



CS & IT ENGINEERING



THEORY OF COMPUTATION

Regular Expressions

Lecture No.-08



By- Venkat sir

Recap of Previous Lecture



Topic

Regular Expression

Topic

Construction of Regular Expression

Topic

DFA States

Topics to be Covered



Topic

Conversion from ϵ NFA to NFA

Topic

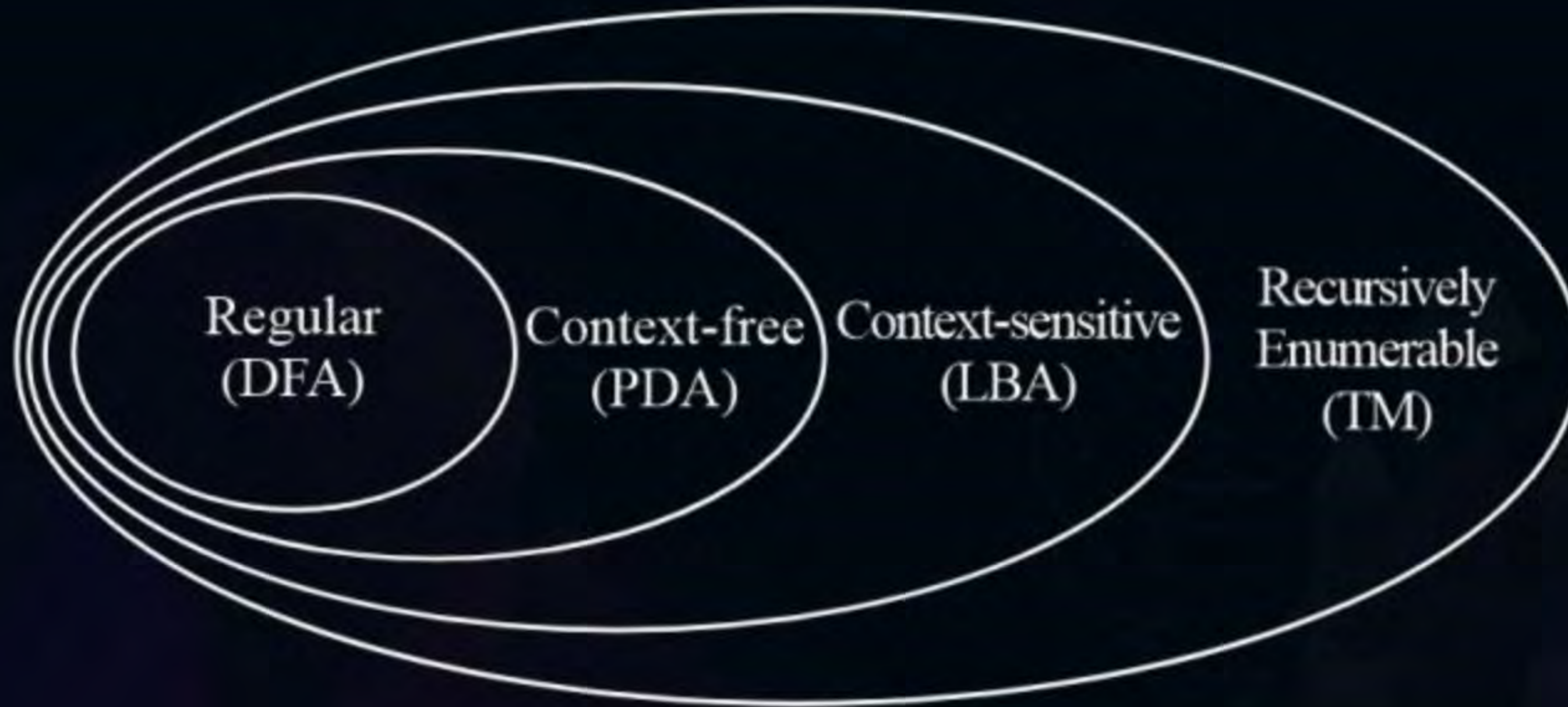
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Topic

??



Topic : Theory of Computation

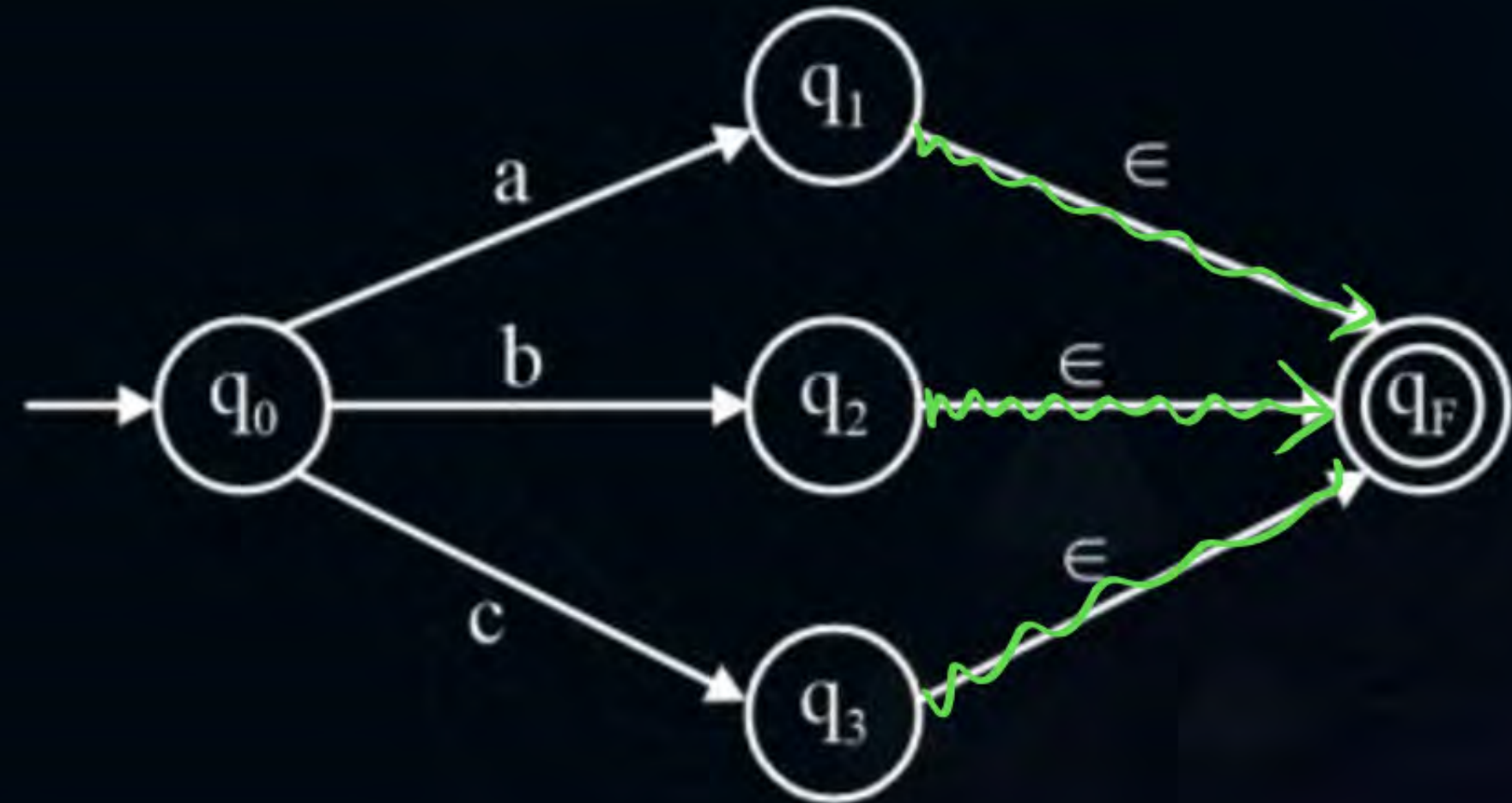
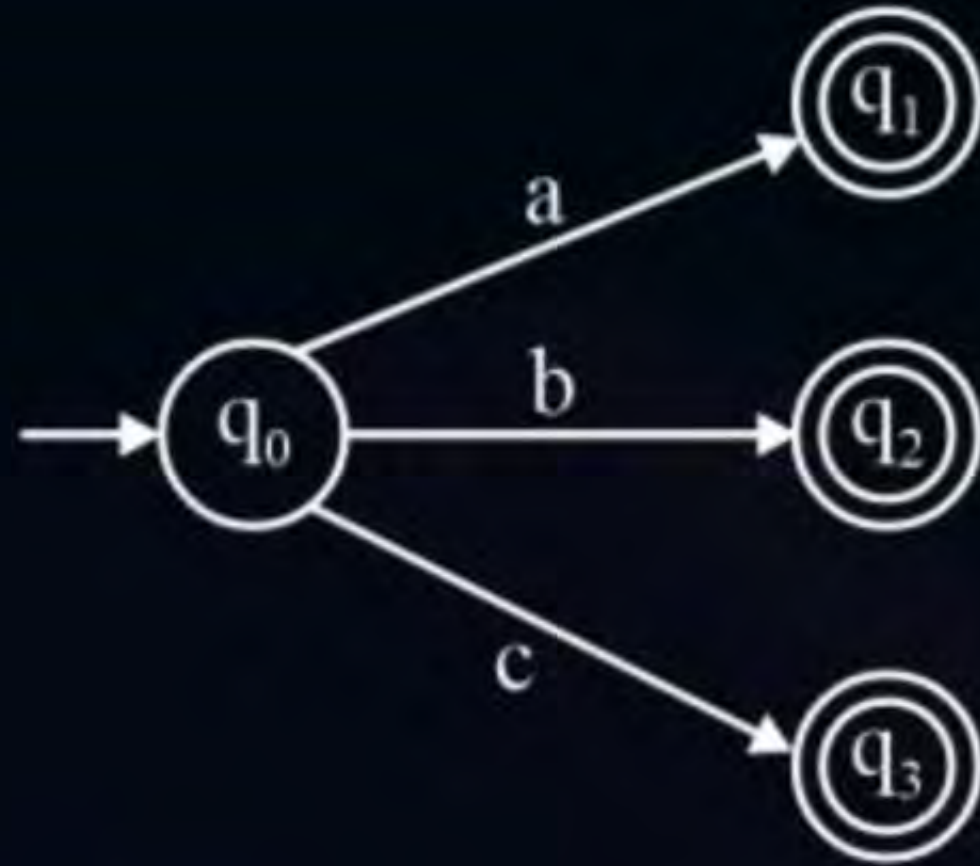




Topic : Finite Automata to Regular Expression

(1)

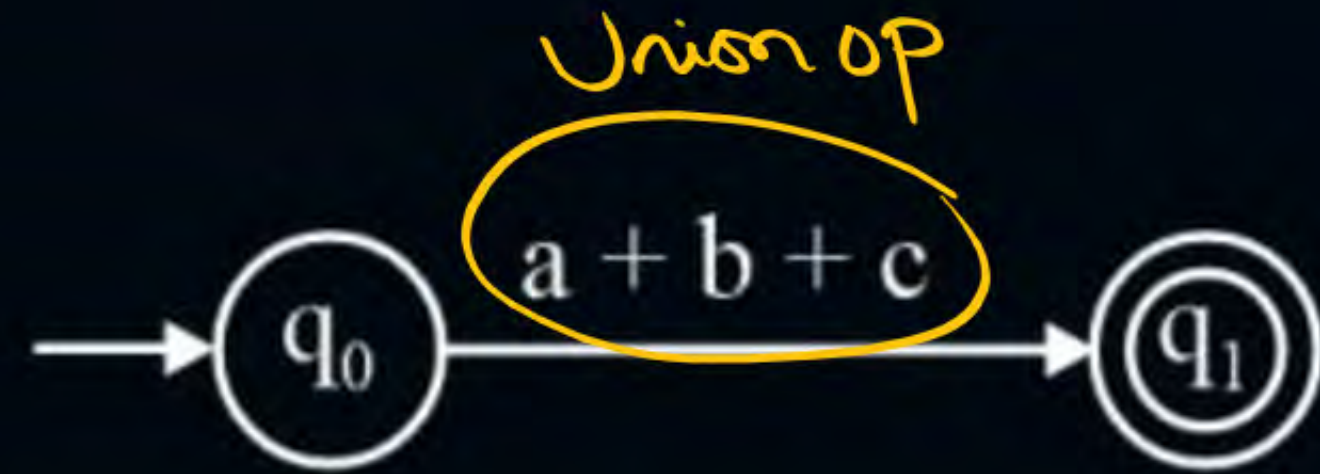
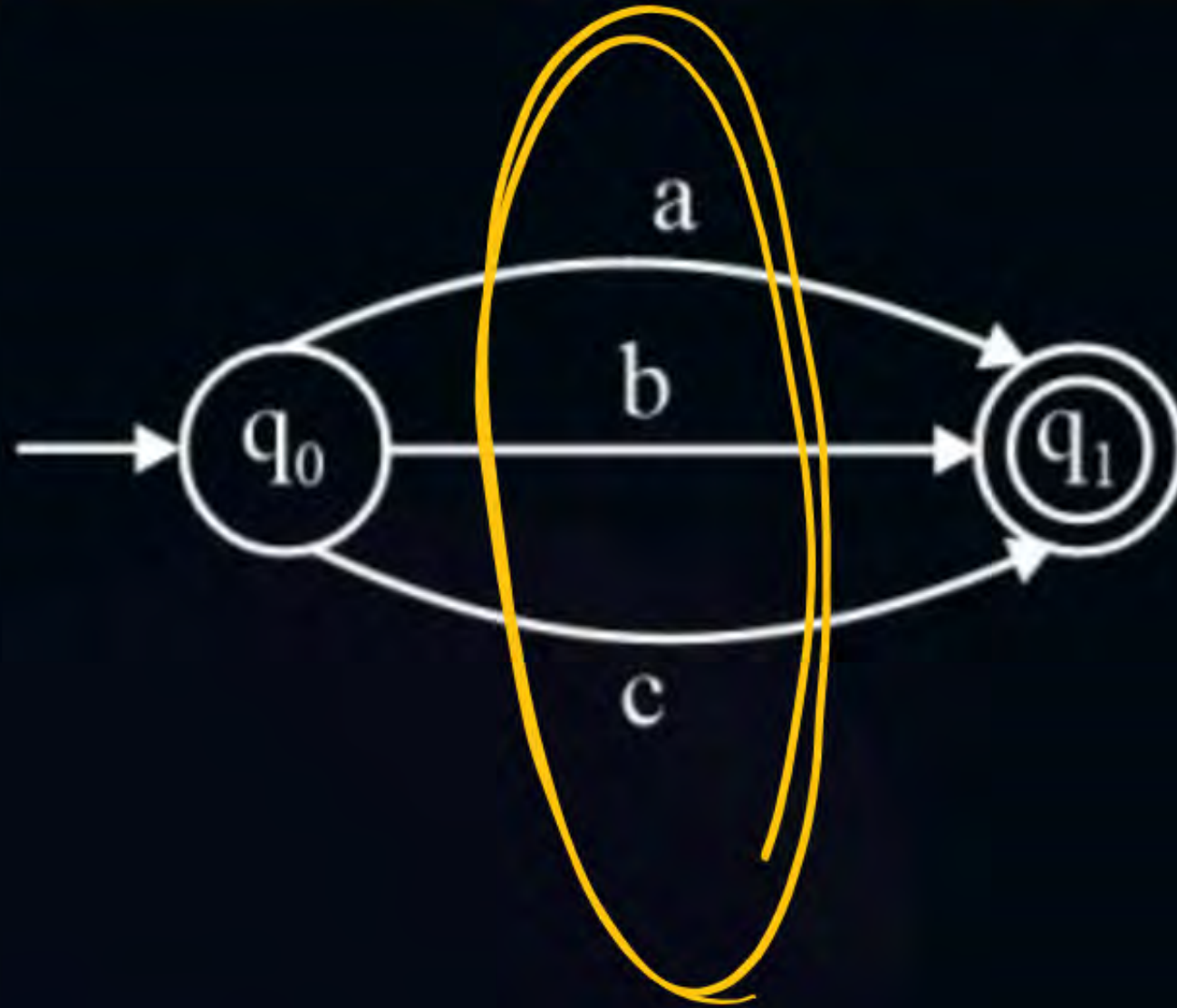
State elimination method





