0146

CS 301 Theory of Automata

Serial No:

Sessional I

Total Time: 1 Hour

Total Marks: 55

Saturday, September 27, 2014

Course Instructor

Dr. Aftab Maroof, Dr. Waseem Shahzad and
MS. Humaira Ehsan

Signature of Invigilator

Student Name | Roll No | Section | Signature

DO NOT OPEN THE QUESTION BOOK OR START UNTIL INSTRUCTED.

Instructions:

1. Attempt on question paper. Attempt all of them. Read the question carefully, understand the question, and then attempt it.
2. Examination is closed books/notes. No notes, cheat sheets, textbook, or printed material allowed.
3. No additional sheet will be provided for rough work. Use the back of the last page for rough work.
4. If you need more space write on the back side of the paper and clearly mark question and part number etc.
5. After asked to commence the exam, please verify that you have nine (9) different printed pages including this title page. There are total of 6 questions.
6. If you believe that some essential piece of information is missing, make an appropriate assumption and use it to solve the problem.
7. Use permanent ink pens only. Any part done using soft pencil will not be marked and cannot be claimed for rechecking.

	Q-1	Q-2	Q-3	Q-4	Q-5	Q-6	Total
Marks Obtained							
Total Marks	5	10	10	10	10	10	55

Solution Copy

Question 1:- **Marks 5.**

Give recursive definitions for the following language L over the alphabet *{a, b}*, the language EVENSTRING of all words of even length.

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

Definition of <u>ES</u>

Base / Rule-1: λ, aa, ab, ba, bb are in ES.

Recursive Step Rule 2:

If x, y are in ES then ~~so~~ are:

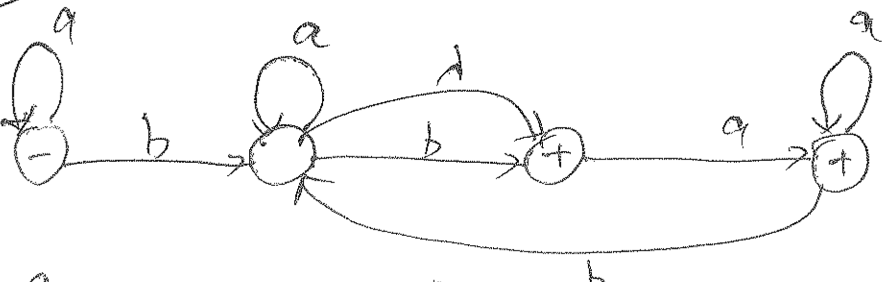
(i) XY
(ii) X^*

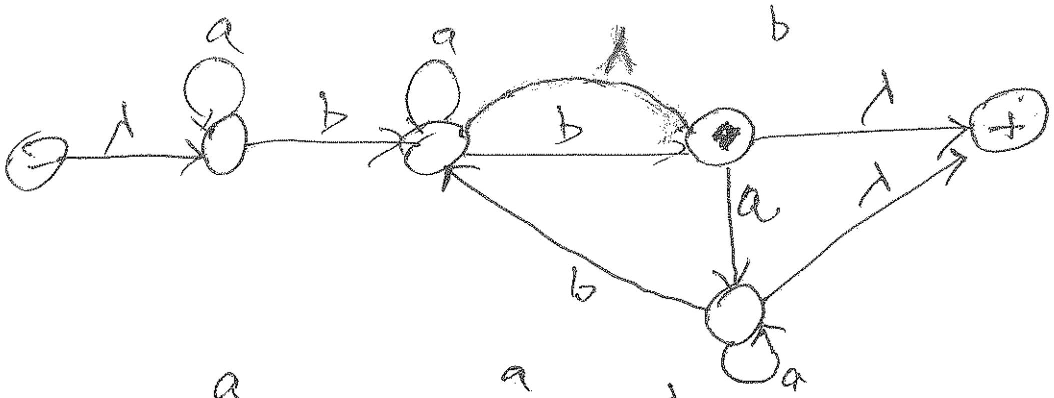
Rule 3:

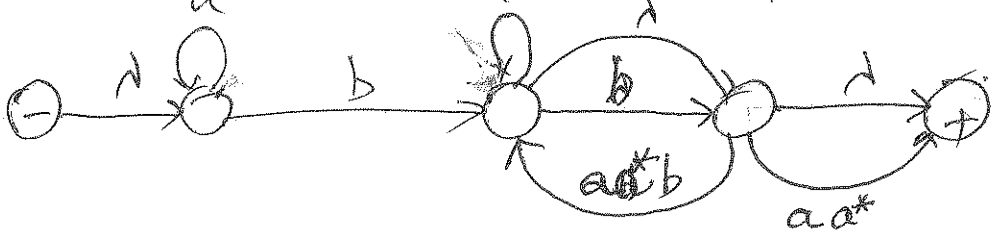
No other string is in ES.

