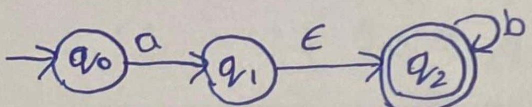
THEORY OF COMPUTATION

SASIKUMAR S
220701525
CSE-E

ASSIGNMENT - I

convert NFA with ϵ to NFA without ϵ

1.



(i) ϵ closure $(q_0) = \{q_0\}$

ϵ closure $(q_1) = \{q_1, q_2\}$

ϵ closure $(q_2) = \{q_2\}$

(ii) For q_0

$\delta(q_0, a) = \epsilon$ closure $(\delta(\hat{\delta}(q_0, \epsilon), a)) = \epsilon$ closure $(\delta\{q_0\}, a) = \epsilon$ closure $(q_1) = \{q_1, q_2\}$

$\delta(q_0, b) = \epsilon$ closure $(\delta(\hat{\delta}(q_0, \epsilon), b)) = \epsilon$ closure $(\delta((q_0), b)) = \epsilon$ closure $(\phi) = \{\phi\}$

For q_1

$\delta(q_1, a) = \epsilon$ closure $(\delta(\hat{\delta}(q_1, \epsilon), a)) = \epsilon$ closure $(\delta\{q_1, q_2\}, a))$

$= \epsilon$ closure $(\delta(q_1, a) \cup \delta(q_2, a)) = \epsilon$ closure $(\phi, \phi) = \epsilon$ closure $(\phi) = \{\phi\}$

$\delta(q_1, b) = \epsilon$ closure $(\delta(\hat{\delta}(q_1, \epsilon), b)) = \epsilon$ closure $(\delta\{q_1, q_2\}, b))$

$= \epsilon$ closure $(\delta(q_1, b) \cup \delta(q_2, b)) = \epsilon$ closure $(\phi \cup q_2) =$

ϵ closure $(q_2) = \{q_2\}$

For q_2

$\delta(q_2, a) = \epsilon$ closure $(\delta(\hat{\delta}(q_2, \epsilon), a)) = \epsilon$ closure $(\delta\{q_2\}, a))$

$= \epsilon$ closure $(\phi) = \{\phi\}$

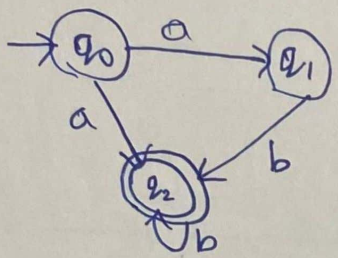
$\delta(q_2, b) = \epsilon$ closure $(\delta(\hat{\delta}(q_2, \epsilon), b)) = \epsilon$ closure $(\delta\{q_2\}, b)$

$= \epsilon$ closure $\{q_2\} = \{q_2\}$

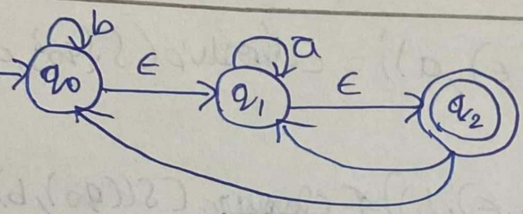
(iii)

STATE	Input a	b
q_0	$\{q_1, q_2\}$	ϕ
q_1	ϕ	$\{q_2\}$
q_2	ϕ	$\{q_2\}$

(iv)



2)



(i) ϵ closure $(q_0) = \{q_0, q_1, q_2\}$
ϵ closure $(q_1) = \{q_1, q_2\}$
ϵ closure $(q_2) = \{q_2\}$

(ii) For q_0

$\delta(q_0, a) = \epsilon \text{ closure}(\delta(\hat{\delta}(q_0, \epsilon), a)) = \epsilon\text{closure}(\delta(\{q_0, q_1, q_2\}, a))$
$= \epsilon \text{ closure}(\delta(q_0, a) \cup \delta(q_1, a) \cup \delta(q_2, a)) = \epsilon\text{closure}(q_1 \cup q_1 \cup q_1)$
$= \epsilon \text{ closure}(q_1) = \{q_1, q_2\}$

$\delta(q_0, b) = \epsilon \text{closure}(\delta(\hat{\delta}(q_0, \epsilon), b)) = \epsilon\text{closure}(\delta(\{q_0, q_1, q_2\}, b))$
$= \epsilon\text{closure}(\cancel{\ldots}) \; (\delta(q_0, b) \cup \delta(q_1, b) \cup \delta(q_2, b)) = \epsilon\text{closure}(q_0 \cup \phi \cup q_0)$
$= \epsilon\text{closure}(q_0) = \{q_0, q_1, q_2\}$

