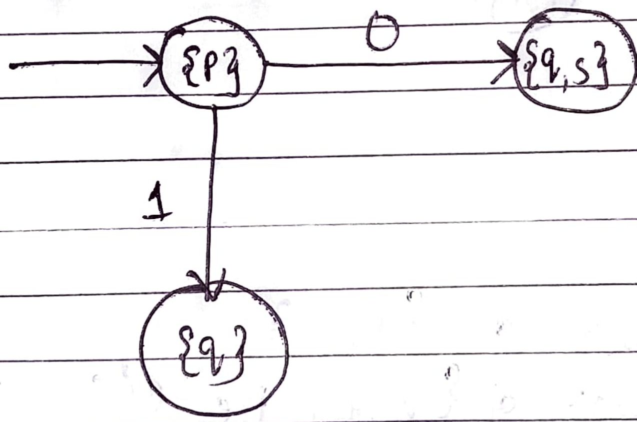
TCS Assignment No. 2.

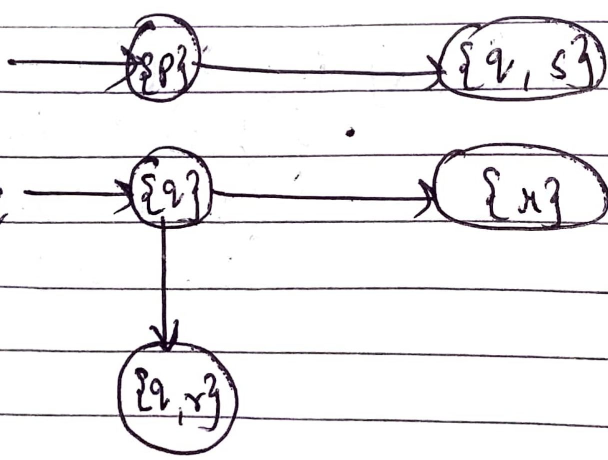
Q1. Convert the following NFA to DFA

	0	1
→ {p}	{q, s}	{q}
q*	{r}	{q, r}
r	{s}	{p}
s*	Φ	{p}

Step 1: Starting state {p} is finite state
0 successor of {p} i.e $\delta(\{p\}, 0) \to \{q, s\}$
1 successor of {p} i.e $\delta(\{p\}, 1) \Rightarrow \{q\}$



Step 2: Successor of {q}
0 : successor of {q} i.e $\delta(\{q\}, 0) = \{r\}$
1 : successor of {q} i.e $(\{q\}, 1) = \{q, r\}$



