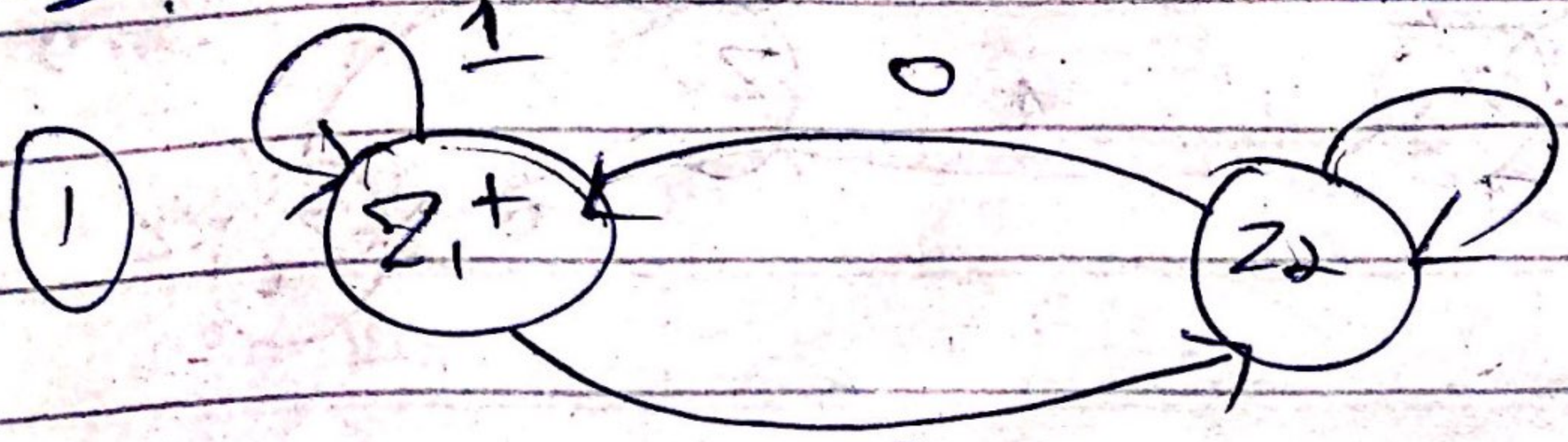
20K-0226
M. Musab

Assignment: 03

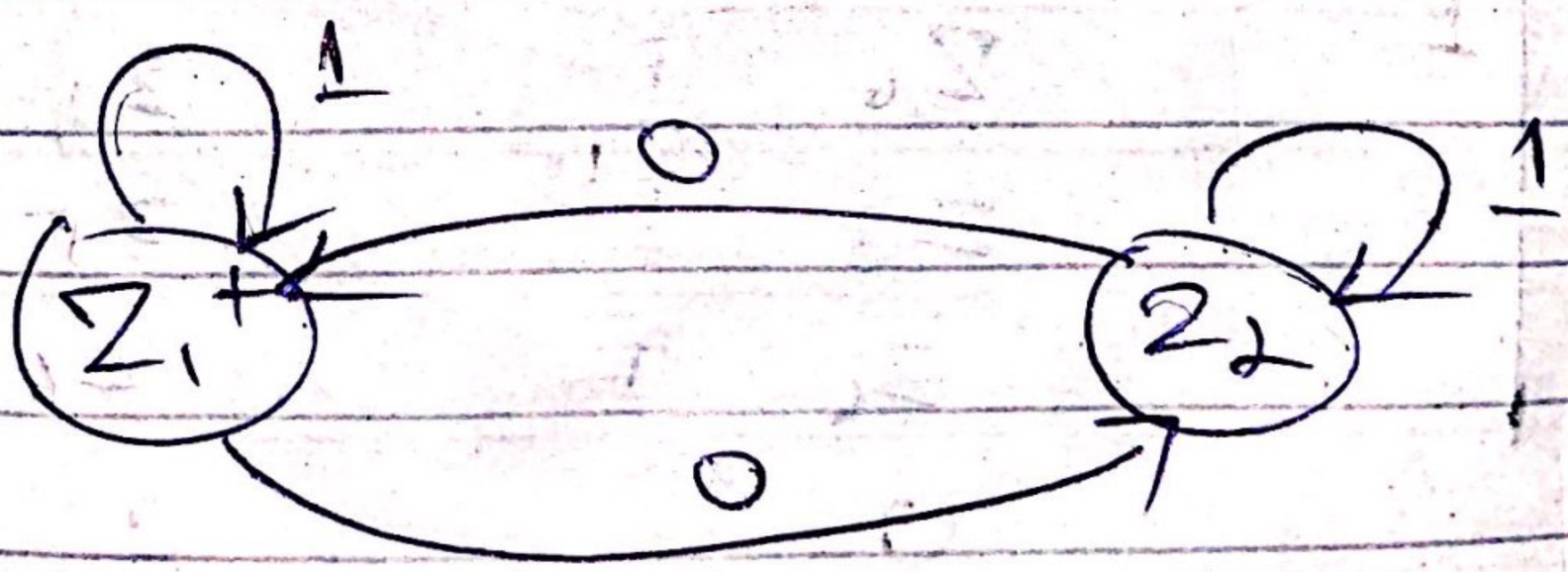
Q1

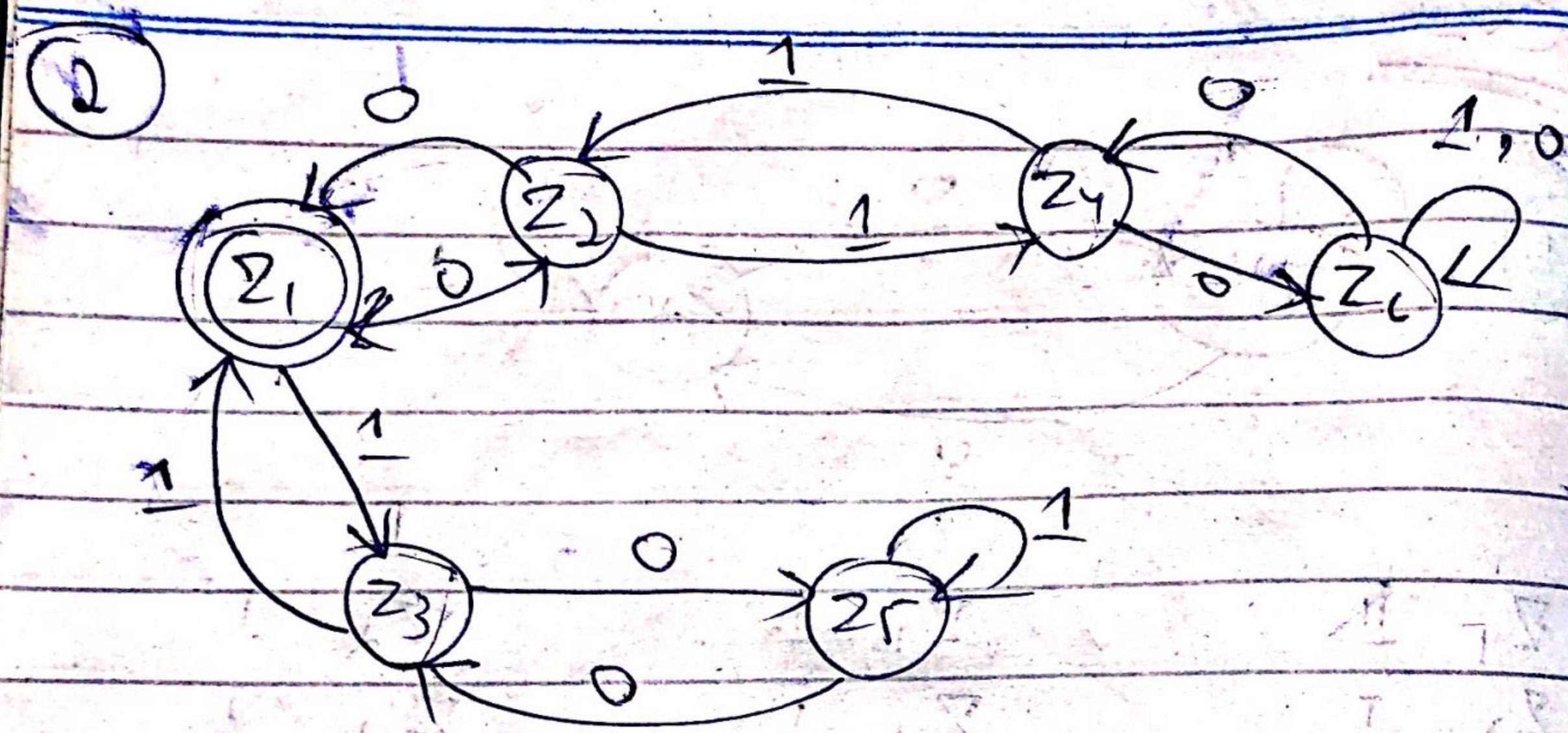


	0	1
Z_1 II	Z_1 II	Z_2 I
Z_2 I	Z_1 II	Z_2 I

{Already Minimized}

Minimized DFA:-





z_1	II		z_2	I	
z_2	}		z_1	II	
z_3			z_5	I	
z_4	I		z_6	I	
z_5			z_3	I	
z_6			z_4	I	
z_1	II		z_2	I	
z_2	I		z_1	II	
z_3	III		z_5	I	
z_4	}		z_4	I	
z_5	I		z_3	III	
z_6			z_6	I	

z_1	II		z_3	III	
z_2	I		z_4	I	
z_3	III		z_1	II	
z_4	}		z_2	I	
z_5	I		z_5	I	
z_6			z_6	I	

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	0		1	
z_1	II	z_2	IV	z_3	III
z_2	IV	z_1	II	z_4	I
z_3	III	z_5	I	z_1	II
z_4	I	z_6	I	z_2	IV
z_5	I	z_3	III	z_5	I
z_6	I	z_6	I	z_6	I

