PAGE No.
DATE / /

ACD Assignment

Q1 $\Sigma = \{a, b\}$

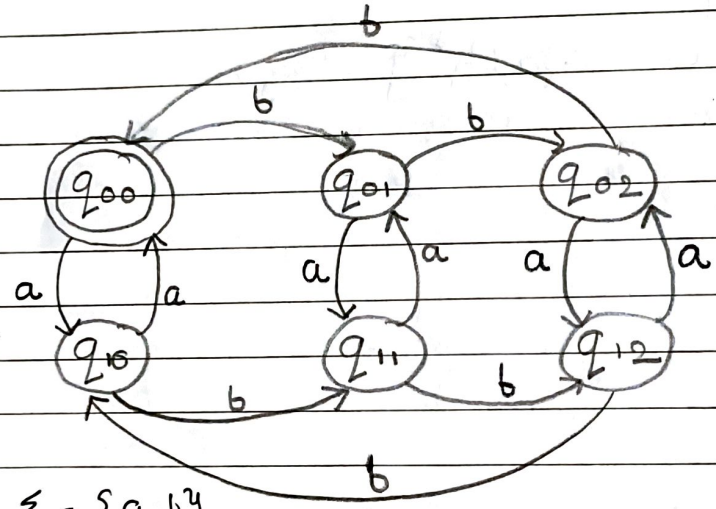
$L(G) = \{ a^{2n} b^{3n} \mid n \geq 0 \}$

$a\%2 = 0, 1$

$a\%3 = 0, 1, 2$

possible combinations $= 2 \times 3 = 6$

a	b
0	0
1	1
0	2
1	0
0	1
1	2



Q2 $\Sigma = \{a, b\}$

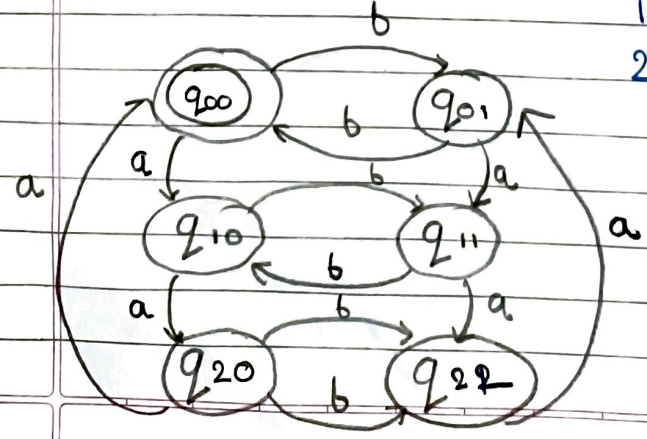
$L(G) = \{ a^{3n} b^{2n} \mid n \geq 0 \}$

$a\%3 = 0, 1, 2$

$b\%2 = 0, 1$

Total $= 3 \times 2 = 6$

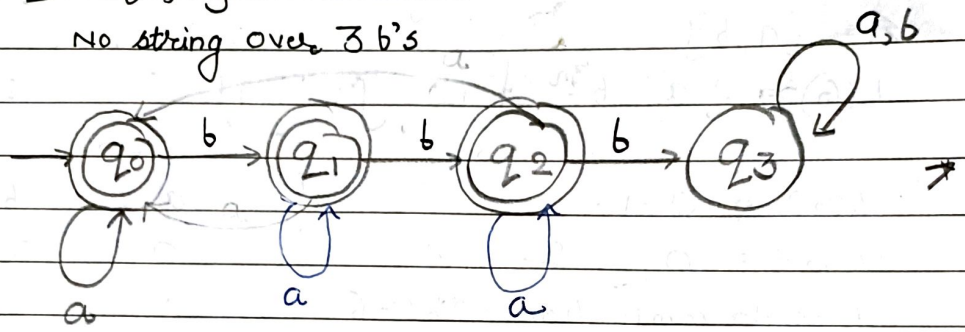
a	b
0	0
1	1
2	0
0	1
1	0
2	1



PAGE No.
DATE / /

Q3 $\Sigma = \{a, b\}$

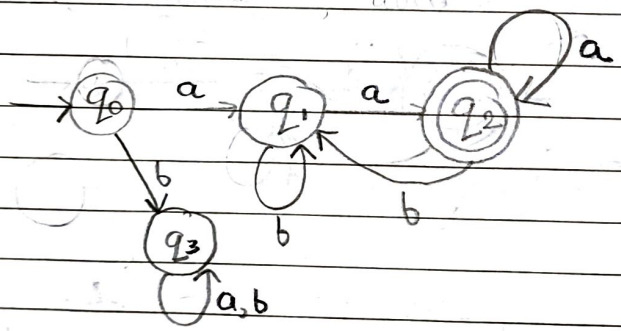
No string over 3 b's



Q4 $\Sigma = \{a, b\}$

$L = \{ awa : w \in \{a, b\}^* \}$

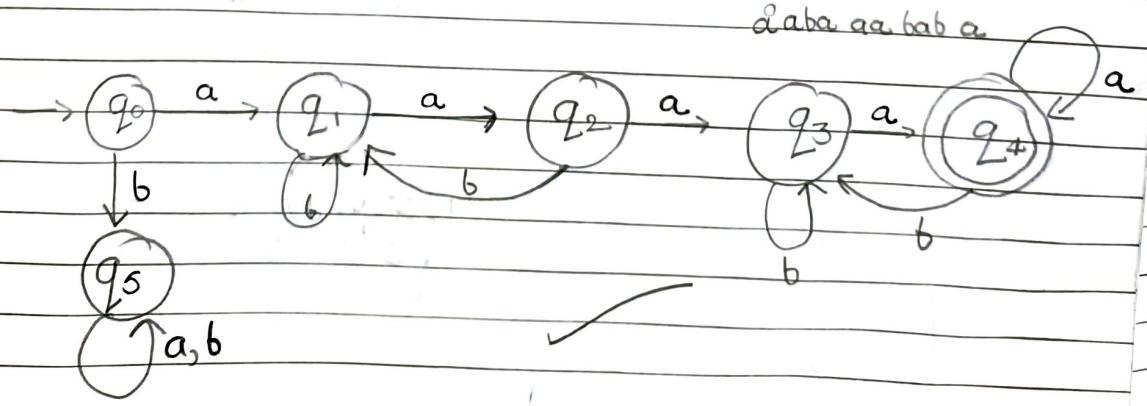
$L = \{ aa, aba, aaa, abaaba, aaba, \ldots \}$



