

ASSIGNMENT-1

Name: Mridul Dhiman [B-1]

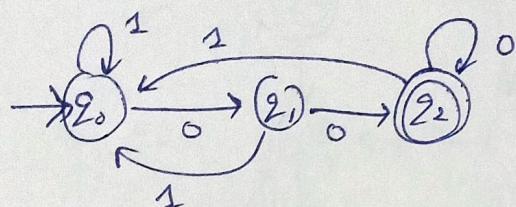
Roll no : 21103096

Submitted to: Dr. Samayveer Singh

Course Code: CSPC+301

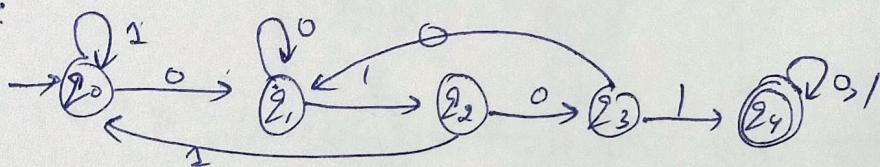
$$\textcircled{1} \quad \Sigma = \{0, 1\}$$

(a) $S:$



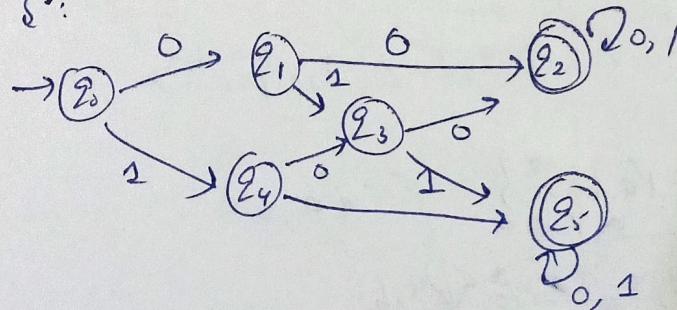
$$FA = \{(q_0, q_1, q_2, q_3), \{0, 1\}, S, q_0, q_2\}$$

(b) $S:$



$$Q = \{q_0, q_1, q_2, q_3, q_4\} \quad FA = \{Q, \{0, 1\}, S, q_0, q_4\}$$

(c) $S:$



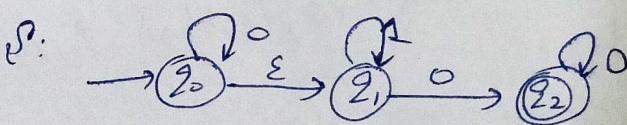
$$Q = \{q_0, q_1, q_2, q_3, q_4, q_5\}$$

$$F.A. = \{Q, \{0, 1\}, S, q_0, q_5\}$$

(d) $S:$ $\rightarrow q_0^{\Sigma}$

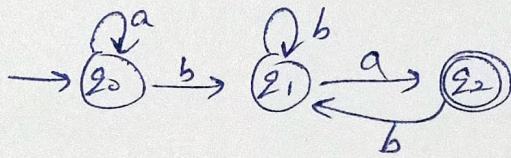
$$F.A. = \{q_0, \{0, 1\}, \Sigma, q_0, q_0\}$$

(e) $S:$



$$② L = a^* b (b \cup ab)^* a, \Sigma = \{a, b\}$$

S:



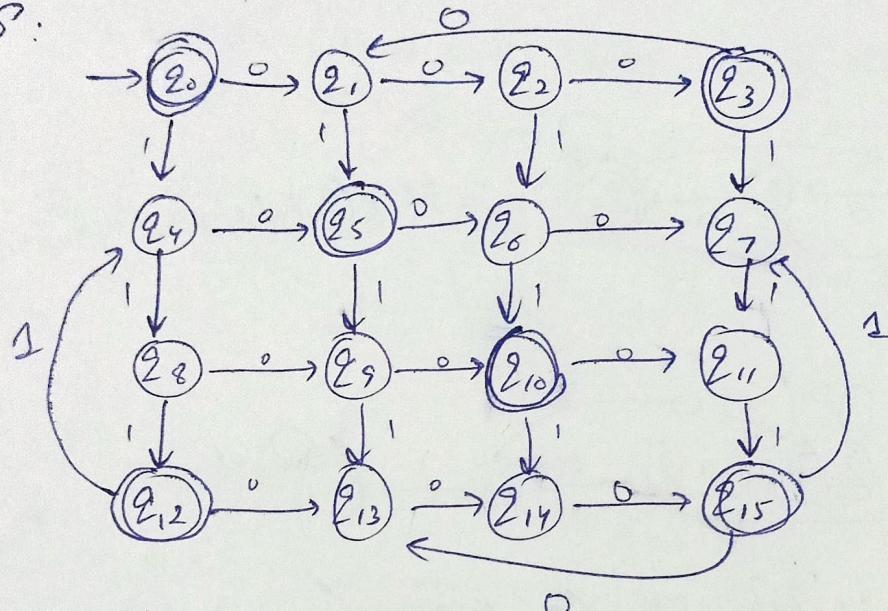
$$Q = \{q_0, q_1, q_2, q_3\}$$

$$F.A. = \{q_0, q_1, q_3, q_2, q_0, q_2\}$$

③

$$(a) A = \{w \in \{a, b\}^* \mid |n_a - n_b| \bmod 3 = 0\}$$

S:

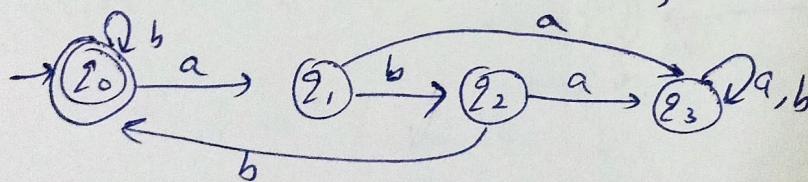


$$Q = \{q_0, q_1, \dots, q_{15}\}$$

$$F.A. = \{q_0, q_1, q_3, q_5, q_7, q_9, q_{11}, q_{13}, q_{15}, q_0, q_1, q_3, q_5, q_7, q_9, q_{11}, q_{13}, q_{15}\}$$

(b)

$$B = \{w \in \{a, b\}^* \mid w = (ab)^*\} \quad \Sigma = \{a, b\}$$

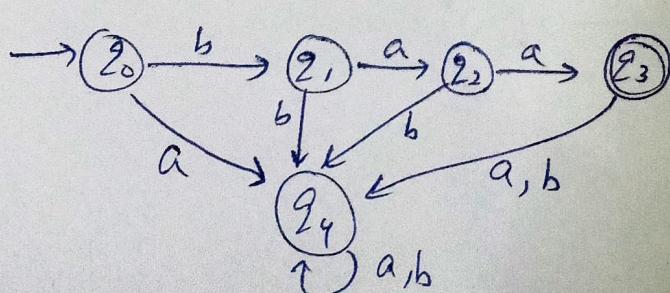


$$Q = \{q_0, q_1, q_2, q_3\}$$

$$F.A. = \{q_0, q_1, q_3, q_2, q_0, q_3\}$$

$$④ L = \{baaa\}, \Sigma = \{a, b\}$$

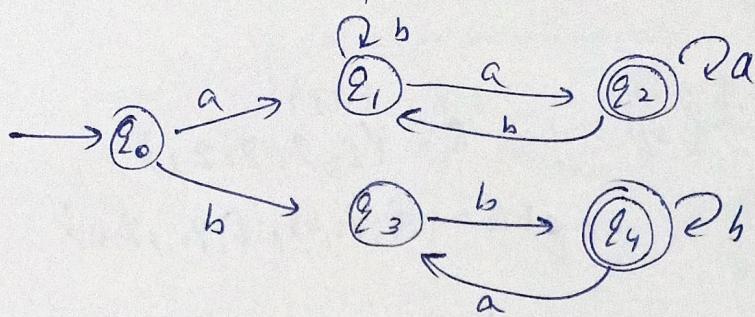
S:



$$Q = \{q_0, \dots, q_4\}$$

$$F.A. = \{q_0, q_1, q_3, q_4, q_0, q_4\}$$

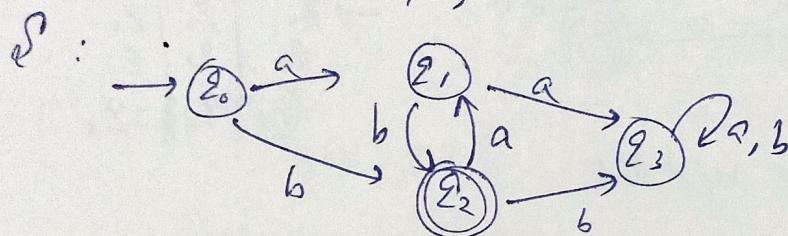
(5) $L = \{w \in \Sigma^* \mid w \neq \epsilon, \text{ and first \& last symbol is same}\}$



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

$$FA = \{Q, \{a, b\}, \Sigma, q_0, \{q_0, q_4\}\}$$

(6) $L = \{w \in \Sigma^* \mid n \text{ is non empty set of alternately seq of } a's \& b's\}$
 $\Sigma = \{a, b\}$

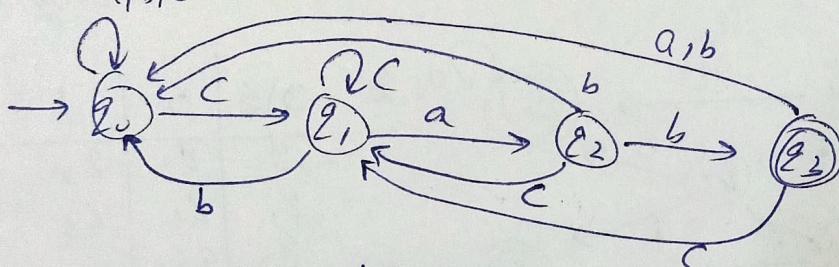


$$Q = \{q_0, q_1, q_2, q_3\}$$

$$FA = \{Q, \{a, b\}, \Sigma, q_0, \{q_1, q_3\}\}$$

(7) $L = \{w \in \Sigma^* \mid w \text{ ends in } 'cab'\}$

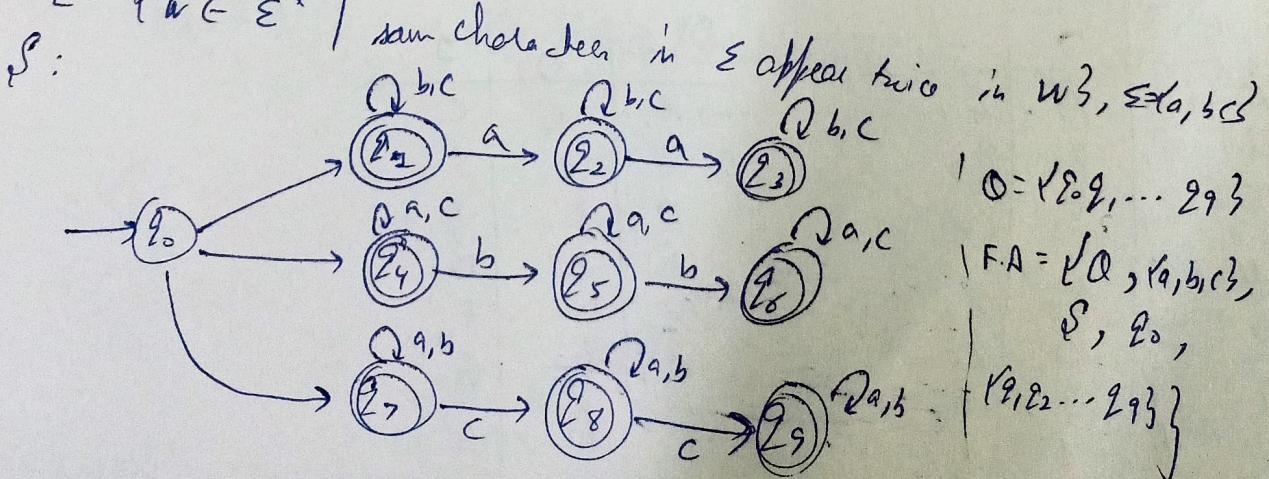
$\Sigma: a, b, c$, $\Sigma = \{a, b, c\}$



$$Q = \{q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7, q_8, q_9\}$$

$$FA = \{Q, \{a, b, c\}, \Sigma, q_0, \{q_9\}\}$$

(8) $L = \{w \in \Sigma^* \mid \text{same character in } \Sigma \text{ appear twice in } w\}$, $\Sigma = \{a, b, c\}$



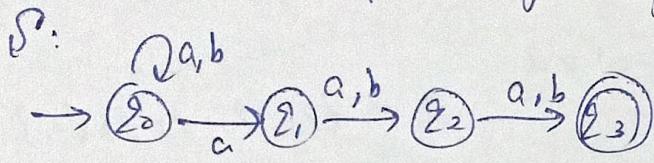
$$Q = \{q_0, q_1, \dots, q_9\}$$

$$FA = \{Q, \{a, b, c\}, \Sigma, q_0, \{q_9\}\}$$

$$S, q_0,$$

$$\{q_1, q_2, \dots, q_9\}\}$$

9) $L = \{ w \in \Sigma^* \mid \text{3rd symbol from last should be 'a'} \}$



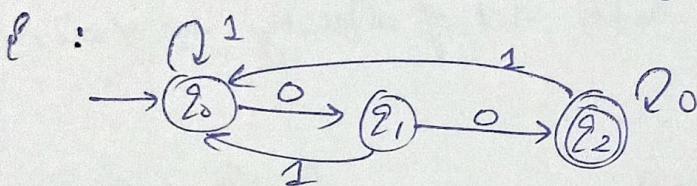
$$\Sigma = \{a, b\}$$

$$Q = \{Q_0, Q_1, Q_2, Q_3\}$$

$$FA = \{Q, \{a, b\}, S, Q_0, Q_3\}$$

10)