This DFA is already Minimized

Question No: 2

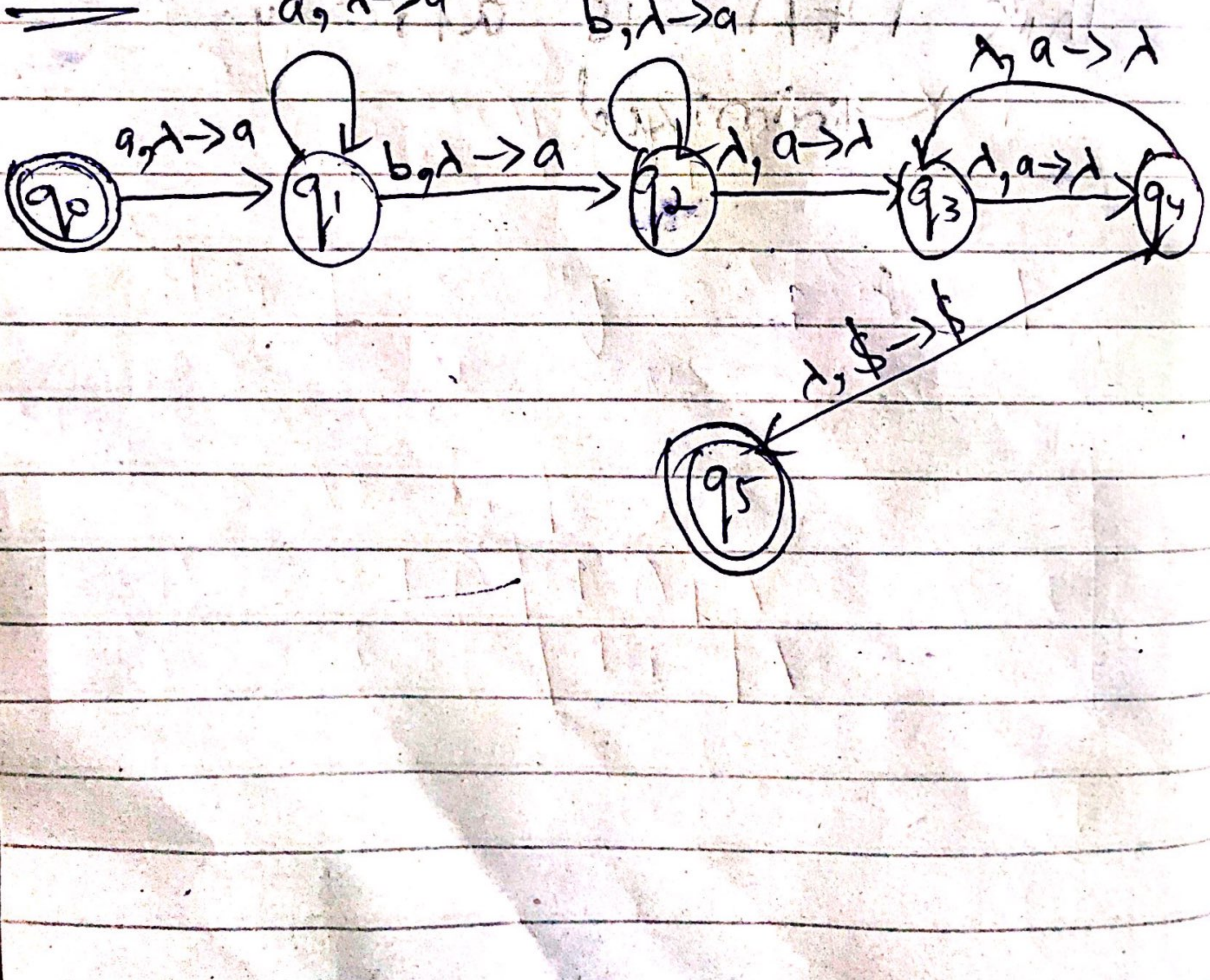
(a) $\{a^n b^m : (n+m)$ is even$\}$

RG: $A \rightarrow aABb \mid AB$

$A \rightarrow aaA \mid \lambda$

$B \rightarrow bbB \mid \lambda$

PDA:



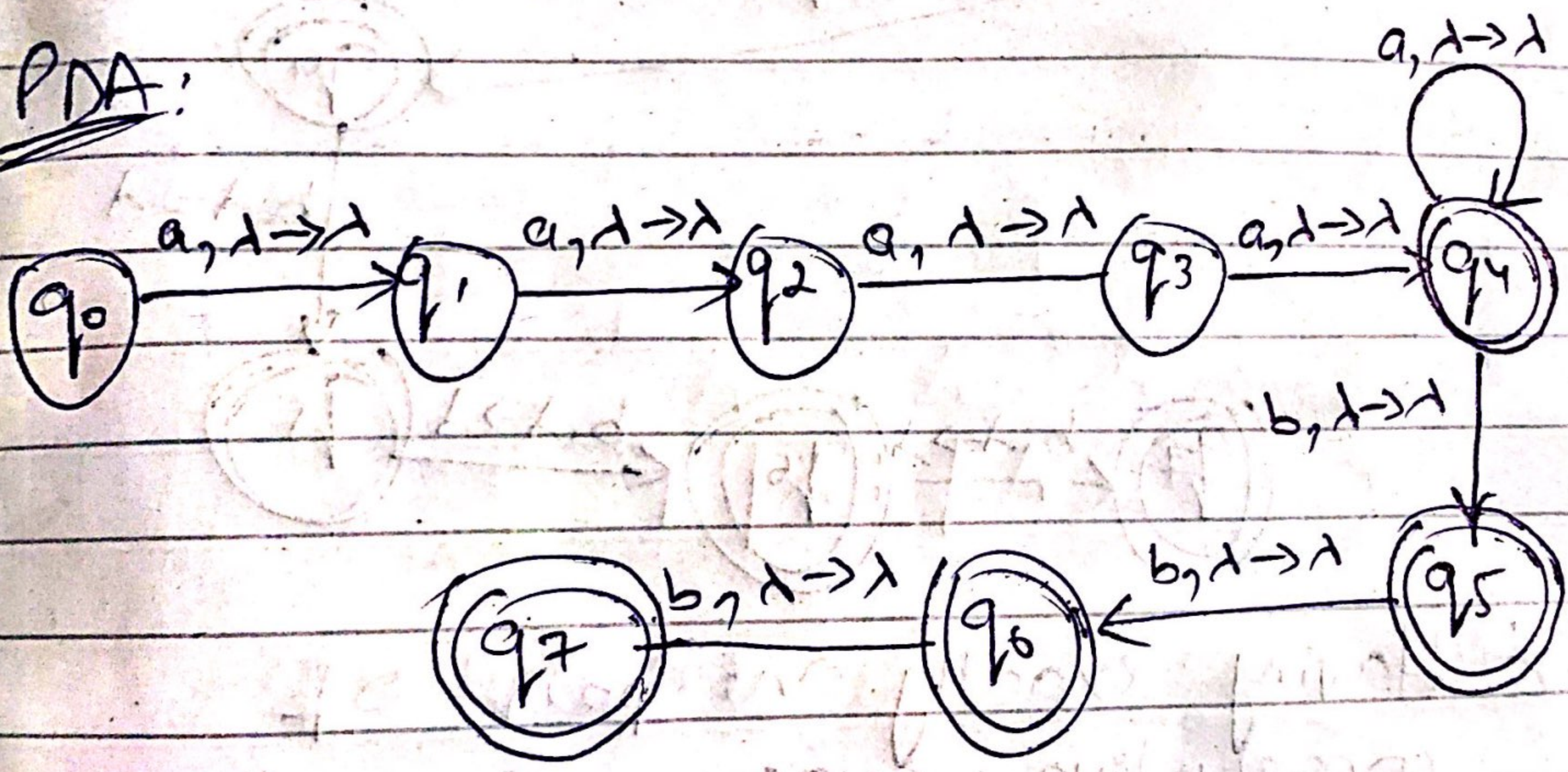
(b) $a^n b^m$, $n \geq 4$, $m \leq 3$

RG: $S \rightarrow AB$

$A \rightarrow aaaa \mid aA$

$B \rightarrow \lambda \mid b \mid bb \mid bbb$

PDA:



(c) $\{a^n b^m, n < 4, m \leq 4\}$

RG: $S \rightarrow AB$

$A \rightarrow \lambda \mid a \mid aa \mid aaa$

$B \rightarrow \lambda \mid b \mid bb \mid bbb \mid bbbb$

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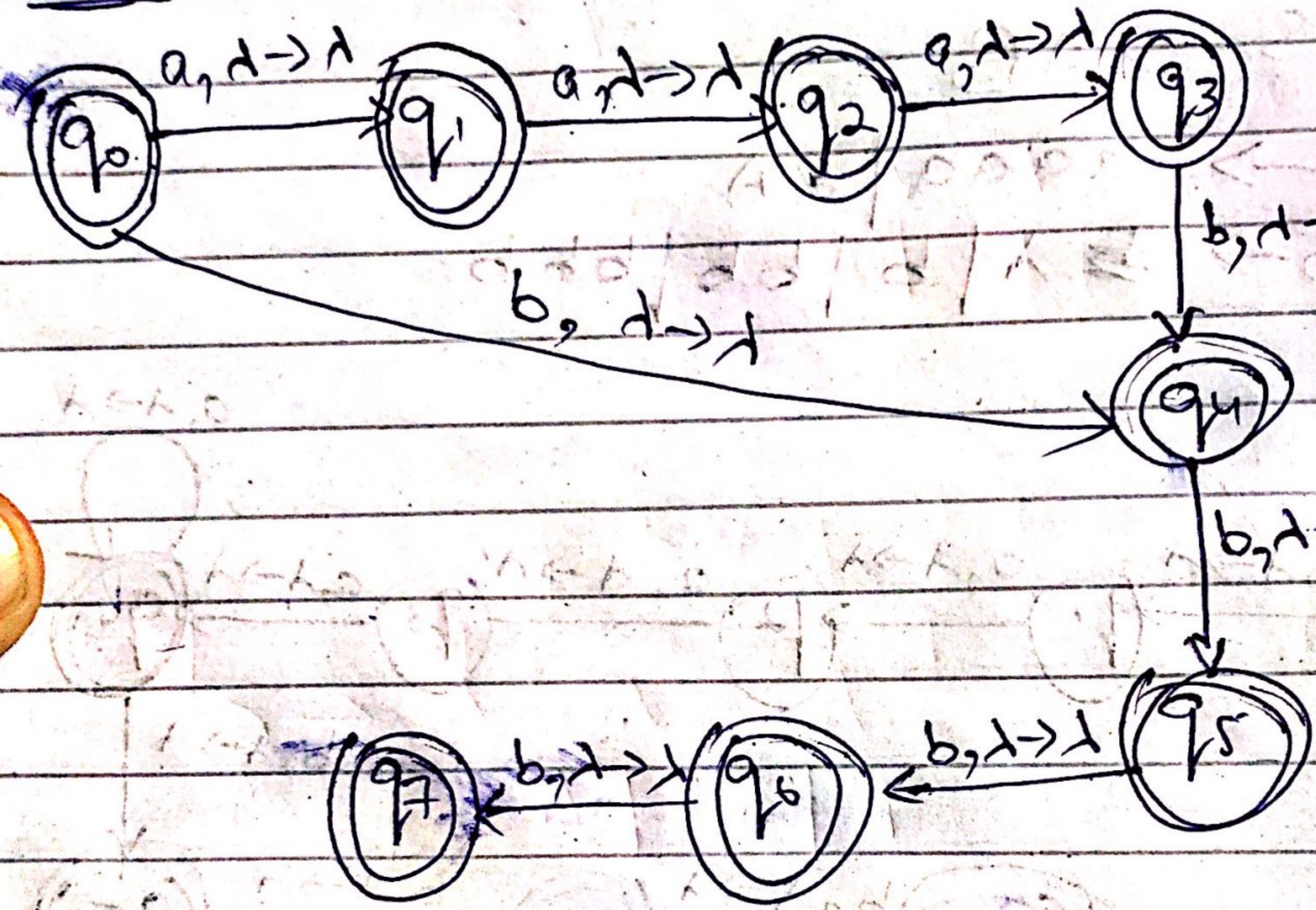
PDA:-



(d) Having exactly one pair of consecutive zeros.

