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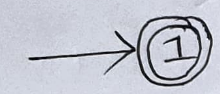
Section - M

1.A Give NFAs with the specified number of states recognizing each of the following language. In all cases, the alphabet is $\Sigma = \{0,1\}$

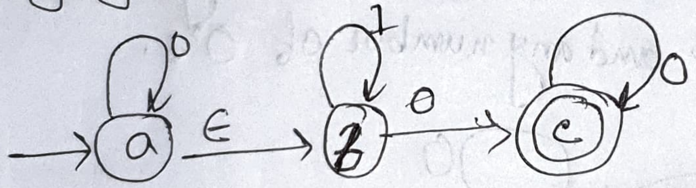
ⓐ The language $\{\epsilon\}$ with one state.

$\boxed{\text{ANS:}}$

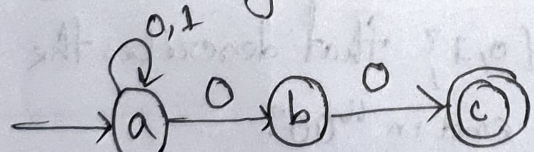


ⓑ The language $0^*1^*0^*0$ with three states.

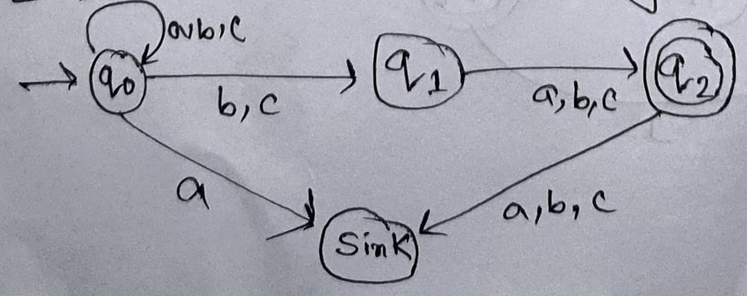
$\boxed{\text{ANS:}}$



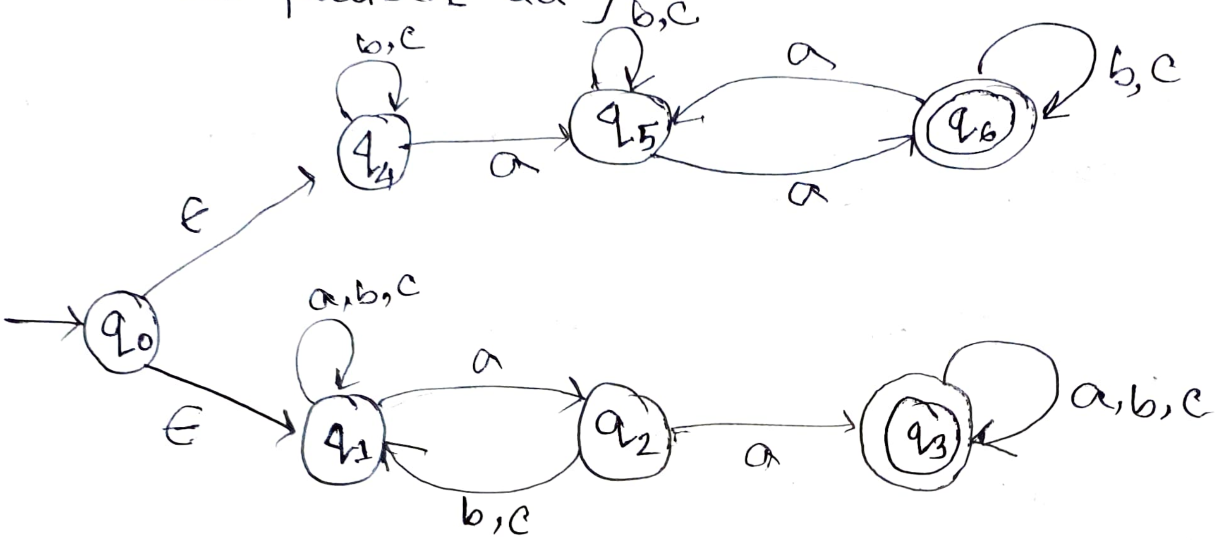
ⓒ Draw the simplest possible NFA (in terms of number of states and arcs) for $\Sigma = \{0,1\}$ that describles the language of all strings that end in "00"



