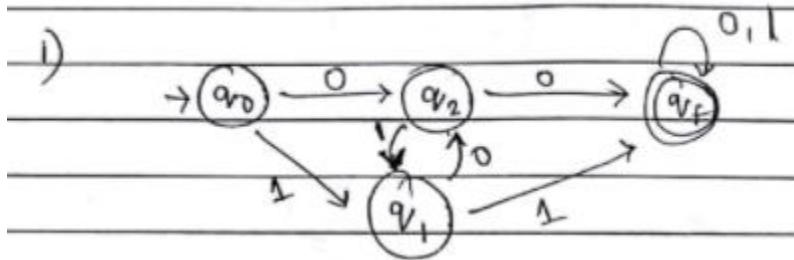
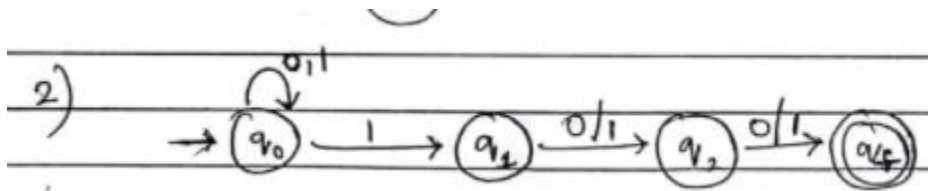


Problem 1

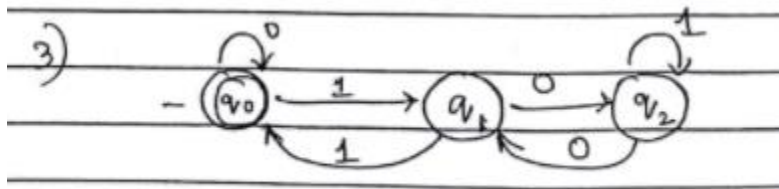
1. All binary numbers that contain 00 or 11



2. All binary numbers that contain a 1 in the 3rd location from the right (e.g. 100, 10111, ...)



3. All binary numbers that can be divided by 3



Problem2

Via subset construction, construct DFAs from all three NFAs that were constructed in problem 1. Please show step-by-step solutions.

Step 1: Create transition table :-

State	0	1
$\rightarrow q_0$	q_0, q_3	q_0, q_1
q_3	q_4	-
q_1	-	q_2
q_4	q_4	q_4
q_2	q_2	q_2

Let Q' be a new set of states for DFA. Let T' be new transition table

Step 2: Add transition of q_0 to T'

State	0	1
$\rightarrow q_0$	$\{q_0, q_3\}$	$\{q_0, q_1\}$

Step 3: new state $\rightarrow \{q_0, q_3\}$

Add it to T'

State	0	1
$\rightarrow q_0$	$\{q_0, q_3\}$	$\{q_0, q_1\}$
$\{q_0, q_3\}$	$\{q_0, q_3, q_4\}$	$\{q_0, q_1\}$

$$\delta'(\{q_0, q_3\}, 0) = \delta(q_0, 0) \cup \delta(q_3, 0)$$

$$= \{q_0, q_3, q_4\}$$

$$\delta'(\{q_0, q_3\}, 1) = \delta(q_0, 1) \cup \delta(q_3, 1)$$

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

Step 4: new state $\rightarrow \{q_0, q_1\}$ to add it to T'

State	0	1
$\rightarrow q_0$	$\{q_0, q_3\}$	$\{q_0, q_1\}$
$\{q_0, q_3\}$	$\{q_0, q_3, q_4\}$	$\{q_0, q_1\}$
$\{q_0, q_1\}$	$\{q_0, q_3\}$	$\{q_0, q_1, q_2\}$

$$\delta'(\{q_0, q_1\}, 0) = \delta(q_0, 0) \cup \delta(q_1, 0)$$

$$= \{q_0, q_3\}$$

$$\delta'(\{q_0, q_1\}, 1) = \delta(q_0, 1) \cup \delta(q_1, 1)$$

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

Step 5: new state $\{q_0, q_3, q_4\}$ add it to T'

