

TURING MACHINE

→ Turing machine is the most powerful computation in general.

→ Aagr koi kham Turing machine nhi kr sakta to wo koi computer nhi kr sakta. (It is an observation which has been proved till now, might possible that in future ~~some~~ it may be disproved)

→ Defined by 7-tuples

[Turing machine accepts language, generate language, can also solve mathematical function like +, -, x, ÷, log, arithm]

$$T.M = \{ \Sigma, Q, q_0, F, \Gamma, B, \delta \}$$

where,

$\Sigma =$ input alphabet

$Q =$ set of states

$q_0 =$ initial state (only one)

$F =$ Final states (none or many)

$\Gamma =$ Tape alphabets $\Sigma \subseteq \Gamma$

$B =$ Blank Symbol ($B \in \Gamma$)

(Tape par jitne symbols likhe hai un sabka set usmein ilp sym bhar diya hai.)

$$\delta: Q \times \Gamma \rightarrow Q \times \Gamma \times \{L/R\}$$

on state Q reading

Symbol Γ from

tape (input alphabet

or, F alphabet dono read kr sakte hai)

usi state par write krenge

yaani jaha read kra hai waha

write krna mandatory hai.

phir hum left ya right kahi

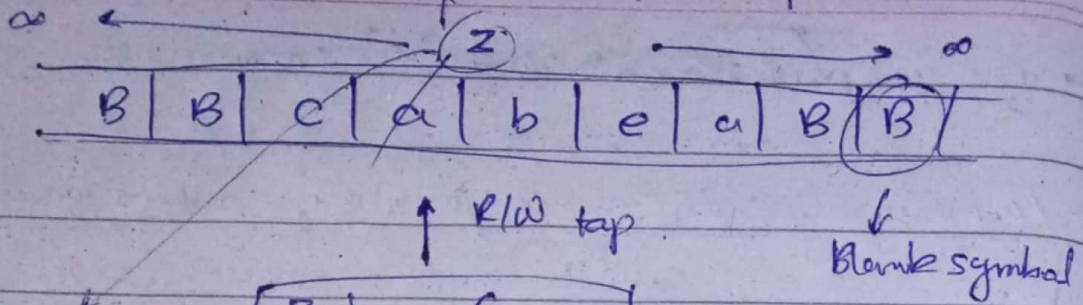
blu jhasakle hai halt nhi

kr sakte move krna toozmi

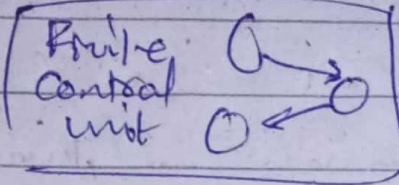
done directions
mein infinite hai

tape can be used
for reading writing both

has cell mein
only one symbol

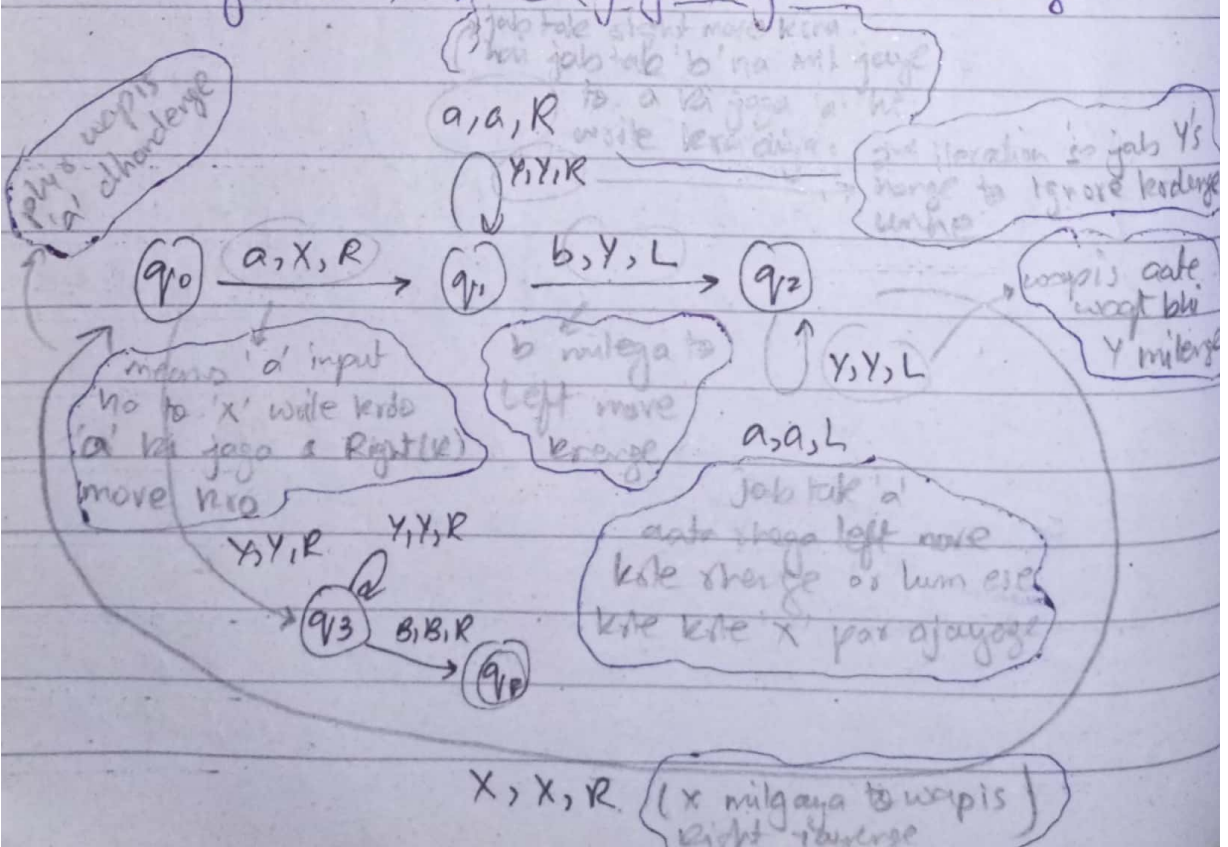


a ko read krke
mein x, y, z kuch
bhi likh sakta hoo.



$L = \{ a^n b^n, n \geq 1 \}$

- ek 'a' ko read krenge or uske corresponding 'b' ko
- is kaha same no of a's & b's count hojayege.
- jo jo 'a' read krenge uska 'x' write krdenge taake
pta rhe konse read krliye hai or konse nhi.
- same for b, b ki jaga 'y' write krenge.



→ agr q_0 par 'Y' input aagya then iska matlab 'a' sab khatam hogai hai

→ phir hum Right move krte shurua jabtak Blank na mil jaye. Agr 'b' aya is daran iska matlab no. of b's zyada hai or uske liye transition define nhi so machine will halt.