Topic : Finite Automata to Regular Expression

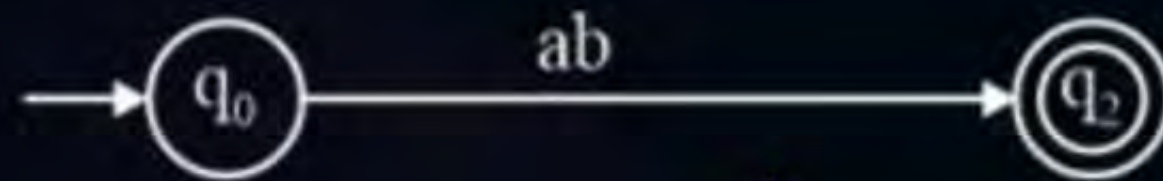
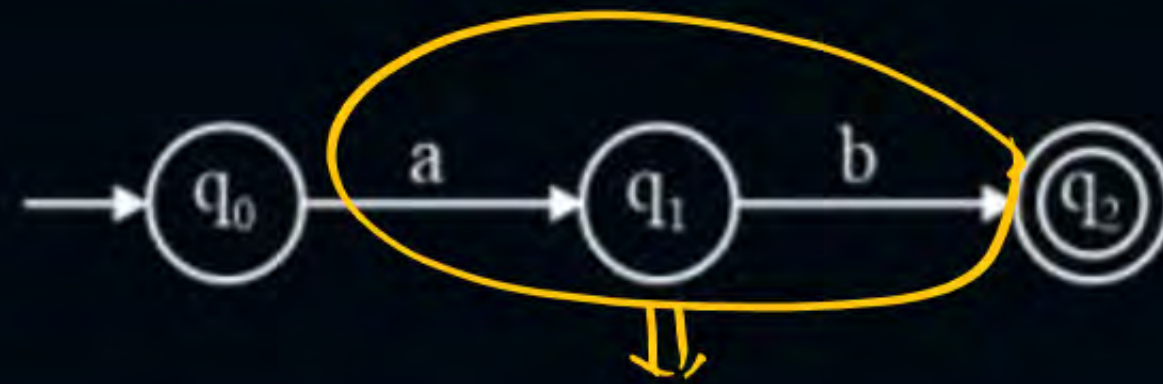
(2)





Topic : Finite Automata to Regular Expression

(3)

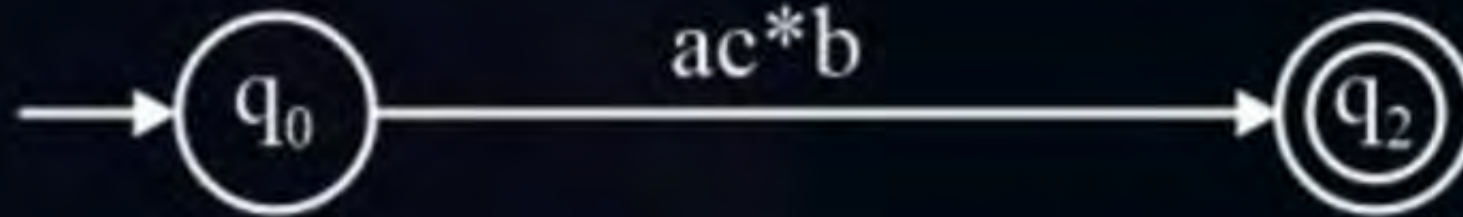
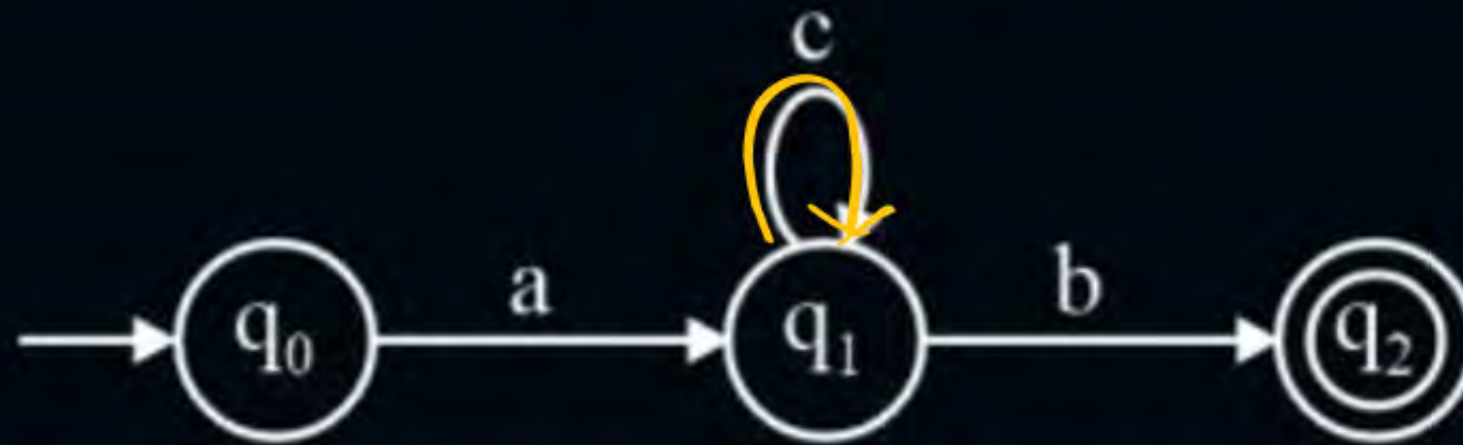


Concatenation op



Topic : Finite Automata to Regular Expression

(4)

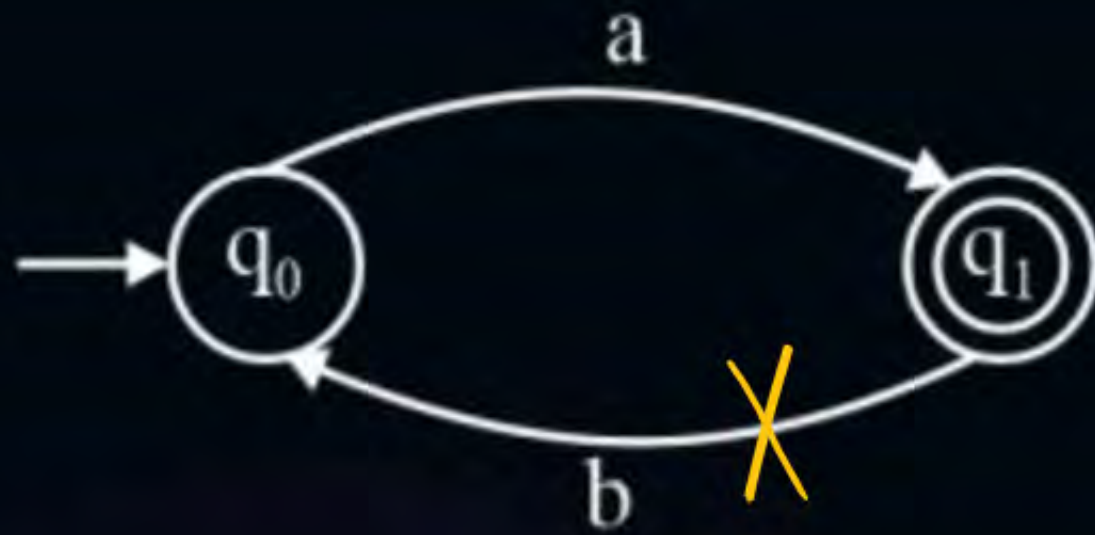


Kleene closure op



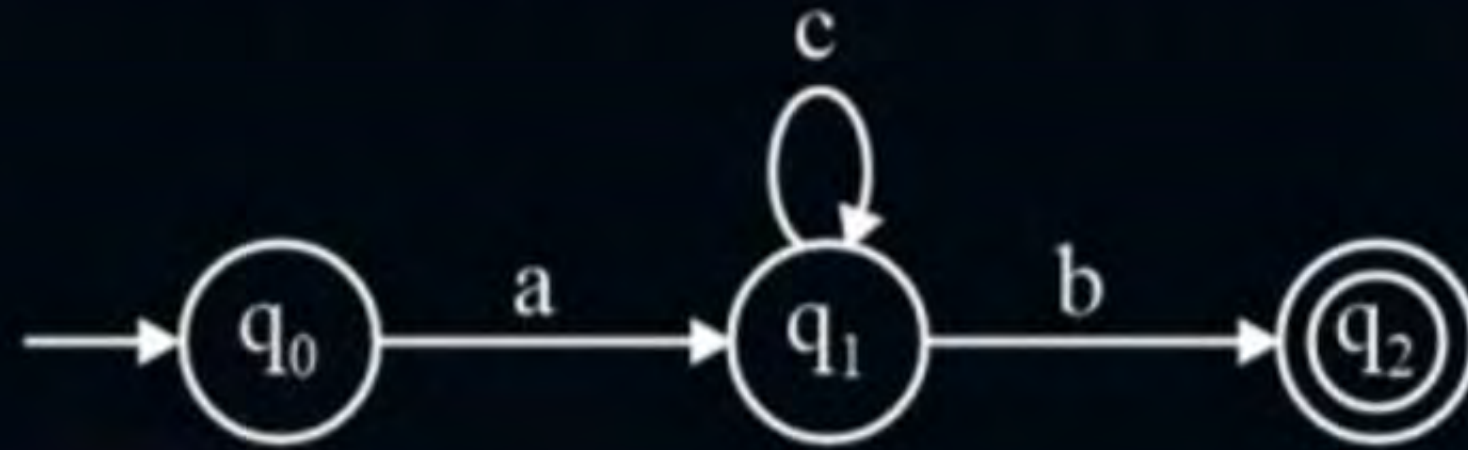
Topic : Finite Automata to Regular Expression

(5)

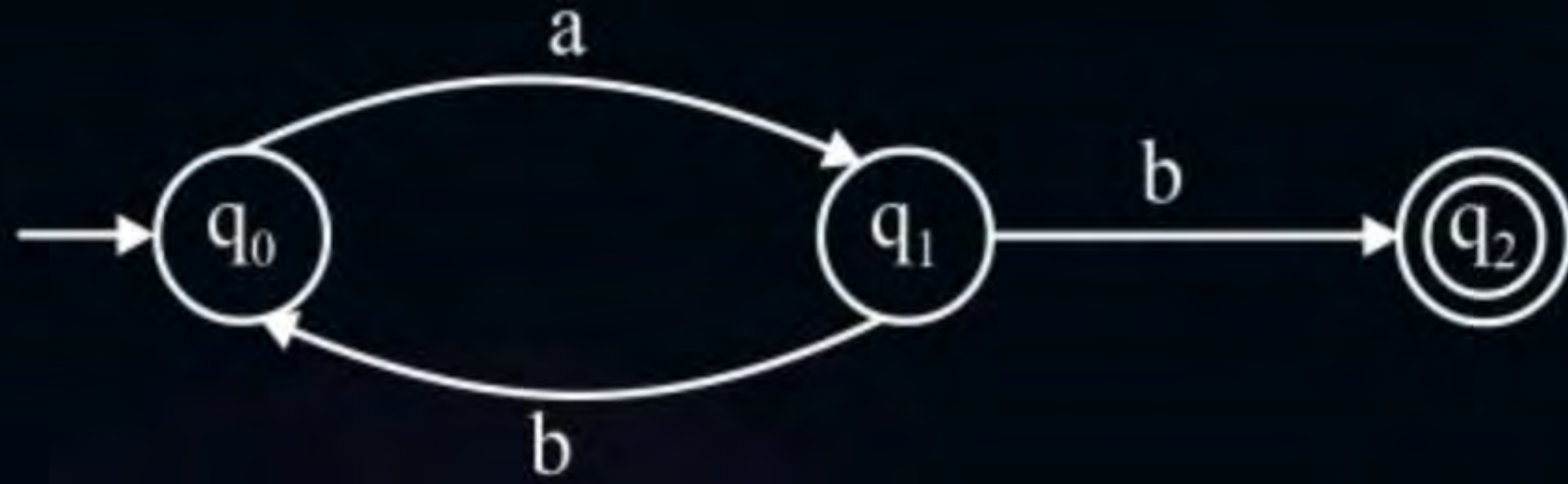


Cycle

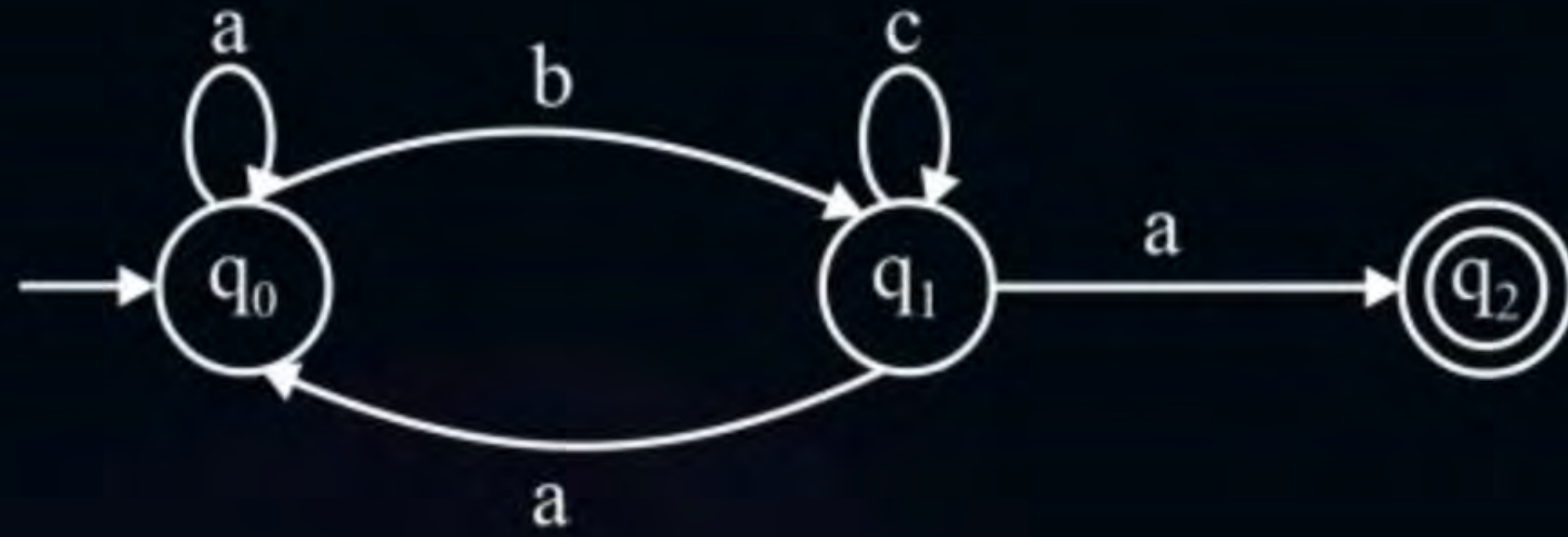
#Q. Construct Regular Expression for the following Finite Automata.