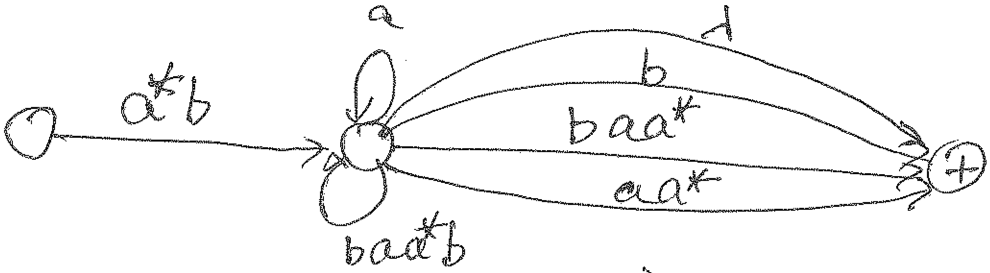
NFA

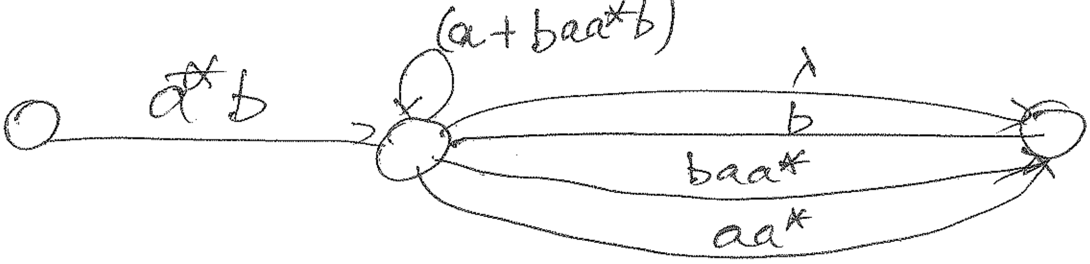
2.a

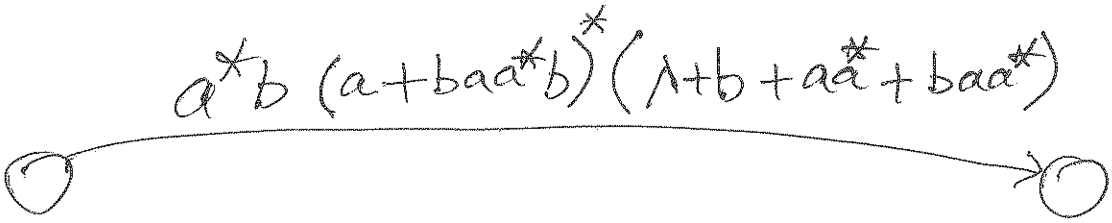

a
a
λ
b
b
a
a
b
−
+
+

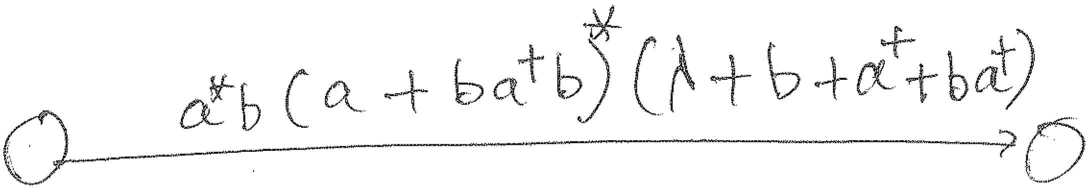

a
a
λ
λ
b
b
λ
a
λ
b
a
−
+


a
a
λ
λ
b
b
λ
aa*b
aa*
−
+


a
λ
a*b
b
baa*
aa*
baa*b
+


(a+baa*b)
λ
a*b
b
baa*
aa*


a*b (a+baa*b)* (λ+b+aa*+baa*)


a*b (a+ba+b)* (λ+b+a+ +ba+)

Question 2:- **Marks 5+5.**

Construct a regular expression defining each of the following languages over the alphabet $\Sigma = \{a, b\}$.

a. All words in which no triple b is allowed i.e bbb never comes in language.

$$a^* b\,(a + ba + ba^+ b)^*\,(\lambda + b + a^+ + ba^+)$$

b. All words in which the total number of 'b' is divisible by 4 no matter how they are distributed and 'a' are only found in clumps that is divisible by 3.

e.g. - b b a a a b a a a a a a a a a b

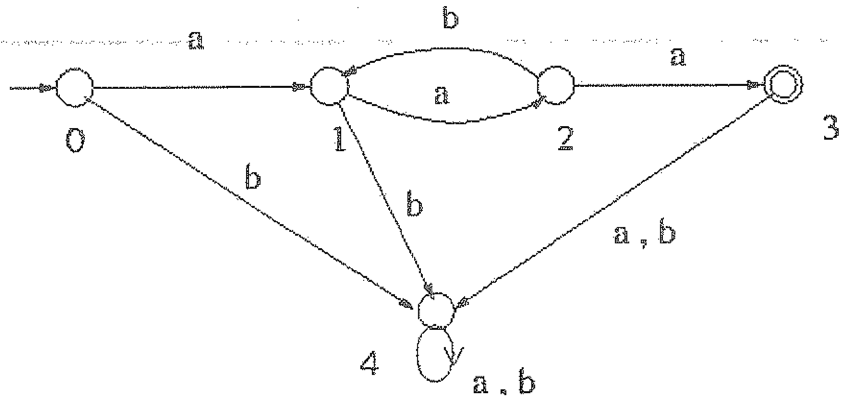
- a a a a a a b b b b a a a b a a a b b b

$$((aaa)^* b\,(aaa)^* b\,(aaa)^* b\,(aaa)^* b\,(aaa)^*)^*$$

Question 3:- **Marks 5+5.**

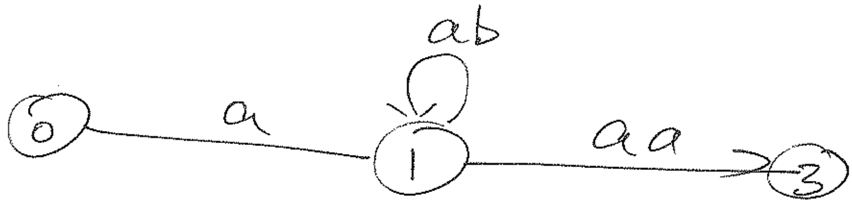
Determine the regular expression of the languages accepted by following FA's.

