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Table of contents:

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[Please see Errata if you have copy of handouts printed before this date]

Theory of Automata

Lecture N0. 1
Reading Material

Introduction to Computer Theory Chapter 2

Summary
Introduction to the course title, Formal and In-formal languages, Alphabets, Strings, Null string, Words, Valid and In-valid alphabets, length of a string, Reverse of a string, Defining languages, Descriptive definition of languages, EQUAL, EVEN-EVEN, INTEGER, EVEN, { $a^n b^n$}, { $a^n b^n a^n$ }, factorial, FACTORIAL, DOUBLEFACTORIAL, SQUARE, DOUBLESQUARE, PRIME, PALINDROME.

What does automata mean?
It is the plural of automaton, and it means "something that works automatically"

Introduction to languages
There are two types of languages

- Formal Languages (Syntactic languages)
- Informal Languages (Semantic languages)

Alphabets
Definition
A finite non-empty set of symbols (called letters), is called an alphabet. It is denoted by Σ (Greek letter sigma).

Example
Σ = {a,b}
Σ = {0,1} (*important as this is the language which the computer understands.*)
Σ = {i,j,k}

Note Certain version of language ALGOL has 113 letters.
Σ (alphabet) includes letters, digits and a variety of operators including sequential operators such as GOTO and IF

Strings
Definition
Concatenation of finite number of letters from the alphabet is called a string.

Example
If Σ = {a,b} then
a, abab, aaabb, ababababababababab

Note
Empty string or null string
Sometimes a string with no symbol at all is used, denoted by (Small Greek letter Lambda) λ or (Capital Greek letter Lambda) Λ, is called an empty string or null string.
The capital lambda will mostly be used to denote the empty string, in further discussion.

Words
Definition
Words are strings belonging to some language.

Example
If Σ= {x} then a language L can be defined as
L={x^n : n=1,2,3,…..} or L={x,xx,xxx,….}
Here x,xx,… are the words of L

Note

All words are strings, but not all strings are words.
Valid/In-valid alphabets
While defining an alphabet, an alphabet may contain letters consisting of group of symbols for example Σ_1= {B, aB, bab, d}.
Now consider an alphabet
Σ_2= {B, Ba, bab, d} and a string BababB.

This string can be tokenized in two different ways
(Ba), (bab), (B)
(B), (abab), (B)
Which shows that the second group cannot be identified as a string, defined over
Σ = {a, b}.
As when this string is scanned by the compiler (Lexical Analyzer), first symbol B is identified as a letter belonging to Σ, while for the second letter the lexical analyzer would not be able to identify, so while defining an alphabet it should be kept in mind that ambiguity should not be created.

Remarks
While defining an alphabet of letters consisting of more than one symbols, no letter should be started with the letter of the same alphabet *i.e.* one letter should not be the prefix of another. However, a letter may be ended in a letter of same alphabet.

Conclusion
Σ_1= {B, aB, bab, d}
Σ_2= {B, Ba, bab, d}
Σ_1 is a valid alphabet while Σ_2 is an in-valid alphabet.

Length of Strings
Definition
The length of string s, denoted by |s|, is the number of letters in the string.

Example
Σ={a,b}
s=ababa
|s|=5

Example
Σ= {B, aB, bab, d}
s=BaBbabBd
Tokenizing=(B), (aB), (bab), (B), (d)
|s|=5

Reverse of a String
Definition
The reverse of a string s denoted by Rev(s) or s^r, is obtained by writing the letters of s in reverse order.

Example
If s=abc is a string defined over Σ={a,b,c}
then Rev(s) or s^r = cba

Example
Σ= {B, aB, bab, d}
s=BaBbabBd
Rev(s)=dBbabaBB

Defining Languages
The languages can be defined in different ways , such as Descriptive definition, Recursive definition, using Regular Expressions(RE) and using Finite Automaton(FA) etc.

Descriptive definition of language
The language is defined, describing the conditions imposed on its words.

Example
The language L of strings of odd length, defined over Σ={a}, can be written as
L={a, aaa, aaaaa,…..}

Example
The language L of strings that does not start with a, defined over Σ ={a,b,c}, can be written as
L ={Λ, b, c, ba, bb, bc, ca, cb, cc, …}

Example
The language L of strings of length 2, defined over Σ ={0,1,2}, can be written as
L={00, 01, 02,10, 11,12,20,21,22}

Example
The language L of strings ending in 0, defined over Σ ={0,1}, can be written as
L={0,00,10,000,010,100,110,…}

Example
The language **EQUAL**, of strings with number of a's equal to number of b's, defined over Σ={a,b}, can be written as
{Λ ,ab,ba,aabb,abab,baba,abba,…}

Example
The language **EVEN-EVEN**, of strings with even number of a's and even number of b's, defined over Σ={a,b}, can be written as
{Λ, aa, bb, aaaa,aabb,abab, abba, baab, baba, bbaa, bbbb,…}

Example
The language **INTEGER**, of strings defined over Σ={-,0,1,2,3,4,5,6,7,8,9}, can be written as
INTEGER = {…,-2,-1,0,1,2,…}

Example
The language **EVEN**, of stings defined over Σ={-,0,1,2,3,4,5,6,7,8,9}, can be written as
EVEN = { …,-4,-2,0,2,4,…}

Example
The language $\{a^n b^n\}$, of strings defined over Σ={a,b}, as
$\{a^n b^n : n=1,2,3,\ldots\}$, can be written as
{ab, aabb, aaabbb,aaaabbbb,…}

Example
The language $\{a^n b^n a^n\}$, of strings defined over Σ={a,b}, as
$\{a^n b^n a^n: n=1,2,3,\ldots\}$, can be written as
{aba, aabbaa, aaabbbaaa,aaaabbbbaaaa,…}

Example
The language **factorial**, of strings defined over Σ={0,1,2,3,4,5,6,7,8,9} *i.e.*
{1,2,6,24,120,…}

Example
The language **FACTORIAL**, of strings defined over Σ={a}, as
$\{a^{n!} : n=1,2,3,\ldots\}$, can be written as
{a,aa,aaaaaa,…}. It is to be noted that the language FACTORIAL can be defined over any single letter alphabet.

Example
The language **DOUBLEFACTORIAL**, of strings defined over Σ={a, b}, as
$\{a^{n!}b^{n!} : n=1,2,3,\ldots\}$, can be written as
{ab, aabb, aaaaaabbbbbb,…}

Example

The language **SQUARE**, of strings defined over Σ={a}, as
{a^{n^2} : n=1,2,3,…}, can be written as
{a, aaaa, aaaaaaaaa,…}

Example
The language **DOUBLESQUARE**, of strings defined over Σ={a,b}, as
{$a^{n^2} b^{n^2}$: n=1,2,3,…}, can be written as
{ab, aaaabbbb, aaaaaaaaabbbbbbbbb,…}

Example
The language **PRIME**, of strings defined over Σ={a}, as
{a^p : p is prime}, can be written as
{aa,aaa,aaaaa,aaaaaaa,aaaaaaaaaaa…}

An Important language
PALINDROME
The language consisting of Λ and the strings s defined over Σ such that Rev(s)=s.
It is to be denoted that the words of PALINDROME are called palindromes.

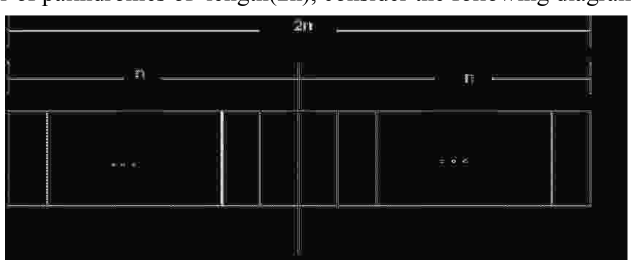
Example
For Σ={a,b},
PALINDROME={Λ , a, b, aa, bb, aaa, aba, bab, bbb, ...}

Remark
There are as many palindromes of length 2n as there are of length 2n-1.
To prove the above remark, the following is to be noted:

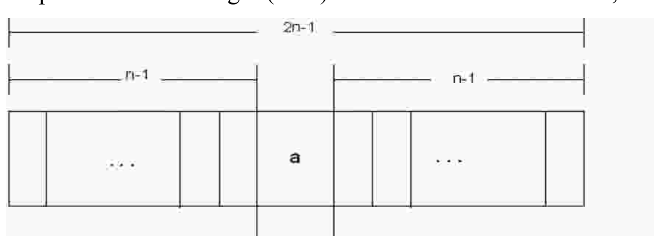
Note
Number of strings of length 'm' defined over alphabet of 'n' letters is n^m.

Examples
The language of strings of length 2, defined over Σ={a,b} is L={aa, ab, ba, bb} *i.e.* number of strings = 2^2
The language of strings of length 3, defined over Σ={a,b} is L={aaa, aab, aba, baa, abb, bab, bba, bbb} *i.e.* number of strings = 2^3

To calculate the number of palindromes of length(2n), consider the following diagram,



which shows that there are as many palindromes of length 2n as there are the strings of length n *i.e.* the required number of palindromes are 2^n.
To calculate the number of palindromes of length (2n-1) with 'a' as the middle letter, consider the following diagram,



which shows that there are as many palindromes of length 2n-1 as there are the strings of length n-1 *i.e.* the required number of palindromes are 2^{n-1}.
Similarly the number of palindromes of length 2n-1, with ' b ' as middle letter, will be 2^{n-1} as well. Hence the total number of palindromes of length 2n-1 will be $2^{n-1} + 2^{n-1} = 2 (2^{n-1})= 2^n$.

Theory of Automata

Lecture N0. 2
<u>Reading Material</u>

<u>Introduction to Computer Theory</u> Chapter 3

Summary

Kleene Star Closure, Plus operation, recursive definition of languages, INTEGER, EVEN, factorial, PALINDROME, {$\mathbf{a^n b^n}$}, languages of strings (i) ending in a, (ii) beginning and ending in same letters, (iii) containing aa or bb (iv) containing exactly one a

Kleene Star Closure

Given Σ, then the Kleene Star Closure of the alphabet Σ, denoted by Σ^*, is the collection of all strings defined over Σ, including Λ.
It is to be noted that Kleene Star Closure can be defined over any set of strings.

Examples

If Σ = {x}
Then Σ^* = {Λ, x, xx, xxx, xxxx, ….}
If Σ = {0,1}
Then Σ^* = {Λ, 0, 1, 00, 01, 10, 11, ….}
If Σ = {aaB, c}
Then Σ^* = {Λ, aaB, c, aaBaaB, aaBc, caaB, cc, ….}

Note

Languages generated by Kleene Star Closure of set of strings, are infinite languages. (By infinite language, it is supposed that the language contains infinite many words, each of finite length).

<u>PLUS Operation ($^+$)</u>
Plus Operation is same as Kleene Star Closure except that it does not generate Λ (null string), automatically.

<u>Example</u>
If Σ = {0,1}
Then Σ^+ = {0, 1, 00, 01, 10, 11, ….}
If Σ = {aab, c}
Then Σ^+ = {aab, c, aabaab, aabc, caab, cc, ….}

Remark

It is to be noted that Kleene Star can also be operated on any string *i.e.* a^* can be considered to be all possible strings defined over {a}, which shows that a^* generates Λ, a, aa, aaa, …
It may also be noted that a^+ can be considered to be all possible non empty strings defined over {a}, which shows that a^+ generates a, aa, aaa, aaaa, …

<u>Recursive definition of languages</u>
The following three steps are used in recursive definition
Some basic words are specified in the language.
Rules for constructing more words are defined in the language.
No strings except those constructed in above, are allowed to be in the language.

