CS & IT ENGINEERING

Theory of Computation

(7 - 10) marks.

{TOC + CD} → 15 marks

DFA (Part 1)

Lecture No.- 01

By- Venkat Sir

Topics to be Covered

Topic DFA

Topic ??

Topic ??

Books

① Ullman. ✓

② Peter Linz ✓

③ M. Sipser

THEORY OF COMPUTATION

1. Topic — Finite Automata & Regular Languages. (5-6) 50%
2. Topic — Pushdown Automata & Context free Languages. 30%
3. Topic — Turing Machine & Recursive Enumerable Languages.
   Topic — Undecidability.

20%

Topic : Introduction:

It is the mathematical study of computing machines and their capability

or

It is the study of automata theory (machine.) and formal languages. (C, C++, Java)

① Finite Automata ⟶ Regular Languages

② Pushdown Automata ⟶ Contextfree languages

③ Linearbounded Automata ⟶ Contextsensitive languages

④ Turing Machine ⟶ Recursive Enumerable language

Topic : Introduction:

Decidable Problem : Computers can solve (Algorithm exist)

Undecidable Problem : No algorithm exist

Topic : Terminologies:

Alphabet(Σ): Finite non-empty set of symbols

Ex:- {a, b} –

{a, 1, 2} –

{} –

① ✓ $\Sigma = \{0, 1, 2\}$

② $\Sigma = \{a, b, c, d\}$

✗ ③ $\Sigma = \{1, 2, 3 \cdots \infty\}$

④ $\Sigma = \{0, 1, a, b\}$

⑤ $\Sigma = \{अ, आ\}$

Topic : String:

$\Sigma = \{a, b\}$

String Finite sequence of symbols over the given alphabet Σ.

Ex:-

length

abaa ⟶ 4

aaa ⟶ 3

bbbb ⟶ 4

ababab ⟶ 6

a ⟶ 1

$a^0 = b^0 = \text{Epsilon} = \epsilon$ ⟶ Zero length

Language :- Any set of strings over the given alphabet $\Sigma = \{a, b\}$.

$L_1 = \{ab, ba, abab\}$ → finite language

$L_2 = \{a, ab, aba, \ldots\}$ - Infinite Language.

$L_3 = \{\}$ → Empty Language

$L_4 = \{\epsilon\}$ → 1 ⇒ finite Language

$L_5 = \{a\}$ - finite language

$L_6 = \{\epsilon, a, b, aa, ab, ba, bb \ldots\}$ - Infinite language

⇓

Complete language

$L_7 = \{\epsilon, a, aa, ba, aaa, \ldots\}$ (b)

