

## Finite Automata ch-5.

Def<sup>n</sup>: finite automata is a collection of three things:

- 1). A finite set of states, one of which is designated as the initial state, called the start state (~~may be none~~), and some (may be none) of which are designated as final states.
- 2). An alphabet  $\Sigma$  of possible input letters.
- 3). A finite set of transitions that tell for each state & for each letter of the input alphabet which state to go to next.

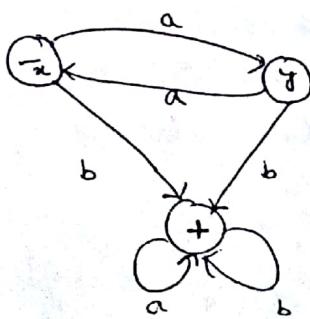
Representation of start & final states:-

1) start                          final  
    ( - )                          ( + ).

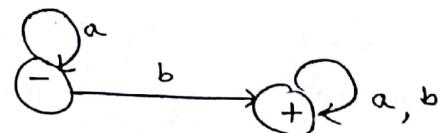
2)                                  ( )

3) start ( )                          final ( )

Q1) machine that accepts atleast one 'b'.



OR

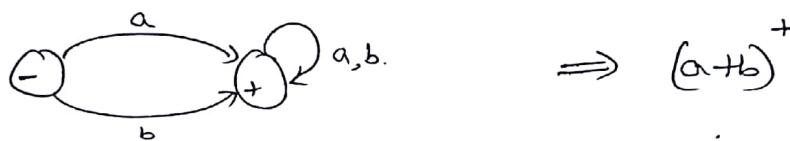


Transition diag table.

(5)

	a	b
start x	y	z
y	x	z
final z	z	z

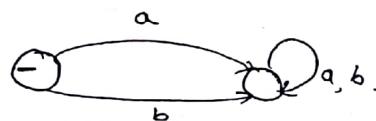
Eg 2) All strings of 'a' & 'b' except ' $\lambda$ '.



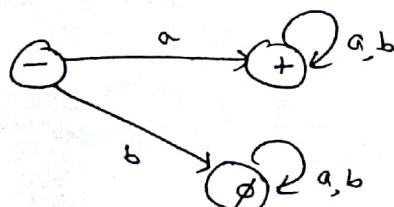
Eg 3) All strings including ' $\lambda$ '.



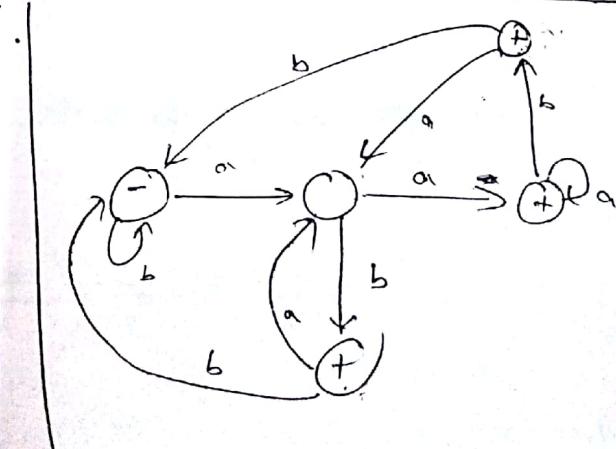
Eg 4) F.A's that accept no languages i.e (no final states)



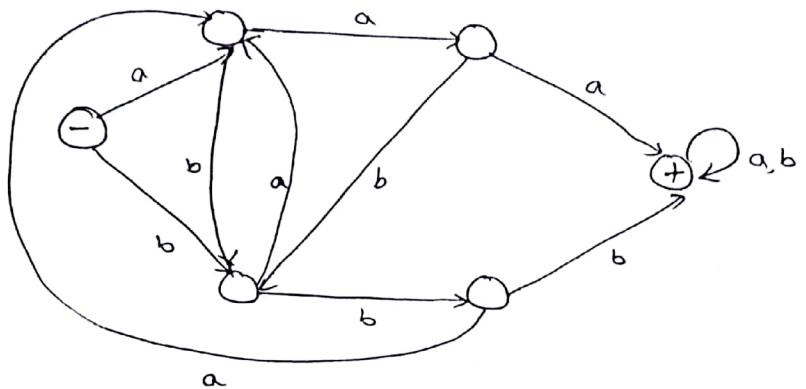
Eg 5) The first letter should be 'a'.



Second last letter should be 'a'

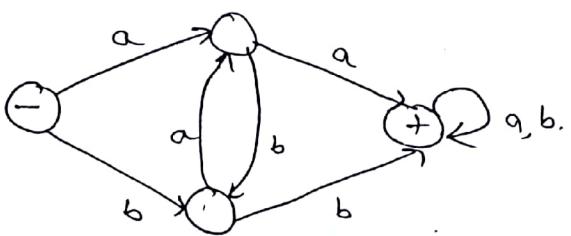


eg 6) FA that accepts atleast one 'aaa' or 'bbb'.  
 (atleast one triplet of aaa or bbb).

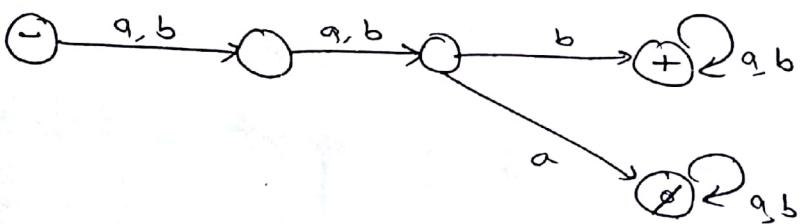


eg 7) Machine that have double letter in them.

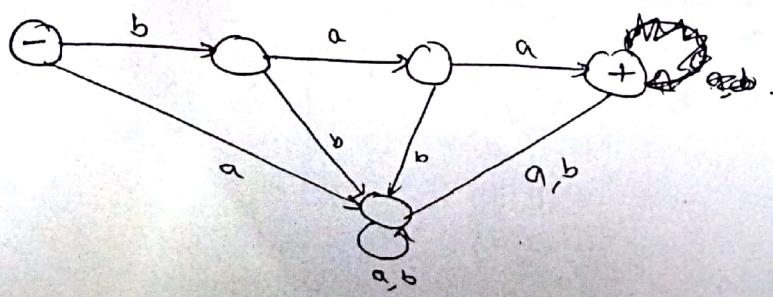
$$(a+b)^* (aa+bb) (a+b)^*$$



eg 8) strings that have 'b' as the third letter.

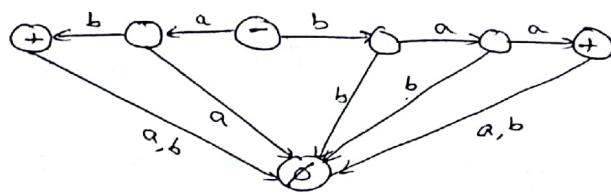


eg 9) Accept only the word baa:

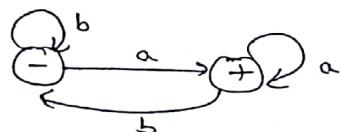


eg 10) accept only baa & ab.