Q5 $\Sigma = \{a, b\}$

$L = \{ aw_1aaw_2a : w_1, w_2 \in \{a, b\}^* \}$

$L = \{ aaaaa, abaaaba, abbaabbaa, ababaaabaaa, aba aa bab a \}$

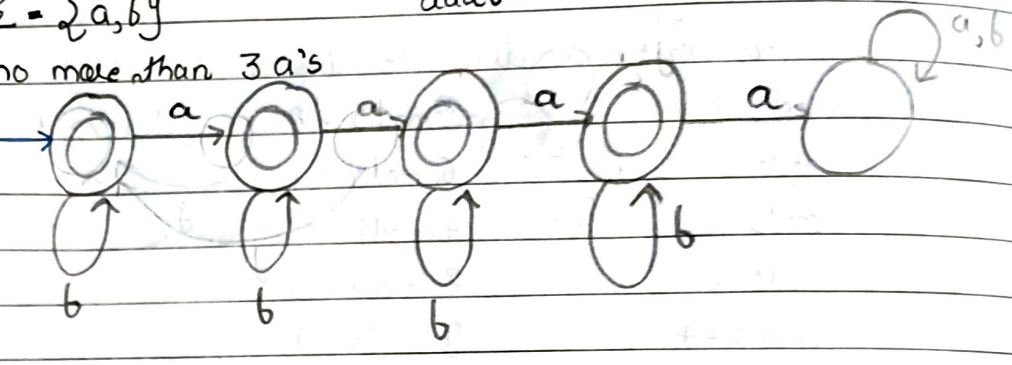


PAGE No.
DATE / /

aaab abab aba

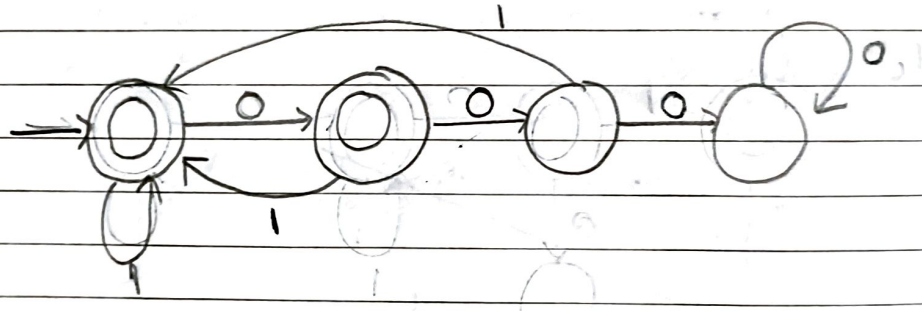
Q6 $\Sigma = \{a, b\}$

no more than 3 a's



Q8 $\Sigma = \{0, 1\}$

$L = \{0, 1, 01, 10, 001, 11, 111, 110, 1001,$



Q9 $\Sigma = \{0, 1\}$

% by 3

0 0 mod 3 = 0

1 1 mod 3 = 1

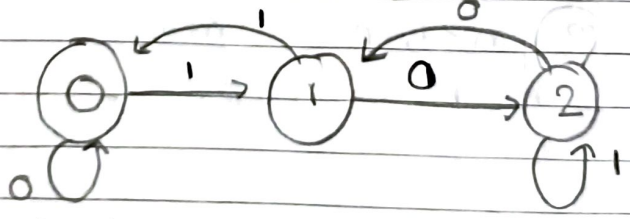
10 2 mod 3 = 2

11 3 mod 3 = 0

100 4 mod 3 = 1

101 5 mod 3 = 2

110 6 mod 3 = 0



Q10 $\Sigma = \{0, 1\}$ % by 2

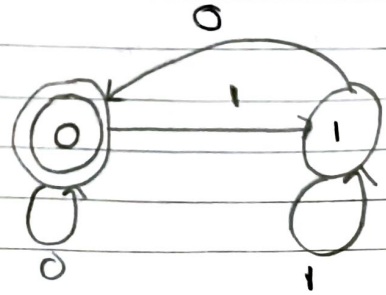
0 0 mod 2 = 0

1 1 mod 2 = 1

10 2 mod 2 = 0

11 3 mod 2 = 1

100 4 mod 2 = 0



Q3

Q4

Q5

Q11 $\Sigma = \{0, 1, 2\}$

sum of digits is divisible by 5

0 0 mod5 = 0

1 1 mod5 = 1

11 2 mod5 = 2

21 111 3 mod5 = 3

22 1111 4 mod5 = 4

5 mod5 = 0

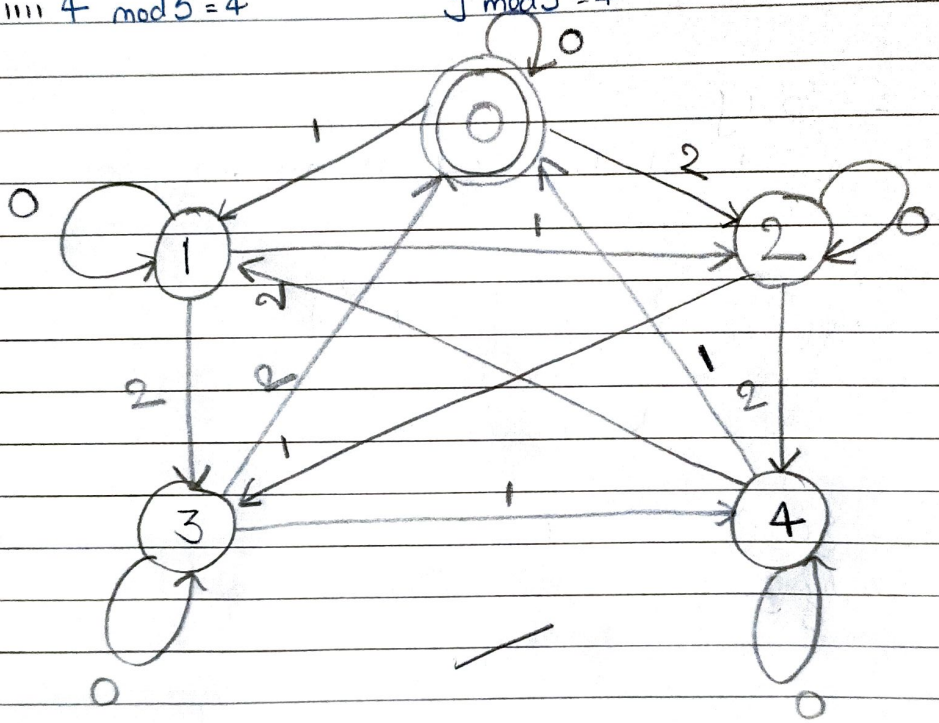
6 mod5 = 1

7 mod5 = 2

8 mod5 = 3

9 mod5 = 4

10 mod5 = 0



Q12 $L = \{0^n 1^m \mid m \geq 1, n \geq 0;$ $(n+m)$ is divisible by 3$\}$

1^3 1^6 1^9 n = 0 m = 3/6/9

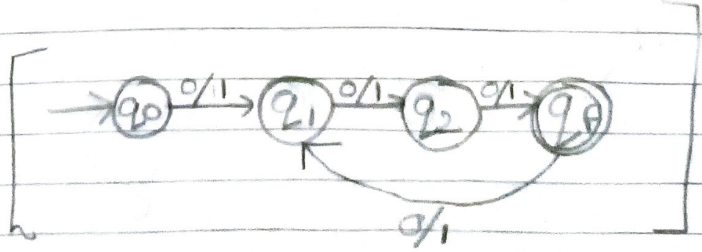
01^2 01^5 01^8 n = 1 m = 2/5/8

$0^2 1$ $0^5 1$ $0^8 1$ n = 2 m = 1/4/7

111

011

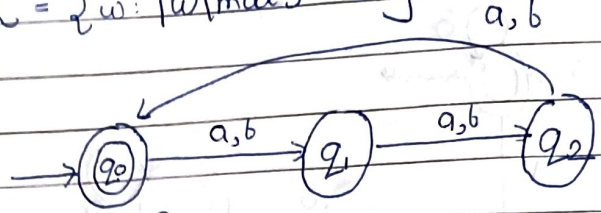
001



PAGE No.
DATE / /

Q7. $\Sigma = \{a, b\}$

a. $L = \{w : |w| \bmod 3 = 0\}$