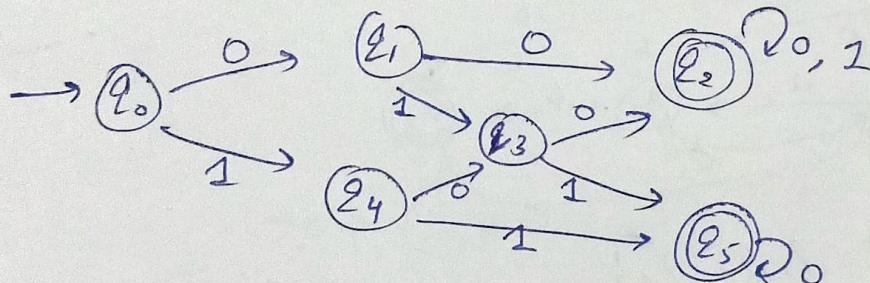
$L = \{ w \in \Sigma^* \mid w \text{ ends with } 00 \}$



$\delta \setminus \Sigma$	Σ	
δ	0	1
Q_0	Q_0	Q_0
Q_1	Q_1	Q_0
Q_2	Q_2	Q_0
Q_3	Q_2	Q_0

This is the reqd DFA

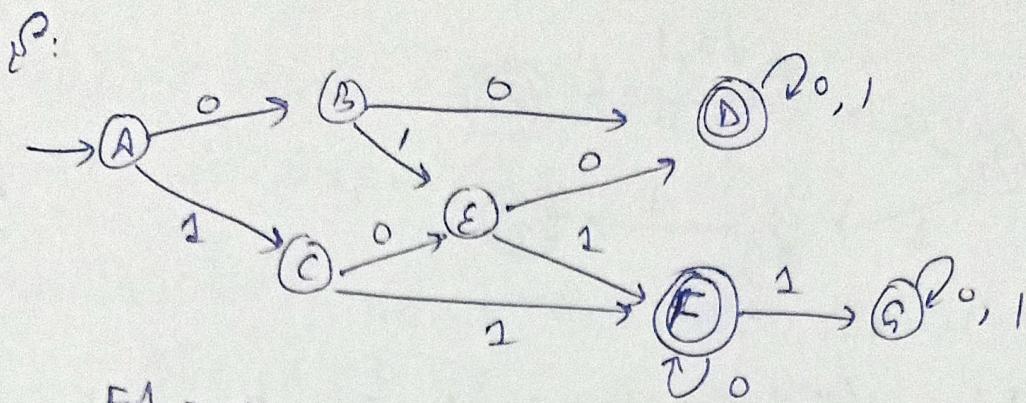
$L = \{ w \in \Sigma^* \mid w \text{ contains at least 2 } 0's, \text{ or exactly 2 } 1's \}$



$\delta \setminus \Sigma$	0	1
Q_0	Q_1	Q_4
Q_1	Q_2	Q_3
Q_2	Q_0	Q_5
Q_3	Q_4	Q_2
Q_4	Q_5	Q_0
Q_5	Q_0	Q_5

$\delta \setminus \Sigma$	0	1
(A) $\rightarrow Q_0$	Q_1	Q_4
(B) Q_1	Q_2	Q_3
(C) Q_4	Q_3	Q_5
(D) Q_2	Q_2	Q_2
(E) Q_3	Q_2	Q_5
(F) Q_5	Q_5	\emptyset
(G) \emptyset	\emptyset	\emptyset

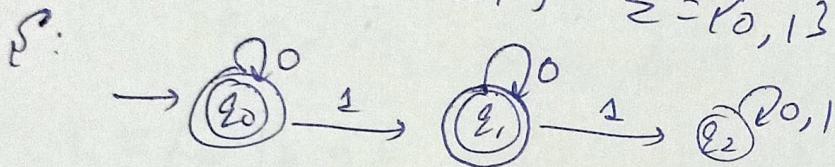
$\delta \setminus \Sigma$	0	1
$\rightarrow A$	B	C
B	D	E
C	E	F
D	D	D
E	D	F
F	F	G
G	G	G



$$FA = \{q_A, q_B, q_C, q_D, q_E, q_F, q_G\}, \{0, 1\}^*, \{q_0, q_1, q_2\}$$

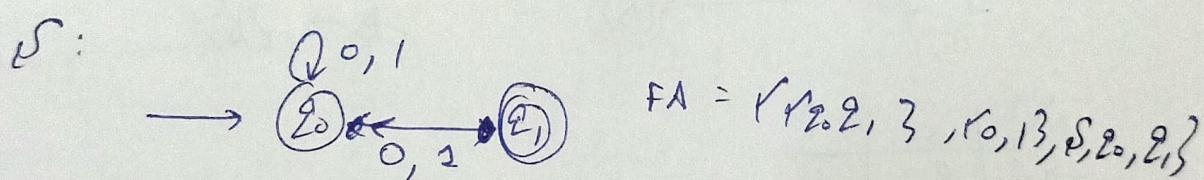
8

$$(11) L = \{w \in \Sigma^* \mid n(w) \leq 13\}$$



$$FA = \{q_0, q_1, q_2\}, \{0, 1\}^*, \{q_0, q_1, q_2\}$$

$$(12) L = \emptyset$$

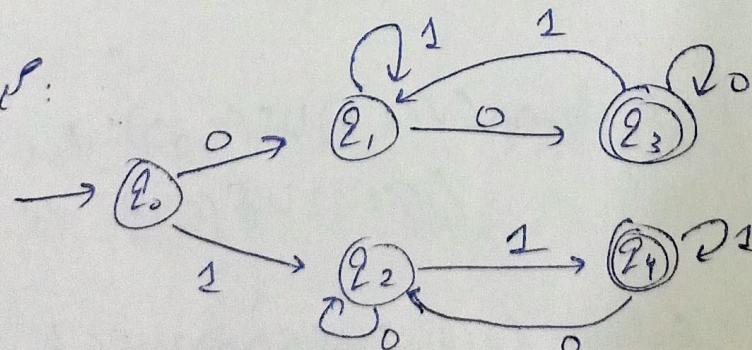


$$FA = \{q_0, q_1\}, \{0, 1\}^*, \{q_0, q_1\}$$

$$(13)$$

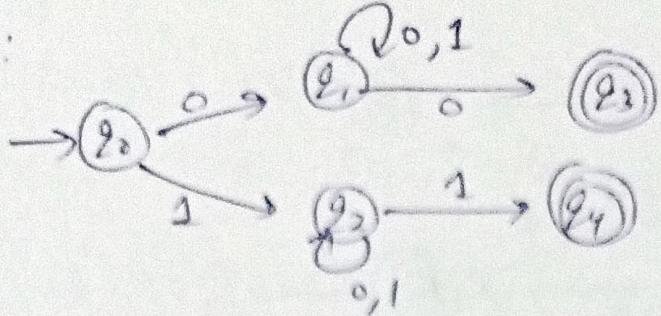
$\Sigma = \{0, 1\}$, $L = \{w \text{ w/begin & ends with same symbol} \mid |w| \geq 2\}$

(a)



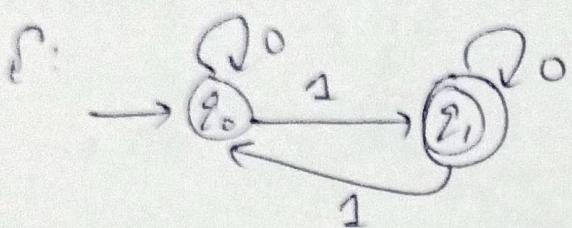
$$FA = \{q_0q_1, q_2q_3, q_4q_3, q_0, 1\}^*, \{q_1, q_3, q_0, q_2q_3\}$$