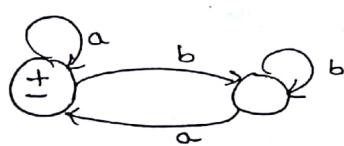
(6)



eg 11) strings that end with a.

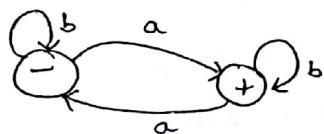


This, does not include  $\lambda$ .

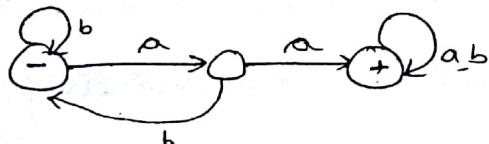


This, also include ' $\lambda$ '.

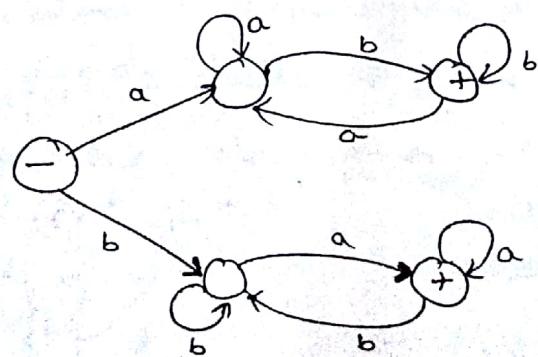
eg 12) machine that accepts odd no. of a's.



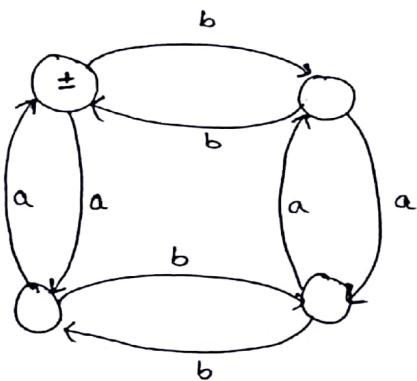
eg 13) machine having double 'aa' in them somewhere.



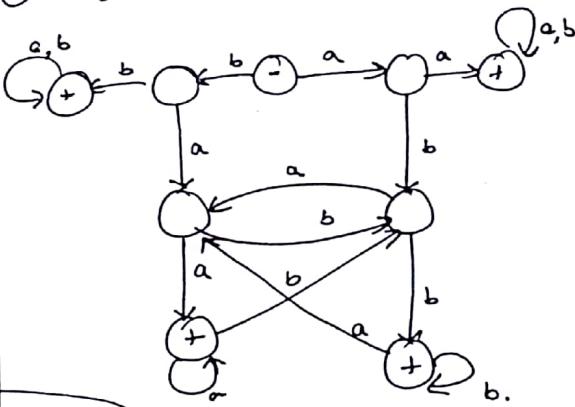
eg 14) FA that accepts all words that have different first and last letters.



Eg 15 Finite Automata for EVEN-EVEN.



(7) begin & end with double letter



Exercise (F.A).

1) words with 'b' as second letter.

2) accepts only ba, ab & abb.

3) words that have more than 4 letters.

4) fewer than four letters.

5) exactly four letters.

6) words do not end with ba ( exclude 1, include 1 )

7) words that begin or end with a double letter

8) words that have both the letters a & b in them in any order.

9) words with only a's or only b's in them.

10) strings of a's & b's such that <sup>prev.</sup> next to last letter is an a.

11) leng. of all strings of length 4 or more such that <sup>prev.</sup> next-to-last letter is equal to the second letter of the input string.

12) all strings that have an even length that is not divisible by 6.

13) odd no. of occurrences of the substring abc.

Regular Exp)

1) 'a' appears tripled, if at all. if every clump of 'a' contain 3, 6, 9, ... 12 .. a's.

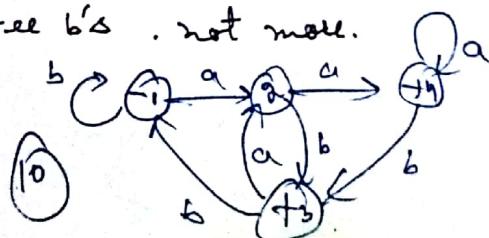
2) words that contain atleast one of the strings  $s_1, s_2, s_3$  or  $s_4$ .

3) that contain exactly two b's or three b's . not more.

4) that end in a double letter.

5) do not end in a double letter.

6) exactly one double letter in them.



end with a '0', we see ~~in the~~ having EVEN-EVEN configuration

Exercise. [contd...]. [ $\Rightarrow$  Prob.]

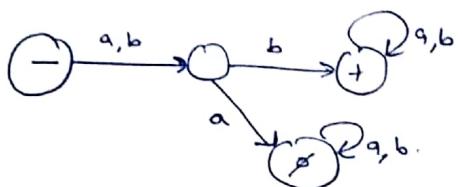
- ⑦ strings in which letter 'b' is never tripled. (ie no words contains the substring  $bbb$ ).
- ⑧ words in which 'a' is tripled or 'b' is tripled, but not both.
- ⑨ words that do not have substring ab.
- ⑩ words that do not have both the substrings  $bba$  and  $abb$ .
- ⑪ total no. of a's div. by 3, no matter how they are distributed.
- ⑫ words in which any b's that occur are found in clumps of an odd no. at a time.
- ⑬ strings that have even no. of a's & odd no. of b's.
- ⑭ strings that have odd no. of a's & odd no. of b's

Dear Students

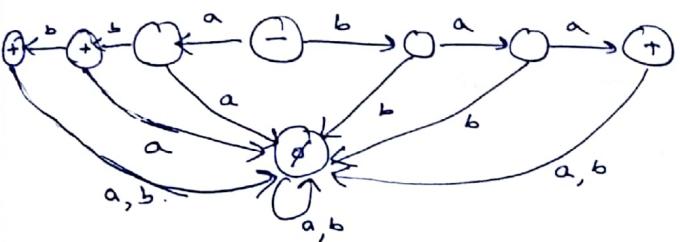
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FA Sol's. (Exercise) Pg-6.

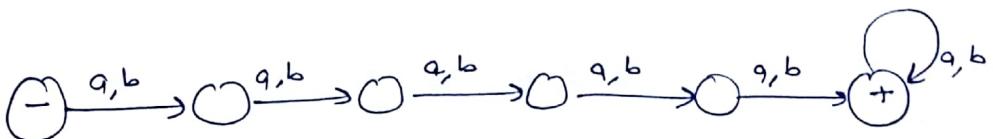
- ① words with 'b' as second letter.



