Mealy Machine to Moore Machine:

$\boxed{\text{From Slide - 46}}$

⇒ From mealy machine,

$q_1 = 1$
$q_2 = 1, 0 \longrightarrow q_{20}, q_{21}$
$q_3 = 0$
$q_4 = 1, 0 \longrightarrow q_{40}, q_{41}$

trace out all output

So, total state need = 6

⇒

Present	2nd step: 0		2nd step: 1		3rd Step ⇒ from the first step	4th step ⇒ add dummy state as initial state
→ q_1	q_3	0	q_{20}	0	1	1
q_{20}	q_1	1	q_{40}	0	0	0
q_{21}	q_1	1	q_{40}	0	1	1
q_3	q_{21}	1	q_1	0	0	0
q_{40}	q_{41}	1	q_3	0	0	0
q_{41}	q_{41}	1	q_3	0	1	1

	0	1	
→ q_{dummy}	q_3	q_{20}	.... don't care

Moore Machine to Mealy Machine :

from slide - 47

- add output to each transition
  - fill from the ~~ø~~ moore machine data

- for initial output, we need to do some hard code, so that the mealy machine starts from the initial output of moore machine.
  - in this case, start with 0.

Example - Slide - 47 - 51

- if transition and output are same for two row, then we can merge them in a single row.

L-9 / 23.02.2025 /

Quiz - 01

Regular expression :

- use regular language & regular grammar.
- conversion ~~to~~ of RE to FA and vice versa possible.
- RE used to express the language for FA.

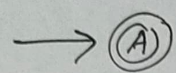
⊛ Some definition of RE:

(i) terminal symbol

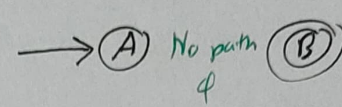
- an element of Σ

$\Rightarrow$ any terminal symbol, ϵ, and ϕ are regular expression

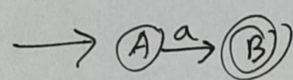
$\Rightarrow \epsilon$



$\Rightarrow \phi$



$\Rightarrow \Sigma = \{a, b\}$; RE = a



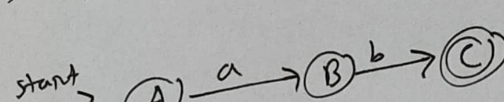
(ii) Union of RE:

$R_1 + R_2$ 'OR'

(iii) Concatenation:

$R_1 \cdot R_2 = R_1 R_2$ (follow kleene closure concatenation)

$\Rightarrow \Sigma = \{a, b\}$; RE = ab



(iv) Iteration / Closure :

R^* $\Rightarrow$ any number of time repetition

$\Rightarrow$ 0 or many

$\Rightarrow$ kleene closure

(v) Only first parenthesis is accepted.

$$\Rightarrow R = (R)$$
$$\Rightarrow R_1(R_1 + R_2)$$
$$\Rightarrow ((a+b)+c)$$

(vi) We can use these five rules recursively to form a RE.

$$\Rightarrow R_1R_2 + (R_3 + R_4)R_5$$

(*) Some examples:

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

(i) accept only 0

RE = 0

(ii) accept only 1

RE = 1

(iii) accept 010

RE = 010

(iv) any number of 0

RE = 0^*

(v) at least one 0

RE = 00^*

(vi) ending with 00

RE = $(0+1)^* 00$

(vii) any string

RE = $(0+1)^*$

(viii) start with 0, end with 1

RE = $0(0+1)^*1$

(ix) even number of 1

RE = $(11)^*$

(x) odd number of 1

RE = $1(11)^*$

$= (11)^*1$

(xi) string of even length

RE = $\cancel{(0+1)^*(0+1)}^*$

$= ((0+1)(0+1))^*$

(xii) string of odd length

RE = $(0+1)((0+1)(0+1))^*$

$= ((0+1)(0+1))^*(0+1)$

$\boxed{\text{(*) Practice the problem from assignment write down the RE.}}$

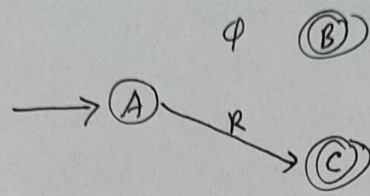
H.W

L-10/25.02.2025/

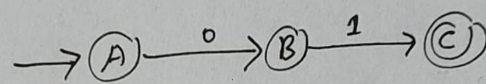
Identities of Regular Expression (RE):