Step 3 : Successor of $\{q, s\}$

0 successor of $\{q, s\}$ i-e $\delta(\{q, s\}, 0)$

$= \delta(q, 0) \cup \delta(s, 0)$

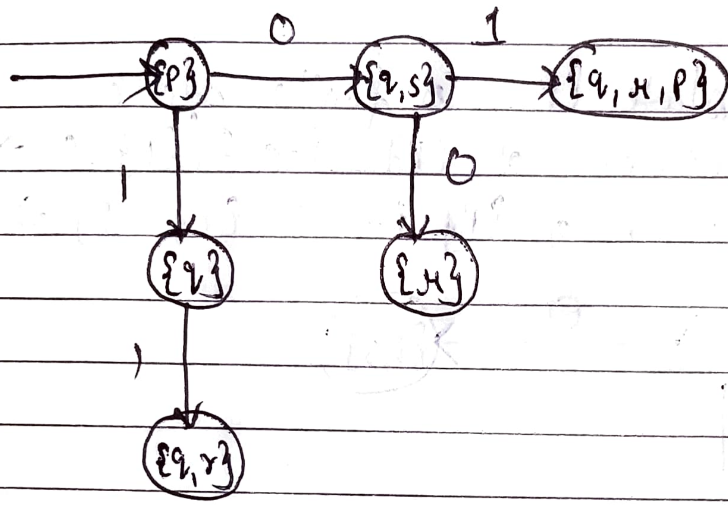
$= \{r\} \cup \{\phi\} = \boxed{\{r\}}$

1 Successor of $\{q, s\}$ i-e $\delta(\{q, s\}, 1)$

$= \delta(q, 1) \cup \delta(s, 1)$

$= \{q, r\} \cup \{p\}$

$= \boxed{\{q, r, p\}}$



Step 4 : Successor of $\{q, r\}$

0 successor of $\{q, r\}$ i-e $\delta(\{q, r\}, 0)$

$= \delta(q, 0) \cup (r, 0)$

$= \{r\} \cup \{s\}$

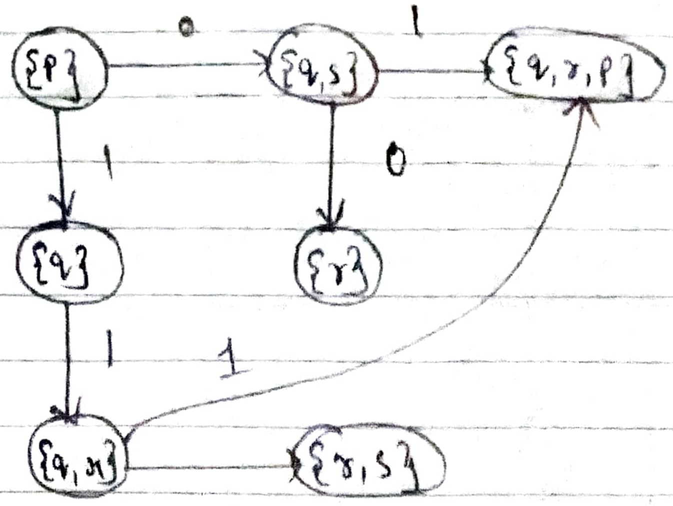
$= \{v, s\}$

1 Successor of $\{q, r\}$ i-e $\delta(\{q, r\}, 1)$

$= \delta(q, 1) \cup \delta(r, 1)$