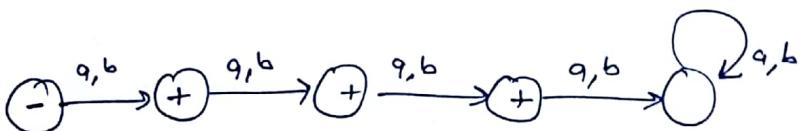
- ② words that accept only baa, ab & abb.



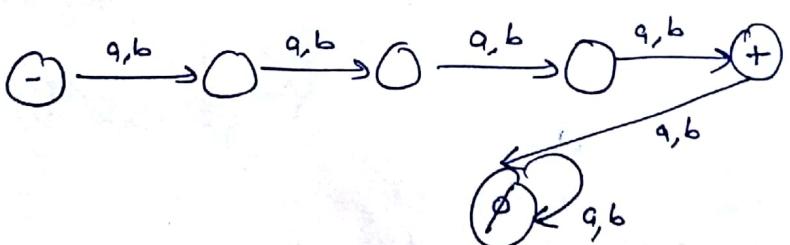
- ③ words that have more than 4 letters.



- ④ fewer than 4 letters.

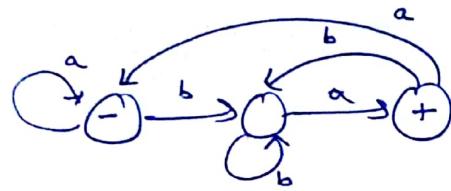


- ⑤ exactly four letters

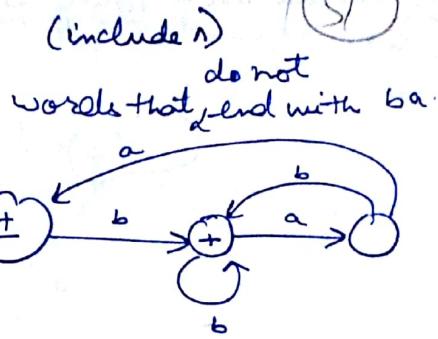


⑥ words that do not end with ba.

C words that end with ba



(6a)  
complement



(51)

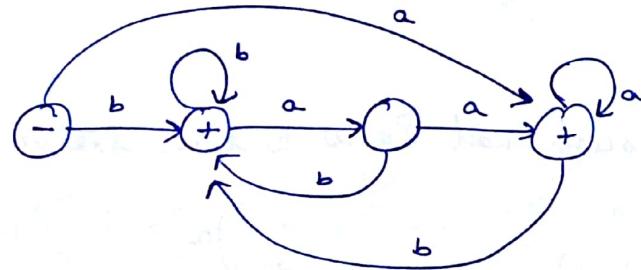
(include n)

do not

words that end with ba.

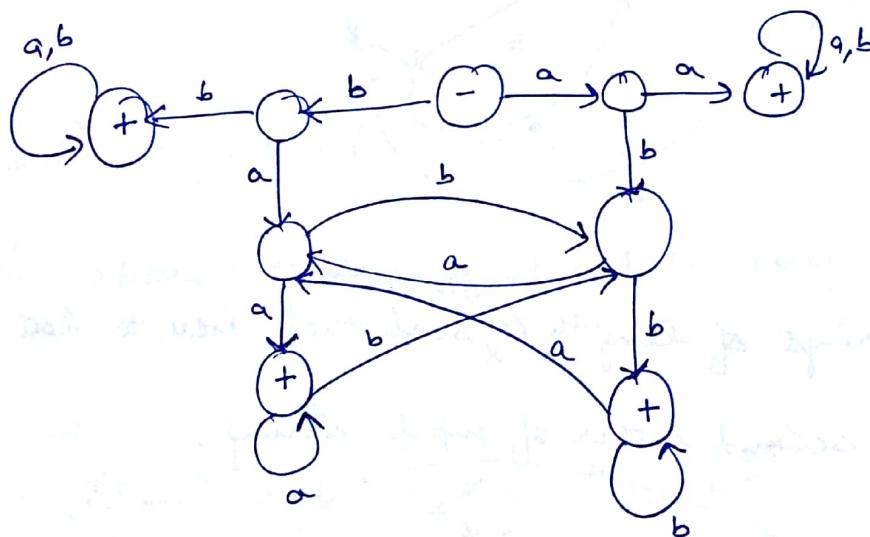
6b)

words that do not end with ba (exclude n)



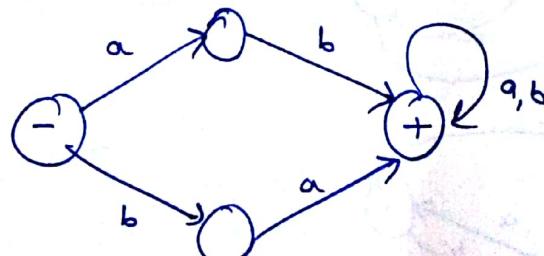
7)

begin or end with a double letter.

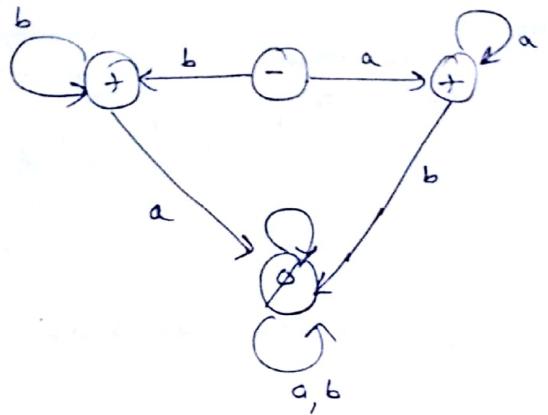


8)

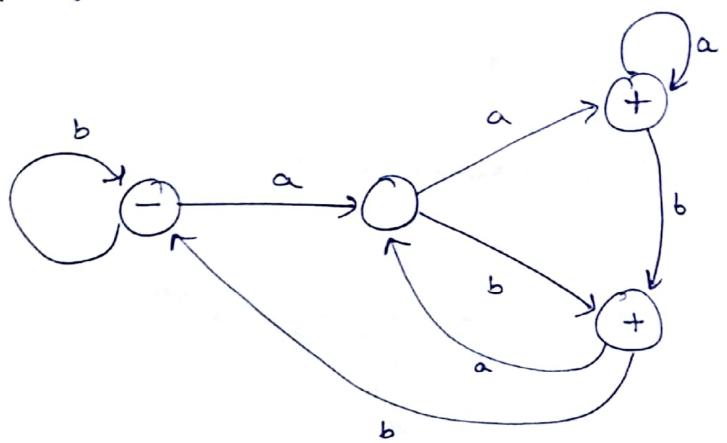
words that have both the letters in them in any order.