	a	b	X	Y	B	
q_0	q_1, X, R	H				→ Halt
q_1						
q_2			q_0, X, R			
q_3						
q_R						

↓ process transition function nhi hai

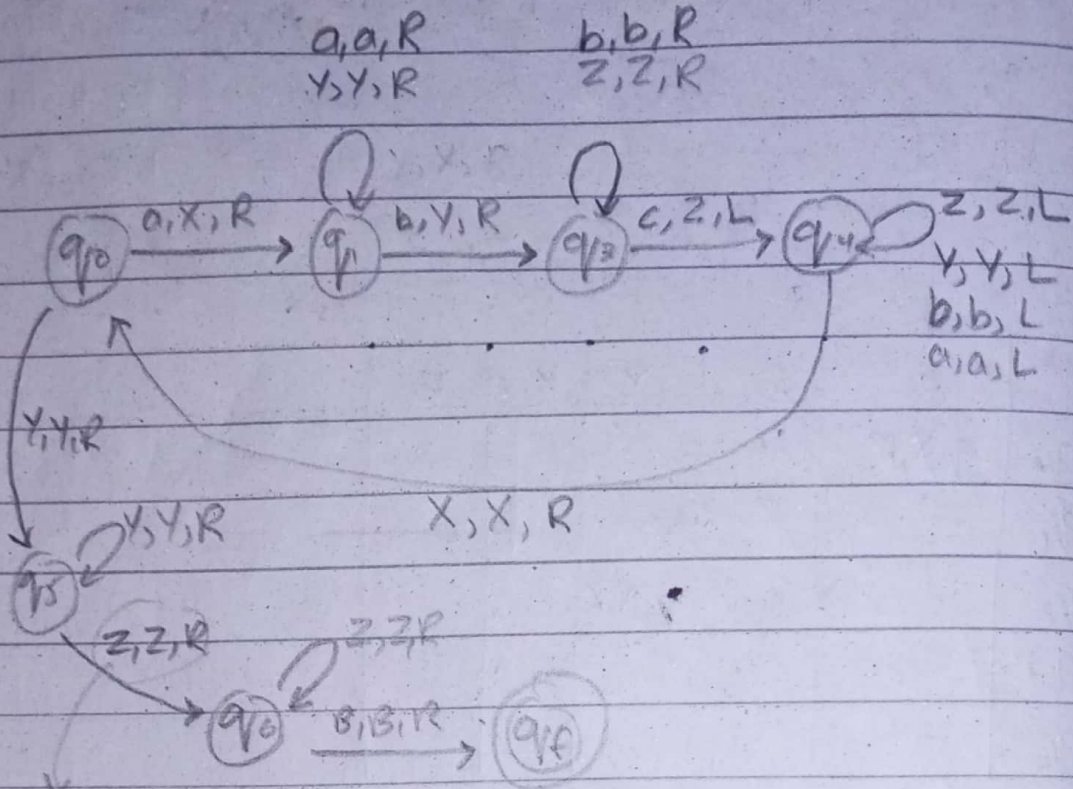
$$\delta(q_0, a) = (q_1, X, R)$$

not a CFL as in PDA we can do comparison b/w to alphabets only.

$L = \{a^n b^n c^n, n \geq 1\}$

B	B	a	a	a	b	b	b	c	c	c	B	B
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Approach: Same as $a^n b^n$.

