CS & IT ENGINEERING

THEORY OF COMPUTATION

Regular Expressions

Lecture No.- 02

By- Venkat sir

Recap of Previous Lecture

Topic ?????

NFA to DFA Conversion

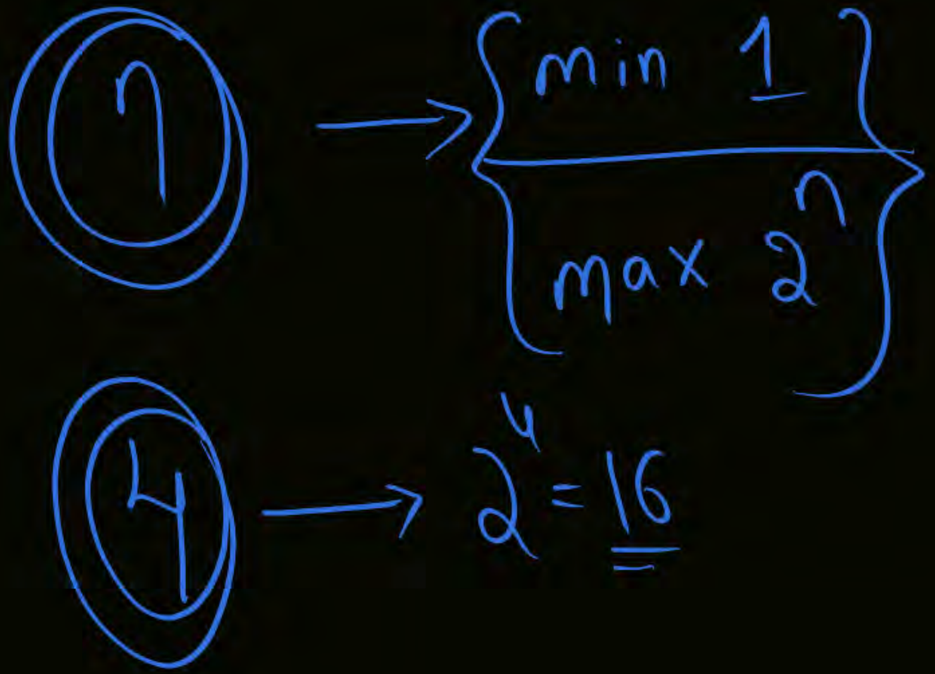
Subset Construction NFA = DFA

Expressive power of Automata

NO. of Languages accepted by Automata

Every NFA is Converted into DFA

NFA → DFA



Topics to be Covered

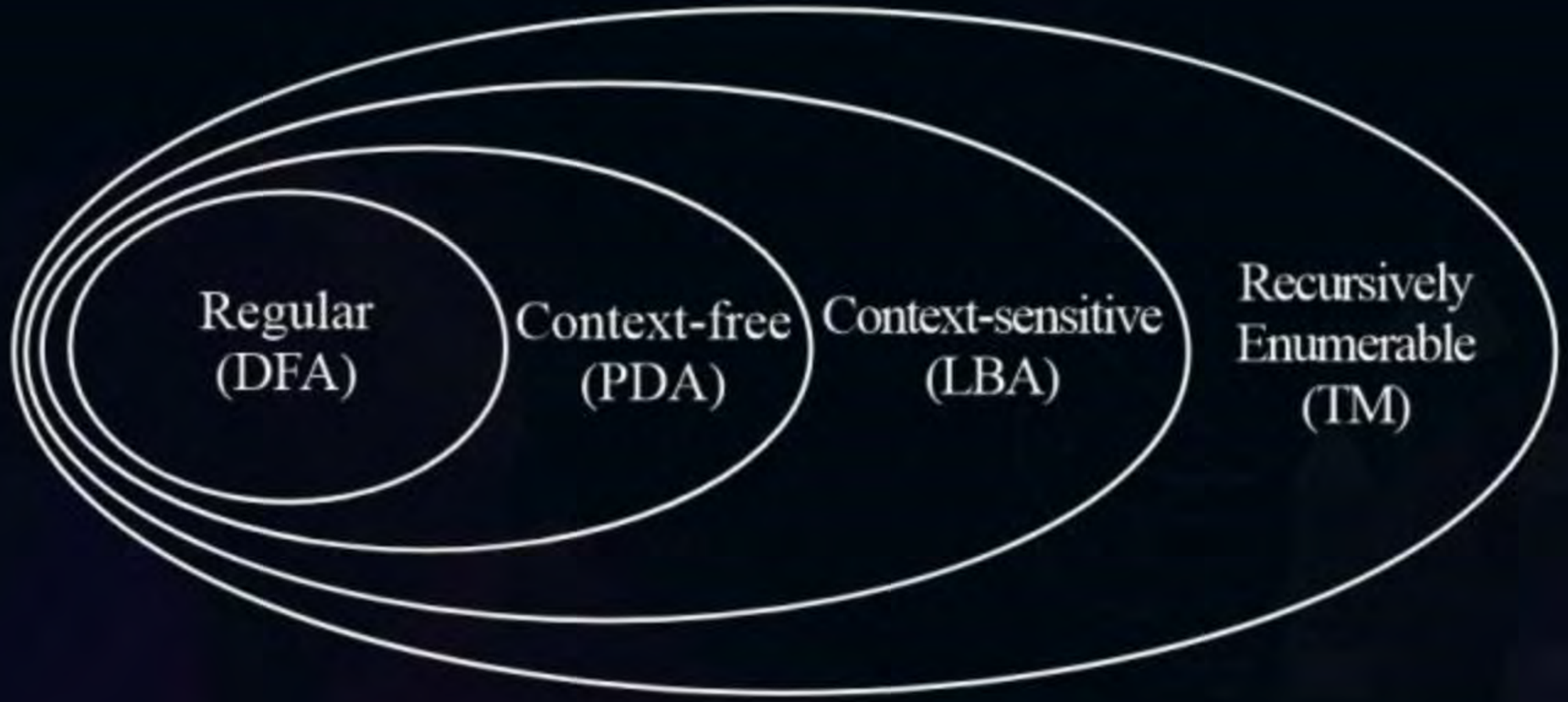
Topic Conversion from $\in$-NFA to NFA

Topic ??

Topic ??

Topic ??

Topic : Theory of Computation



Topic : ϵ -NFA

DFA
NFA
ϵ-NFA

NOTE: Construction of ϵ - NFA is easy than NFA

$$\{Q, \Sigma, q_0, F, \delta\}$$

Q	-	Finite number of states (set of state)
Σ	-	Input alphabet
q_0	-	initial state
F	-	Set of final states → any no. of final states
δ	-	transition function