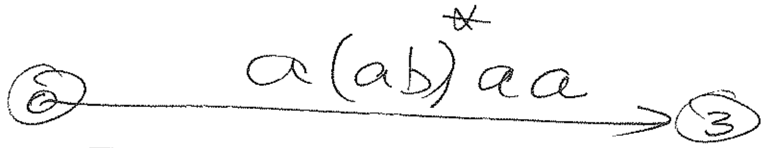
a.

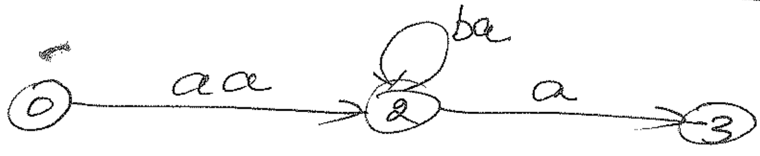


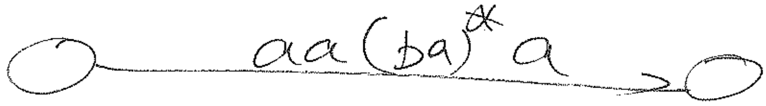
$aa(ba)^*a$ / $aa(ba)^*a$

Eliminating Method



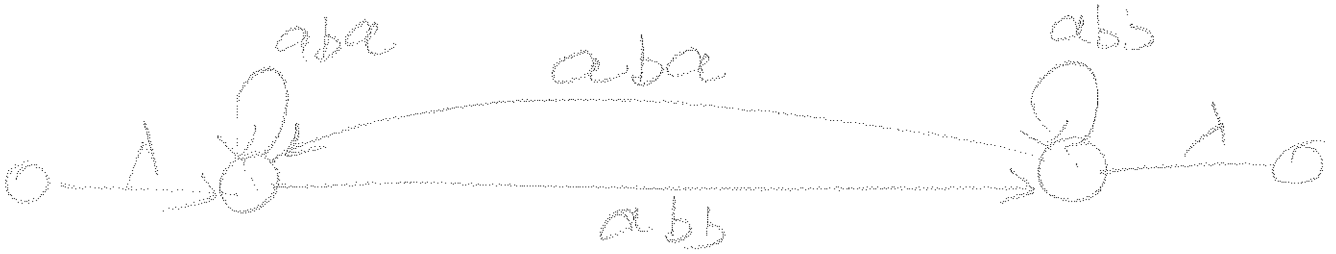


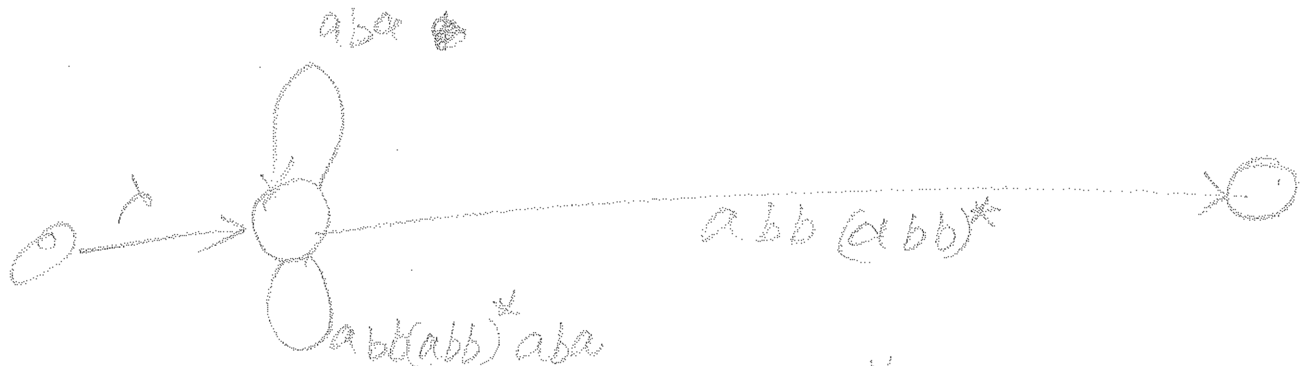





a
a
Λ
a
b
b
Λ
0
1
2
3
+


ba
a
Λ
a
bb
Λ
1
3
+


