Unit-VI

TURING MACHINE

* Mathematical Representation of Recursively enumerable Language is Turing Machine

→ Turing Machine is a 7-tuple variable

$$M = (Q, \Sigma, T, \beta, \delta, q_0, F)$$

where

Q = Set of all states

Σ = set of input symbols

T = Set of all tape symbols

β = Blank symbol (B)

q_0 = Initial State

F = Set of all Final states

$\delta : Q \times T \longrightarrow Q \times T \times \{L/R\}$ → Transition Function

Note:-

① FA with memory and with Read and write capability is known as Turing Machine.

② The abstract model of real computer system is Turing machine

③ The expressive power of Turing Machine and real Computer system is same

④ The TM has infinite tape which is 2-way infi and is divided into cells such that each cell contain only one input symbol.

⑤ The empty cells of infinite tape is filled with blank symbol B.

⑥ Tape header of the TM is bidirectional

⑦ It can read data from the tape and write the data over the tape

⑧ TM works as

① Language Acceptor

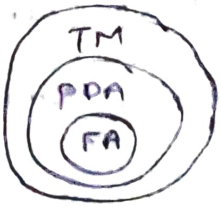
② Language Generator

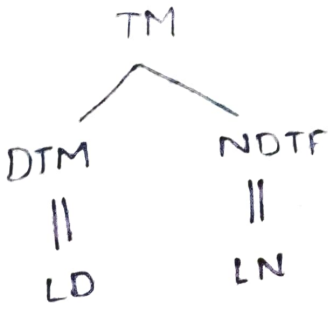
③ Transducer

⑧ The Language which is accepted by TM is known as Recursively Enumerable Language.

⑨ The language acepted by FA and PDA is also accepted by TM.

⑩ TM also accepts some of languages which are not accepted by PDA





LD=LN

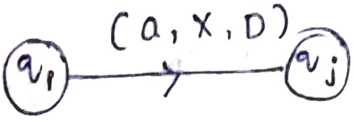
Instantaneous Description (ID) TM:

ID describe the next move of the Turing Machine

→ Next move of TM depends on 2 entities

$$Q \times T \longrightarrow Q \times T \times L/R$$

$$\delta(q_i, a) = (a_j, X, L/R)$$



Dis - Direction

Acceptance by TM

After taking the string TM has 3 possibilities

① May go to Final Halt

② May go to Non-Final Halt

③ May go to infinite loop

→ Final Halt (FH)

After processing input string if the TM reaches the Final Halt then the input string is accepted by TM

→ Non-Final Halt (NFH)

the TM reaches Non-Final Halt then input string is rejected by TM.

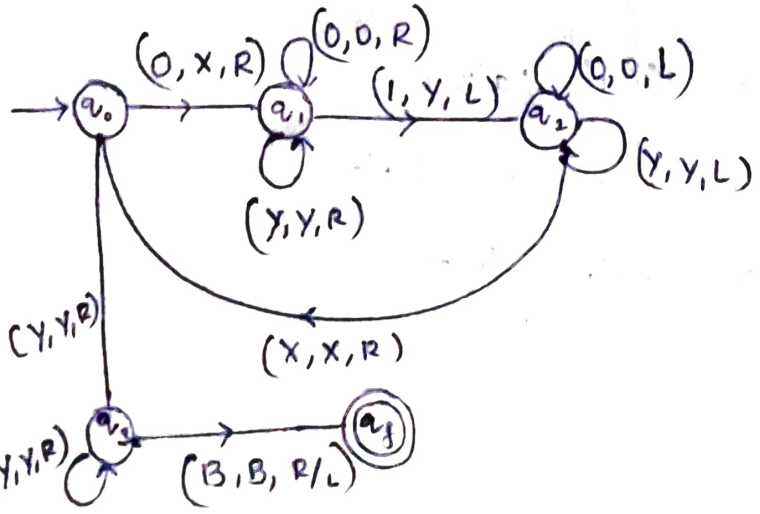
→ Loop

the TM goes to Infinite loop then the accepti is undecidable.

