

# **SNS COLLEGE OF TECHNOLOGY**

**Coimbatore-36.**

**An Autonomous Institution**

**Accredited by NBA – AICTE and Accredited by NAAC – UGC with ‘A++’ Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai**

**COURSE CODE & NAME : *19CSB301* & **AUTOMATA THEORY  
AND COMPILER DESIGN****

**III YEAR/ V SEMESTER**

**UNIT – I FINITE AUTOMATA AND REGULAR LANGUAGES**

**Topic: Turing Machines- Languages of Turing Machine**

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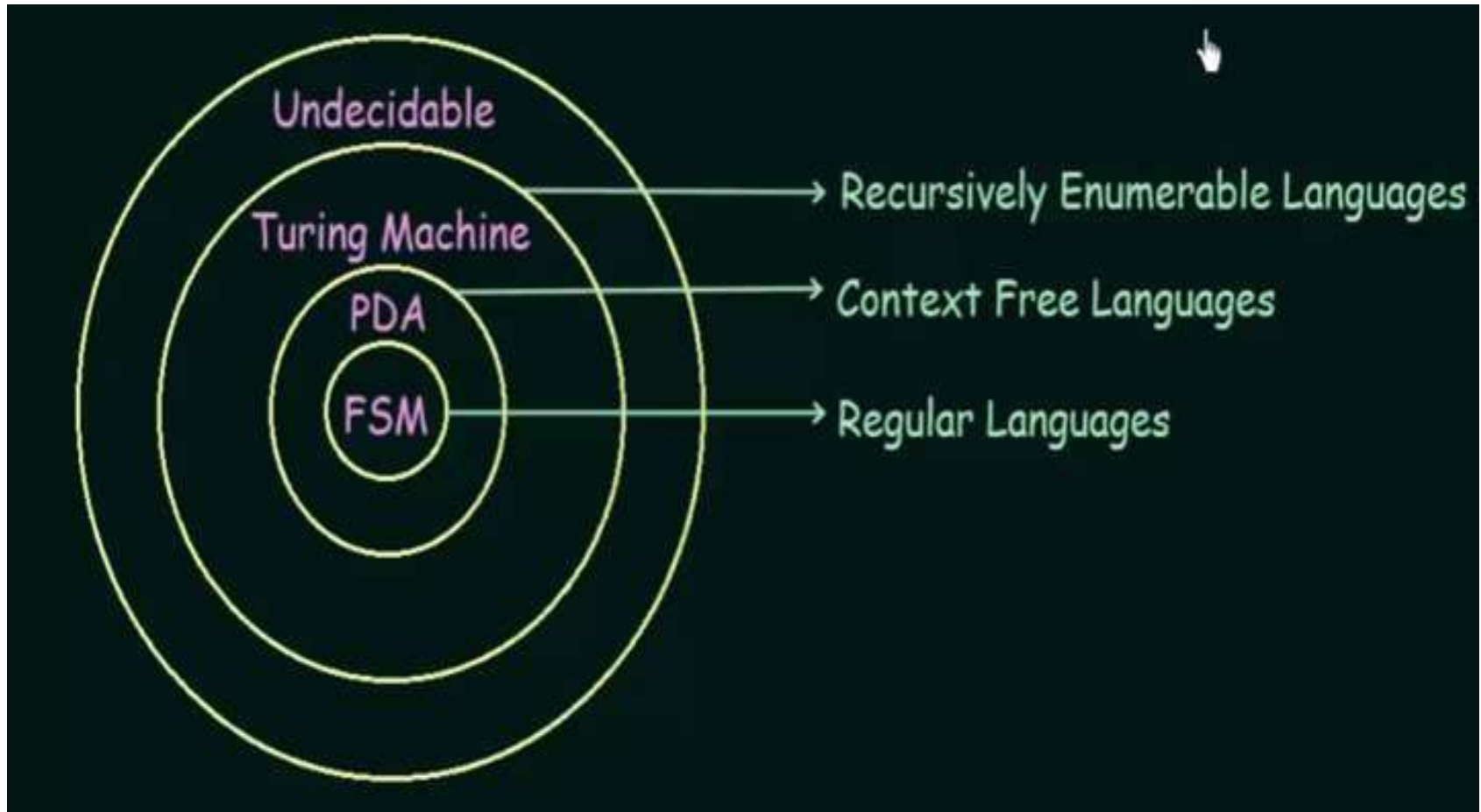
AT&CD - UNIT I - Turing Machines-