aba
aba
abb
Λ
Λ
abb


aba
Λ
abb(abb)*
abb(abb)*aba


(aba+abb(abb)*aba)* abb(abb)*

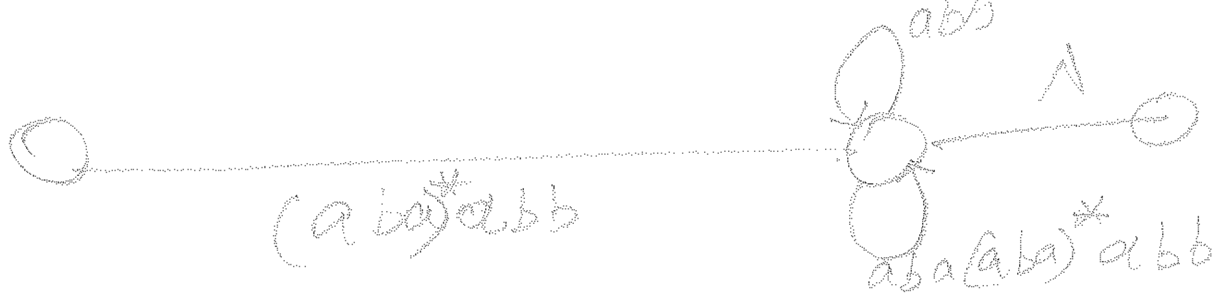
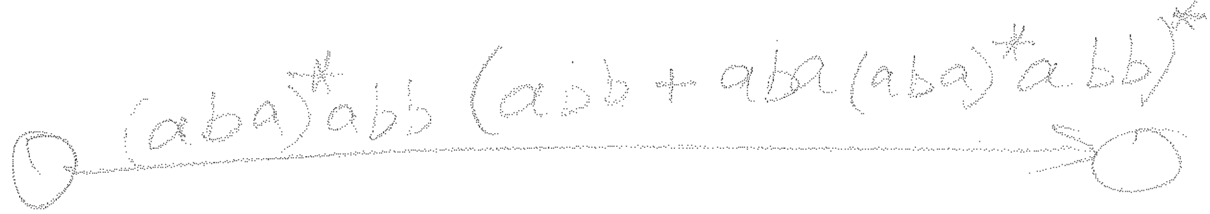
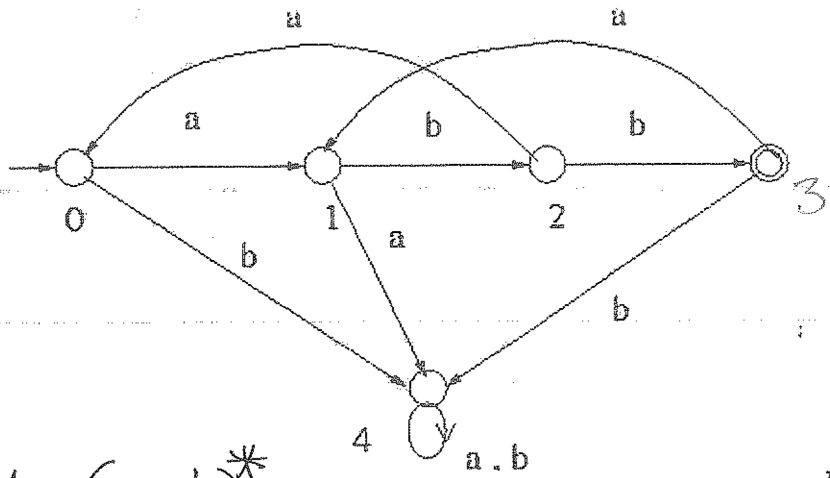


abb
Λ
(aba)*abb
aba(aba)*abb


(aba)*abb(abb+aba(aba)*abb)*

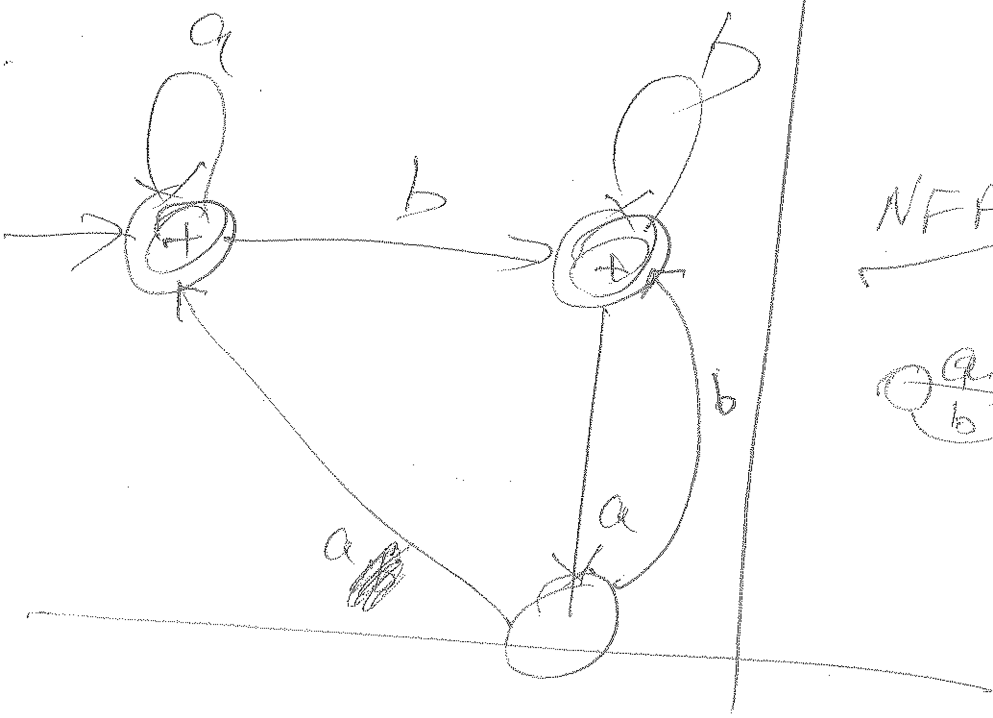
b.