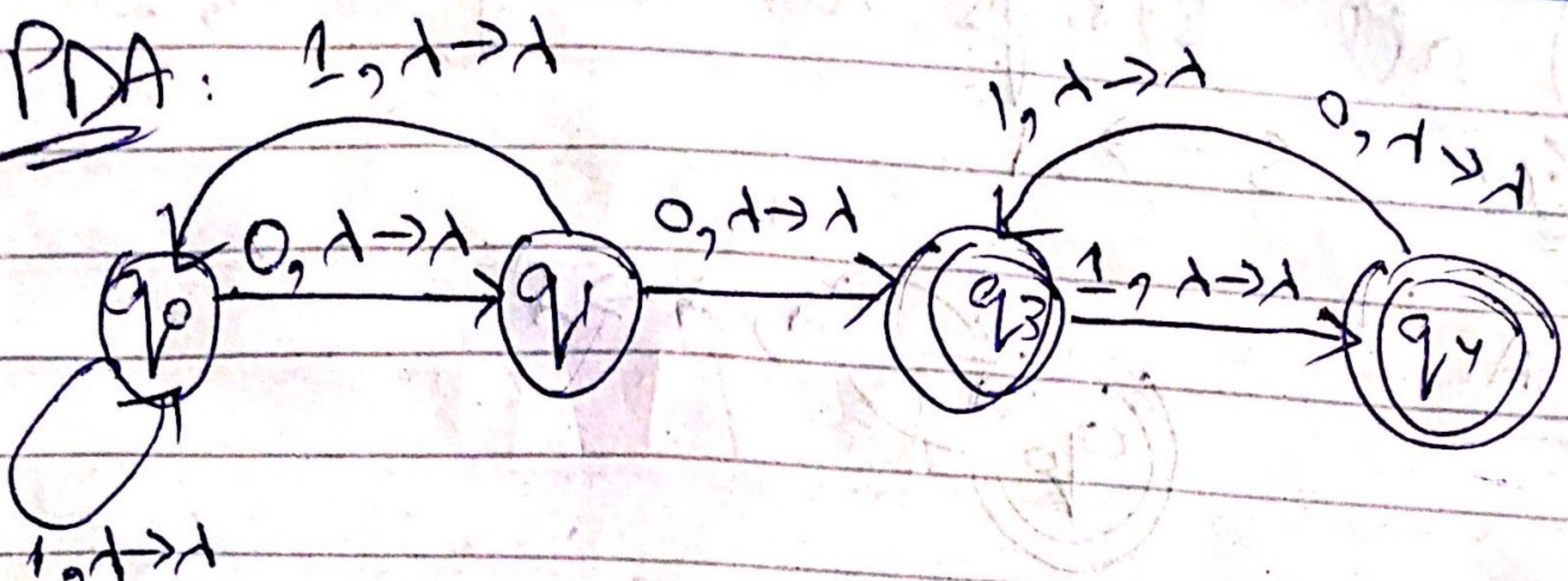
RG:

S → AbOB|OO

A → 01A | 1A | λ

B → 10B | 1B | λ

PDA:



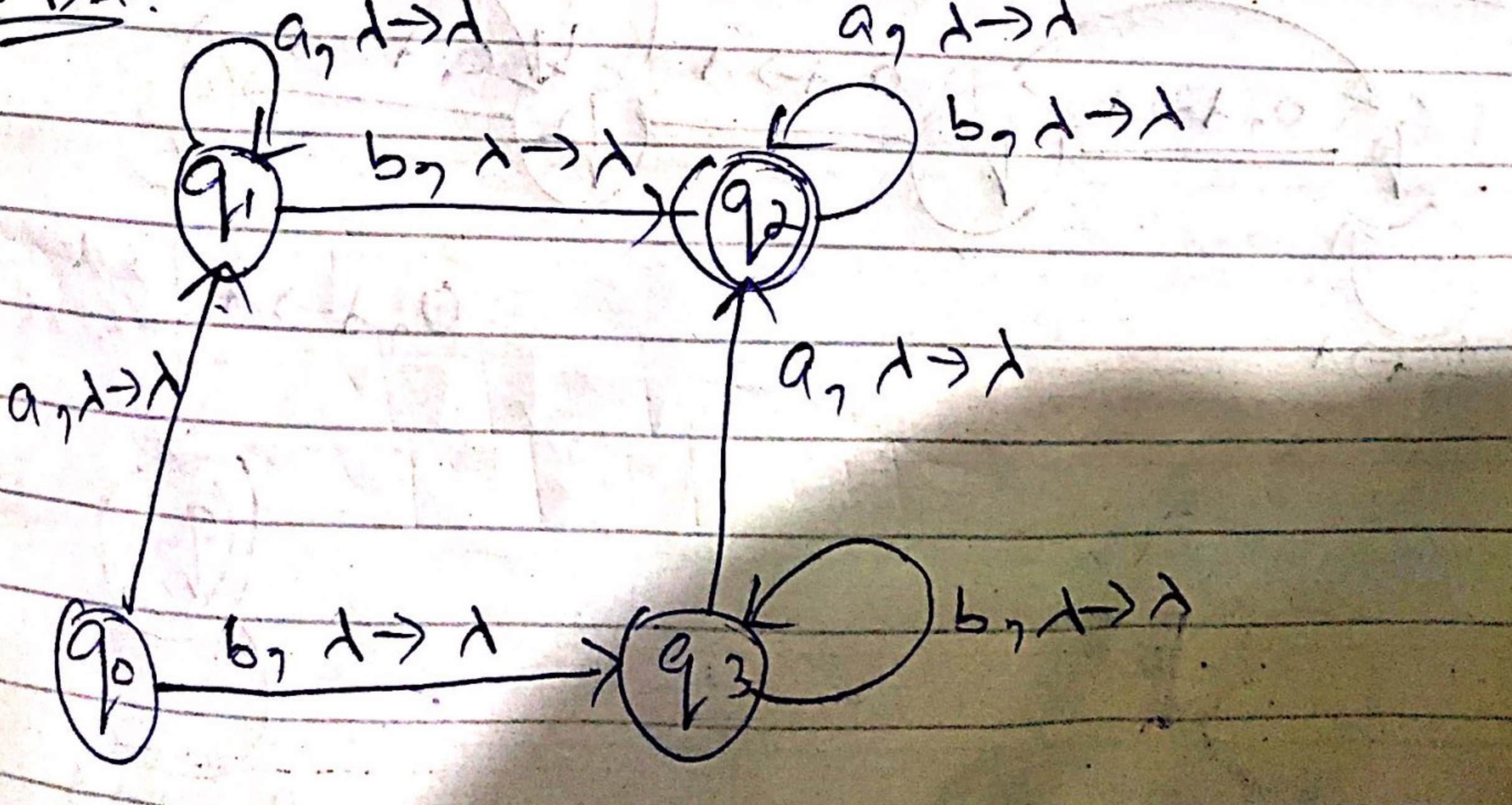
(e) at least one occurrence of each symbol in alphabet.

RG:

$S \rightarrow AaAbA \mid AbAaA$

$A \rightarrow aA \mid bA \mid \lambda$

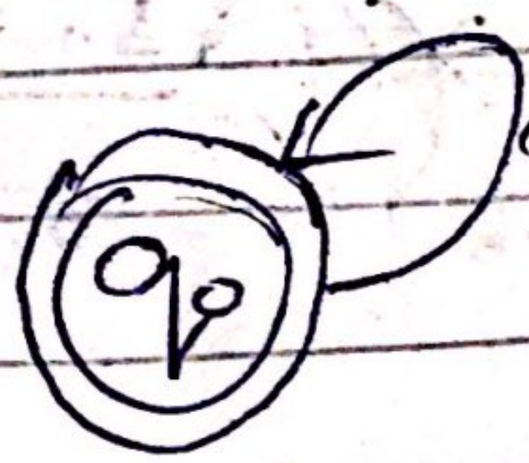
PDA:



(f) all strings not ending in 0, 1

RG: $S \rightarrow \lambda$

PDA

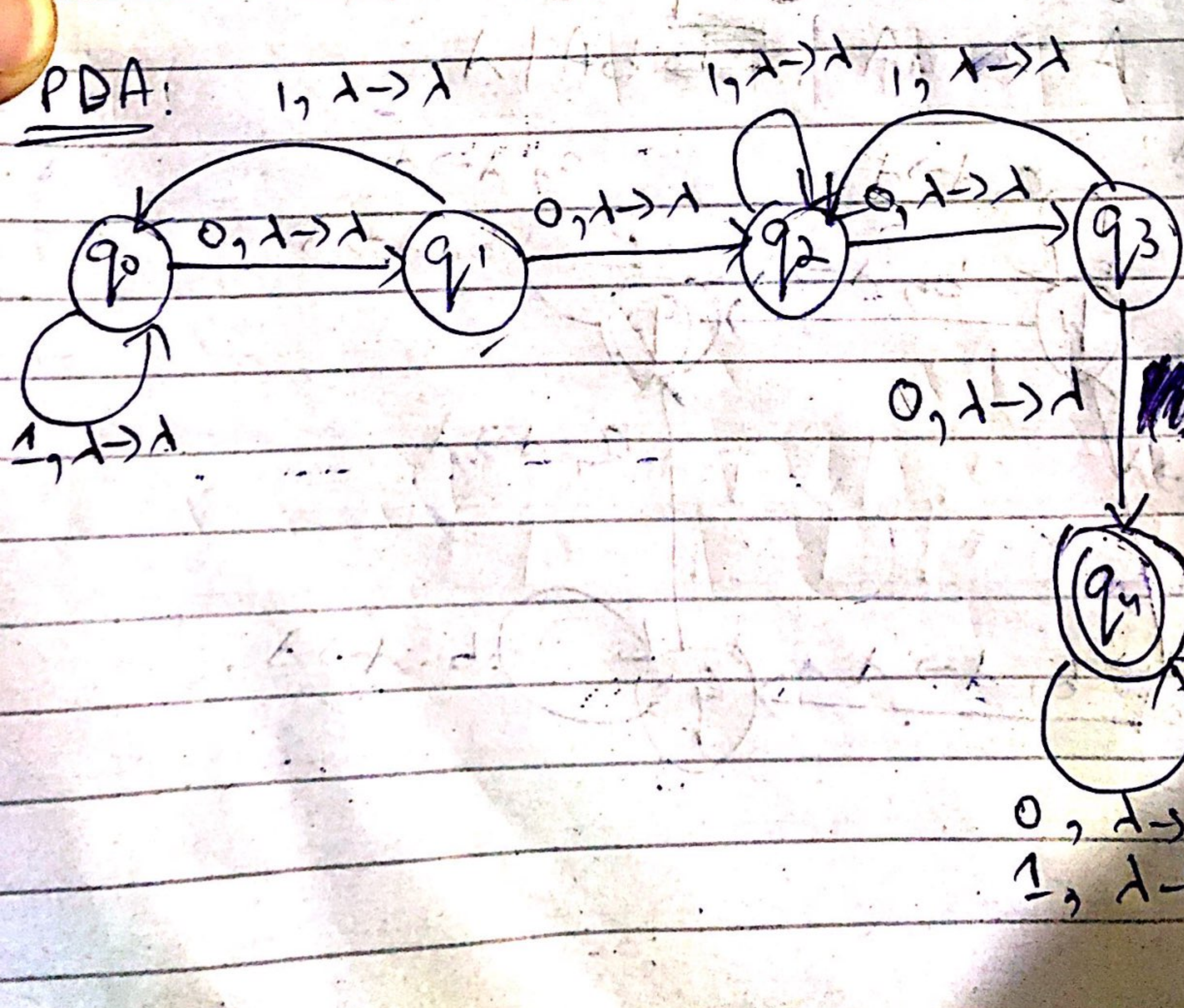


(g) All strings having at least occurrences of substring 00.

