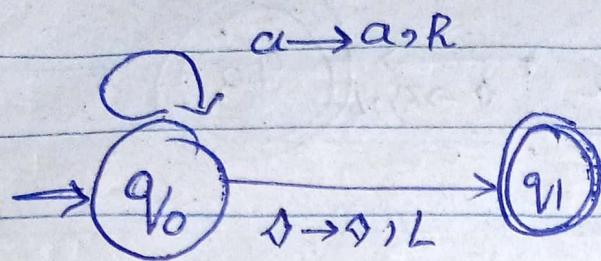


Q. TM for  $a^*$ .



$\diamond |a|a|a|a|\diamond$

$\uparrow \uparrow \uparrow \uparrow$   
 $q_0 \ q_0 \ q_0 \ q_0$

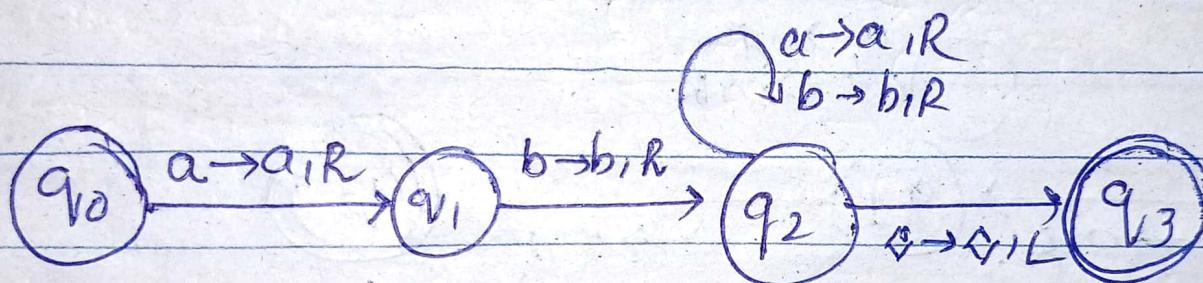
Accepted

$\diamond |a|b|a|\diamond$

$\uparrow \uparrow$   
 $q_0 \ q_0$

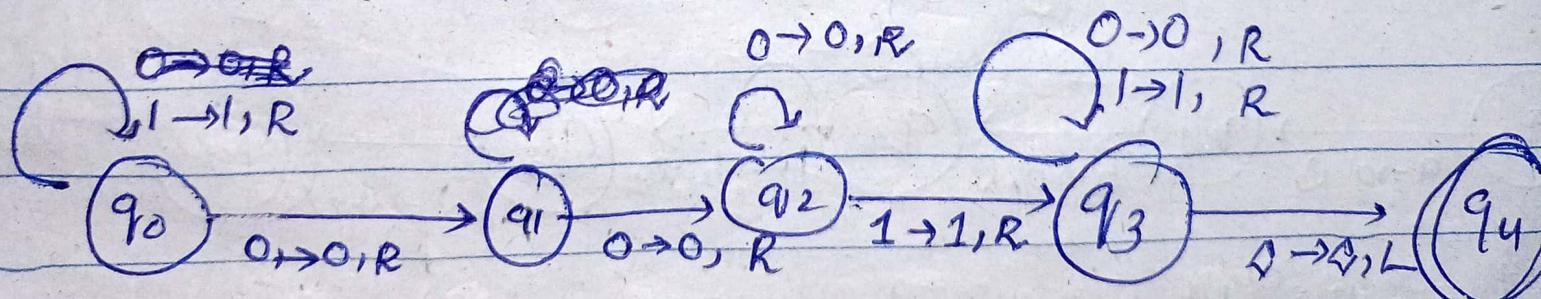
No transition halt  $q_1$

Q. TM for all strings with prefix ab in  $\{a, b\}^*$   
 $ab.(a+b)^*$



Q. containing strings with substring 001.

$(0+1)^*(001)(0+1)^*$



$\diamond |100010|\diamond$

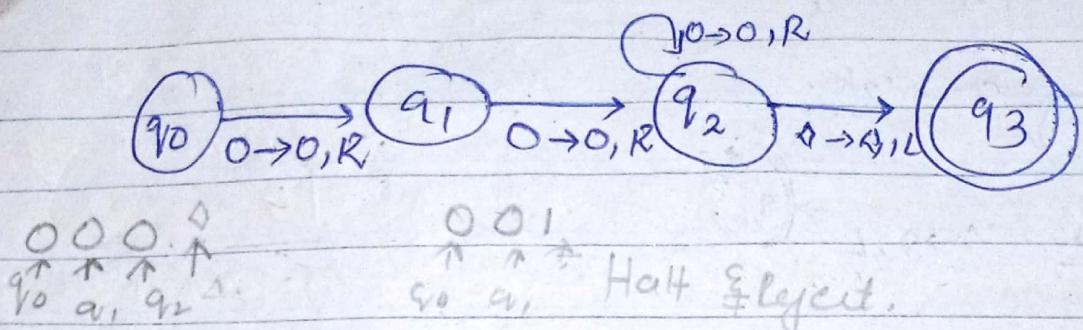
$\uparrow \uparrow \uparrow \uparrow \uparrow \uparrow$   
 $q_0 \ q_1 \ q_2 \ q_3 \ q_4$

Q. Containing strings without substring 001.

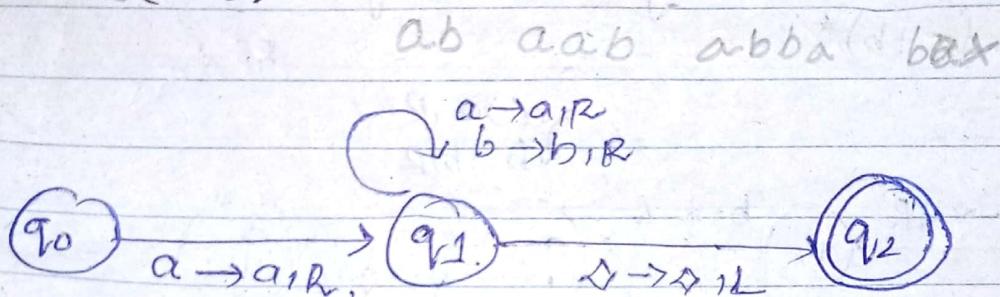
B halts  $\rightarrow 1001$

11111 000001  
 10000

Q.  $\Sigma = \{0, 1\}$ , design TM for  $R.E. \infty^*$ .



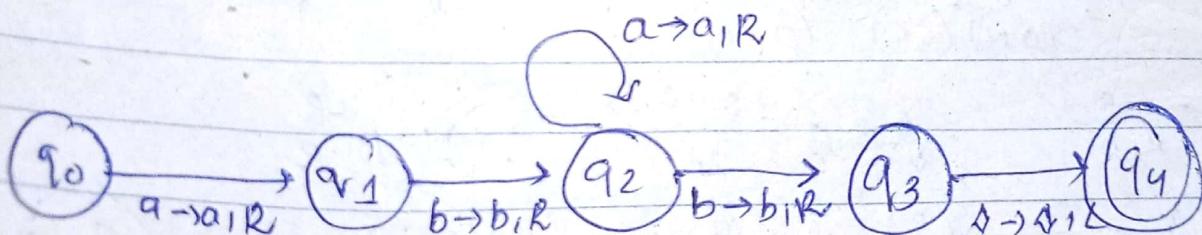
Q.  $a(a+b)^*$ .



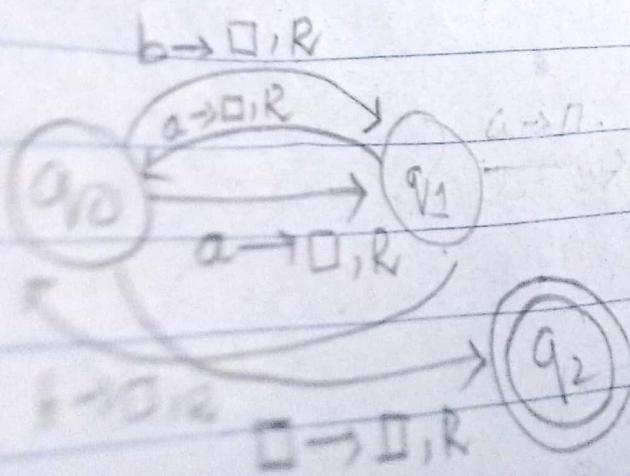
Q.

$aba^*b$

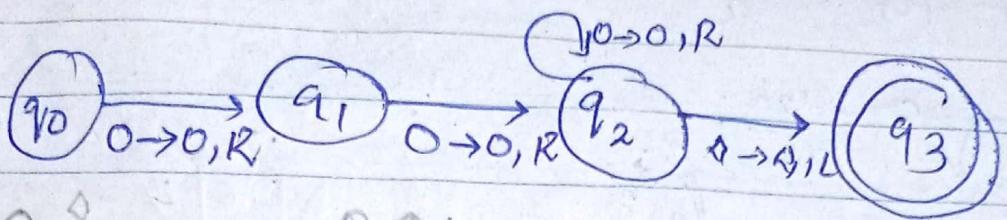
abaab  
abbx



Q.  $L = \{w : |w| \text{ is even}\} \subset \{a, b\}^*$



Q.  $\Sigma = \{0, 1\}$ , design TM for  $R \in \omega^*$

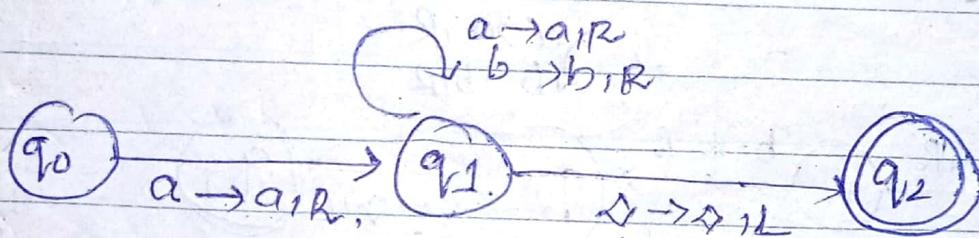


$000 \uparrow \uparrow \uparrow$   
 $q_0 \xrightarrow{\uparrow} q_1, q_2 \xrightarrow{\uparrow} q_3$