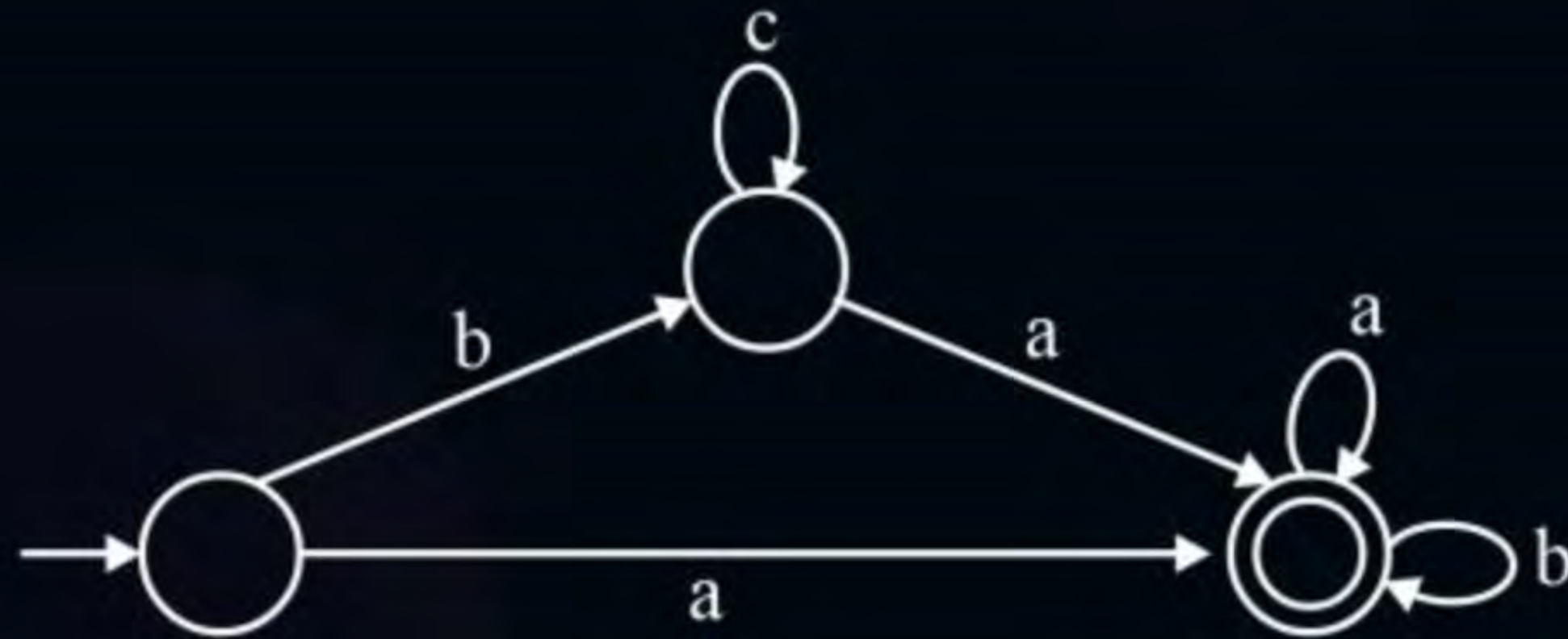
#Q. Construct Regular Expression for the following Finite Automata



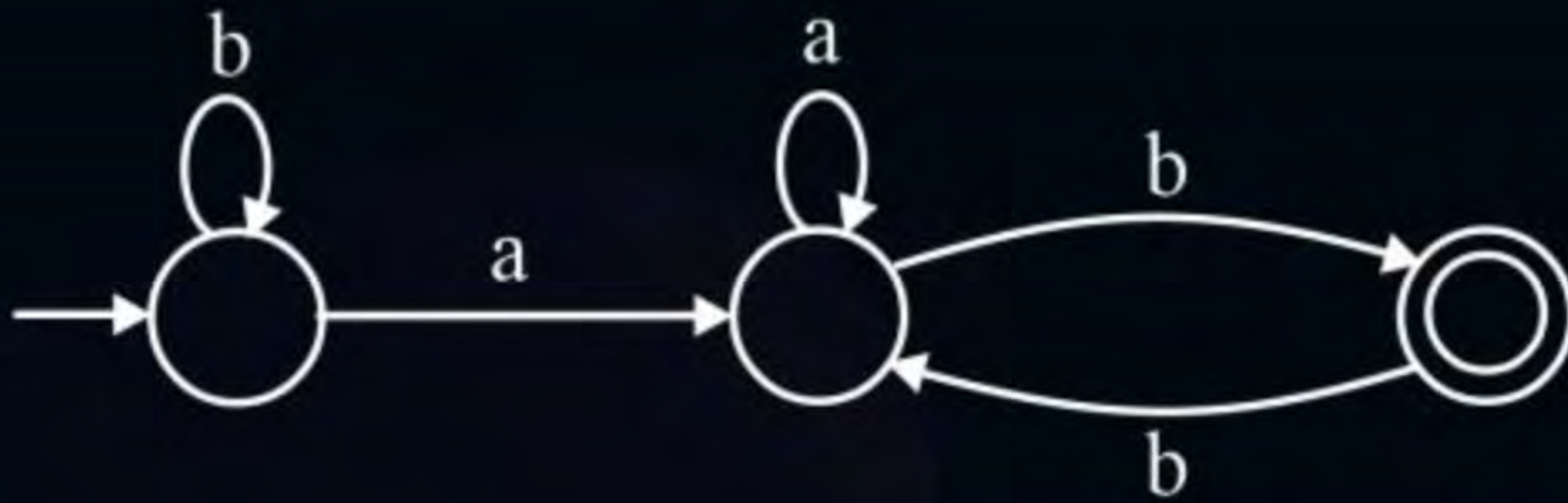
#Q. Construct Regular Expression for the following Finite Automata



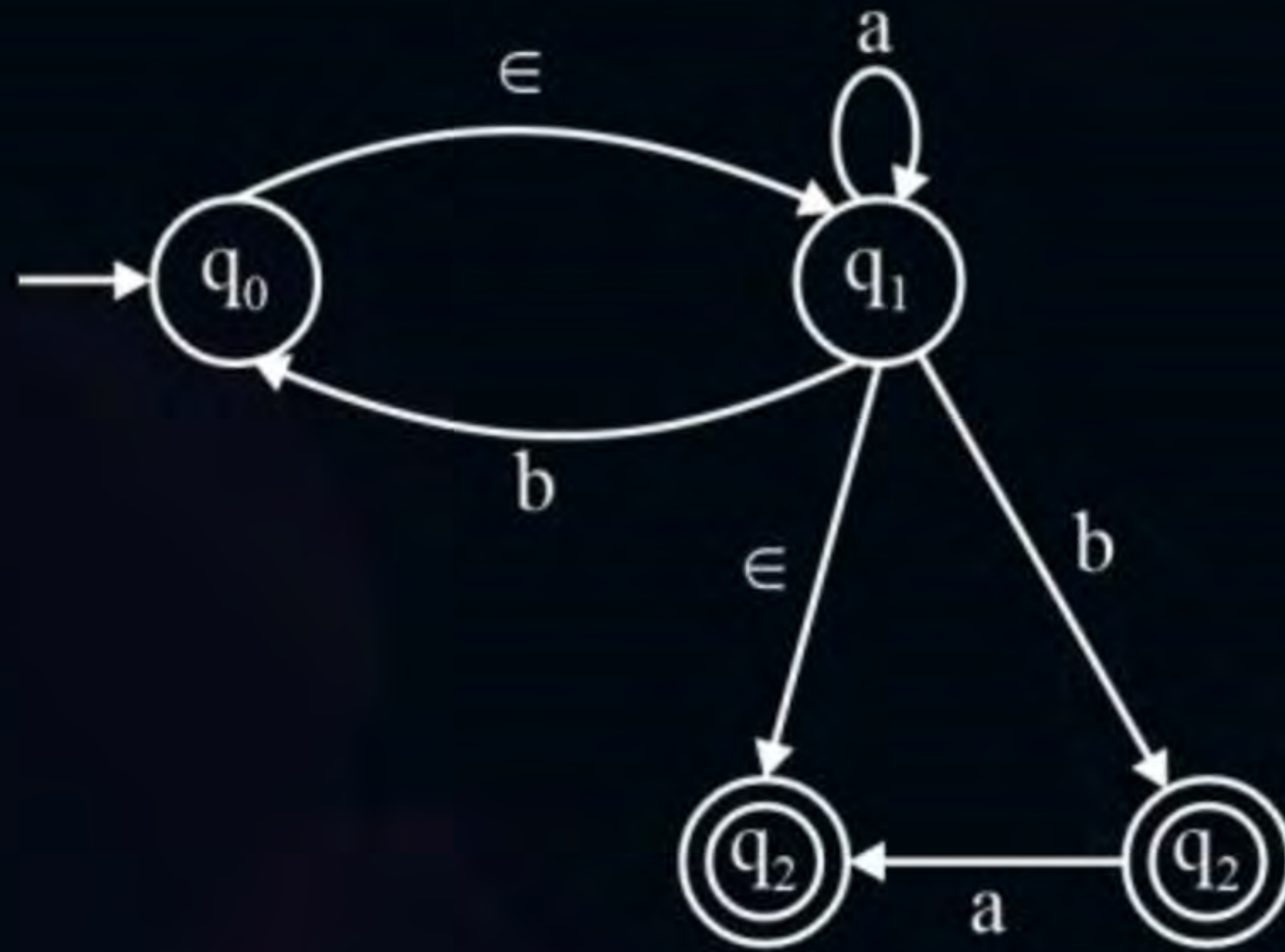
#Q. Construct Regular Expression for the following Finite Automata



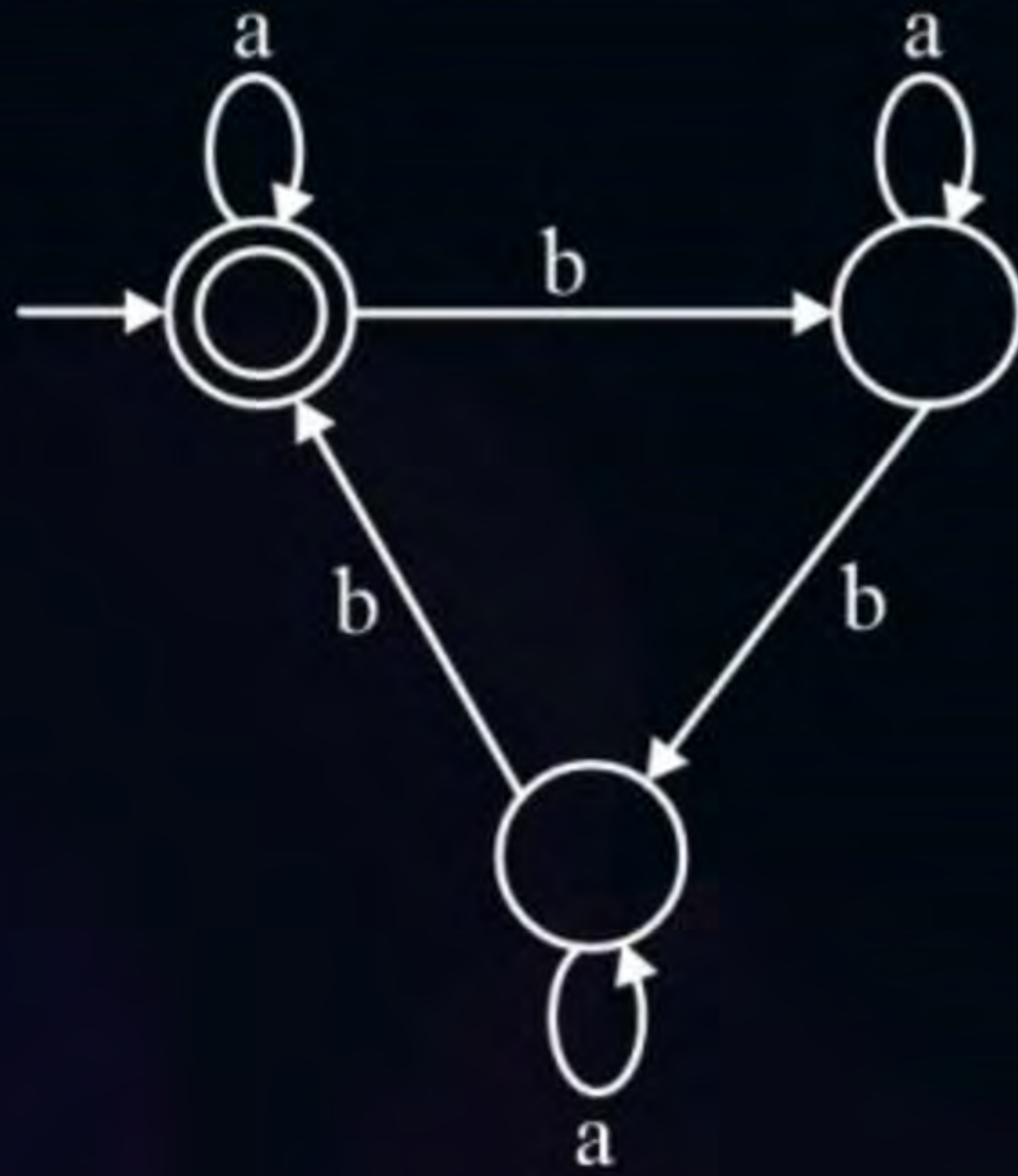
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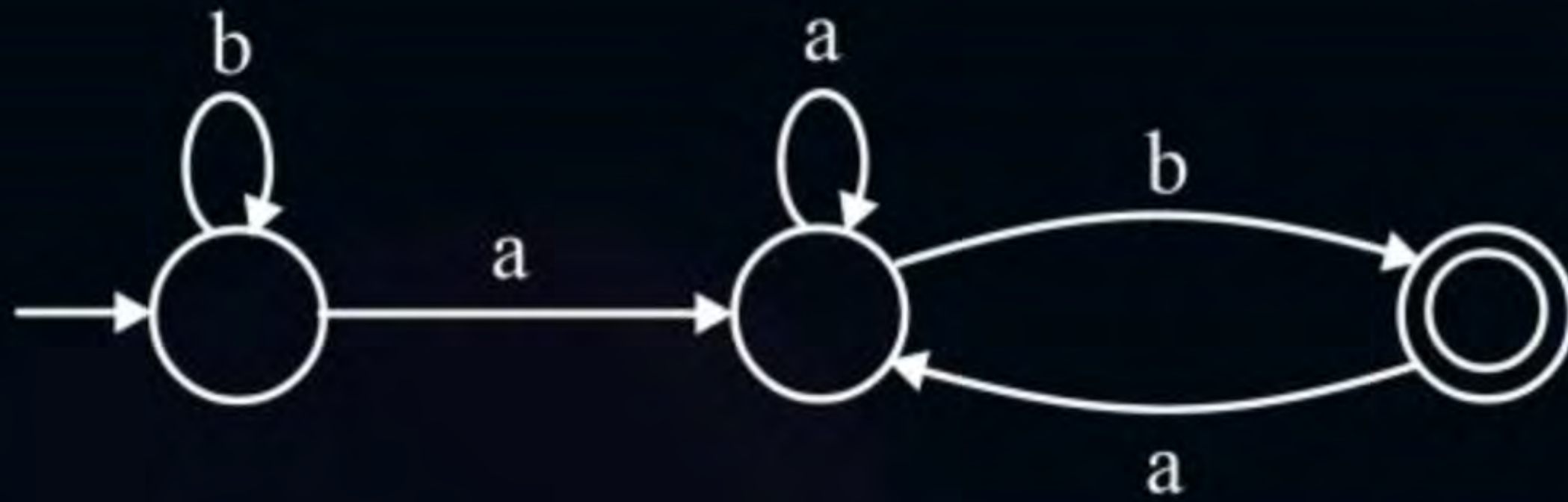
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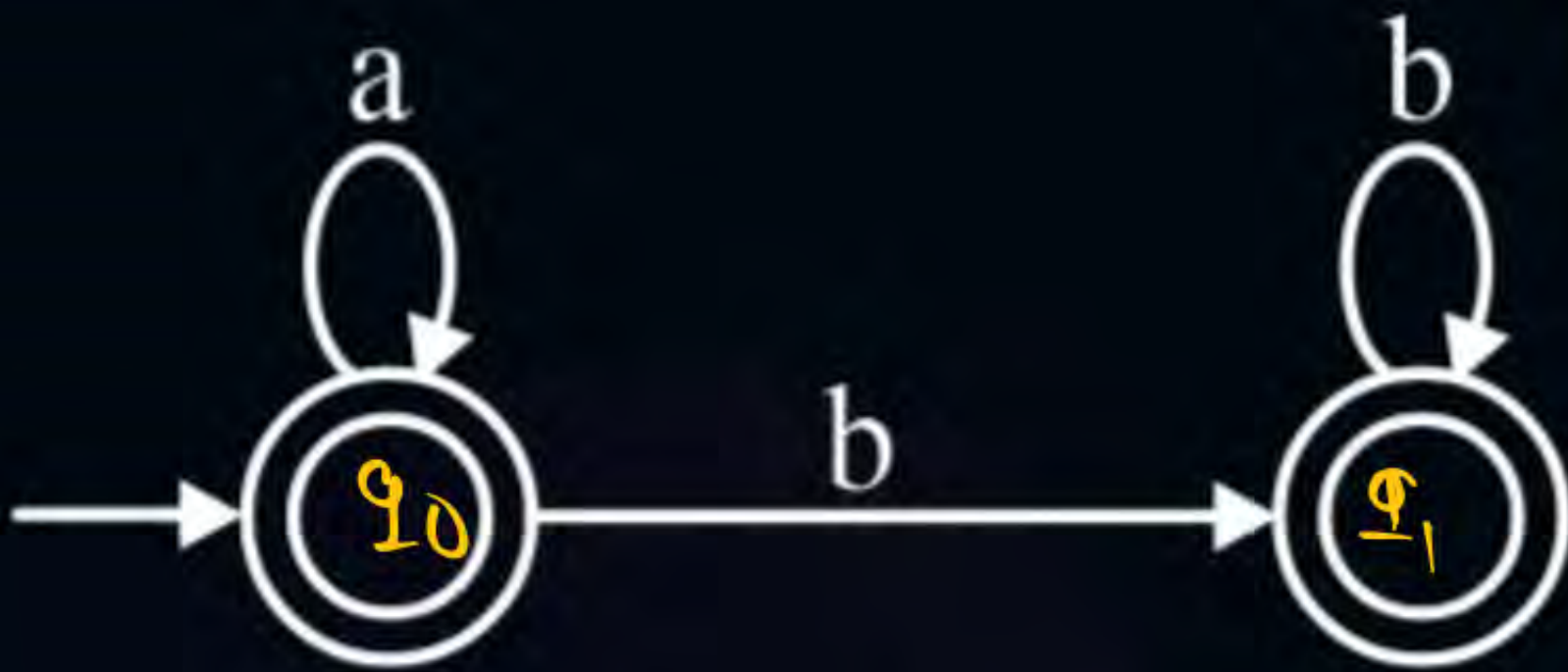
①

a^*b^*

$$b^+ + \epsilon = b^*$$

#Q.