mod3 = 0, 1, 2

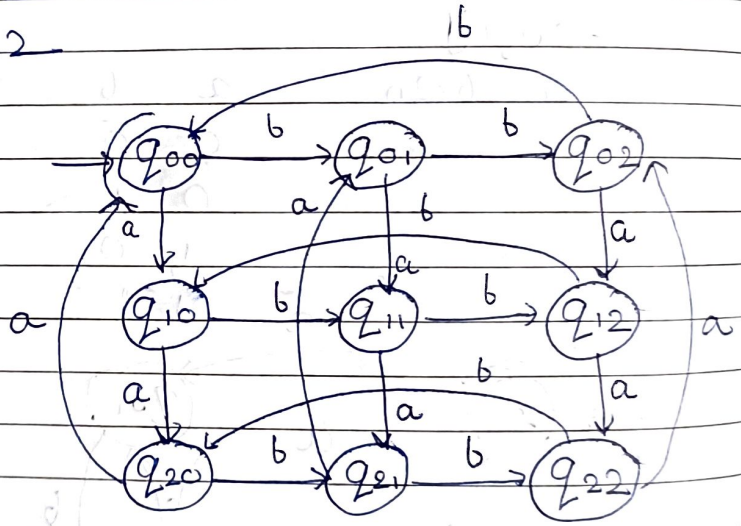
q_0, q_1, q_2

b. $L = \{w : n_a(w) \bmod 3 > n_b(w) \bmod 3\}$

mod3 = 0, 1, 2

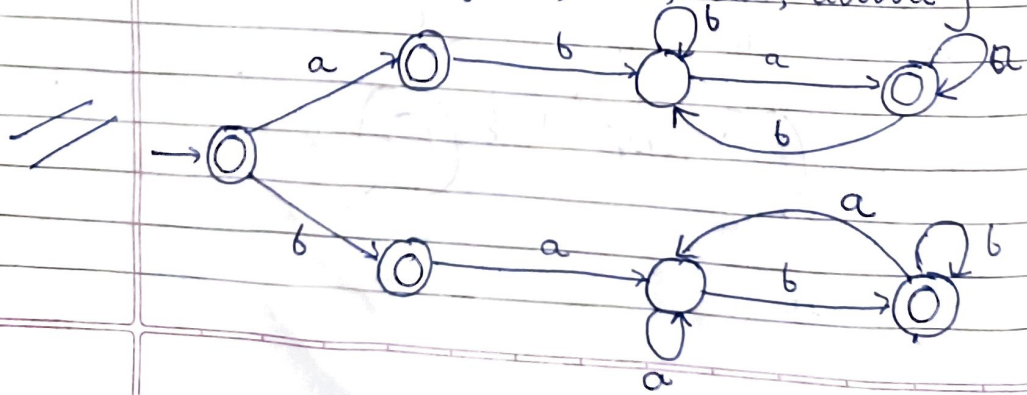
mod3 = 0, 1, 2

A	B
0	0
1	0
2	0
0	1
1	1
2	1
0	2
1	2
2	2



Q13 $\Sigma = \{a, b\}$

$ab = ba$, $L = \{a, b, aba, bab, abbbba\}$



Q11

0
1
11
21 111
22 1111
0

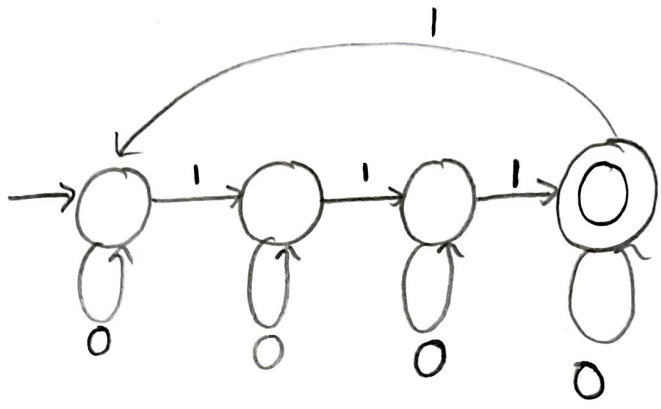
Q12

✗

a666

Q14 $\Sigma = \{0, 1\}$

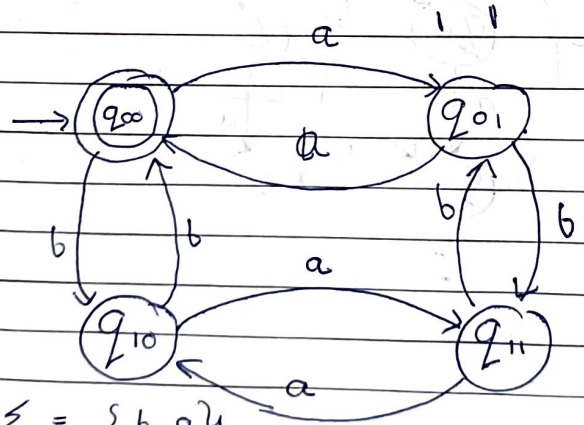
1 - 3multiple



Q15 $\Sigma = \{a, b\}$

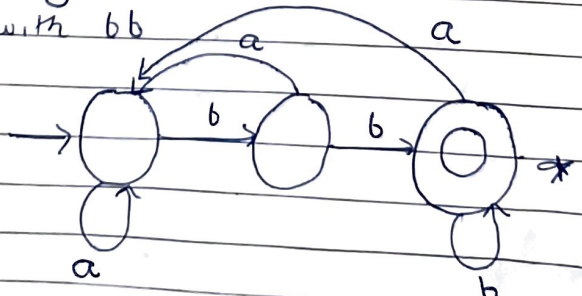
a=2n b=2n

a	b
0	0
0	1
1	0
1	1



Q16 $\Sigma = \{b, a\}$

L = end with bb



:.bbb

PAGE No.
DATE / /

Q17 Regular Expressions

a) $1^{2n+1} \mid n>0$

1, 111, 11111

$1(11)^*$

b) $\Sigma = \{0, 1\}$ atmost 2 zero

1) No zero = 1^*

2) One zero = 1^*01^*

3) Two zero = $1^*01^*01^*$

$\Rightarrow$ $1^* + 1^*01^* + 1^*01^*01^*$

c) a^n, $n\%2$ or $\%3$ or $n=5$

1) $a^{2n} = (aa)^*$

2) $a^{3n} = (aaa)^*$

3) $n=5$, aaaaa

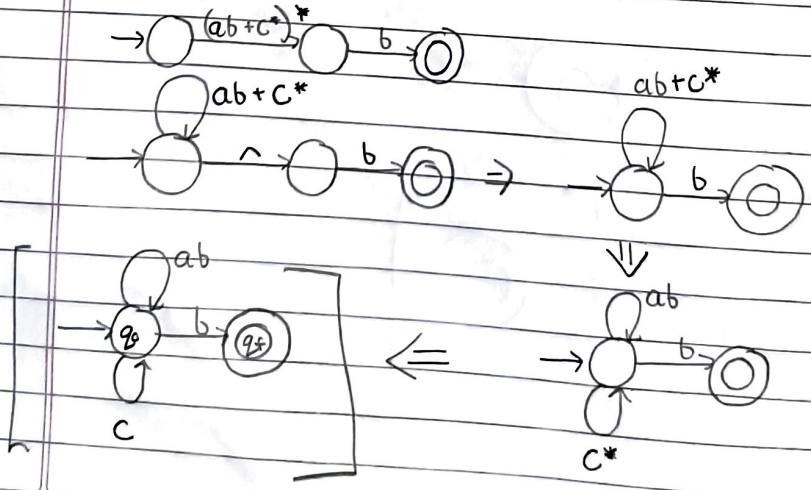
$\Rightarrow$ $(aa)^* + (aaa)^* + aaaaa$

d) $\Sigma = \{a, b\}$, start = a / end = a

$\Rightarrow$ $a(a+b)^*a$

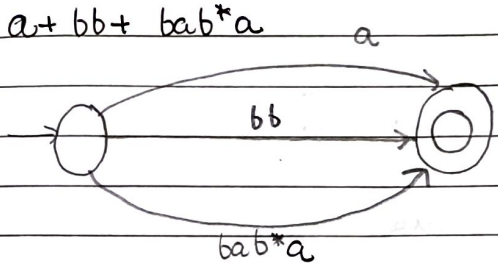
Q18 Transition System /

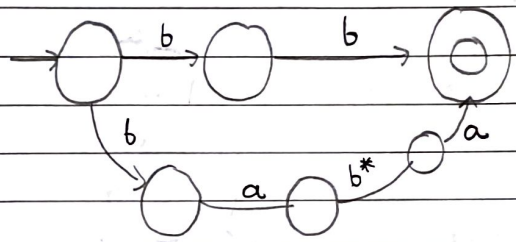
a) $(ab+c^*)^*b$



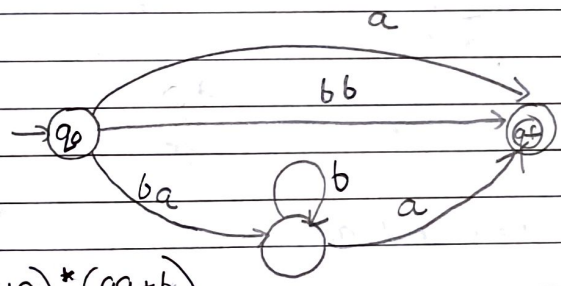
PAGE No.
DATE / /