$001$   
 $q_0 \xrightarrow{\uparrow} q_1, \text{ Halt & Eject.}$

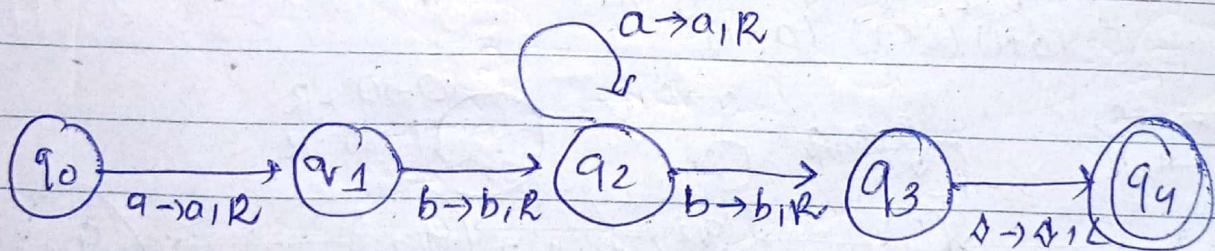
Q.  $a(a+b)^*$

ab aab abbaab abx

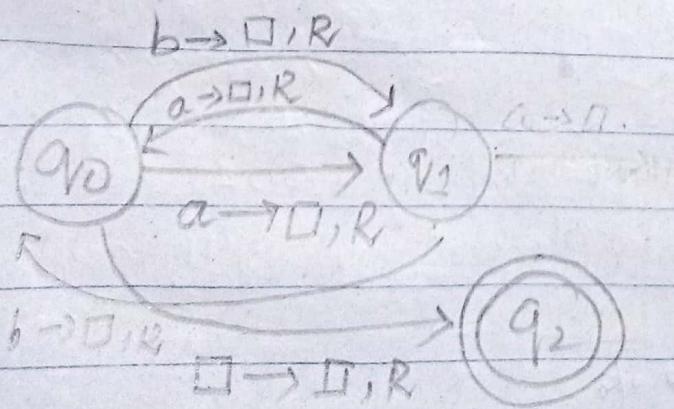


Q. aba\*: b

abaab  
abbx



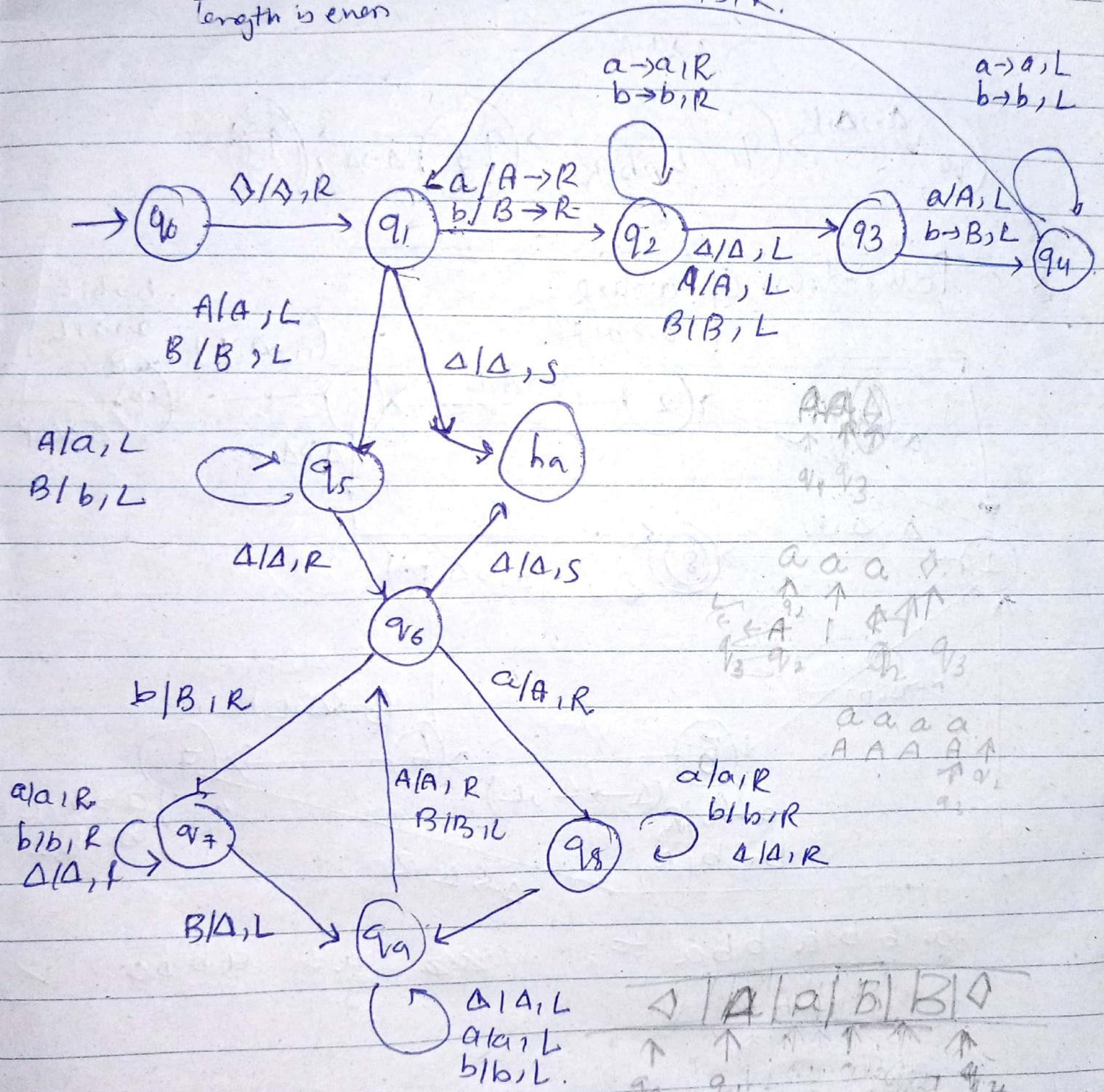
Q.  $L = \{w : |w| \text{ is even}\} \subset \{a, b\}^*$



$$\Omega_L = \{ x \cdot x \mid x \in \{a, b\}^*\}$$

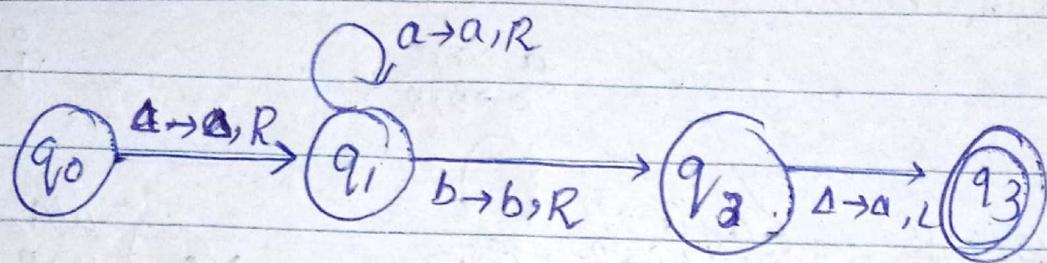
length is even

A/A, R  
B/B, R.



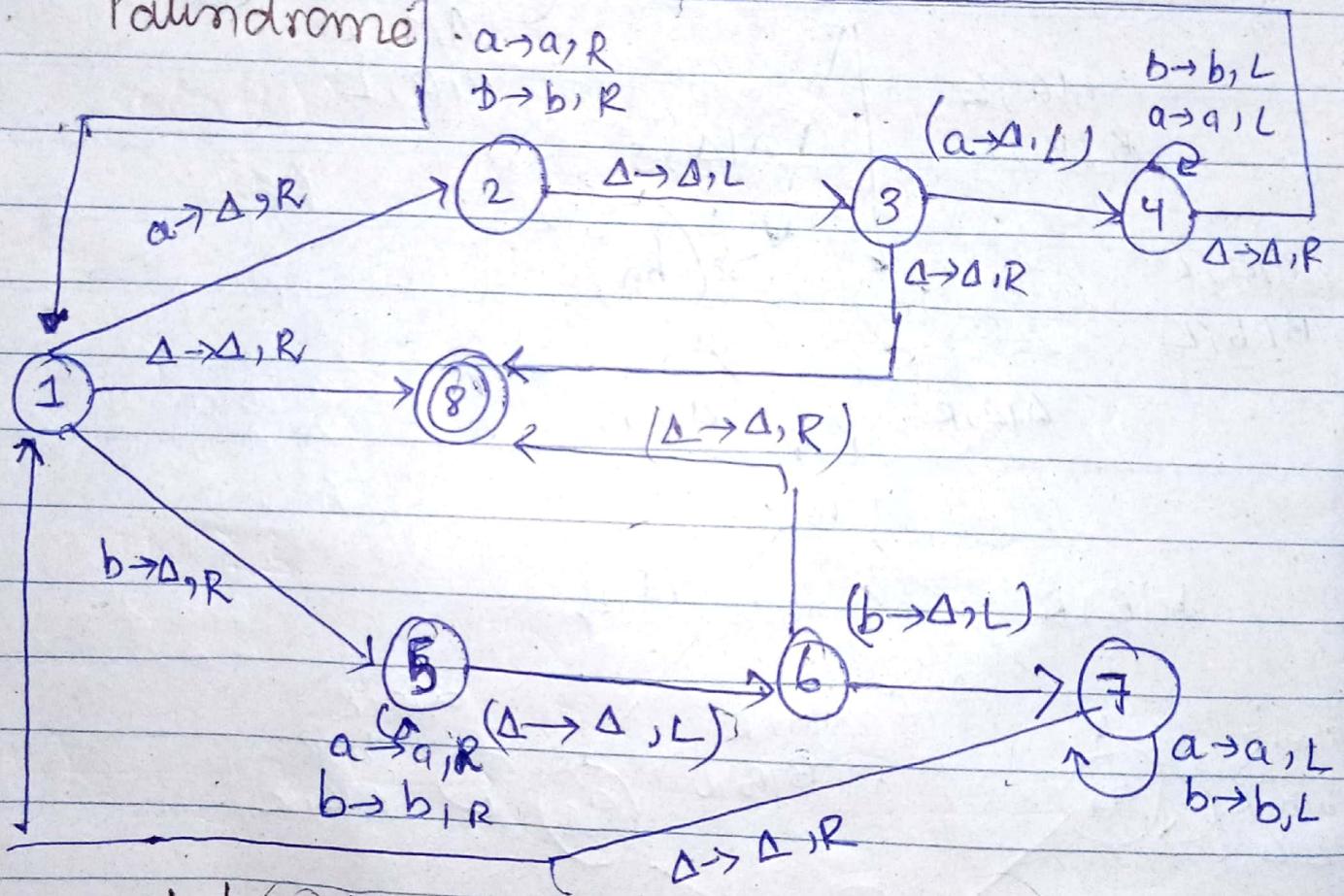
Q.  $\{a^n b ; n \geq 0\}$

$\uparrow ab, b, aab, aaab$



Q.