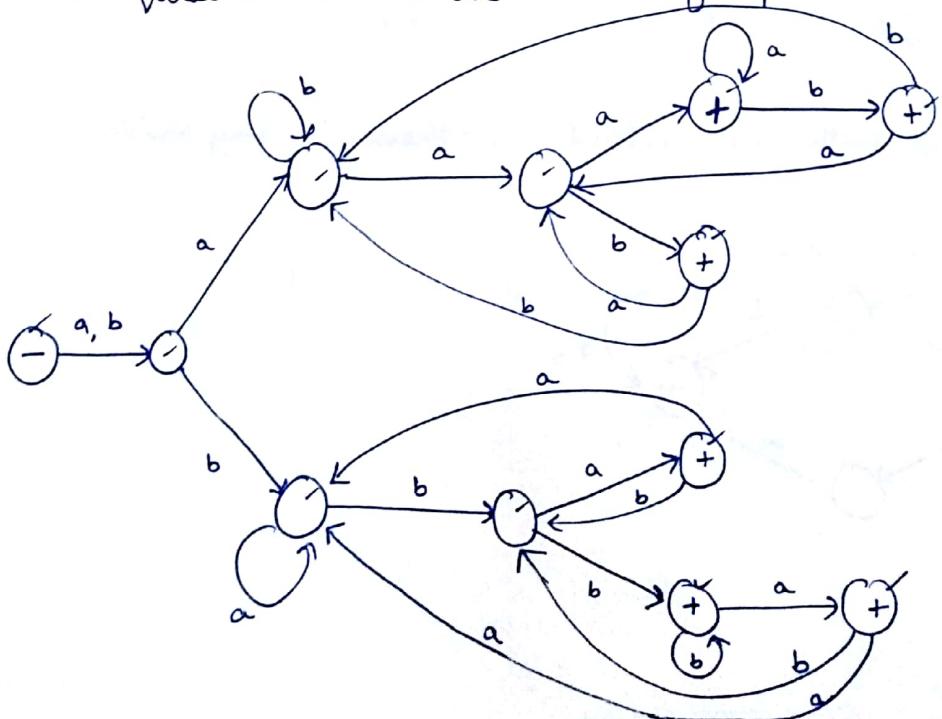
9) words with only 'a's or only 'b's in them.



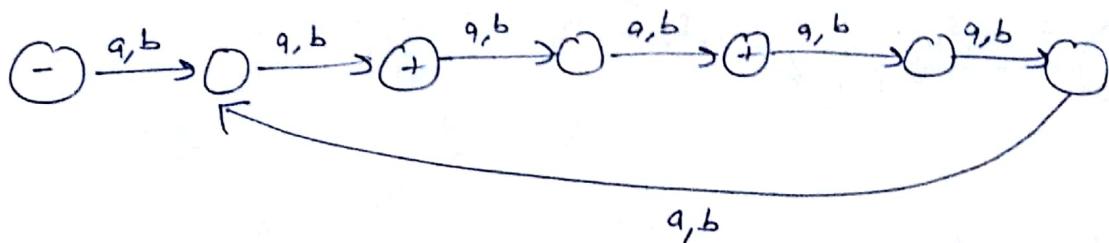
10) strings of 'a's & 'b's such that Prev. to last letter is an 'a'.



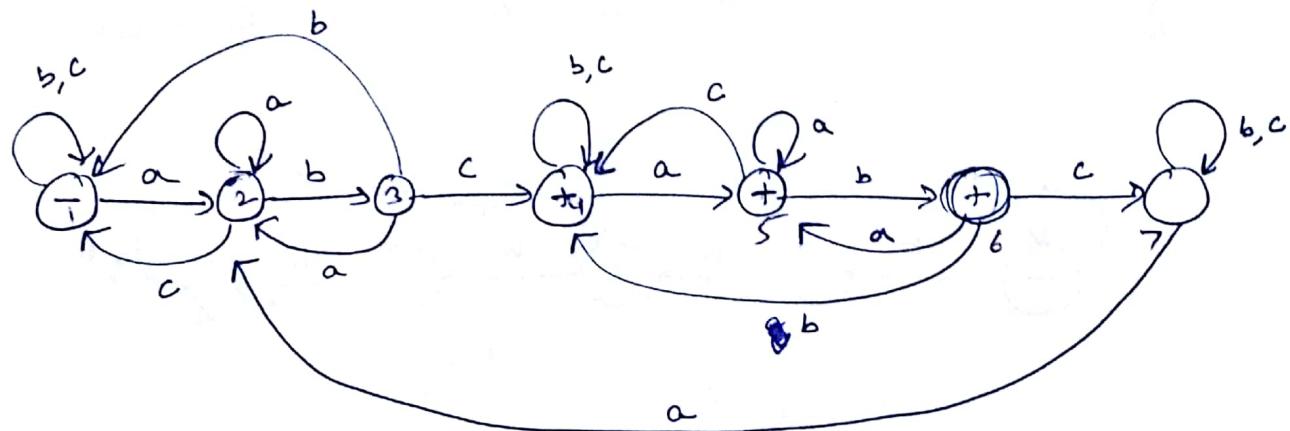
11) long. of all strings of length 4 such that Prev. to last letter is equal to the second letter of input string.



(12) All strings that have even length that is not divisible by 6. (52)

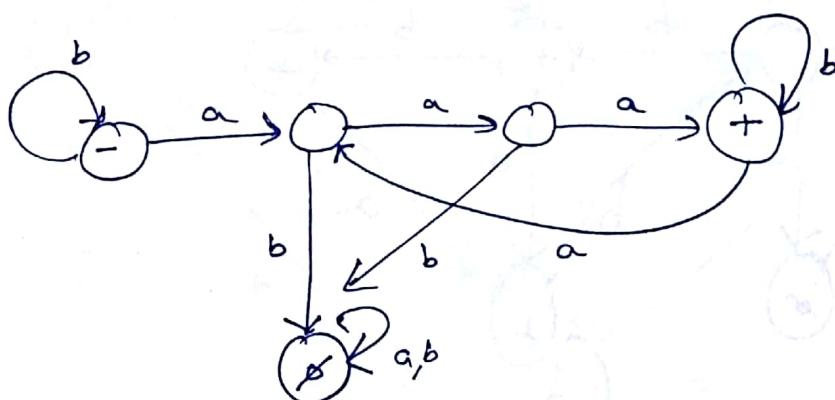


(12) odd no. of occurrences of the substring abc.

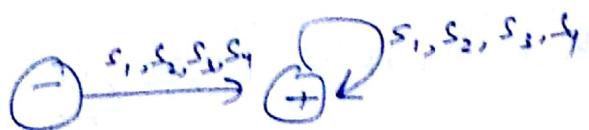


fA Sol" (Reg.ExP - Exercise Pg-6).

① 'a' appears tripled if at all i.e every clumps of a contain  
3, 6, 9, 12, ... a's.