b) $a + bb + bab^*a$

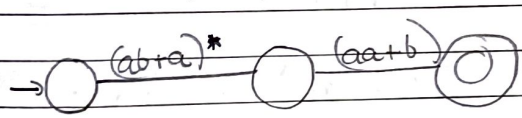




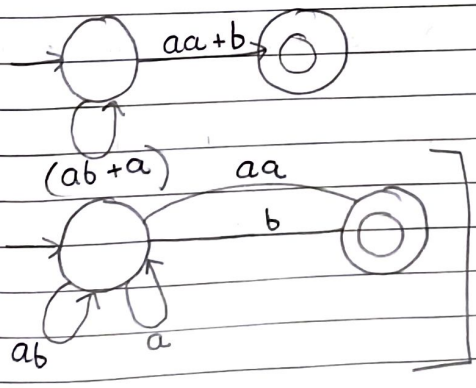
$\Rightarrow$



c) $(ab+a)^*(aa+b)$

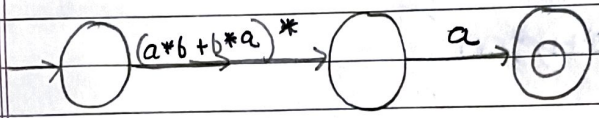


$\Rightarrow$

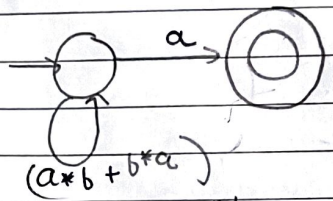


PAGE No.
DATE / /

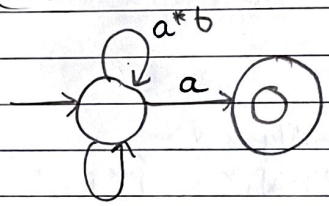
d) $(a^*b + b^*a)^* a$



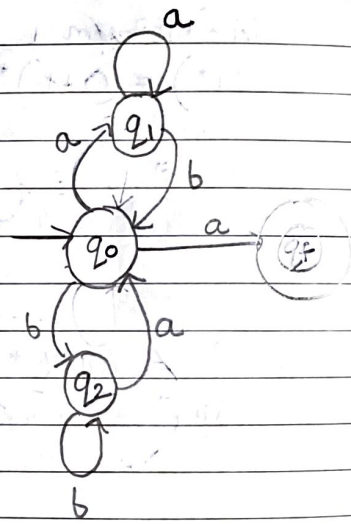
⇒



⇒



⇒



Q.9

a) $\Sigma = \{0, 1\}$

Atmost 1 pair of Zero

1.) No pair of 0 ⇒ $(1+01)^* + (1+10)^*$

2.) 1 pair of 0 ⇒ $(01)^*00(10)^*$

⇒ $(1+01)^* + (1+10)^* + (01)^*00(10)^*$

for 1 ⇒ $(0+10)^* + (0+01)^* + (10)^* || (01)^*$

b)

c)

d) $(a+b)^* bbb (a+b)^*$

e) $00(0+1)^*$

f) $1(0+1)^*00$

Q20

a. Arden's Theorem

b. $(0^*1^*) = (0+1)^*$

$0 = P$

$1 = Q$

$(P^*Q^*)^* = (P+Q)^*$

using identity

$(P+Q)^* = (P^* + Q^*)^* = (P^*Q^*)^*$

c. $(ab)^* \neq (a^*b^*)$

$(ab)^* = ab, abab.$

$a^*b^* = ab, aab$ ✗

d. $(r+s)^* \neq r^* + s^*$

$(r+s)^* = (r^* + s^*)^*$

$(r^* + s^*)^* \neq r^* + s^*$

e. $\lambda + 1^*(011)^*(1^*(011)^*)^* = (1+011)^*$

$1 \rightarrow P \quad 011 \rightarrow Q$

$\lambda + \underbrace{P^*Q^*}_{R}(\underbrace{P^*Q^*}_{R})^* = (P+Q)^*$

$\lambda + RR^*$

$\Rightarrow R^*$

$\Rightarrow (P^*Q^*)^*$ using I_{12}

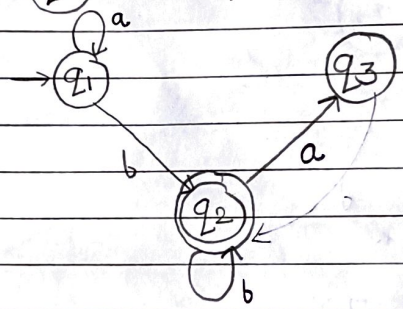
$\Rightarrow (P+Q)^* = RHS$

PAGE No.
DATE / /

Q21

a.