$\{\}$ ⇒ empty

$\{\epsilon\}$ ⇒ finite

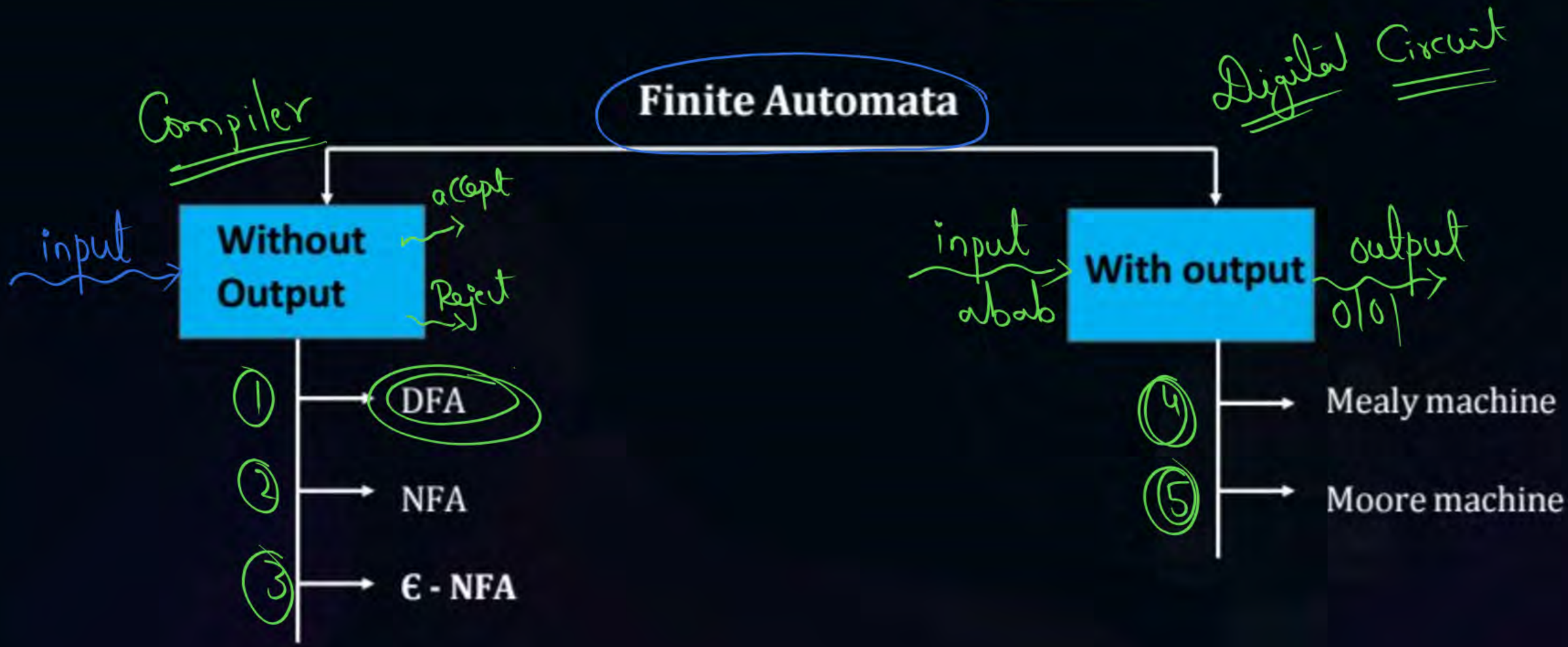
$L_8 = \{a^n b^m \mid n, m \geq 1\}$ ⇒ Infinite

$L_9 = \{a^n \mid 1 \leq n \leq 10\}$ finite

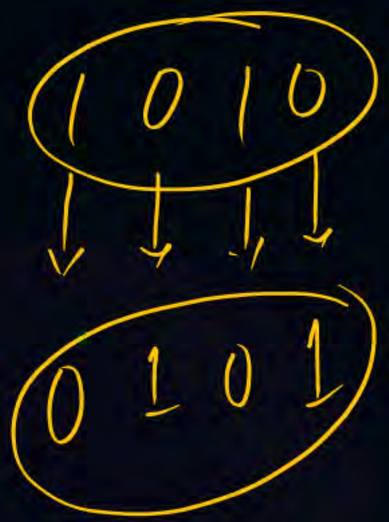
FINITE AUTOMATA

Topic : Finite Automata

It is a mathematical model which contains finite number of states and transitions.