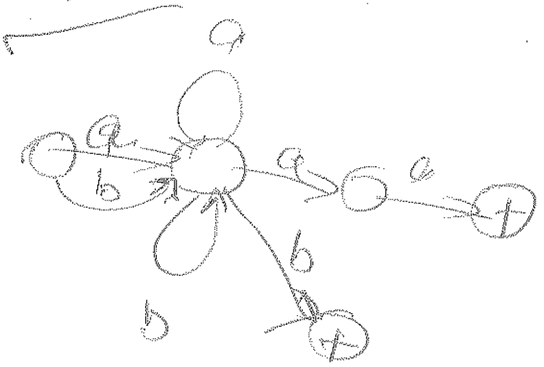
$$\left(ab(aab)^*b + abb(abb)^*\right)^+$$

$$\left(aba + (abb)^+aba\right)^*(abb)^+$$

$$(aba)^*abb\left((aba)^+abb + abb\right)^*$$



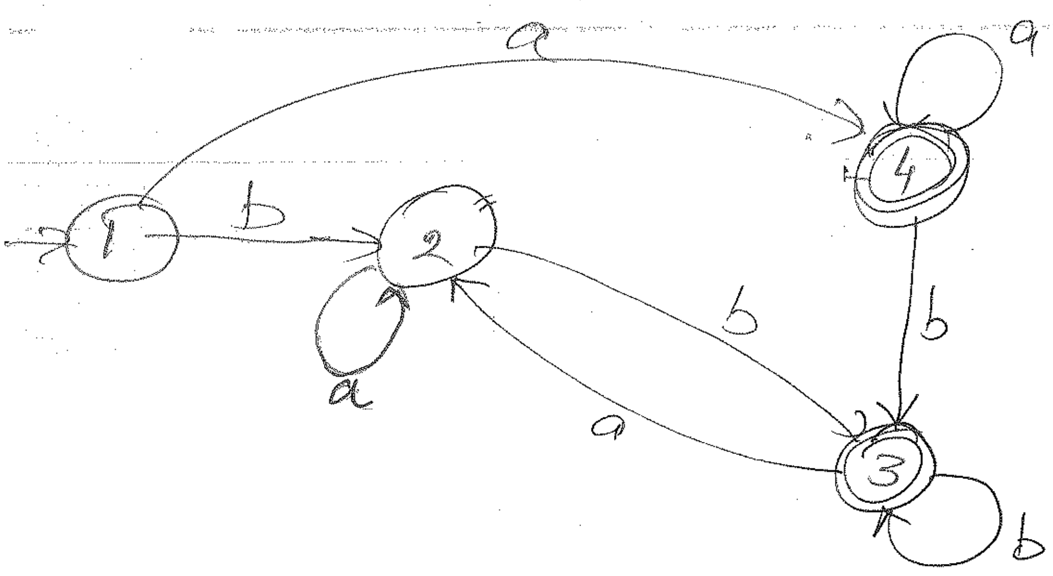
NFA

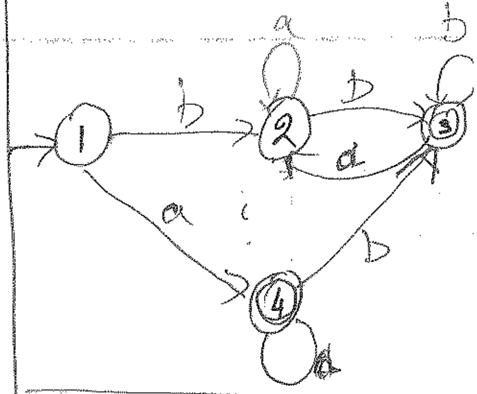


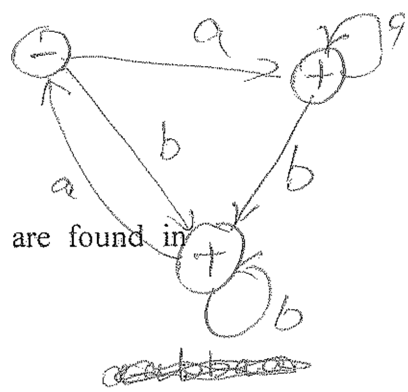
$$\left(\left(b^{*}a\,b^{*}a\right)\left(b+\lambda\right)\right)^{*}$$

Question 4:-   Marks 5+5.

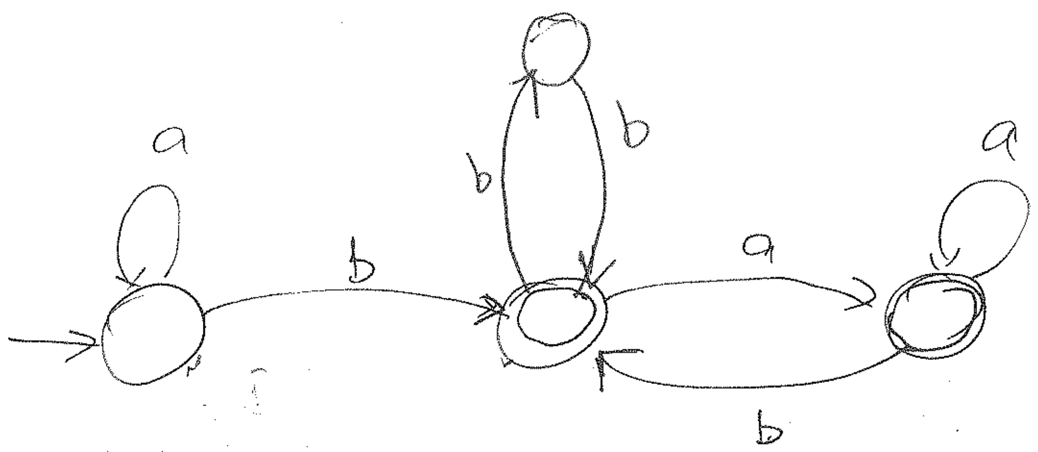
a. Build an FA that accepts only those words that do not end with ba.