RG: $S \rightarrow A00A00A$

$A \rightarrow 0A \mid 1A \mid \lambda$

PDA:

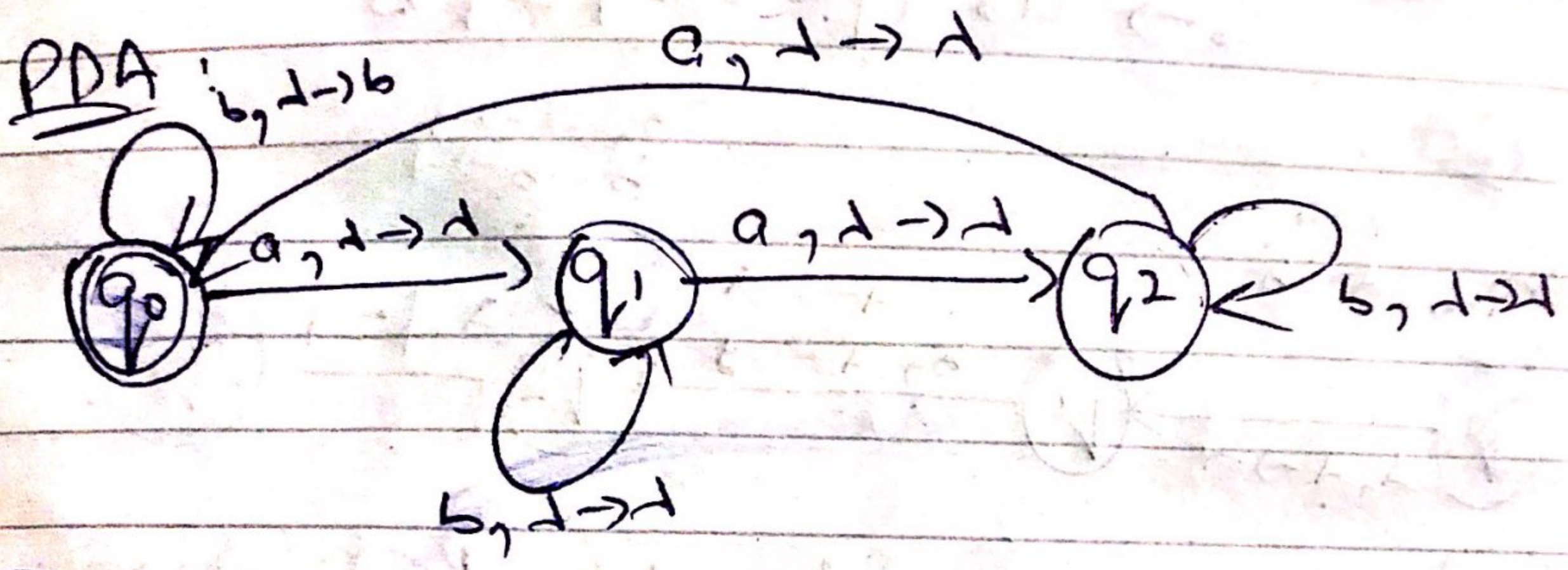


(h) $\{w : n_a(w) \bmod 3 = 0\}$

RG: $S \rightarrow AaAaAaA \mid S \mid \lambda$

$A \rightarrow bA \mid b$

PDA :



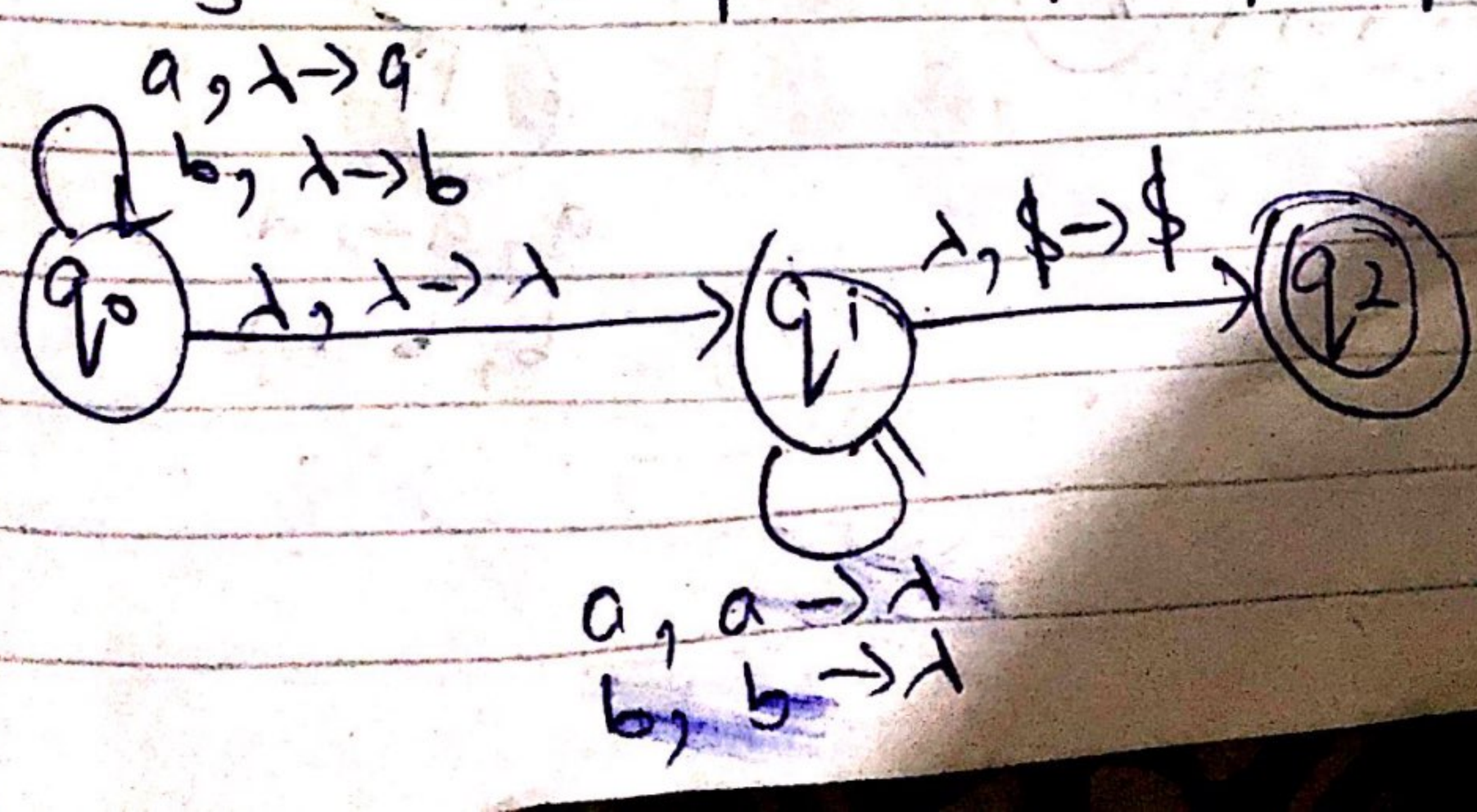
Question No: 3

(a) Even length Palindromes.

(1) CFG & PDA

CFG: $S \rightarrow aSa \mid bSb \mid aa \mid bb \mid \lambda$

PDA.



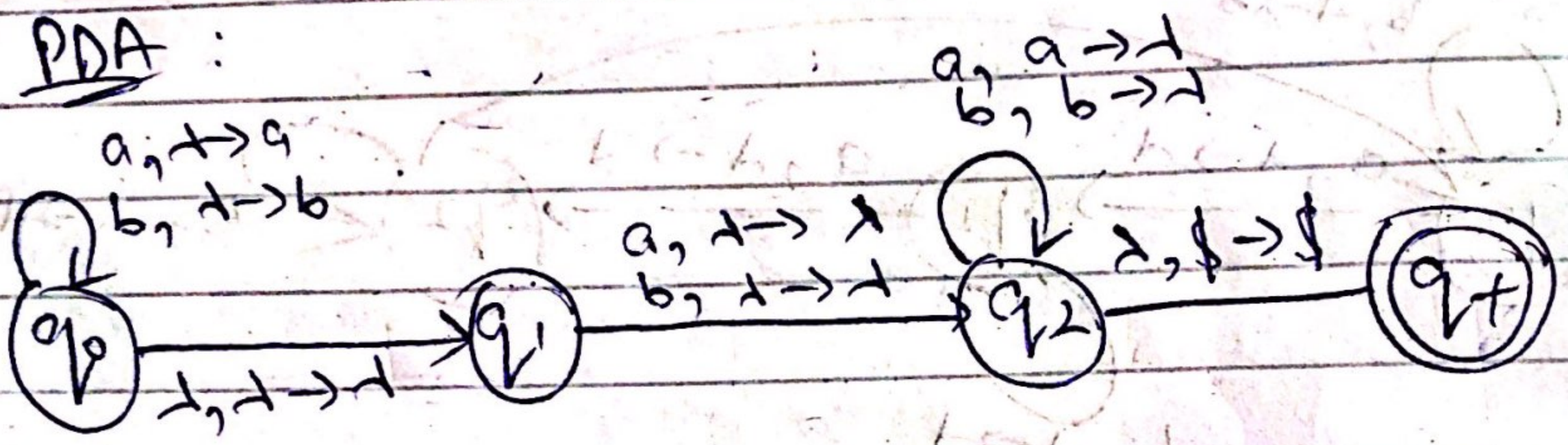
Pumping Lemma

(b) Odd length Palindrome.

CFG:

$S \rightarrow aSa \mid bSb \mid a \mid b$

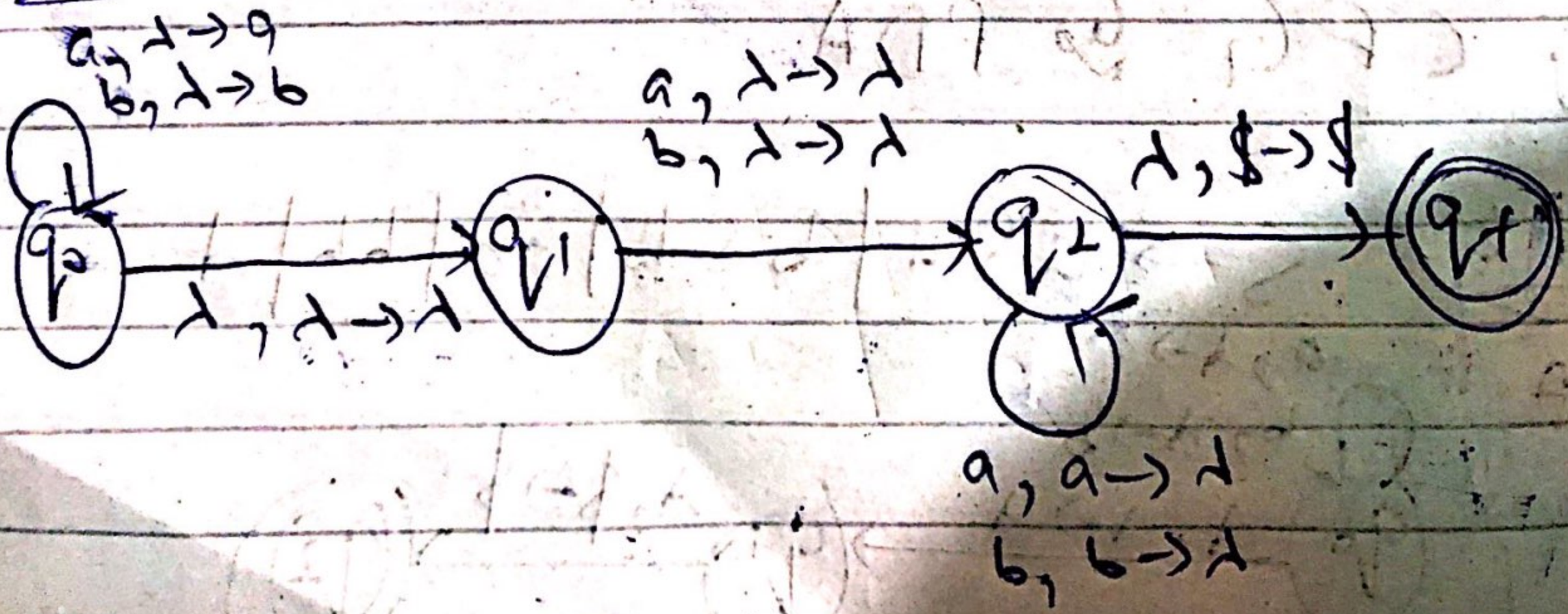
PDA:



(c) Language of odd Palindromes.