Examples

<u>Defining language of INTEGER</u>
<u>Step 1:</u> 1 is in **INTEGER**.
<u>Step 2:</u> If x is in **INTEGER** then x+1 and x-1 are also in **INTEGER**.
<u>Step 3:</u> No strings except those constructed in above, are allowed to be in **INTEGER**.

<u>Defining language of EVEN</u>
<u>Step 1:</u> 2 is in **EVEN**.

Step 2: If x is in **EVEN** then x+2 and x-2 are also in **EVEN**.
Step 3: No strings except those constructed in above, are allowed to be in **EVEN**.

Defining the language factorial
Step 1: As 0!=1, so 1 is in **factorial**.
Step 2: n!=n*(n-1)! is in **factorial**.
Step 3: No strings except those constructed in above, are allowed to be in **factorial**.

Defining the language PALINDROME, defined over Σ = {a,b}
Step 1: a and b are in **PALINDROME**
Step 2: if x is palindrome, then s(x)Rev(s) and xx will also be palindrome, where s belongs to Σ^*
Step 3: No strings except those constructed in above, are allowed to be in palindrome

Defining the language $\{a^nb^n\}$, n=1,2,3,… , of strings defined over Σ={a,b}
Step 1: ab is in $\{a^nb^n\}$
Step 2: if x is in $\{a^nb^n\}$, then axb is in $\{a^nb^n\}$
Step 3: No strings except those constructed in above, are allowed to be in $\{a^nb^n\}$

Defining the language L, of strings ending in a , defined over Σ={a,b}
Step 1: a is in L
Step 2: if x is in L then s(x) is also in **L,** where s belongs to Σ^*
Step 3: No strings except those constructed in above, are allowed to be in **L**

Defining the language L, of strings beginning and ending in same letters , defined over Σ={a, b}
Step 1: a and b are in L
Step 2: (a)s(a) and (b)s(b) are also in **L,** where s belongs to Σ^*
Step 3: No strings except those constructed in above, are allowed to be in **L**

Defining the language L, of strings containing aa or bb , defined over Σ={a, b}
Step 1: aa and bb are in L
Step 2: s(aa)s and s(bb)s are also in **L,** where s belongs to Σ^*
Step 3: No strings except those constructed in above, are allowed to be in **L**

Defining the language L, of strings containing exactly one a, defined over Σ={a, b}
Step 1: a is in L
Step 2: s(a)s is also in **L,** where s belongs to b^*
Step 3: No strings except those constructed in above, are allowed to be in **L**

Theory of Automata

Lecture N0. 3
Reading Material

Introduction to Computer Theory Chapter 4

Summary

RE, Recursive definition of RE, defining languages by RE, { x}*, { x}+, {a+b}*, Language of strings having exactly one a, Language of strings of even length, Language of strings of odd length, RE defines unique language (as Remark), Language of strings having at least one a, Language of strings having at least one a and one b, Language of strings starting with aa and ending in bb, Language of strings starting with and ending in different letters.

Regular Expression

As discussed earlier that a^* generates Λ, a, aa, aaa, … and a^+ generates a, aa, aaa, aaaa, …, so the language L_1 = {Λ, a, aa, aaa, …} and L_2 = {a, aa, aaa, aaaa, …} can simply be expressed by a^* and a^+, respectively.
a^* and a^+ are called the regular expressions (RE) for L_1 and L_2 respectively.

Note a^+, aa^* and a^*a generate L_2.

Recursive definition of Regular Expression(RE)
Step 1: Every letter of Σ including Λ is a regular expression.
Step 2: If r_1 and r_2 are regular expressions then
(r_1)
$r_1\ r_2$
$r_1 + r_2$ and
r_1*
are also regular expressions.
Step 3: Nothing else is a regular expression.

Method 3 (Regular Expressions)
Consider the language L={Λ, x, xx, xxx,…} of strings, defined over Σ = {x}.
We can write this language as the Kleene star closure of alphabet Σ or L=Σ^*=$\{x\}^*$.
This language can also be expressed by the regular expression x^*.
Similarly the language L={x, xx, xxx,…}, defined over Σ = {x}, can be expressed by the regular expression x^+.
Now consider another language L, consisting of all possible strings, defined over Σ = {a, b}. This language can also be expressed by the regular expression (a + b)*.
Now consider another language L, of strings having exactly one a, defined over Σ = {a, b}, then it's regular expression may be b*ab*.
Now consider another language L, of even length, defined over Σ = {a, b}, then it's regular expression may be ((a+b)(a+b))*.
Now consider another language L, of odd length, defined over Σ = {a, b}, then it's regular expression may be (a+b)((a+b)(a+b))* or ((a+b)(a+b))*(a+b).

Remark

It may be noted that a language may be expressed by more than one regular expression, while given a regular expression there exist a unique language generated by that regular expression.

Example

Consider the language, defined over
Σ = {a , b} of words having at least one a, may be expressed by a regular expression (a+b)*a(a+b)*.
Consider the language, defined over Σ = {a, b} of words having at least one a and one b, may be expressed by a regular expression (a+b)*a(a+b)*b(a+b)*+ (a+b)*b(a+b)*a(a+b)*.
Consider the language, defined over Σ ={a, b}, of words starting with double a and ending in double b then its regular expression may be aa(a+b)*bb
Consider the language, defined over Σ ={a, b} of words starting with a and ending in b OR starting with b and ending in a, then its regular expression may be a(a+b)*b+b(a+b)*a

Theory of Automata

Lecture N0. 4
Reading Material

Introduction to Computer Theory Chapter 4, 5

Summary
Regular expression of EVEN-EVEN language, Difference between a* + b* and (a+b)*, Equivalent regular expressions; sum, product and closure of regular expressions; regular languages, finite languages are regular, introduction to finite automaton, definition of FA, transition table, transition diagram

An important example

The Language EVEN-EVEN
Language of strings, defined over Σ={a, b} having even number of a's and even number of b's. i.e.
EVEN-EVEN = {Λ, aa, bb, aaaa,aabb,abab, abba, baab, baba, bbaa, bbbb,…}, its regular expression can be written as (aa+bb+(ab+ba)(aa+bb)*(ab+ba))*

Note
It is important to be clear about the difference of the following regular expressions
r_1 = a*+b*
r_2 = (a+b)*
Here r_1 does not generate any string of concatenation of a and b, while r_2 generates such strings.

Equivalent Regular Expressions

Definition
Two regular expressions are said to be equivalent if they generate the same language.

Example
Consider the following regular expressions
r_1 = (a + b)* (aa + bb)
r_2 = (a + b)*aa + (a + b)*bb then both regular expressions define the language of strings ending in aa or bb.

Note
If r_1 = (aa + bb) and r_2 = (a + b) then
r_1+r_2 = (aa + bb) + (a + b)
r_1r_2 = (aa + bb) (a + b)
= (aaa + aab + bba + bbb)
$(r_1)^*$ = (aa + bb)*

Regular Languages
Definition
The language generated by any regular expression is called a **regular language**.
It is to be noted that if r_1, r_2 are regular expressions, corresponding to the languages L_1 and L_2 then the languages generated by $r_1+ r_2$, r_1r_2(or r_2r_1) and r_1*(or r_2*) are also regular languages.

Note
It is to be noted that if L_1 and L_2 are expressed by $r_1$and r_2, respectively then the language expressed by
$r_1+ r_2$, is the language $L_1 + L_2$ or $L_1 \cup L_2$
r_1r_2, , is the language L_1L_2, of strings obtained by prefixing every string of L_1 with every string of L_2
r_1*, is the language L_1*, of strings obtained by concatenating the strings of L, including the null string.

Example
If r_1 = (aa+bb) and r_2 = (a+b) then the language of strings generated by r_1+r_2, is also a regular language, expressed by (aa+bb) + (a+b)
If r_1 = (aa+bb) and r_2 = (a+b) then the language of strings generated by r_1r_2, is also a regular language, expressed by (aa+bb)(a+b)
If r = (aa+bb) then the language of strings generated by r*, is also a regular language, expressed by (aa+bb)*

<u>All finite languages are regular</u>

<u>Example</u>

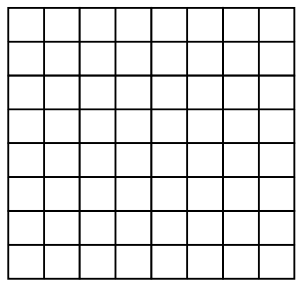
Consider the language L, defined over Σ = {a,b}, of strings of length 2, starting with a, then
L = {aa, ab}, may be expressed by the regular expression aa+ab. Hence L, by definition, is a regular language.

<u>Note</u>

It may be noted that if a language contains even thousand words, its RE may be expressed, placing ‘ + ’ between all the words.
Here the special structure of RE is not important.
Consider the language L = {aaa, aab, aba, abb, baa, bab, bba, bbb}, that may be expressed by a RE aaa+aab+aba+abb+baa+bab+bba+bbb, which is equivalent to (a+b)(a+b)(a+b).

Introduction to Finite Automaton

Consider the following game board that contains 64 boxes



There are some pieces of paper. Some are of white colour while others are of black colour. The number of pieces of paper are 64 or less. The possible arrangements under which these pieces of paper can be placed in the boxes, are finite. To start the game, one of the arrangements is supposed to be initial arrangement. There is a pair of dice that can generate the numbers 2,3,4,…12 . For each number generated, a unique arrangement is associated among the possible arrangements.
It shows that the total number of transition rules of arrangement are finite. One and more arrangements can be supposed to be the winning arrangement. It can be observed that the winning of the game depends on the sequence in which the numbers are generated. This structure of game can be considered to be a finite automaton.

<u>Method 4 (Finite Automaton)</u>

<u>Definition</u>

A Finite automaton (FA), is a collection of the followings
Finite number of states, having one initial and some (maybe none) final states.
Finite set of input letters (Σ) from which input strings are formed.
Finite set of transitions i.e. for each state and for each input letter there is a transition showing how to move from one state to another.

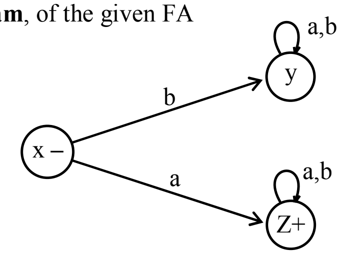
<u>Example</u>

Σ = {a,b}
States: x, y, z where x is an initial state and z is final state.
<u>Transitions:</u>
At state x reading a, go to state z
At state x reading b, go to state y
At state y reading a, b go to state y
At state z reading a, b go to state z

These transitions can be expressed by the following table called transition table

Old States	New States	
	Reading a	Reading b
x -	z	y
y	y	y
z +	z	z

Note
It may be noted that the information of an FA, given in the previous table, can also be depicted by the following diagram, called the **transition diagram**, of the given FA



Remark
The above transition diagram is an FA accepting the language of strings, defined over Σ = {a, b}, **starting with a**. It may be noted that this language may be expressed by the regular expression a(a + b)*

Theory of Automata

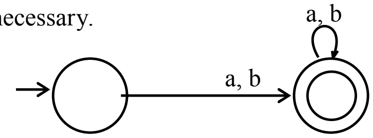
Lecture N0. 5
Reading Material

Introduction to Computer Theory Chapter 5

Summary

Different notations of transition diagrams, languages of strings of **even length, Odd length, starting with b, ending in a, beginning with b, not beginning with b, beginning and ending in same letters**

Note
It may be noted that to indicate the initial state, an arrow head can also be placed before that state and that the final state with double circle, as shown below. It is also to be noted that while expressing an FA by its transition diagram, the labels of states are not necessary.