$= \delta\{q, r\} \cup \{p\}$

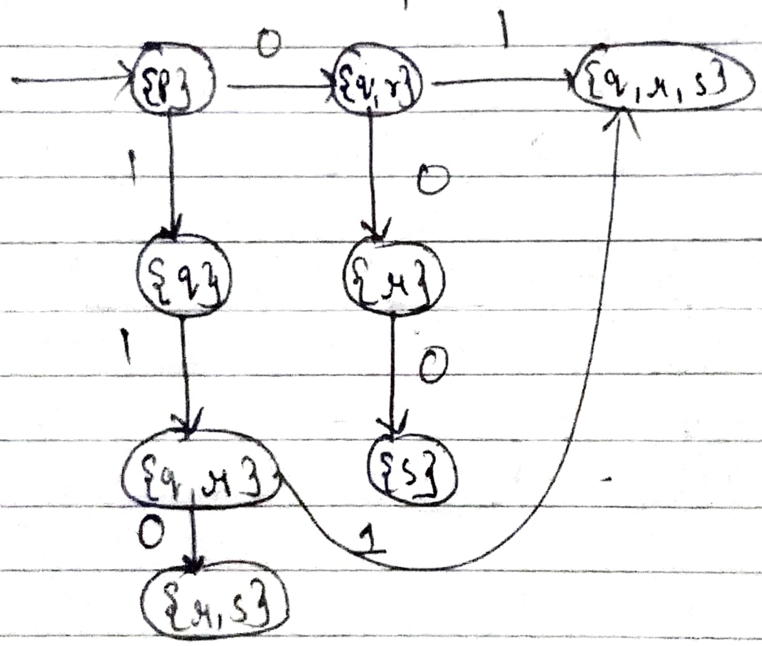
$= \{p, q, r\}$



Step 5 :- Successor of $\{r\}$

0 successor of $\{r\}$ i.e $\delta(r,0) = \{s\}$

1 successor of $\{r\}$ i.e $\delta(r,1) = \{p\}$



Step 6: Successor of $\{q,r,p\}$

0 successor of $\{q,r,p\}$ i.e $\delta(\{q,r,p\})$

$= \delta(q,0) \cup \delta(r,0) \cup \delta(p,0)$

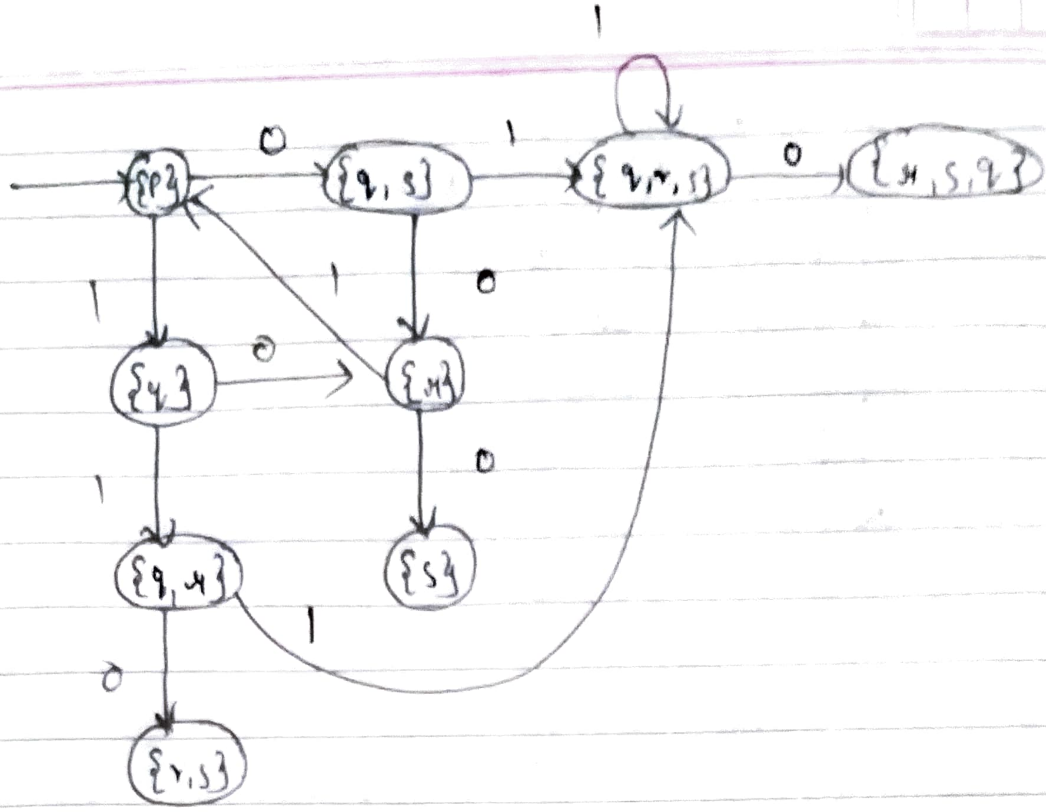
$= \{r\} \cup \{s\} \cup \{q,s\}$

$= \{r,s,q\}$

1 successor of $\{q,r,p\}$ i.e $\delta(\{q,r,p\},1)$

$= \delta(q,1) \cup \delta(r,1) \cup \delta(p,1)$

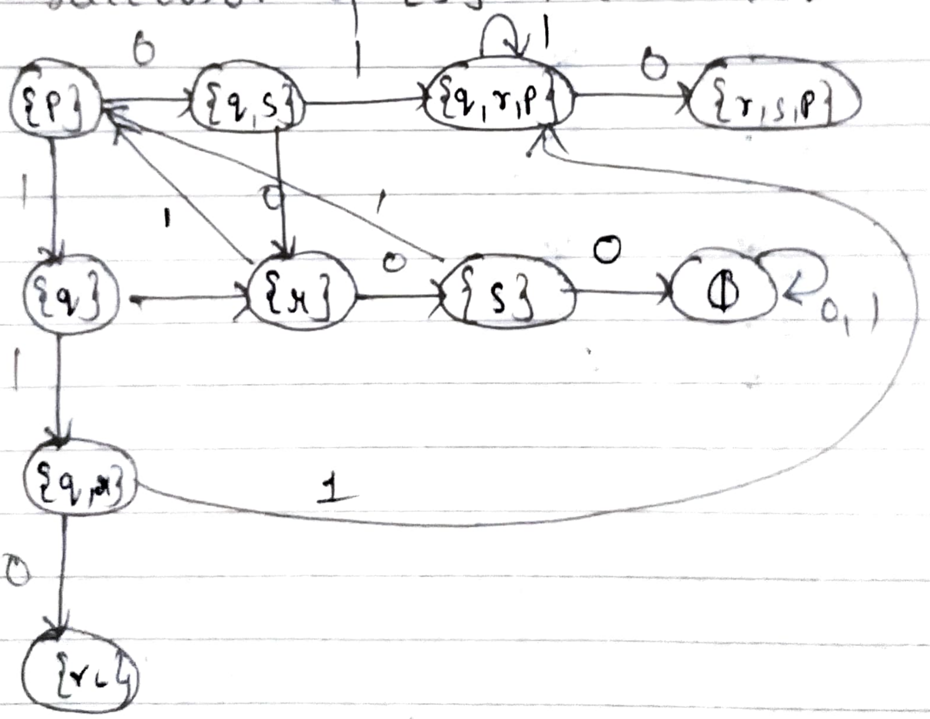
$= \{q,r\} \cup \{p\} \cup \{q\}$