Languages of Turing Machine

B.Vinodhini, AP/CSE/SNSCT



# Turing Machine

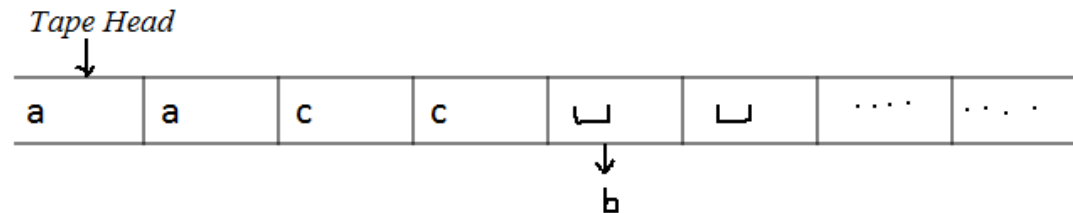




# Turing Machine

- FSA  $\rightarrow$  Regular language
- PDA  $\rightarrow$  CFG  $\rightarrow$  Context Free language  $\rightarrow$  Stack
- Turing Machine  $\rightarrow$  recursively enumerable language
  - Alan Turing (1936)
  - Unrestricted Grammar

– **Tape**



- TM  $\rightarrow$  what can be computed
- **Model for Computer**
- Algorithm  $\rightarrow$  TM can do its computation
- (Simulation)

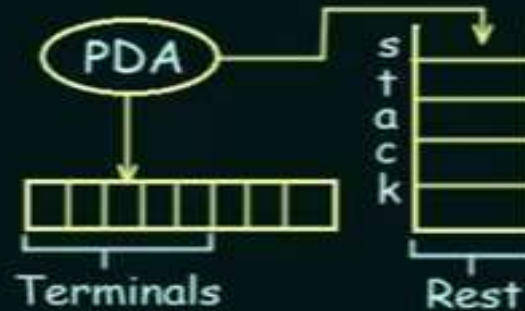


# Turing Machine

FSM: The Input String 

a	a	a	a	b	a	b	b
---	---	---	---	---	---	---	---

PDA: -> The Input String  
-> A Stack



## TURING MACHINE:

-> A Tape



Tape Alphabets:  $\Sigma = \{0, 1, a, b, x, Z_0\}$

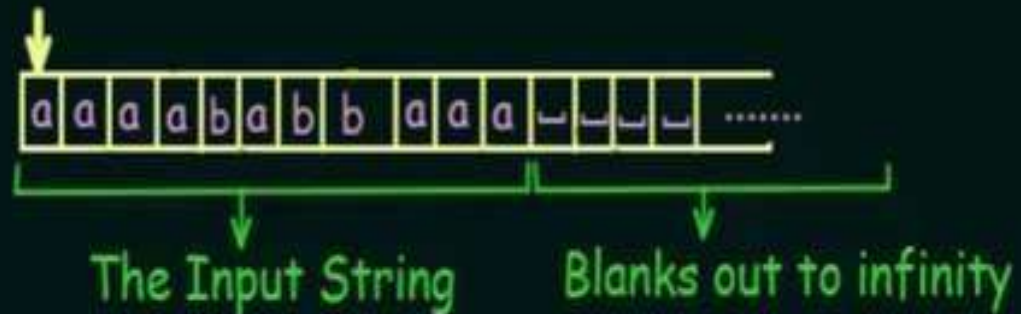
The Blank  $\_$  is a special symbol.  $\_ \notin \Sigma$