$$\delta: Q \times \Sigma \cup \{\epsilon\} \rightarrow 2^Q$$

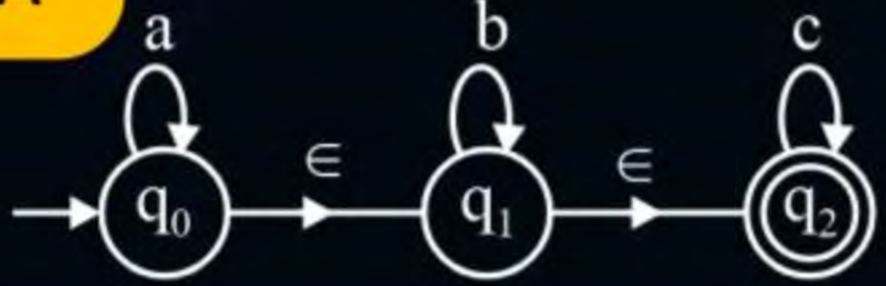
Topic : ϵ -NFA

$L = \{a^n b^m c^k / n, m, k \geq 0\}$ construct $\in$-NFA for L

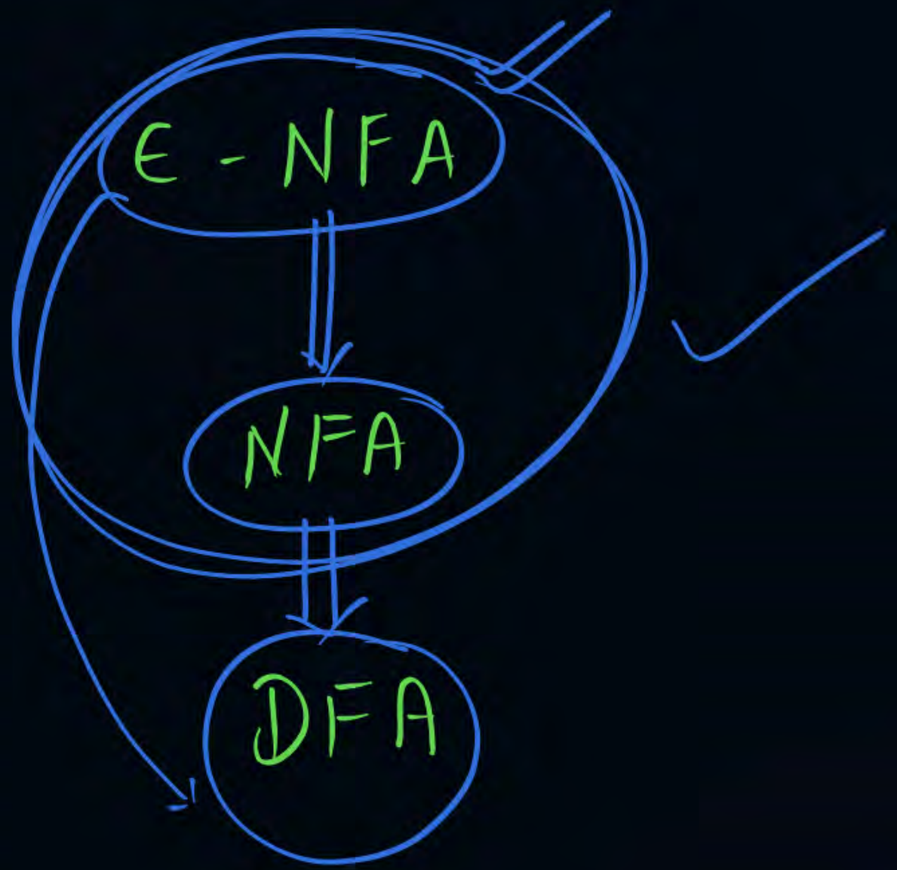
$\in$NFA

Topic : ϵ -NFA

ϵ-NFA



Topic : ε-NFA to NFA



Topic : ϵ -NFA

While converting ∈-NFA into NFA (without ∈) the following are the possibilities

1. → No. of states are same

2. → Initial state is same

3. → Final state may changes → final states may increase

→ Transitions may changes

Topic : Conversion from ∈-NFA to NFA

1. Number of states in ∈-NFA is same of NFA

2. Initial state of ∈- NFA is same as NFA

3. In NFA make states as final where ∈-closure of that state contains a final state of ∈-NFA.

Topic : Conversion from ∈-NFA to NFA

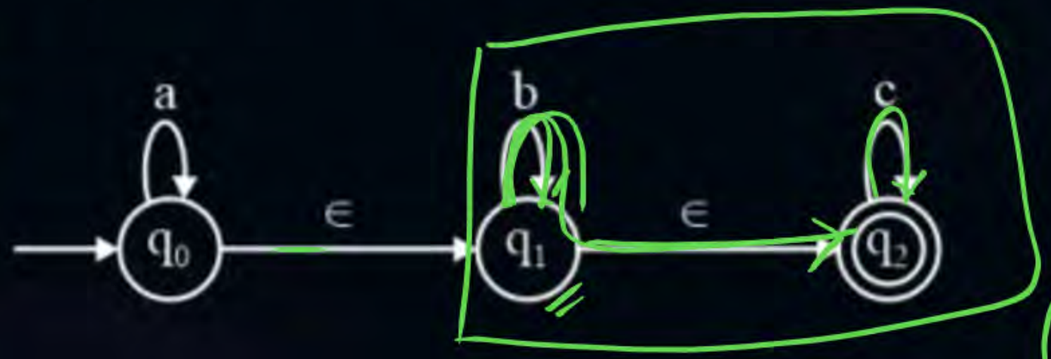
∈-closure (q) = set of all states which are reachable from state q by reading only ∈.