Step 7 Successor of {s}

0 successor of {s} i.e $\delta(s,0) = \phi$

1 successor of {s} i.e $\delta(s,1) = \{p\}$



Step 8 :- Successor of {r,s}

0 successor of {r,s} i.e $\delta(\{r,s\},0)$

$= \delta(r,0) \cup \delta(s,0)$

$= \delta\{s\} \cup \{\phi\}$

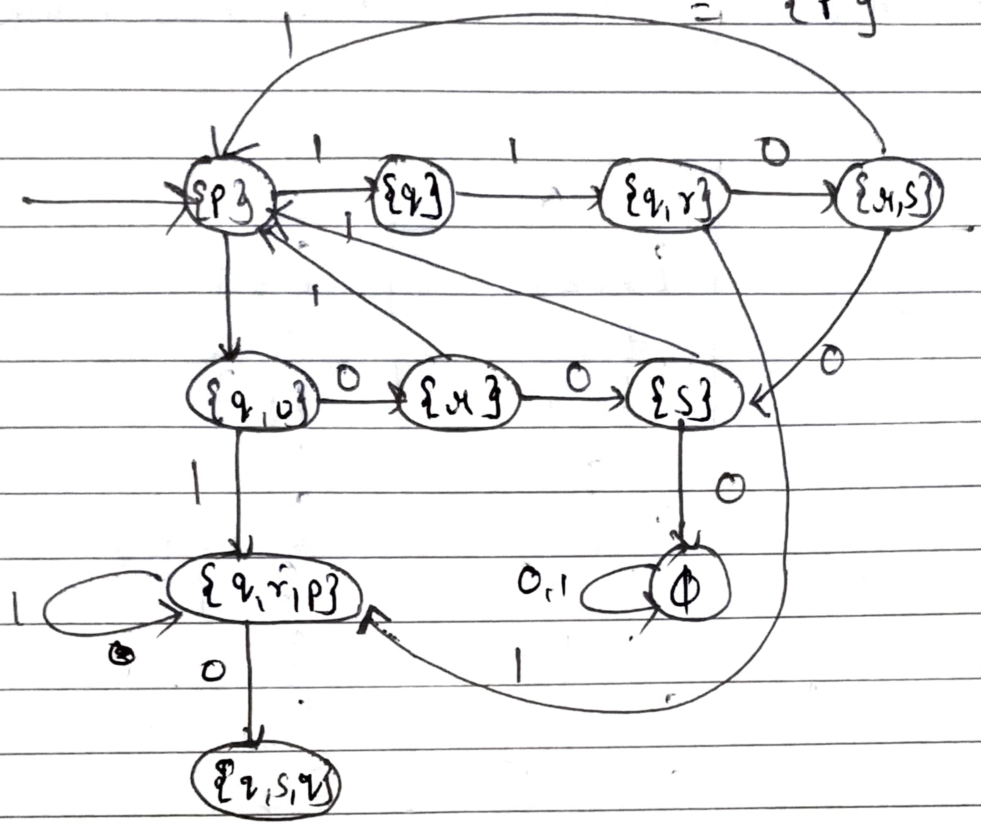
$= \{s\}$

1 successor of $\{r, s\}$ i.e $\delta(\{r, s\}, 1)$

$= \delta(r, 1) \cup \delta(s, 1)$

$= \{p\} \cup \{p\}$

$= \{p\}$



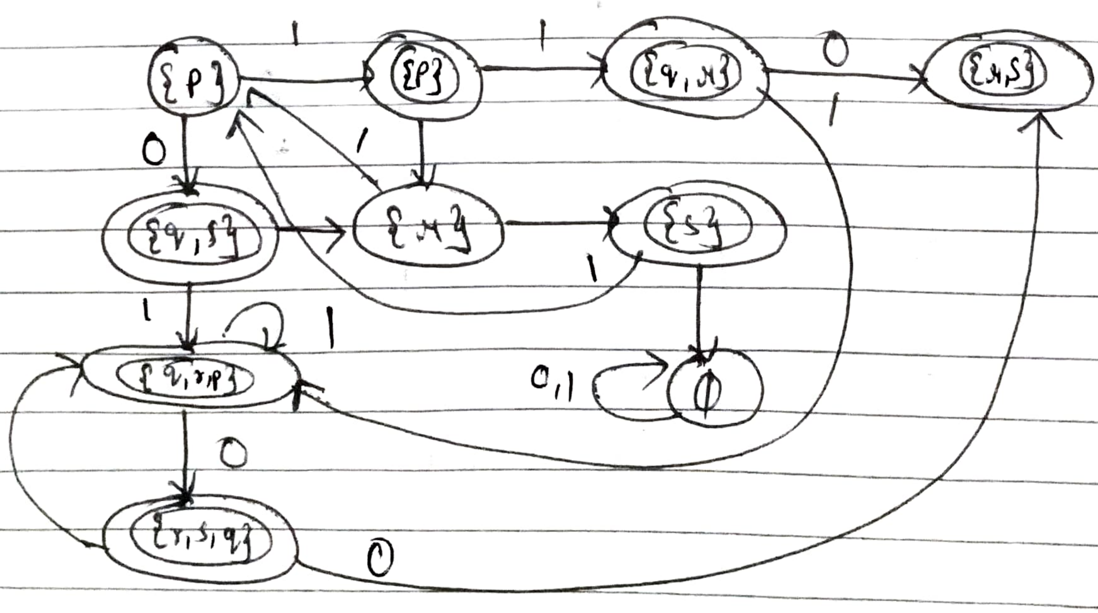
Step 9 : Successor of $\{r, s, q\}$

0 successor of $\{r, s, q\}$ i.e $\delta(\{r, s, q\}, 0)$

$= \delta(r, 0) \cup \delta(s, 0) \cup \delta(q, 0)$

