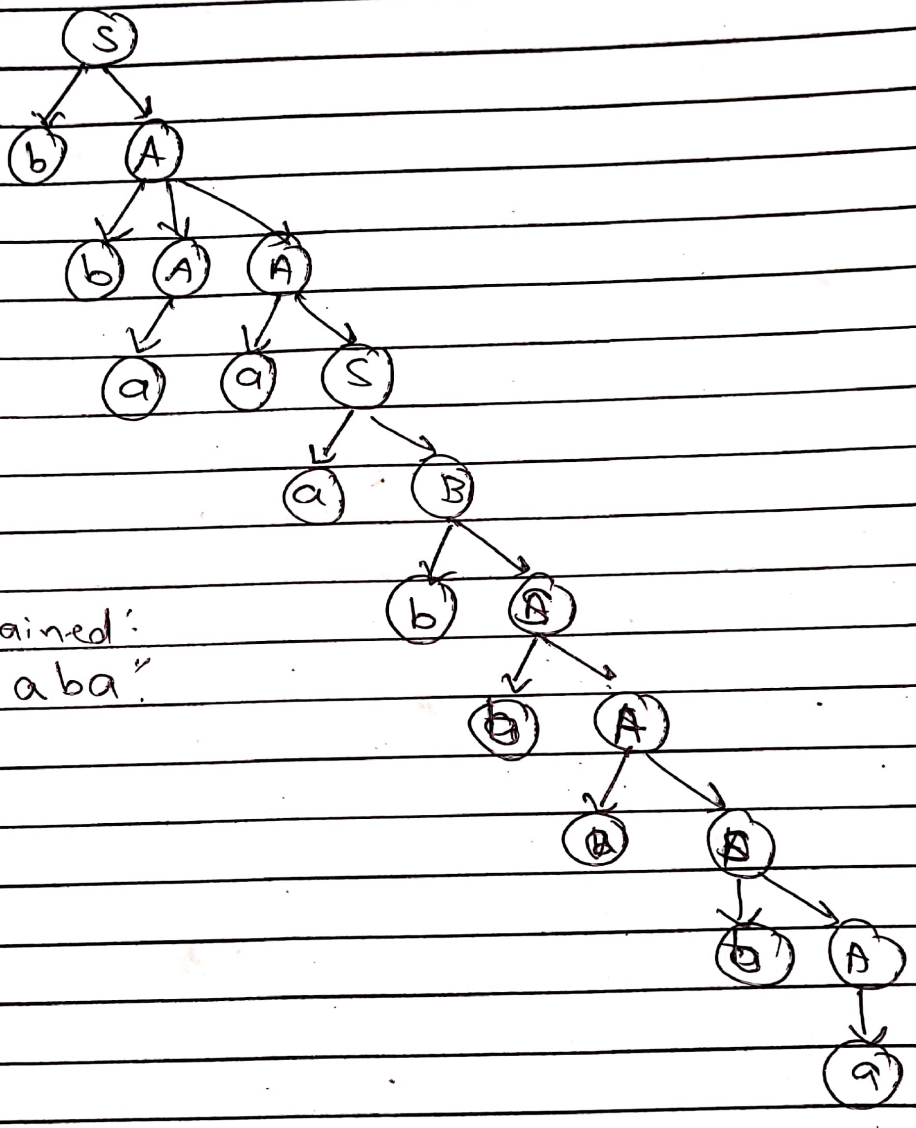
(4) Parse Tree for the Rightmost Derivation



String Obtained:
"bbaaabbaba"

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Q2. B)

Turing Machine to recognize language
$L = \{ a^n b^{n+1} \mid n \geq 1 \}$

⇒

The language becomes

$L = \{ abb, aabbb, aaabbbb, \ldots \}$

(1) Logic:

(A) Each 'a' is replaced by 'X' and head movement towards right till 'b'.

(B) Each 'b' is replaced by 'Y' and head movement towards left till 'X'

(C) Repeat above two steps till all 'a's and b's are over.

(D) For last 'b' make it Blank.