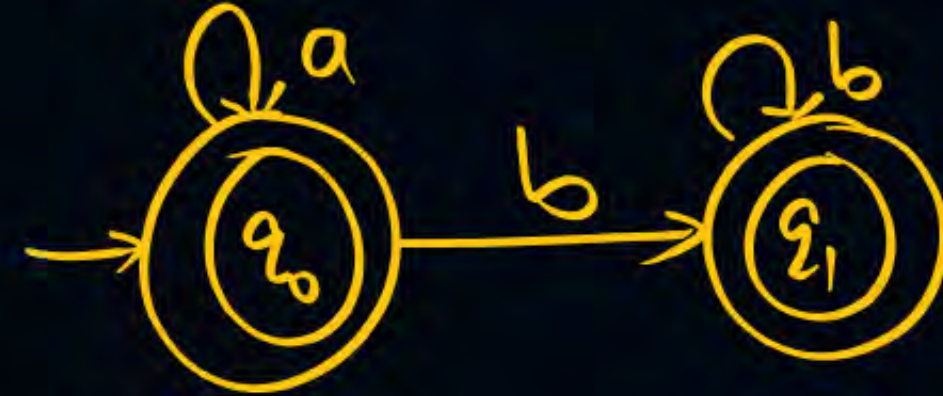
Construct Regular Expression for the following Finite Automata



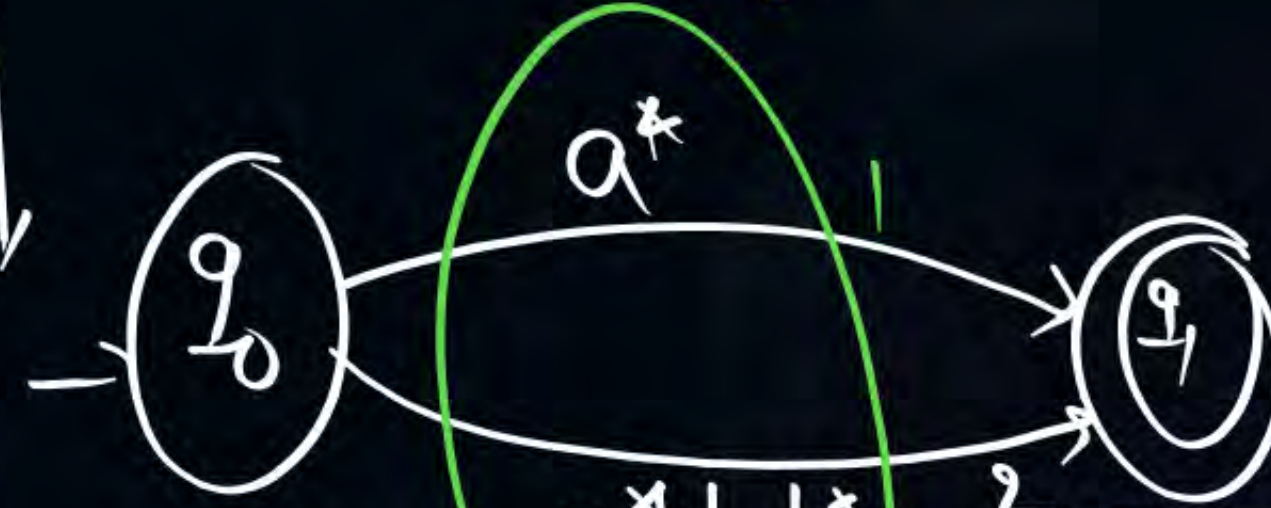
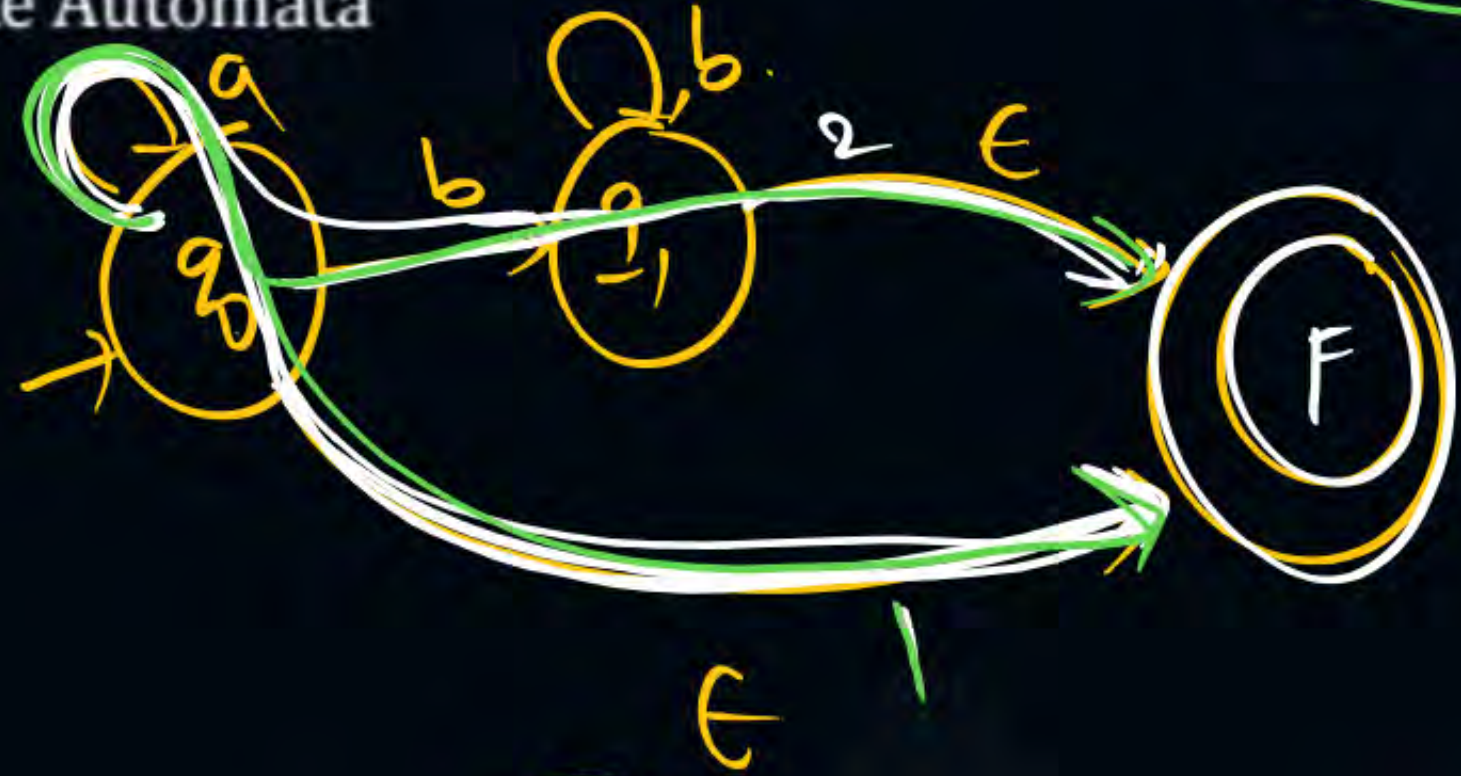
$$a^* + a^*b^+$$

$$a^*(\epsilon + b^+)$$

a^*b^*

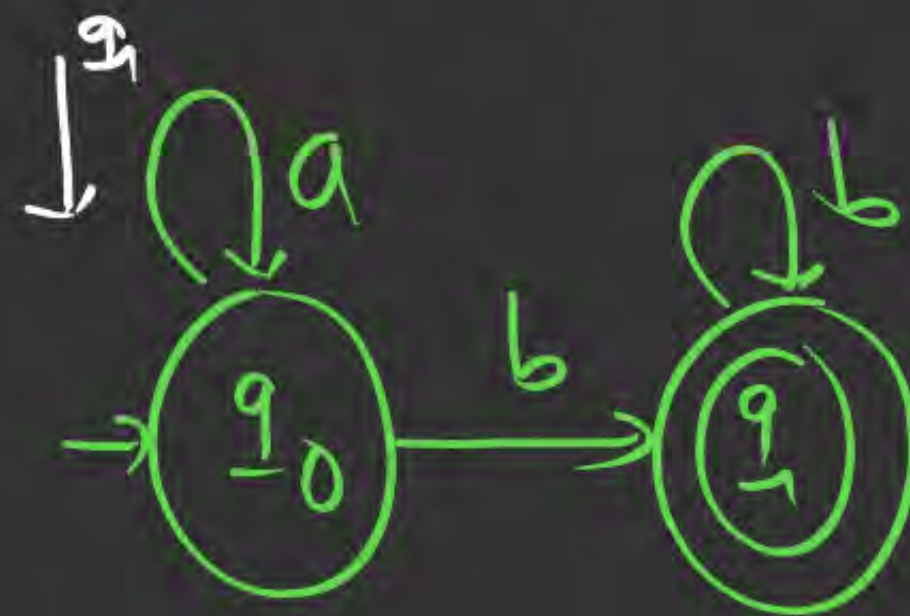
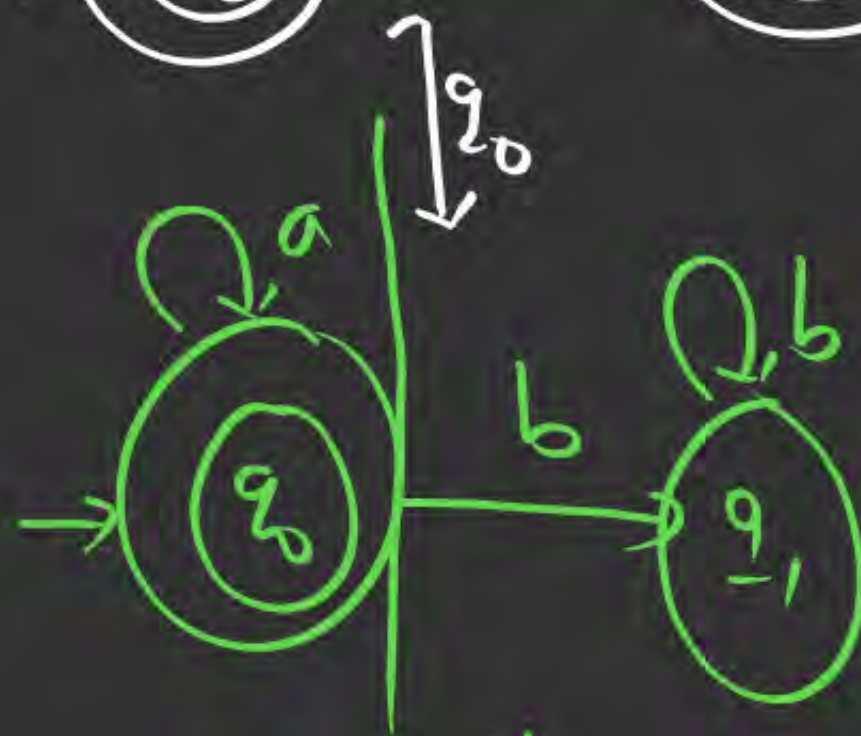
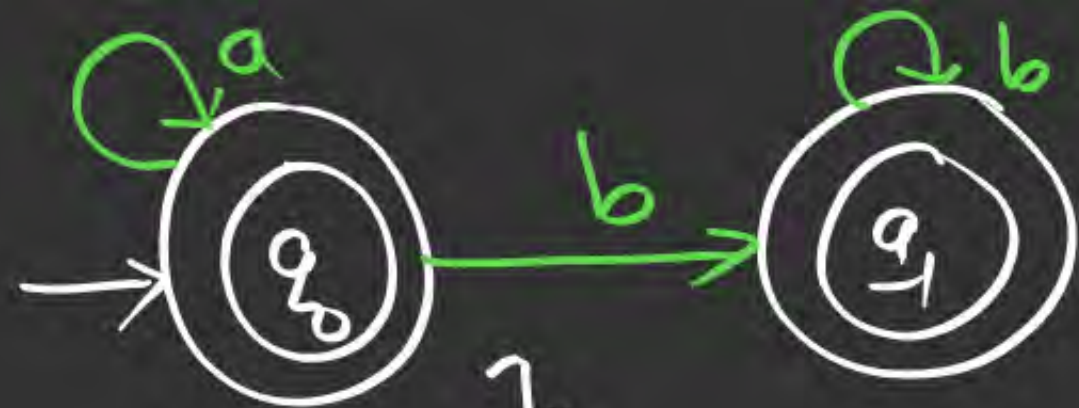


$b \cdot b^* = b^+$



$$a^* + a^*b b^*$$

$$a^* + a^*b b^*$$



\Downarrow

$$a^* + a^* b b^*$$

$$a^* (\epsilon + b^+) \Rightarrow \underline{a^* b^*}$$

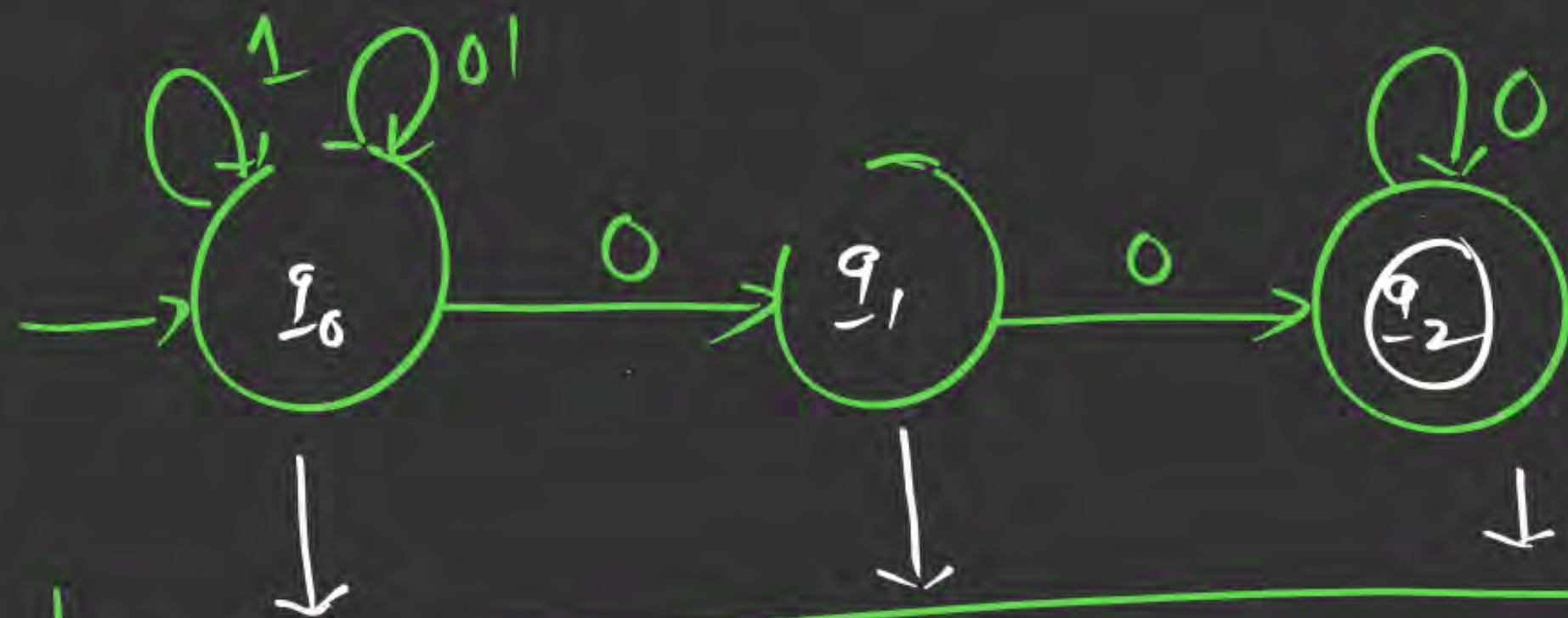
Home work

#Q. Construct Regular Expression for the following Finite Automata



DFA?

✓ NFA?