(b) f:



$$FA = \ell^*(q_0 q_1 q_2 q_3, q_0, 13, \delta, q_{\text{final}} q_3, 2, 3)$$

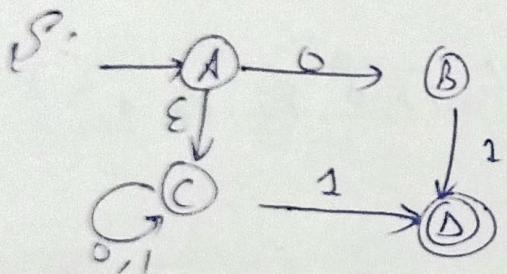
(14)



$$FA = \ell^*(q_0 q_1, 10, 13, \delta, q_{\text{final}} q_1, 2, 3)$$

(15)

(a)



\in closure of
 $A \rightarrow \{A, C\}$
 $B \rightarrow \{B\}$
 $C \rightarrow \{C\}$
 $D \rightarrow \{D\}$

$\emptyset \setminus \epsilon$	0	1
$\rightarrow A$	B	-
B	-	D
C	C	$\{C, D\}$
$\rightarrow D$	-	-

For $\{A, C\}$:

$$\ell^*(\{A, C\}, 0) = \in \text{ closure } (\ell(A, 0) \cup \ell(C, 0)) = \{B, C\}$$

$$\ell^*(\{A, C\}, 1) = \in \dots (\ell(A, 1) \cup \ell(C, 1)) = \{C, D\}$$

For $\{B, C\}$

$$\ell^*(\{B, C\}, 0) = \in \text{ closure } (\ell(B, 0) \cup \ell(C, 0)) = \{C\}$$

$$\ell^*(\{B, C\}, 1) = \in \dots (\ell(B, 1) \cup \ell(C, 1)) = \{C, D\}$$

$\text{Ror}(C) :$

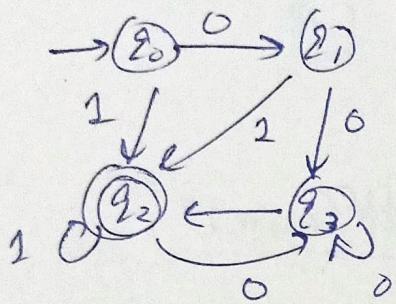
$$S'(C, 0) = \text{closure}(\{f(C, 0)\}) = \{C\}$$

$$S'(C, 1) = \text{closure}(\{f(C, 1)\}) = \{C, D\}$$

Now let $(A, C) \rightarrow \{e_0\}$, $(B, C) \rightarrow \{e_1\}$, $(C, D) \rightarrow \{e_2\}$, $(C, B) \rightarrow \{e_3\}$

$$\Omega_0 = \{A, C\} = \{e_0\} \quad \Omega_1 = \{C, D\} = \{e_2\}$$

8:

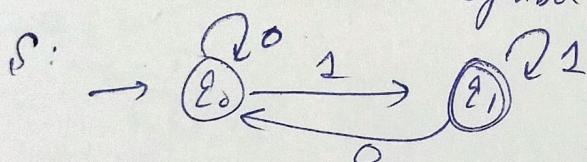


$\Omega \setminus \Sigma$	0	1
e_0	e_0	e_2
e_1	e_1	e_2
e_2	e_3	e_2
e_3	e_3	e_2

$$FA = \{ \{e_0, e_1, e_2, e_3\}, \{e_0, e_1\}, S, \{e_0, e_2\} \}$$

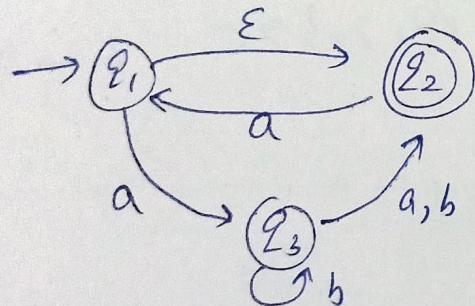
(b) $L = \{w \mid w \text{ ends with symbol '1'}\}$

9:



$$FA = \{ \{e_0, e_3\}, \{e_0, e_1\}, S, \{e_0, e_1\} \}$$

10



$\Omega \setminus \Sigma$	a	b
e_2	e_3	-
e_2	e_1	-
e_3	e_2	$\{e_2, e_3\}$

ϵ closure: $e_1 \Rightarrow \{e_2, e_3\}$ $e_2 \Rightarrow \{e_2, e_3\}$ $e_3 \Rightarrow \{e_3\}$

\therefore For $\{e_2, e_3\}$:

$$S'(\{e_2, e_3\}, a) = \text{closure}(\{e_2, a\} \cup \{e_3, a\}) = \{e_2, e_3, e_1\}$$

$$S'(\{e_2, e_3\}, b) = \text{closure}(\{e_2, b\} \cup \{e_3, b\}) = \emptyset$$

For $\{q_1, q_2, q_3\}$:

$$\begin{aligned} S'(\{q_1, q_2, q_3\}, a) &= \text{closure}(S(q_1, a) \cup S(q_2, a) \cup S(q_3, a)) \\ &= \{q_1, q_2, q_3\} \end{aligned}$$

$$\begin{aligned} S'(\{q_1, q_2, q_3\}, b) &= \text{closure}(S(q_1, b) \cup S(q_2, b) \cup S(q_3, b)) \\ &= \{q_2, q_3\} \end{aligned}$$

For $\{q_2, q_3\}$:

$$\begin{aligned} S'(\{q_2, q_3\}, a) &= \text{closure}(S(q_2, a) \cup S(q_3, a)) \\ &= \{q_1, q_2\} \end{aligned}$$

$$\begin{aligned} S'(\{q_2, q_3\}, b) &= \text{closure}(S(q_2, b) \cup S(q_3, b)) \\ &= \{q_2, q_3\} \end{aligned}$$

For \emptyset :

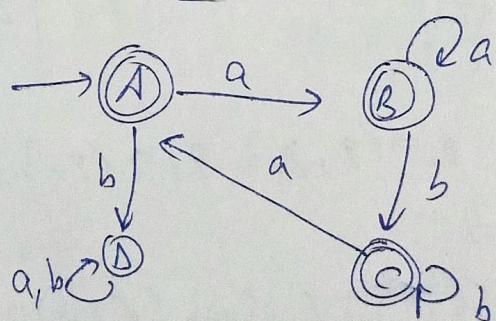
$$S'(\emptyset, a) = \emptyset$$

$$S'(\emptyset, b) = \emptyset$$

Let, $(q_1, q_2, q_3 \rightarrow A)$ $\{q_1, q_2, q_3\} \rightarrow B$ $\{q_2, q_3\} \rightarrow C$ $\emptyset \rightarrow D$