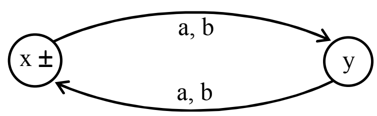


Example
Σ = {a,b}
States: x, y, where x is both initial and final state.
Transitions:
At state x reading a or b go to state y.
At state y reading a or b go to state x.

These transitions can be expressed by the following transition table

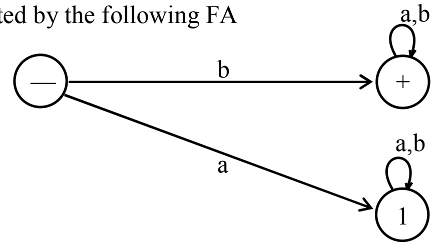
Old States	New States	
	Reading a	Reading b
x ±	y	y
y	x	x

It may be noted that the above transition table may be depicted by the following transition diagram.



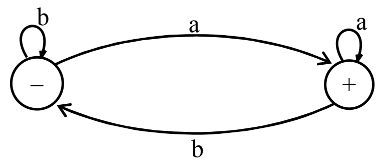
The above transition diagram is an FA accepting the language of strings, defined over Σ={a, b} of **even length**. It may be noted that this language may be expressed by the regular expression $((a+ b) (a + b))^*$

Example:
Consider the language L of strings, defined over Σ={a, b}, **starting with b.** The language L may be expressed by RE $b(a + b)^*$, may be accepted by the following FA

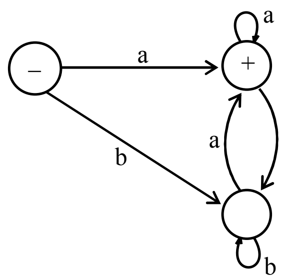


Example
Consider the language L of strings, defined over Σ={a, b}, **ending in a. T**he language L may be expressed by RE $(a+b)^*a$.

This language may be accepted by the FA shown aside

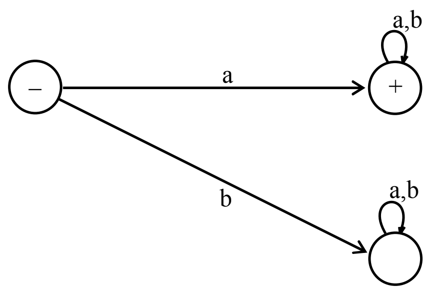


There may be another FA corresponding to the given language, as shown aside



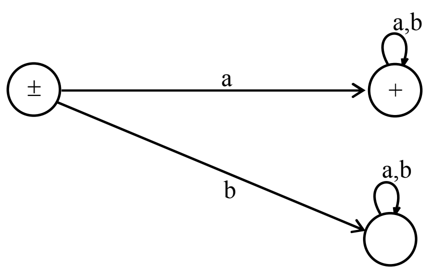
Note
It may be noted that corresponding to a given language there may be more than one FA accepting that language, but for a given FA there is a unique language accepted by that FA.
It is also to be noted that given the languages L_1 and L_2 ,where
L_1 = The language of strings, defined over $\Sigma = \{a, b\}$, **beginning with a.**
L_2 = The language of strings, defined over $\Sigma = \{a, b\}$, **not beginning with b**
The Λ does not belong to L_1 while it does belong to L_2 . This fact may be depicted by the corresponding transition diagrams of L_1 and L_2.

FA$_1$ Corresponding to L_1



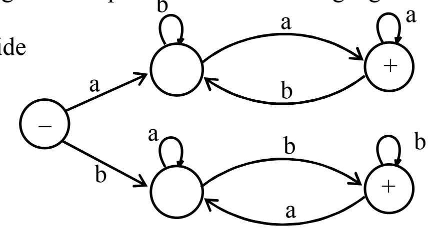
The language L_1 may be expressed by the regular expression $a(a + b)^*$

FA$_2$ Corresponding to L_2



The language L_2 may be expressed by the regular expression $a(a + b)^* + \Lambda$

Example
Consider the Language L of Strings of **length two or more**, defined over $\Sigma = \{a, b\}$, **beginning with and ending in same letters.**
The language L may be expressed by the following regular expression $a(a + b)^*a + b(a + b)^*b$
It is to be noted that if the condition on the length of string is not imposed in the above language then **the strings a and b will then belong to the language.**
This language L may be accepted by the FA as shown aside



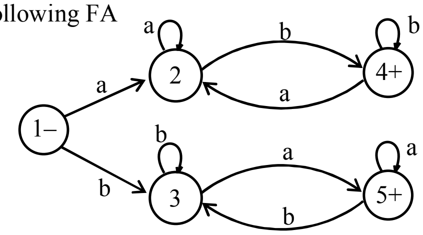
Theory of Automata

Lecture N0. 6
Reading Material

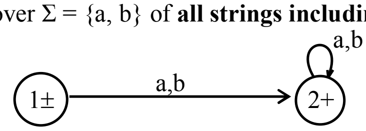
Introduction to Computer Theory Chapter 5

Summary
Language of strings beginning with and ending in different letters, Accepting all strings, accepting non-empty strings, accepting no string, containing double a's, having double 0's or double 1's, containing triple a's or triple b's, EVEN-EVEN

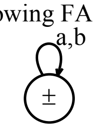
Example
Consider the Language L of Strings, defined over Σ = {a, b}, **beginning with and ending in different letters.**
The language L may be expressed by the following regular expression $a(a + b)^*b + b(a + b)^*a$
This language may be accepted by the following FA



Example
Consider the Language L, defined over Σ = {a, b} of **all strings including Λ**. The language L may be accepted by the following FA

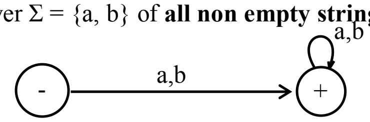


The language L may also be accepted by the following FA



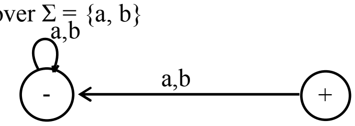
The language L may be expressed by the regular expression $(a + b)^*$

Example
Consider the Language L , defined over Σ = {a, b} of **all non empty strings**. The language L may be accepted by the following FA



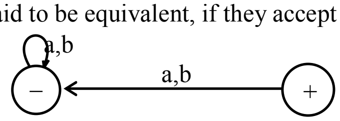
The above language may be expressed by the regular expression $(a + b)^+$

Example
Consider the following FA, defined over Σ = {a, b}

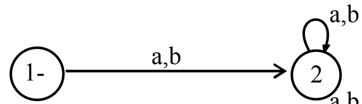


It is to be noted that the above FA **does not accept any string,** even it does not accept the null string; as there is no path starting from initial state and ending in final state.

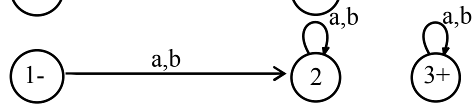
Equivalent FAs
It is to be noted that two FAs are said to be equivalent, if they accept the same language, as shown in the following FAs.
FA_1



FA_2



FA_3



Note

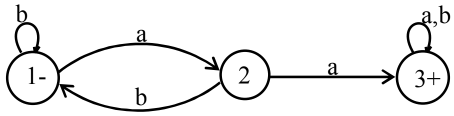
FA_1 has already been discussed, while in FA_2, there is no final state and in FA_3, there is a final state but FA_3 is disconnected as the states 2 and 3 are disconnected.

It may also be noted that the language of strings accepted by FA_1, FA_2 and FA_3 is denoted by the empty set *i.e.* { } OR Ø

Example

Consider the Language L of strings , defined over Σ = {a, b}, **containing double a.**

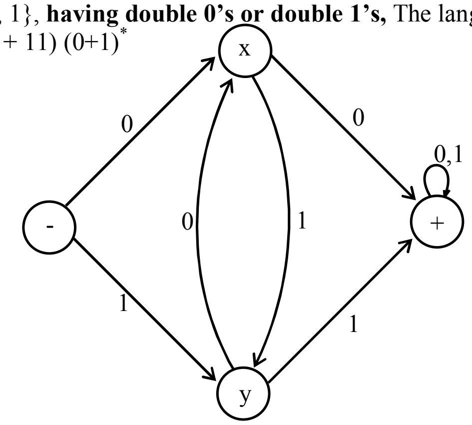
The language L may be expressed by the regular expression $(a+b)^*(aa)(a+b)^*$. This language may be accepted by the following FA.



Example

Consider the language L of strings, defined over Σ={0, 1}, **having double 0's or double 1's,** The language L may be expressed by the regular expression $(0+1)^*(00 + 11)(0+1)^*$

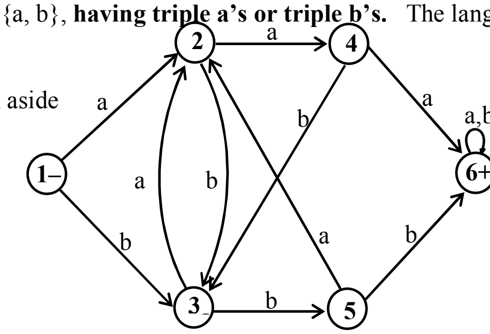
This language may be accepted by the following FA



Example

Consider the language L of strings, defined over Σ={a, b}, **having triple a's or triple b's.** The language L may be expressed by RE $(a+b)^*(aaa + bbb)(a+b)^*$

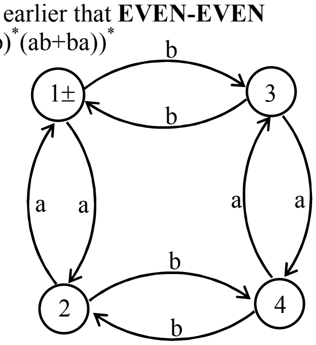
This language may be accepted by the FA as shown aside



Example

Consider the **EVEN-EVEN** language, defined over Σ = {a, b}. As discussed earlier that **EVEN-EVEN** language can be expressed by the regular expression $(aa+bb+(ab+ba)(aa+bb)^*(ab+ba))^*$

EVEN-EVEN language may be accepted by the FA as shown aside



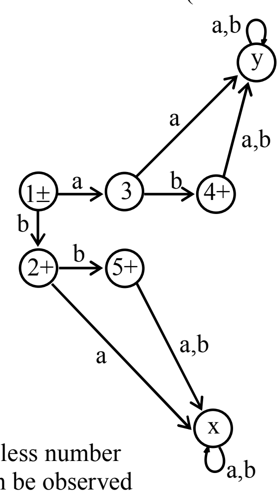
Theory of Automata

Lecture N0. 7
<u>Reading Material</u>

<u>Introduction to Computer Theory</u> Chapter 5, 6

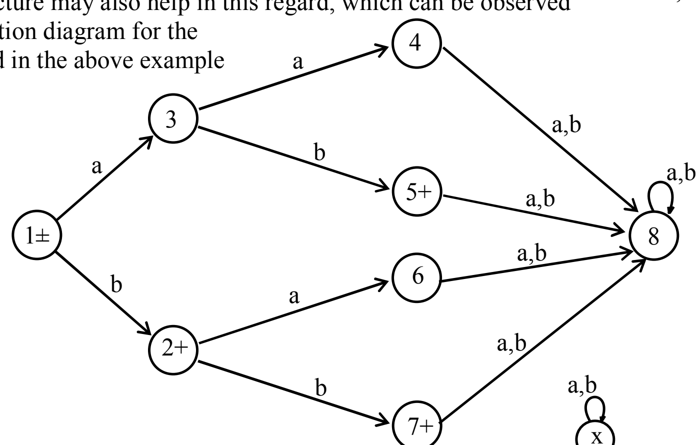
Summary
FA corresponding to finite languages(using both methods), Transition graphs.