The blank is a special symbol used to fill the infinite tape



# Turing Machine

Initial Configuration:

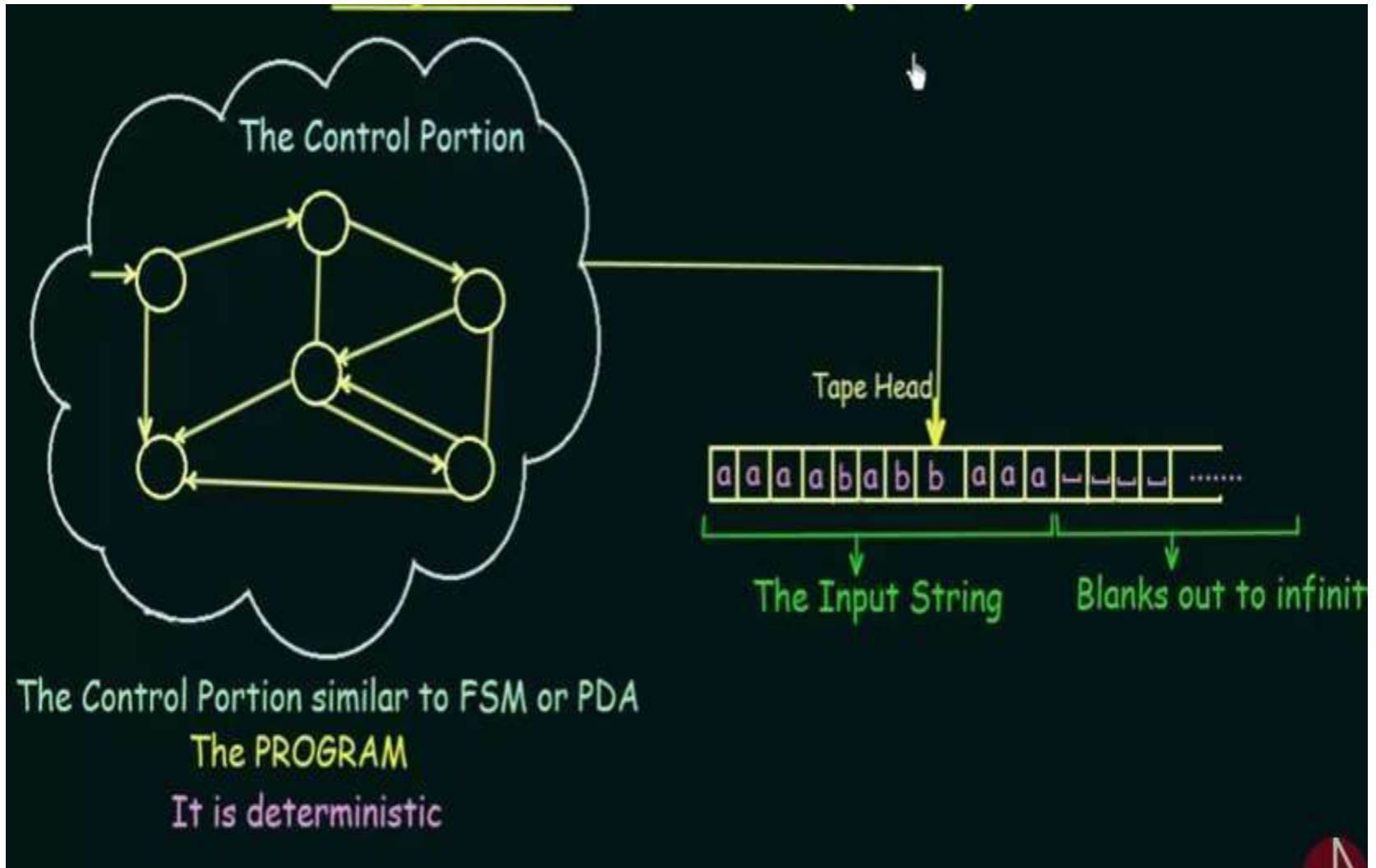


Operations on the Tape:

- > Read / Scan symbol below the Tape Head
- > Update / Write a symbol below the Tape Head
- > Move the Tape Head one step LEFT
- > Move the Tape Head one step RIGHT



# Turing Machine





# Turing Machine

A Turing Machine can be defined as a set of 7 tuples

$$(Q, \Sigma, \Gamma, \delta, q_0, b, F)$$

$Q \rightarrow$  Non empty set of States

$\Sigma \rightarrow$  Non empty set of Symbols

$\Gamma \rightarrow$  Non empty set of Tape Symbols

$\delta \rightarrow$  Transition function defined as

$$Q \times \Sigma \rightarrow \Gamma \times (R/L) \times Q$$

$q_0 \rightarrow$  Initial State

$b \rightarrow$  Blank Symbol

$F \rightarrow$  Set of Final states (Accept state & Reject State)

Thus, the Production rule of Turing Machine will be written as

$$\delta(q_0, a) \rightarrow (q_1, \gamma, R)$$



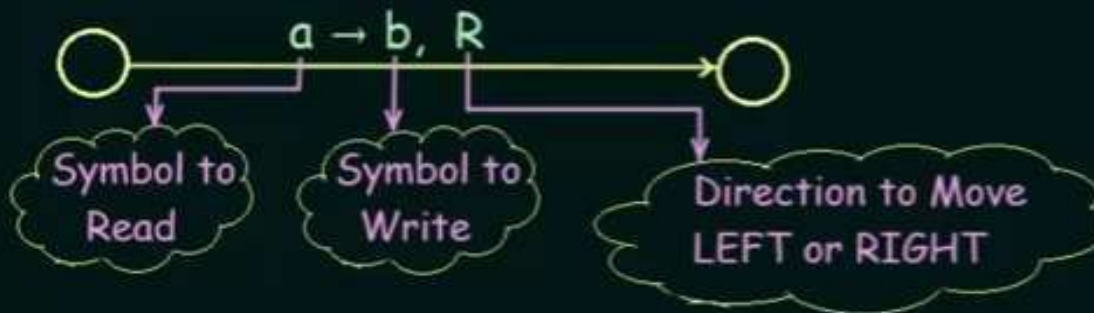
# Turing Machine

## Rules of Operation - 1

At each step of the computation:

- > Read the current symbol
- > Update (i.e. write) the same cell
- > Move exactly one cell either LEFT or RIGHT

If we are at the left end of the tape, and trying to move LEFT, then do not move.  
Stay at the left end