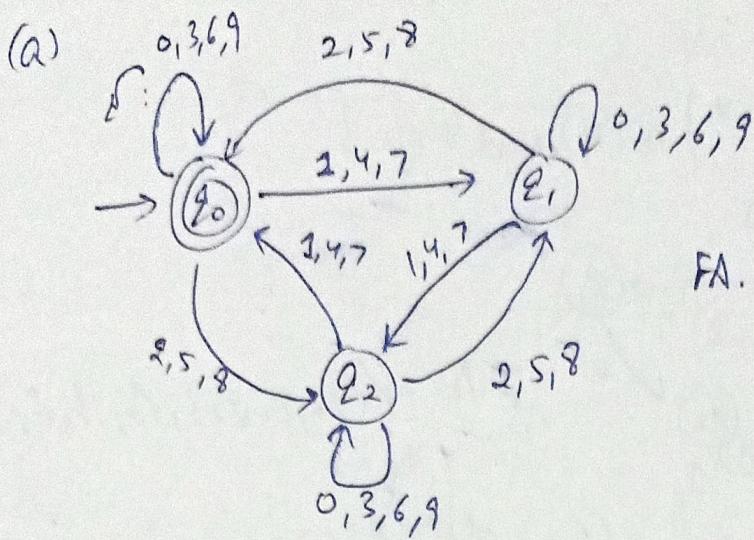
$\emptyset \subseteq$	a	b
$\rightarrow (A)$	\emptyset	Δ
$\rightarrow (B)$	\emptyset	C
$\rightarrow (C)$	A	C
$\rightarrow (D)$	\emptyset	Δ

regd PFA:

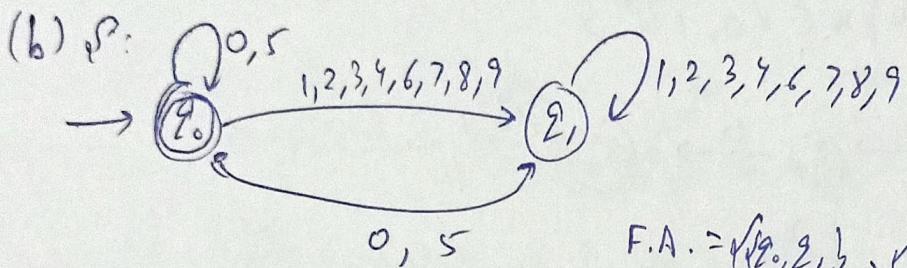


$$F^A = \{\{A, B, C, D\}, \{a, b\}, S, A, \{A, B, C\}\}$$

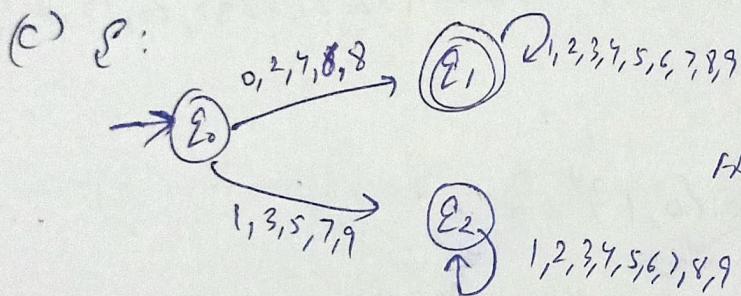
(18)



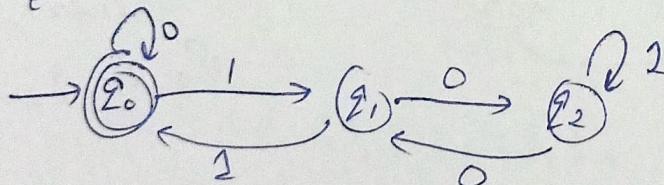
$$FA = \{ (q_0, q_2), (q_0, \dots, q_3), \\ \{q^P, q_0, q_0\} \}$$



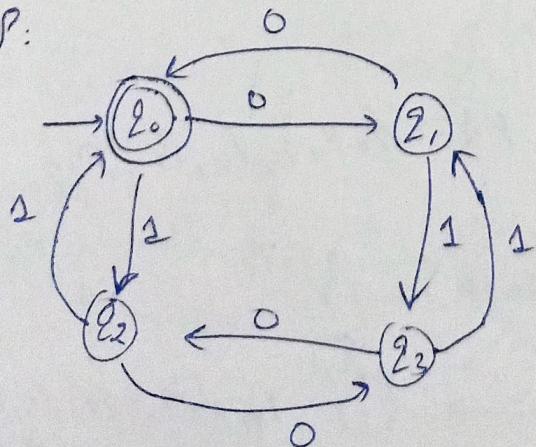
$$FA = \{ (q_0, q_1), (q_0, \dots, q_3), \\ \{q^P, q_0, q_0\} \}$$



$$FA = \{ (q_0, q_2), (q_0, \dots, q_3), \\ \{q^P, q_0, q_0\} \}$$

(19) δ^P :

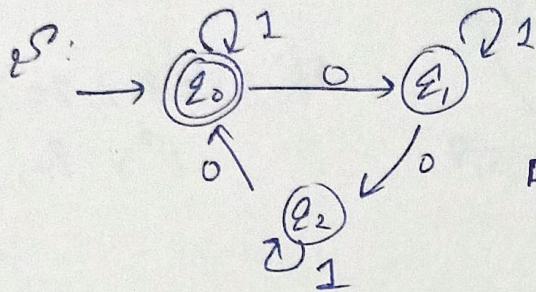
$$FA = \{ (q_0, q_2), (q_0, \dots, q_3), \\ \{q^P, q_0, q_0\} \}$$

(20) δ^P :

$$FA = \{ (q_0, q_2), (q_0, \dots, q_3), \\ \{q^P, q_0, q_0\} \}$$

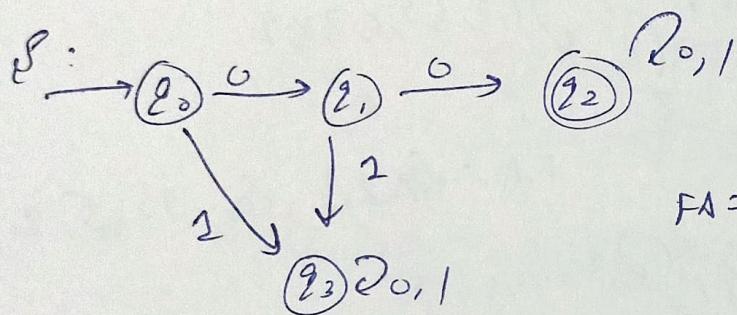
(21)

$$(a) L = \{w \in \{0, 1\}^* \mid n_0(w) \bmod 3 = 0\}$$



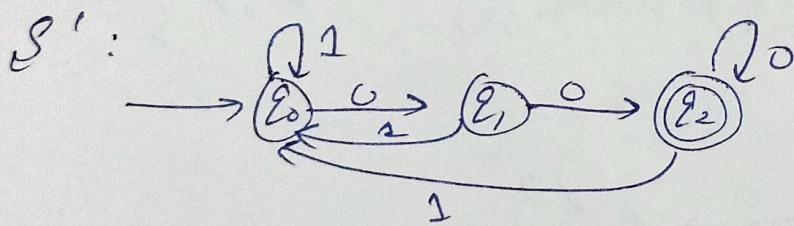
$$FA = \{(q_0, q_1, q_2, q_3, \delta, q_0, q_3)\}$$