Palindrome



a b b (a) b b a

$\Delta \rightarrow \Delta, L, R$

a a a b b b a a a

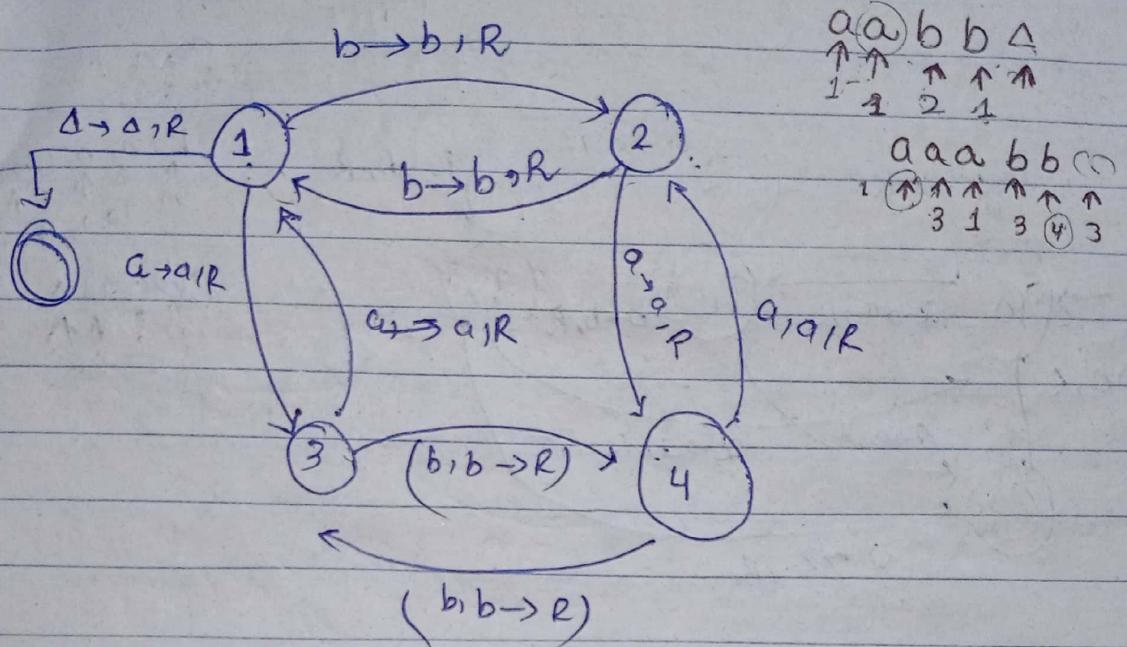
$\Delta \rightarrow \Delta, L, R$

(q11)

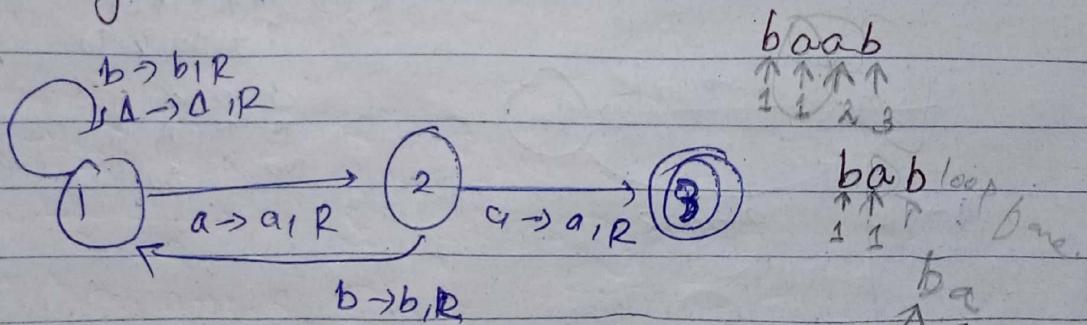
( $\Delta | 0 | 1 | 1 | 0 | 1 | 1 | \Delta$ )

$q_0 \uparrow q_0 \uparrow q_1 \uparrow q_0 \uparrow q_1 \uparrow q_0 \uparrow q_1 \uparrow q_0 \uparrow (q_1)$

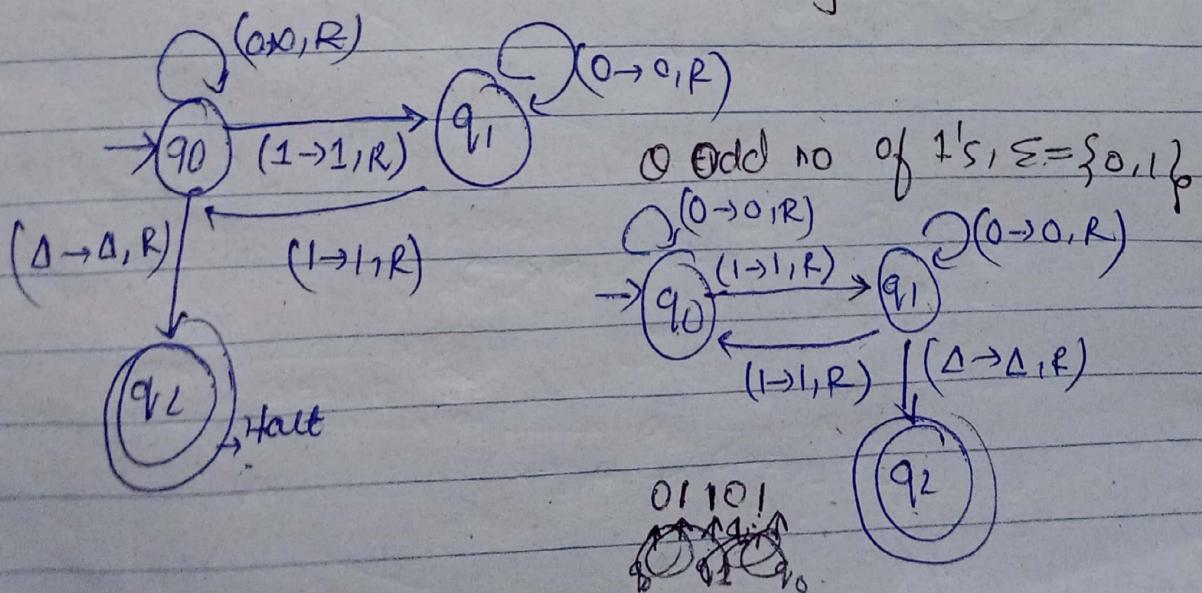
Q. EVEN-EVEN, even no of a's and even no of b's.



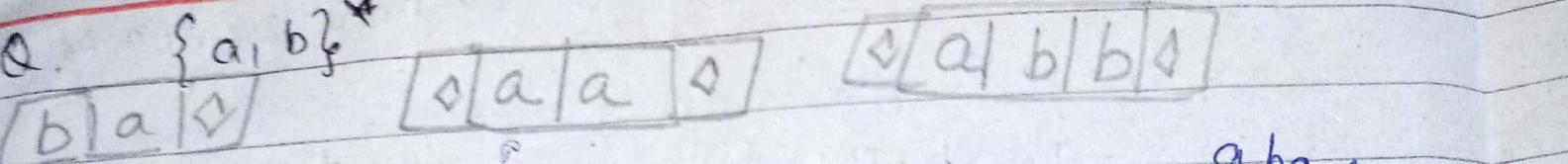
Q. having double 'a' in somewhere.