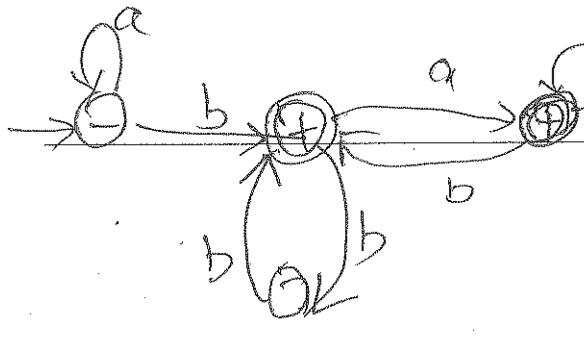


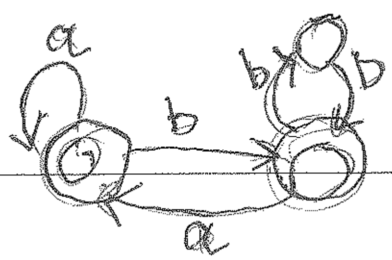


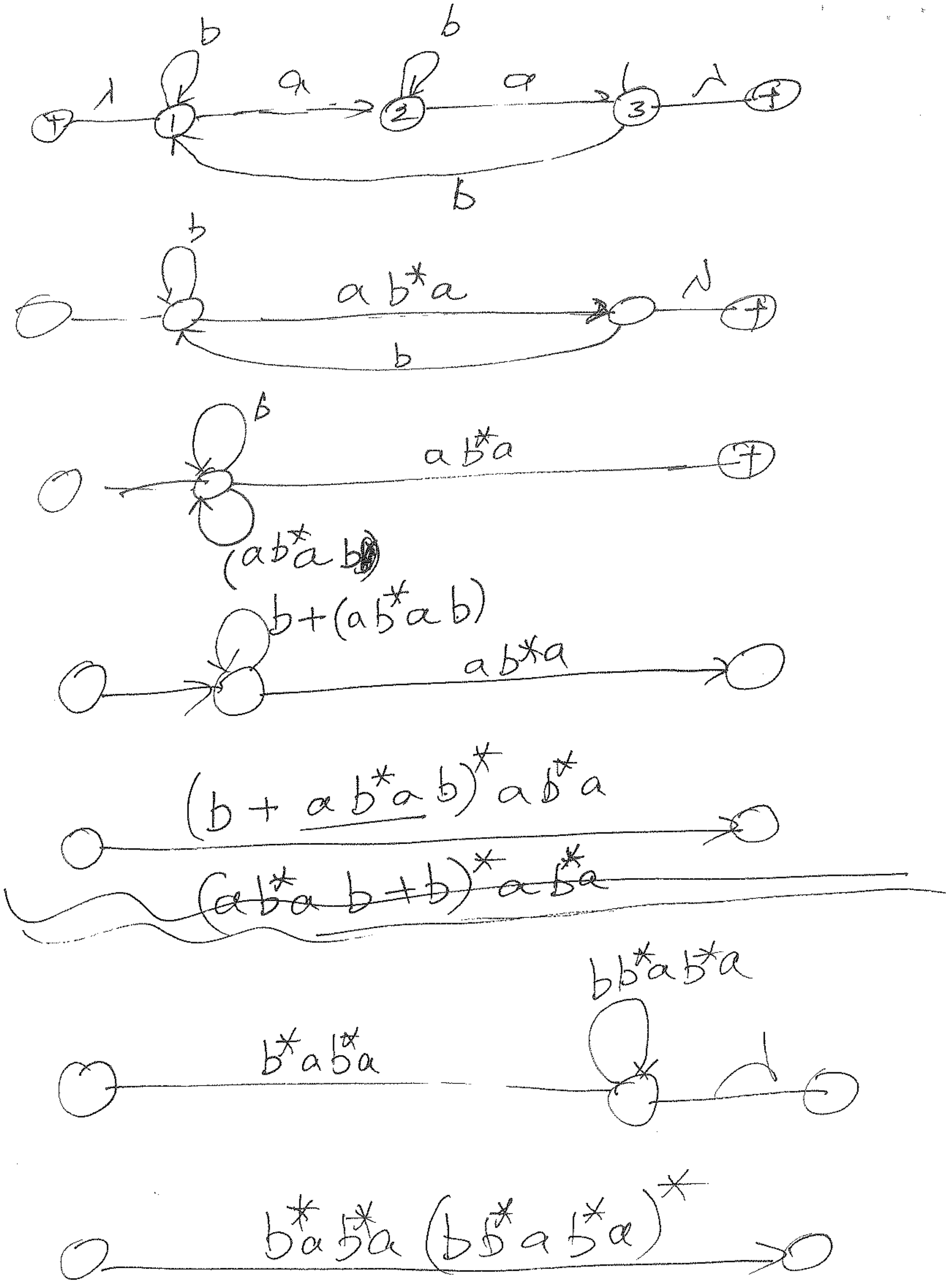
b. Build an FA that accepts all strings in which any b's that occur are found in clumps of an odd number at a time.