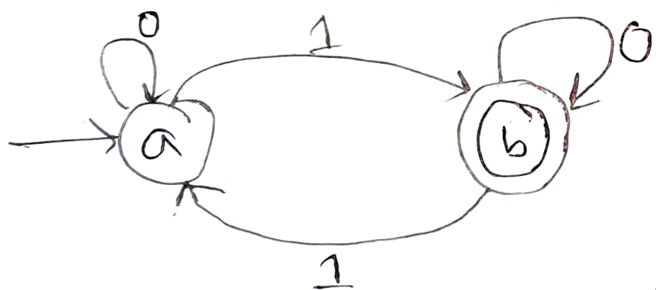
$\boxed{B}$ Give NFAs with for the following languages where alphabet is $\Sigma = \{a,b,c\}$. ⓐ $L1 = \{w$: the second last symbol of w is not 'a'$\}$



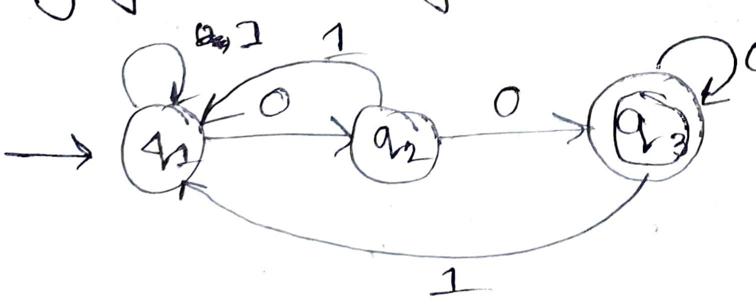
(b) L2 = {w: w contains an even number of a's or contains the pattern 'aa'}



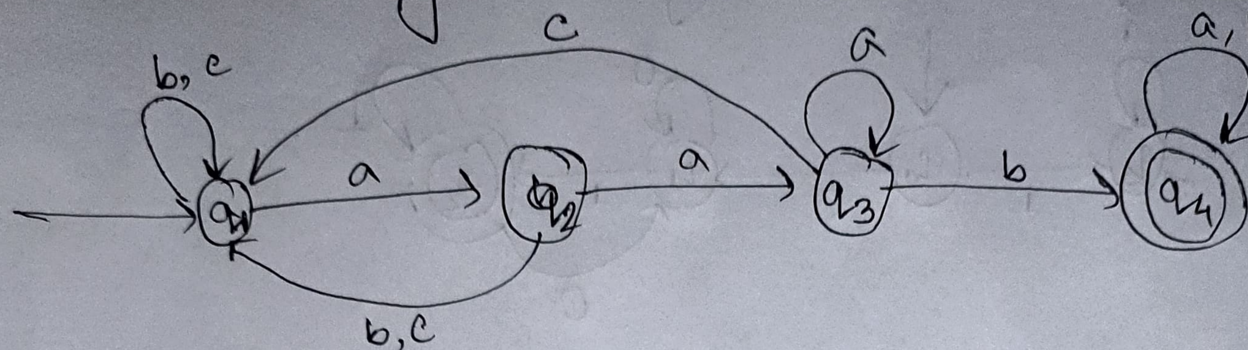
2 (A) Give a DFA for $\Sigma = \{0,1\}$ and strings that have an odd number of 1's and any number of 0's.



