Regular Expressions : Using regular operations to build up expressions describing languages.

(i) Text search of certain pattern
(ii) Token detection in compiler for constant, variable, numerics.
(iii) To generate Lexical analyzer in compiler.

precedence

1. Star (*)
2. Concat (∘)
3. Union (∪)

To violate precedence parenthesis required.

Formal Definition

1. a
2. ε

} a & ε alphabet

3. ϕ - Empty
4. $(R_1 \cup R_2)$
5. $(R_1 \circ R_2)$
6. (R_1^*).

exactly one 1

w contains a $\boxed{\text{single } 1}$: $0^* 1 0^*$

w has $\boxed{\text{at least } 1}$: $\Sigma^* 1 \Sigma^*$

string 001 as substring : $\Sigma^* 001 \Sigma^*$

every 0 in w is followed by at least one 1.

$1^* (01^+)^*$ 110110101

w is a string of even length : $(\Sigma\Sigma)^*$

w is a length is a multiple of 3 : $(\Sigma\Sigma\Sigma)^*$

$(0 \cup \varepsilon) 1^* = 01^* \cup 1^*$

all binary strings : $(\Sigma)^*$

Begins with 1 and ends with 1

$1 \Sigma^* 1$

contain at least three 1s.

$(\Sigma)^* 1 \Sigma^* 1 \Sigma^* 1 \Sigma^*$

contain at least three consecutive 1s

$\Sigma^* 111 \Sigma^*$

contains substring 110

$\Sigma^* 110 \Sigma^*$

Scanned with CamScanner

Doesn't contain 110 $\boxed{101}$ $\boxed{011}$ $\boxed{001}$

$(0 \cup 10)^* 1^*$

contain at least two 0s but not consecutive 0s.

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

has at least 3 char, 3rd one is 0.

$\Sigma \Sigma 0 \Sigma^*$

Number of 0s is a multiple of 3.

$1^* \cup (1^* 0 1^* 0 1^* 0 1)^*$

odd length

$\Sigma(\Sigma\Sigma)^*$

even length

$\epsilon \cup (\Sigma\Sigma)^*$

length is at least 1 and at most 3

$\Sigma \cup \Sigma\Sigma \cup \Sigma\Sigma\Sigma$

w starts & end with different symbol

$0\,\Sigma^*1 \cup 1\,\Sigma^*0 \cup 1 \cup 0$

number of 0's in w is a multiple of 3

$1^* \cup (1^*0\,1^*0\,1^*0\,1)^*$

w doesn't contain two consecutive 0's

$\boxed{(01)^* \cup (10)^* \cup 1^*} \cup (01)^*0 \cup (10)^*1 \cup 1^*0$

{w is of even length if it starts with a 0, is of odd length if it starts with 1}

~~0(ΣΣ)*0000~~ $0\,\Sigma(\Sigma\Sigma)^* \cup 1(\Sigma\Sigma)^*$

{w has at least two 1's}

$\Sigma^*1\Sigma^*1\Sigma^*$

0 1 $\boxed{010}$ 01001 001010 010101 101010 10101

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

i) $w \mid w$ contains at least three 1.

w $\Sigma^* 1 \Sigma^* 1 \Sigma^* 1 \Sigma^*$

$\Sigma^*(111)^+\Sigma^*$

$\Sigma^* 111 \Sigma^*$ w

0 1 0 1 0 1

ii) $w \mid w$ has length at least 3 and third symbol is 0

~~$\Sigma \cup \Sigma\Sigma \cup \Sigma\Sigma\Sigma$~~

$(\Sigma\Sigma 0)^+$

$((0 \mid 1)(0 \mid 1)(0))^+$

iii) starts with 0 and has odd length or starts with 1 and has even length

$\boxed{0(\Sigma\Sigma)^* \cup 1\Sigma(\Sigma\Sigma)^*}$

10
11 w.

iv) every odd position of w is 1.

$1(\Sigma 1)^*$

1
101

$1(0 \mid 1)\, 1(0 \mid 1)\, 1 \cdot (0 \mid 1)$

22

v) w | w contains an even number of 0's or contains exactly two 1's.

01001

~~$1^*(00)^*1^* \cup 0^*11$~~ ~~$0^*10^*10^*$~~

$$\boxed{1^*(00)^*1^* \cup 0^*10^*10^*}$$

aab aab

vii) w contains even no of a's

~~aabaa~~

~~$(b^* a b^* a b^*)^*$~~

~~$b^* a b^* (b^* a b)^*$~~

$(b^* a b^* a b^*)^*$

vii) w contains ~~even~~ odd no of a's

$$\boxed{b^* a b^* (b^* a b^* a b^*)^*}$$

a

babaa

viii) w contains neither aa nor bb as substring.