$a \cdot \epsilon \cdot \epsilon = a$

$a \cdot \epsilon = a$

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

#Q. Construct an equivalent NFA for the following ε-NFA



ϵ-NFA

$(q_1, a) = X$

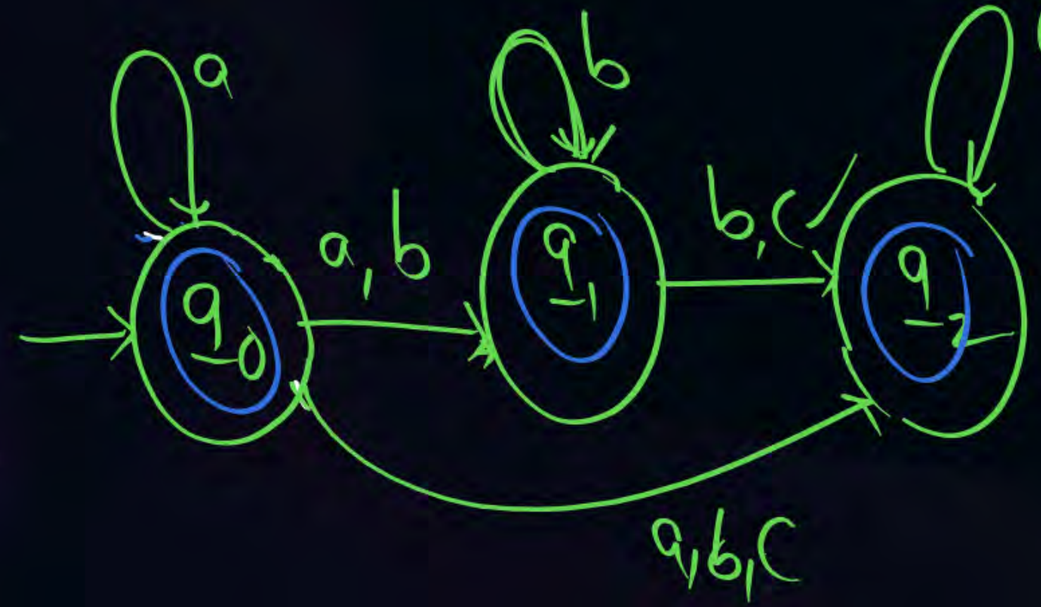
$(q_1, b) \rightarrow q_1 \checkmark$

$b \cdot \epsilon \rightarrow q_2 \checkmark$

$\delta(q_1, c) \rightarrow q_1 X$

$q_2 \checkmark$

NFA



q_0, b, c

NFA → DFA

$(q_0, a) \xrightarrow{a \cdot \epsilon} q_1 \checkmark$

$a \cdot \epsilon \cdot \epsilon \rightarrow q_2 \checkmark$

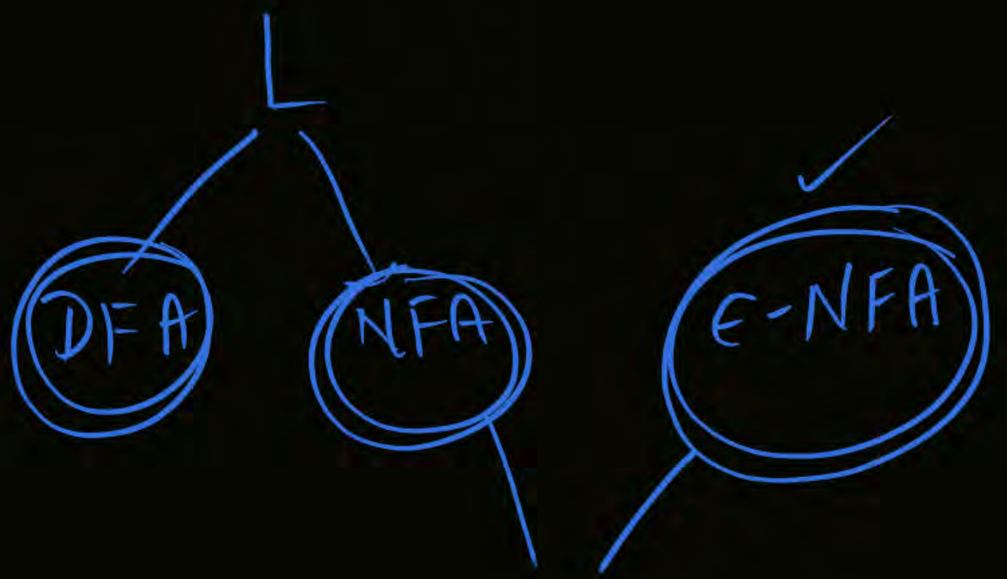
$(q_0, b) \rightarrow q_0 X$