$= \{p\} \cup \{p\} \cup \{q, r\}$

$= \{p, q, r\}$



Step 10: Since no new successors are generated the process of subset generation step of and s are find state in the NFA. Every subset containing the q and s are find states

DFA

		0	1
A	{p}	{q, s}	{q}
B	{q}*	{r}	{q, r}
C	{r}	{s}	{p}
D	{s}*	ϕ	{p}
E	{q, r}*	{r, s}	{q, r, p}
F	{r, s}*	{s}	{p}
G	{q, s}*	{r}	{q, r, p}
H	{q, r, p}*	{r, s, q}	{q, r, p}
I	{r, s, p}*	{r, s}	{q, r, p}
J	ϕ	ϕ	ϕ

	0	1
A	G	B
B	C	E
C	D	A
D	J	A
E	F	H
F	D	A
G	C	H
H	I	H
I	F	H
J	J	J

Q2.

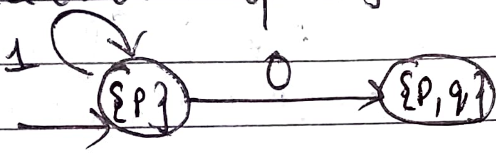
		0	1
→	p	{p, q}	{p}
	q	{r, s}	{t}
	r	{p, s}	{t}
	s*	{ϕ	ϕ
	t*	ϕ	ϕ