CFG: $S \rightarrow aSa \mid bSb \mid a \mid b \mid \lambda$

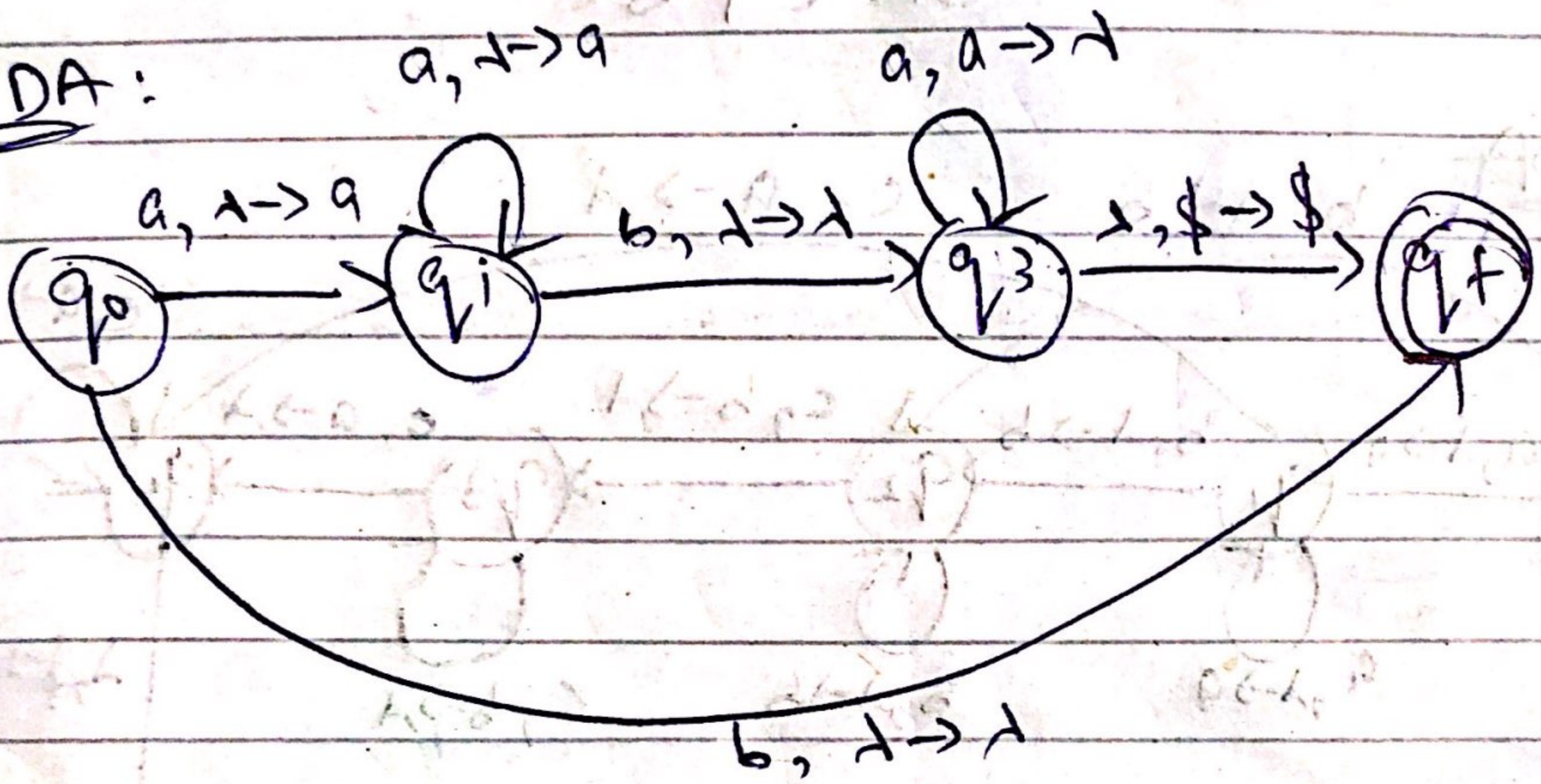
PDA:



(d) $a^n b a^n \quad n \geq 0$

CFG: $S \rightarrow aSa \mid b$

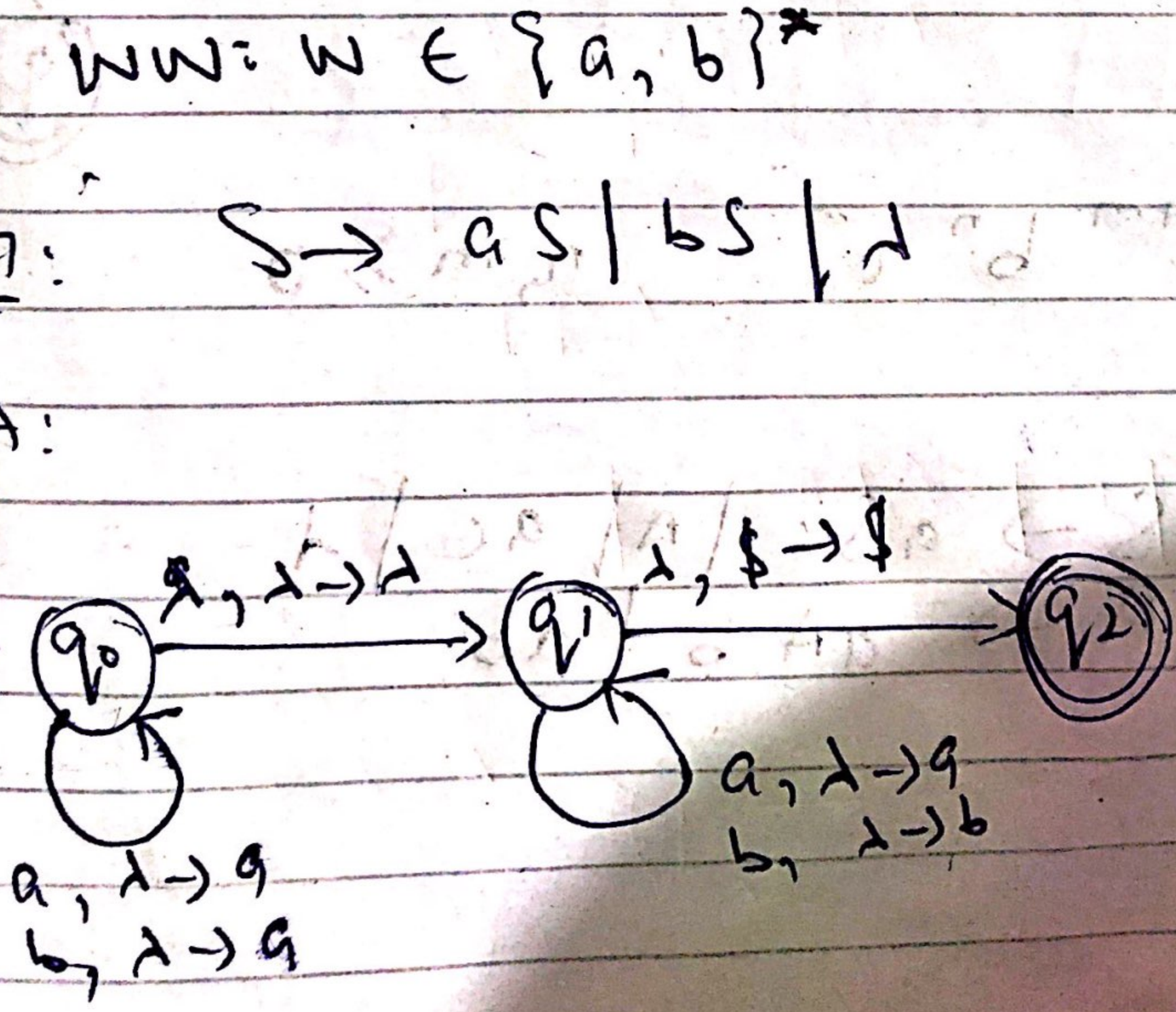
PDA:



(e) $WW : W \in \{a, b\}^*$

CFG: $S \rightarrow aS \mid bS \mid \lambda$

PDA:

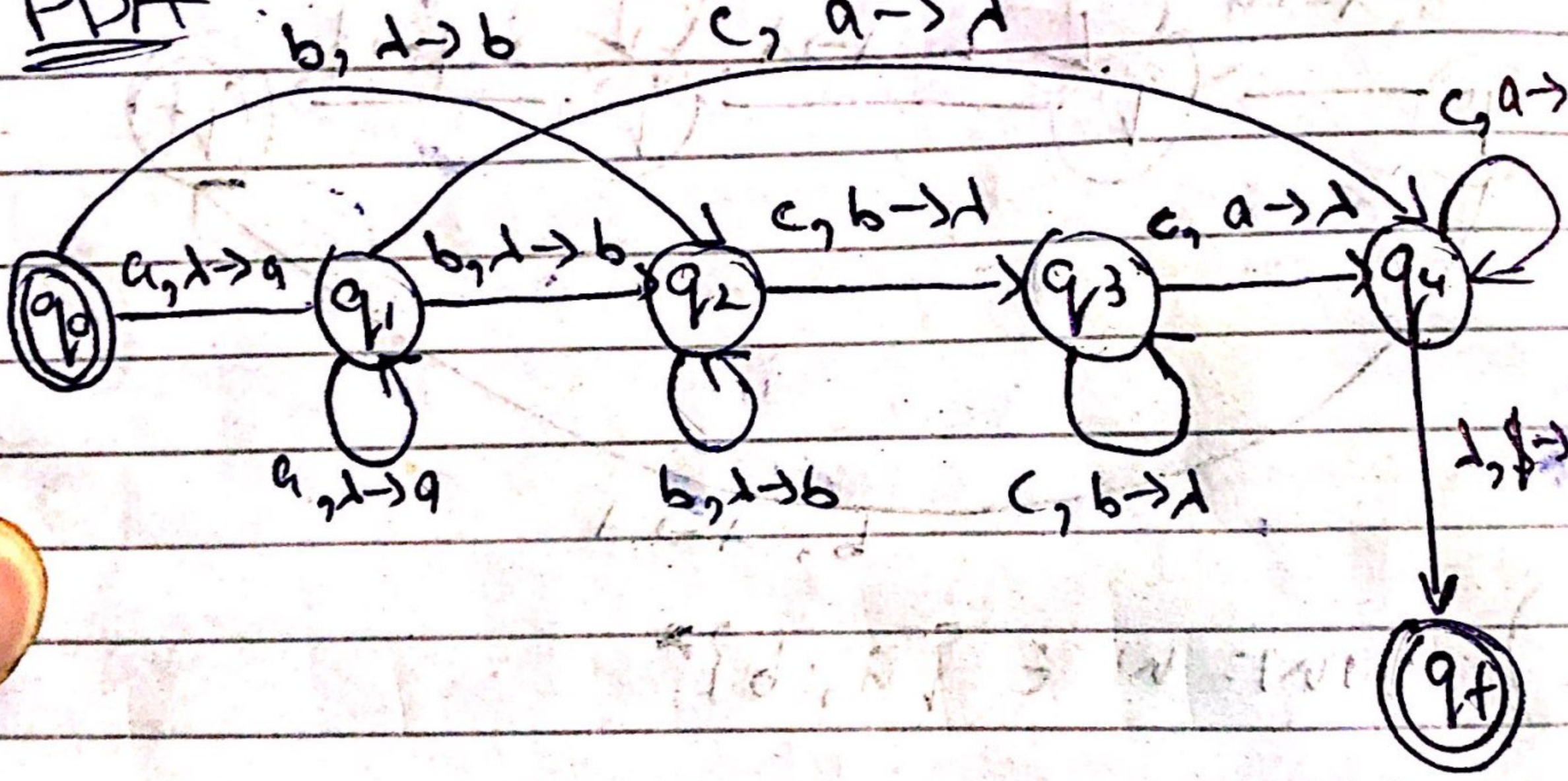


(f) $a^n b^m . c^{n+m}$ $n, m \geq 0$

CFG: $S \rightarrow aSc \mid A \mid ac \mid \lambda$

$A \rightarrow bAc \mid bc$

PDA:



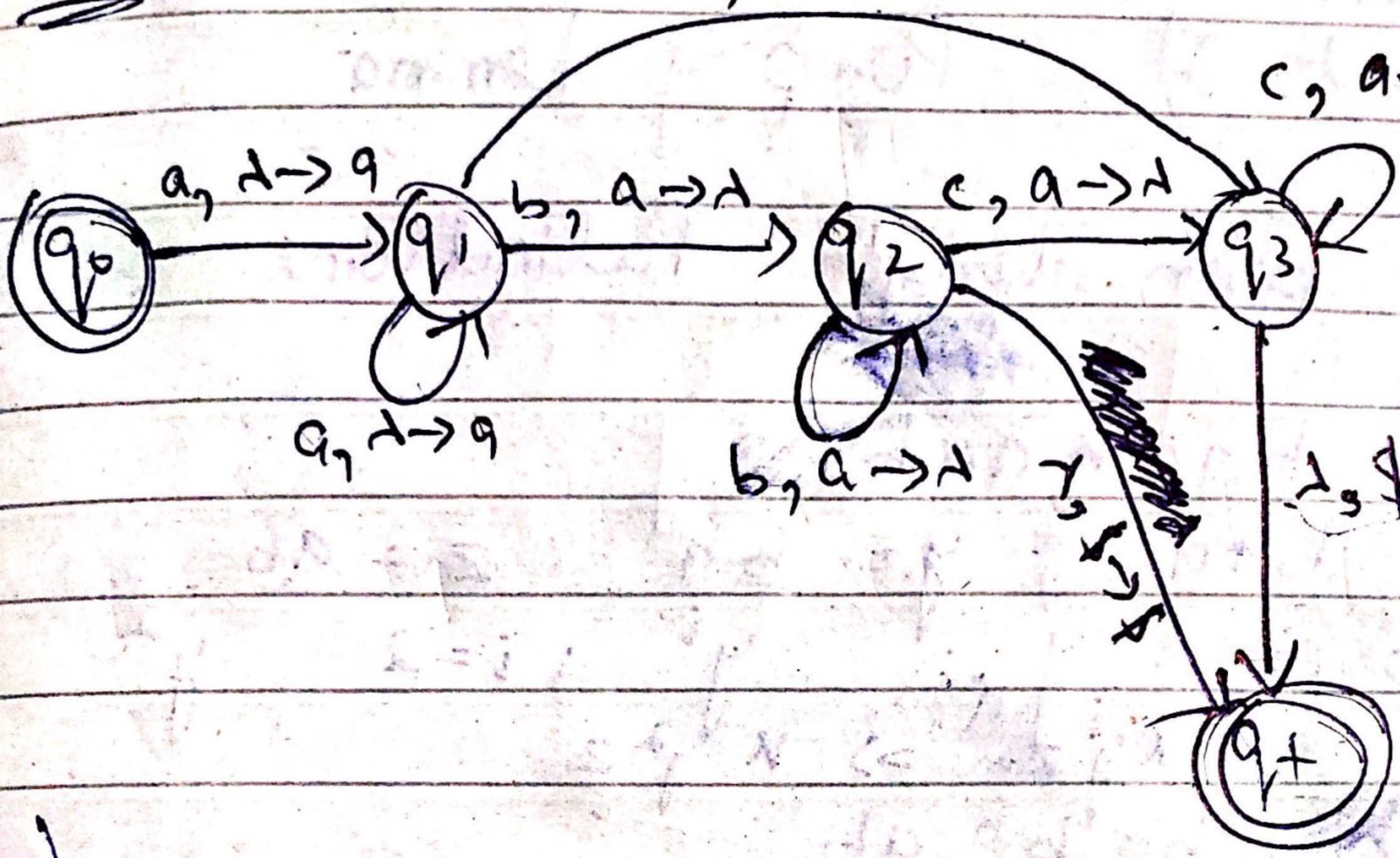
(g) $a^{n+m} b^n c^m$ $n, m \geq 0$

CFG:

$S \rightarrow aSc \mid A \mid ac \mid \lambda$

$A \rightarrow aAb \mid ab$

PDA :



h) $a^n b^{n+m} c^m$

CFG :

$S \rightarrow AB \mid \lambda$

$A \rightarrow aAb \mid ab$

$B \rightarrow bBc \mid bc$

20K-0226

Question No. 3

Part (2) Pumping Lemma

(a) Even length Palindrome

baabaab

x = baa , y = ba , z = ab

Pumping y : y^i ; i = 2 y^2

xyz ⇒ xy^2z

⇒ baababaab

Not the Part of language

Hence, Not Regular.

(i) $a^n b^{2m}$ n, m ≥ 0

aabbbbb

x = aa y = bb , z = bb

i = 2

$xy^iz \Rightarrow xy^2z$

⇒ aabbbbbb (Not the Part of language)

Hence Not Regular.

(i) $a^{2n} b^{3n}$

let $n = 1$

aa bbb

$u = a$ $y = ab$ $z = bb$

$u y^i z$; $i = 2$

$u y^2 z$

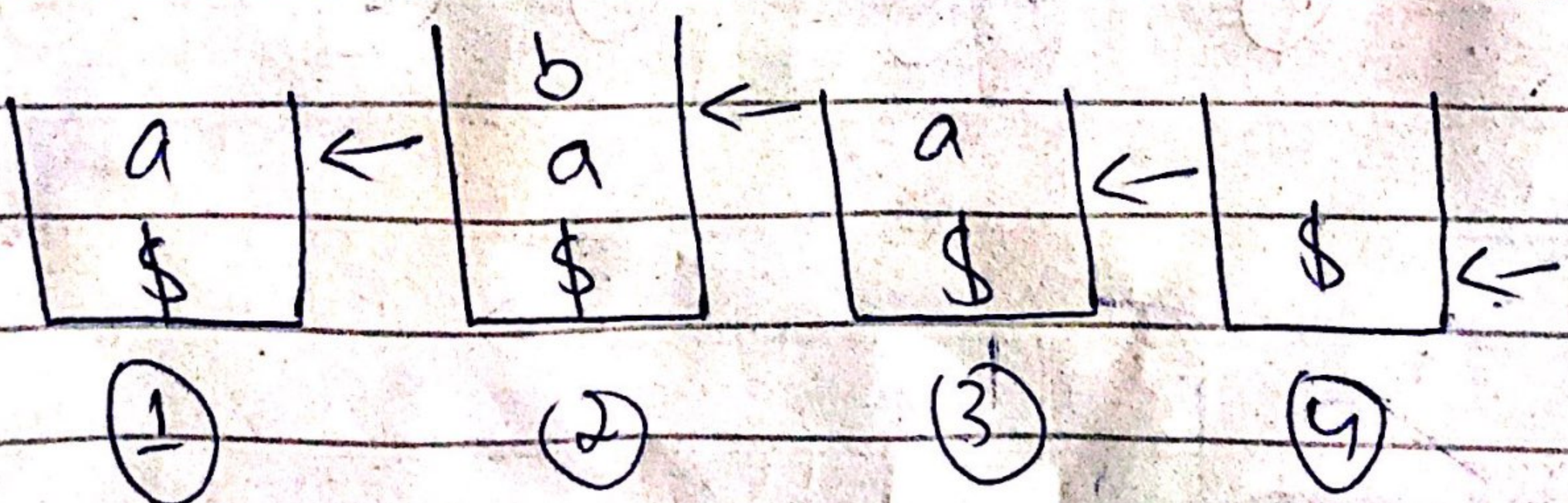
=> a abab bb (Not Part of language)

Hence, Not Regular.

Q3 Part (3) Stack Operations

(a) $a^n b a^n$

let $n = 1$ so, aba



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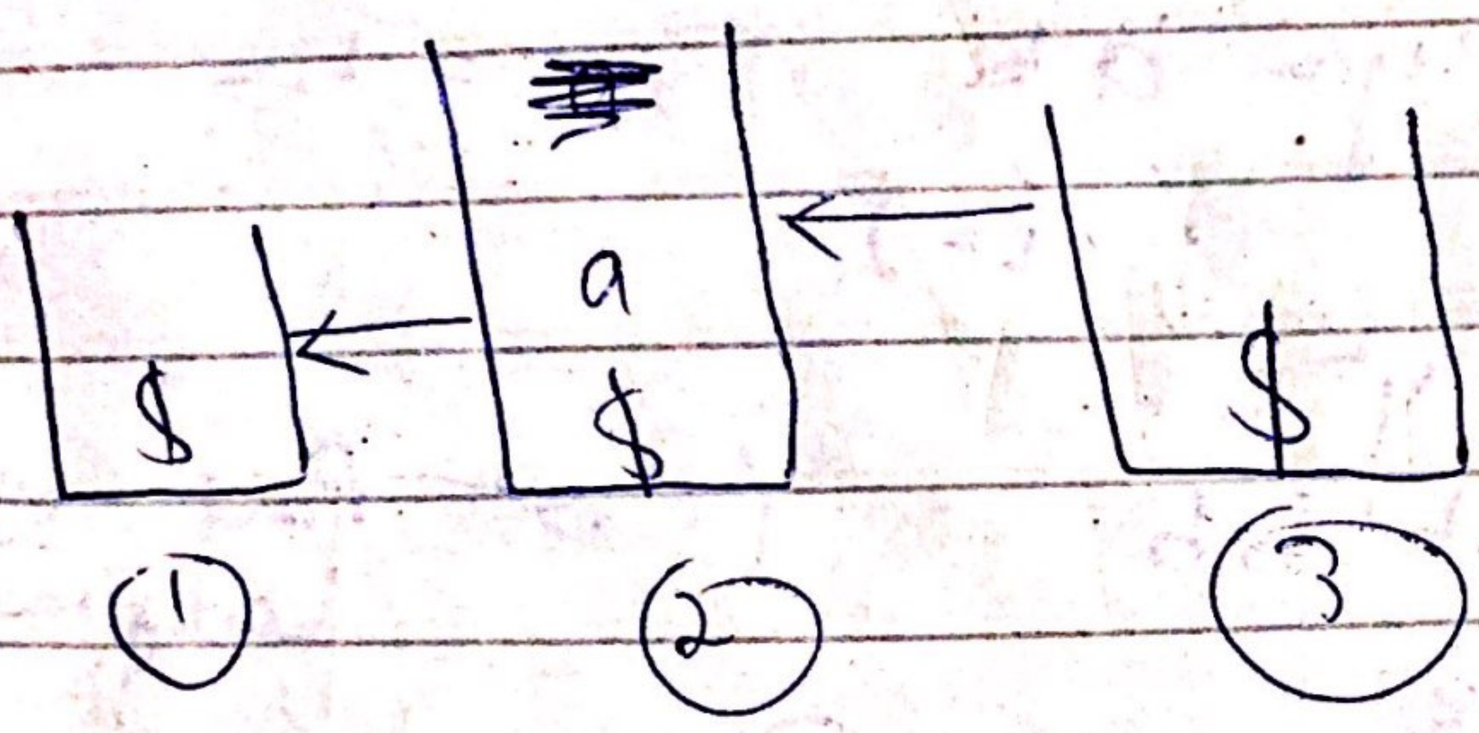
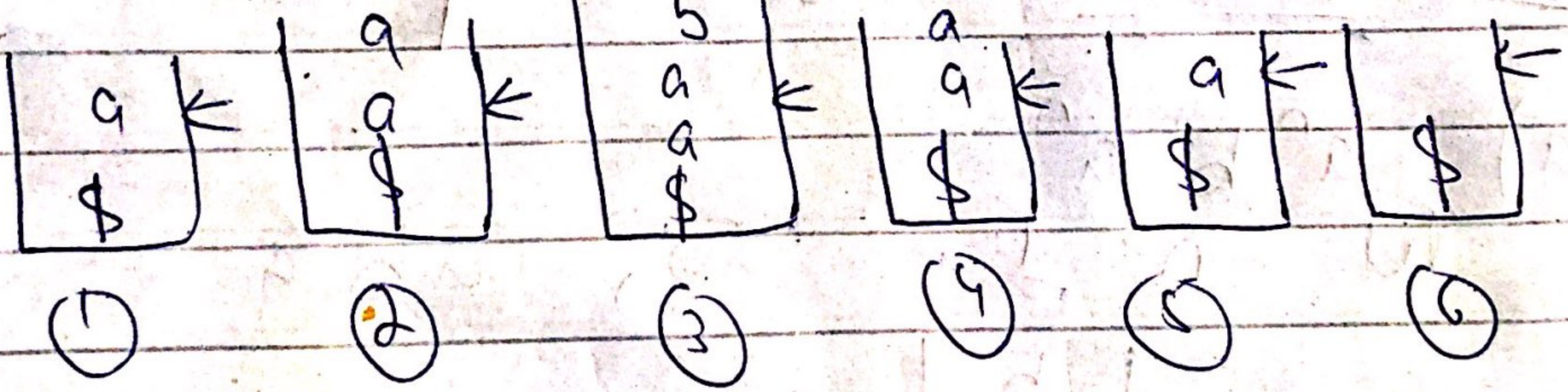
(b) $a^{2n} b^{3n}$ $n=1$ $\Rightarrow$ aabbb