1's Complement Circuit



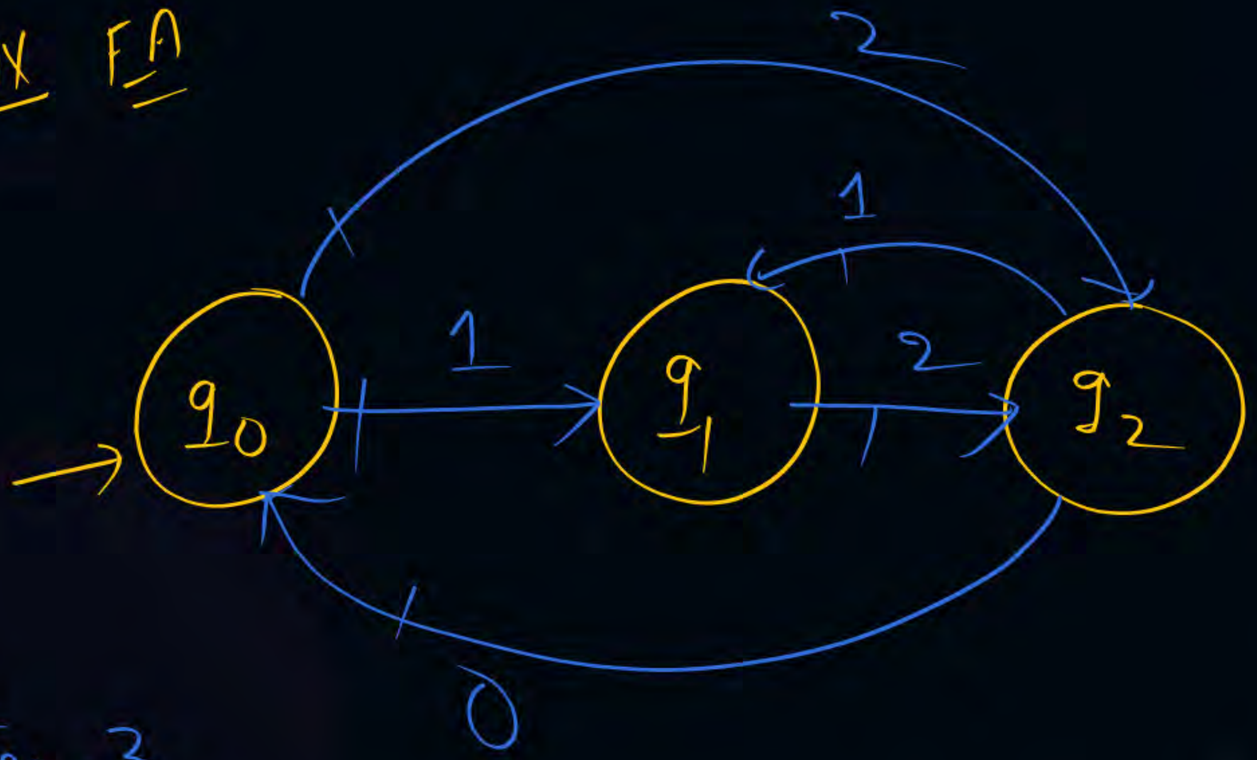
machine

F.A

States

transitions

FAIK FA

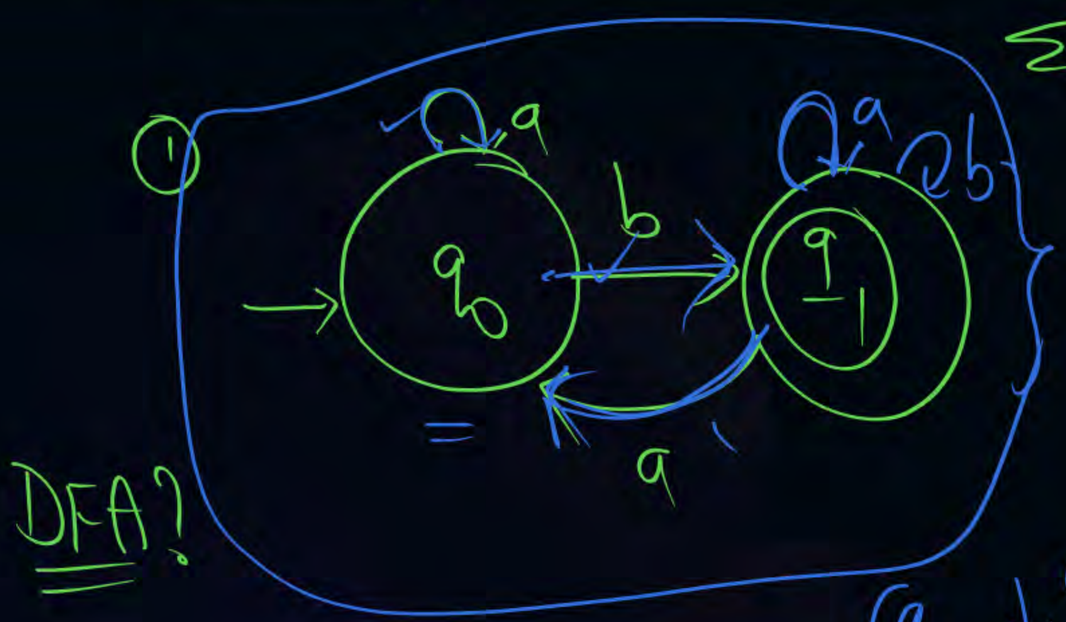


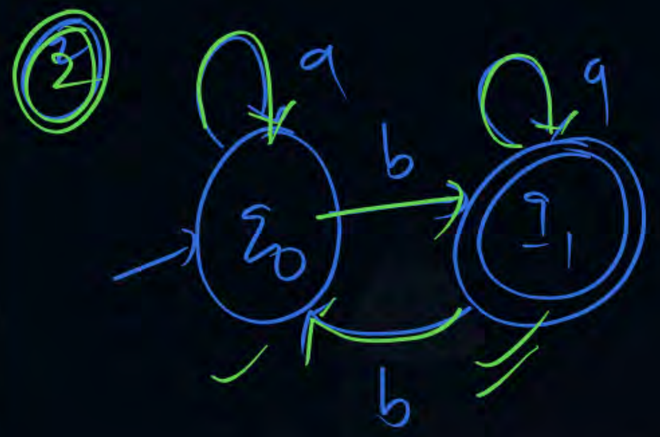
States = 3

transitions : 6

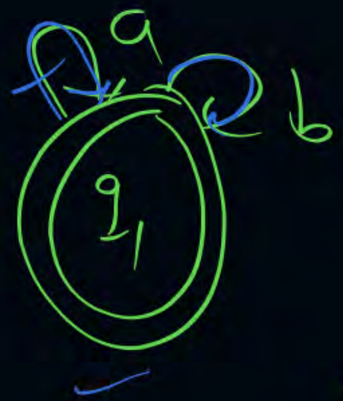
Deterministic Finite Automata

DEF : It is a finite automata in which from every state on every input symbol exactly one transition should exits.