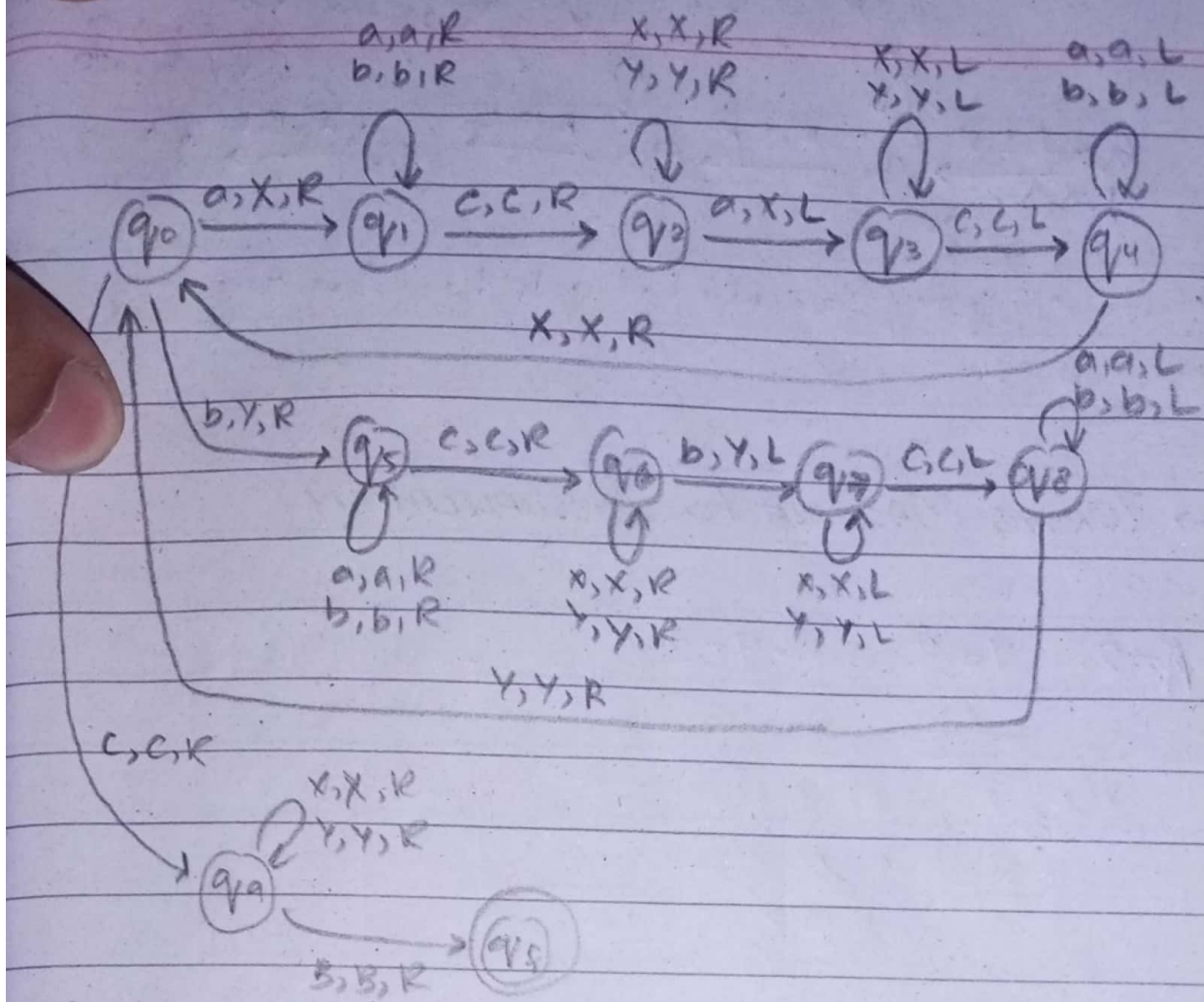


state change
is liye koi karte
pta chate y k baad
'z' hai

$L = \{w c w \mid w \in (a, b)^*\}$

a	b	a	a	b	c	a	b	a	a	b
---	---	---	---	---	---	---	---	---	---	---

Approach: a ko X mein krenge or phir c tak jayenge or uske baad jo hoga ags wo bin 'a' hai to X mein convert phir wapis 'a' tak aaenge. Same 'b' k liye hoga.
or jab q0 par c milega iska matlab w is complete or w complete hogaya hai iska