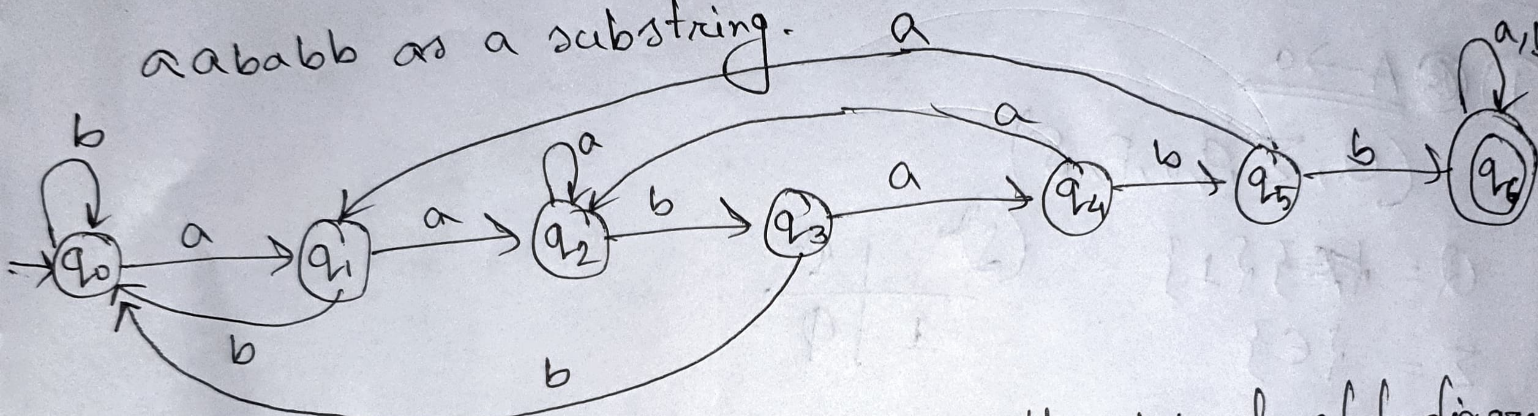
(B) Draw the simplest possible DFA (in terms of number of states and arcs) for $\Sigma = \{0,1\}$ that describes the language of all strings that end in "00".



(C) Give a DFA for $\Sigma = \{a,b,c\}$ that accepts any string with aab as a substring. (3)

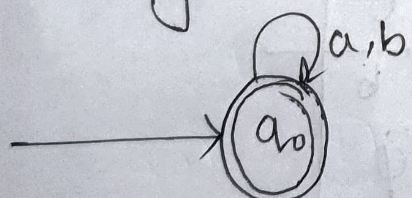


(D) Give a DFA for $\Sigma = \{a,b\}$ that accepts any strings with aababb as a substring.

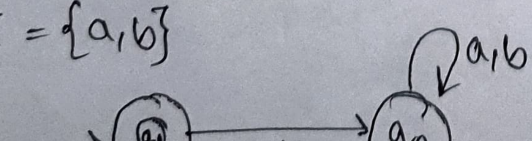


(3) For each of the below parts, draw the minimal state diagram of the DFA that recognizes the given language.

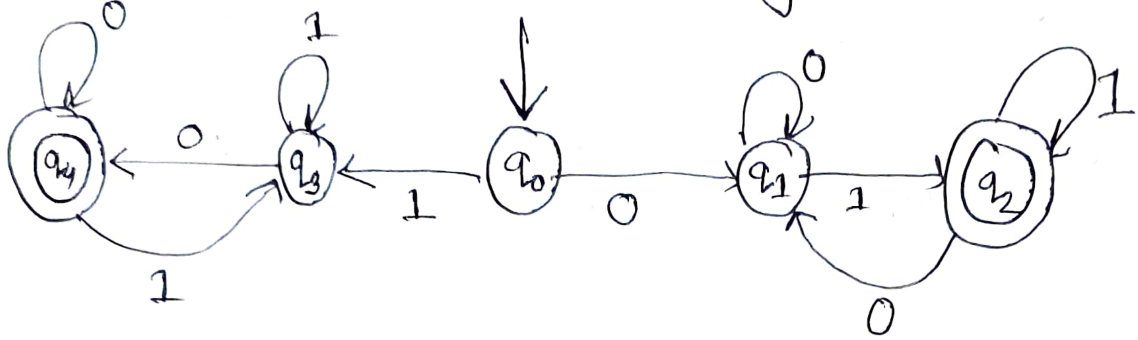
A. L = the empty ϕ language with $\Sigma = \{a,b\}$



B. L = the language that accepts only the empty string ϵ with $\Sigma = \{a,b\}$



c $L = \{ w \in \Sigma^* \mid w$ does not contain an equal number of occurrences of the substrings 01 and 10$\}$ with $\Sigma = \{0,1\}$