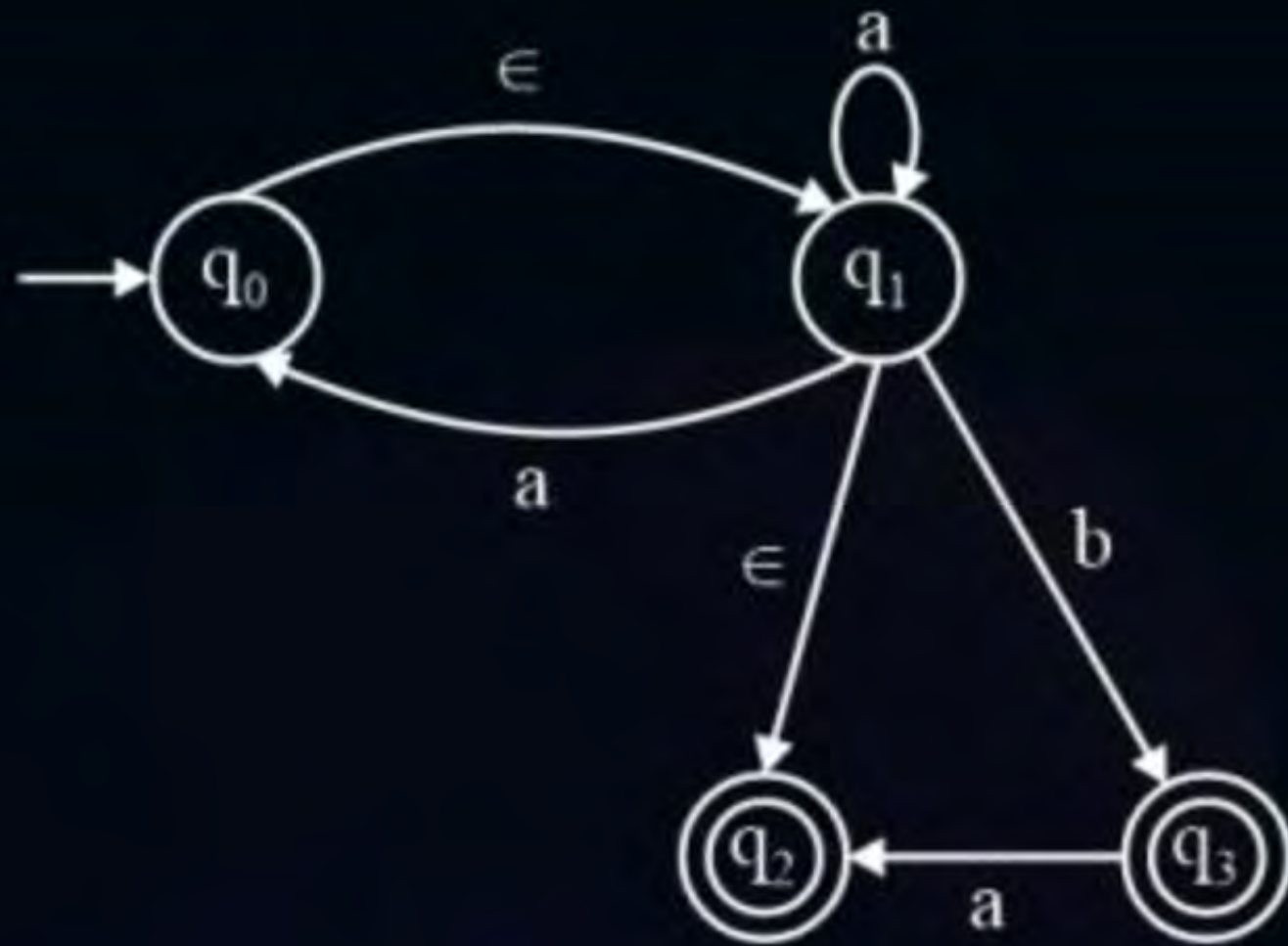


$$(1+01)^* + (1+01)^*0 + (1+01)^*000^*$$

$$(1+01)^* (\epsilon + 0 + 000^*)$$

$$(1+01)^* 0^*$$

#Q. Construct Regular Expression for the following Finite Automata



[MCQ]



#Q. Which one of the following regular expressions is equivalent to the language accepted by the DFA given below? **[GATE-CS-shift-II-24: 1M]**

- A** $0^*1(0 + 10^*1)^*$
- B** $0^*(10^*11)^*0^*$
- C** $0(1 + 0^*10^*1)^*0^*$
- D** $0^*1(010^*1)^*0^*$



[MCQ]



#Q. Let M be the 5-state NFA with ϵ - transitions shown in the diagram below. Which one of the following regular expressions represents the language accepted by M ? **[GATE-CS-shift-II-24: 2M]**

- A** $0^* + (1 + 0(00)^*)(11)^*$
- B** $(00)^* + 1(11)^*$
- C** $(00)^* + (1 + (00)^*)(11)^*$
- D** $0^+ + 1(11)^* + 0(11)^*$



Consider the languages $L_1 = \phi$ and $L_2 = \{a\}$. Which one of the following represents $L_1 L_2^* \cup L_1^*$? [2013: 1 Mark]

- ☐ A $\{\epsilon\}$
- ☐ B ϕ
- ☐ C a^*
- ☐ D (ϵ, a)

#Q. Construct Regular Expression for the following Finite Automata





In order to find out a regular expression of a Finite Automaton we use Arden's Theorem.

Statement-

$$R = R(P) + Q$$

↓
Regular Expression

Let P and Q be two regular expressions.

If P does not contain null string, $R = Q + RP$ has a unique solution that is $R = QP^*$

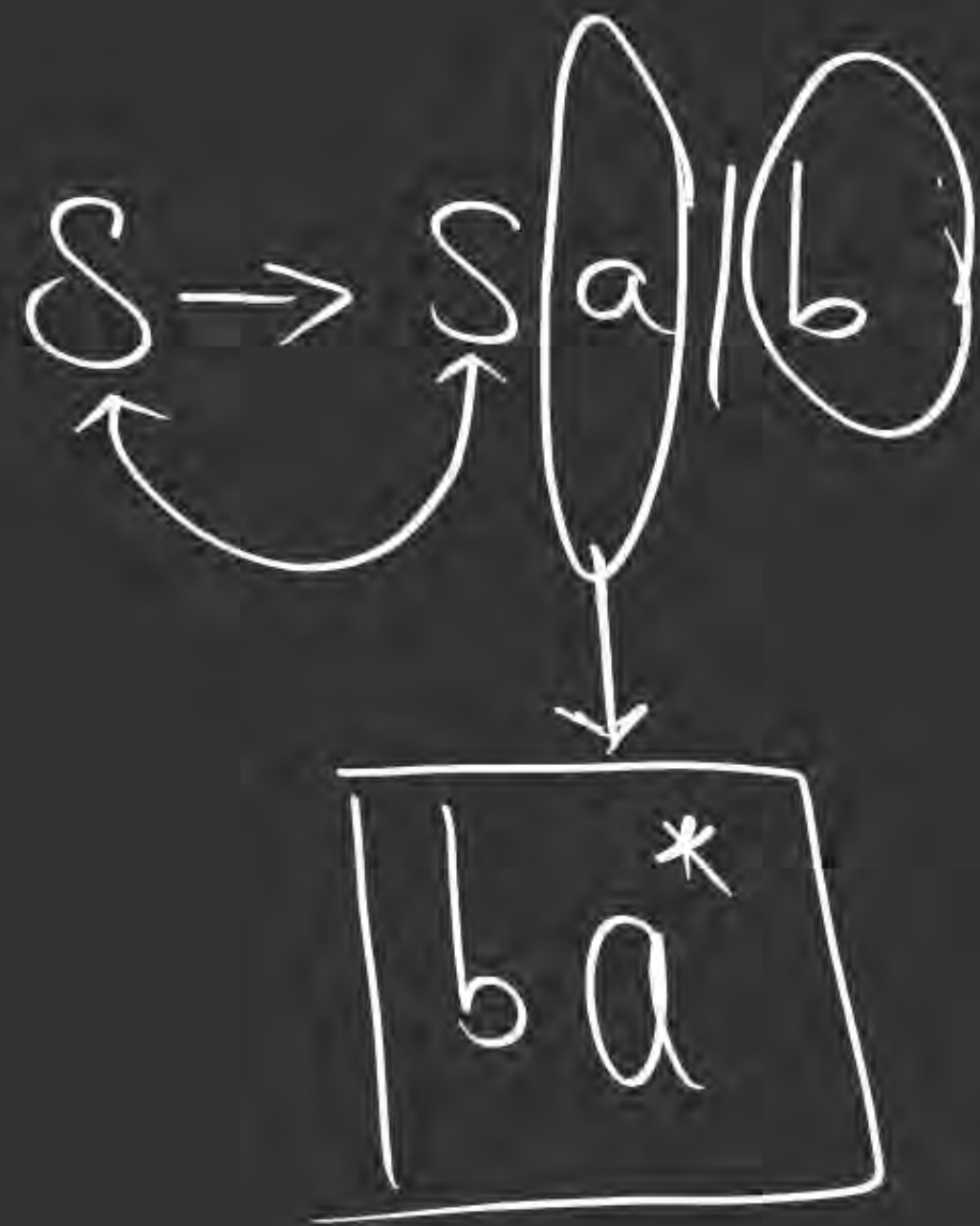
$$\rightarrow R = QP^*$$

$$R = Q + RP$$

$$R = RP + Q$$

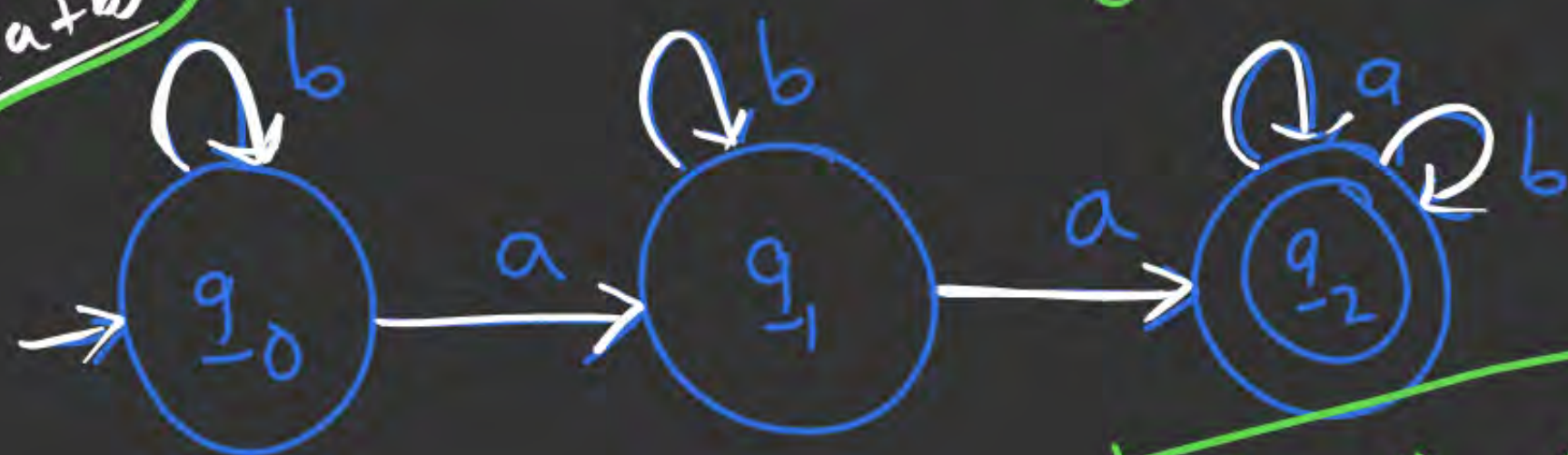
$$\underline{\underline{R = QP^*}}$$

$$R = RP + Q$$



(Q) Construct Regular Expression for the given Finite Automata?

$b^* a b^* a (a+b)^*$



$$R = R P + Q \rightarrow R = \underline{Q} \underline{P}^*$$

$$\overset{R}{q_0} = \overset{R}{q_0} \overset{P}{b} + \overset{Q}{\epsilon}$$

$$q_0 = \epsilon \cdot b^* \rightarrow q_0 = b^*$$

$$q_0 = q_0 b + \epsilon$$

$$q_1 = \underline{q_0} a + q_1 b$$

$$\overset{R}{q_1} = \overset{R}{q_1} \overset{P}{b} + \overset{Q}{b a}$$

$$q_1 = \underline{b^* a} \underline{b^*}$$

$$q_2 = q_1 a + q_2 a + q_2 b$$

$$q_2 = q_2 (a+b) + q_1 a$$

$$\overset{R}{q_2} = \overset{R}{q_2} \overset{P}{(a+b)} + \overset{Q}{b^* a b^* a}$$

$$q_2 = \underline{b^* a b^* a (a+b)^*}$$



Topic : Regular Expression to Finite Automata Construction

Algorithm

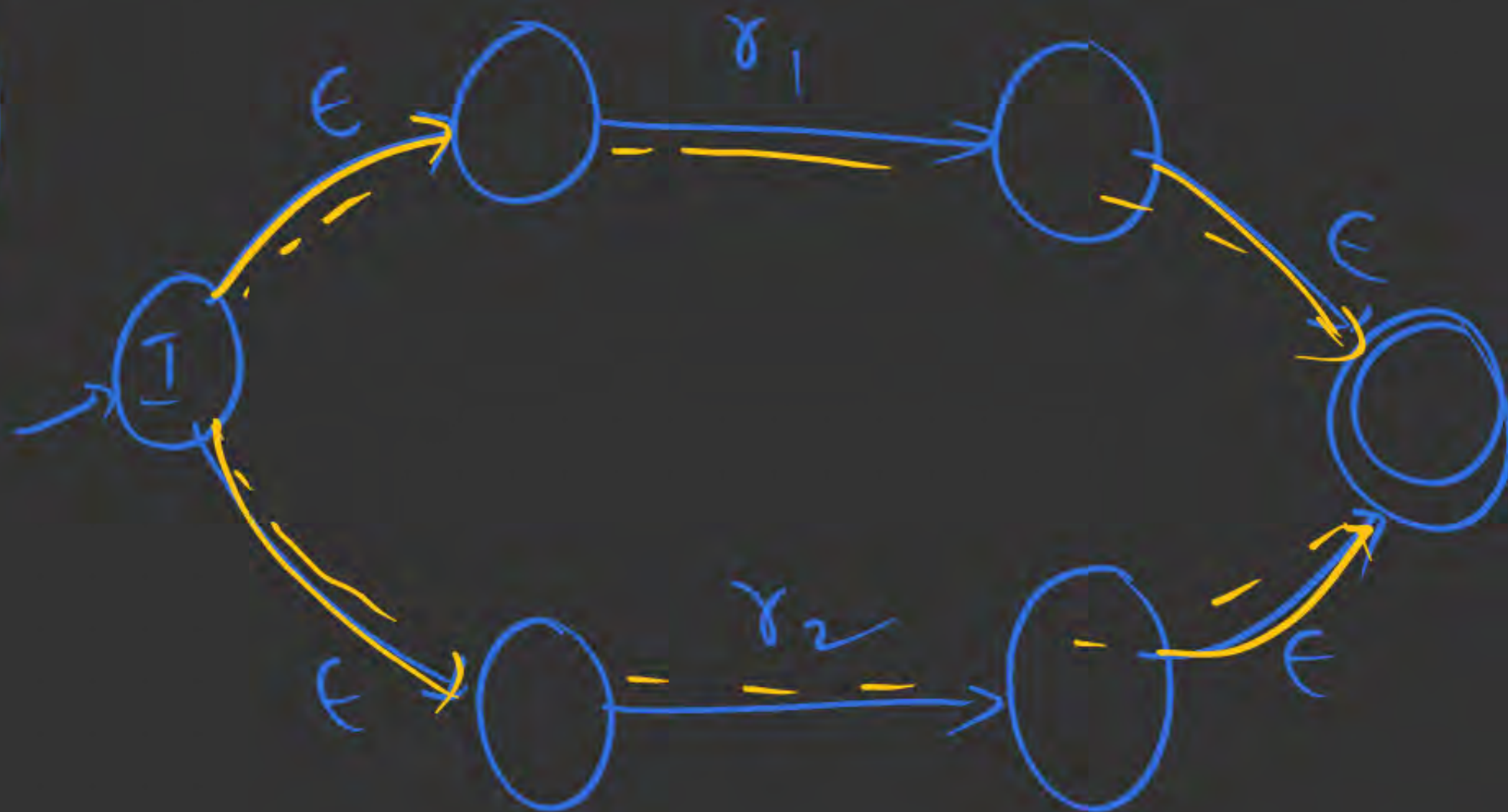
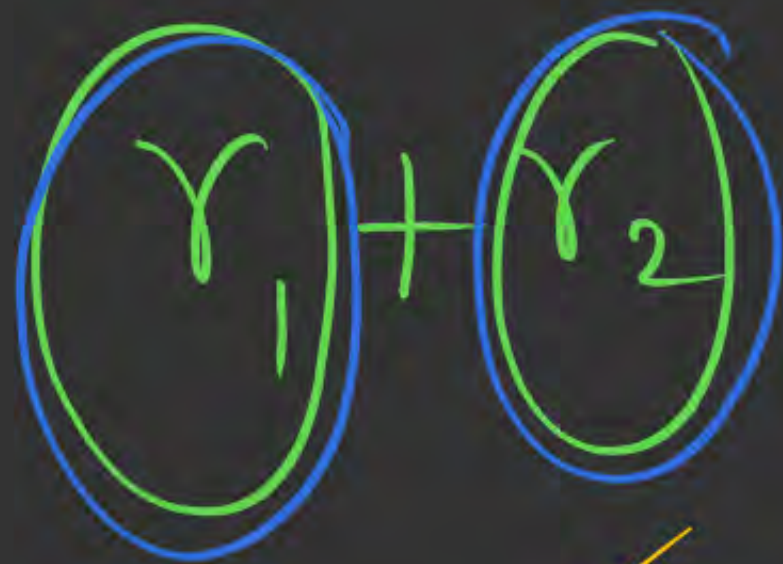
Regular expression	ϵ -NFA
1. ϕ	
2. ϵ	
3. a	
4. $r_1 + r_2$	