If you don't want to update the cell,  
JUST WRITE THE SAME SYMBOL







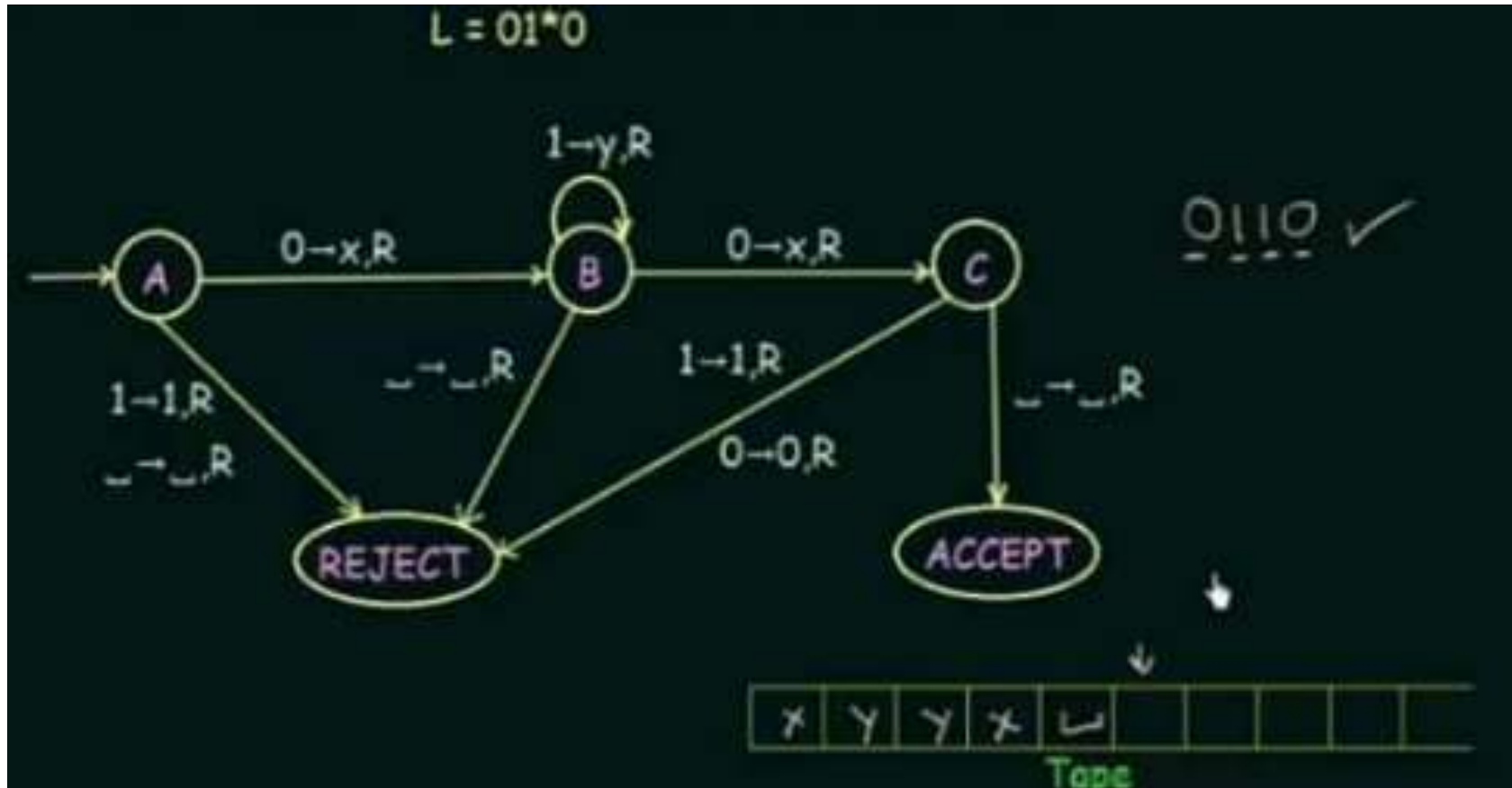
# Turing Machine

## Rules of Operation - 2

- > Control is with a sort of FSM
- > Initial State
- > Final States: (there are two final states)
  - 1) The **ACCEPT STATE**
  - 2) The **REJECT STATE**
- > Computation can either
  - 1) HALT and **ACCEPT**
  - 2) HALT and **REJECT**
  - 3) **LOOP** ( the machine fails to HALT )