<u>FA corresponding to finite languages</u>
<u>Example</u>
Consider the language
L = {Λ, b, ab, bb}, defined over Σ ={a, b}, expressed by Λ + b + ab + bb OR Λ + b (Λ + a + b).
The language L may be accepted by the FA as shown aside

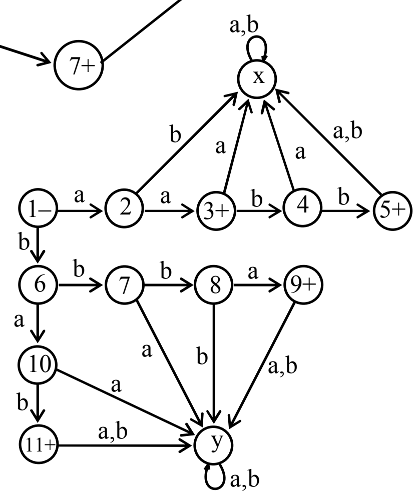


It is to be noted that the states x and y are called
Dead States, Waste Baskets or Davey John Lockers, as the moment one enters these states there is no way to leave it.

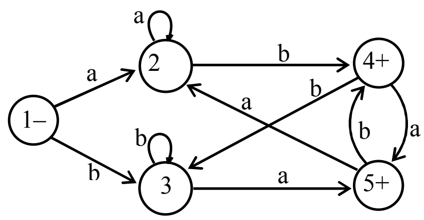
<u>Note</u>
It is to be noted that to build an FA accepting the language having less number of strings, the tree structure may also help in this regard, which can be observed in the following transition diagram for the Language L, discussed in the above example



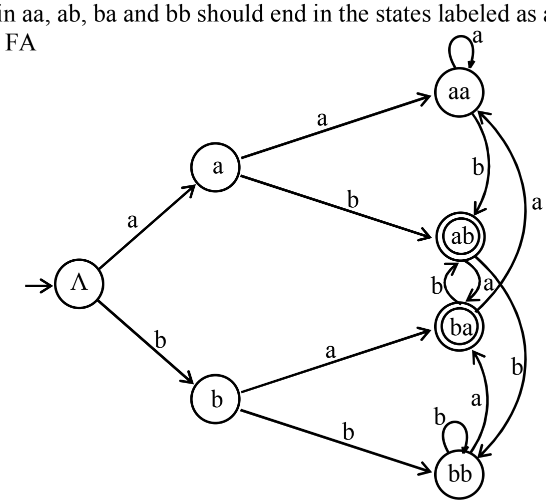
<u>Example</u>
Consider the language
L = {aa, bab, aabb, bbba}, defined over Σ ={a, b}, expressed by aa + bab + aabb + bbba
OR aa (Λ + bb) + b (ab + bba)
The above language may be accepted by the FA as shown aside



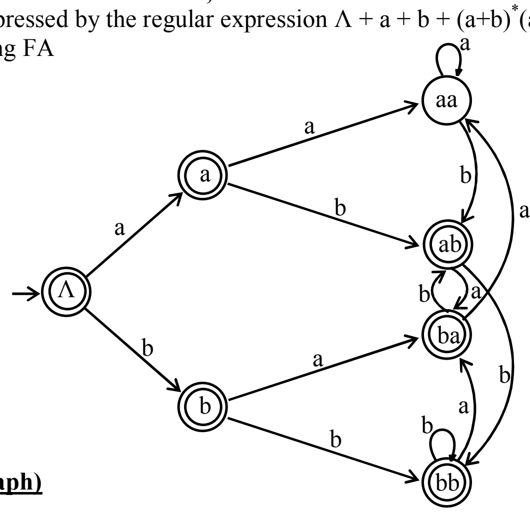
Example
Consider the language L = {w belongs to $\{a,b\}^*$: length(w) ≥2 and w neither ends in **aa** nor **bb**}.
The language L may be expressed by the regular expression $(a+b)^*(ab+ba)$
This language may be accepted by the following FA



Note
It is to be noted that building an FA corresponding to the language L, discussed in the above example, seems to be quite difficult, but the same can be done using tree structure along with the technique discussed in the book *Introduction to Languages and Theory of Computation*, by J. C. Martin
so that the strings ending in aa, ab, ba and bb should end in the states labeled as aa, ab, ba and bb, respectively; as shown in the following FA



Example
Consider the language FA corresponding to r_1+r_2 can be determined as
L = {w belongs to $\{a,b\}^*$: w does not end in **aa**}.
The language L may be expressed by the regular expression $\Lambda + a + b + (a+b)^*(ab+ba+bb)$. This language may be accepted by the following FA



Method 5 (Transition Graph)
Definition:
A Transition graph (TG), is a collection of the followings
Finite number of states, at least one of which is start state and some (maybe none) final states.
Finite set of input letters (Σ) from which input strings are formed.
Finite set of transitions that show how to go from one state to another based on reading specified substrings of input letters, possibly even the null string (Λ).

Theory of Automata

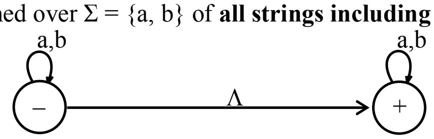
Lecture N0. 8
Reading Material

Introduction to Computer Theory Chapter 6

Summary
Examples of TGs: accepting all strings, accepting none, starting with b, not ending in b, containing aa, containing aa or bb

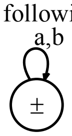
Note
It is to be noted that in TG there may exist more than one paths for certain string, while there may not exist any path for certain string as well. If there exists at least one path for a certain string, starting from initial state and ending in a final state, the string is supposed to be accepted by the TG, otherwise the string is supposed to be rejected. Obviously collection of accepted strings is the language accepted by the TG.

Example
Consider the Language L , defined over Σ = {a, b} of **all strings including Λ.** The language L may be accepted by the following TG

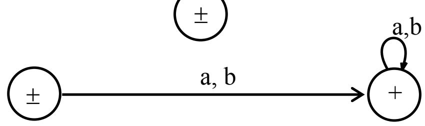


The language L may also be accepted by the following TG

TG$_1$

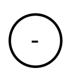


TG$_2$

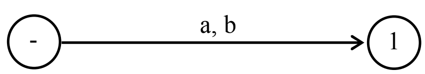


Example
Consider the following TGs

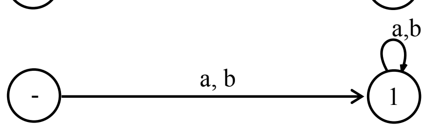
TG$_1$



TG$_2$

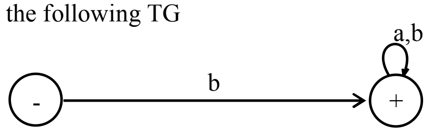


TG$_3$



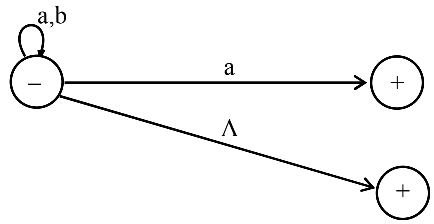
It may be observed that in the first TG, no transition has been shown. Hence this TG does not accept any string, defined over any alphabet. In TG$_2$ there are transitions for a and b at initial state but there is no transition at state 1. This TG still does not accept any string. In TG$_3$ there are transitions at both initial state and state 1, but it does not accept any string.
Thus none of TG$_1$, TG$_2$ and TG$_3$ accepts any string, *i.e.* these TGs accept empty language. It may be noted that TG$_1$ and TG$_2$ are TGs but not FA, while TG$_3$ is both TG and FA as well.
It may be noted that every FA is a TG as well, but the converse may not be true, *i.e.* every TG may not be an FA.

Example
Consider the language L of strings, defined over Σ={a, b}, **starting with b.** The language L may be expressed by RE b(a + b)* , may be accepted by the following TG



Example

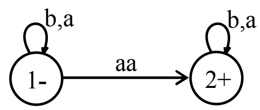
Consider the language L of strings, defined over Σ={a, b}, **not ending in b.** The language L may be expressed by RE $\Lambda + (a + b)^* a$, may be accepted by the following TG



Example

Consider the Language L of strings, defined over Σ = {a, b}, **containing double a.**

The language L may be expressed by the following regular expression $(a+b)^* (aa) (a+b)^*$. This language may be accepted by the following TG

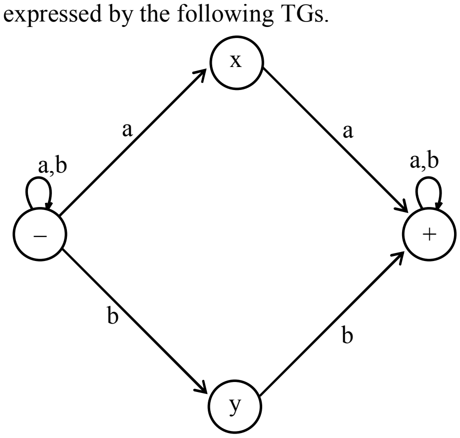


Example

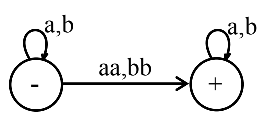
Consider the language L of strings, defined over Σ={a, b}, **having double a or double b**.

The language L can be expressed by RE $(a+b)^* (aa + bb) (a+b)^*$.

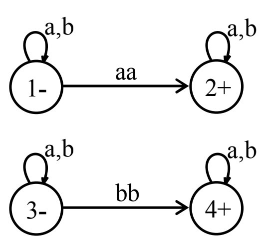
The above language may also be expressed by the following TGs.