3



DFA

Eg

NO

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

2 $\{a, b\}$

Deterministic Finite Automata

FORMAL DEF :

DFA is defined as

DFA = (Q, Σ, q_0, F, δ)

Q : Finite set of states

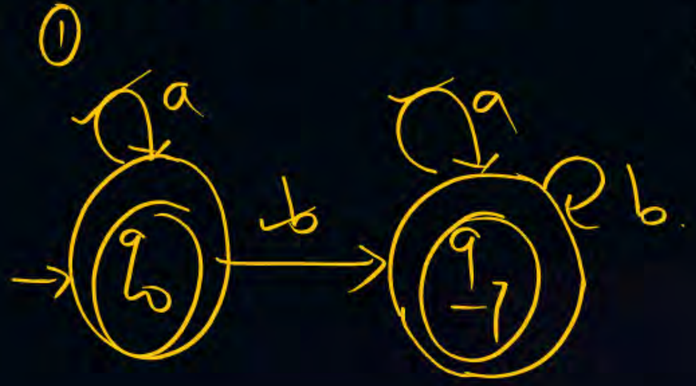
Σ : input alphabet

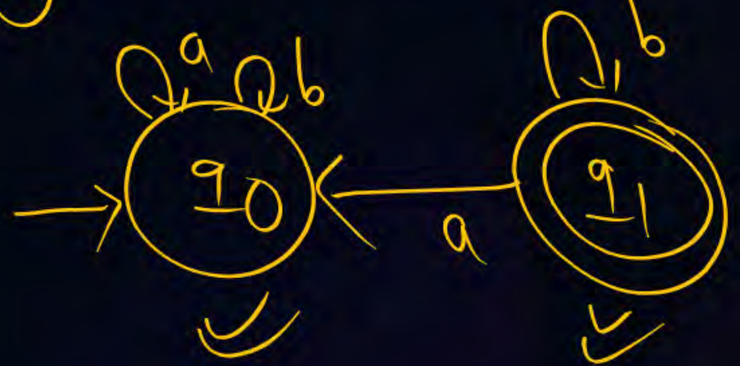
q_0 : initial state → only one.