matlab c k baad wala bin w finish hogaya hoga to usko check krenge & accept a string when we get a blank.



Q: Adder using Turing Machine.

→ Hum binary system follow krenge q k binary ya decimal addition k liye machine bahut complex hojayege. if we want to add 2 & 3 so we write B | 1 | 1 | B | 1 | 1 | 1 | B - jitna no. utne no. of 1's

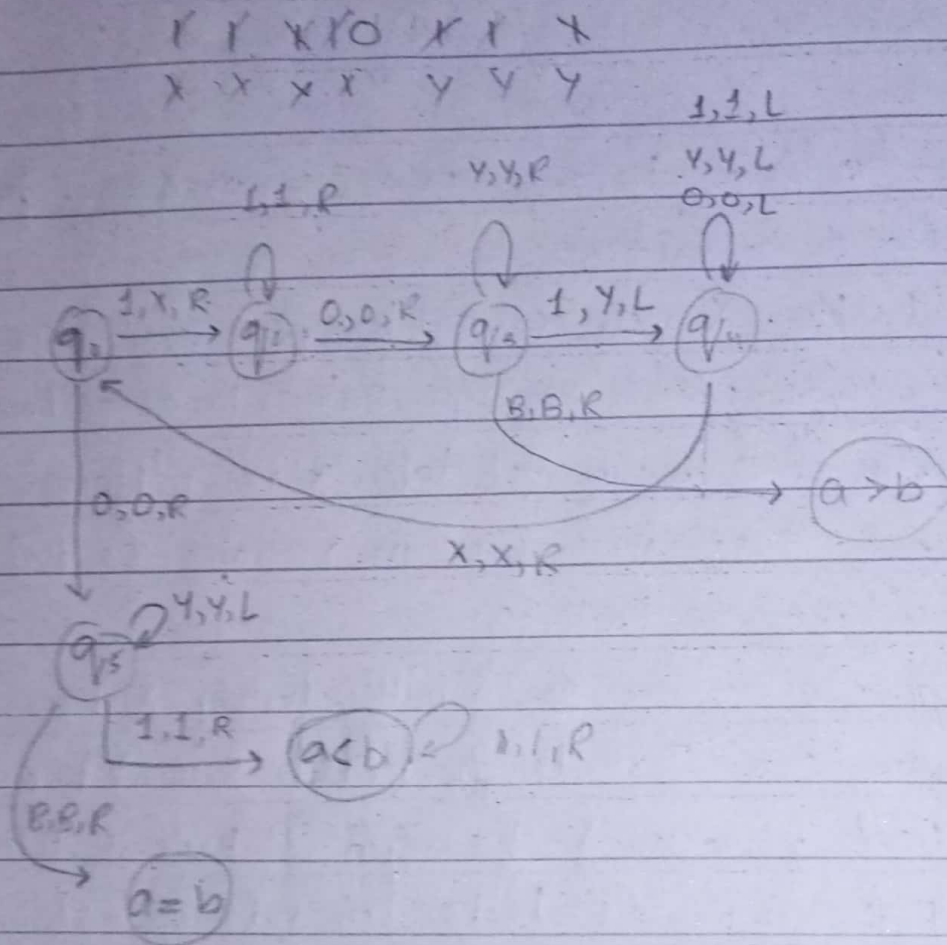
jab string complete ho to tape par 5 ones milne chahiye.