states	a	b
→ q_1	q_1	q_2
q_2	q_3	q_2
q_3	ϕ	ϕ



$q_1 = q_1 a + \wedge$

$q_3 = q_2 a$

$q_2 = q_1 b + q_2 b$

$q_1 = \wedge + q_1 A$

R Q R P

$R = QP^*$

$q_1 = a^*$

$q_2 = a^* b + q_2 b$

$\Rightarrow a^* b$

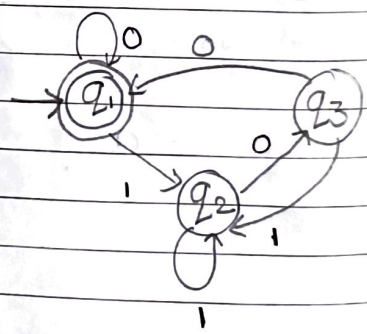
R Q R P

$R = QP^* =$

$(q_2 = a^* b\, b^*)$ ✓

b.

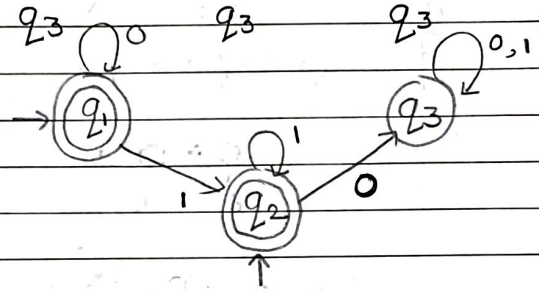
states	0	1
→ q_1	q_1	q_2
q_2	q_3	q_2
q_3	q_1	q_2



PAGE No.
DATE / /

6.

States	0	1
→ q_1	q_1	q_2
→ q_2	q_3	q_2
q_3	q_3	q_3



$q_1 = q_1 0 = 0^*$

$q_2 = q_2 1 + q_3 0$

$q_3 = q_3 (0+1)$

$q_3 = (0+1)^*$

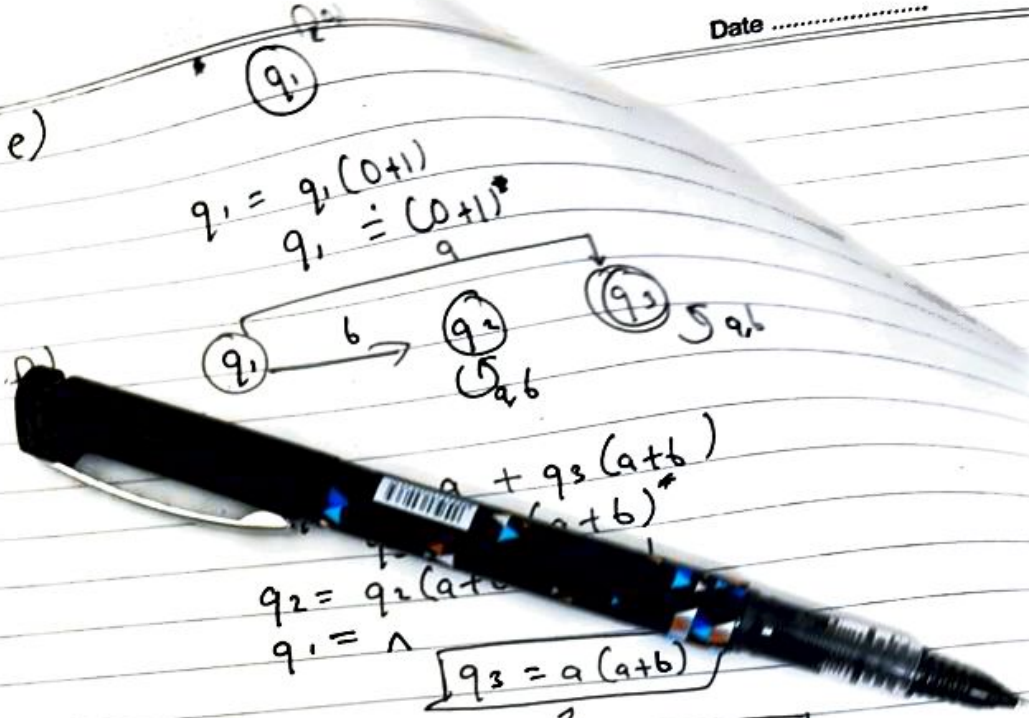
$q_2 = (0+1)^* 0 + q_2 1$

(Q) (P)

$\left(q_2 = (0+1)^* 0 1^*\right)$

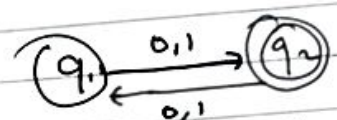
Date .....

e)



g)

	0	1
→*q1 q2	q2 q1	q2 q1



$q_1 = q_2(0+1)$

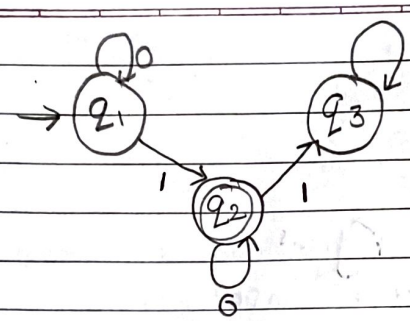
$q_2 = q_1(0+1)$

$q_2 = q_2(0+1)(0+1) + \wedge$

$q_2 = ((0+1)(0+1))^*$

PAGE No.
DATE / /

Q22



$q_1 = q_1 0 = 0^*$

$q_2 = q_1 1 + q_2 0$

$q_3 = q_2 1 + q_3(0+1)$

$q_2 = q_2 0 + 0^* 1$

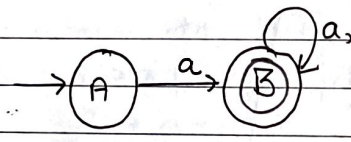
(P, Q)

$(q_2 = 0^* 10^*)$

Q23 ✓

Q24

a)

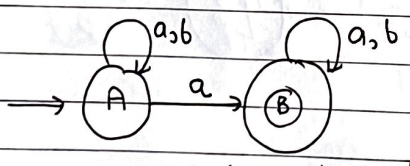


$G = \{(A,B)\ (a,b)\ P\ \{A\}\}$

$A \rightarrow aB$

$B \rightarrow a|b|aB|bB$

b)