OR



OR



Note

In the above TG if the states are not labeled then it may not be considered to be a single TG

Theory of Automata

Lecture N0. 9
Reading Material

Introduction to Computer Theory Chapter 6

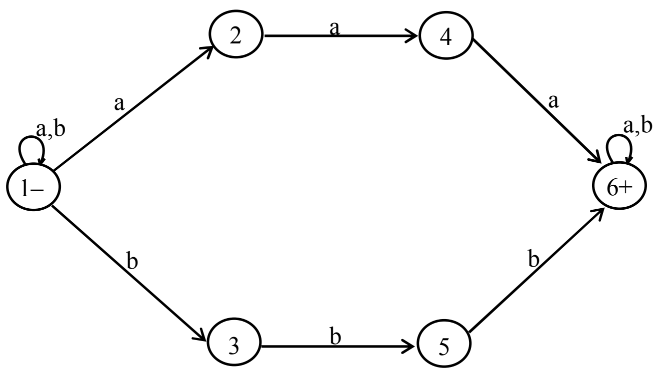
Summary

TGs accepting the languages: containing aaa or bbb, beginning and ending in different letters, beginning and ending in same letters, EVEN-EVEN, a's occur in even clumps and ends in three or more b's, example showing different paths traced by one string, Definition of GTG

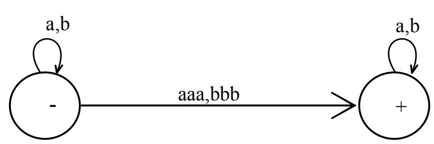
Example

Consider the language L of strings, defined over Σ = {a, b}, **having triple a or triple b.** The language L may be expressed by RE $(a+b)^* (aaa + bbb) (a+b)^*$

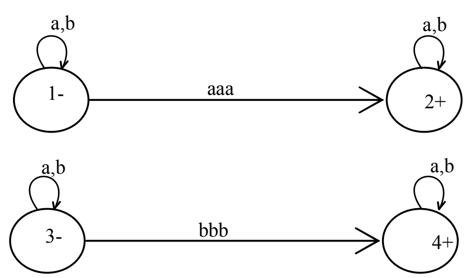
This language may be accepted by the following TG



OR

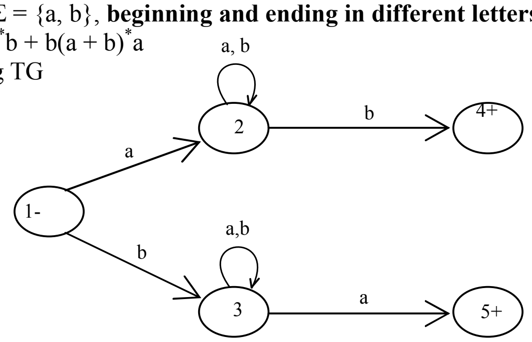


OR

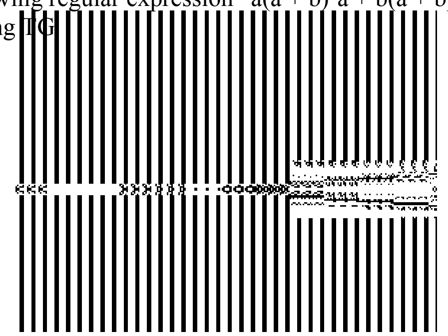


Example

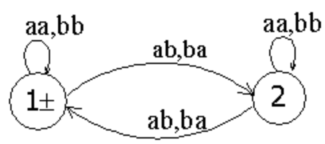
Consider the language L of strings, defined over Σ = {a, b}, **beginning and ending in different letters**.
The language L may be expressed by RE $a(a + b)^*b + b(a + b)^*a$
The language L may be accepted by the following TG



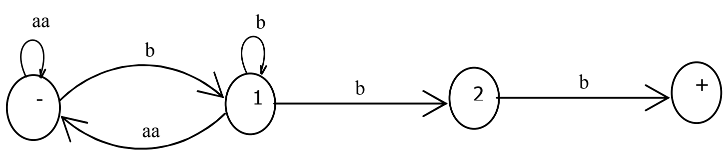
<u>Example</u>
Consider the Language L of strings **of length two or more**, defined over Σ = {a, b}, **beginning with and ending in same letters.**
The language L may be expressed by the following regular expression $a(a + b)^*a + b(a + b)^*b$
This language may be accepted by the following TG



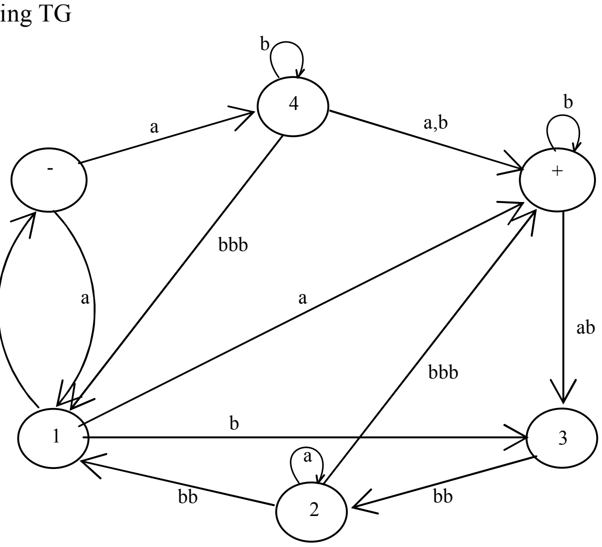
<u>Example</u>
Consider the **EVEN-EVEN** language, defined over Σ = {a, b}. As discussed earlier that **EVEN-EVEN** language can be expressed by a regular expression $(aa+bb+(ab+ba)(aa+bb)^*(ab+ba))^*$
The language **EVEN-EVEN** may be accepted by the following TG



<u>Example</u>
Consider the language L, defined over Σ={a, b}, in which **a's occur only in even clumps and that ends in three or more b's**. The language L can be expressed by its regular expression $(aa)^*b(b^*+(aa(aa)^*b)^*)$ bb OR $(aa)^*b(b^*+((aa)^+b)^*)$ bb.
The language L may be accepted by the following TG



<u>Example</u>
Consider the following TG



Consider the string abbbabbbabba. It may be observed that the above string traces the following three paths, (using the states)
(a)(b) (b) (b) (ab) (bb) (a) (bb) (a)
(-)(4)(4)(+)(+)(3)(2)(2)(1)(+)
(a)(b) ((b)(b)) (ab) (bb) (a) (bb) (a)
(-)(4)(+)(+)(+)(3)(2)(2)(1)(+)
(a)((b) (b)) (b) (ab) (bb) (a) (bb) (a)
(-) (4)(4)(4)(+) (3)(2)(2)(1)(+)
Which shows that all these paths are successful, (*i.e.* the path starting from an initial state and ending in a final state).
Hence the string abbbabbbabba is accepted by the given TG.

Generalized Transition Graphs
A generalized transition graph (GTG) is a collection of three things
Finite number of states, at least one of which is start state and some (maybe none) final states.
Finite set of input letters (Σ) from which input strings are formed.
Directed edges connecting some pair of states labeled with regular expression.
It may be noted that in GTG, the labels of transition edges are corresponding regular expressions

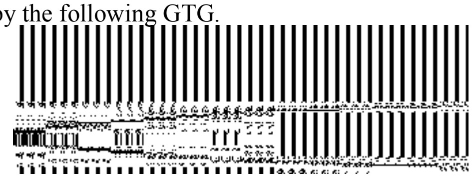
Theory of Automata

Lecture N0. 10
Reading Material

Introduction to Computer Theory Chapter 6, 7

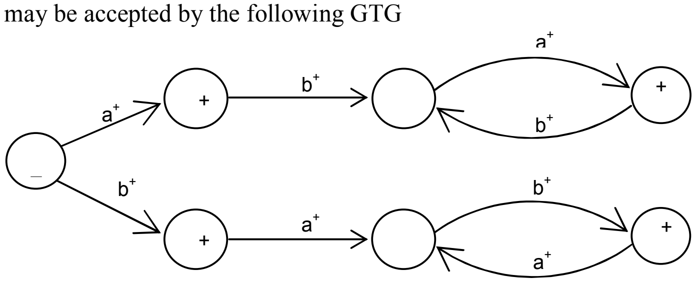
Summary
Examples of GTG accepting the languages of strings: containing aa or bb, beginning with and ending in same letters, beginning with and ending in different letters, containing aaa or bbb,
Nondeterminism, Kleene's theorem (part I, part II, part III), proof of Kleene's theorem part I

Example
Consider the language L of strings, defined over Σ = {a,b}, containing **double a or double b**. The language L can be expressed by the following regular expression $(a+b)^*(aa + bb)(a+b)^*$
The language L may be accepted by the following GTG.

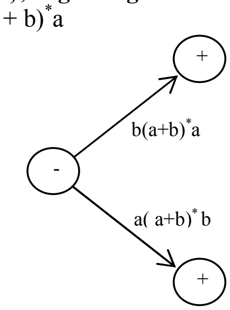


Example
Consider the Language L of strings, defined over Σ = {a, b}, **beginning with and ending in same letters.**
The language L may be expressed by the following regular expression $(a+b)+ a(a + b)^*a + b(a + b)^*b$.
This language may be accepted by the following GTG

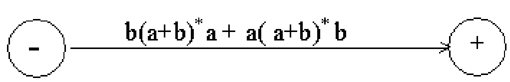
Example



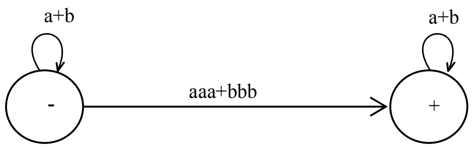
Example
Consider the language L of strings of, defined over Σ = {a, b}, **beginning and ending in different letters**.
The language L may be expressed by RE $a(a + b)^*b + b(a + b)^*a$
The language L may be accepted by the following GTG



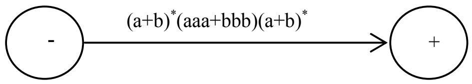
The language L may be accepted by the following GTG as well



Example
Consider the language L of strings, defined over Σ = {a, b}, **having triple a or triple b.** The language L may be expressed by RE $(a+b)^*(aaa + bbb)(a+b)^*$
This language may be accepted by the following GTG



OR



Nondeterminism

TGs and GTGs provide certain relaxations *i.e.* there may exist more than one path for a certain string or there may not be any path for a certain string, this property creates **nondeterminism** and it can also help in differentiating TGs or GTGs from FAs. Hence an FA is also called a Deterministic Finite Automaton (DFA).

Kleene's Theorem

If a language can be expressed by
FA or
TG or
RE
then it can also be expressed by other two as well.
It may be noted that the theorem is proved, proving the following three parts

Kleene's Theorem Part I

If a language can be accepted by an FA then it can be accepted by a TG as well.

Kleene's Theorem Part II

If a language can be accepted by a TG then it can be expressed by an RE as well.

Kleene's Theorem Part III

If a language can be expressed by a RE then it can be accepted by an FA as well.

Proof(Kleene's Theorem Part I)

Since every FA can be considered to be a TG as well, therefore there is nothing to prove.

Theory of Automata

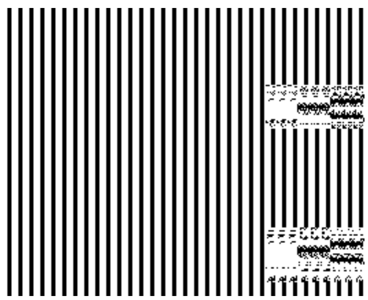
Lecture N0. 11
Reading Material

Introduction to Computer Theory Chapter 7

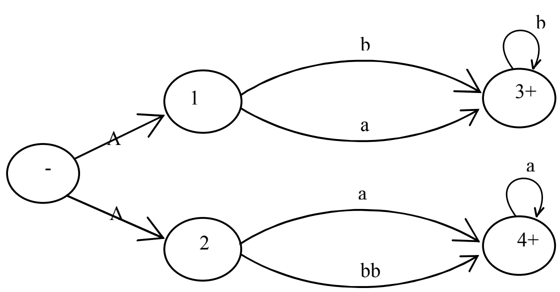
Summary
proof of Kleene's theorem part II (method with different steps), particular examples of TGs to determine corresponding REs.