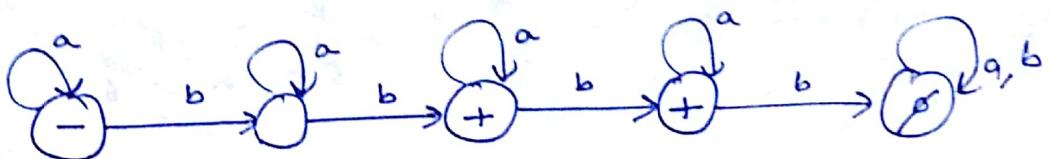
(2) words that contain at least one of the strings  $s_1, s_2, s_3, s_4$



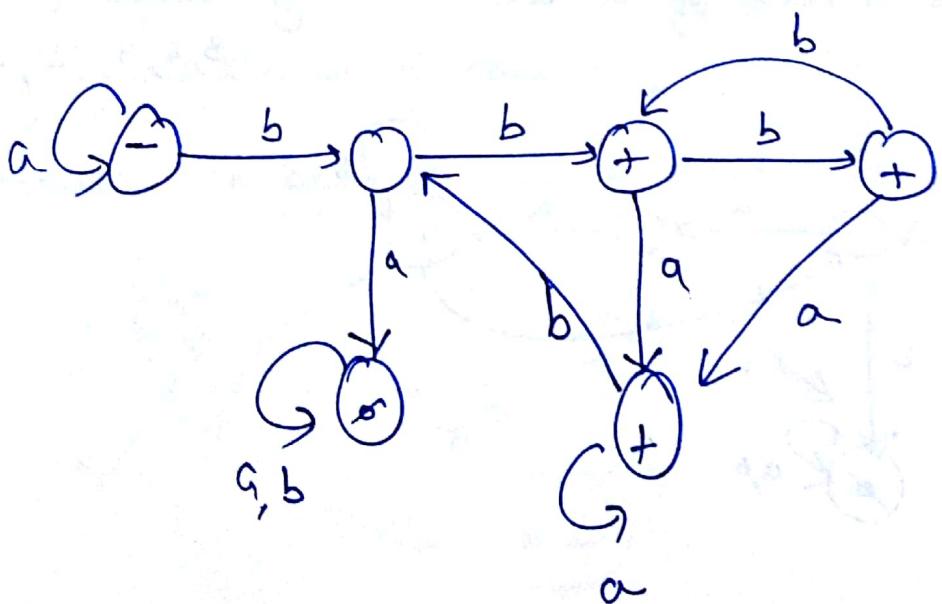
(3) words that contain exactly two 'b's or three 'b's.

(a) no matter how they are distributed.

$$L = \{ \text{bab, bbb, abb, bob, bba, bbb, } \dots \}$$

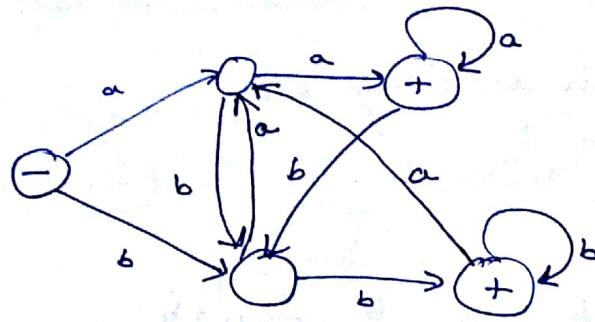


(b). That contain ~~exactly~~ double 'b' or triple 'b'.

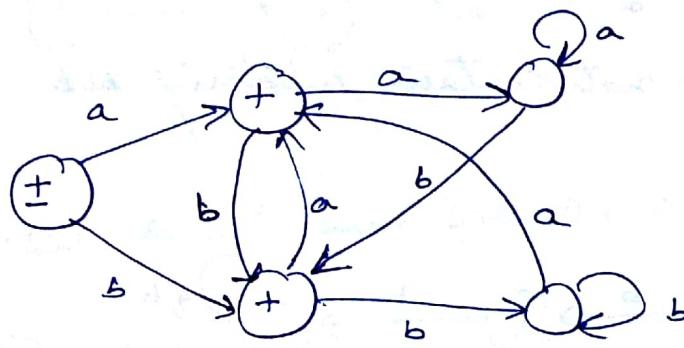


④ words that end in a double letter.

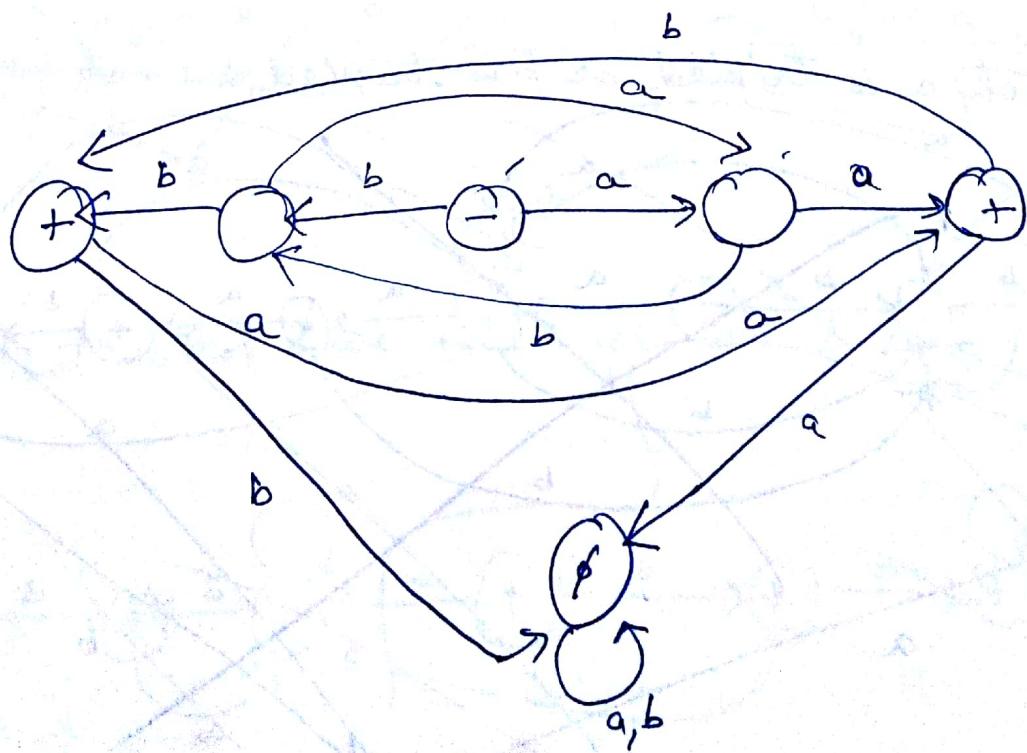
(53)



⑤ do not end in a double letter.



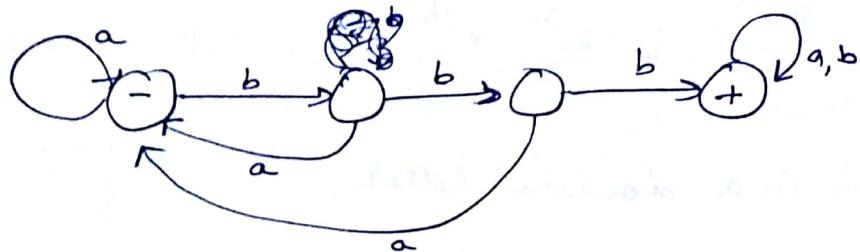
⑥ exactly one double letter in them.