For q_1

$\delta(q_1, a) = \epsilon\text{closure}(\delta(\hat{\delta}(q_1, \epsilon), a)) = \epsilon\text{closure}(\delta(\{q_1, q_2\}, a)) = \epsilon\text{closure}(\delta(q_1, a) \cup \delta(q_2, a)) = \epsilon\text{closure}(q_1 \cup q_1) = \epsilon \text{ closure}(q_1) = \{q_1, q_2\}$

$\delta(q_1, b) = \epsilon\text{closure}(\delta(\hat{\delta}(q_1, \epsilon), b)) = \epsilon\text{closure}(\delta(\{q_1, q_2\}, b)) = \epsilon\text{closure}(\delta(q_1, b) \cup \delta(q_2, b)) = \epsilon\text{closure}(\phi \cup q_0) = \epsilon\text{closure}(q_0) = \{q_0, q_1, q_2\}$

For q_2

$\delta(q_2, a) = \epsilon closure(\delta \hat{\delta}(q_2, \epsilon), a)) = \epsilon closure(\delta(\{q_2\}, a))$

$= \epsilon closure(q_1) = \{q_1, q_2\}$

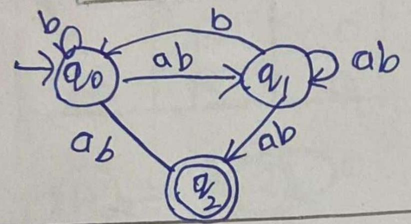
$\delta(q_2, b) = \epsilon closure(\delta(\hat{\delta}(q_2, \epsilon), b)) = \epsilon closure(\delta\{q_2\}, b), \epsilon closure$

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

(iii)

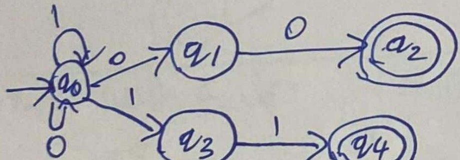
STATE	input	
	a	b
q_0	$\{q_1, q_2\}$	$\{q_0, q_1, q_2\}$
q_1	$\{q_1, q_2\}$	$\{q_0, q_1, q_2\}$
q_2	$\{q_1, q_2\}$	$\{q_0, q_1, q_2\}$

(iv)



NFA to DFA conversion

3)



state	input	
	0	1
q_0	q_0, q_1	q_0, q_3
q_1	q_2	ϕ
q_2	ϕ	ϕ
q_3	ϕ	q_4
q_4	ϕ	ϕ

(i) $q_0 \to NS(A)$

(ii) $\delta((q_0, 0) = \{q_0\ q_1\} \to NS(B)$

$\delta(q_0, 1) = \{q_0, q_3\} \to NS(C)$

$\delta(q_0, q_2\}, 0) = \delta(q_0, 0) \cup \delta(q_1, 0) = \{q_0 q_1\} \cup \{q_2\} = \{q_0, q_1, q_2\} \to NS(D)$

$\delta(\{q_0, q_1\}, 1) = \delta(q_0, 1) \cup \delta(q_1, 1) = \{q_0, q_3) \cup \{\phi\} = \{q_0, q_3\} \to C$

$\delta(q_0, q_3\}, 0) = \delta(q_0, 0) \cup \delta(q_3, 0) = \{q_0, q_1\} \cup \{\phi\} = \{q_0, q_1\} \to B$

$\delta\{q_0, q_3\}, 1) = \delta(q_0, 1) \cup (q_3, 1) = \{q_0, q_3) \cup \{q_4\} = \{q_0, q_3, q_4\} \to NS(E)$

D

$\delta(\{q_0,q_1,q_2\},0) = \delta(q_0,0) \cup \delta(q_1,0) \cup \delta(q_2,0) = \{q_0,q_1\} \cup \{q_2\} \cup \{\phi\}$
$= \{q_0,q_1,q_2\} \to D$

$\delta(\{q_0,q_1,q_2\},1) = \delta(q_0,1) \cup \delta(q_1,1) \cup \delta(q_2,1) = \{q_0,q_1\} \cup \{\phi\} \cup \{\phi\}$
$= \{q_0,q_1\} \to B$