(i) $\phi + R = R$

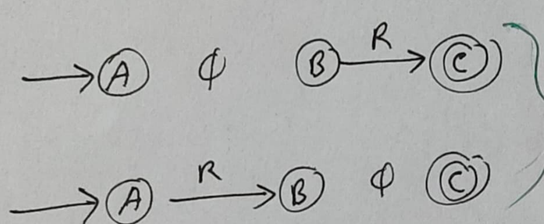
⇒ we have two way, where one way is not possible, so we must choose the second one.



(ii) $\phi R = R\phi = \phi$

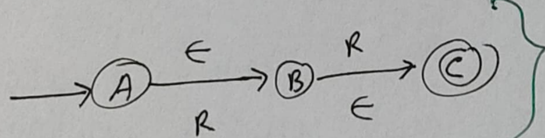
For 01, 

Then,



Not possible to reach the final state.

(iii) $\epsilon R = R\epsilon = R$



final cost/ total cost is alway R.

(iv) $\epsilon^* = \epsilon, \epsilon\epsilon, \epsilon\epsilon\epsilon, \ldots$

$= \epsilon, \epsilon, \epsilon, \ldots$

$= \epsilon$

$\phi \neq \epsilon$; But, $\phi^* = \epsilon$ ⇒ because, for * it will start with ϵ, that mean ϕ is not taken.

$\phi^* = \epsilon, \phi, \phi\phi, \phi\phi\phi, \ldots = \epsilon$

(v) $R + R = R$

$\Rightarrow$ we need to choose any one, so whatever we choose, it will be R.

(vi) $R^* R^* = R^*$

$\Rightarrow$ whatever we can make using two R^*, that can also be produce by using one R^*

$$\left.\begin{aligned} R^* &= RR \\ R^* &= RR \end{aligned}\right\} \quad \left.\begin{aligned} R^* R^* &= RRRR \\ \Rightarrow R^* &= RRRR \end{aligned}\right\} \text{ Both are same.}$$

(vii) $RR^* = R^*R$

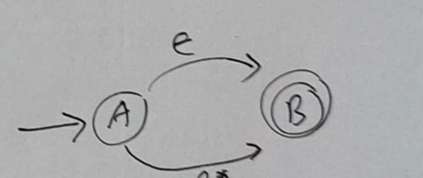
$\Rightarrow$ same string can be produce by both expression.

$\Rightarrow$ express the string with one mandatory R.

(viii) $(R^*)^* = R^*$

$\Rightarrow$ same as (vi)

(ix) $$\left.\begin{aligned} &\epsilon + \underbrace{RR^*}_{R^*} = \cancel{R^*}\ \epsilon + \underbrace{R^*R}_{R^*} = R^* \\ &\Rightarrow \epsilon + R^* = R^* \end{aligned}\right\}$$



$\Rightarrow$ same destination

(x) $(PQ)^* P = P(QP)^*$

$$\left.\begin{array}{l} \overline{PQ}\ \overline{PQ}\ \overline{PQ}\ \overline{P} \\ \underline{P}\ \underline{QP}\ \underline{QP}\ \underline{QP} \end{array}\right\} \text{ same, symentic}$$

(xi) $(P+Q)^* = (P^* Q^*)^* = (P^* + Q^*)^*$

But, $(P+Q)^* \neq (PQ)^*$

comes with package

(xii) $\underbrace{(P+Q)R}_{\text{one concatanation}} = \underbrace{PR + QR}_{\text{two concatamation}}$

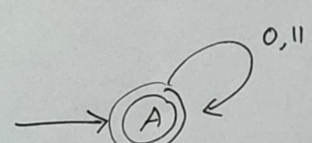
$R(P+Q) = RP + RQ$

(*) RE to finite automata.