Soln

Step 1 : Starting state {p} is the first state

0 successor of {p} i-e $\delta(p, 0) = \{p, q\}$

1 Successor of {p} i-e $\delta(p, 1) = \{p\}$



Step 2 : Successor of {p, q}

0 successor of {p, q} i-e $\delta(\{p, q\}, 0\}$

$= \delta(p, 0) \cup \delta(q, 0)$

$= \{p, q\} \cup \{r, s\}$

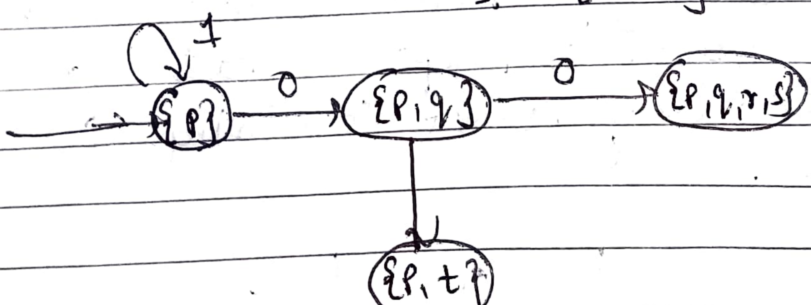
$= \{p, q, r, s\}$

1 Successor of {p, q} i-e $\delta(\{p, q\}, 1)$

$= \delta(p, 1) \cup \delta(q, 1)$

$= \{p\} \cup \{t\}$

$= \{p, t\}$



Step 3 :- Successor of {p, t}

0 successor of {p, t} i-e $\delta(\{p, t\}, 0)$

$= \delta(p, 0) \cup \delta(t, 0)$

$= \{p, q\} \cup \{\phi\}$

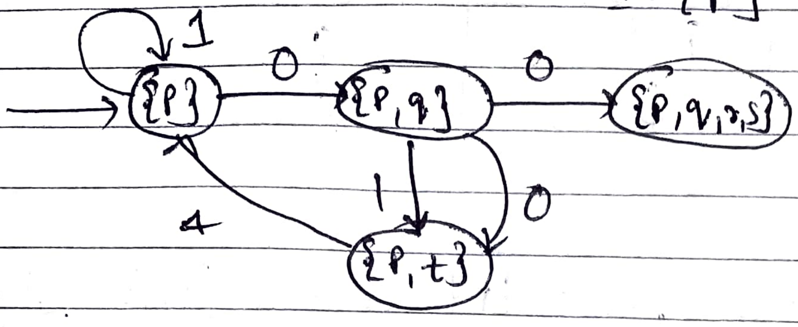
$= \{p, q\}$

1 Successor of {p, t} i.e $\delta(\{p,t\},1)$

$= \delta(p,1) \cup (t,1)$

$= \{p\} \cup \{\phi\}$

$= \{p\}$



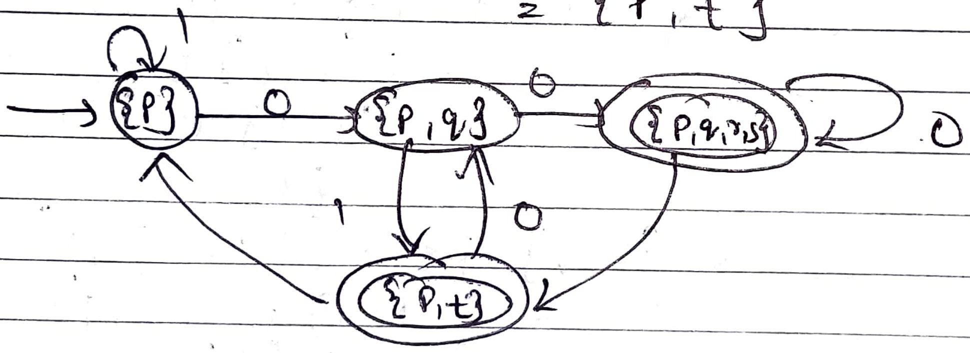
Step 4 :- Successor of {p, q, r, s}

0 successor {p, q, r, s} i.e $\delta(\{p,q,r,s\},0)$

$= \delta(p,0) \cup \delta(q,p) \cup \delta(r,0) \cup \delta(s,$

$= \{p,q\} \cup \{r,s\} \cup \{p,r\} \cup \{\phi\}$

$= \{p,t\}$



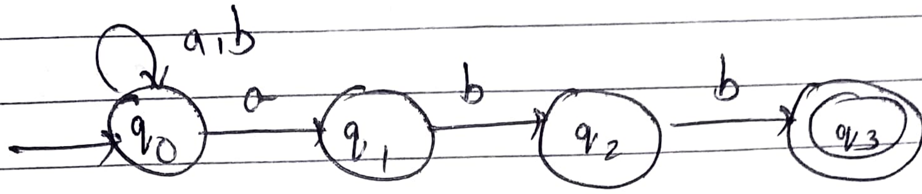
Step 5 :- Since, no. of successors are generated, the process of subset generation steps. S and t are final state in the NFA. Every subset containing S and t is the final state.