$G = (\{A,B\}\ \{a,b\}\ P\ A\}$

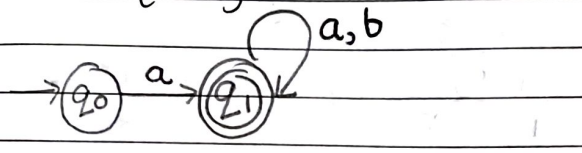
$A \rightarrow aB|aA|bA|$

$B \rightarrow a|b|aB|bB$

0

PAGE No.
DATE / /

Q25 R.E = $a(a+b)^*$

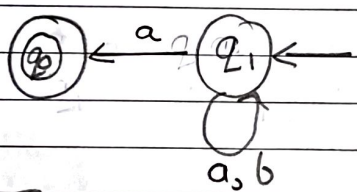


$G = \{(q_0, q_1)(a,b)\ q_0\ P\}$

P =

$q_0 \rightarrow aq_1$

$q_1 \rightarrow a|b|aq_1|aq_1$

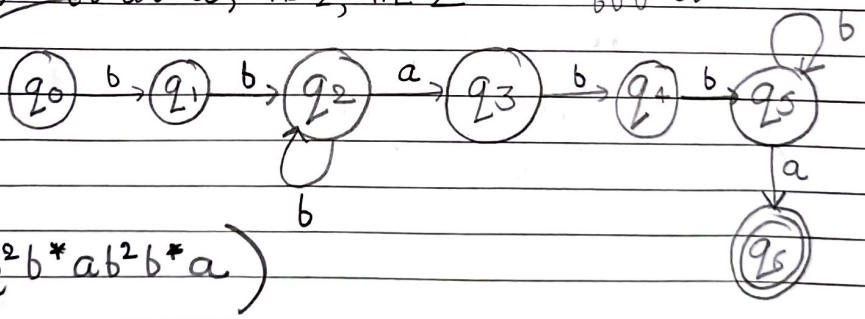


$q_1 \rightarrow aq_1 | bq_1 | aq_0$

$q_0 \rightarrow \wedge$

Q26 $L(G) = \{b^n a b^m a;\ n \geq 2,\ m \geq 2$

bbb abbbba
bbb aba



$(b^2b^*ab^2b^*a)$

Right

$q_0 \rightarrow bq_1$

$q_1 \rightarrow bq_2$

$q_2 \rightarrow bq_2 | aq_3$

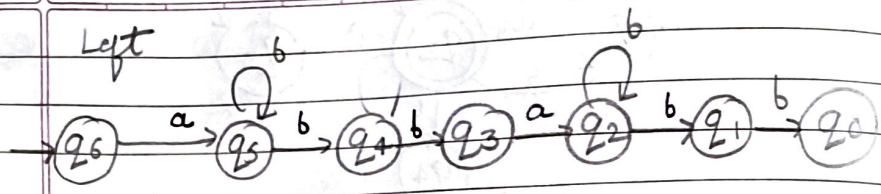
$q_3 \rightarrow bq_4$

$q_4 \rightarrow bq_5$

$q_5 \rightarrow bq_5 | aq_6$

$q_6 \rightarrow \wedge$

Left



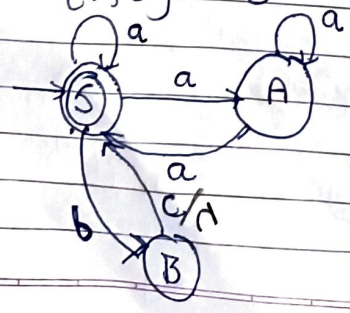
$q_6 \rightarrow q_5 a$ or aq_5
$q_5 \rightarrow bq_5 \mid bq_4$
$q_4 \rightarrow bq_3$
$q_3 \rightarrow aq_2$
$q_2 \rightarrow bq_2 \mid bq_1$
$q_1 \rightarrow bq_0$
$q_0 \rightarrow \wedge$

Q27 Grammar to DFA

$S \rightarrow a \mid aA \mid bB \mid \varepsilon$
$A \rightarrow aA \mid aS$
$B \rightarrow cS \mid \varepsilon$

({S, A, B}, {a, b}, P, S)

$\delta(S, a) \rightarrow (S)$
$\delta(S, a) \rightarrow A$
$\delta(S, b) \rightarrow B$
$\delta(S, \varepsilon) \rightarrow S$
$\delta(A, a) \rightarrow A$
$\delta(A, a) \rightarrow S$
$\delta(B, c) \rightarrow S$
$\delta(B, \varepsilon) \rightarrow B$



Q25 R.E =

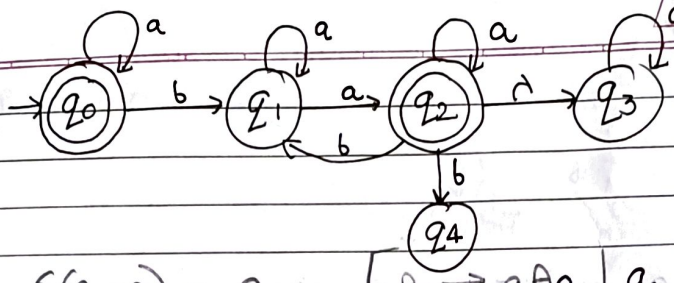
G =

Q26 L(G) =

Right

$q_0 \rightarrow$
$q_1 \rightarrow$
$q_2 \rightarrow$
$q_3 \rightarrow$
$q_4 \rightarrow$
$q_5 \rightarrow$
$q_6 \rightarrow$

Q28



$\delta(q_0, a) = q_0$
$\delta(q_0, b) = q_1$
$\delta(q_1, a) = q_1$
$\delta(q_1, a) = q_2$
$\delta(q_2, a) = q_2$
$\delta(q_2, b) = q_1$
$\delta(q_2, d) = q_3$
$\delta(q_3, a) = q_3$
$\delta(q_3, b) = q_3$
$\delta(q_2, b) = q_4$

$A_0 \rightarrow aA_0 \mid a$
$A_0 \rightarrow bA_1$
$A_1 \rightarrow aA_1$
$A_1 \rightarrow aA_2$
$A_2 \rightarrow aA_2 \mid a$
$A_2 \rightarrow A_1 b$
$A_2 \rightarrow q_3 d$
$A_3 \rightarrow aA_3$
$A_3 \rightarrow bA_3$
$A_2 \rightarrow bA_4$

$G_R = (\{A_0, A_1, A_2, A_3, A_4\}, \{a, b, d\}, P, \{A_0\})$

Q29 $L = \{(10)^p 1^q \mid p, q \in N,\ p \geq q\}$

1. Let L be a regular grammar:—
   Let n be the total no. of states in f.A

2. Let $L = xyz$; $|xy| \leq n$; $|y| > 0$

   $= \underbrace{(10)^{p-1}}_{x}\underbrace{(10)}_{y}\underbrace{1^{q-1}}_{z}$

3. If $L = xyz$ is regular grammar & ; so xy^2z should also be regular

   $L = xy^2z = (10)^{p-1}(10)(10)1^{q-1}$
   $\Rightarrow (10)^p 0 1 0 1^q$

   $xy^2z \notin L$

   Hence our assumption contradicts

PAGE No.
DATE / /

Q30 $L = \{a^n b^n \mid n \in N, n \geq 0\}$

$L = \{\wedge, ab, aabb, \ldots\}$

1. Let L be regular grammar
   Let m be the total no. of states in the F.A

2. Let $L = xyz \quad |xy| \leq m \quad |y| > 0$
   $L = \underbrace{a^{n-1}}_{x} \underbrace{ab}_{y} \underbrace{b^{n-1}}_{z}$

3. if $L = xyz$ is regular then
   xy^2z should also be regular
   $L = xy^2z$
   $= a^{n-1} abab\, b^{n-1}$
   $= a^n ba\, b^n$
   $\notin L$
   Hence this contradicts our assumption.
   so $L = \{a^n b^n\}$ is not regular.