F : set of final states → any no. of final states

δ : Transition function $Q * \Sigma \rightarrow Q$

$Q \times \Sigma \rightarrow Q$

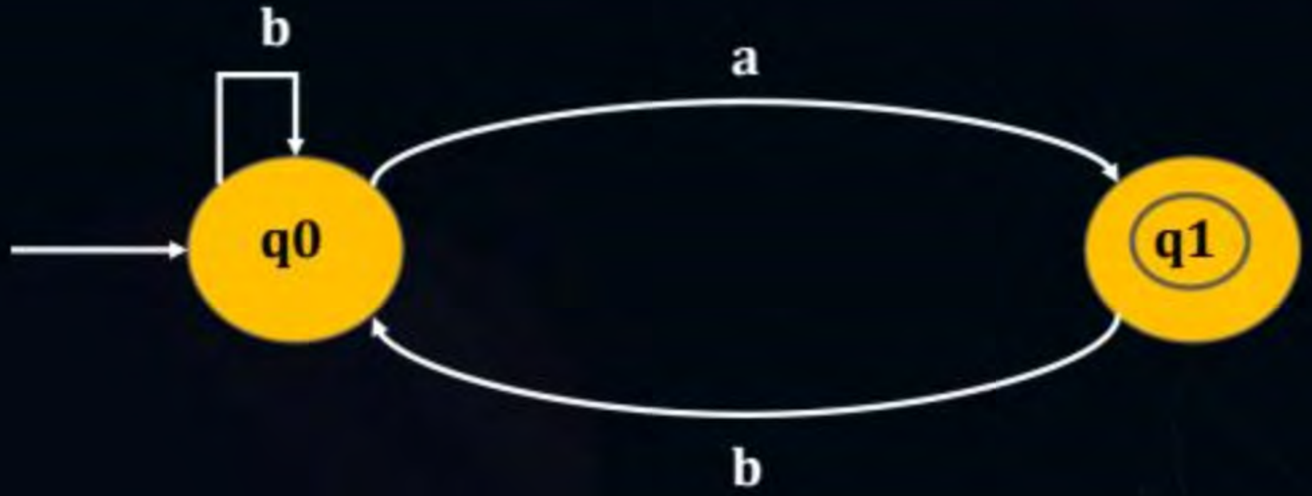
① 

② 

Q
Σ
q_0
F
δ

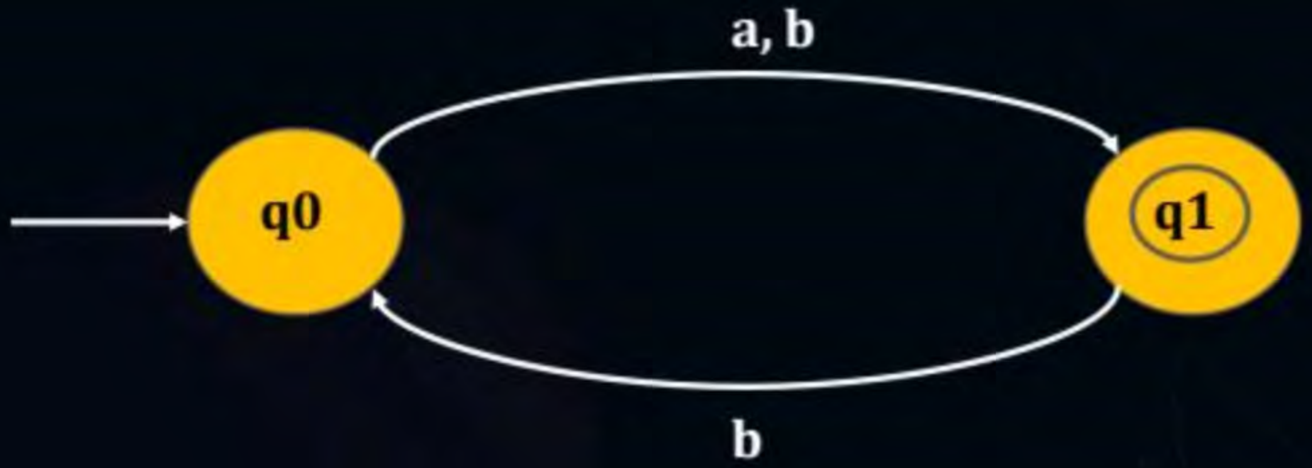
Example of DFA :