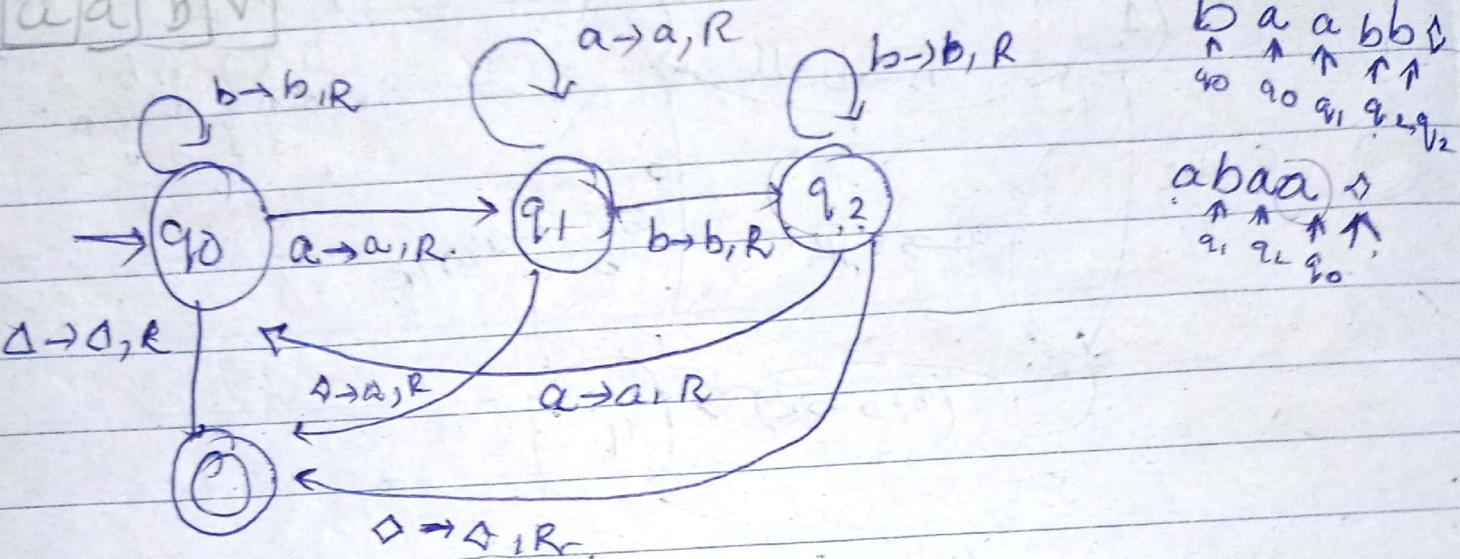
Q. Even no of 1's,  $\Sigma = \{0, 1\}$



Q.  $\{a, b\}^*$



$b|a|a|b$

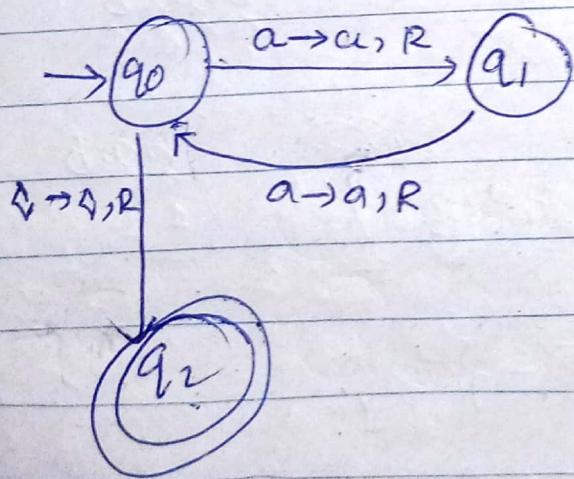


aba  
q1 q2 q3 q4

b a a b b  
q0 q0 q1 q2 q3  
q1 q2 q3 q4

abaa  
q1 q2 q3 q4

Q.  $\{x : x \in \{a\}^* \text{ and } |x| \text{ is even}\}$ .

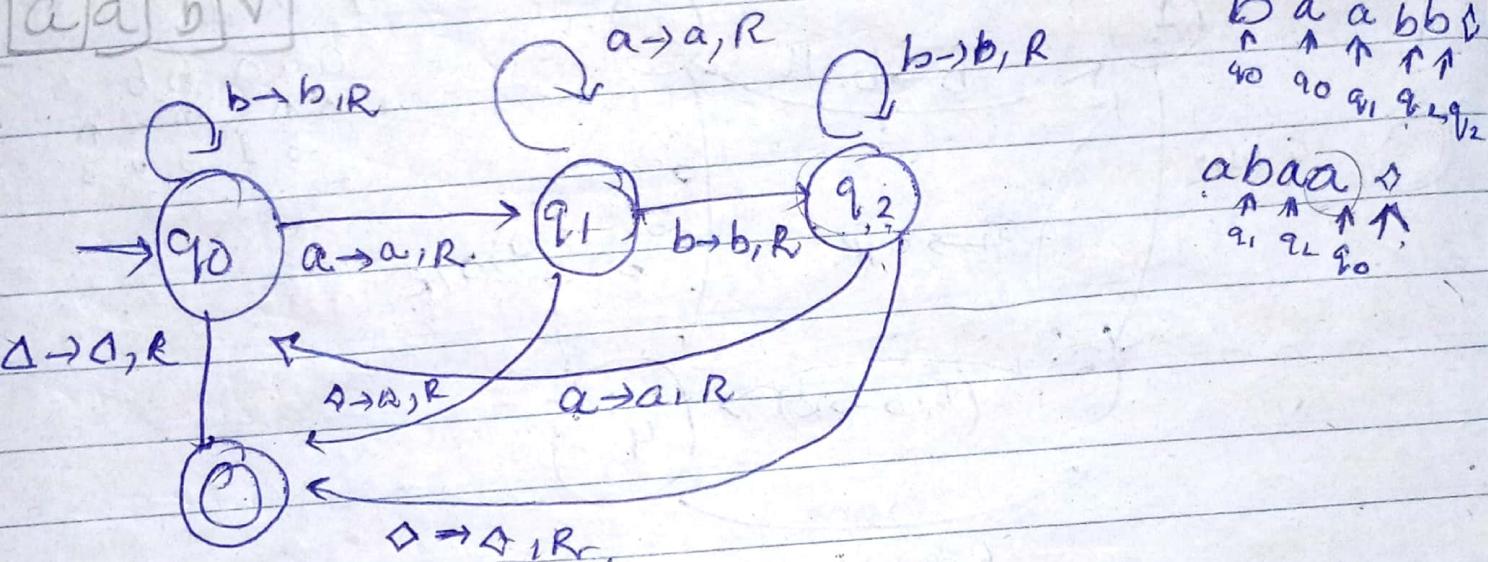


a a a  
q1 q2 q3  
a a a  
q1 q2 q3

a a a  
q0 q1 q0  
a a a  
q0 q1 q0

$\{a, b\}^*$

a a b

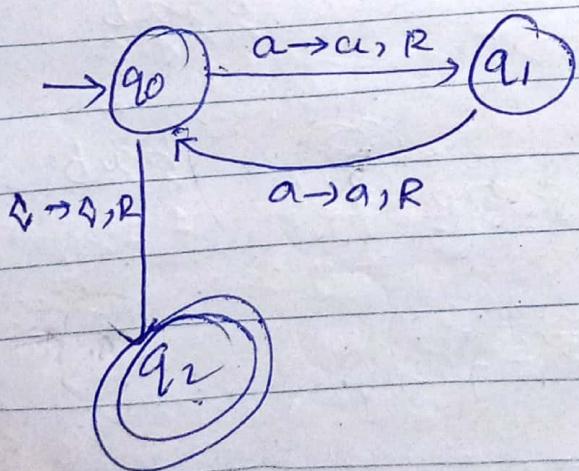


aba  
 $q_1, q_2, q_{10}$

b a a bb  
 $q_0, q_0, q_1, q_2, q_2$

abaa  
 $q_1, q_2, q_0$

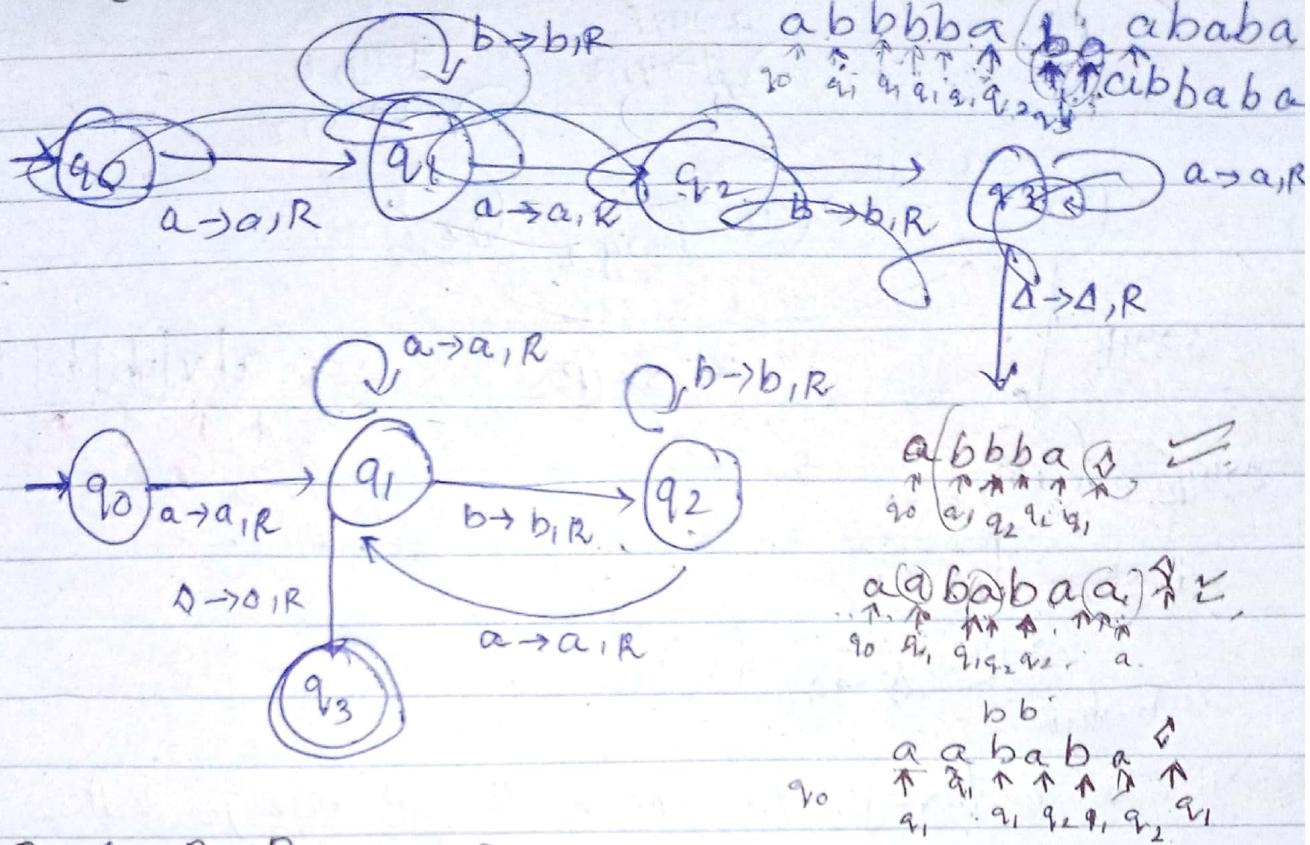
Q.  $\{n : x \in \{a\}^* \text{ and } |x| \text{ is even}\}$



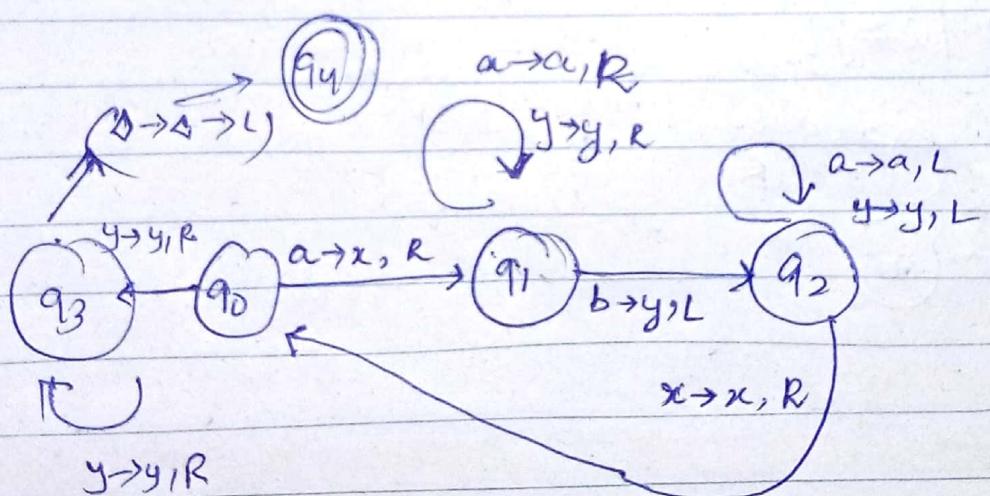
a aa  
 $q_1, q_0, q_1, q_0$

a a a  
 $q_0, q_1, q_0$

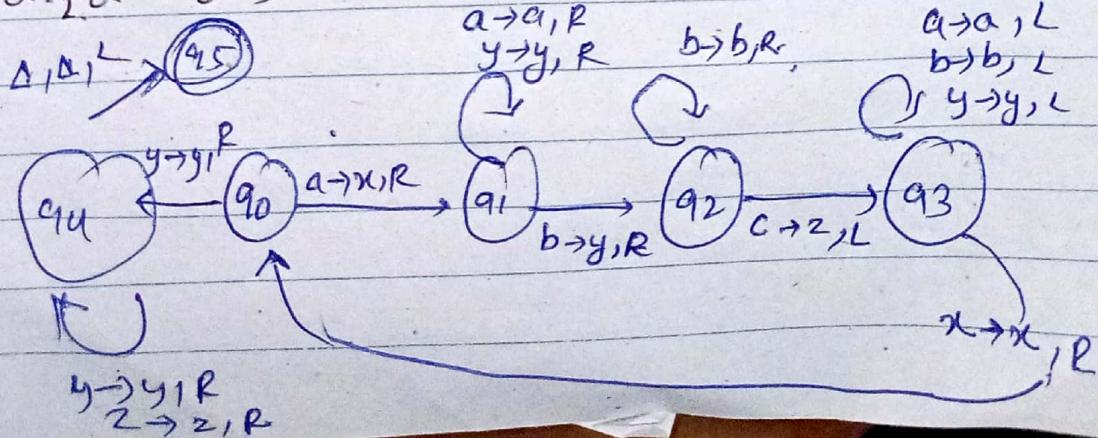
a.  $\{ \text{awa} : w \in \{a, b\}^* \}$ .