Q28 (20)

$\delta(q_0, \ldots$
$\delta(q_0, \ldots$
$\delta(q_\ldots$
$\delta(q_\ldots$
$\delta(q_\ldots$
$\delta(q_\ldots$
$\delta(q_\ldots$
$\delta(q_\ldots$
$\delta(q_\ldots$

$G_n = \{\{A$

Q29 $L = \{(10)^n$

1. Let L ab
   Let

2. Let L =
   =

3. If L = x
   also be
   L =

PAGE No.
DATE / /

Q32 $S \to ABC$

$A \to a$

$B \to b$

$C \to c$

(i) $w = abc$ / LMD — RMD

$S \to ABC$ — $S \to ABC$

$S \to aBC$ — $S \to aBC$

$S \to AbC$ — $S \to abC$

$S \to abC$ — $S \to abC$

Q33 $S \to aS / \Lambda$

i) LMD — RMD

$S \to aS$

$S \to aaS$

$S \to aaaS$

$S \to aaa$

Q34 $S \to aB \mid bA$

$S \to aS \mid bAA \mid a$ — $w = aaabbabba$

$B \to bS \mid aBB \mid b$

i) LMD

$S \to aB$

$S \to aaBB$ [$B \to aBB$]

$S \to aaaBBB$ [$B \to aBB$]

$S \to aaabbB$ [$B \to b$]

$S \to aaabbaBB$ [$B \to aBB$]

$S \to aaabbabB$ [$B \to b$]

$S \to aaabbabbS$ [$B \to bS$]

$S \to aaabbabbba$

Simplify

PAGE No.
DATE / /

ii) RMD

S → aB
S → aaBB (B → aBB)
S → aaBaBB (B → aBB)
S → aaBaBbS (B → bS) ✗
S → aaBaBbbA (B → bA)
S → aaBaBbba (A → a)
S → aaBabbba (B → b)

Q35 S → bB | aA
A → b | bS | aAA
B → a | aS | bBB
W = bbaababa

1. Left Most Derivation
S → bB
S → bbBB [B → bBB]
S → bbaSB [S → aA]
S → bbaaABB [A → b]
S → bbaabB [B → aS]
S → bbaababS [S → bB]
S → bbaababB [B → a]
S → bbaababa

2. RMD
S → bB
S → bbBB
S → bbBaS [B → aS]
S → bbBabB [S → bB]
S → bbBabaS [B → aS]
S → bbBababB [S → bB]
S → bbBababa [B → a]
S → bbaababa [B → a]

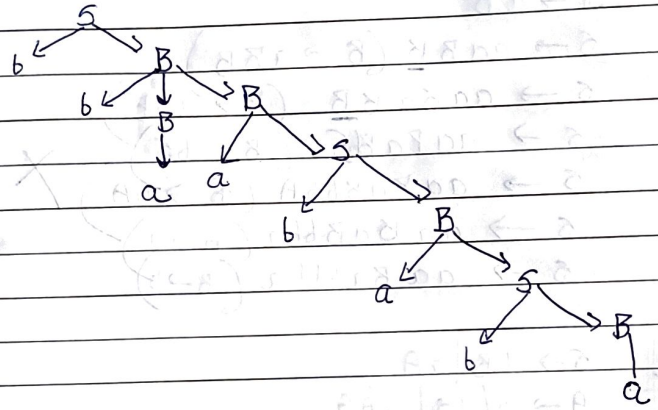
Q32 S → AB
A → a
B → b
C → c
(i) W =
S → A
S →
S →
S →

Q33 S → aS
i) LMD
S

Q34 S → aB
S → aS
B → bS
i) LMD
S → aB
S → aa
S → a
S →
S →
S →
S →
S →

PAGE No.
DATE / /

3. Parse Tree



PAGE No.
DATE / /

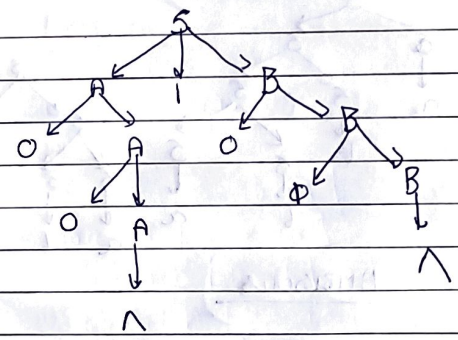
Q36 $S \to A1B$
$S \to 0A \mid \Lambda$
$B \to 0B \mid 1B \mid \Lambda$
$w = 00101$

(i) LMD

$S \to \underline{A}1B$
$S \to 0\underline{A}1B \quad [A \to 0A]$
$S \to 00\underline{A}1B \quad [A \to 0A]$
$S \to 001\underline{B} \quad [A \to \Lambda]$
$S \to 0010\underline{B} \quad [B \to 0B]$
$S \to 00101\underline{B} \quad [B \to 1B]$
$S \to 00101 \quad [B \to \Lambda]$

(ii) RMD

$S \to A1\underline{B}$
$S \to A10\underline{B} \quad [B \to 0B]$
$S \to A101\underline{B} \quad [B \to 01]$
$S \to A101 \quad [B \to \Lambda]$
$S \to 0A101 \quad [A \to 0A]$
$S \to 00A101 \quad [A \to 0A]$
$S \to 00101 \quad [A \to \Lambda]$



3. Parse Tree

Q48) Check for Ambiguity

$S \to SS$

$S \to a$

$S \to b$

Let w = abba

LMD

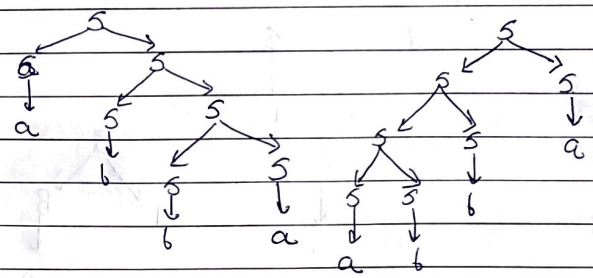
$S \to \underline{S}S$

$S \to \underline{S}SS$ [$S \to SS$]

$S \to \underline{S}Sa$ [$S \to a$]

$S \to \underline{S}SSa$ [$S \to SS$]