$$(b) L = \{00 \mid w \in \{0, 1\}^*\}$$



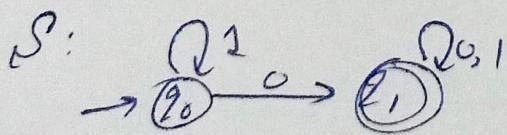
$$FA = \{(q_0, q_1, q_2, q_3, \delta, q_0, q_3)\}$$

$$(c) L = \{w00 \mid w \in \{0, 1\}^*\}$$



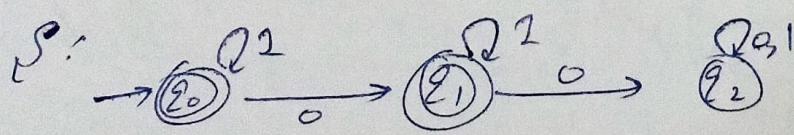
$$FA = \{(q_0, q_1, q_2, q_3, \delta, q_0, q_3)\}$$

$$(d) L = \{w \in \{0, 1\}^* \mid n_0(w) \geq 1\}$$



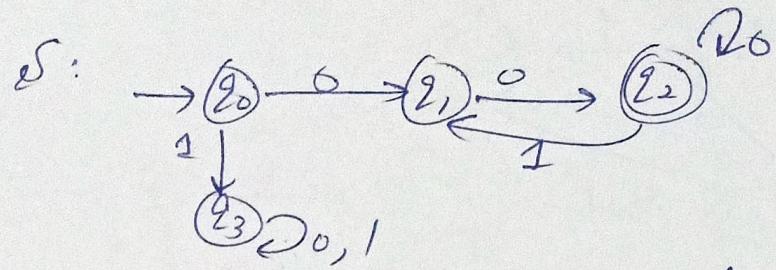
$$FA = \{(q_0, q_1, q_2, \delta, q_0, q_2)\}$$

$$(e) L = \{w \in \{0, 1\}^* \mid n_0(w) \leq 1\}$$



$$FA = \{(q_0, q_1, q_2, \delta, q_1, q_0)\}$$

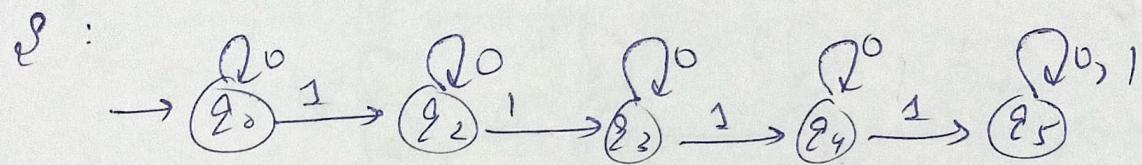
(?) $L = \{w_0 \mid w \in \{0,1\}^*\}$



$$FA = \{ (q_0, q_1, q_2, q_3, \varnothing, \{0,1\}, \delta, q_0, q_2) \}$$

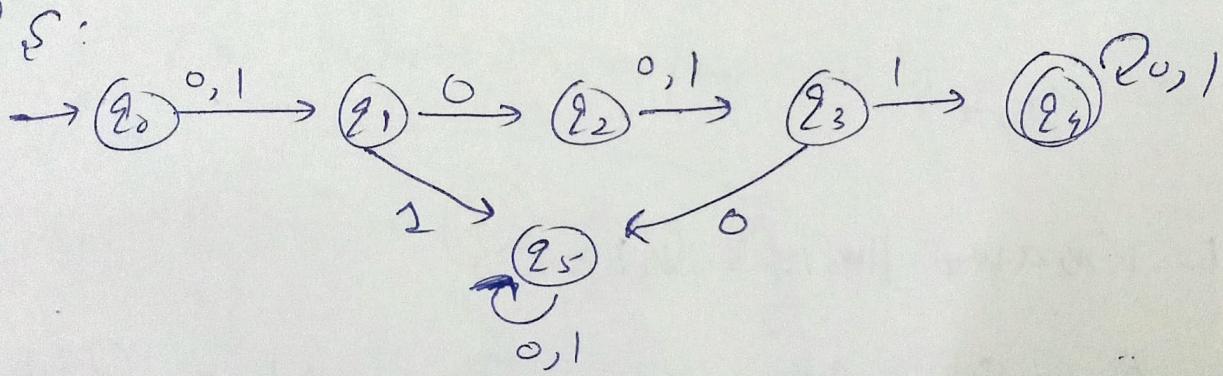
(22)

$L = \{w \in \{0,1\}^* \mid n_1(w) = 4\}$



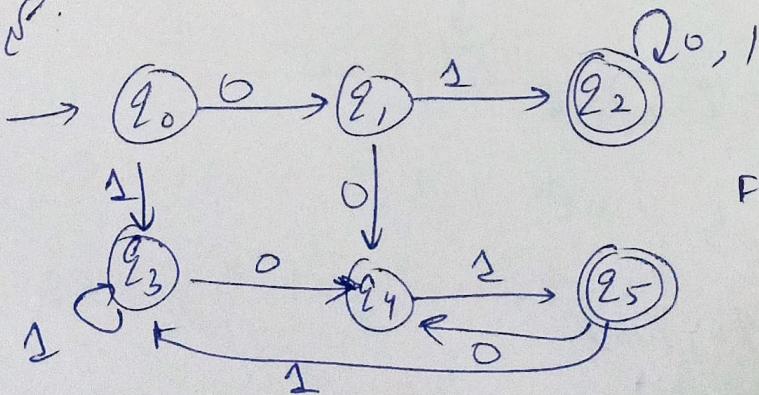
$$FA = \{ (q_0, q_1, q_2, q_3, q_4, \varnothing, \{0,1\}, \delta, q_0, q_5) \}$$

(23)

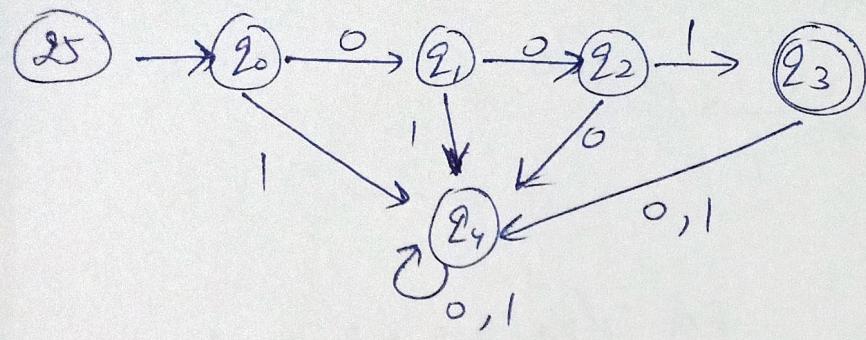


$$FA = \{ (q_0, q_1, q_2, q_3, \varnothing, \{0,1\}, \delta, q_0, q_5) \}$$

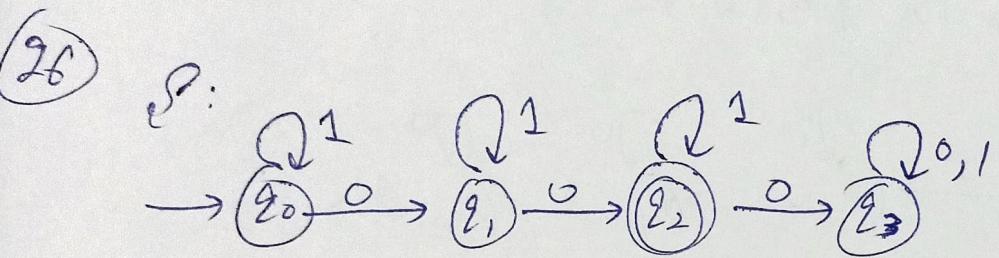
(24)