$\epsilon \cdot b \rightarrow q_1 \checkmark$

$q_2 \checkmark$

$(q_0, c) \rightarrow q_0 X$

$q_1 X$


L
DFA
NFA
ϵ-NFA

$$\epsilon \cdot \epsilon \cdot \epsilon = \epsilon$$

$$a \cdot \epsilon = a$$

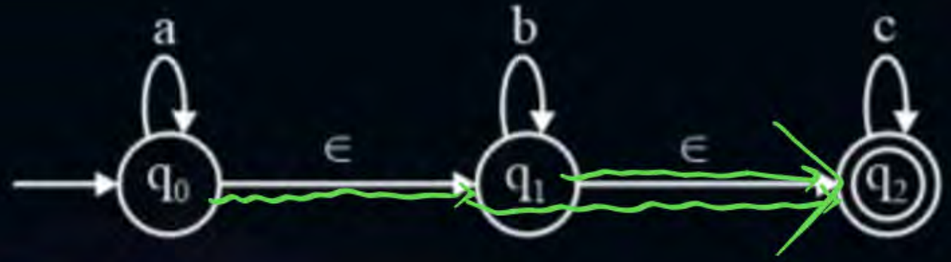
$$\epsilon \cdot a = a$$

$$\epsilon \cdot \epsilon \cdot a \cdot \epsilon \cdot \epsilon = a$$

$\epsilon = 1$

$\epsilon \cdot \epsilon \cdot \epsilon \cdot \epsilon = \epsilon$

#Q. Construct an equivalent NFA for the following ε-NFA



$\epsilon\text{-closure}(q_0) = \{q_0, q_1, q_2\}$ → q_0

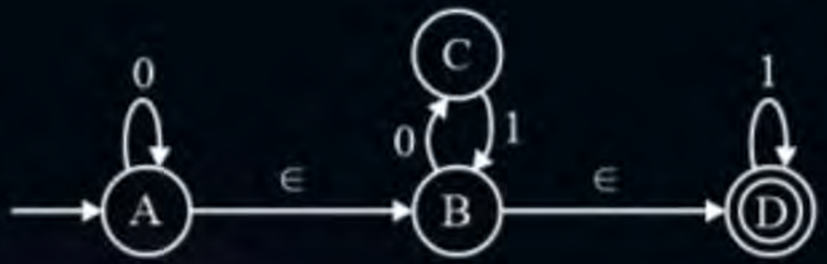
$\epsilon\text{-closure}(q_1) = \{q_1, q_2\}$ → q_1