$S \to abba$ [$S \to a, S \to b$]

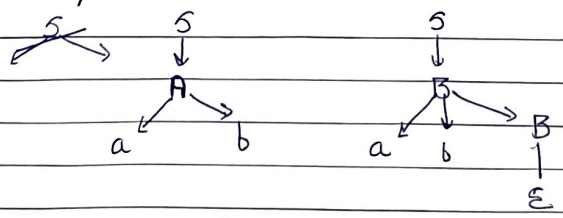


AMBIGOUS

Q49 $S \to A|B$

$A \to aAb/ab$ Let w = ab

$B \to abB/\varepsilon$

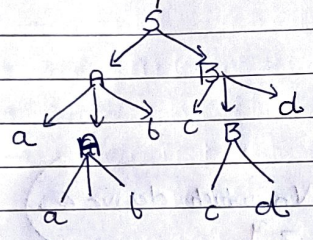
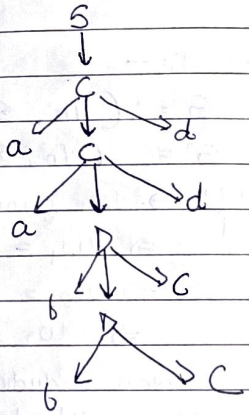


Ambiguous

PAGE No.
DATE / /

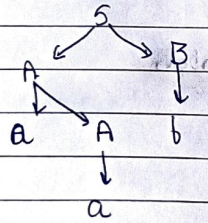
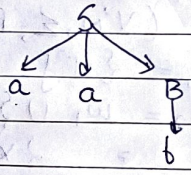
Q50 $S \to AB/C$
$A \to aAb/ab$
$B \to cBd/cd$
$C \to aCd/aDd$
$D \to bDC/bC$

$w = abcd$
$w = aabbccdd$

AMBIGOUS

Q51 $S \to AB/aaB$
$A \to a/Aa$
$B \to b$
$w = aab$

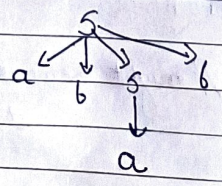
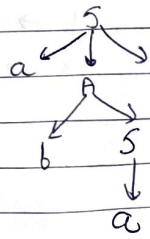



AMBIGOUS

Q52 $S \to a/abSb/aAb$
$A \to bS/aAAb$

$S \to aAb$
$S \to abSb$
$S \to abab$

$w = abab$ / $abababb$

AMBIGOUS

Q48 Check for

$S \to S$
$S \to$
$S \to$
Let $w =$
LMD
$S \to \underline{S}S$
$S \to S\underline{S}$
$S \to \underline{S}$
$S \to \underline{S}$
$S \to$

Q49 $S \to A/$
$A \to aA$
$B \to ab$

PAGE No.
DATE / /

Q.59 Removal of Useless Symbols (Reductions)

~~S → ABA~~ T → xxY | xbX | xxT

~~A → CA~~ X → xX

Y → xy | y

Z → xZ

Phase I:-

$G_1 = (V_n, \Sigma, P, S)$

$G' = (V_n', \Sigma, P', S)$

Step1 :→ W_1 { include all V_n which derive Σ }

⇒ $W_1 = \{T, X, Y, Z\}$

⇒ $W_2 =$ { all V_n which derive W_1 }

⇒ $W_2 = W_1 = \{T, X, Y, Z\}$

New Productions :→ P'

T → xxY | xbX | xxT

X → xX

Y → xy | y

Z → xZ

Phase 2:- $G'' = (V'_N, \Sigma, P', S)$

Step1 → $W_1 = \{TY$ starting symbols

$W_2 = W_1 \cup \{X, Y, TY$

$= \{X, Y, TY$

$W_3 = W_2 \cup \phi = W_2$

New productions

T → xxY | xbX | xxT

Y → xy | y

X → xX // might remove because it does not terminate

00 Z → 01

PAGE No.
DATE / /

Q60 Remove ε production.

$S \to ABA$

$A \to 0A \mid \wedge$

$B \to 1B \mid \wedge$

1. $A \to \wedge$

$S \to ABA \mid AB \mid BA \mid B$

$A \to 0A \mid 0$

$B \to 1B \mid \wedge$

2. $B \to \wedge$

$S \to ABA \mid AA \mid A$

$A \to 0A \mid 0$

$B \to 1B \mid 1$

Final $\Rightarrow$ $S \to ABA \mid AB \mid BA \mid A \mid B \mid AA$

$A \to 0A \mid 0$

$B \to 1B \mid 1$

Q61 Remove Unit production.

$S \to 0X \mid 1Y \mid Z$

$X \to 0S \mid 00$

$Y \to 1 \mid X$

$Z \to 01$

1. Step 1 :→ Identify all Units

$S \to Z$ $Y \to X$

2. a) $Y \to X$

$X \to 0S \mid 00$

$Y \to 0S \mid 00$

$\Rightarrow S \to 0X \mid 1Y \mid Z$ $X \to 0S \mid 00$ $Y \to 1 \mid 0S \mid 00$ $Z \to 01$

Q59 Removal o

$S \to$

$A \to$

Phase I :–

$G =$

$G' =$

Step 1 :→

$\Rightarrow$

$\Rightarrow$

$\Rightarrow$

New

$T \to$

$X \to$

$Y \to$

$Z \to$

Phase 2 :– G''

Step 1 →

New

b) $S \to Z$

$Z \to 01$

$S \to 01$

$\Rightarrow S \to 0X \mid 1Y \mid 01$

$X \to 0S \mid 00$

$Y \to 1 \mid 0S \mid 00$

$Z \to 01$

Q62 $S \to a \mid aA \mid B$

$A \to aBB \mid \wedge$

$B \to Aa \mid b$

1. No need of $S' \to S$

2. Remove Null production

a) $A \to \wedge$

$S \to a \mid B \mid aA \mid a$

$A \to aBB$

$B \to Aa \mid a \mid b$

final

$S \to a \mid B \mid aA$

$A \to aBB$

$B \to a \mid b \mid Aa$

3. UNIT production

$S \to B$

when $B \to a \mid b \mid Aa$

then $S \to a \mid b \mid Aa \mid aA$

$A \to aBB$

$B \to a \mid b \mid Aa$

PAGE No.
DATE / /

4. assuming $X \to a$

$S \to a|b|AX|XA$

$A \to XBB$

$B \to a|b|AX$

$X \to A$

5. Assuming $Y \to BB$

$\Rightarrow S \to a|b|AX|XA$

$A \to XY$ or $A \to YB$

$B \to a|b|AX$

$X \to A$

$Y \to BB$ $\quad Y \to AB$

b) $S \to Z$

$Z \to 01$

$S \to 01$

$\Rightarrow S \to 0X$

$X \to 0S$

$Y \to 1$

$Z \to$

Q62 $S \to a|a$

$A \to aBB$

$B \to Aa$

1. No Need

2. Remove N

a) A

$S \to a|$

$A \to a$

$B \to A$

Final

$S \to a|B$

$A \to aB$

$B \to a|b$

3. UNIT prod

$S \to B$

when B

then S

A

B