Proof(Kleene's Theorem Part II)
To prove part II of the theorem, an algorithm consisting of different steps, is explained showing how a RE can be obtained corresponding to the given TG. For this purpose the notion of TG is changed to that of GTG *i.e.* the labels of transitions are corresponding REs.
Basically this algorithm converts the given TG to GTG with one initial state along with a single loop, or one initial state connected with one final state by a single transition edge. The label of the loop or the transition edge will be the required RE.
Step 1 If a TG has more than one start states, then introduce a new start state connecting the new state to the old start states by the transitions labeled by Λ and make the old start states the non-start states. This step can be shown by the following example

Example

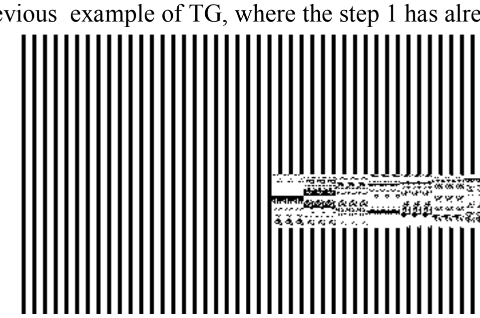


The above TG can be converted to

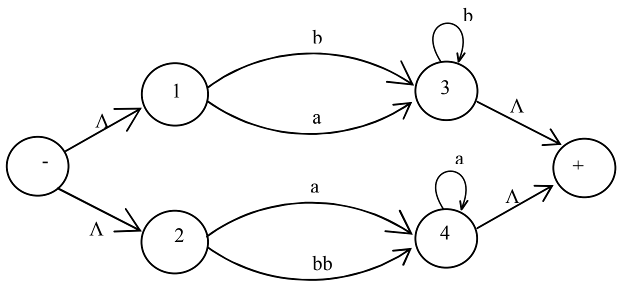


Step 2:
If a TG has more than one final states, then introduce a new final state, connecting the old final states to the new final state by the transitions labeled by Λ.
This step can be shown by the previous example of TG, where the step 1 has already been processed

Example

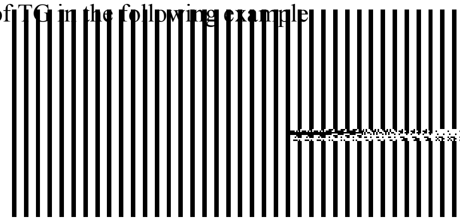


The above TG can be converted to

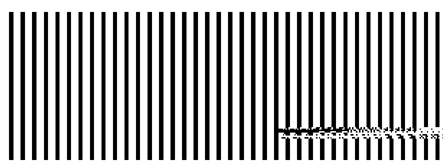


Step 3:
If a state has two (more than one) incoming transition edges labeled by the corresponding REs, from the same state (including the possibility of loops at a state), then replace all these transition edges with a single transition edge labeled by the sum of corresponding REs.
This step can be shown by a part of TG in the following example

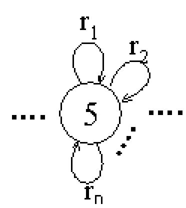
Example



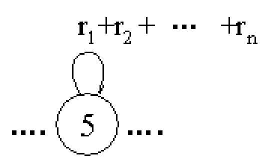
The above TG can be reduced to



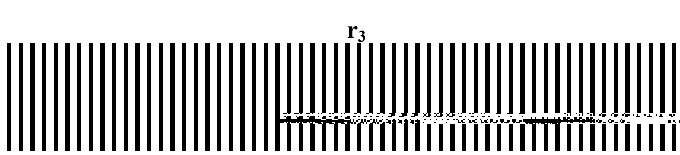
Note
The step 3 can be generalized to any finite number of transitions as shown below



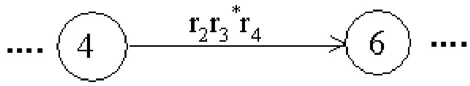
The above TG can be reduced to



Step 4 (bypass and state elimination)
If three states in a TG, are connected in sequence then eliminate the middle state and connect the first state with the third by a single transition (include the possibility of circuit as well) labeled by the RE which is the concatenation of corresponding two REs in the existing sequence. This step can be shown by a part of TG in the following example
Example

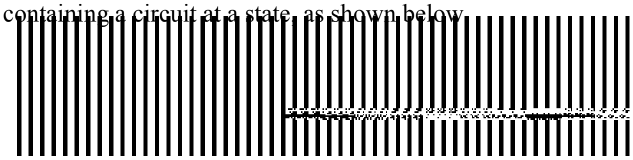


To eliminate state 5 the above can be reduced to

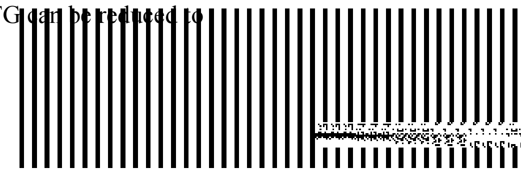


Consider the following example containing a circuit

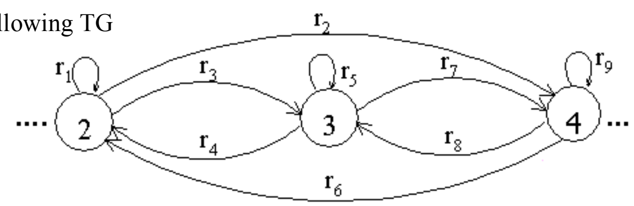
<u>Example</u>
Consider the part of a TG, containing a circuit at a state, as shown below



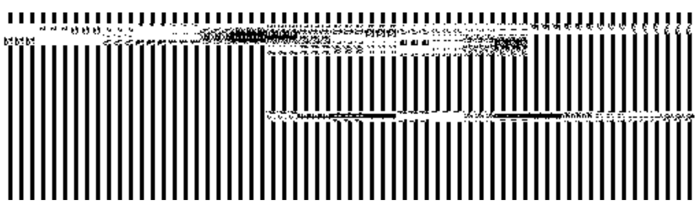
To eliminate state 3 the above TG can be reduced to



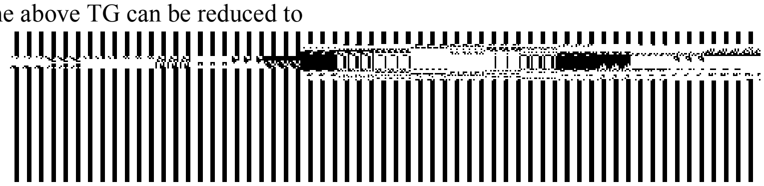
<u>Example</u>
Consider a part of the following TG



To eliminate state 3 the above TG can be reduced to

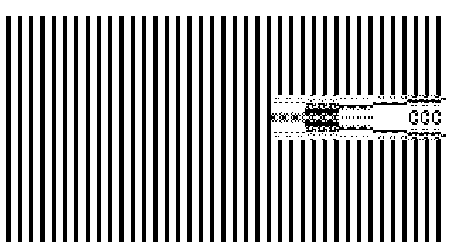


To eliminate state 4 the above TG can be reduced to

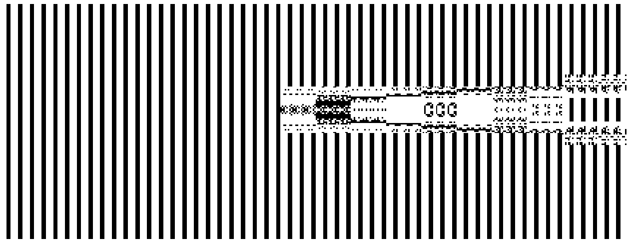


<u>Note</u>
It is to be noted that to determine the RE corresponding to a certain TG, four steps have been discussed. This process can be explained by the following particular examples of TGs

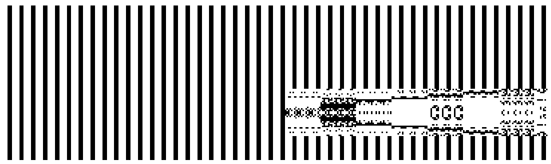
<u>Example</u>
Consider the following TG



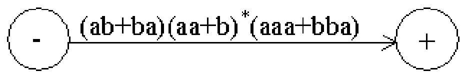
To have single final state, the above TG can be reduced to the following



To eliminate states 2 and 3, the above TG can be reduced to the following



To eliminate state 1 the above TG can be reduced to the following



Hence the required RE is $(ab+ba)(aa+b)^*(aaa+bba)$

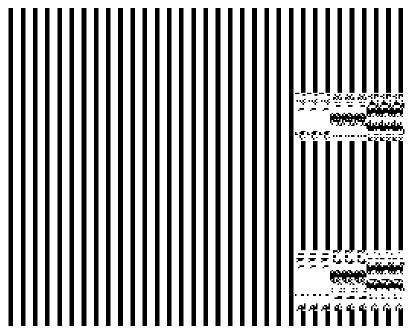
Theory of Automata

Lecture N0. 12
Reading Material

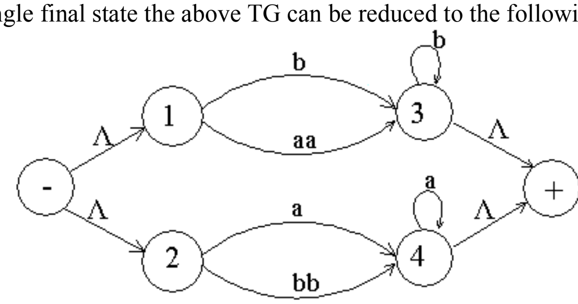
Introduction to Computer Theory Chapter 7

Summary
Examples of writing REs to the corresponding TGs, RE corresponding to TG accepting EVEN-EVEN language, Kleene's theorem part III (method 1:union of FAs), examples of FAs corresponding to simple REs, example of Kleene's theorem part III (method 1) continued

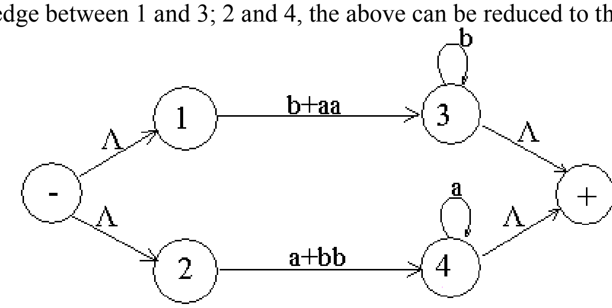
Example
Consider the following TG



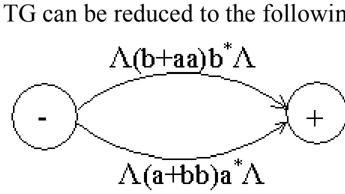
To have single initial and single final state the above TG can be reduced to the following



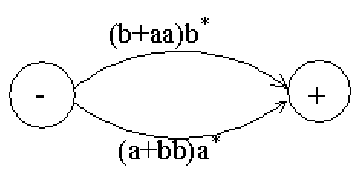
To obtain single transition edge between 1 and 3; 2 and 4, the above can be reduced to the following



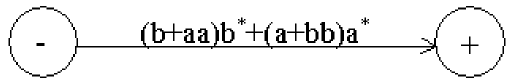
To eliminate states 1,2,3 and 4, the above TG can be reduced to the following TG



OR



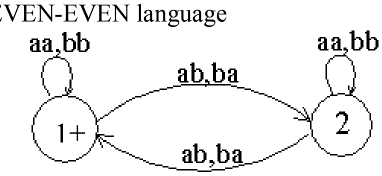
To connect the initial state with the final state by single transition edge, the above TG can be reduced to the following