(1)



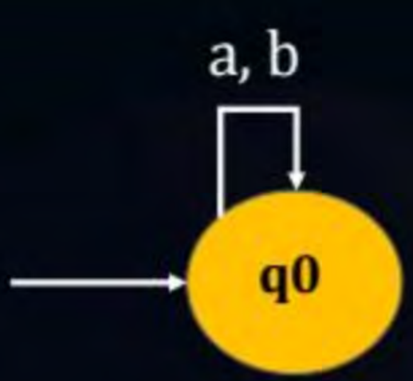
Example of DFA :

(2)



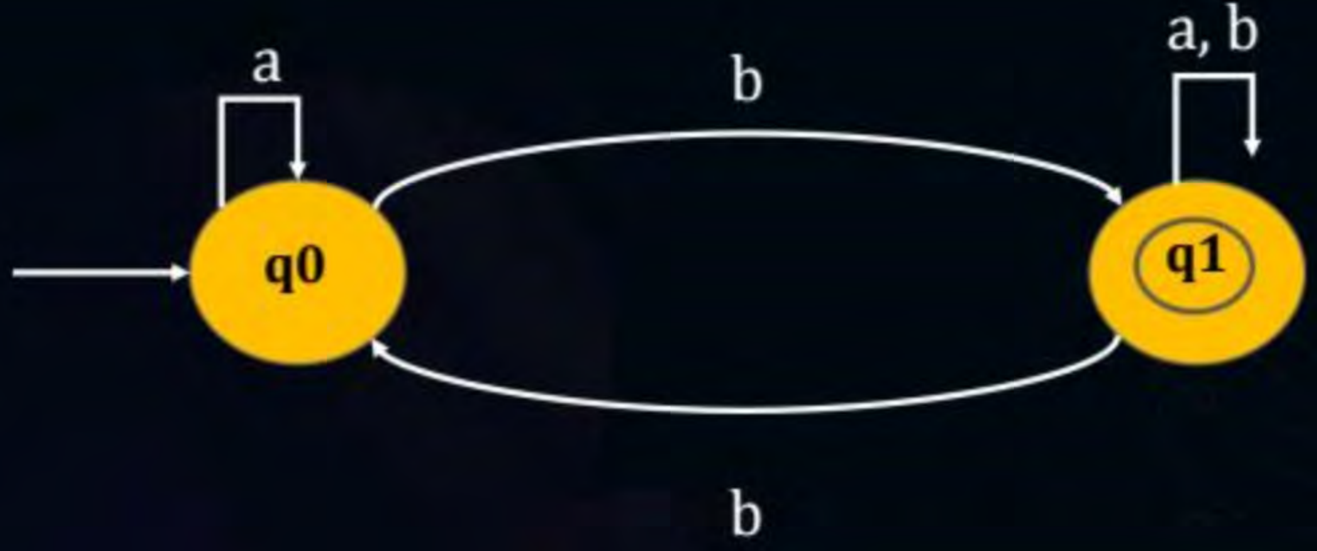
Example of DFA :

(7)