state	0	1	
$\rightarrow q_0$	$\{q_0, q_3\}$	$\{q_0, q_1\}$	$\delta'(\{q_0, q_3, q_4\}, 0) = \delta(q_0, 0) \cup \delta(q_3, 0) \cup \delta(q_4, 0)$ $= \{q_0, q_3, q_4\}$
	$\{q_0, q_3\}$	$\{q_0, q_1, q_2\}$	
	$\{q_0, q_1\}$	$\{q_0, q_3\}$	
	$\{q_0, q_3, q_4\}$	$\{q_0, q_3, q_4\}$	

Step 6: new state $\{q_0, q_1, q_2\}$ add it to T'

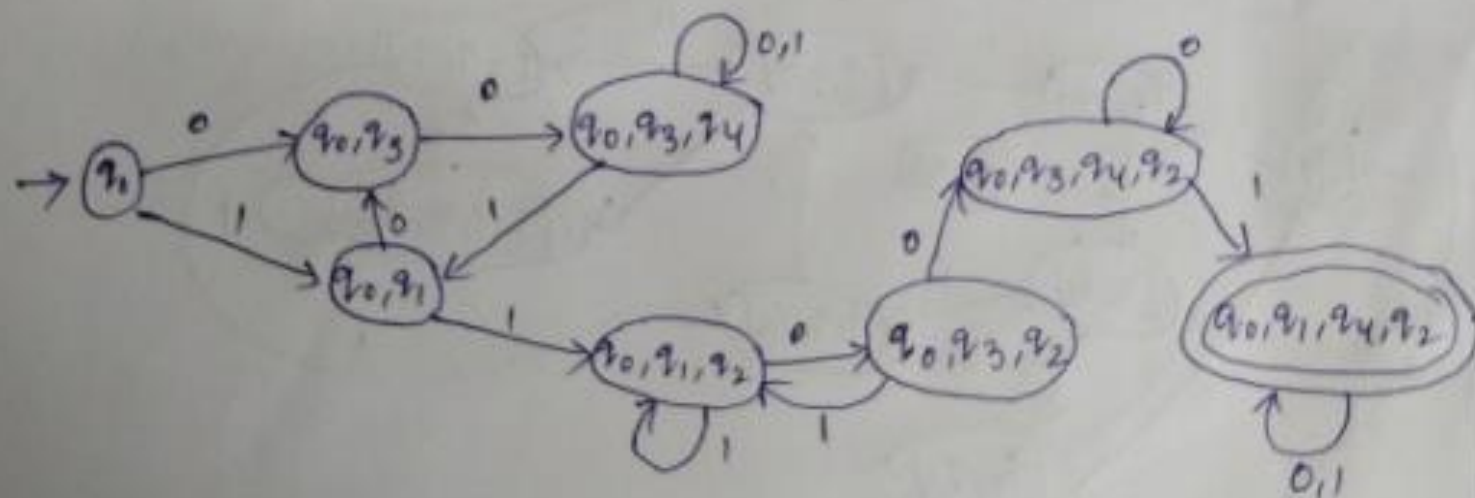
State	0	1	
$\rightarrow q_0$	$\{q_0, q_3\}$	$\{q_0, q_1\}$	$\delta'(\{q_0, q_1, q_2\}, 0) = \delta(q_0, 0) \cup$ $\delta(q_1, 0) \cup \delta(q_2, 0)$ $= \{q_0, q_3, q_2\}$
$\{q_0, q_3\}$	$\{q_0, q_3, q_4\}$	$\{q_0, q_1\}$	
$\{q_0, q_1\}$	$\{q_0, q_3\}$	$\{q_0, q_1, q_2\}$	$\delta'(\{q_0, q_1, q_2\}, 1) = \delta(q_0, 1) \cup \delta(q_1, 1)$ $\cup \delta(q_2, 1)$ $= \{q_0, q_1, q_2\}$
$\{q_0, q_3, q_4\}$	$\{q_0, q_3, q_4\}$	$\{q_0, q_3, q_4\}$	
$\{q_0, q_1, q_2\}$	$\{q_0, q_3, q_2\}$	$\{q_0, q_1, q_2\}$	