$$FA = \{ (q_0, q_1, q_2, q_3, q_4, \varnothing, \{0,1\}, \delta, q_0, q_5) \}$$



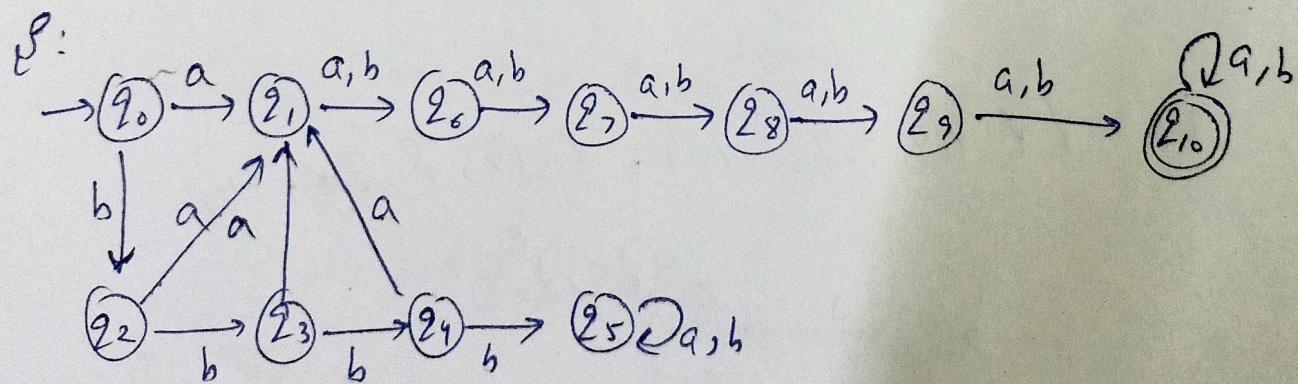
$$FA = \{Q_0 Q_1 Q_2 Q_3 Q_4\}, \{0, 1\}^*, \{Q_0, Q_3\}$$



$$FA = \{Q_0 Q_1 Q_2 Q_3\}, \{0, 1\}^*, \{Q_0, Q_3\}$$

(27) $S = \{a, b\}$

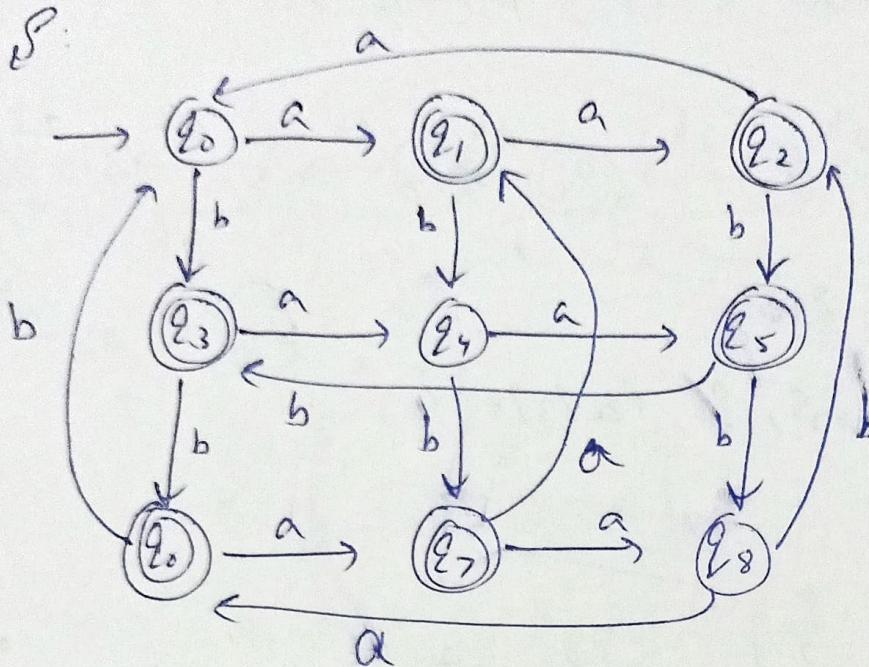
(a) $L = \{w_1 a w_2 \mid |w_1| \leq 3, |w_2| \geq 5\}$



$$\emptyset = \{Q_0 Q_1 \dots Q_{10}\}$$

$$FA = \{\emptyset, \{a, b\}^*, \{Q_0, Q_{10}\}\}$$

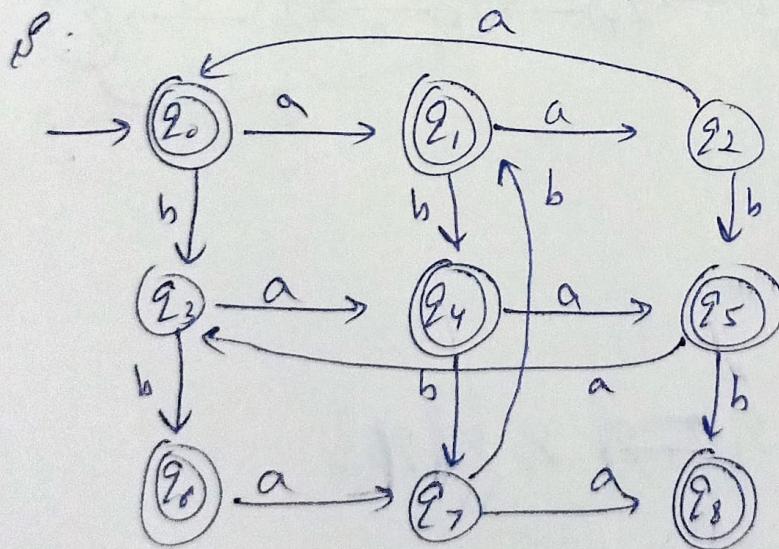
$$(b) L = \{ w \mid |n_a(w) - n_b(w)| \bmod 3 \neq 0 \}$$