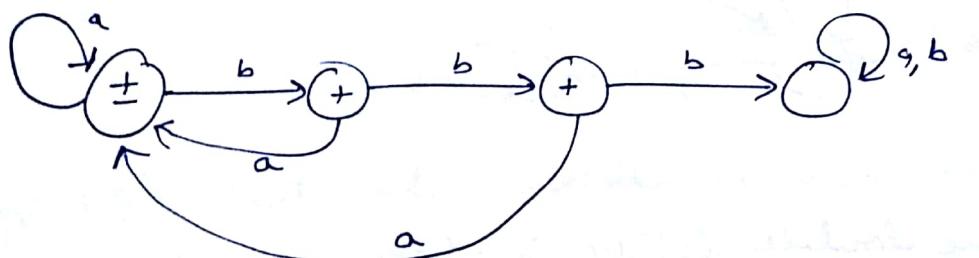
(7) strings in which letter 'b' is never tripled (no word contain the substring  $bbb$ ).



7a) words that contain substring  $bbb$ .



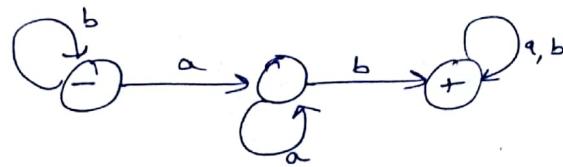
7b) words that do not contain substring  $bbb$ .



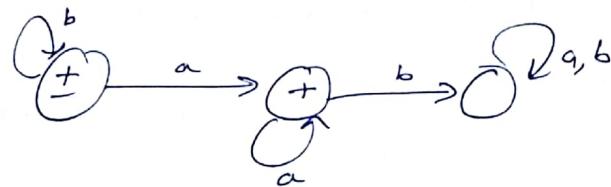
(9) words that do not have substring ab.

(54)

(9a) that have substring 'ab'.

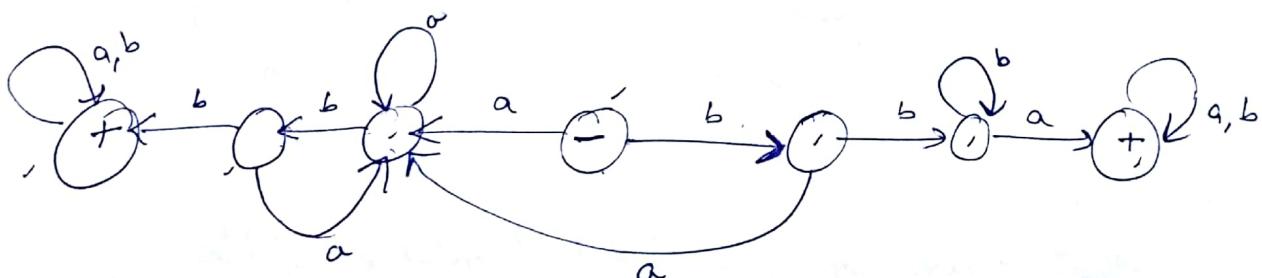


(10) that do not have substring 'ab'

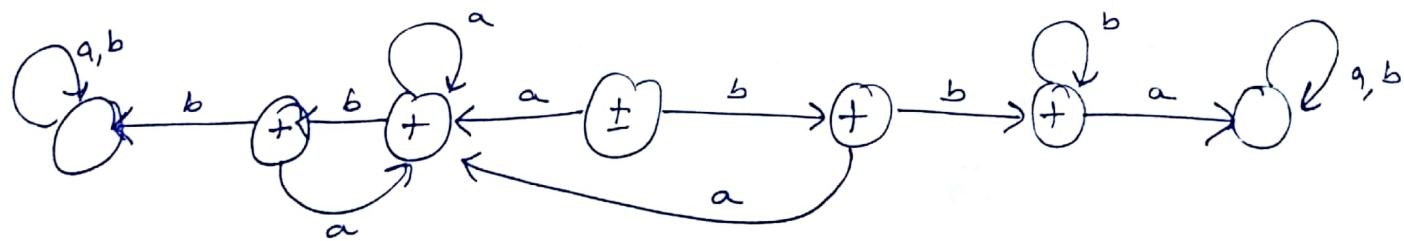


(10) words that do not have both the substrings bba & abb.

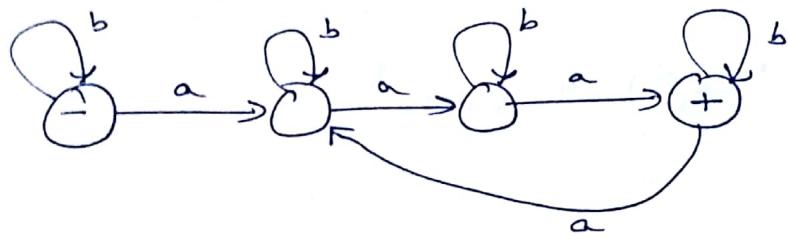
(10a) that have substrings bba & abb.



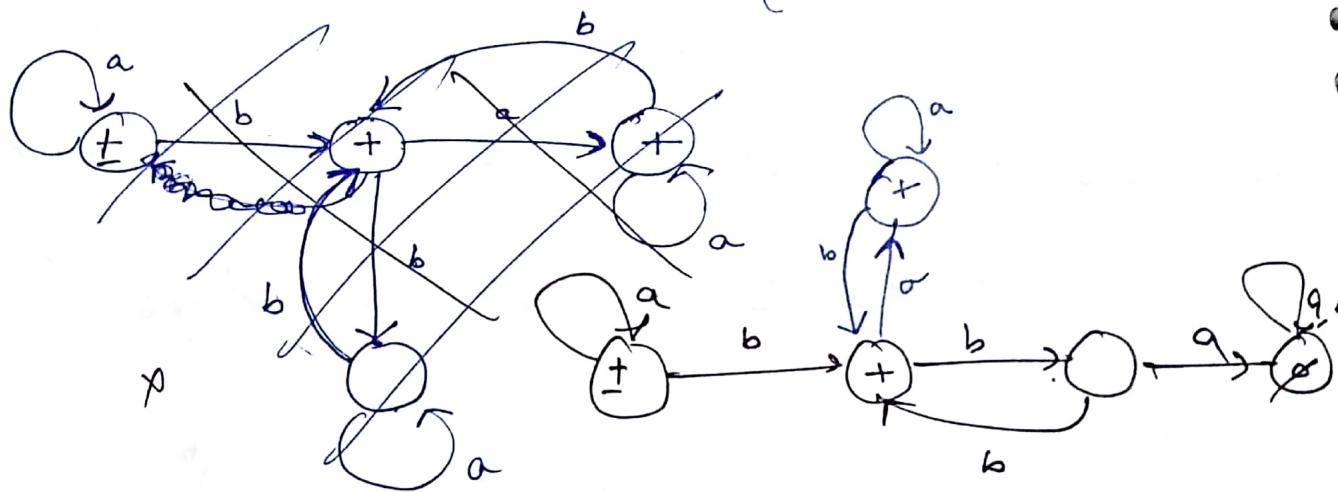
(10b) that do not have substrings bba & abb.