$(\Sigma^* aa \Sigma^* \cup \Sigma^* bb \Sigma^*)'$

~~$a^* \cup b^*$~~

$$\boxed{(ab)^* a \cup (ba)^*}$$

ababa

$[(ab)^* a \cup (ba)^* b$

$(ab)^* \cup (ba)^*]$

6 ababab

bababa

w contain 01 or 10 as substring

$\Sigma^* 01 \Sigma^* \cup \Sigma^* 10 \Sigma^*$

neither, $0^* \cup 1^*$.

iii) starts with a and is a string of even length.

ab
aaba

$\boxed{a(b|a)}$

$\boxed{a\Sigma(\Sigma\Sigma)^*}$

w starts and ends with different symbols.

$a\Sigma^* b \cup b\Sigma^* a$ ~~$\cup a \cup b$~~

w starts and ends with same symbols.

$a\Sigma^* a \cup b\Sigma^* b \cup a \cup b$

~~a's in w always appear in pairs.~~

baabaa

~~$b^*(aa^*)^* b^*$~~

~~baabaa~~

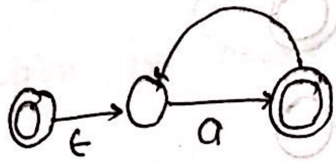
~~a's in w always in pair $b^*(aa)^* b^*(aa)^* \cup (aa)^* b^*(aa)^*$~~

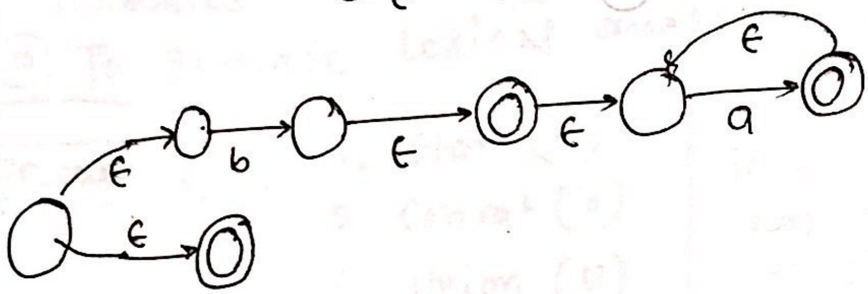
$(b^*(aa)^*)^* b^* \cup ((aa)^* b^*)(aa)^*$