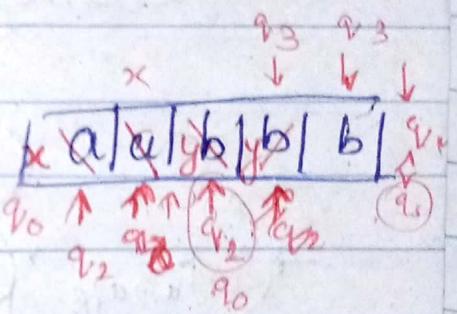
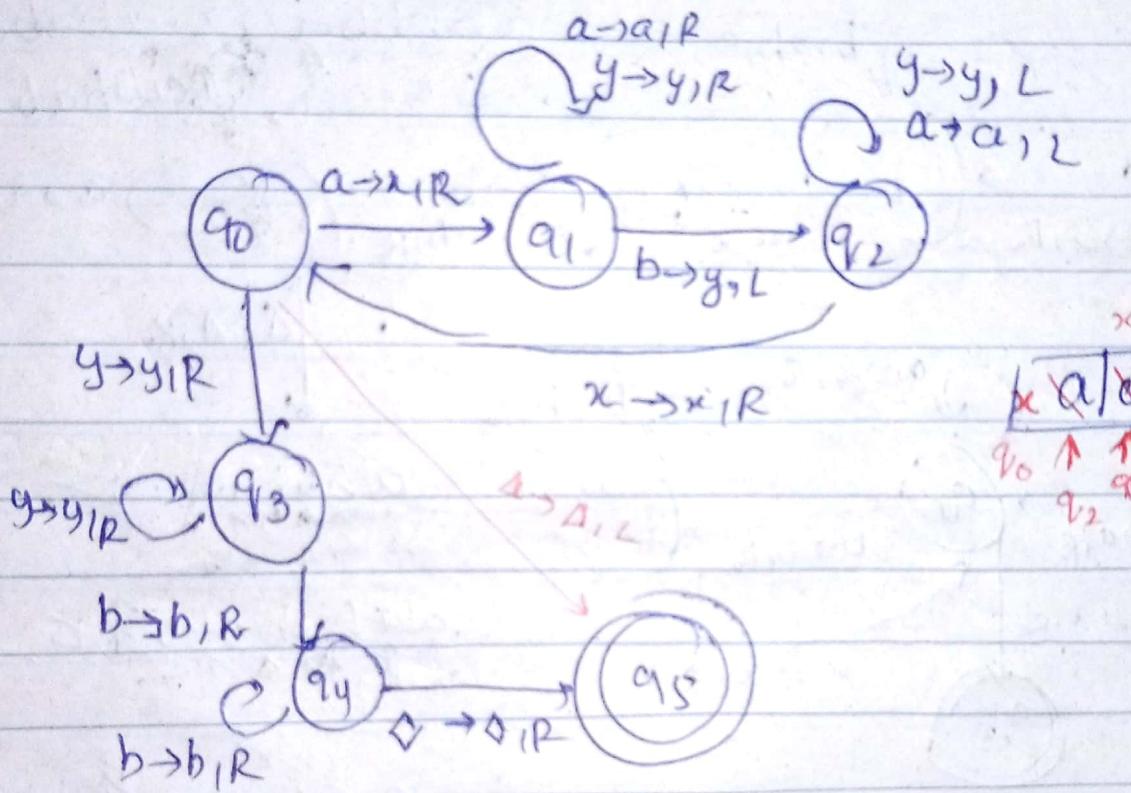
a.  $\{ a^n b^n ; n \geq 0 \}$