(c) Even length Palindrome :- ~~abbba~~ aabbaa



Q4: CFG to CNF

① $S \rightarrow abS \mid abA\$ \mid abB$

$A \rightarrow Cd$

$B \rightarrow aB$

$C \rightarrow dC$

'B' is non generating

'C' is not reachable

Simplified CFG:

$S \rightarrow abS \mid abA$

$A \rightarrow Cd$

$X_a \rightarrow a$

$X_b \rightarrow b$

$X_c \rightarrow c$

$X_d = d$

$S \rightarrow X_aX_bS \mid X_aX_bA$

$A \rightarrow X_cX_d$

2018-022C

$Y_1 \rightarrow X_b S$

$Y_2 \rightarrow X_b A$

$S \rightarrow X_a Y_1 \mid X_a Y_2$

$A \rightarrow X_c X_d$ (Ans)

(2) $S \rightarrow ABC \mid a$

$A \rightarrow b$

$B \rightarrow c$

$C \rightarrow d$

~~$E \rightarrow e$~~

~~$F \rightarrow f$~~

~~$G \rightarrow G$~~

* No Null & unit productions
* E, F & G are not reachable

Simplified CFG

$S \rightarrow ABC \mid a$

$A \rightarrow b$ $B \rightarrow c$ $C \rightarrow d$

$X_1 \rightarrow BC$

$S \rightarrow AX_1 \mid a$

$A \rightarrow b$

$B \rightarrow c$

$C \rightarrow d$ (Ans)

(3) $S \rightarrow aB \mid bX$

~~$A \rightarrow Bad \mid bSX \mid a$~~

$B \rightarrow aSB \mid bBX$

$X \rightarrow SBD \mid aBX \mid ad$

* No Null & Unit Productions
* A & D are not reachable

Simplified CFG :-

$S \rightarrow aB \mid bX$

$B \rightarrow aSB \mid bBX$

$X \rightarrow aBX \mid ad$

$X_a \rightarrow a$

$X_b \rightarrow b$

$X_d \rightarrow d$

$S \rightarrow X_aB \mid X_bX$

$B \rightarrow X_aSB \mid X_bBX$

$X \rightarrow X_aBX \mid X_aX_c$

20K-0226

$Y_1 \rightarrow SB$

$Y_2 \rightarrow BX$

$S \rightarrow X_a B \mid X_b X$

$B \rightarrow X_a Y_1 \mid X_b Y_2$

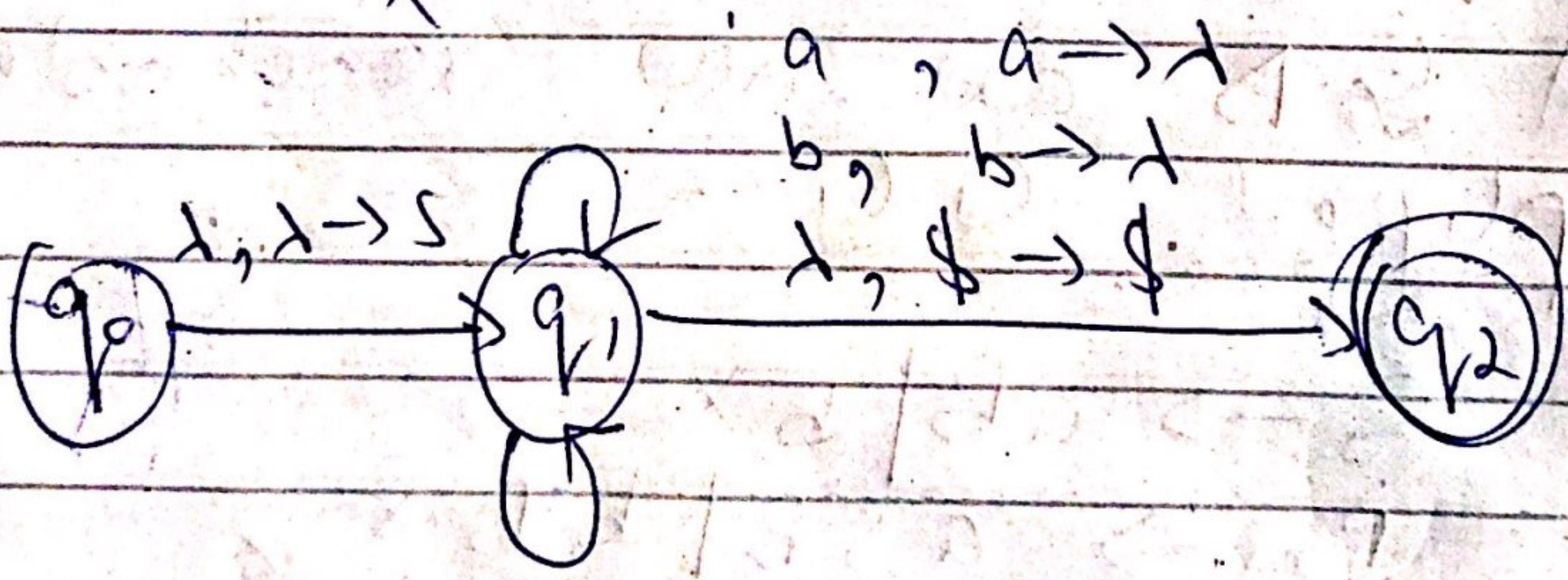
$X \rightarrow X_a Y_2 \mid X_a X_d$ (Ans)

Q5: CFG to PDA

(a) $S \rightarrow XS \mid \varepsilon$

$A \rightarrow aXb \mid Ab \mid ab$

$X \rightarrow ?$



$\lambda, S \rightarrow XS$

$X, S \rightarrow \lambda$

$\lambda, A \rightarrow aXb$

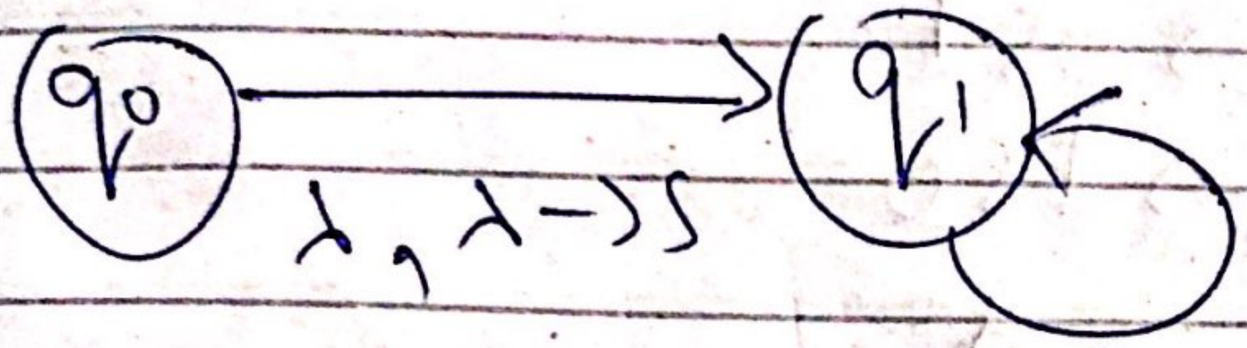
$\lambda, A \rightarrow Ab$

$\lambda, A \rightarrow ab$

(b) $S \to S+X \mid X$

$X \to X^* Y \mid Y$

$Y \to S$



λ, S → S+X

λ, S → X

λ, X → X*Y

λ, X → Y

λ, Y → S

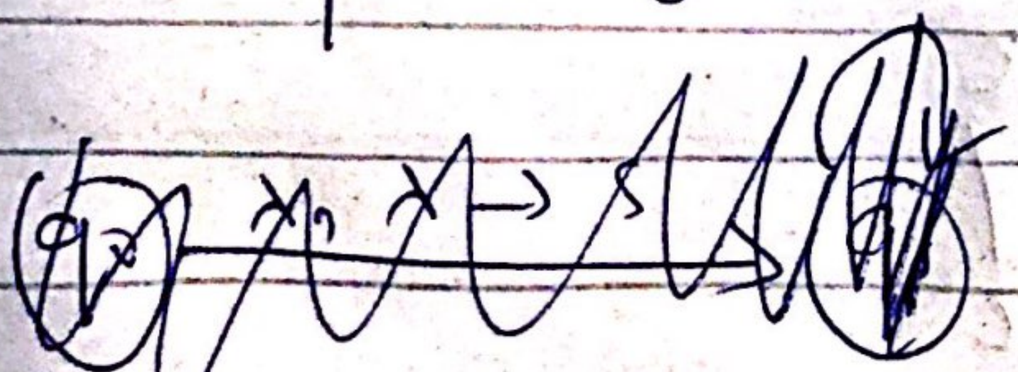
This is non generating so our PDA will not have any find state