$\epsilon\text{-closure}(q_2) = \{q_2\}$ → q_2

$0 \cdot \epsilon = 0$ $0 \cdot \epsilon \cdot \epsilon =$ $\Sigma = \{0, 1\}$

#Q. Construct an equivalent NFA for the following ε-NFA

ε-NFA

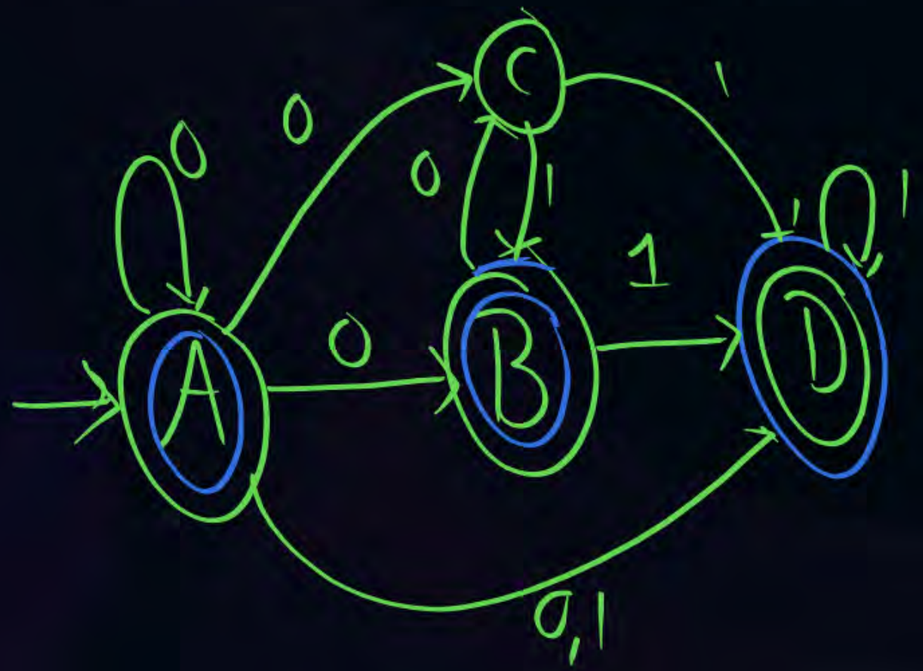


$\epsilon \cdot 0 = 0$ $(A, 0)$ A ✓ B ✓ C D

$0 \cdot \epsilon \cdot \epsilon$

$(B, 0)$ B ✓ C ✓ D ✗

NFA



$(C, 1)$ — B

$1 \cdot \epsilon$ D ✓

$(A, 1)$ A ✗ B ✓ C ✗ D ✓

$\epsilon \cdot \epsilon \cdot 1$