a.  $\{ a^n b^n c^n \}$

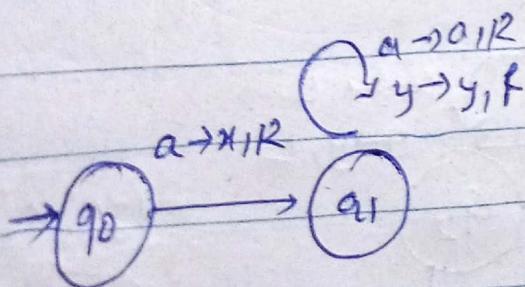


Q.  $\{a^i b^j \mid i < j\}$

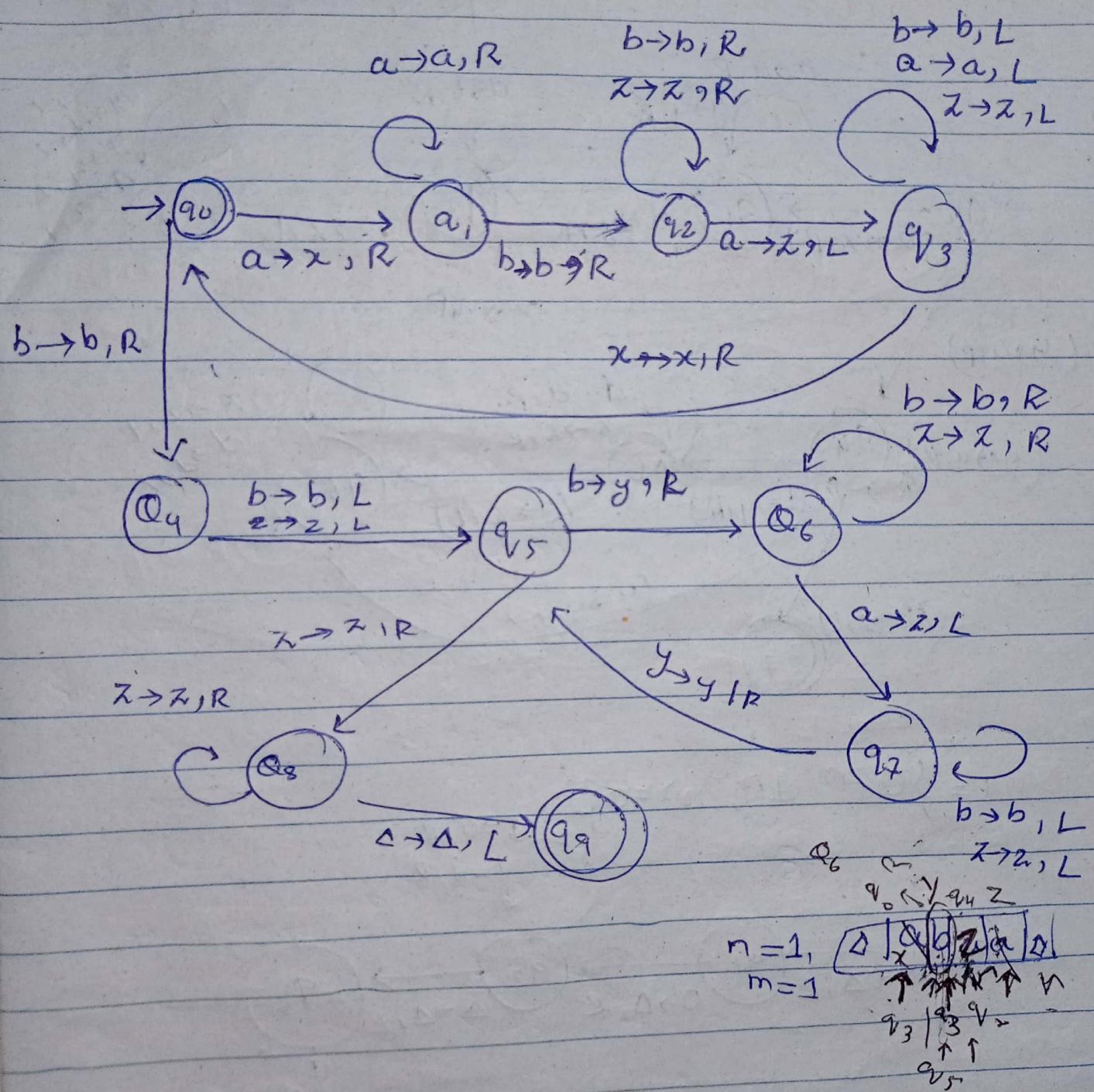


Q. if  $a^i b^j \mid i < j$ , to uper wali TM mai jo Redline hui wo add hogi bs.

Q.  $\{a^i b^j \mid i \neq j\}$ .



$$Q. \quad L = \{ a^n b^m \mid a^{n+m} \mid n, m \geq 1 \}.$$

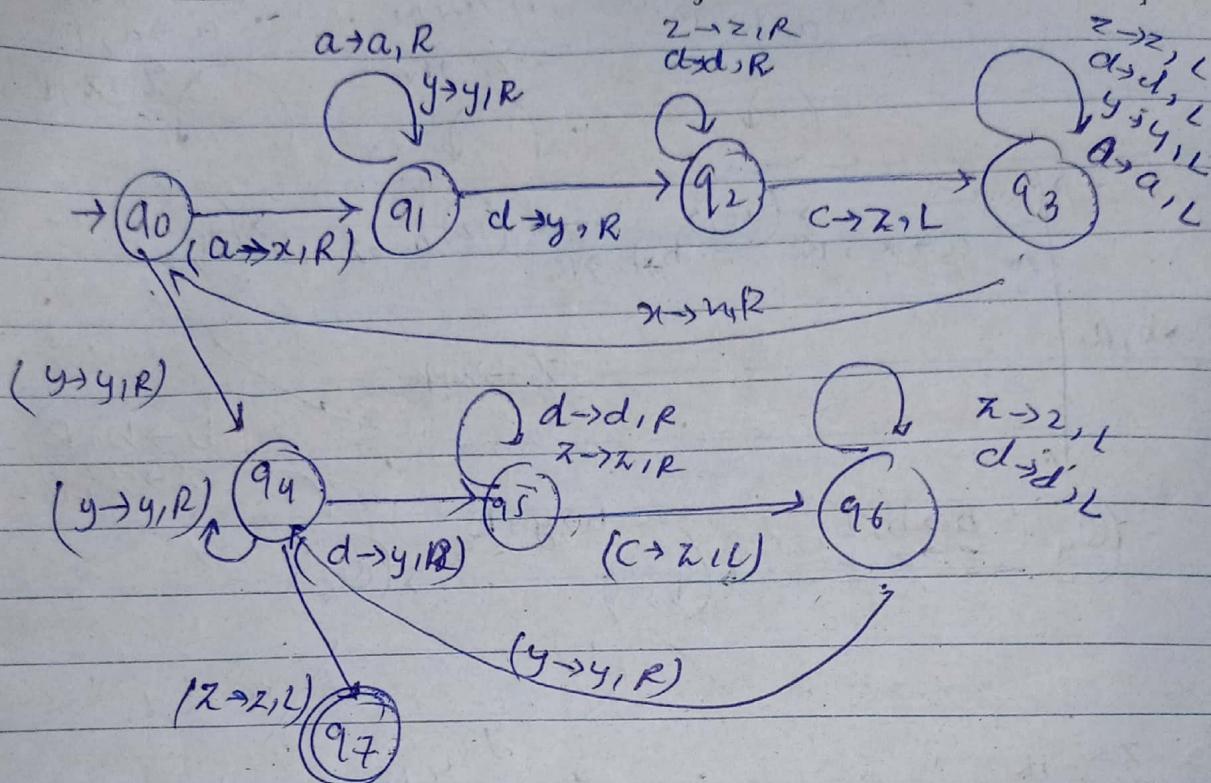


$$n=1, \quad m=1$$

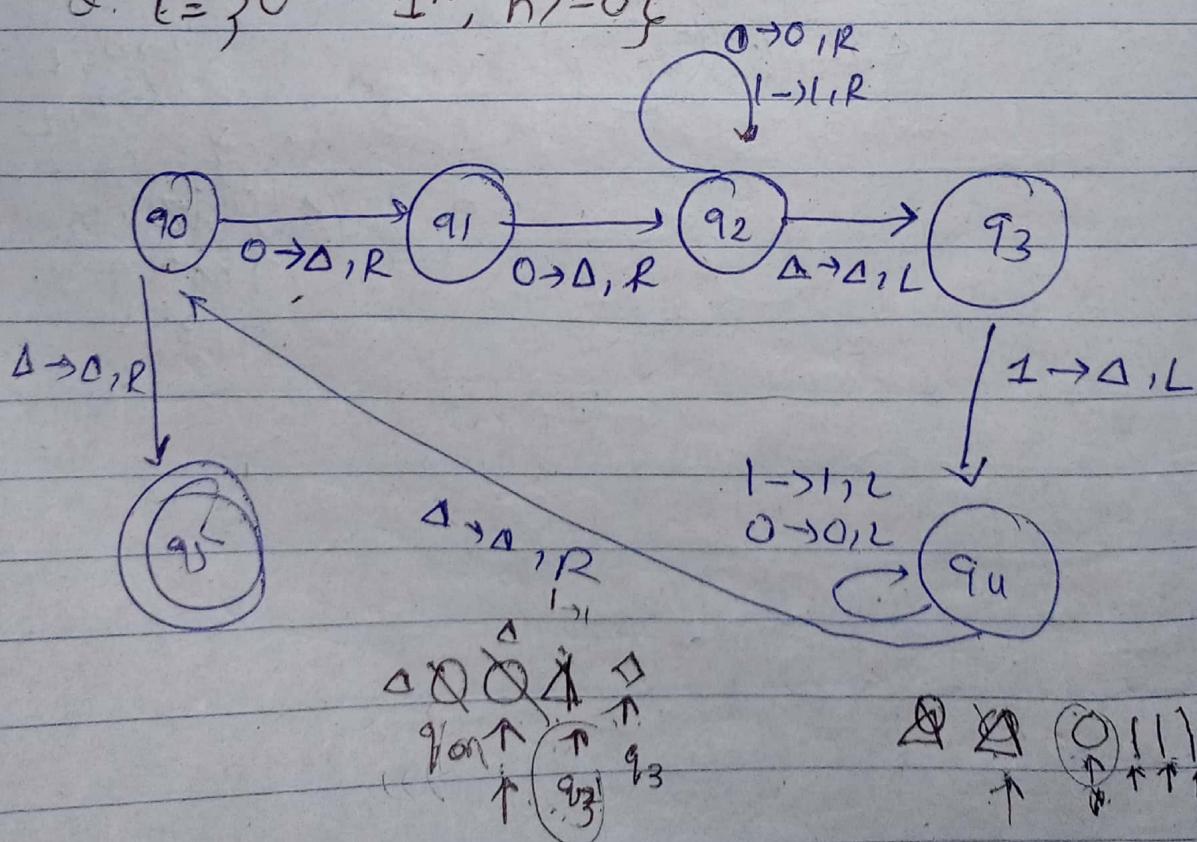
$\begin{array}{|c|c|c|c|c|} \hline & q_0 & q_1 & q_2 & q_3 \\ \hline q_0 & x & & & \\ \hline q_1 & & y & & \\ \hline q_2 & & & z & \\ \hline q_3 & & & & \\ \hline \end{array}$

Q.

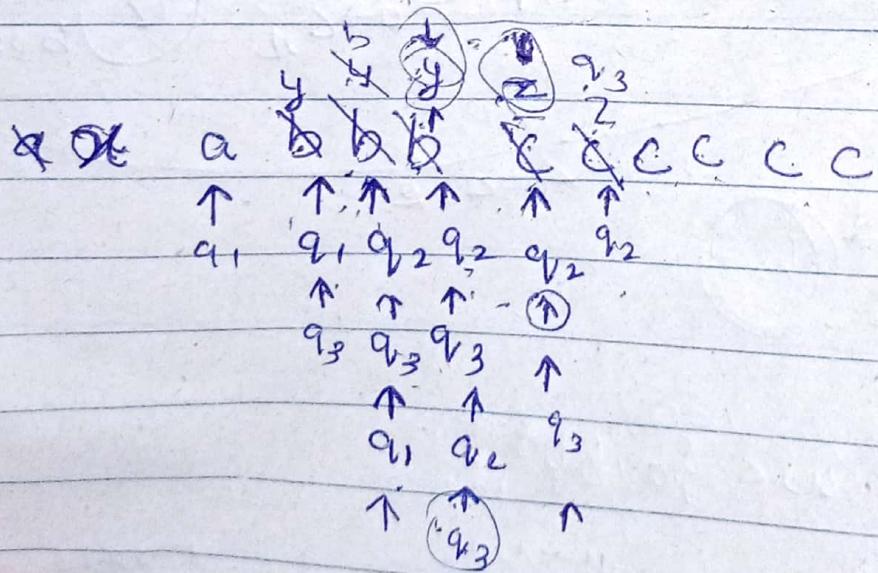
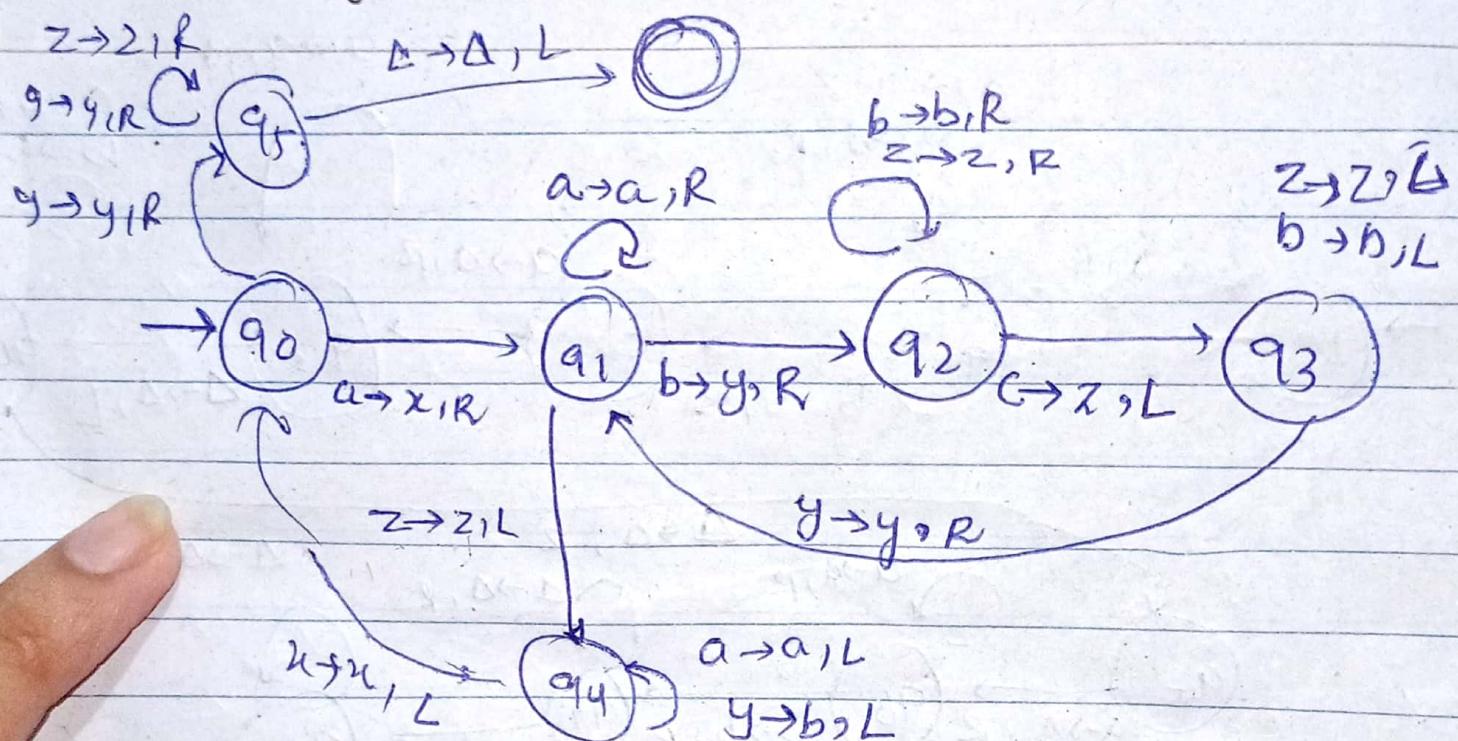
$$L = \{a^i b^j c^k \mid i < j < k \text{ or } i > j > k\}$$