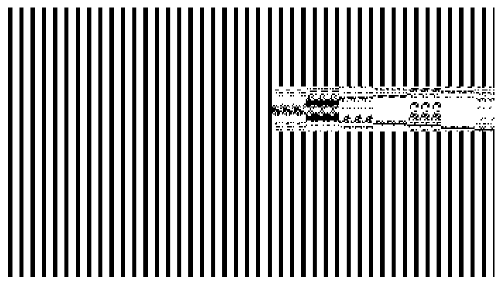
Hence the required RE is $(b+aa)b^*+(a+bb)a^*$

Example

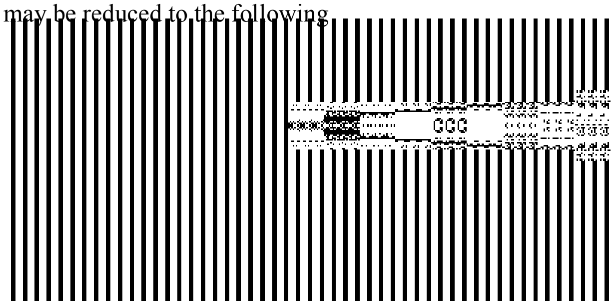
Consider the following TG, accepting EVEN-EVEN language



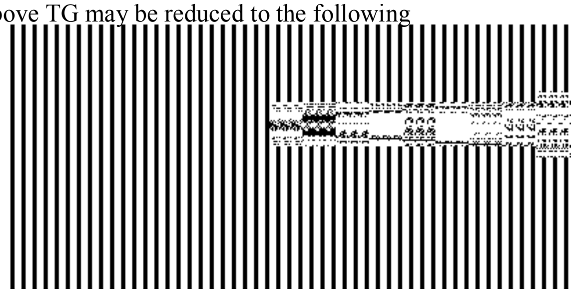
It is to be noted that since the initial state of this TG is final as well and there is no other final state, so to obtain a TG with single initial and single final state, an additional initial and a final state are introduced as shown in the following TG



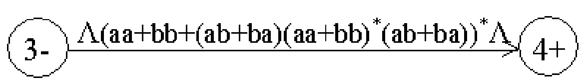
To eliminate state 2, the above TG may be reduced to the following



To have single loop at state 1, the above TG may be reduced to the following



To eliminate state 1, the above TG may be reduced to the following



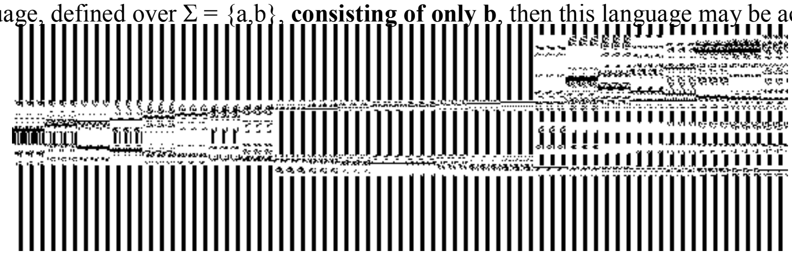
Hence the required RE is $(aa+bb+(ab+ba)(aa+bb)^*(ab+ba))^*$

Kleene's Theorem Part III

Statement:

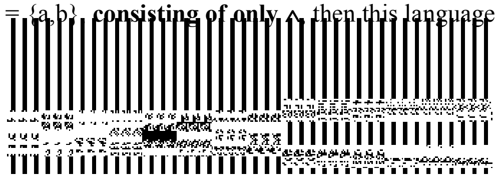
If the language can be expressed by a RE then there exists an FA accepting the language.
As the regular expression is obtained applying addition, concatenation and closure on the letters of an alphabet and the Null string, so while building the RE, sometimes, the corresponding FA may be built easily, as shown in the following examples

Example
Consider the language, defined over $\Sigma = \{a,b\}$, **consisting of only b**, then this language may be accepted by the following FA



which shows that this FA helps in building an FA accepting only one letter

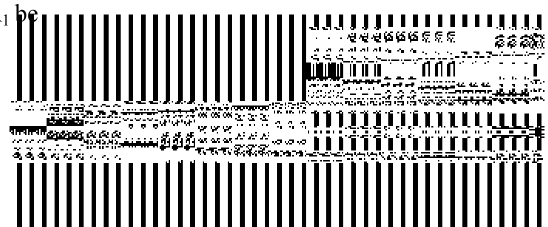
Example
Consider the language, defined over $\Sigma = \{a,b\}$, **consisting of only Λ**, then this language may be accepted by the following FA



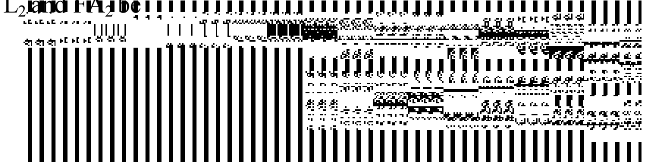
As, if r_1 and r_2 are regular expressions then their sum, concatenation and closure are also regular expressions, so an FA can be built for any regular expression if the methods can be developed for building the FAs corresponding to the sum, concatenation and closure of the regular expressions along with their FAs. These three methods are explained in the following discussion

Method1 (Union of two FAs): Using the FAs corresponding to r_1 and r_2 an FA can be built, corresponding to $r_1+ r_2$. This method can be developed considering the following examples

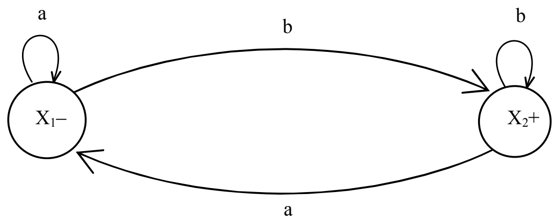
Example
Let $r_1 = (a+b)^*b$ defines L_1 and the FA_1 be

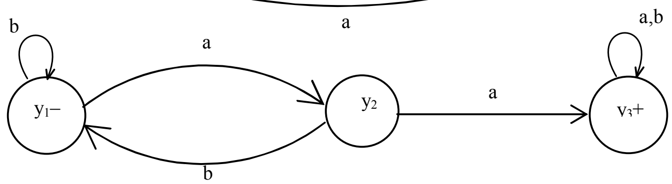


and $r_2 = (a+b)^*aa(a+b)^*$ defines L_2 and FA_2 be

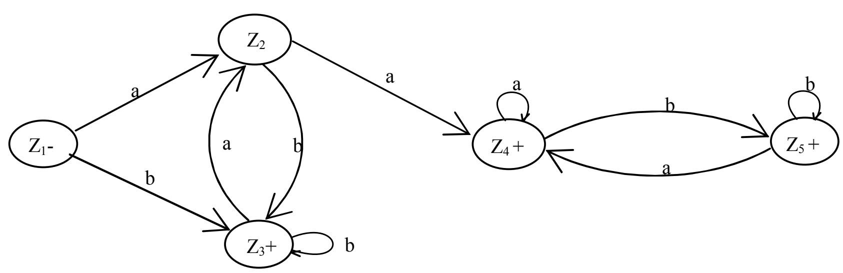


Let FA_3 be an FA corresponding to $r_1+ r_2$, then the initial state of FA_3 must correspond to the initial state of FA_1 and the initial state of FA_2.
Since the language corresponding to $r_1+ r_2$ is the union of corresponding languages L_1 and L_2, consists of the strings belonging to L_1 or L_2 or both, therefore a final state of FA_3 must correspond to a final state of FA_1 or FA_2 or both.
Since, in general, FA_3 will be different from both FA_1 and FA_2, so the labels of the states of FA_3 may be supposed to be $z_1, z_2, z_3, \ldots$, where z_1 is supposed to be the initial state. Since z_1 corresponds to the states x_1 or y_1, so there will be two transitions separately for each letter read at z_1. It will give two possibilities of states either z_1 or different from z_1. This process may be expressed in the following transition table for all possible states of FA_3.





Old States	New States after reading	
	a	b
$z_1 \equiv (x_1,y_1)$	$(x_1,y_2) \equiv z_2$	$(x_2,y_1) \equiv z_3$
$z_2 \equiv (x_1,y_2)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_1) \equiv z_3$
$z_3+ \equiv (x_2,y_1)$	$(x_1,y_2) \equiv z_2$	$(x_2,y_1) \equiv z_3$
$z_4+ \equiv (x_1,y_3)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_3) \equiv z_5$
$z_5+ \equiv (x_2,y_3)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_3) \equiv z_5$



RE corresponding to the above FA may be $r_1+r_2 = (a+b)^*b + (a+b)^*aa(a+b)^*$.

<u>Note:</u> Further examples are discussed in the next lecture.

Theory of Automata

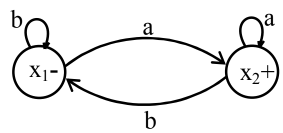
Lecture N0. 13
Reading Material

Introduction to Computer Theory Chapter 7

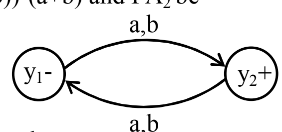
Summary
Examples of Kleene's theorem part III (method 1) continued, Kleene's theorem part III (method 2: Concatenation of FAs), Example of Kleene's theorem part III (method 2 : Concatenation of FAs)

Note
It may be noted that the example discussed at the end of previous lecture, FA_1 contains two states while FA_2 contains three states. Hence the total number of possible combinations of states of FA_1 and FA_2, in sequence, will be six. For each combination the transitions for both a and b can be determined, but using the method in the example, number of states of FA_3 was reduced to five.

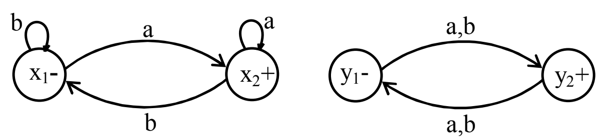
Example
Let $r_1 = (a+b)^*a$ and the corresponding FA_1 be



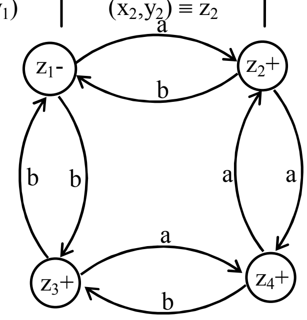
also $r_2 = (a+b)((a+b)(a+b))^*$ or $((a+b)(a+b))^*(a+b)$ and FA_2 be



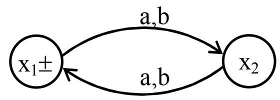
FA corresponding to r_1+r_2 can be determined as



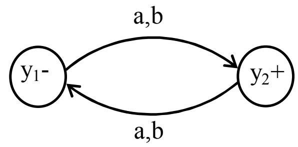
Old States	New States after reading	
	a	b
$z_1- \equiv (x_1,y_1)$	$(x_2,y_2) \equiv z_2$	$(x_1,y_2) \equiv z_3$
$z_2+ \equiv (x_2,y_2)$	$(x_2,y_1) \equiv z_4$	$(x_1,y_1) \equiv z_1$
$z_3+ \equiv (x_1,y_2)$	$(x_2,y_1) \equiv z_4$	$(x_1,y_1) \equiv z_1$
$z_4+ \equiv (x_2,y_1)$	$(x_2,y_2) \equiv z_2$	$(x_1,y_2) \equiv z_3$



Example
Let $r_1 = ((a+b)(a+b))^*$ and the corresponding FA_1 be



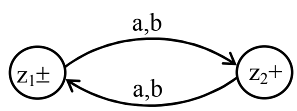
also $r_2 = (a+b)((a+b)(a+b))^*$ or $((a+b)(a+b))^*(a+b)$ and FA_2 be