→ Bechh wale B ki jagah ek 1 laga denge or last wale one ko 'B' kr denge take 5 continuous one mil jayen.

Ek 'x' ka 1 mila to uske against Y ko ek pair copy kodenge plus wapis peche ayenge or dobara 1 mila to uske against wapis copy kodenge.

1. '1' ayega to blank kodenge or aage move krenge jab tak Y ka 1 na mil jaye.
2. Y k '1' ko X mein convert kra plus aage jake usko copy kodenge blank par jo zeroes k aage honge.
3. Plus wapis peche ayenge jab tak 'x' na mil jaye.
4. X mil gaya to aage jayenge or jo remaining 1's hai Y k usko copy kodenge.
5. Jab peche ayenge or X milta hai or X ka right par aage zero hai to matlab sare Y k ones copy hoge plus un X ko wapis '1' kodenge take jo A k remaining 1's bache hai unke against wapis yehi procedure follow kr sakein.
6. Plus jab sare A k 1's Blank hojaye to hum right more kote shenge or sabko blank kote jayenge jab tak last zero wale k baad jo 1's hai uska tak nhi pohnc jate.

• AS COMPARATOR



1 1 1 0 1 1 $\Rightarrow a = b$ ($a^m b^n$)

1 X X 0 1 1 1 \rightarrow equal to hone k baad ag X 'Y' k baad
 X X X Y Y Y koi 1 bach sha hai it means $a < b$.

1 X (1) 0 X 1 B $>$ ab is one k baad ek age \neq hone chahye k
 X X Y Y lekin humen B mila it mean $a > b$.

• As Subtractor

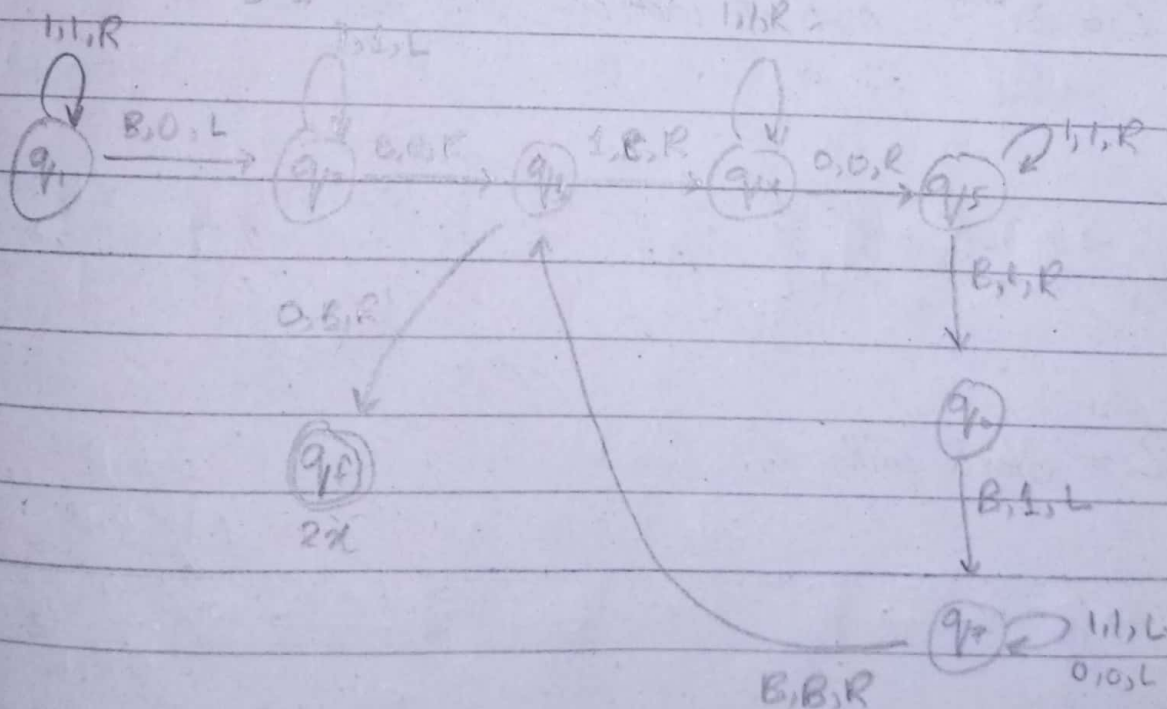
$$f(m, n) = \begin{cases} 0 & , m \geq n \\ m-n & , m > n \\ -(m-n) & , m < n \end{cases}$$