4. Write formal definition for the question 1,3.

1 A → a

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

$Q = \{1\}$

$\Sigma = \{\epsilon\}$

$q_0 = \{1\}$

$F = \{1\}$

δ	ϵ
1	ϕ

A → b

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

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

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

$q_0 = a$

$F = \{c\}$

	0	1	ϵ
a	a	ϕ	b
b	c	b	ϕ
c	c	ϕ	ϕ

$A \to c$

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

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

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

$q_0 = a$

$F = \{c\}$

δ

	0	1
a	a	a
b	c	φ
c	φ	φ

$B \to a$

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

$Q = \{q_0, q_1, q_2\}$

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

start state $q_0 = q_0$

$F = \{q_2\}$

	a	b	c
q_0	$\{q_0, \text{sink}\}$	q_0	q_0
q_1	q_2	q_2	q_2
q_2	sink	sink	sink

$\boxed{B \to b}$

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

$Q = \{q_0, q_1, q_2, q_3, q_4, q_5, q_6\}$

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

Start state, $q_0 = q_0$

$F = \{q_3, q_6\}$

δ

	a	b	c	ϵ
q_0	φ	φ	φ	$\{q_1, q_4\}$
q_1	$\{q_1, q_2\}$	q_1	q_1	φ
q_2	q_3	q_1	q_1	φ
q_3	q_3	q_3	q_3	φ
q_4	q_5	q_4	q_4	φ
q_5	q_6	q_5	q_5	φ
q_6	q_5	q_6	q_6	φ

$\boxed{3} \rightarrow A$

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

$Q = q_0$

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

start state $q_0 = q_0$

$F = \{q_0\}$

δ	a	b
q_0	q_0	q_0

$3 \rightarrow B$

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

$Q = \{q_1, q_2\}$

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

start state $q_0 = q_1$

$F = \{q_1\}$.

	a	b
q_1	q_2	q_2
q_2	q_2	q_2

3 — C

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

$Q = \{q_0, q_1, q_2, q_3, q_4\}$

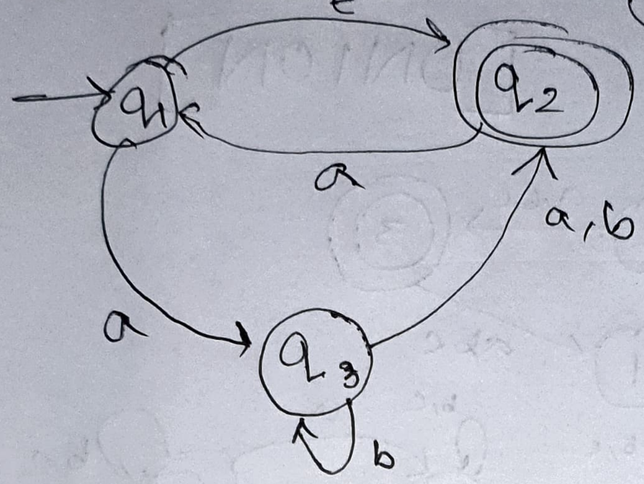
$\Sigma = \{0, 1\}$

start state $q_0 = q_0$

$F = \{q_2, q_4\}$

	0	1
q_0	q_1	q_3
q_1	q_1	q_2
q_2	q_1	q_2
q_3	q_4	q_3
q_4	q_4	q_3

5. Given the following state diagram of an NFA over the alphabet $\Sigma = \{a,b\}$, convert it into the state diagram of its equivalent DFA. Show every step.