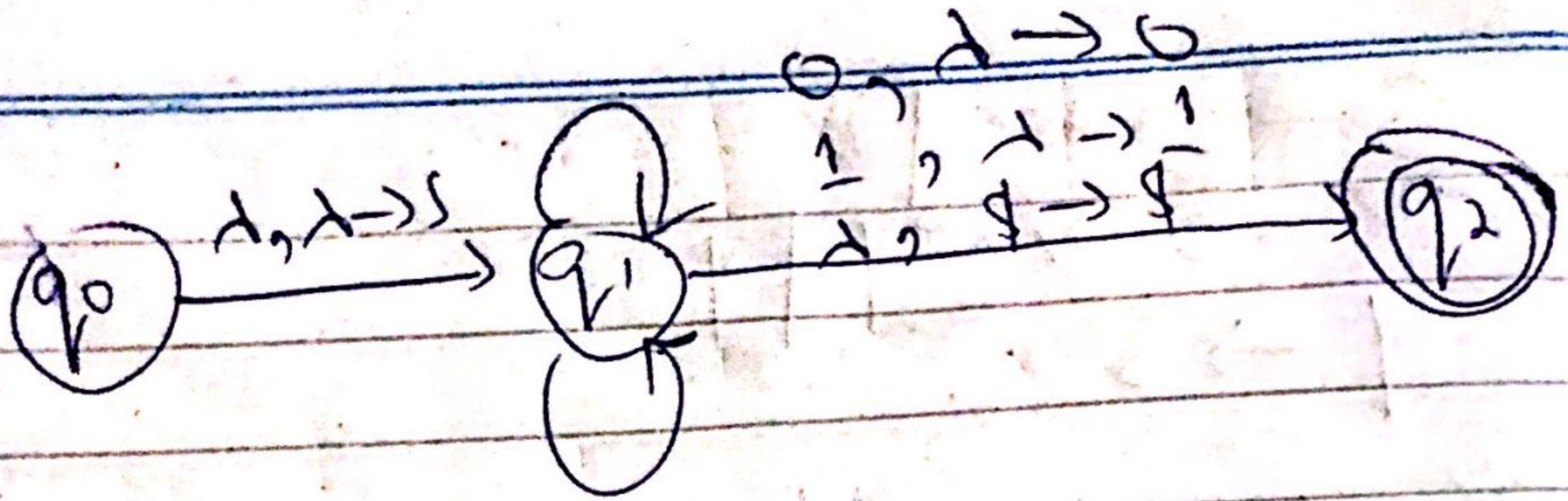
(c) $S \to 0S\underline{1} \mid \underline{1}S0 \mid \Sigma$

$S \to 0SX \mid 1SY \mid \Sigma$

$X \to \underline{1}$

$Y \to 0$





$\lambda, S \to 0S\overline{1}$

$\lambda, S \to \overline{1}S0$

$\lambda, S \to \lambda$

$\lambda, S \to 0S\overline{1}$

$\lambda, S \to \overline{1}S1$

$\lambda, S \to \lambda$

Q6 : Ambiguity in CFG

(1) $S \to ABC$

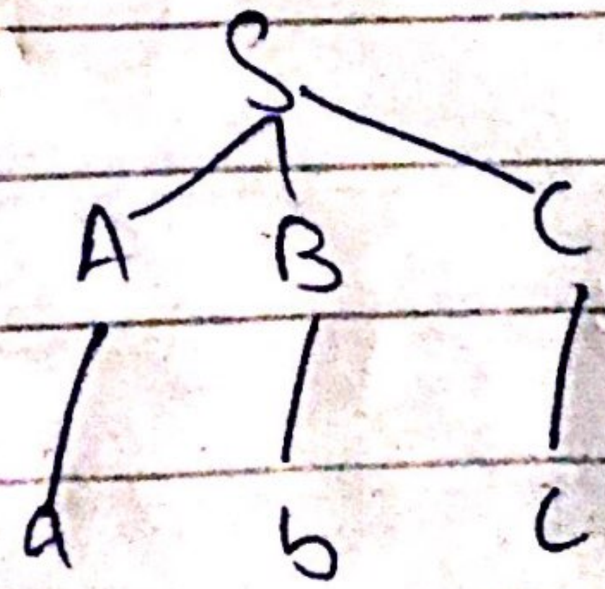
$A \to a$

$B \to b$

$C \to c$

String: abc

right most tree

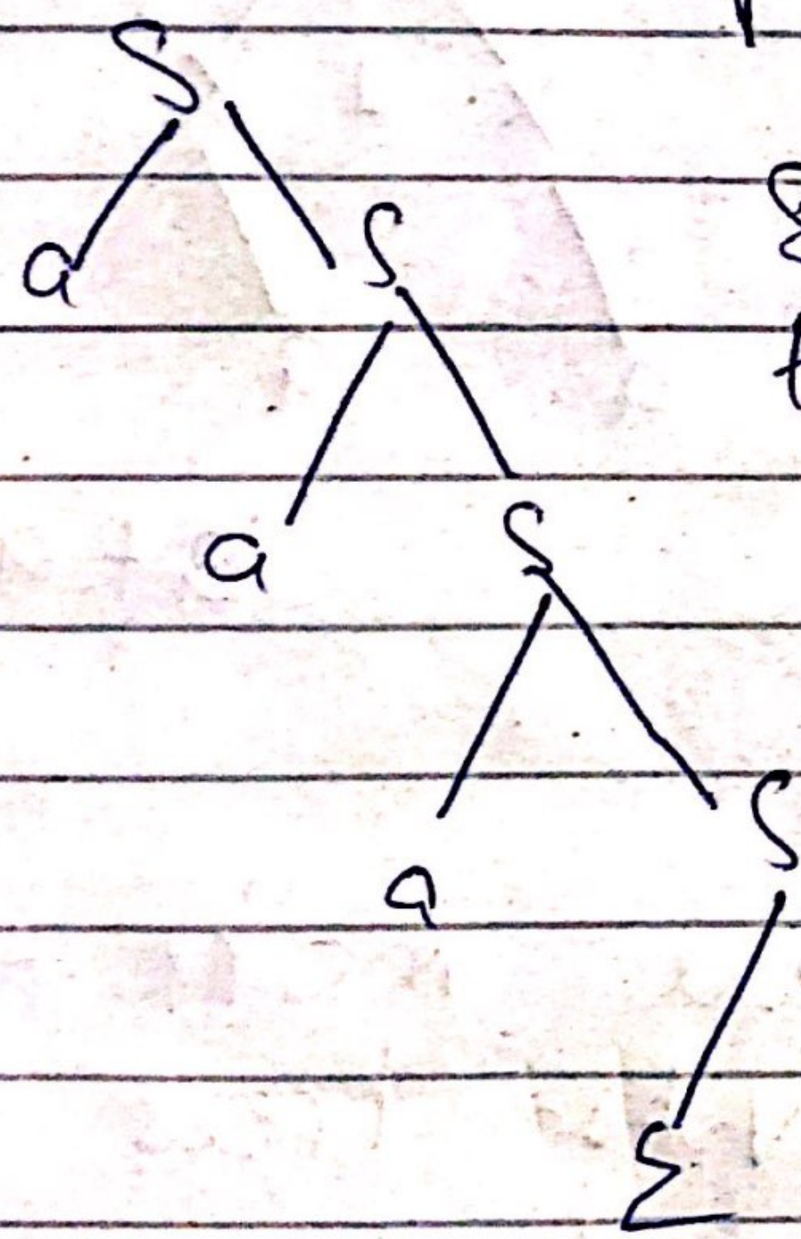


Since there is no other tree possible for the same string so the language does not have ambiguity.

(2) $S \rightarrow aS \mid \varepsilon$

String: aaa

right most tree



other

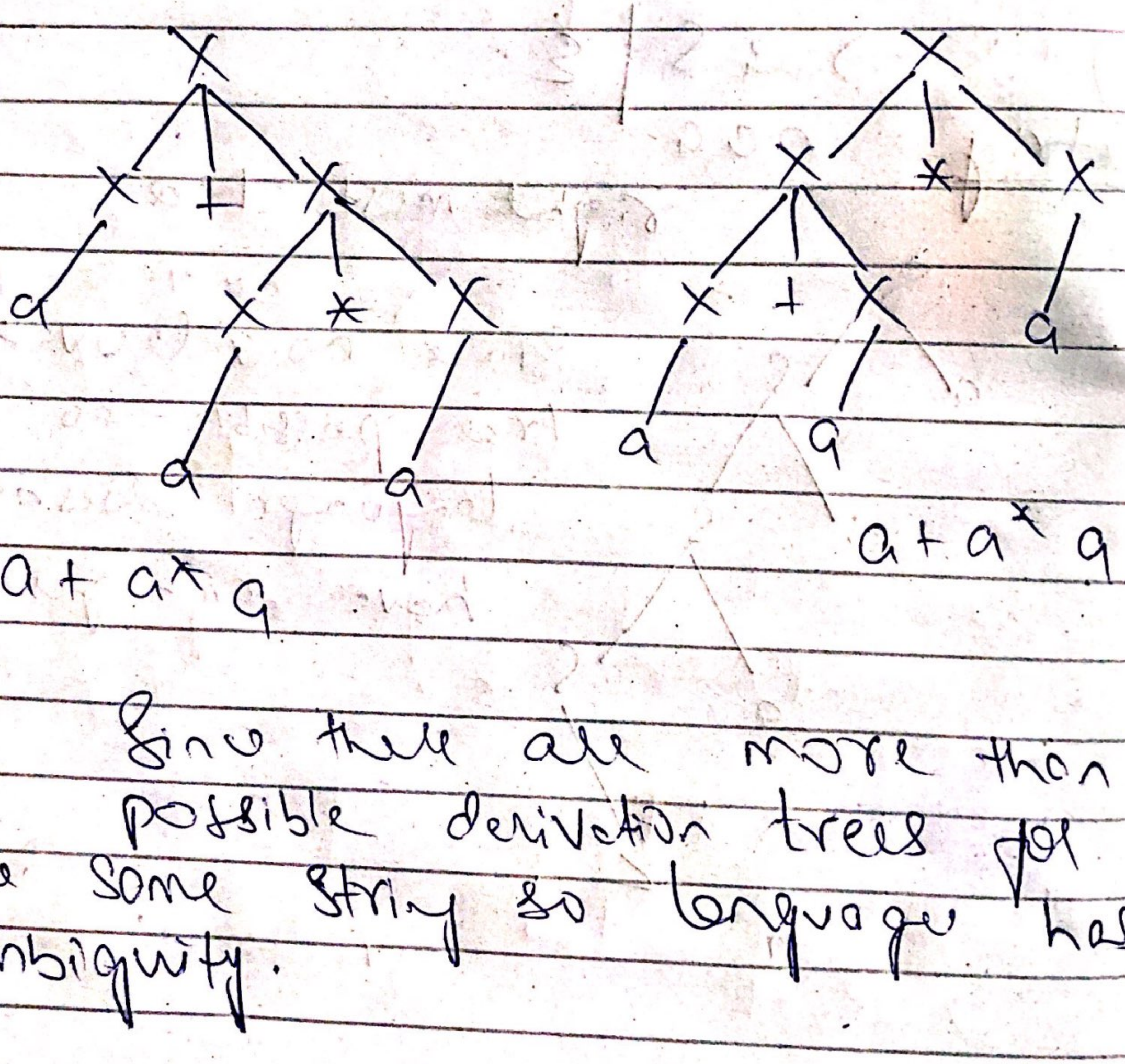
Since no derivation tree possible so language doesn't have ambiguity.

20K-0226

(3) $X \rightarrow X+X \mid X*X \mid X \mid a$

String :- $a+a*a$

left most tree :



Since there are more than 1 possible derivation trees for the some string so language has ambiguity.