~~odd~~ odd
#b's





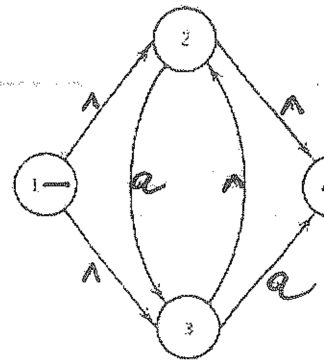


b
b
a
a
λ
λ
1
2
3
+
b
b
ab*a
λ
b
b
ab*a
(ab*ab)
b+(ab*ab)
ab*a
(b + ab*ab)* ab*a
~~(ab*ab+b)* ab*a~~
bb*ab*a
b*ab*a
λ
b*ab*a (bb*ab*a)*

Question 5:- **Marks 5+5.**

Determine the languages of following NFAs.

a.



$\lambda\lambda$

$\lambda a \lambda\lambda$

λa

λaa

$\lambda a \lambda a \lambda a \lambda a \lambda aa$

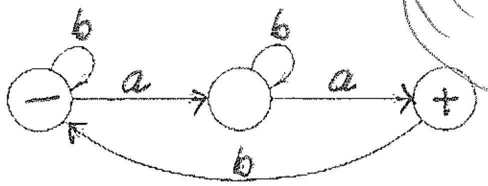
$\lambda a \lambda a \lambda a \lambda\lambda$

$\lambda (a\lambda)^* \lambda = a^*$

a^*

b.

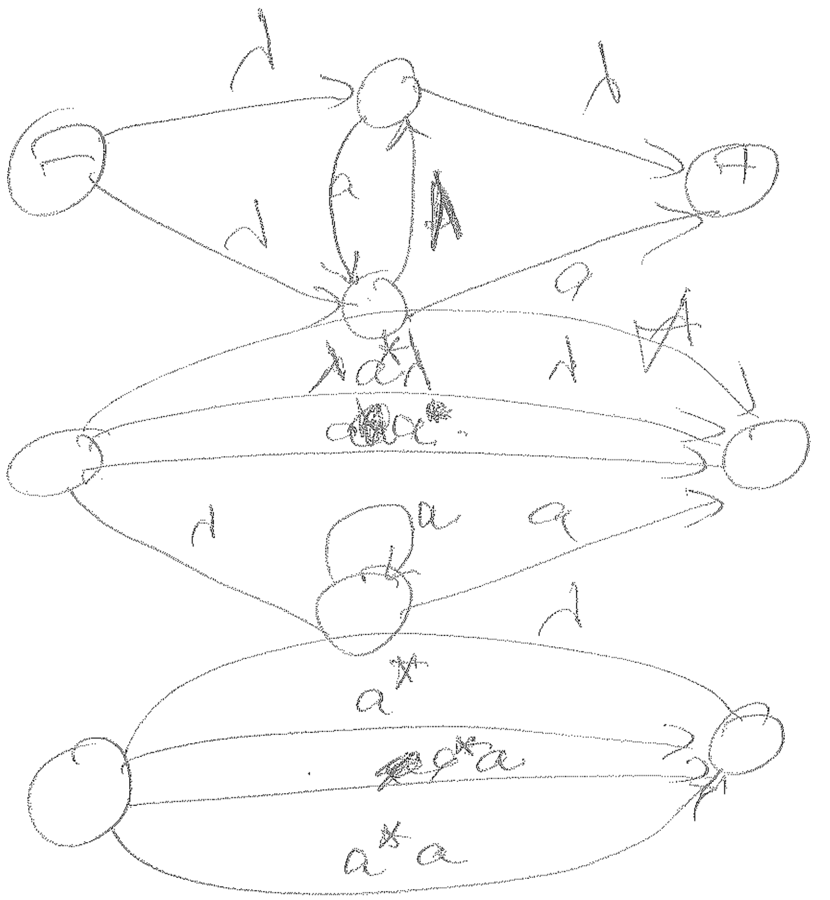
$\left((b^*ab^*a)(\lambda + bb^*ab^*a)\right)^*$

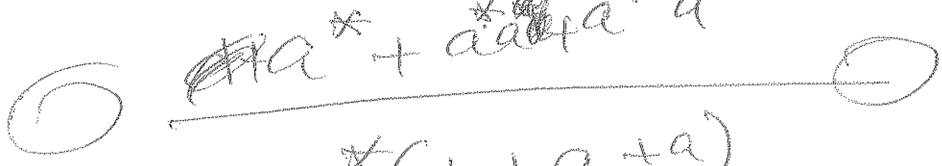


$b^*ab^*a(bb^*ab^*a)^*$

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

Number of a's is always Even.