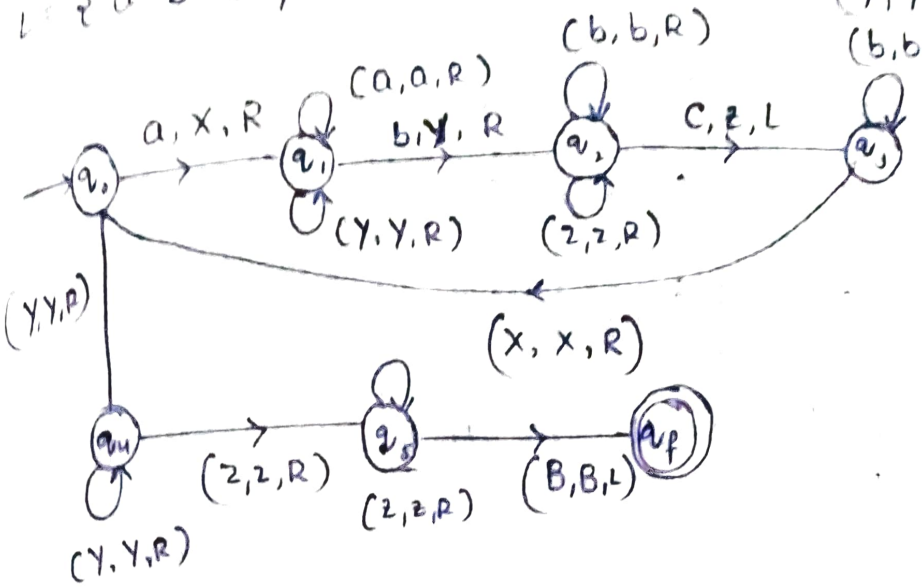
P: Construct Turing Machine for the language

$$L = \{0^n 1^n / n \geq 1\}$$

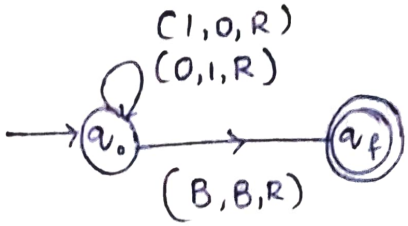
Sol: $L = \{01, 0011, 000111, 00001111, \ldots\ldots\}$



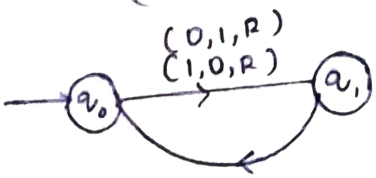
$L = \{a^n b^n c^n / n \geq 1\}$: : (Z, Z, L) (0, 0, L) (Y, Y, L) (b, b, L)



③ Turing Machine generates 1's compliment



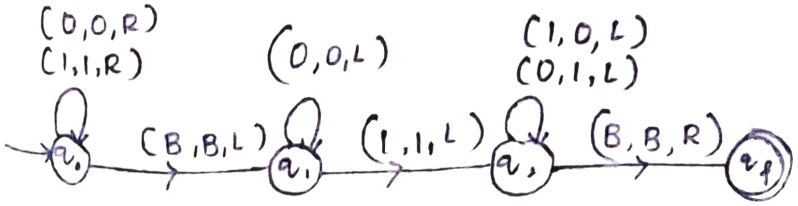
(01)



(0, 1, R)

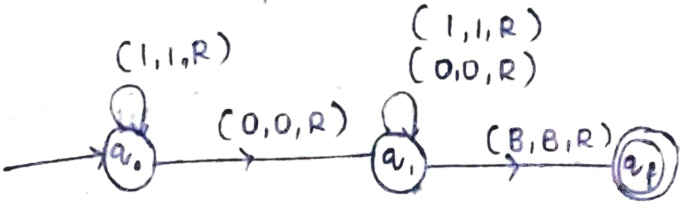
(1, 0, R)

④ Turing Machine generates 2's compliment



δ	0	1	B
q_0	$q_1, 0, R$	$q_0, 1, R$	Halt
q_1	$q_1, 0, R$	$q_1, 1, R$	q_f, B, R
f	Halt	Halt	Halt

TM



Ex: $L = \{ a^n b^n / 1 < n < 2021 \}$

a) RL

b) CFL

c) CSL

d) REL

① only a

② a, b, but not c

③ b, c, but not d

④ All a, b, c, d ✓

Recursive set / Recursively enumerable set

The Language which is accepted by TM is known as TM recognisable Language

TM recognisable Language is of 2 types

① Recursive set or Recursive Language

② Recursively Enumerable set

Recursive set (RS)

The Language L which is accepted by TM for which the membership property is decidable

(or)

The Language L is accepted by TM is said to be RS if for every $x \in L$, Turing Machine goes to Final Halt, for every $x \notin L$ TM goes to Non Final Halt.

Recursive Enumerated set (RES)

The Language which is accepted by TM for which the membership propty is undecidable is RES.

(or)

The Language L accepted by TM is said to be RES if for every $x \in L$, TM goes to Final Halt or for every $x \notin L$, TM goes to Non final Halt or Infinite loop

closure properties of RS

closed	Not closed
① union	① kleen closure
② intersection	② Homomorphism
③ concatenation	③ Substitution
④ complement	④ Quotient with RL
⑤ Inverse Homomorphism	
⑥ Reversal	
⑦ Intersection with RL	

closure properties of RES

closed	Not closed
① Union	① Compliment
② Concatenation	
③ kleen closure	
④ Intersection	
⑤ Substitution	
⑥ Homomorphism	
⑦ Inverse Homomorphism	
⑧ Intersection with RL	
⑨ Quotient with RL	