- (11) Total no. of a's , divisible by 3 , no matter how they are distributed.



- (12) words in which b's ~~that if occur~~ are found in clumps of an odd no. at a time. (Λ included).

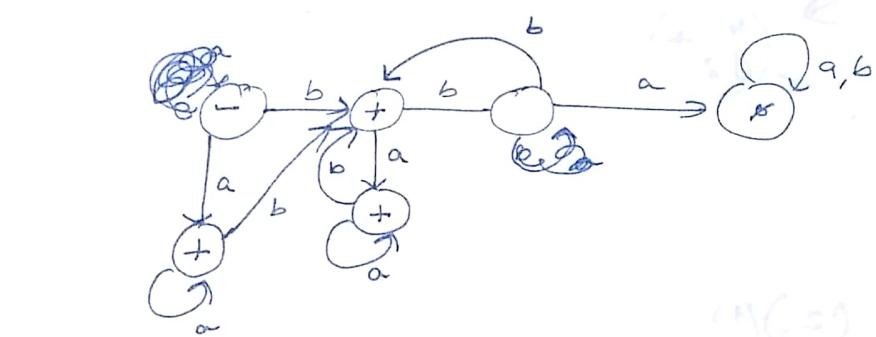


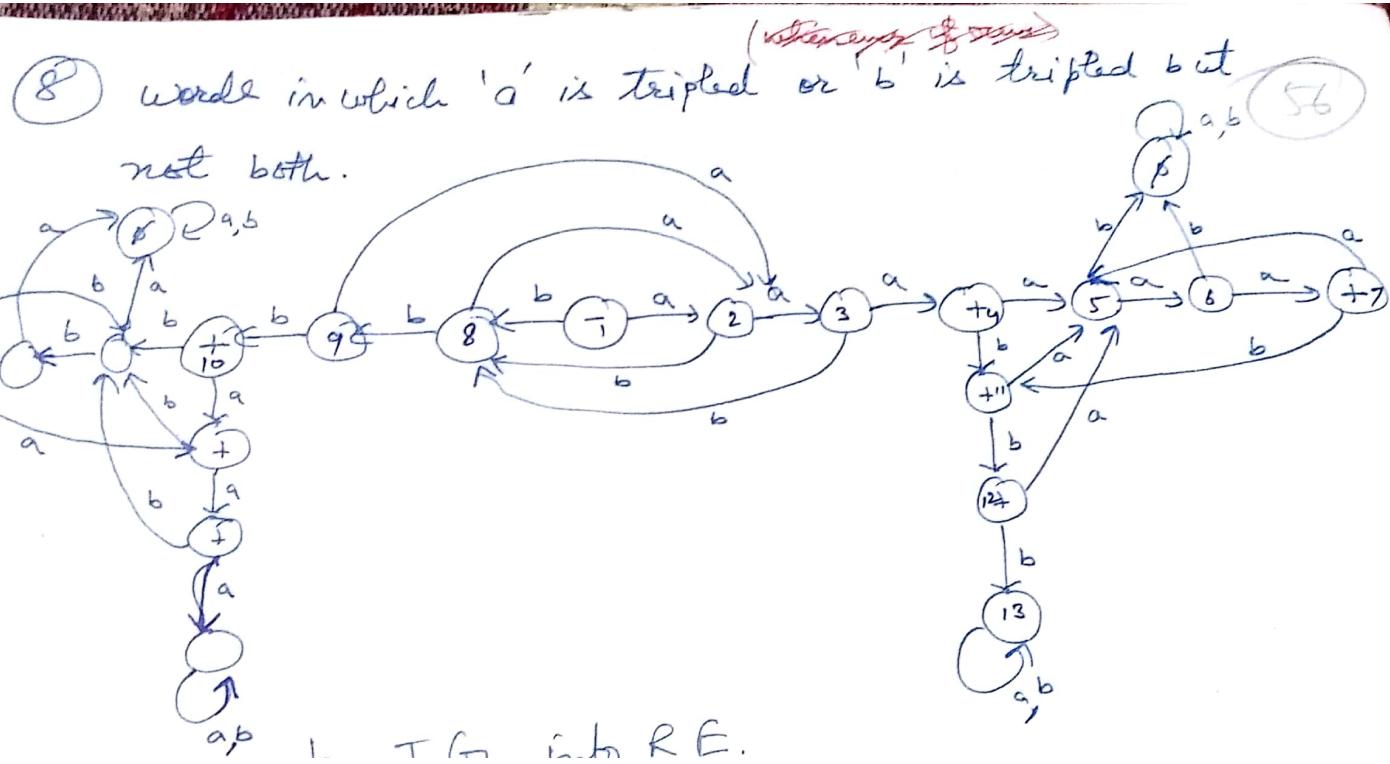
- (13) strings that have even no. of a's & odd no. of b's  
# use Kleen's → Intersection Th.

(14) strings that have odd no. of a's & odd no. of b's  
# Kleene's Intersection Theorem.

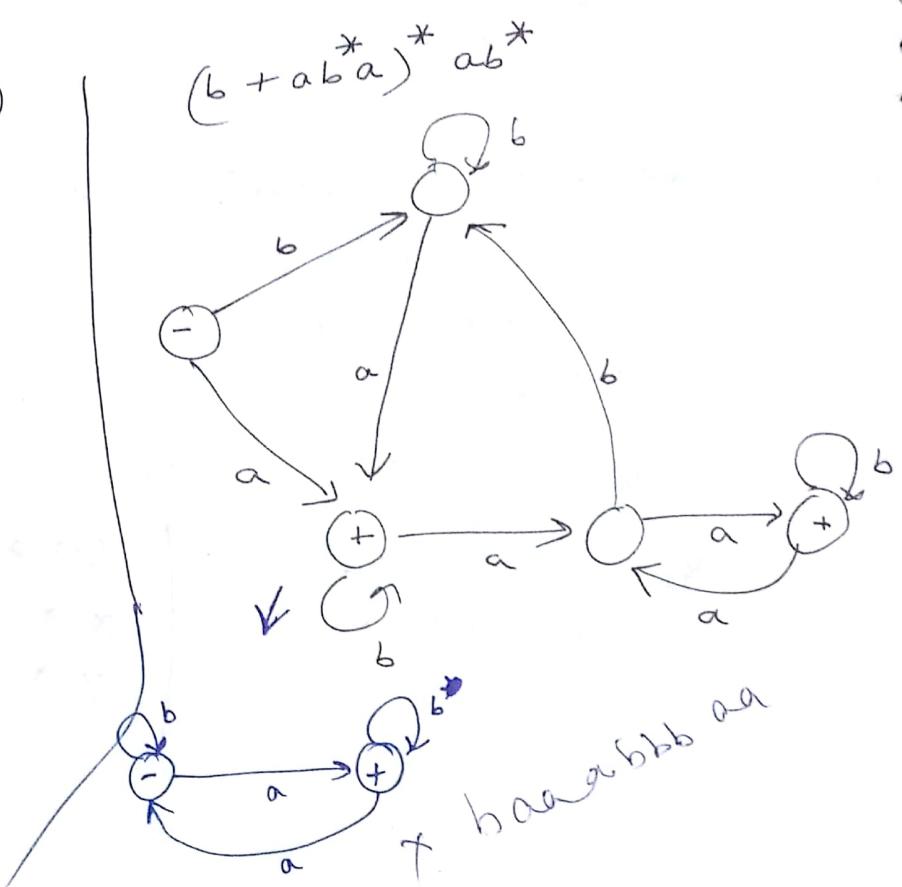
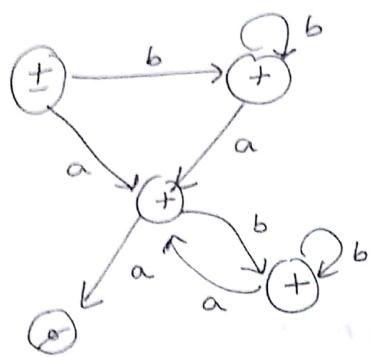
(55)