Step 7: new state $\{q_0, q_3, q_2\}$ add it to T'

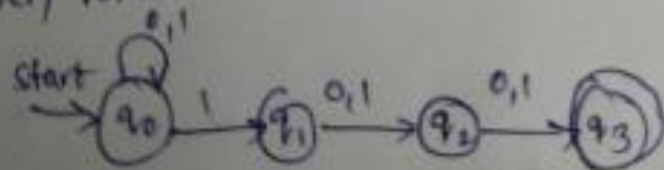
State	0	1	
$\rightarrow q_0$	$\{q_0, q_3\}$	$\{q_0, q_1\}$	$\delta'(\{q_0, q_3, q_2\}, 0) = \delta(q_0, 0) \cup \delta(q_3, 0)$
$\{q_0, q_3\}$	$\{q_0, q_3, q_4\}$	$\{q_0, q_1\}$	$\cup \delta(q_2, 0)$
$\{q_0, q_1\}$	$\{q_0, q_3\}$	$\{q_0, q_1, q_2\}$	$= \{q_0, q_3, q_4, q_2\}$
$\{q_0, q_3, q_4\}$	$\{q_0, q_3, q_4\}$	$\{q_0, q_3, q_4\}$	$\delta'(\{q_0, q_3, q_2\}, 1) = \delta(q_0, 1) \cup \delta(q_3, 1) \cup \delta(q_2, 1)$
$\{q_0, q_1, q_2\}$	$\{q_0, q_3, q_2\}$	$\{q_0, q_1, q_2\}$	$= \{q_0, q_1, q_2\}$
$\{q_0, q_3, q_2\}$	$\{q_0, q_3, q_4, q_2\}$	$\{q_0, q_1, q_2\}$	

Steps: new state $\{q_0, q_3, q_4, q_2\}$

State	0	1
$\rightarrow q_0$	$\{q_0, q_3\}$	$\{q_0, q_1\}$
$\{q_0, q_3\}$	$\{q_0, q_3, q_4\}$	$\{q_0, q_1\}$
$\{q_0, q_1\}$	$\{q_0, q_3\}$	$\{q_0, q_1, q_2\}$
$\{q_0, q_3, q_4\}$	$\{q_0, q_3, q_4\}$	$\{q_0, q_3, q_4\}$
$\{q_0, q_1, q_2\}$	$\{q_0, q_3, q_2\}$	$\{q_0, q_1, q_2\}$
$\{q_0, q_3, q_2\}$	$\{q_0, q_3, q_4, q_2\}$	$\{q_0, q_1, q_2\}$
$\{q_0, q_3, q_4, q_2\}$	$\{q_0, q_3, q_4, q_2\}$	$\{q_0, q_1, q_4, q_2\}$
$\{q_0, q_1, q_4, q_2\}$	$\{q_0, q_1, q_4, q_2\}$	$\{q_0, q_1, q_4, q_2\}$