$$a^*(\lambda + a + a)$$

$$a^*(\lambda + a) \qquad a^* + a^+ = a^*$$

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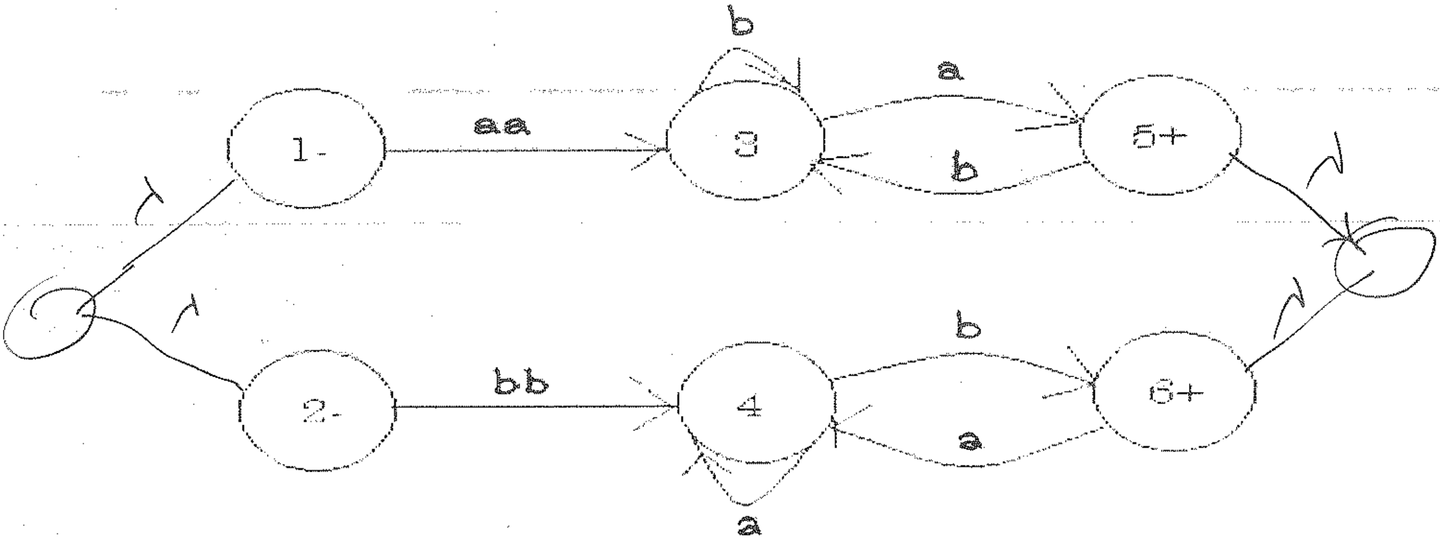
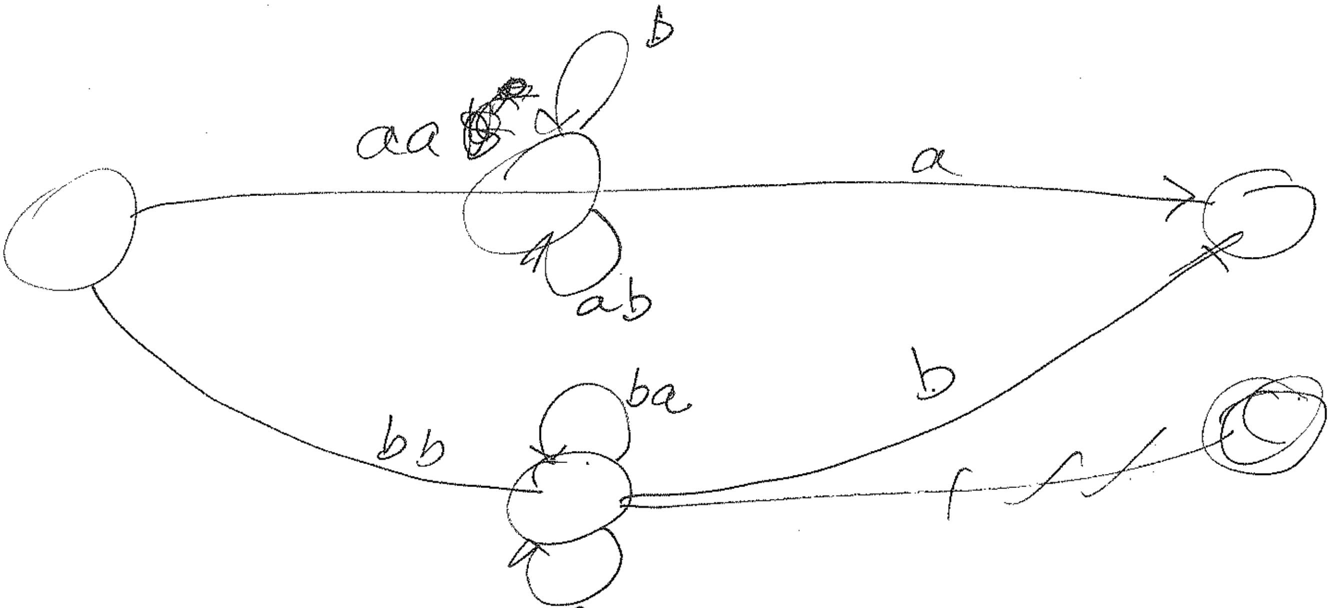
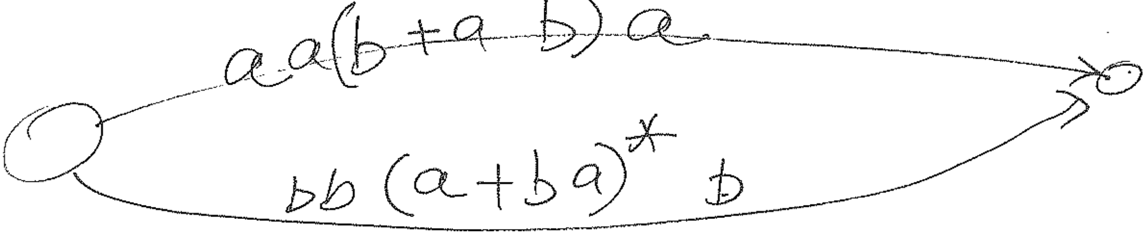
Question 6:- **Marks 5+5.**

For the following transition graph use the algorithm discussed in class to find an equivalent regular expression.







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