+ / U

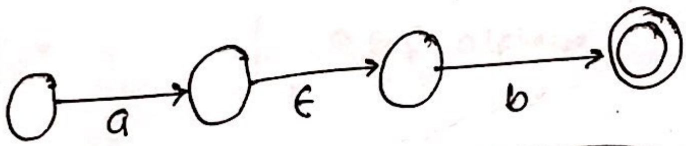
$ba^* + \varepsilon$

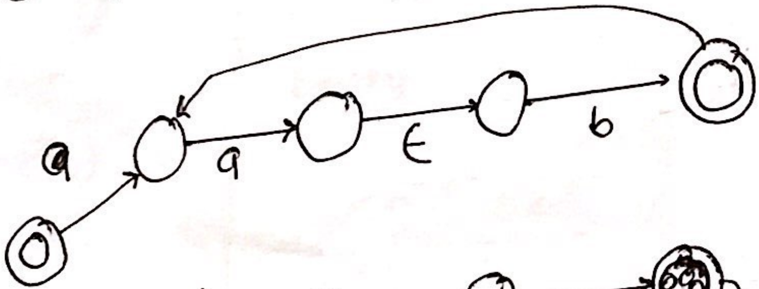
ε = 

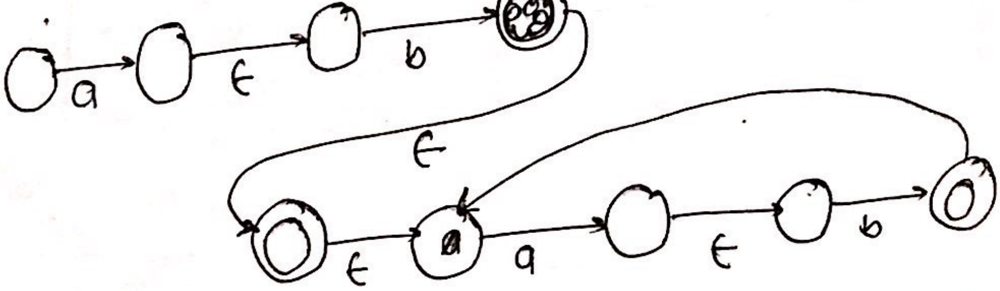
a^* = 

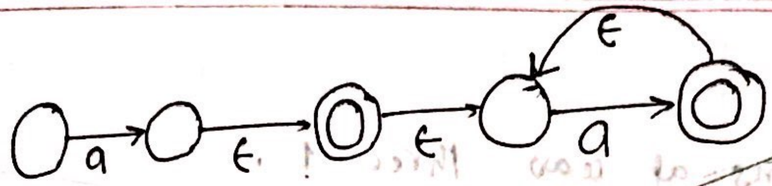


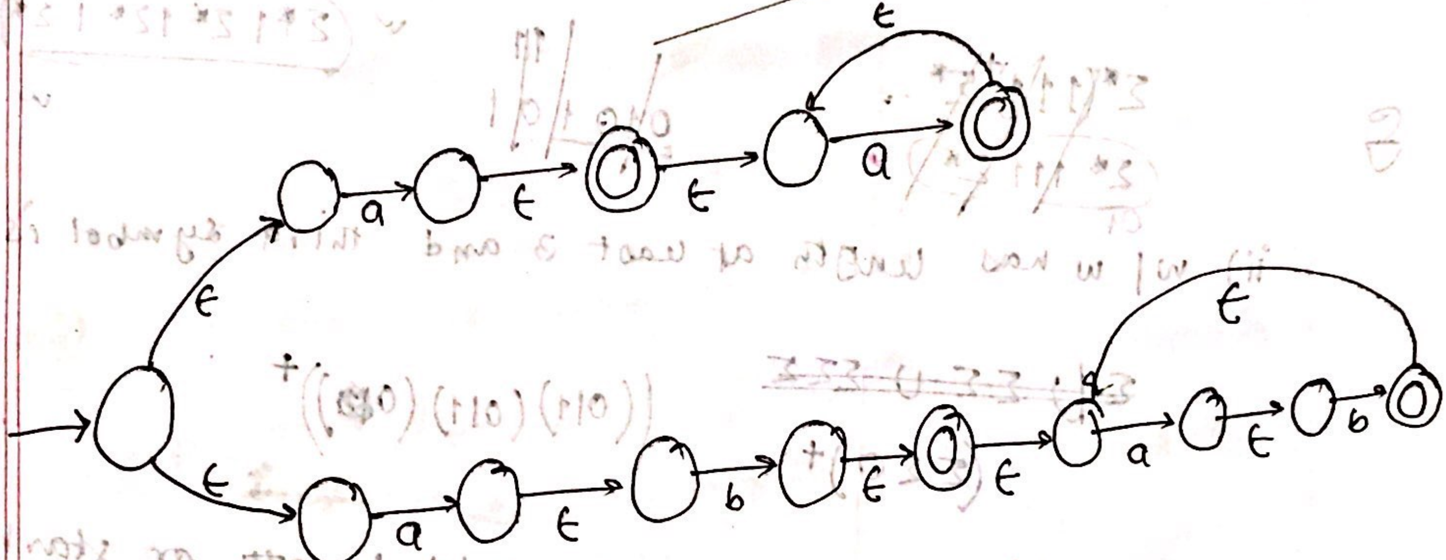
$a^+ \cup (ab)^+ = aa^* \cup (ab)^* (ab)^*$





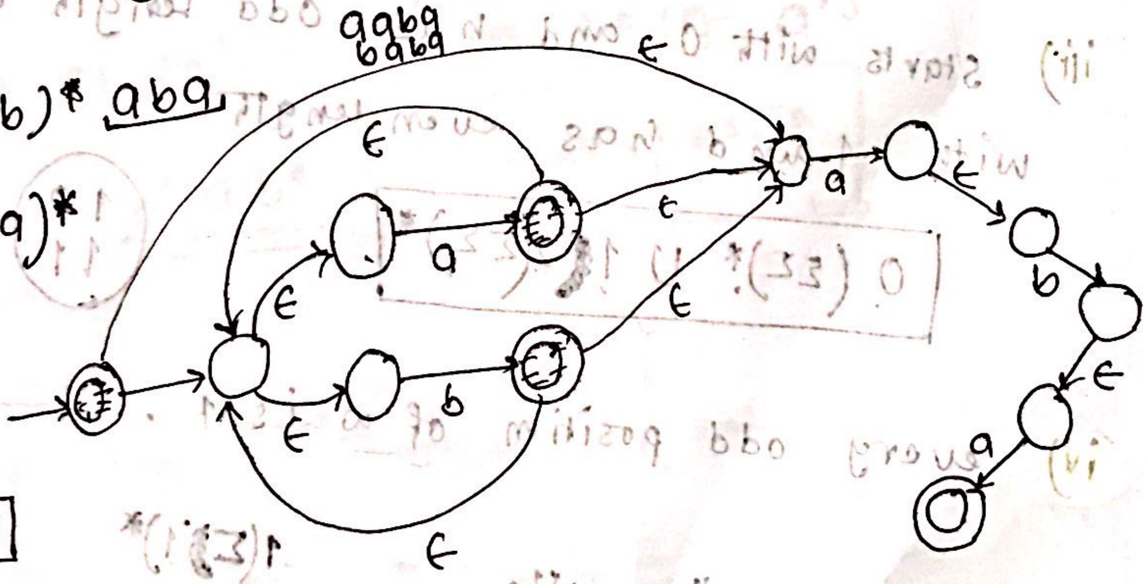






(aUb)* aba

(abUa)*



$\boxed{\text{a aba}}$