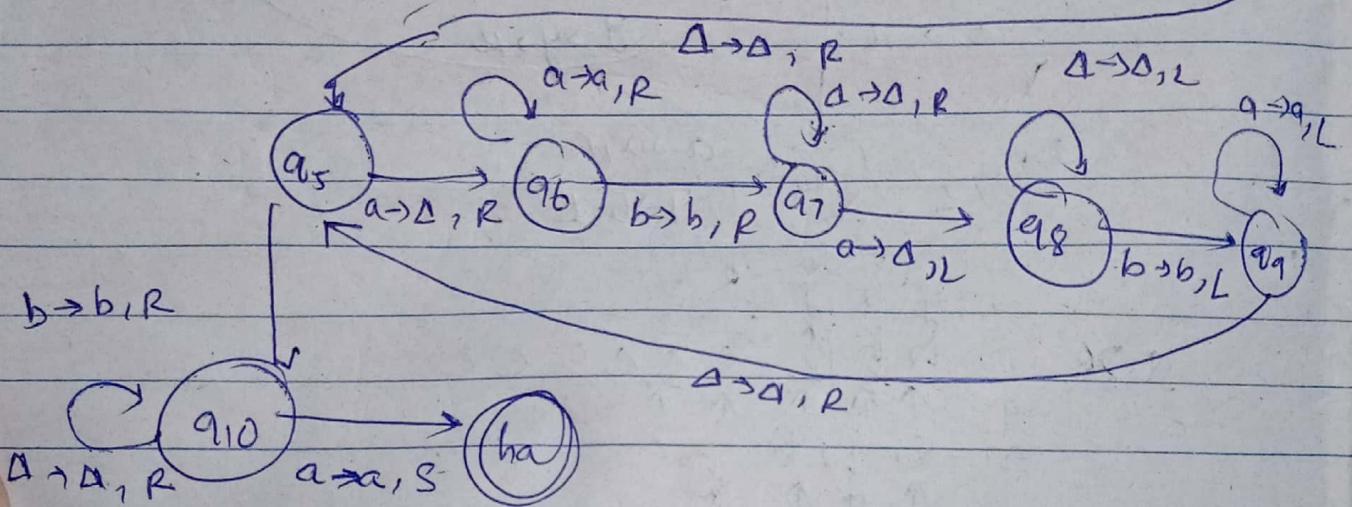
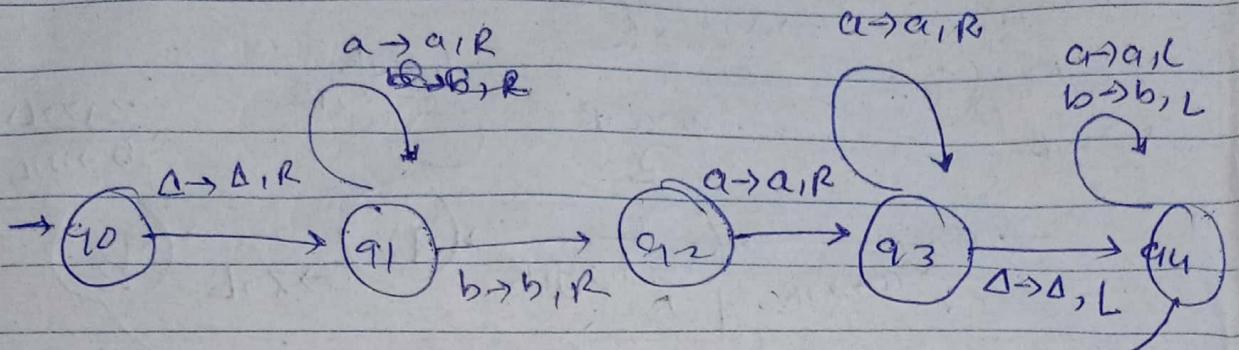
$$Q. L = \{0^{2n} 1^n, n \geq 0\}$$



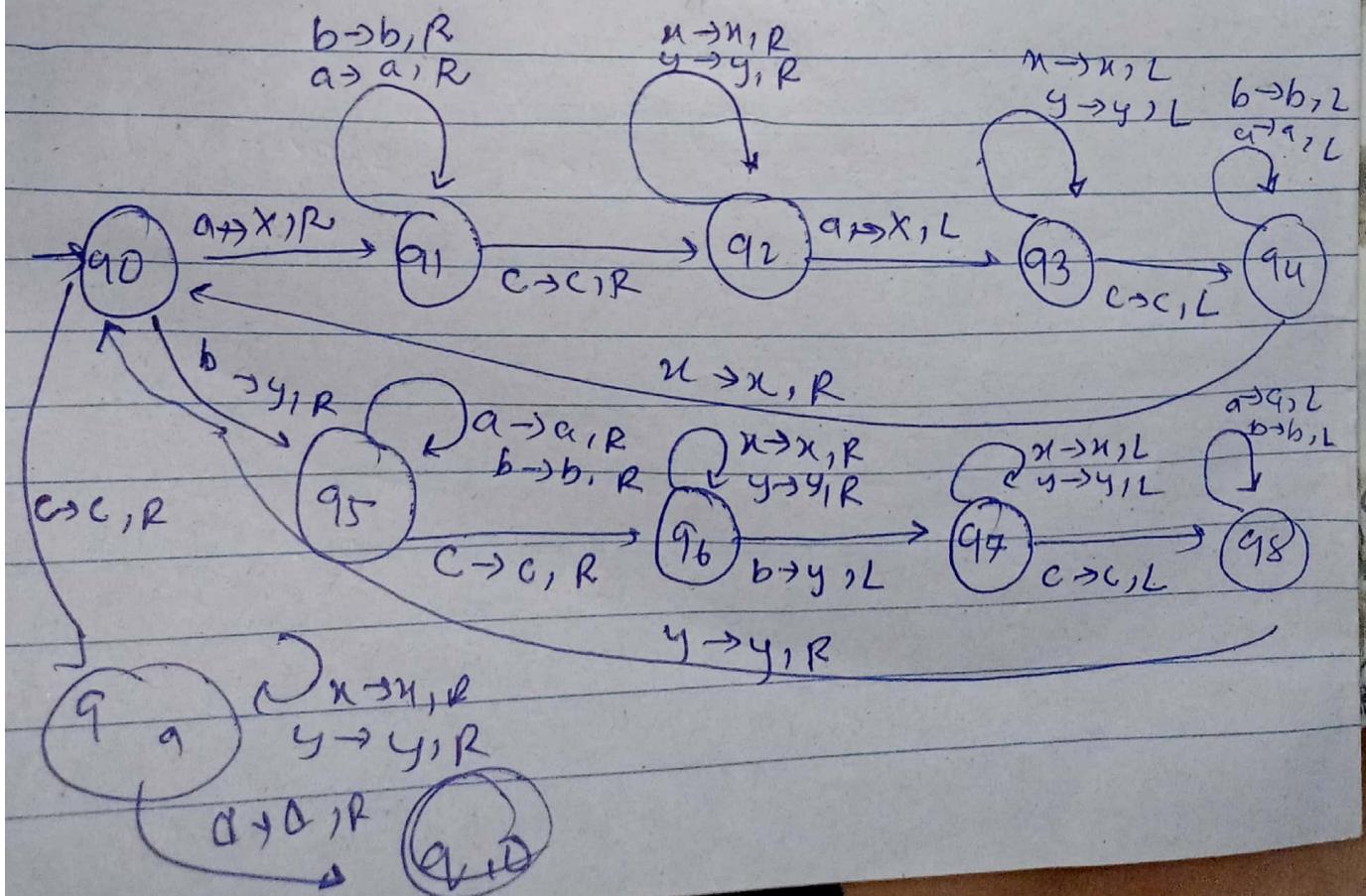
$$Q. \quad L = \{ a^i b^j c^k \mid i^* j = k, \quad i, j, k \geq 1 \}$$



Q.  $\{a^i b a^j \mid 0 \leq i < j\}$



Q.  $L = \{wcyw, w \in \{a,b\}^*\}$ .

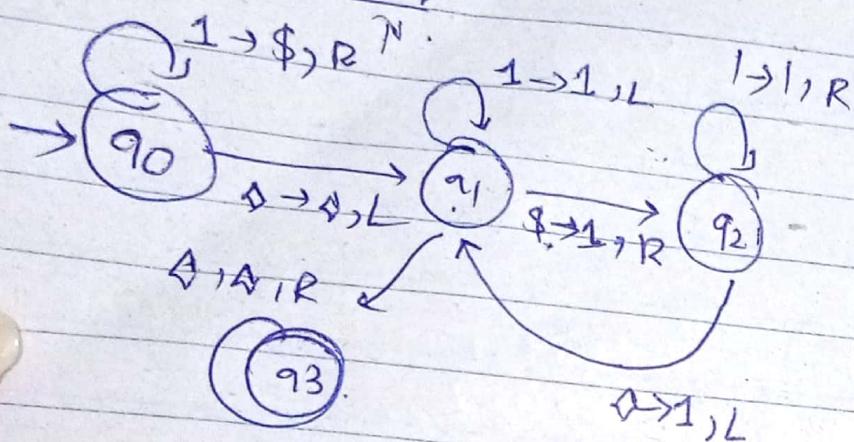


$$Q. \quad f(n) = 2^n.$$

Input =  $n$

$\boxed{0|1|1|\Delta|1|0|}$

Output =  $2^n$ .



$\begin{array}{c} A|1|X|1|0| \\ \uparrow \quad \uparrow \quad \uparrow \quad \uparrow \\ q_0 \quad q_0 \quad q_1 \quad q_1 \\ \$ \quad \$_{c_1} \quad a_2 \\ 1 \cancel{\$} \quad 1 \cancel{1} \quad \Delta \cancel{1} \\ \uparrow \quad \uparrow \quad \uparrow \\ a_1 \quad q_1 \quad q_2 \\ \uparrow \quad \uparrow \\ q_0 \quad q_1 \quad q_2 \end{array}$

$\boxed{0|0|1|1|\Delta|1|}$

$$Q. \quad f(x,y) = xy$$

$$x=2 \quad y=3$$

11

111

$xy = 11111$

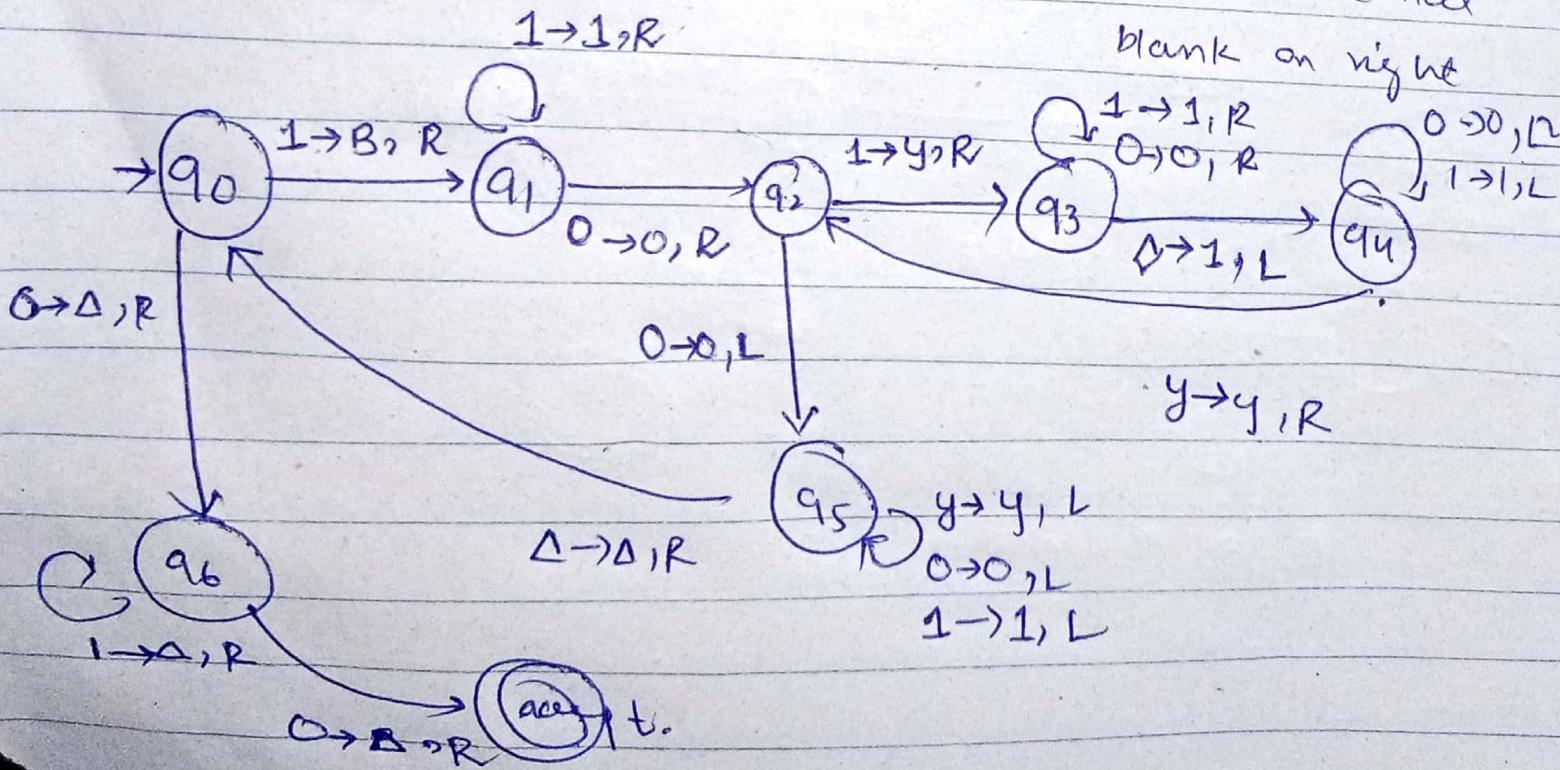
$\boxed{B|B| \Delta |1|0|1|1|1|0|B|B|B|B|}$