#Q. Construct an equivalent NFA for the following ε-NFA

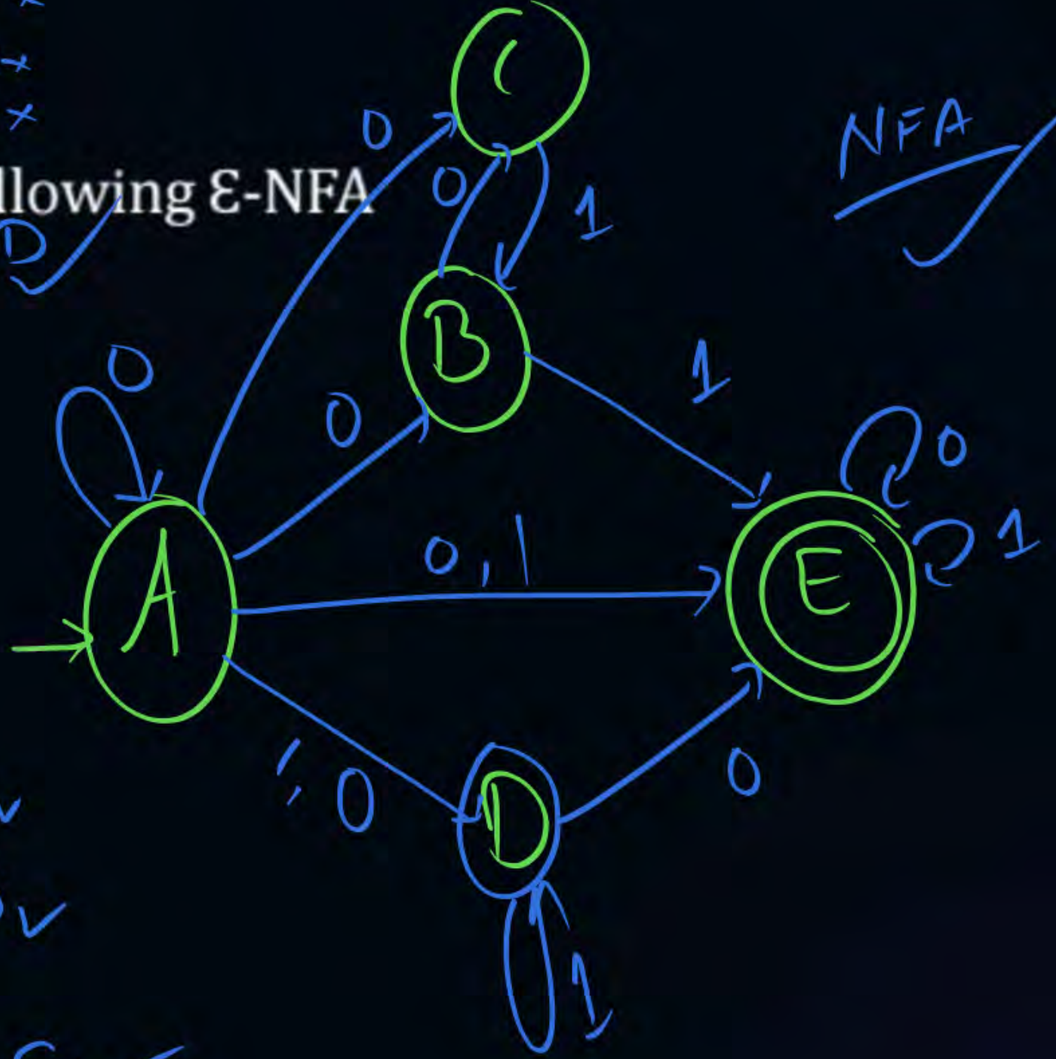
ϵ-closure(A) = {A, B, D}

ϵ-closure(B) = {B}

ϵ-closure(D) = {D}

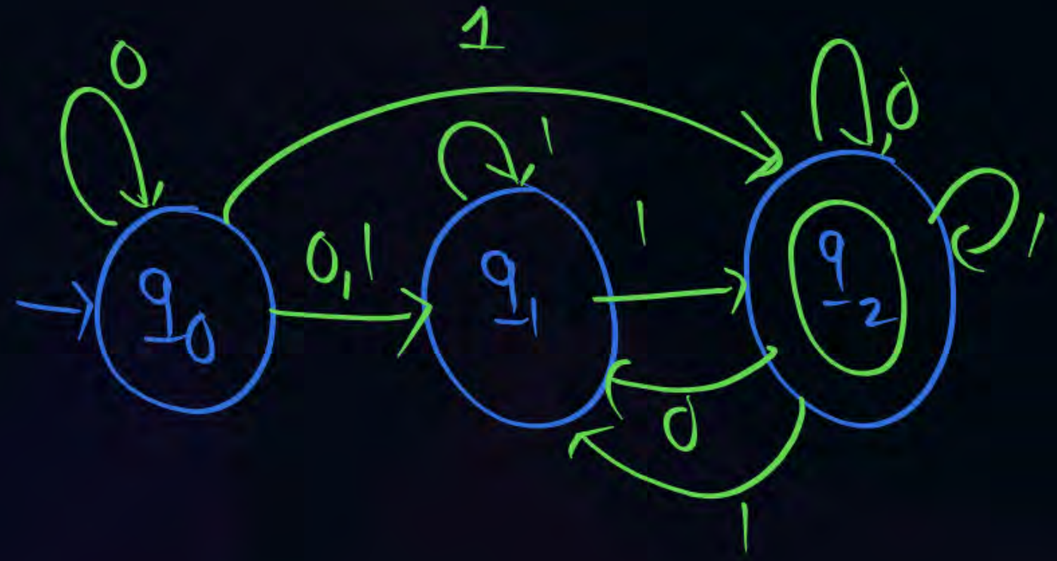
A

#Q. Construct an equivalent NFA for the following ε-NFA



#Q. Construct an equivalent NFA for the following ε-NFA

NFA



$(q_0, 1) \rightarrow q_1, q_2$

$\epsilon\text{-closure}(q_0) = \{q_0, q_1\}$

$\epsilon\text{-closure}(q_1) = \{q_1\}$

$\epsilon\text{-closure}(q_2) = \{q_1, q_2\}$