✓ ✓ ✓ 0 ✓ ✓ ✓
✗ ✗ ✗ ✗ ✗ ✗

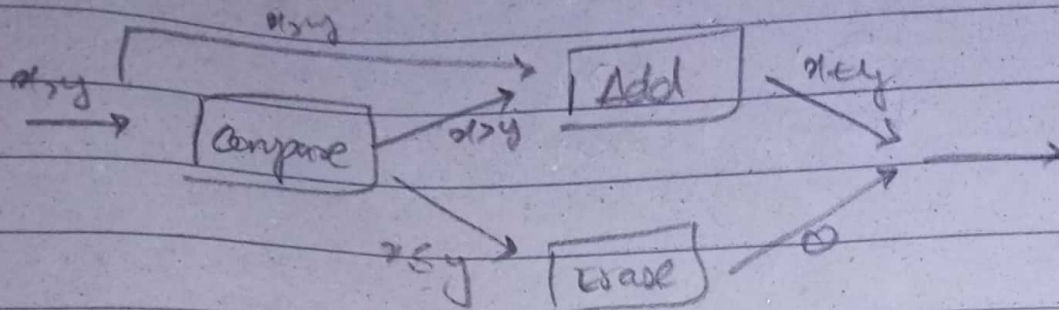
ye bhi comparator jesi bnegi bilkul. 9s mein bhi 9 R conditions hi check krni hai.

$f(x) = 2x$ → phle ek separator insert krin plus wapis start kr aye 0s. har ek 1 R corresponding 2's insert kr diya '0' k बाद.

B B 1 1 1 0 1 B B B B B
B B B 1 1 1 1 1



$$f(x,y) = \begin{cases} x+y & , x > y \\ 0 & , x \leq y \end{cases}$$

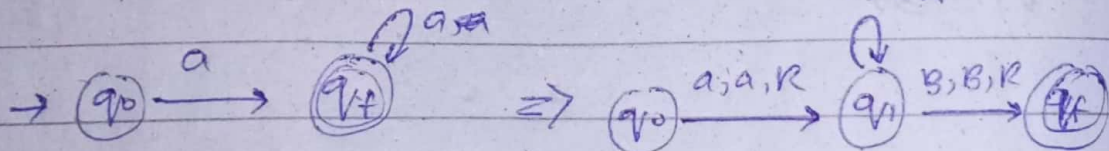


"TURING MACHINE FOR RL"

$$L = a^n, n \geq 1 \Rightarrow a^*a \text{ or } aa^*$$

First make DFA

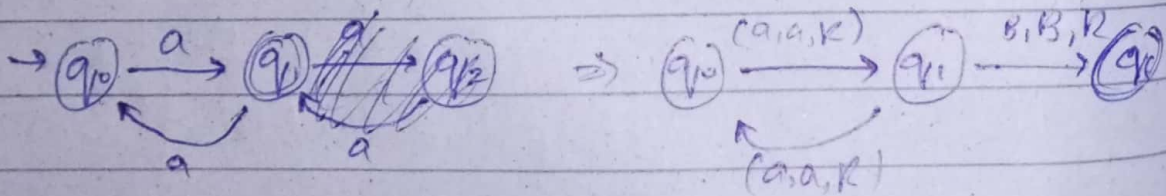
Now convert to Turing m.



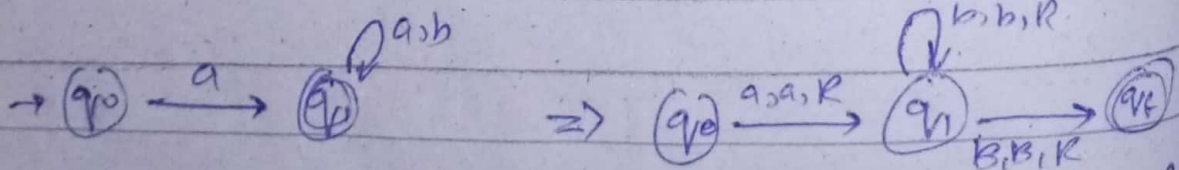
$$L = a^{2n+1} : n \geq 0 \Rightarrow (aa)^*a$$

$a^{2n}a$. odd a 's

hamesha Right ki tarf jayenge.