Answer:

STT of NFA

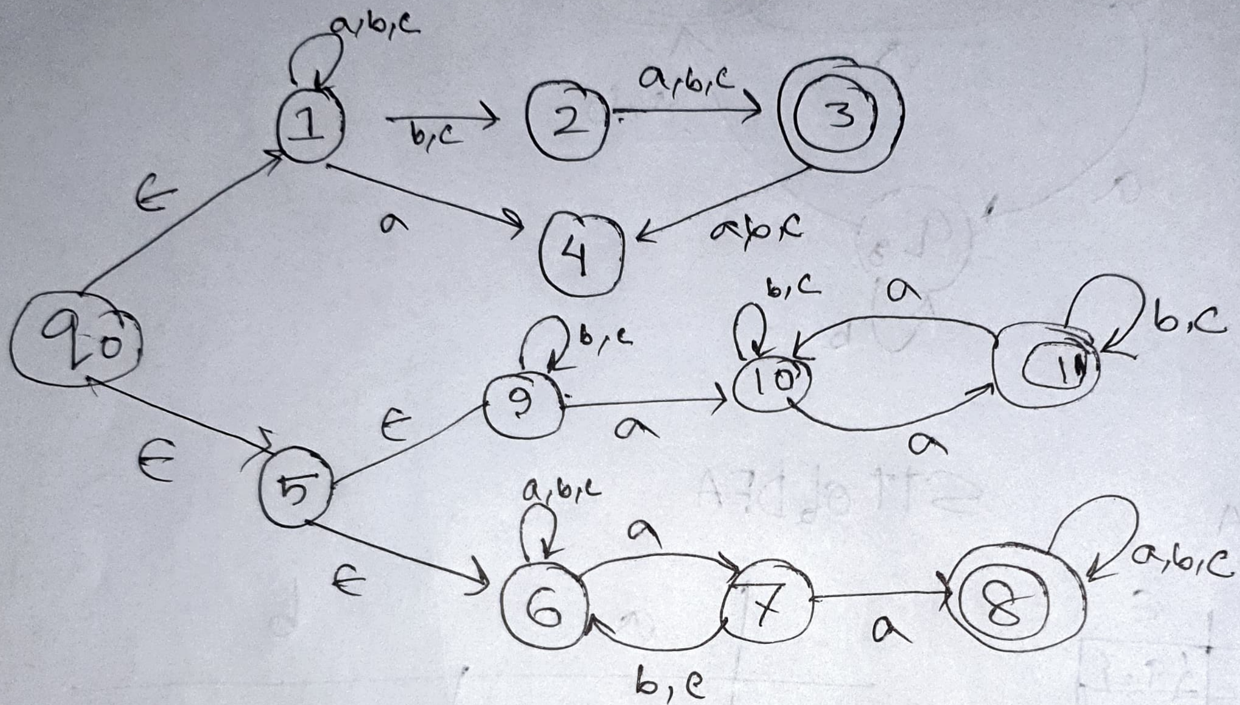
	a	b	ε
$\rightarrow q_1$	$\{q_3$	Φ	$\{q_2\}$
q_2	$\{q_1\}$	Φ	Φ
q_3	$\{q_2\}$	$\{q_2, q_3\}$	Φ