Basic R.E

DFA ✗

NFA ✗

ϵ -NFA ✓





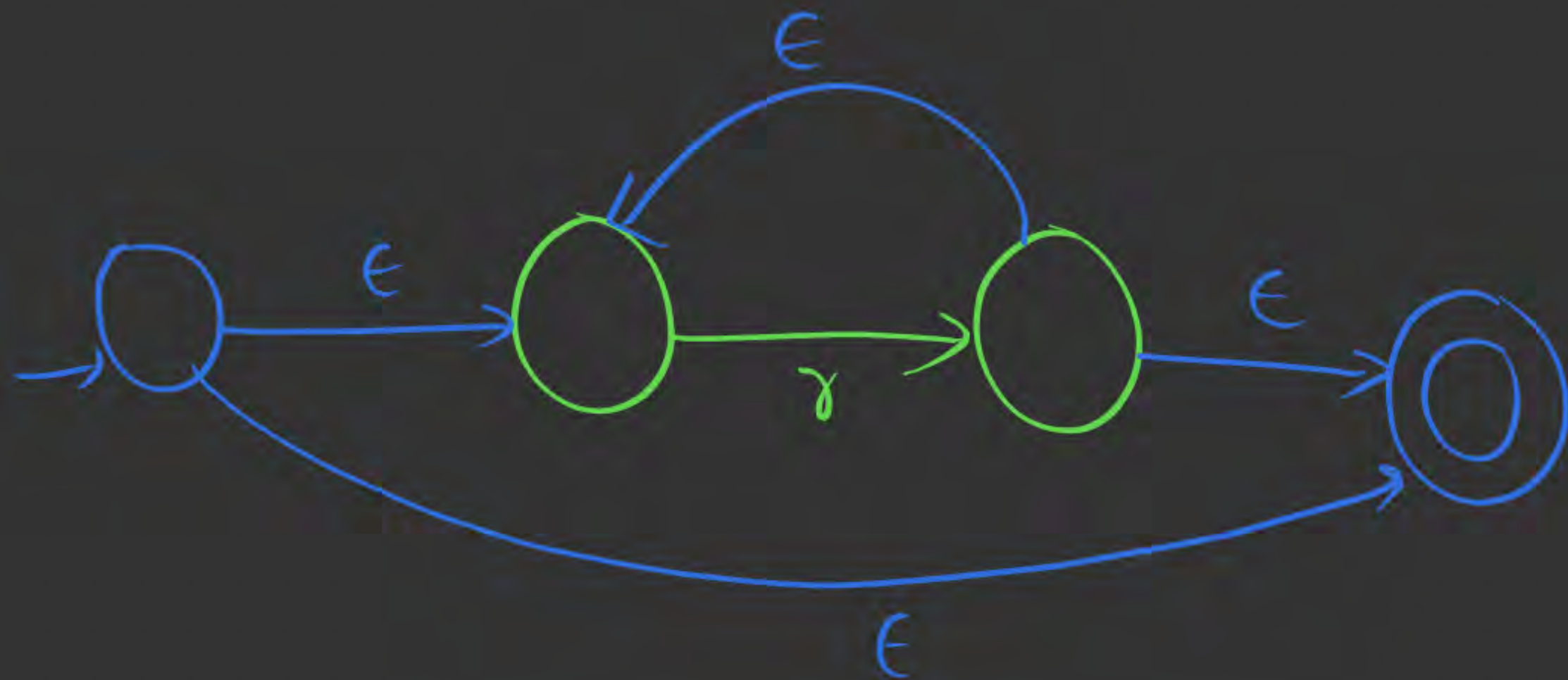
Topic : Regular Expression to Finite Automata Construction

Regular expression	ϵ -NFA
5. $r_1 \cdot r_2$	
6. r^*	



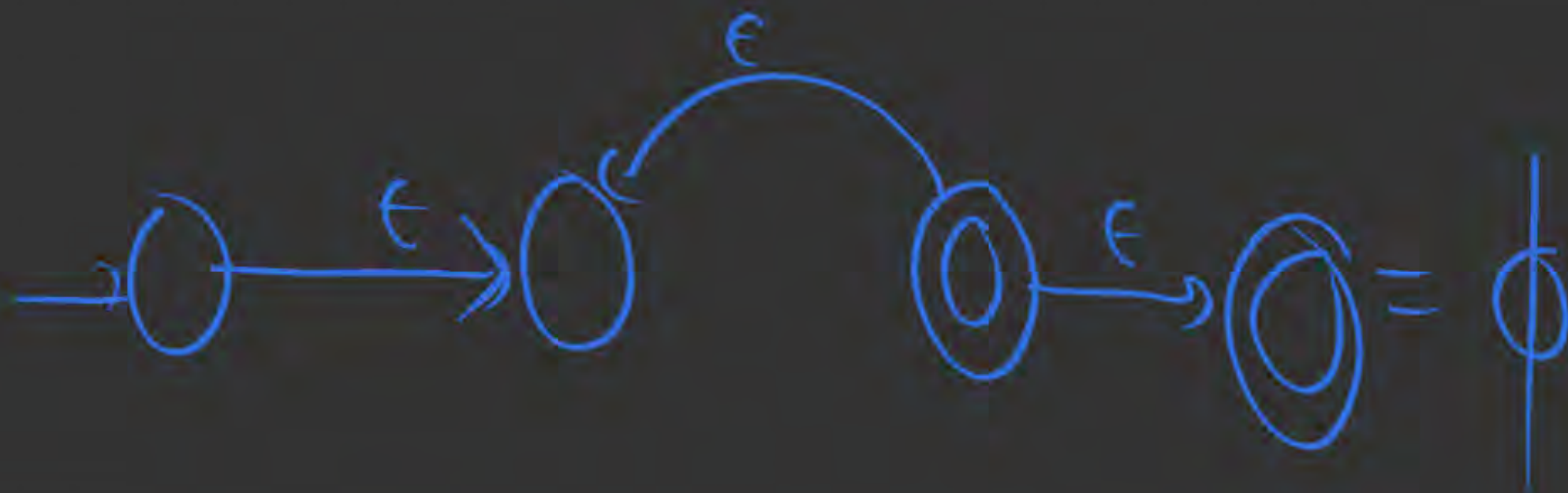
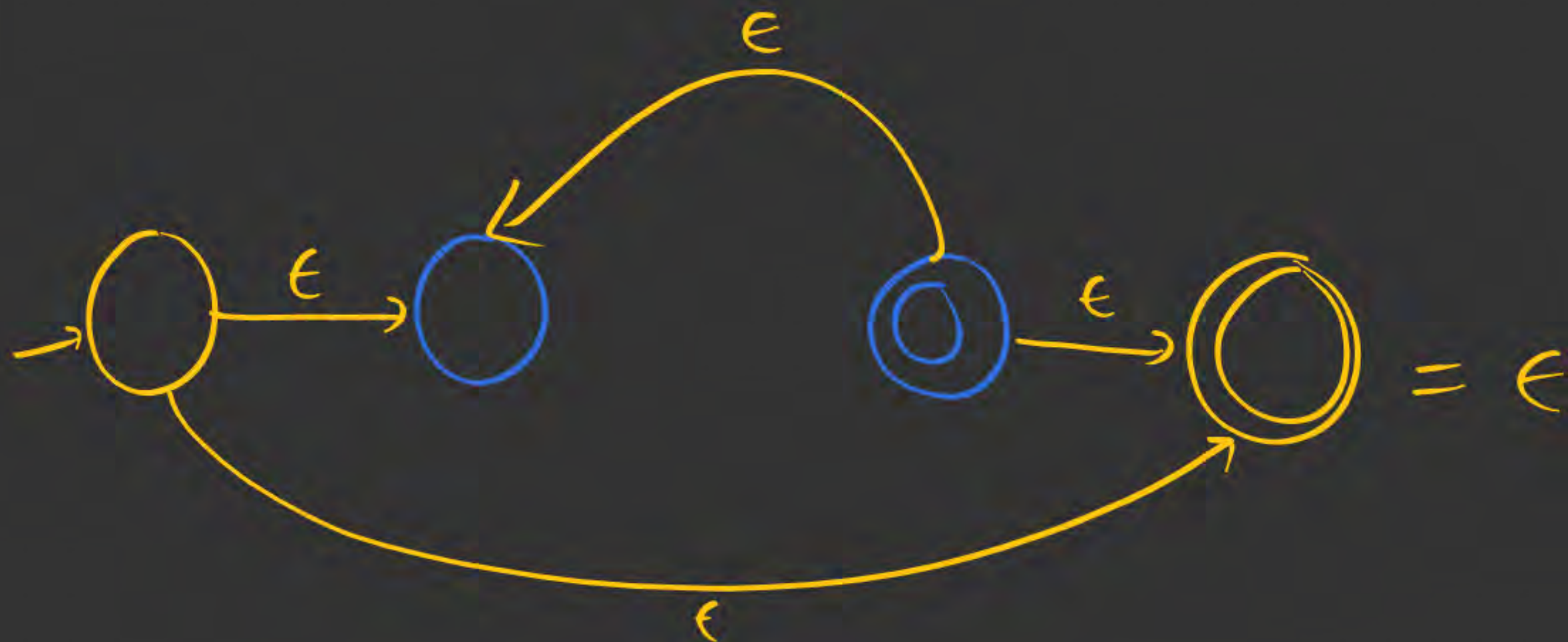
r^+

ϵ

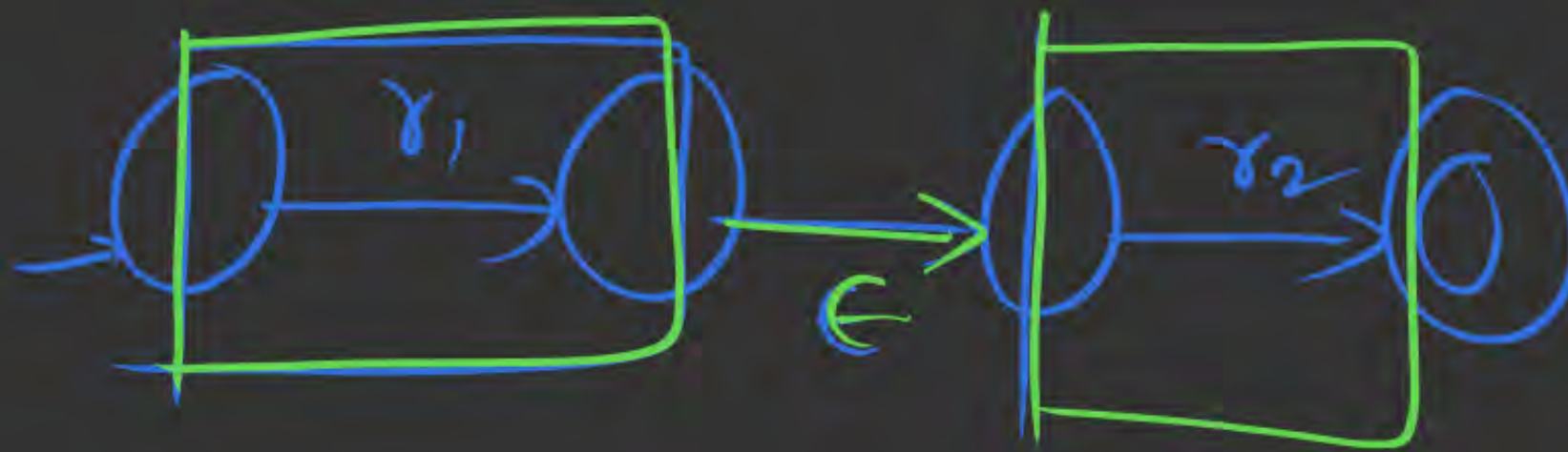


$$\{\overset{0}{\underbrace{\}}_{=\epsilon}} \quad \boxed{\overset{*}{\phi}}_{=\epsilon} \quad \checkmark$$

$$\overset{+}{\phi} = \phi$$



$$\gamma_1 \cdot \gamma_2$$



#Q.

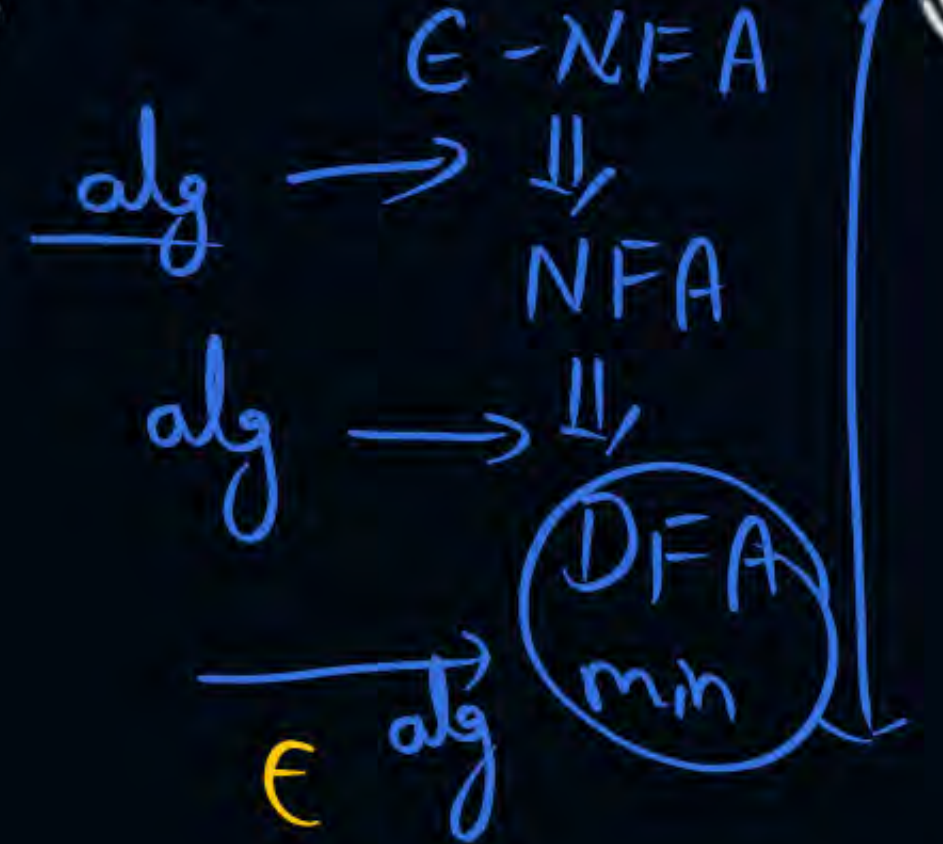
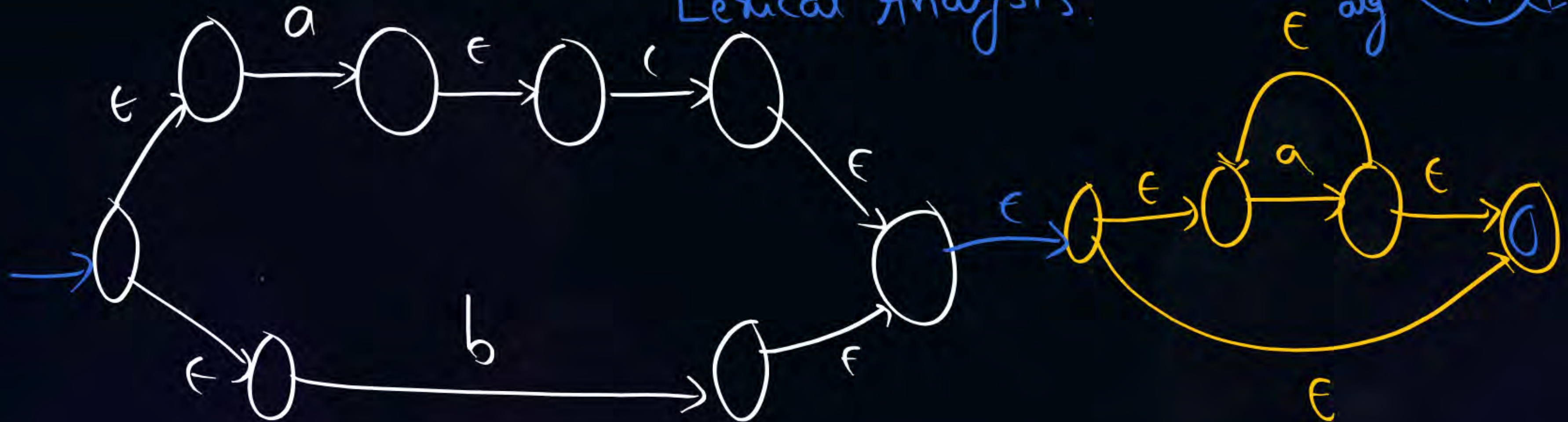
Construct Regular Expression for the following Regular Expression