2) Given NFA



State	0	1
q_0	q_0	q_0, q_1
q_1	q_2	q_2
q_2	q_3	q_3
q_3	—	—

Step 1 :- new state $\{q_0, q_1\}$

state 0 1
 $\rightarrow q_0$ q_0 $\{q_0, q_1\}$

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

Step 2:- $\{q_0, q_2\}$ $\{q_0, q_3\}$ $\{q_0, q_1, q_3\}$

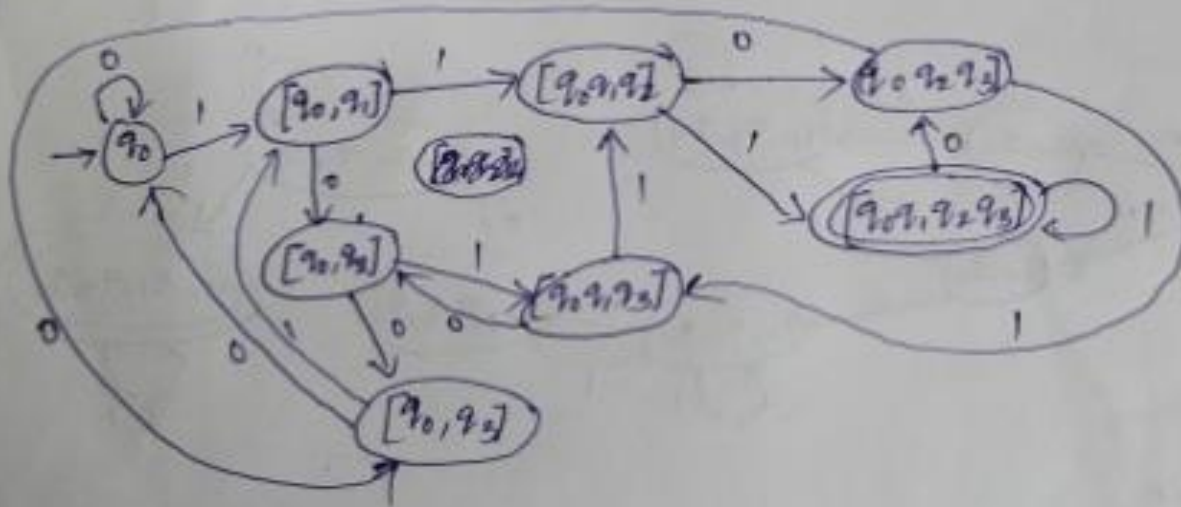
Step 3:- $\{q_0, q_1, q_2\}$ $\{q_0, q_2, q_3\}$ $\{q_0, q_1, q_2, q_3\}$

Step 4:- $\{q_0, q_3\}$ q_0 $\{q_0, q_1\}$

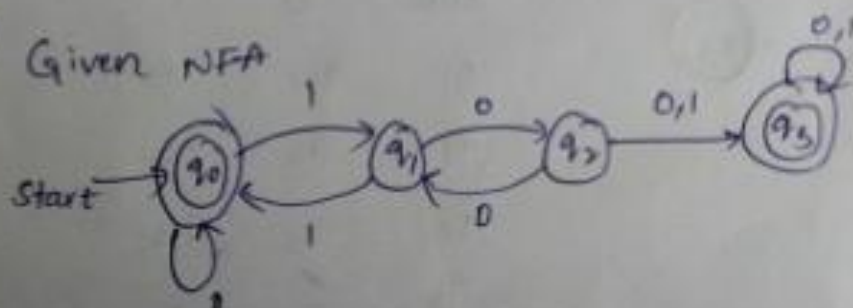
Step 5:- $\{q_0, q_1, q_3\}$ $\{q_0, q_2\}$ $\{q_0, q_1, q_2\}$

Step 6:- $\{q_0, q_2, q_3\}$ $\{q_0, q_3\}$ $\{q_0, q_1, q_3\}$

Step 7:- $\{q_0, q_1, q_2, q_3\}$ $\{q_0, q_2, q_3\}$ $\{q_0, q_1, q_2, q_3\}$



3) Given NFA



Start	0	1
$\rightarrow q_0$	q_0	q_1
q_1	q_2	q_0
q_2	$\{q_1, q_3\}$	q_3
q_3	q_3	q_3

Step 1:- Start 0 1

$\rightarrow q_0$ q_1 q_1

Step 2:- q_1 q_2 q_0

Step 3:- q_2 $\{q_1, q_3\}$ q_3

Step 4:- $\{q_1, q_3\}$ $\{q_2, q_3\}$ $\{q_0, q_3\}$

Step 5:- $\{q_2, q_3\}$ $\{q_1, q_3\}$ q_3

Step 6:- $\{q_0, q_3\}$ $\{q_0, q_3\}$ $\{q_1, q_3\}$

Step 7:- q_3 q_3 q_3