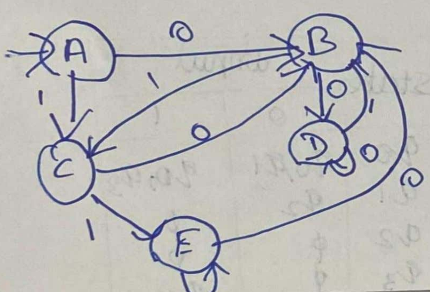
E

$\delta(\{q_0,q_3\},0) = \delta(q_0,0) \cup \delta(q_3,0) = \{q_0,q_1\} \cup \{\phi\} = \{q_0,q_1\} \to B$
$\delta(\{q_0,q_1\},1) = \delta(q_0,1) \cup \delta(q_1,1) = \{q_0,q_3\} \cup \{\phi\} = \{q_0,q_3\} \to E$

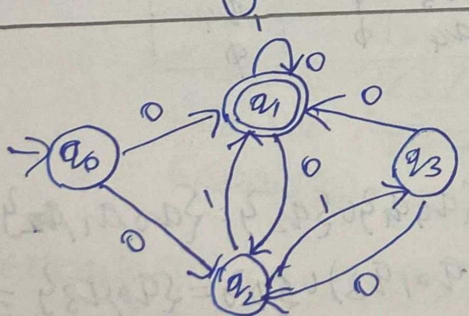
(iii)

STATE	input 0	input 1
A	B	C
B	D	C
C	B	E
D	D	B
E	B	E

(iv)



4)



state	input 0	input 1
q_0	$\{q_1,q_2\}$	ϕ
q_1	$\{q_1,q_2\}$	ϕ
q_2	ϕ	$\{q_1,q_2\}$
q_3	$\{q_1,q_2\}$	ϕ

(i) $q_0 \to NS(B)$

(ii) A

$\delta(q_0,0) = \{q_1,q_2\} \rightarrow NS(B)$

$\delta(q_0,1) = \phi$

B

$\delta(\{q_1,q_2\},0) = \delta(q_1,0) \cup \delta(q_2,0) = \{q_1,q_2\} \cup \phi = \{q_1,q_2\} \rightarrow B$

$\delta(\{q_1,q_2\},1) = \delta(q_1,1) \cup \delta(q_2,1) = \phi \cup \{q_1,q_3\} = \{q_1,q_3\} \rightarrow NS(C)$

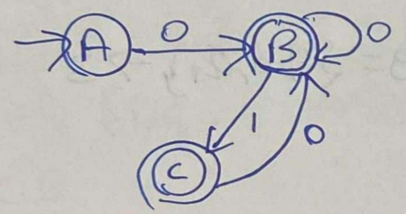
C

$\delta(\{q_1,q_3\},0) = \delta(q_1,0) \cup \delta(q_3,0) = \{q_1,q_2\} \cup \phi = \{q_1,q_2\} \rightarrow B$

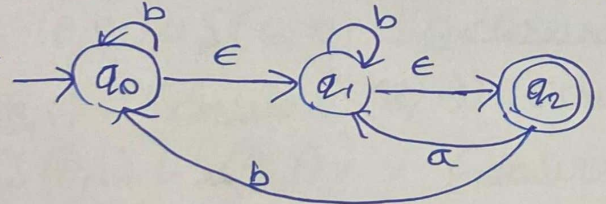
$\delta(\{q_1,q_3\},1) = \delta(q_2,1) \cup \delta(q_3,1) = \phi \cup \phi = \phi$

(iii)

State	Input	
	0	1
A	B	ϕ
B	B	C
C	B	ϕ

(iv) 

NFA with ϵ to DFA conversion

5. 

(i) ϵ closure$(q_0) = \{q_0,q_1,q_2\} \rightarrow NS(1)$

ϵ closure$(q_1) = \{q_1,q_2\}$

ϵ closure$(q_2) = \{q_2\}$

(ii) For 1

$\delta(1,a) = \epsilon$ closure $(\delta(1,a)) = \epsilon$ closure $(\delta(\{q_0,q_1,q_2\},a))$

$= \epsilon$ closure $(\delta(q_0,a) \cup \delta(q_1,a) \cup \delta(q_2,a))$

$= \epsilon$ closure $(\phi \cup \phi \cup q_1) = \{q_1,q_2\} \rightarrow NS(2)$

$= E\,closure(q \cup r \cup \phi) = \{p,q\} \cup \{p,q,r\} = \{p,q,r\} \Rightarrow Z$

(iii)

State	IP 0	IP 1
A	A	B
B	B	C
C	C	C

(iv)