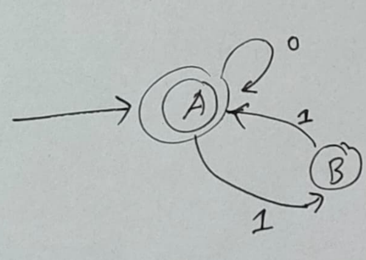
⇒ recursively divide according to (·) or (+) or ('*')

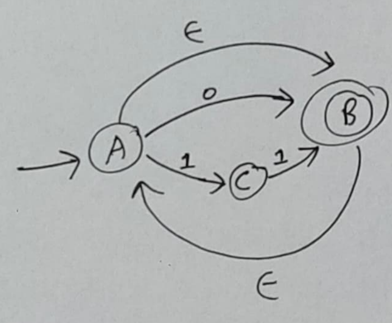
$\boxed{\text{slide - 57}}$ ***

(*) $(0 + 11)^*$



⇒





worked for a total (*)

$\boxed{\text{Midterm — Upto this — 04.03.2025}}$

L-11/02.03.2025/

FA to RE conversion

(i) Arden's theorem

(ii) Pumping Lemma

Arden's theorem:

$$R = Q + RP$$

if, ~~P~~ 'ε' $\notin P$

and $P, Q \in RE$

then,

$$\boxed{R = QP^*}$$

~~Example from P~~

- Behavior of a state, depends on incoming and outgoing transition.

Here, in the Arden's theorem, only incoming transitions are considered.

Example from page 50:

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

For each state,

$$\overset{\text{destination}}{q_1} = \overset{\text{source}}{q_1}\overset{\text{symbol}}{a} + q_2 b + \overset{\text{for starting state sign}}{\epsilon}$$

$$q_2 = q_1 a + q_2 b + q_3 a$$

$$* q_3 = q_2 a$$

Here, q_1, q_2, q_3 are not RE. We need to solve ~~the~~ for these.

final state.

⇒ final RE will be the ~~solve~~ solution of q_3.

⇒ if more than one final state, then all the ~~soll~~ solution need to add using (+) sign.

Now,

$$q_2 = q_1 a + q_2 b + q_3 a$$

$$= q_1 a + q_2 b + q_2 aa \quad [\because q_3 = q_2 a]$$

$$\underset{R}{q_2} = \underset{Q}{q_1 a} + \underset{R}{q_2}\underset{P}{(b + aa)}$$

$$\therefore q_2 = q_1 a (b + aa)^*$$

from,

$$q_1 = q_1 a + q_2 b + \epsilon$$

$$= \epsilon + q_1 a + q_1 a (b + aa)^* b$$

$$= \epsilon + q_1 (a + a(b + aa)^* b)$$

$$= \epsilon \cdot (a + a(b + aa)^* b)^* \quad \} \text{ completely RE, no extra state.}$$

$\therefore q_2 = (a + a(b+aa)^*b)^* \, a(b+aa)^*$

$\therefore q_3 = (a + a(b+aa)^*b)^* \, a \, (b+aa)^* a$ Ans.

Final RE, as q_3 is the final state.

Example, from page-64:

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

Here,

$*A = B1 + C0 + \epsilon$

$B = A0$

$C = A1$

$D = B0 + C1 + D0 + D1$

we just need to focus on final state and try to solve it with complete RE without any state.

Now,

$A = \epsilon + A01 + A10$

$= \epsilon + A(01+10)$

$= \epsilon(01+10)^*$

$= (01+10)^*$ Ans

Example, from page-66:

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

$*P = \epsilon + P0 = \epsilon \cdot 0^* = 0^*$

$*Q = P1 + Q1 = 0^*1 + Q1 = 0^*11^*$

$R = Q0 + R0 + R1$

$RE = P + Q = 0^* + 0^*11^*$ Ans

⊛ Enample, from page-67:

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

$$^{*}A = \epsilon + A0 + A1 + C0$$

$$B = A1 + B1 + C1$$

$$C = B0$$

Now,

$$\therefore B = A1 + B1 + B01$$

$$= A1 + B(1+01)$$

$$= A1 \cdot (1+01)^{*}$$

$$\therefore C = A1(1+01)^{*}0$$

$$\therefore A = \epsilon + A0 + A1 + A1(1+01)^{*}00$$

$$= \epsilon + A\left(0+1+1(1+01)^{*}00\right)$$

$$= \left(0+1+1(1+01)^{*}00\right)^{*}$$

Next Class

Midterm

upto 57 page