DFA

		0	1
A	{p}	{p, q}	{p}
B	{p, q}	{p, q, r, s}	{p, t}
C	{p, t} *	{p, q}	{p}
D	{p, q, r, s} *	{p, q, r, s}	{p, t}

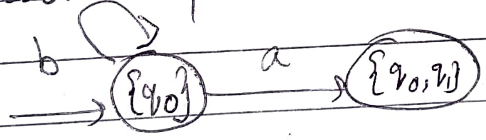
	0	1
A	B	A
B	D	C
C^{a}	B	A
D*	D	C

Q3



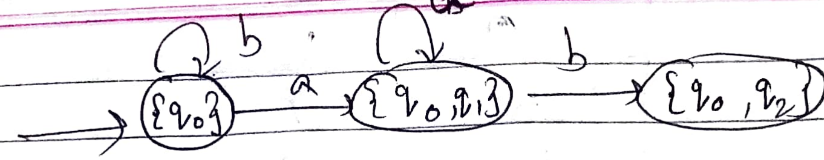
	a	b
$\rightarrow q_0$	$\{q_0, q_1\}$	$\{q_0\}$
q_1	ϕ	$\{q_0\}$
q_2	$\{q_3\}$	ϕ
q_3	ϕ	ϕ

Step 1 : q_0 is the starting state
$\because q_0$ is the final state
a successor of $\{q_0\}$ i.e $\delta(q_0, a) - \{q_0, q_1\}$
b successor of $\{q_0\}$ i.e $\delta(q_0, b) - \{q_0\}$



Step 2 : successor of $\{q_0, q_1\}$
a successor of $\{q_0, q_1\}$ i.e $\delta(\{q_0, q_1\}, a)$
$= \delta(q_0, a) \cup \delta(q_1, a)$
$= \{q_0, q_1\} \cup \{\phi\}$
$= \{q_0, q_1\}$

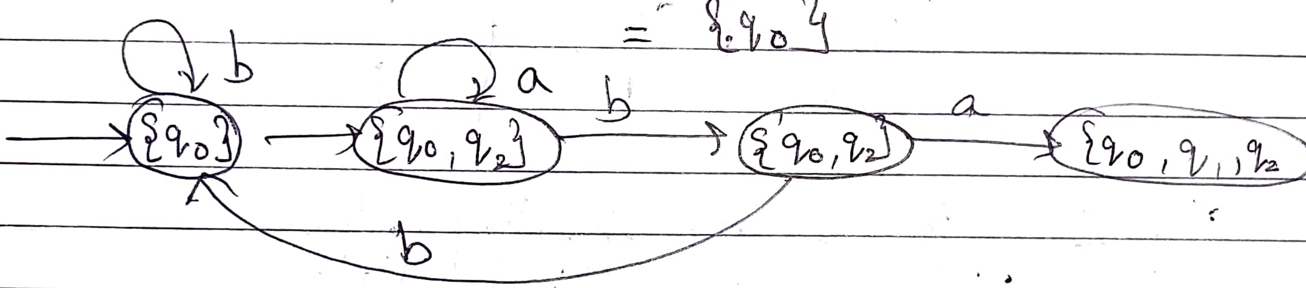
b successor of $\{q_0, q_1\}$ i.e $\delta(\{q_0, q_1\}, b)$
$= \delta(q_0, b) \cup (q_1, b)$
$= \{q_0\} \cup \{q_2\}$
$= \{q_0, q_2\}$



Step 3 :- Successor of $\{q_0, q_2\}$

a successor of $\{q_0, q_1\}$ ie $\delta(\{q_0, q_2\}, a)$
$= \delta(q_0, a) \cup \delta(q_2, a)$
$= \{q_0, q_1\} \cup \{q_2\}$
$= \{q_0, q_1, q_3\}$