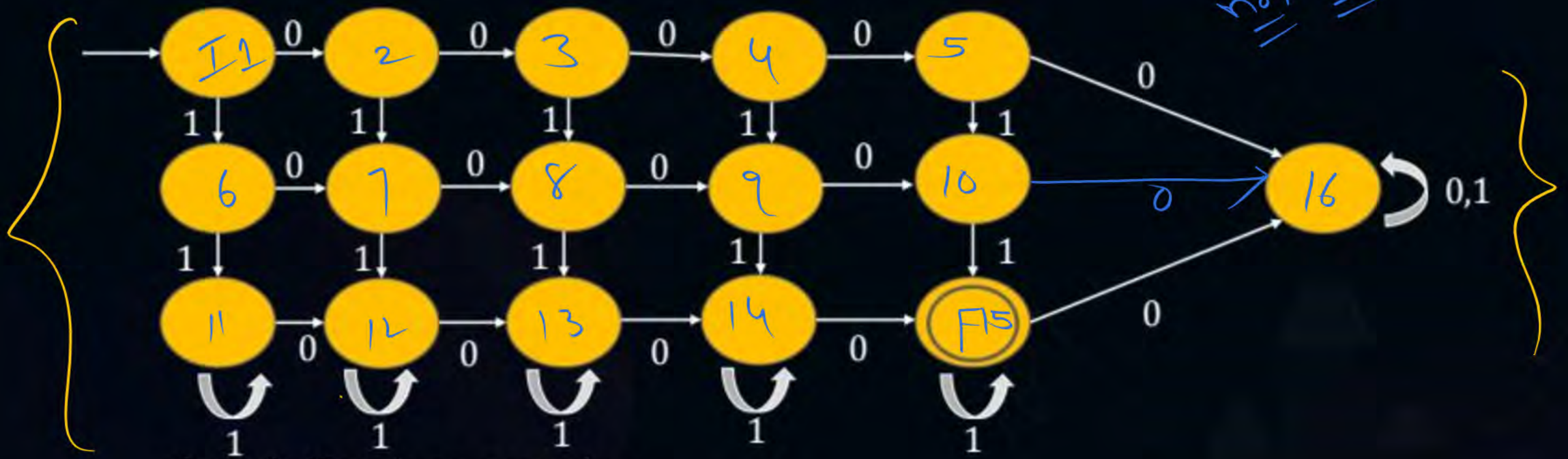


Example of DFA :

(8)



#Q. Identify language accepted by following DFA



Set of all strings contains

A Length of the string alteast 6

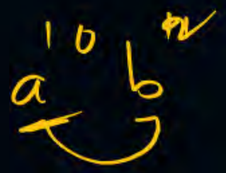
B # 0's exactly4 and 1's atleast 3

C # 0's atleast 4 and # 1's exactly 2

D None

Topic : DFA Construction

Construct DFA for the following Language.



1. $L = \{a^n b^m \mid n, m \geq 1\}$ → DFA possible
2. $L = \{a^n b^n \mid n \geq 1\}$ → DFA not possible
3. $L = \{a^n b^m \mid n < m\}$ → Dependy → DFA not possible
4. $L = \{a^n b^m \mid n \neq m\}$ → Dependy → DFA not possible
5. $L = \{a^n b^m c^{n+m} \mid n, m \geq 1\}$ → $a^2 b^3 c^5$ } ⇒ DFA not possible
6. $L = \{a^n b^{2m} \mid n, m \geq 1\}$

$L = \{a^n b^{2m} \mid n, m \geq 1\}$ – No Dependy → DFA possible.

$a^2 b^4$

Topic : DFA Construction

(Dependency)

If comparision exist between symbols of language then DFA is not possible.

Topic : DFA Construction

Construct DFA for the following Language.

$$L = \{a^n b^n \mid n \geq 1\} = \{ab, a^2b^2, a^3b^3 - - -\}$$

How many states?

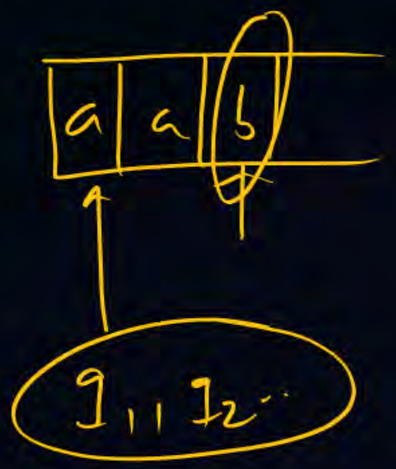
DFA not possible

X

Dependency

$L_1 = \{a^n b^n / n \geq 1\} = \{ab, a^2b^2, a^3b^3 \cdots\}$

$\{a^{10} b^{10}$ Dependency $\}$ DFA ✗



$L_2 = \{a^n b^m / n, m \geq 1\} = \{ab, a^2b, ab^2, a^3b, ab^3 \cdots\}$

any any

$q^{10} b^{\text{any}}$ 10000

$\}$ No Dependency

DFA ✓

THANK - YOU