(12) words in which b's ~~if ever~~ are found in odd no. at a time  
( $\wedge$  excluded).

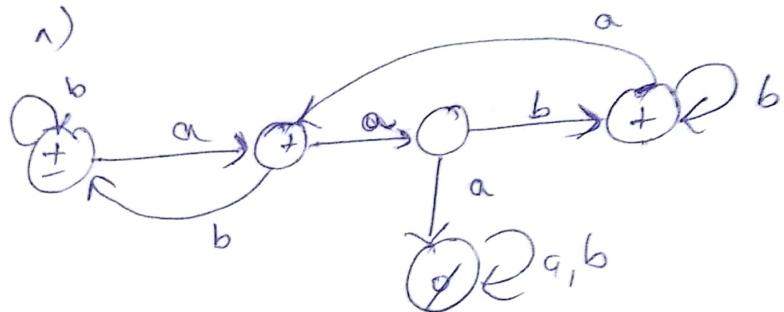




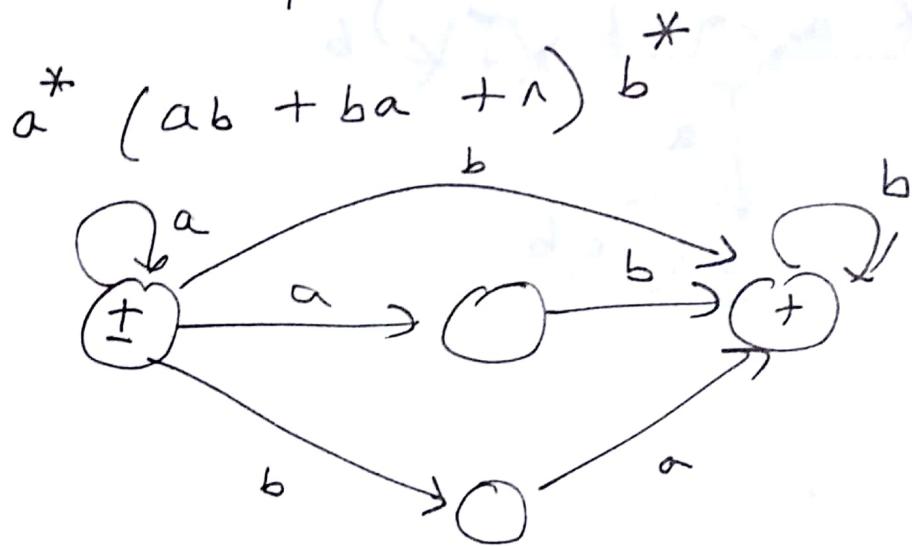
a. Design FA for  
 $(b+ab)^* (a+a)$



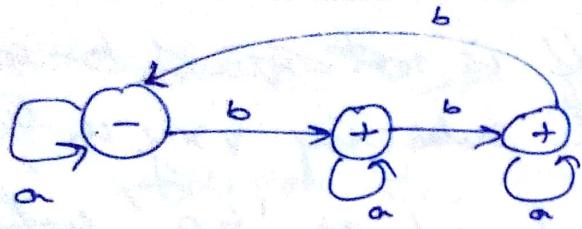
FA in which every 'a' is foll. immediately by 'b'.  
(incl.  $\lambda$ )



④ construct FA for

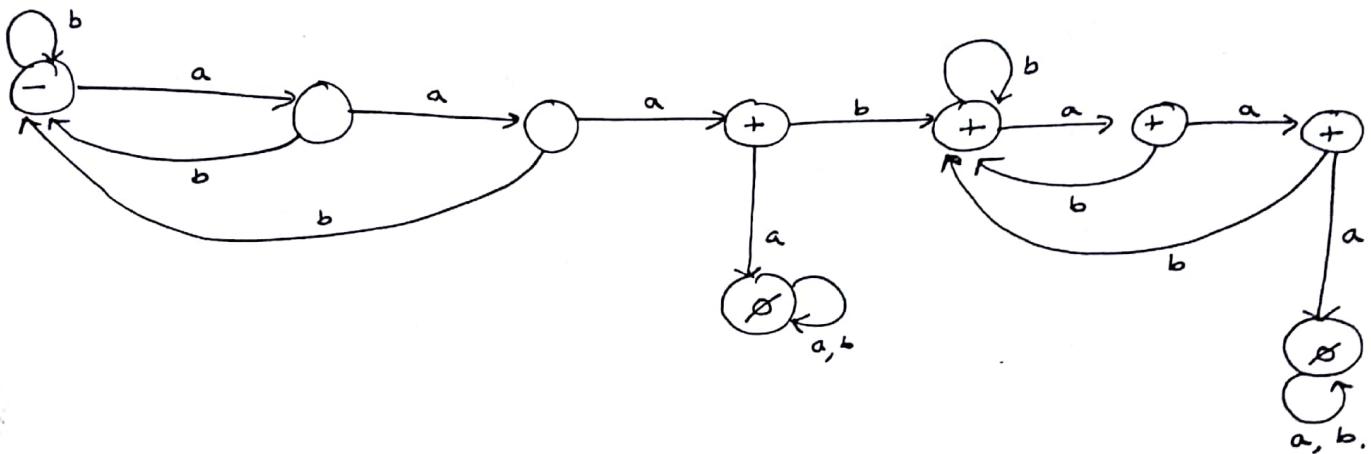


Now convert NFA  $\rightarrow$  DFA



words that do not contain no. of  $b$ 's  
div. by 3.

exactly one 'aaa' ~~grrr~~



exactly one 'aaa' or 'bbb' ~~grrr~~