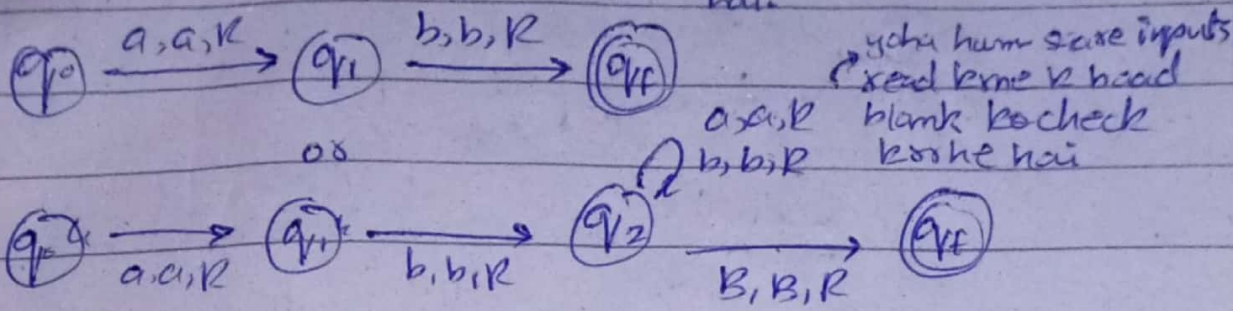
$$L = \text{Starts with } a. \Sigma\{a,b\}^*$$



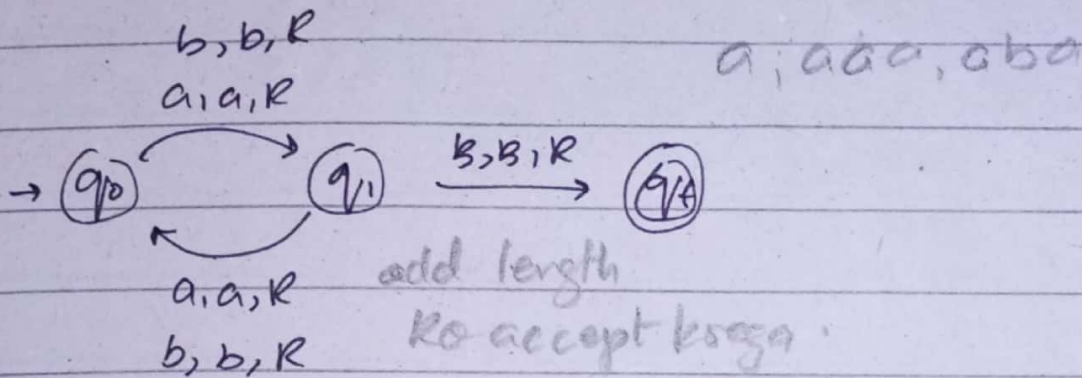
or
 $q_0 \xrightarrow{a,a,R} \text{PRF}$ \rightarrow 'a' read krke And mein pohuch gaye hain

$$L = ab(a+b)^*$$

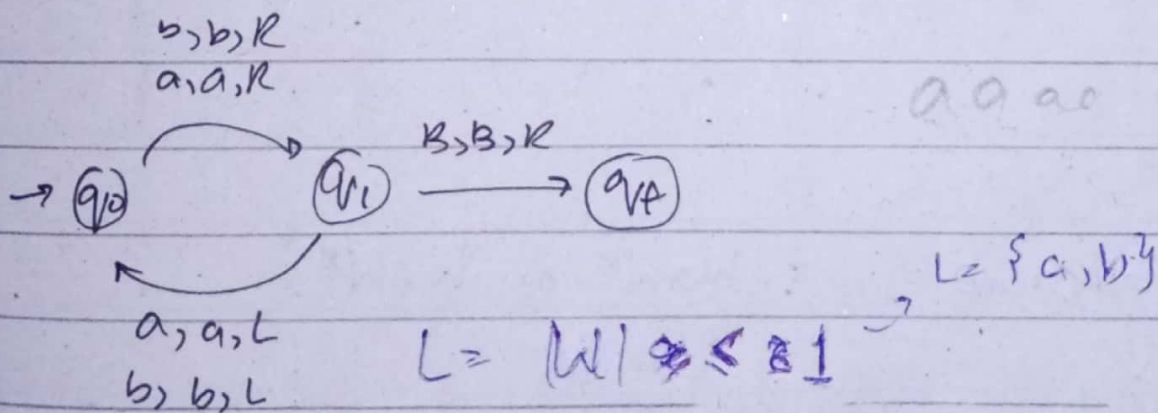
a o b read krne
→ le head sub kuch acceptable
hai.