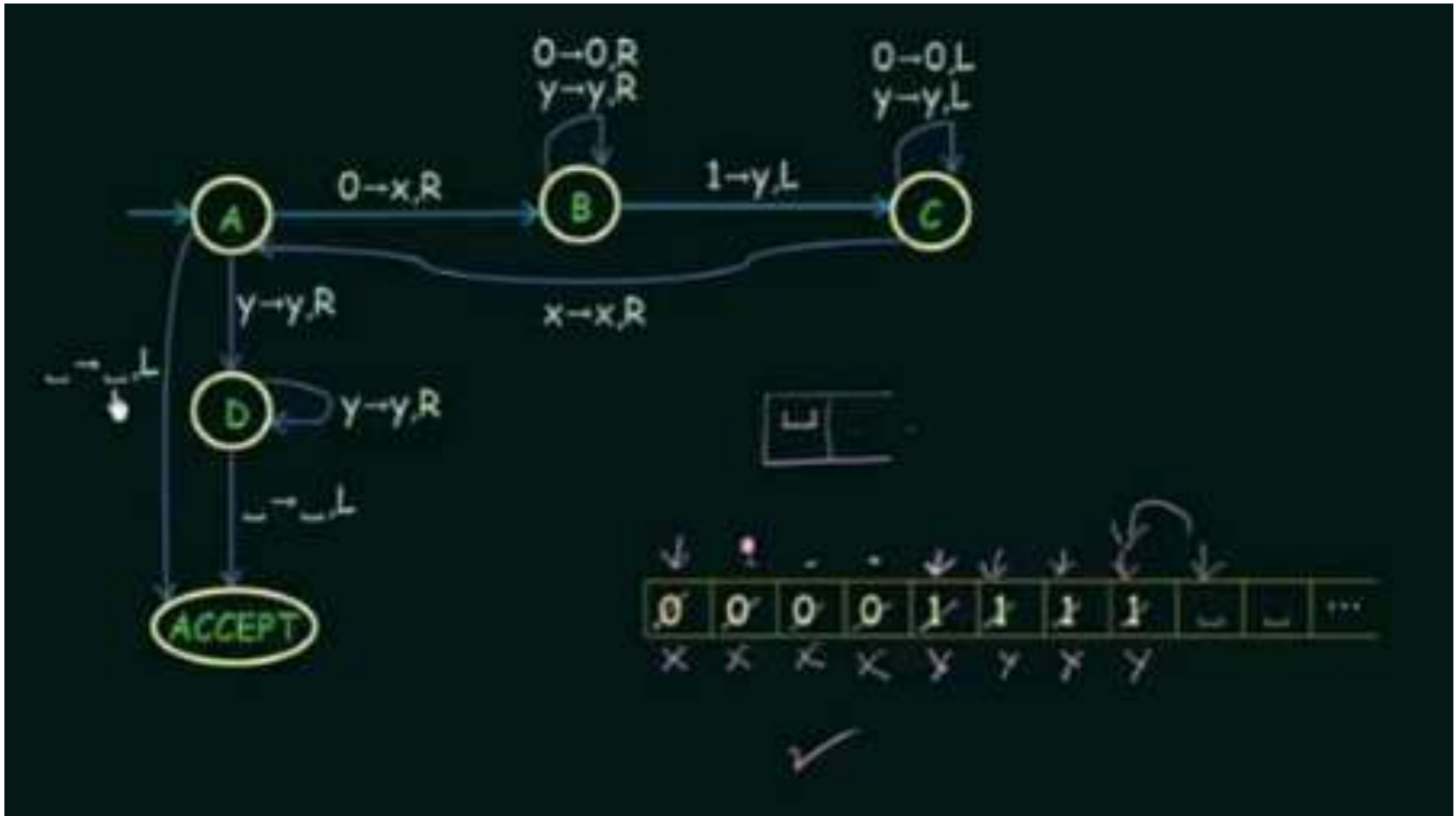


# Turing Machine – Example 1





# Turing Machine – Example2 ( $L=0^n1^n$ )





# Applications



- Applications
  - Computer Networks
  - Artificial Intelligence
  - Machine Learning
- Turing Machine was invented by
  - Alan Turing                  Turing taring                  Nickel Turing
- In one move the turing machine
  - May change the state
  - Move one tape position by Left or Right
  - Write the Symbol on the cell
  - All these
- Turing machine is more powerful than
  - PDA                  -FSA                  -Both these

# *References*

- John E. Hopcroft and Rajeev Motwani and Jeffrey D. Ullman, “Introduction to Automata Theory, Languages and Computation”, Second Edition, Pearson Education, New Delhi, (2007) (UNIT-I )
- Linz P. An introduction to formal languages and automata. Sixth edition, Jones and Bartlett Publishers; 2016.(UNIT-I)
- [Ramaiah k. Dasaradh](#) “Introduction to Automata and Compiler Design “ First Edition ,Prentice Hall India Learning Private Limited(2011)( UNIT-I to V)