$(ac+b)$ a^*

$(ac+b)$

Compiler
Lexical Analysis

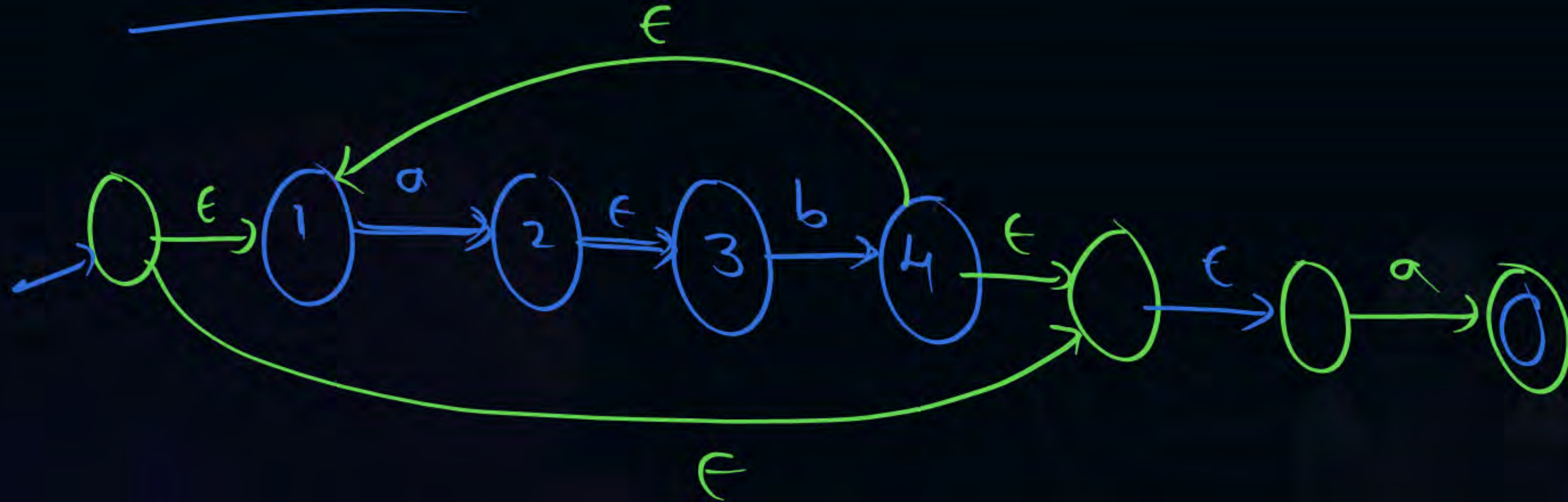
a^*



#Q. Construct Finite Automata for the given regular expression

$(a.b)^* a$

E-NFA



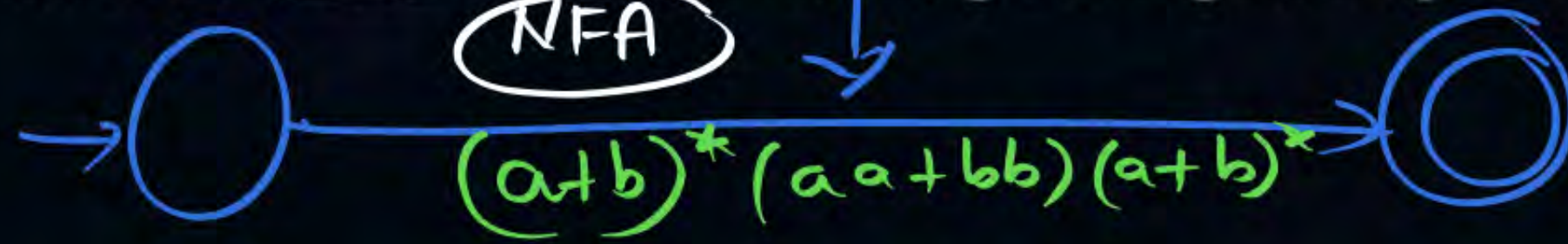
$(ab)^*$

#Q.

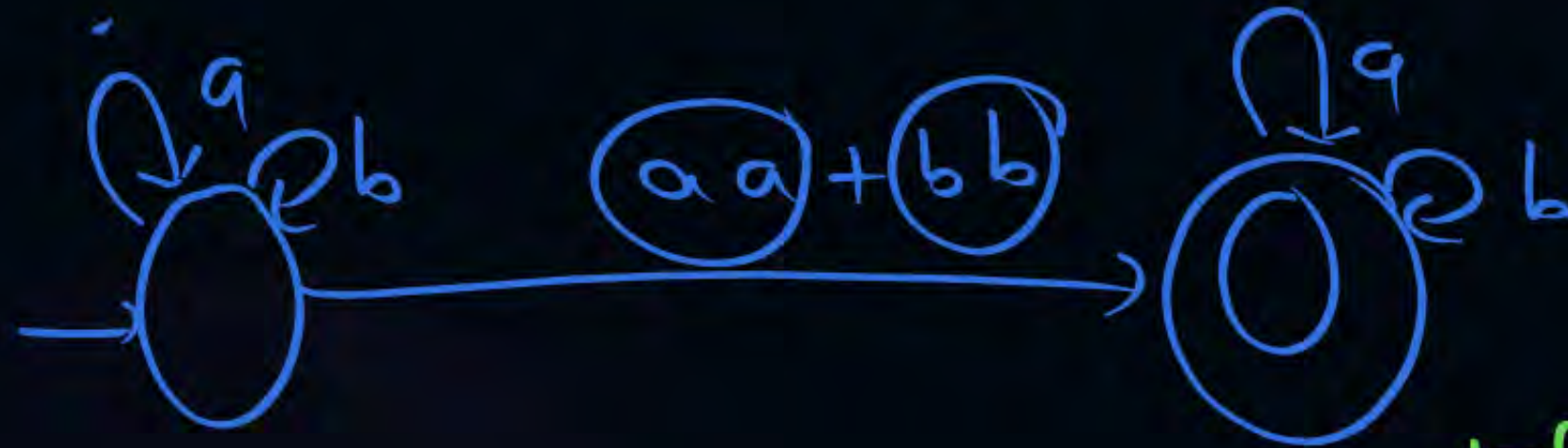
Construct ~~finite automata~~ NFA for the given regular expression

$(a+b)^* (aa+bb) (a+b)^*$

①

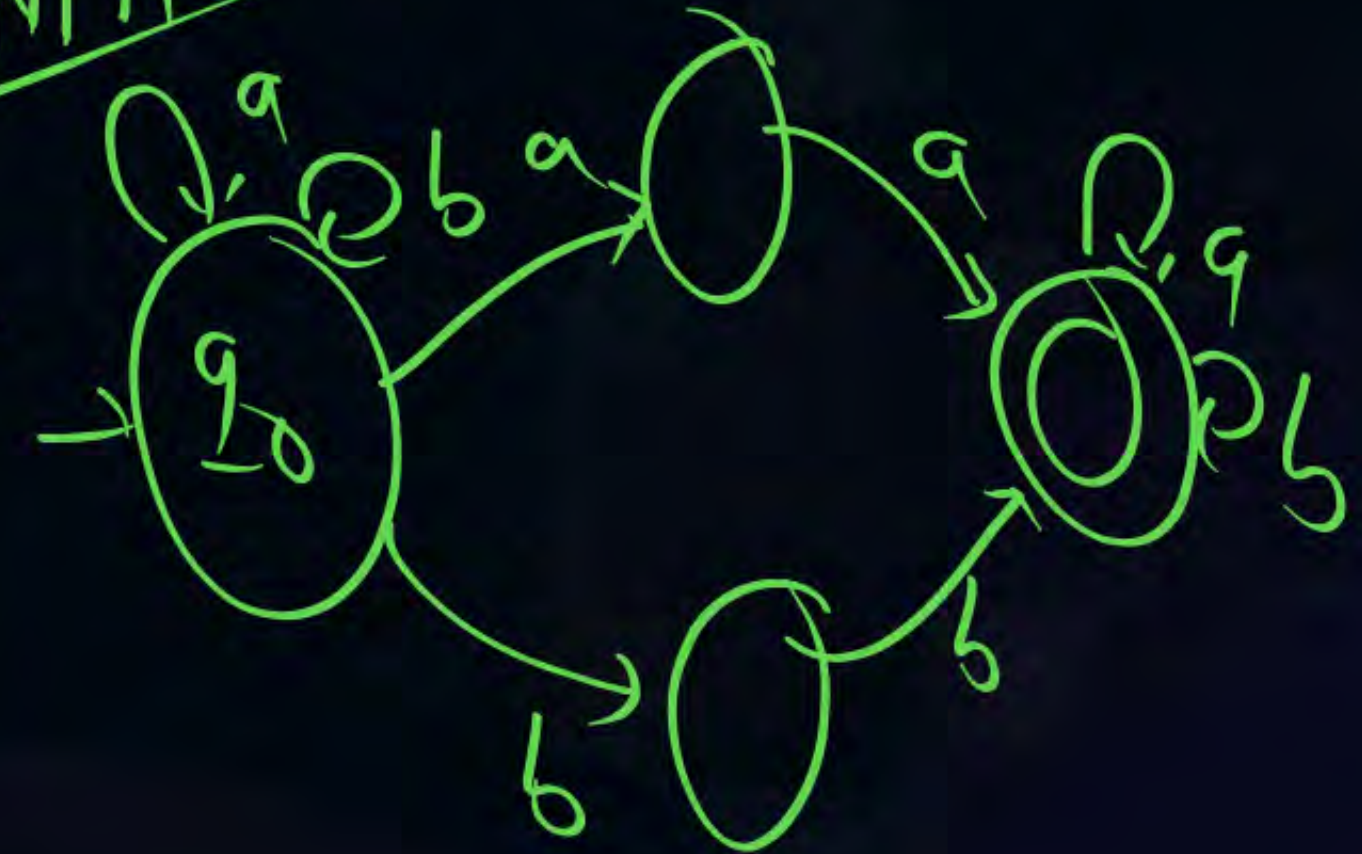


{ State elimination
in Reverse }



NFA

4 states



#Q.

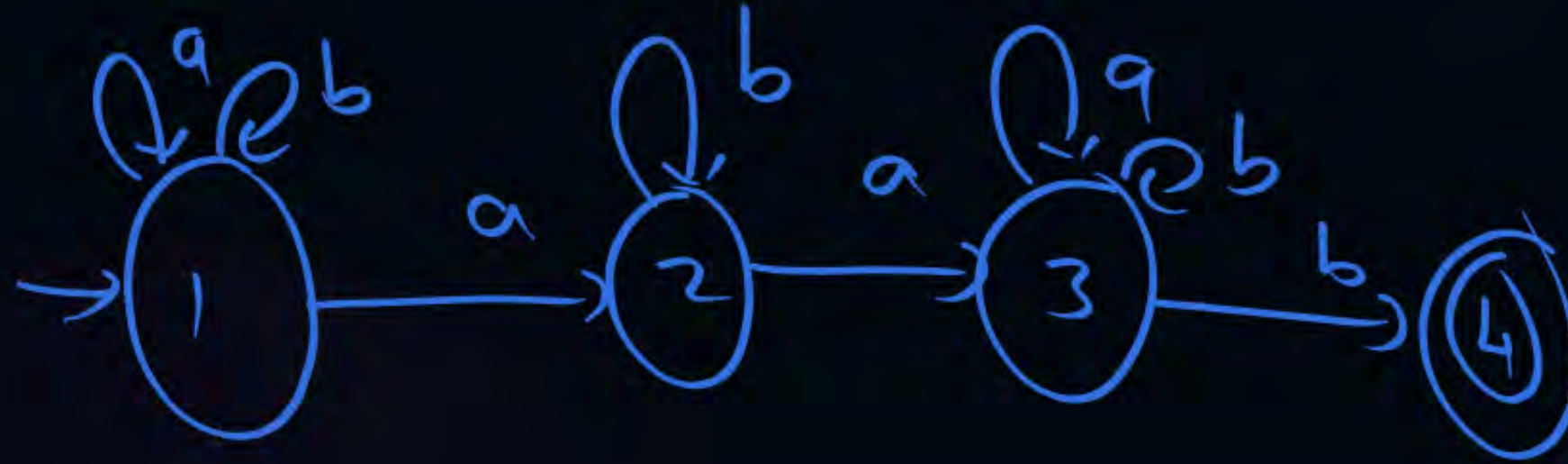
Construct Finite Automata for the given regular expression

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

NFA

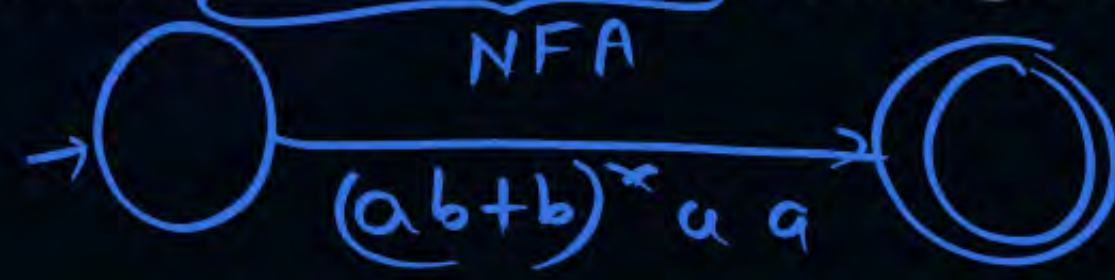


10 am



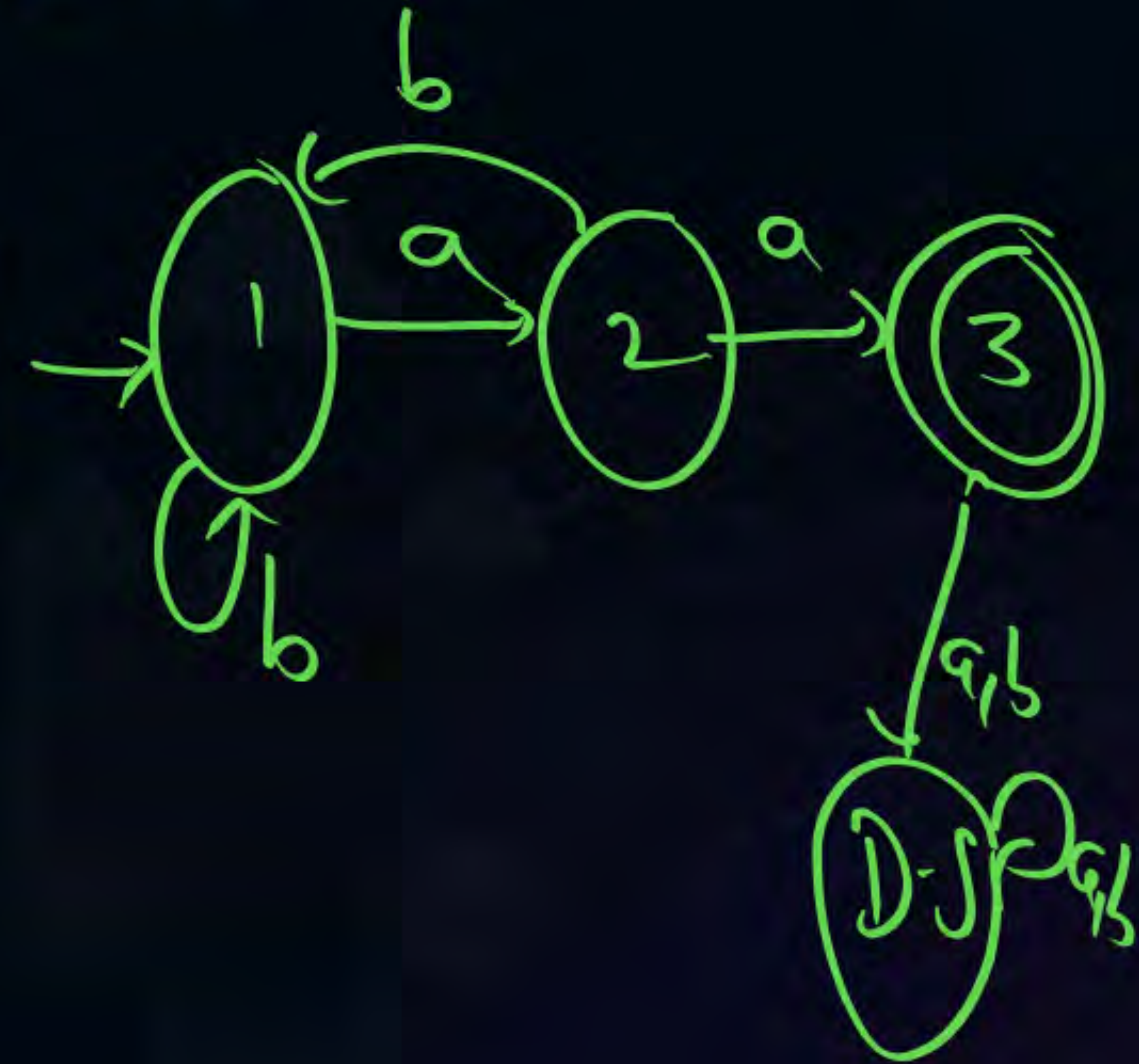
#Q.