$(q_0, 0) \rightarrow q_0, q_1, q_2$

$(q_1, 1) \rightarrow q_1, q_2$

$1\text{-}\epsilon$

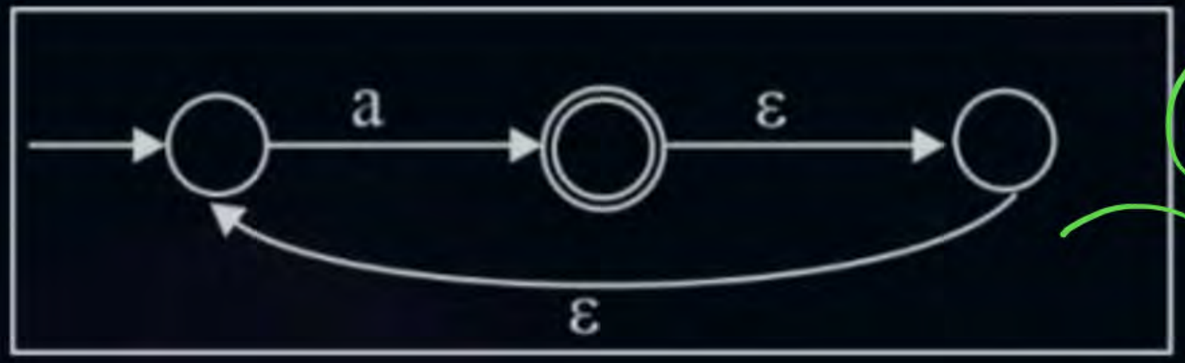
$(q_2, 0) \rightarrow q_2, q_1$

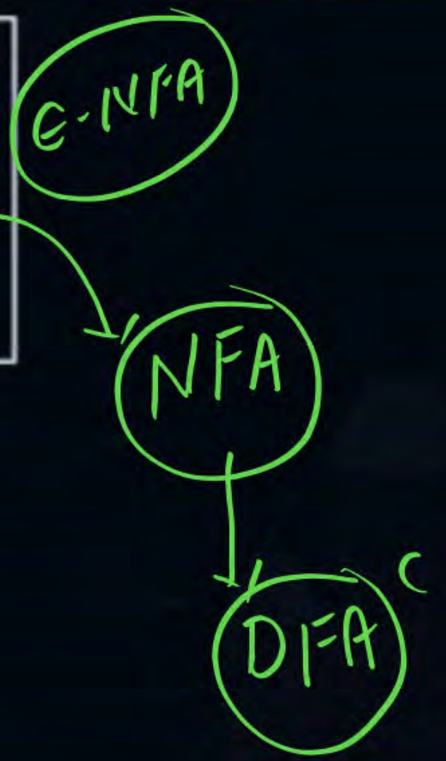
$(q_2, 1) \rightarrow q_1, q_2$

Q

What is the complement of the language accepted by the NFA shown below? Assume $\Sigma = \{a\}$ and ε is the empty string.

[2012: 1 Mark]





A $\varnothing$

B $\{\varepsilon\}$

C a^*

D $\{a, \varepsilon\}$

THANK - YOU