→ The pointer of TM always moves to Right for Regular Languages in TM.

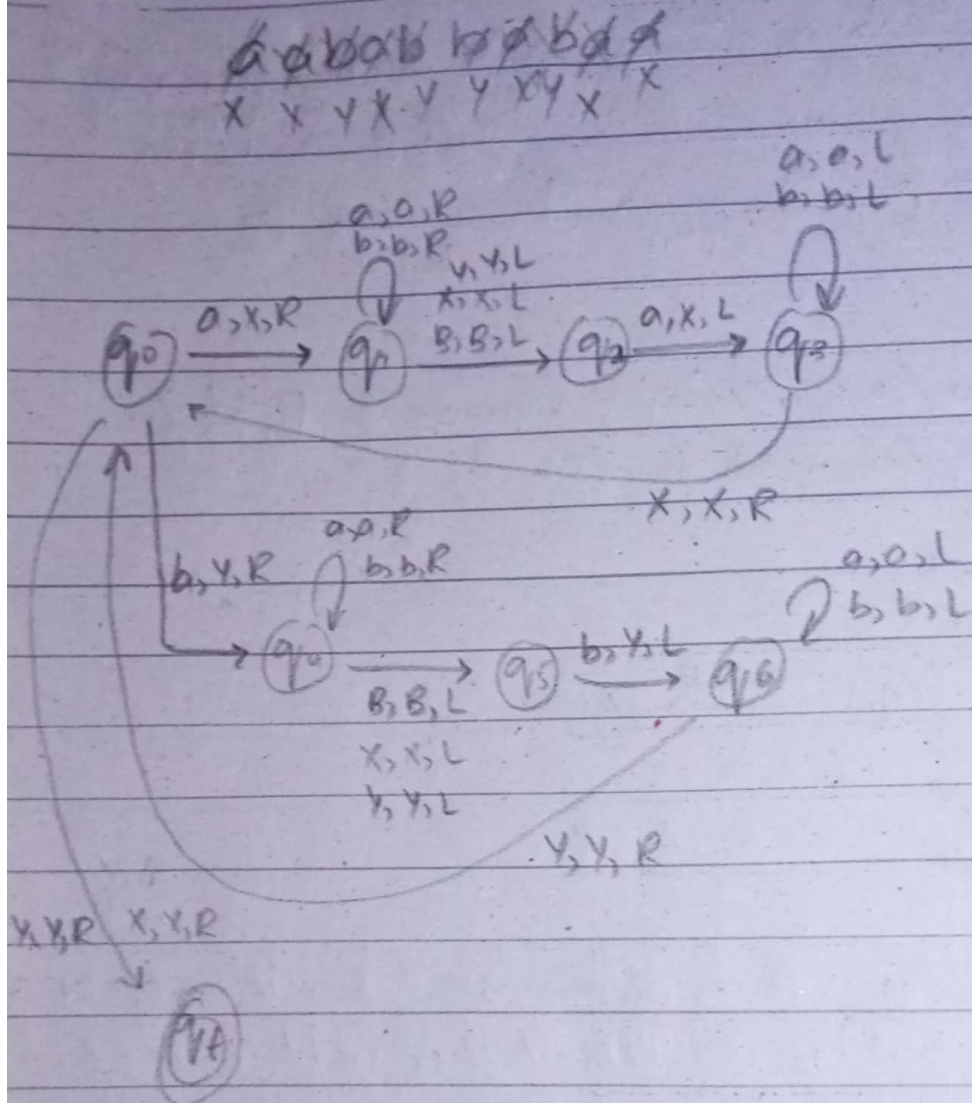


→ If the pointer of TM is always right then it's regular language but if it's either left or right then we are not sure whether it will be RL or not.



→ regular (but yaha 'L' bli laga hoo)
hai

- TM For ww^R (Even Palindrome)



→ Here 1st symbol pair last, pair 2nd or 2nd last
 ese sabko cut krte gayenge or end mein sab
 kham hogaya, agr to accepted.

- Odd Palindrome ($L = waw^R$ or wbw^R)