Construct Finite Automata for the given regular expression $(ab+b)^* aa$

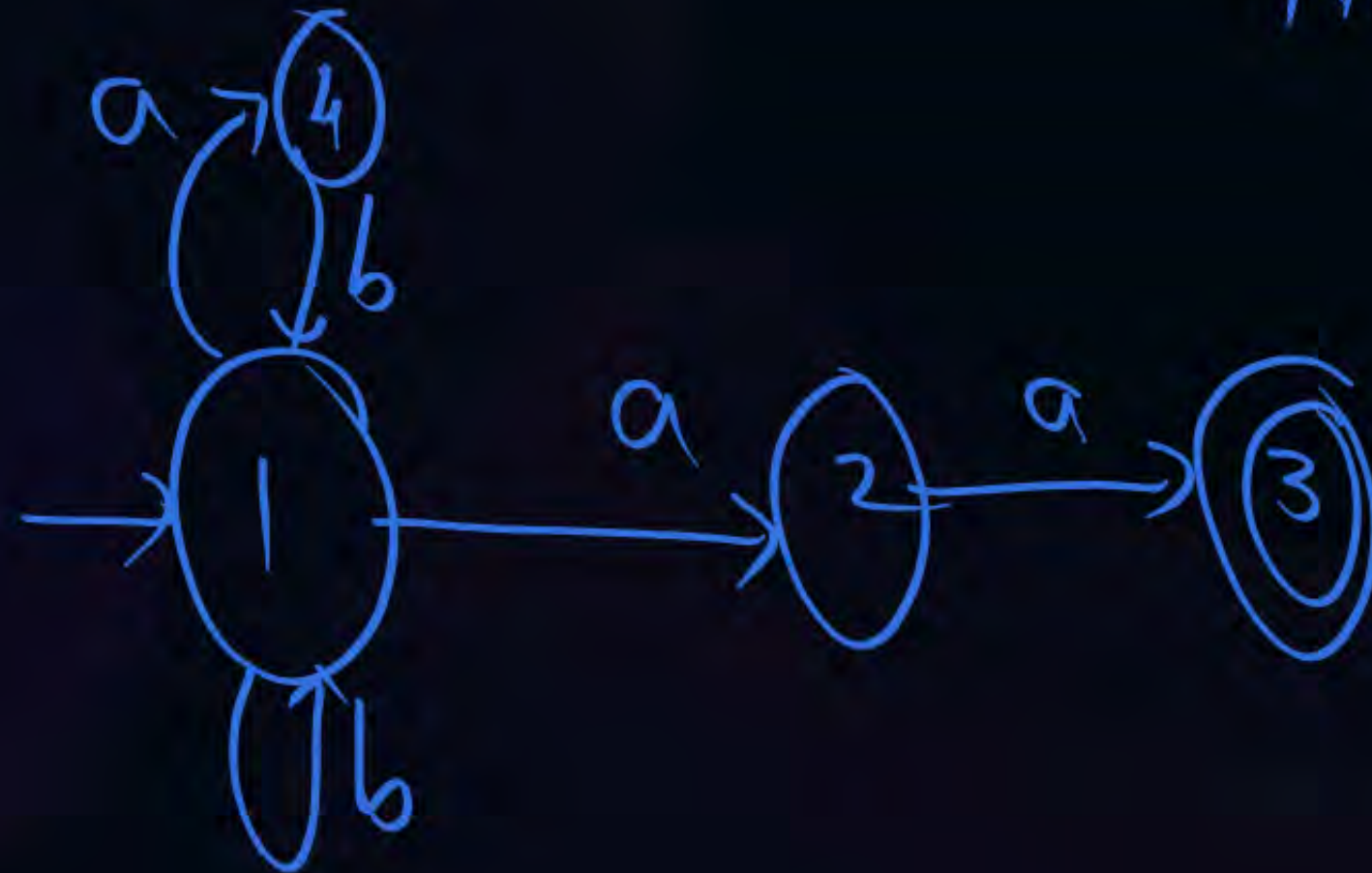


Home Work

NFA \rightarrow min DFA

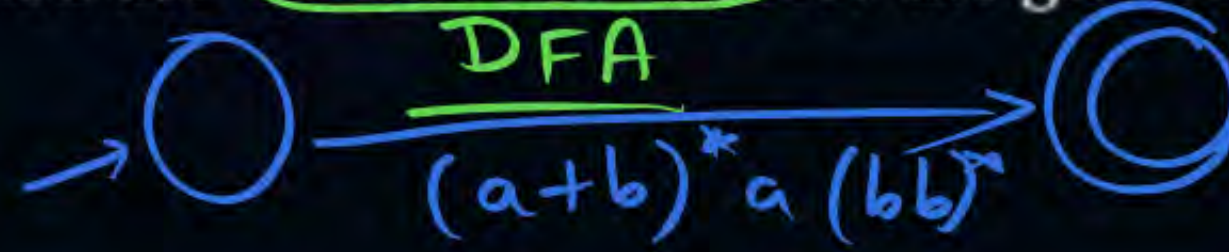


NFA

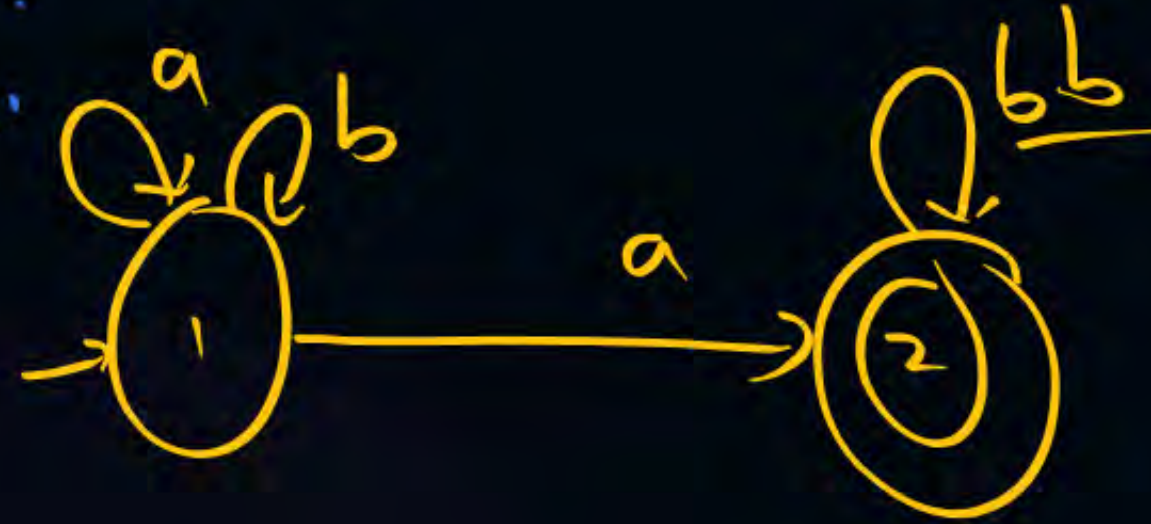


#Q.

Construct Finite Automata for the given regular expression $(a+b)^* a (bb)^*$



NFA



Home Work

DFA

3 states

NFA



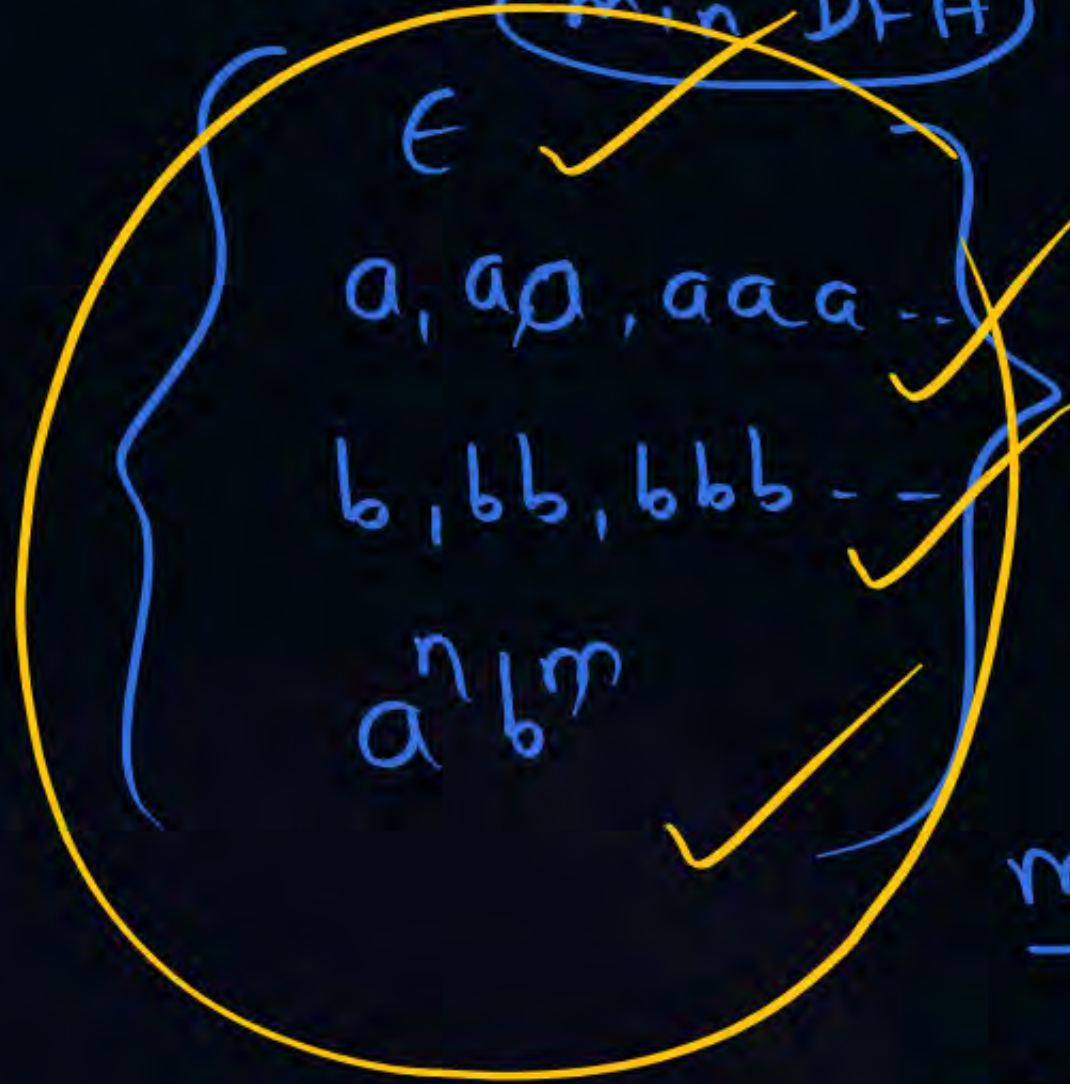
#Q.

Construct ~~Finite Automata~~ for the given regular expression

a^*b^*

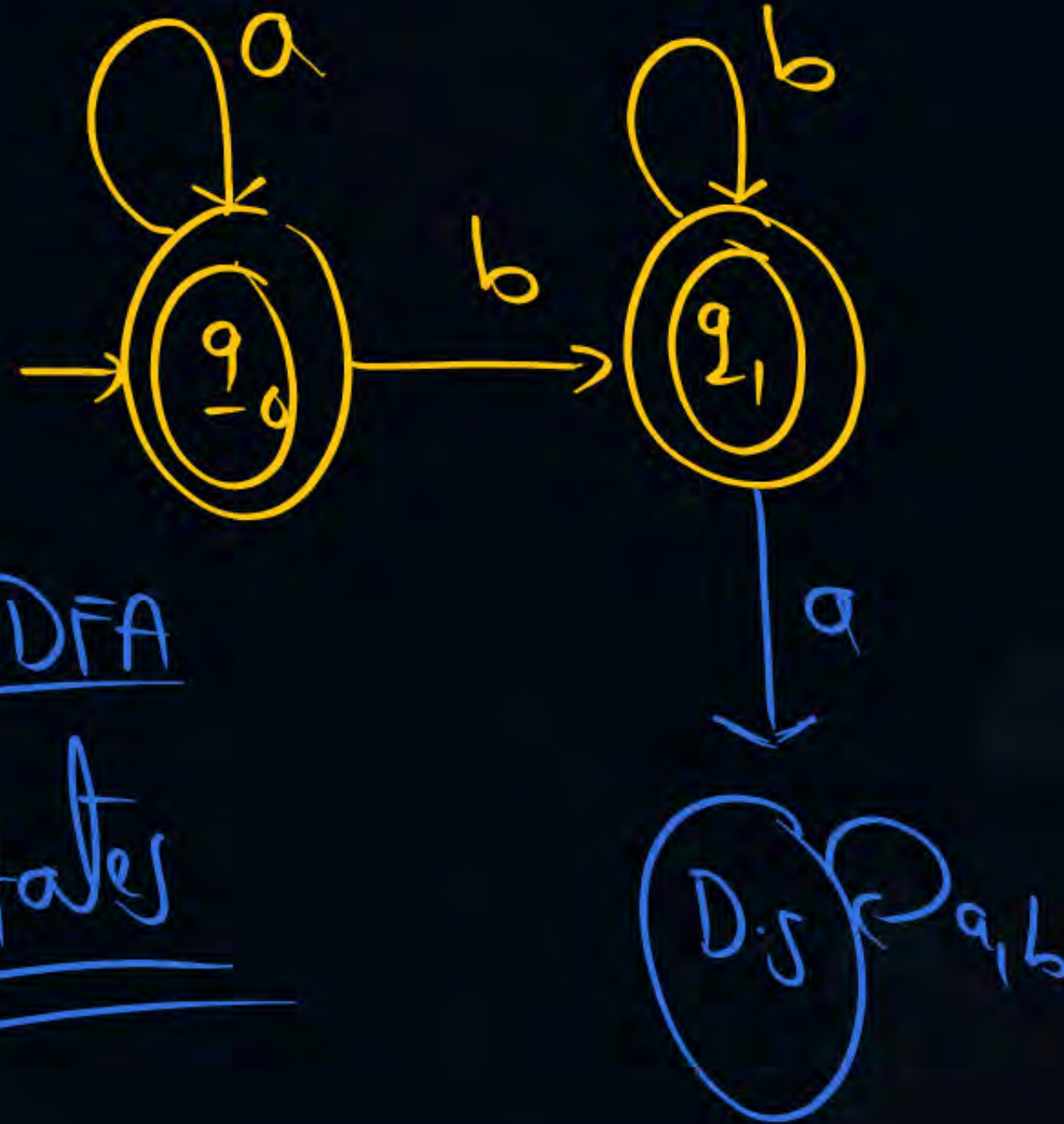
$$L = \{a^n b^m \mid n, m \geq 0\}$$

min DFA



min DFA

3 states



$(a+b)^*$



$$\underline{a^*} \underline{b^*} \xrightarrow{\min \frac{DFA}{(n+1)}} 3$$

$$\underline{a^*} \underline{b^*} \underline{c^*} \rightarrow 4$$

$$\underline{a^*} \underline{b^*} \underline{c^*} \underline{d^*} \rightarrow 5$$

$$a^* b^* c^* d^* e^* \dots z^* \rightarrow 27$$

$$0^* 1^* 2^* 3^* \dots 9^* \rightarrow \textcircled{11}$$

10 am

min
DFA

#Q.

Construct Finite Automata for the given regular expression

$a^*b^*c^*$

#Q.

Construct Finite Automata for the given regular expression $(11 + 111)^*$



THANK - YOU