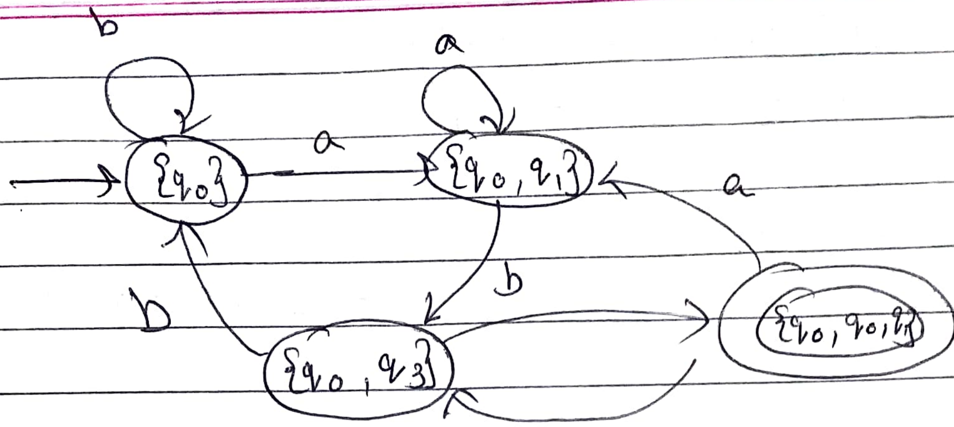
b successor of $\{q_0, q_2\}$ i.e $\delta(\{q_0, q_0\}, b)$
$= \delta(q_0, b) \cup \delta(q_2, b)$
$= \{q_0\} \cup \phi$
$= \{q_0\}$



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

a successor of $\{q_0, q_1, q_3\}$ i.e $(\{q_0, q_1, q_3\}; a)$
$= \delta(q_0, a) \cup \delta(q_1, a) \cup \delta(q_3, a)$
$= \{q_0, q_1\} \cup \{\Phi\} \cup \{\Phi\}$
$= \{q_0, q_1\}$

b successor of $\{q_0, q_1, q_3\}$ ie $\delta(\{q_0, q_1, q_3\}, b)$
$= \delta\{q_0, b\} \cup \delta(q_2, b) \cup \delta(q_3, b)$
$= \{q_0\} \cup \{q_2\} \cup \{\Phi\}$
$= \{q_0, q_2\}$



Step 5 : Since, now new successor is generated
∴ subset generation stops
q_3 is the final state in NFA
Every subset containing q_3 is final state

DFA

	a	b
$\{q_0\}$	$\{q_0, q_1\}$	$\{q_0\}$
$\{q_0, q_1\}$	$\{q_0, q_1\}$	$\{q_0, q_3\}$
$\{q_0, q_3\}$	$\{q_0, q_1, q_3\}$	$\{q_0\}$
$\{q_0, q_1, q_3\}$	$\{q_0, q_1\}$	$\{q_0, q_3\}$

Q4. $A = \{yy \mid y \in \{0,1\}^*\}$

→ Step 1 Assuming that A is regular.
pumping length p

$S = \cancel{0p}\ 0^p 1 0^p 1$

X Y Z

let's assume $p = 7$

$S = \underbrace{00}_{x}\ \underbrace{00000}_{y}\ \underbrace{100000001}_{z}$ $|xy| \leq p$

Step 2:- (i) ~~fro~~ for $i = 0$

$S = xyz$, $xy^iz \in A$

Consider $i = 0$

$x = 00$ $y = 00000$ $z = 100000001$

$= xy^0z \Rightarrow xz$

$= \underbrace{00}_{x} \underbrace{100000001}_{z}$

Hence, $xy^iz \in A$

(2) for $i = 1$

$S = xyz$, $xy^iz \in A$

Consider $i = 1$,

$x = 00$ $y = 00000$ $z = 100000001$

$xy^iz = xy^1z = xyz$

$= \underbrace{00}_{x} \underbrace{00000}_{y} \underbrace{10000001}_{z}$

$|xy| \leq p$

$\therefore$ It satisfies $xy^iz \in A$ for $i = 1$

(3) For $i = 2$

$S = xyz$, $xy^iz \in A$

Consider $i = 2$

$x = 00$, $y = 000000$, $z = 10000001$

$xy^iz = xy^0z$

$= \underbrace{00}_{x} \underbrace{00000\ 00000}_{y^2} \underbrace{1000000001}_{z}$

Hence, $xy^1z \in A$

Hence, all the conditions are not satisfied Therefore, S Cannot be pumped.