STT of DFA

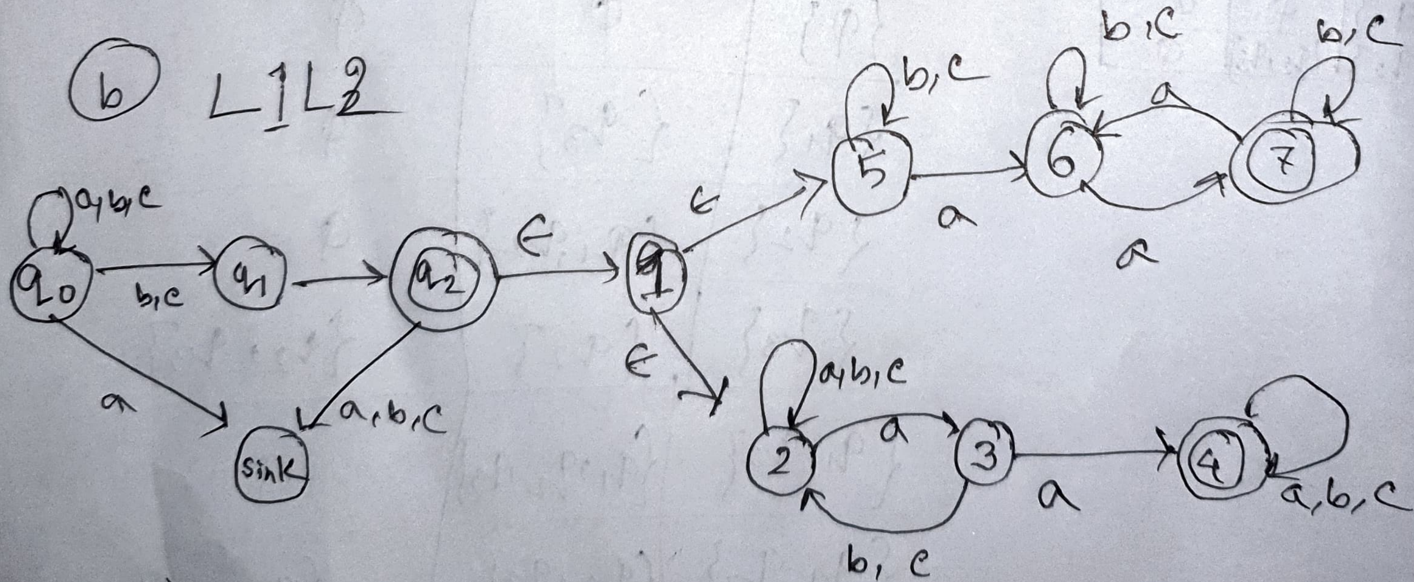
	a	b
$\{\Phi\}$	Φ	Φ
$\{q_1\}$	$\{q_3\}$	Φ
$\{q_2\}$	$\{q_1, q_2\}$	Φ
$\{q_3\}$	$\{q_2\}$	$\{q_2, q_3\}$
$\{q_1, q_2\}$	$\{q_1, q_2, q_3\}$	Φ
$\{q_1, q_3\}$	$\{q_2, q_3\}$	$\{q_2, q_3\}$
$\{q_2, q_3\}$	$\{q_1, q_2\}$	$\{q_2, q_3\}$
$\{q_1, q_2, q_3\}$	$\{q_1, q_2, q_3\}$	$\{q_2, q_3\}$

6 Based on our answer in 1 (B), design an NFA to recognize each of the following language:

ⓐ L1 U L2 [UNION]

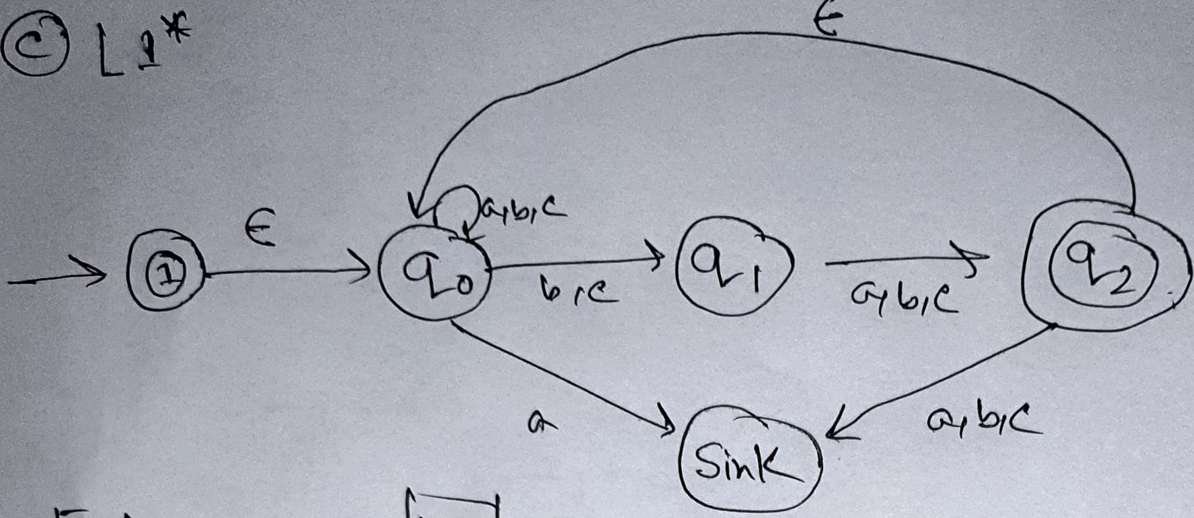


ⓑ L1L2



[CONCATENATION]

c) L_1^*



[star operation]