~~place~~

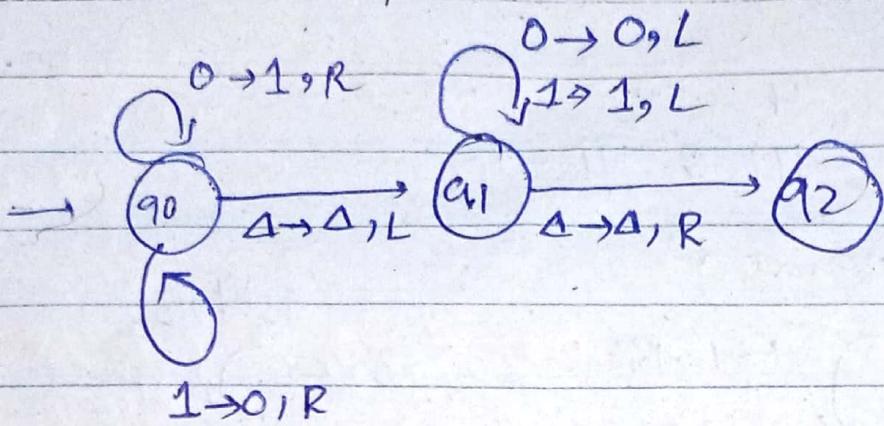
On each 1 cancel

blank on right

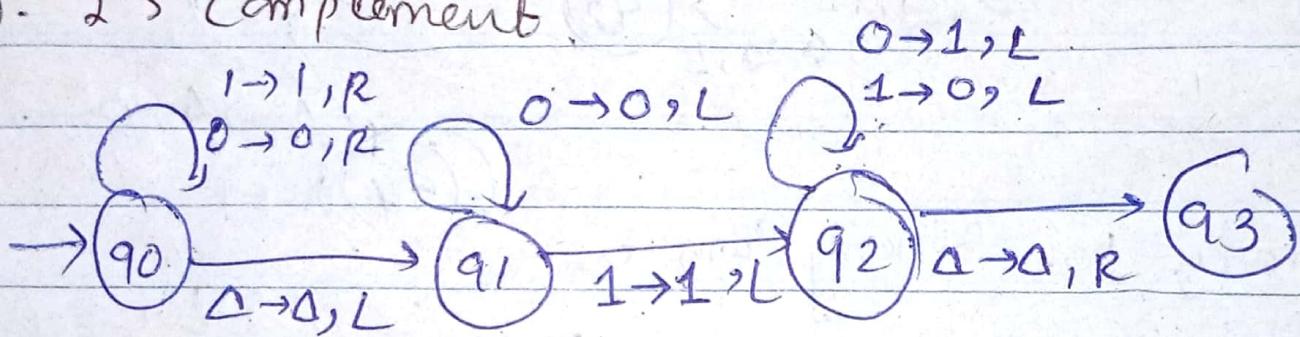
$0 \rightarrow 0, R$   
 $1 \rightarrow 1, L$



Q. 1's complement.



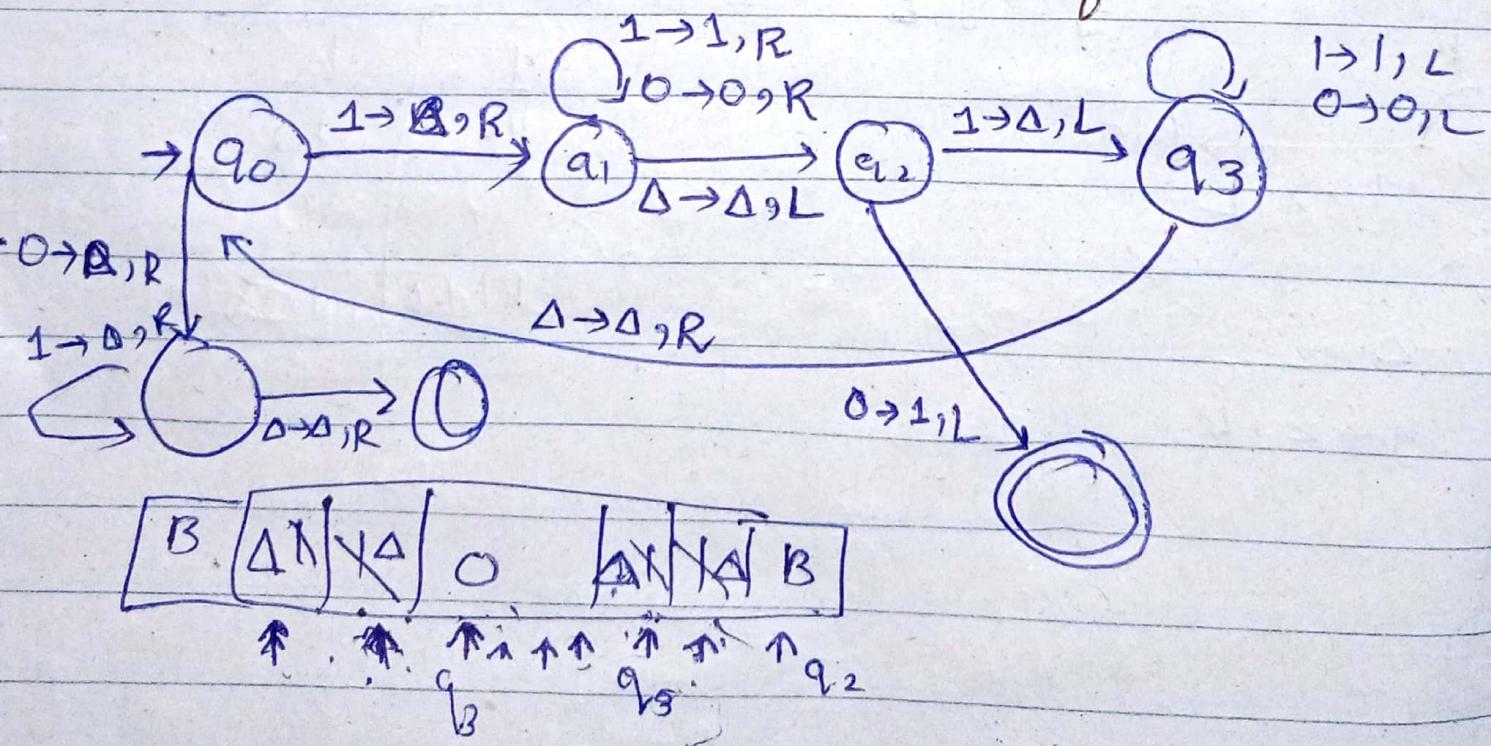
Q. 2's complement.



Q. Subtraction

$$\text{f}(m, n) = \begin{cases} m-n & \text{if } m > n \\ 0 & \text{if } m \leq n \end{cases}$$

~~$A | 1 \ 1 \ 1 \ 0 \ 1 \ 1 \ B | B$~~

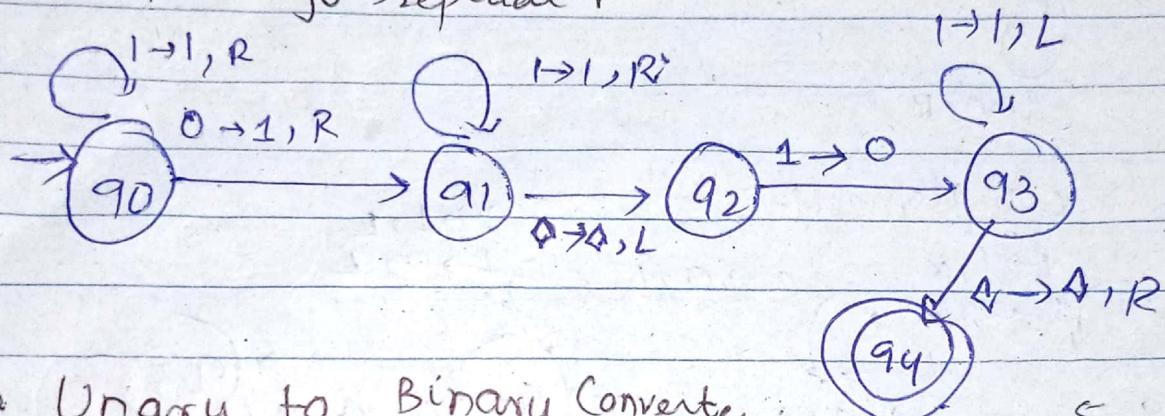


Q. TM as adder.

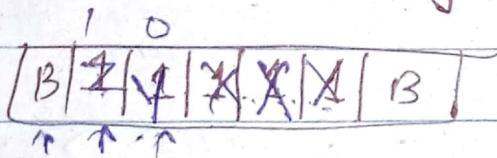
$$f(x, y) = x + y$$

Input:  $n \ 0_y \quad \underbrace{1111}_4 \ 0 \ \underbrace{111}_3$

Output  $x+y \rightarrow$  separator.



Q. Unary to Binary Converter.



Binary:  $0 \rightarrow y$   
Unary:  $1 \rightarrow z$ .      8 4 2 1  
Binary:  $1 \rightarrow z$ .  
Unary:  $1 \rightarrow x$ .      1 0 1  
                  x y z.