$$Q = \{q_0, q_1, \dots, q_8\}$$

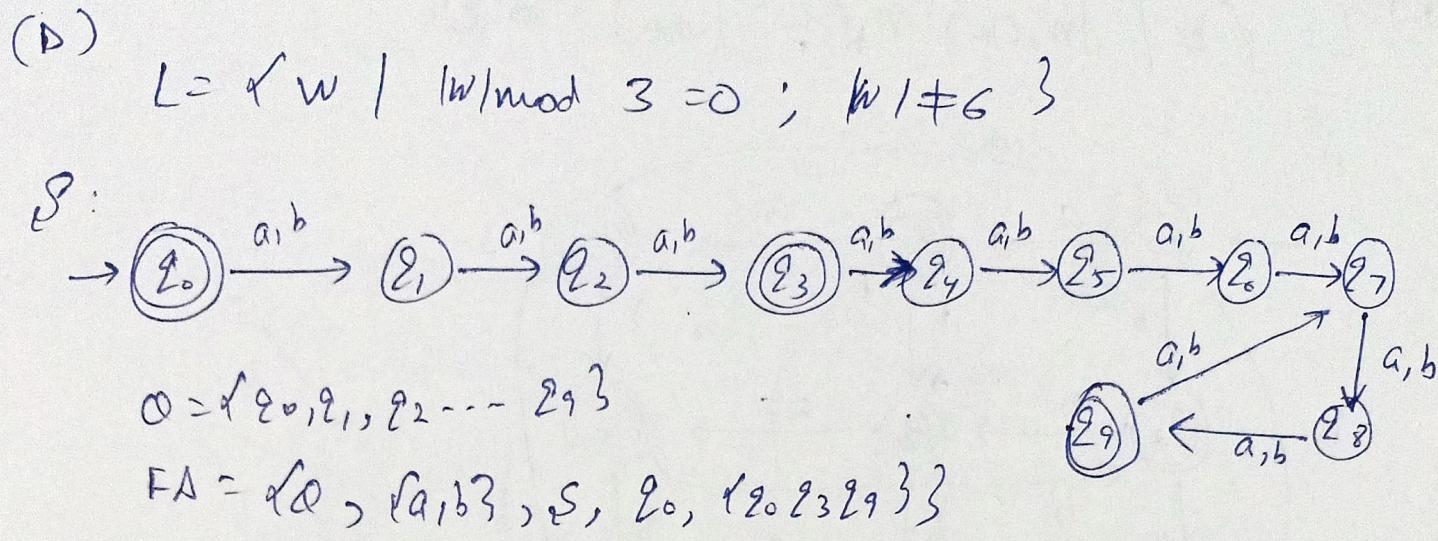
$$FA = \{\emptyset, \{a, b\}, \{q_0, q_2, q_3, q_5, q_6, q_7\}\}$$

$$(c) L = \{ w \mid |n_a(w) + 2n_b(w)| \bmod 3 < 2 \}$$



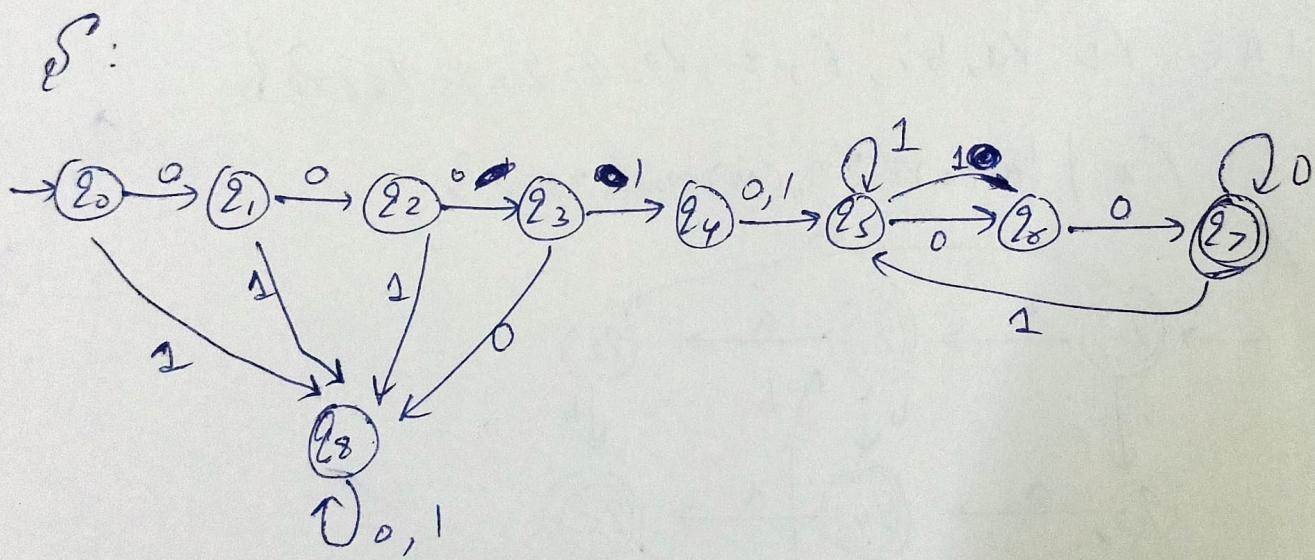
$$Q = \{q_0, q_1, q_2, q_3, \dots, q_8\}$$

$$FA = \{\emptyset, \{a, b\}, \{q_0, q_1, q_4, q_5, q_6, q_7, q_8\}\}$$



28

(A) $L = \{ 0^3 1 w 0^2 \mid w \in \{0, 1\}^+ \}$

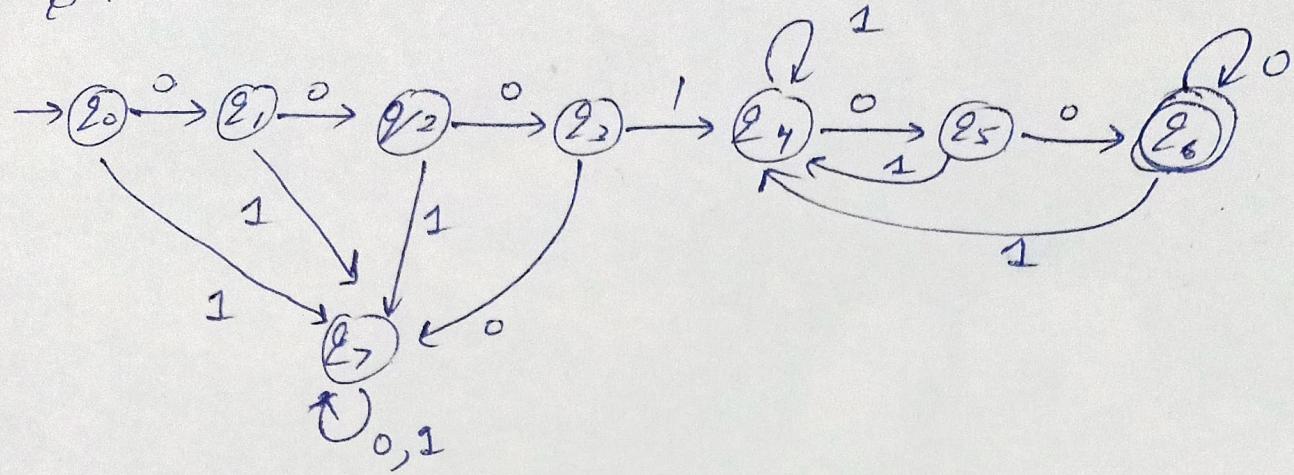


$Q = \{Q_0, Q_1, Q_2, Q_3, Q_4, Q_5, Q_6, Q_7, Q_8\}$

FA = $\{Q, \{0, 1\}, S, Q_0, \{Q_8\}\}$

$$(b) L = \{0^3 1 w 0^2 \mid w \in \{0, 1\}^*\}$$

S:



$$Q = \{q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7\}$$

$$FA = Q_0 \rightarrow \{q_0, q_1, q_5, q_6, q_7\}$$