(2) Implementation:

Let $M = (Q, \Sigma, \Gamma, \delta, q_0, B, F)$

where,

$Q = \{q_0, q_1, q_2, q_3, q_4, q_5\}$

$\Sigma = \{a, b\}$

$\Gamma = \{a, b, X, Y, B\}$

$q_0 = q_0$

$B =$ Blank symbol

$F = \{q_5\}$

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③ Working

q_0 – Replace 'a' by 'X' and head moves towards right.

q_1 – Search for 'b' and and replace it by 'y' and head moves towards left, Bypass all 'a's and 'y's

q_2 – Bypass all a's and Y's. Search for 'X' and replace it by 'X' only and head moves towards 'right' whenever get 'a' at q_0 state repeat the cycle for all a's and b's

q_3 – On q_0 state if we get Y replace it by 'y' only and head moves towards right. Now, move the head right to search for the last 'b'. Bypass all 'y's.

q_4 – Afterall 'y's if we get 'b' this indicates one extra 'b' than 'a' is found.

q_5 – After the last 'b' if we get blank symbol · means no more b's are remaining

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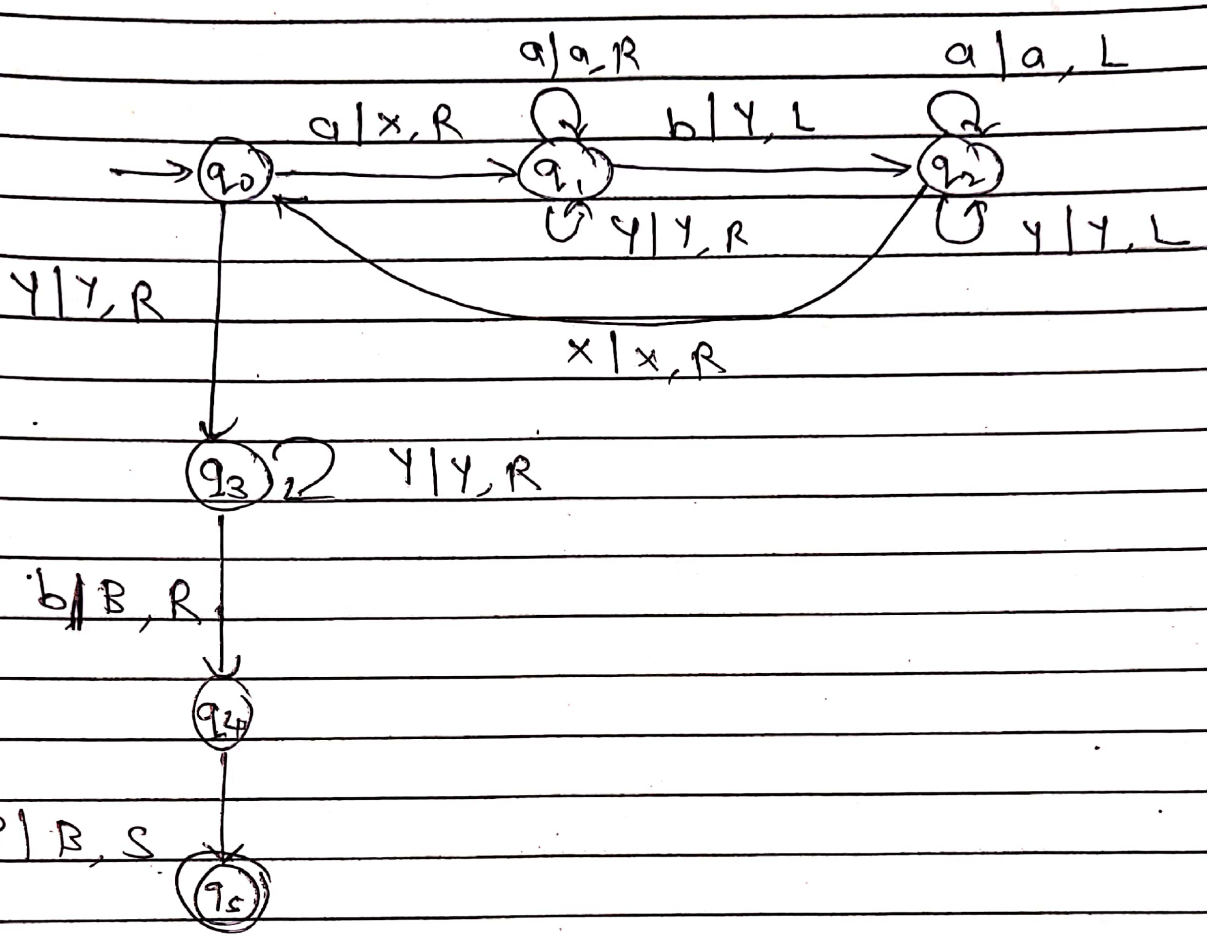
(4) Transition Diagram



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(5) Transition table:

Σ →	a	b	X	Y	B
Q					
↓					
→ q_0	(q_1, X, R)	–	–	(q_3, Y, R)	–
q_1	(q_1, a, R)	(q_2, Y, L)	–	(q_1, Y, R)	–
q_2	(q_2, a, L)	–	(q_0, X, R)	(q_2, Y, L)	–
			(		
q_3	–	(q_4, B, R)	–	(q_3, Y, R)	–
q_4	–	–	–	–	(q_5, B, S)
q_5	–	–	–	–	–

(6) Simulation

$\delta(q_0, abbB)$	$\rightarrow \delta(X q_0 Y b B)$
$\rightarrow \delta(q_1, bbB)$	$\rightarrow \delta(X Y q_3 b B)$
$\rightarrow \delta(q_2, YbB)$	$\rightarrow \delta(X Y B q_4 B)$
$\rightarrow \delta(q_2, X Y b B)$	$\rightarrow \delta(X Y B q_5)$
	Accept

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Q.2 C)

Design FSM to check whether any ternary number is divisible by 3 or not.

(1) Step 1.:

No. of states = No. of Remainders
= {0, 1, 2}
= 3 remainders.

$\therefore Q = \{0, 1, 2\}$
$= \{q_0, q_1, q_2\}$

Σ = Ternary Number = {0, 1, 2}

(2) Step 2:

Logical Table

	(3R+0) Mod 3	(3R+1) Mod 3	(3R+2) Mod 3			
	0	1	2			
0 *q_0	q_0	q_1	q_2	0	1	2
1 q_1	q_0	q_1	q_2	0	1	2
2 q_2	q_0	q_0	q_2	0	1	2

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③ Step 3:

Implementation

$\Sigma = \{0, 1, 2\}$ Output = {Y, N}

$Q = \{q_0, q_1, q_2\}$

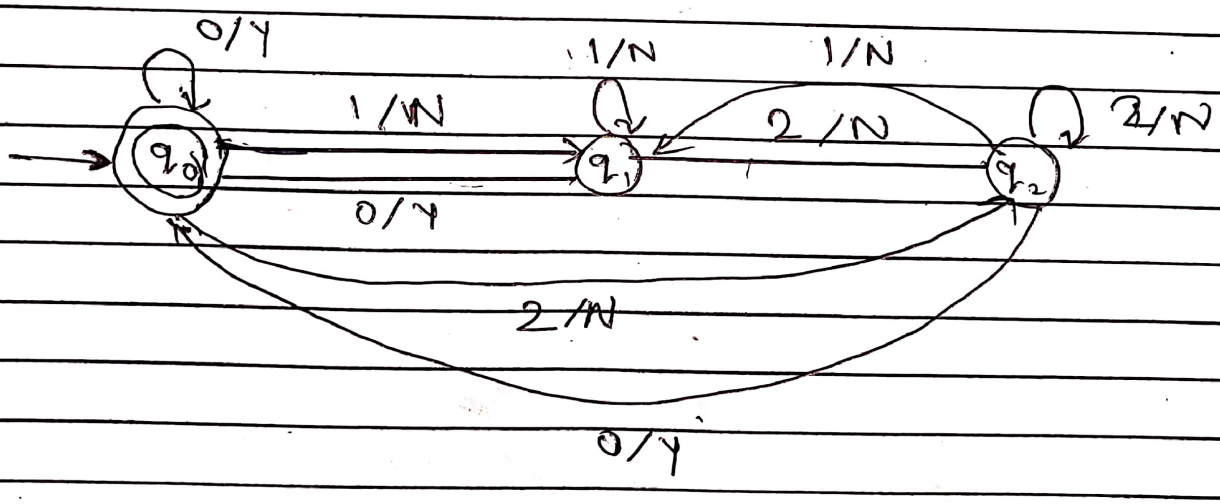
STF

	0	1	2
→q_0	q_0	q_1	q_2
q_1	q_0	q_1	q_2
q_2	q_0	q_1	q_3

MAF

	0	1	2
q_0	Y	N	N
q_1	Y	N	N
q_2	Y	N	N

Transition Diagram.



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(4) Step 4:
Examples:

(A) $\delta(q_0, 1020)$
$\delta(q_1, 020)$
$\delta(q_0, 20)$
$\delta(q_2, 0)$
$\delta(q_0)$
$\Rightarrow$ Y

(B) $\delta(q_0, 221)$
$\delta(q_2, 21)$
$\delta(q_2, 1)$
$\delta(q_1)$
$\Rightarrow$ N

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