FA corresponding to r_1+r_2 can be determined as

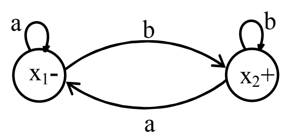
Old States	New States after reading	
	a	b
$z_1\pm\equiv(x_1,y_1)$	$(x_2,y_2)\equiv z_2$	$(x_2,y_2)\equiv z_2$
$z_2+\equiv(x_2,y_2)$	$(x_1,y_1)\equiv z_1$	$(x_1,y_1)\equiv z_1$

Hence the required FA will be as follows

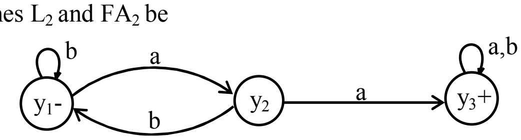


Method2 (Concatenation of two FAs):
Using the FAs corresponding to r_1 and r_2, an FA can be built, corresponding to r_1r_2. This method can be developed considering the following examples

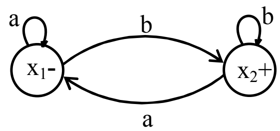
Example
Let $r_1 = (a+b)^*b$ defines L_1 and FA_1 be

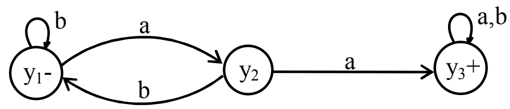


and $r_2 = (a+b)^*aa(a+b)^*$ defines L_2 and FA_2 be



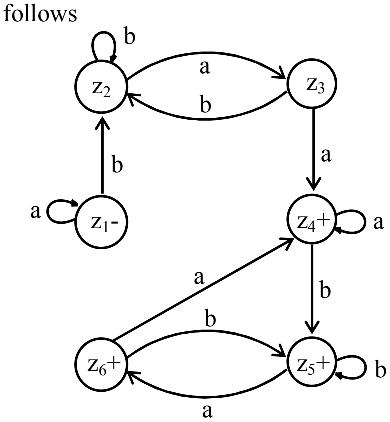
Let FA_3 be an FA corresponding to r_1r_2, then the initial state of FA_3 must correspond to the initial state of FA_1 and the final state of FA_3 must correspond to the final state of FA_2.Since the language corresponding to r_1r_2 is the concatenation of corresponding languages L_1 and L_2, consists of the strings obtained, concatenating the strings of L_1 to those of L_2 , therefore ***the moment a final state of first FA is entered, the possibility of the initial state of second FA will be included as well.***
Since, in general, FA_3 will be different from both FA_1 and FA_2, so the labels of the states of FA_3 may be supposed to be $z_1,z_2, z_3, \ldots$, where z_1 stands for the initial state. Since z_1 corresponds to the states x_1, so there will be two transitions separately for each letter read at z_1. It will give two possibilities of states which correspond to either z_1 or different from z_1. This process may be expressed in the following transition table for all possible states of FA_3





Old States	New States after reading	
	a	b
z_1-≡x_1	x_1≡z_1	(x_2,y_1)≡ z_2
z_2≡(x_2,y_1)	(x_1,y_2)≡z_3	(x_2,y_1)≡ z_2
z_3≡(x_1,y_2)	(x_1,y_3)≡z_4	(x_2,y_1)≡ z_2
z_4+≡(x_1,y_3)	(x_1,y_3)≡ z_4	(x_2,y_1,y_3)≡ z_5
z_5+≡(x_2,y_1,y_3)	(x_1,y_2,y_3)≡ z_6	(x_2,y_1,y_3)≡ z_5
z_6+≡(x_1,y_2,y_3)	(x_1,y_3)≡ z_4	(x_2,y_1,y_3)≡ z_5

Hence the required FA will be as follows



<u>Note</u>: Another example is discussed in the next lecture.

Theory of Automata

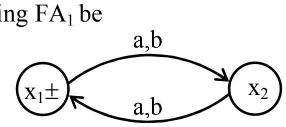
Lecture N0. 14
Reading Material

Introduction to Computer Theory Chapter 7

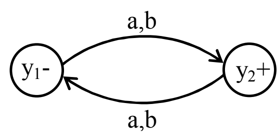
Summary

Examples of Kleene's theorem part III (method 1) continued ,Kleene's theorem part III (method 2: Concatenation of FAs), Examples of Kleene's theorem part III(method 2:concatenation FAs) continued, Kleene's theorem part III (method 3:closure of an FA), examples of Kleene's theorem part III(method 3:Closure of an FA) continued

Example
Let $r_1 = ((a+b)(a+b))^*$ and the corresponding FA_1 be



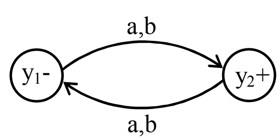
also $r_2 = (a+b)((a+b)(a+b))^*$ or $((a+b)(a+b))^*(a+b)$ and FA_2 be



FA corresponding to r_1r_2 can be determined as

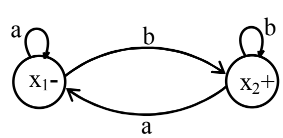
Old States	New States after reading a	New States after reading b
$z_1- \equiv (x_1,y_1)$	$(x_2,y_2) \equiv z_2$	$(x_2,y_2) \equiv z_2$
$z_2+ \equiv (x_2,y_2)$	$(x_1,y_1) \equiv z_1$	$(x_1,y_1) \equiv z_1$

Hence the required FA will be as follows

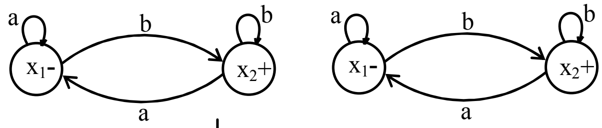


Method3: (Closure of an FA)
Building an FA corresponding to r^*, using the FA corresponding to r.
It is to be noted that if the given FA already accepts the language expressed by the closure of certain RE, then the given FA is the required FA. However the method, in other cases, can be developed considering the following examples
Closure of an FA, is same as concatenation of an FA with itself, except that the initial state of the required FA is a final state as well. Here the initial state of given FA, corresponds to the initial state of required FA and a non final state of the required FA as well.

Example
Let $r = (a+b)^*b$ and the corresponding FA be

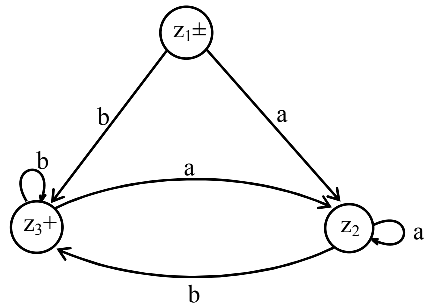


then the FA corresponding to r^* may be determined as under

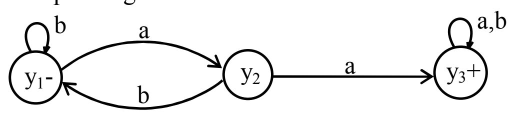


Old States	New States after reading	
	a	b
Final $z_1 \pm \equiv x_1$	$x_1 \equiv z_2$	$(x_2,x_1) \equiv z_3$
Non-final $z_2 \equiv x_1$	$x_1 \equiv z_2$	$(x_2,x_1) \equiv z_3$
$z_3 + \equiv (x_2,x_1)$	$x_1 \equiv z_2$	$(x_2,x_1) \equiv z_3$

The corresponding transition diagram may be as under



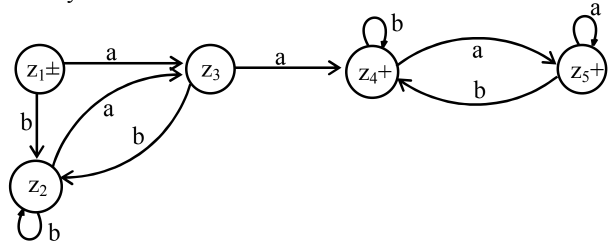
<u>Example</u>
Let $r = (a+b)^*aa(a+b)^*$ and the corresponding FA be



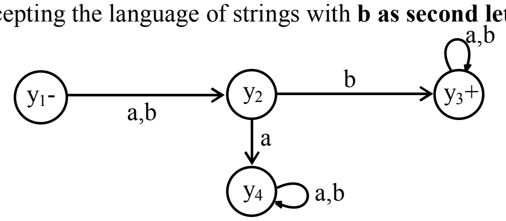
then the FA corresponding to r^* may be determined as under

Old States	New States after reading	
	a	b
Final $z_1 \pm \equiv y_1$	$y_2 \equiv z_3$	$y_1 \equiv z_2$
Non-Final $z_2 \equiv y_1$	$y_2 \equiv z_3$	$y_1 \equiv z_2$
$z_3 \equiv y_2$	$(y_3,y_1) \equiv z_4$	$y_1 \equiv z_2$
$z_4 + \equiv (y_3,y_1)$	$(y_3,y_1,y_2) \equiv z_5$	$(y_3,y_1) \equiv z_4$
$z_5 + \equiv (y_3,y_1,y_2)$	$(y_3,y_1,y_2) \equiv z_5$	$(y_3,y_1) \equiv z_4$

The corresponding transition diagram may be



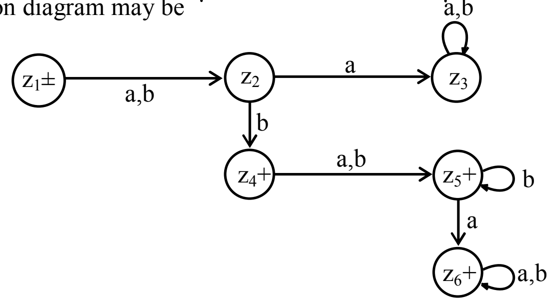
Example
Consider the following FA, accepting the language of strings with **b as second letter**



then the FA corresponding to r^* may be determined as under

Old States	New States after reading	
	a	b
$z_1\pm\equiv y_1$	$y_2\equiv z_2$	$y_2\equiv z_2$
$z_2\equiv y_2$	$y_4\equiv z_3$	$(y_3,y_1)\equiv z_4$
$z_3\equiv y_4$	$y_4\equiv z_3$	$y_4\equiv z_3$
$z_4+\equiv(y_3,y_1)$	$(y_3,y_1,y_2)\equiv z_5$	$(y_3,y_1,y_2)\equiv z_5$
$z_5+\equiv(y_3,y_1,y_2)$	$(y_3,y_1,y_2,y_4)\equiv z_6$	$(y_3,y_1,y_2)\equiv z_5$
$z_6\equiv(y_1,y_1,y_2,y_4)$	$(y_1,y_1,y_2,y_4)\equiv z_6$	$(y_1,y_1,y_2,y_4)\equiv z_6$

The corresponding transition diagram may be



Theory of Automata

Lecture N0. 15
Reading Material

Introduction to Computer Theory Chapter 7

Summary

Examples of Kleene's theorem part III (method 3), NFA, examples, avoiding loop using NFA, example, converting FA to NFA, examples, applying an NFA on an example of maze

Note

It is to be noted that as observed in the examples discussed in previous lecture, if at the initial state of the given FA, there is either a loop or an incoming transition edge, the initial state corresponds to the final state and a non-final state as well, of the required FA, otherwise the initial state of given FA will only correspond to a single state of the required FA (*i.e.* the initial state which is final as well).

Nondeterministic Finite Automaton (NFA)

Definition

An NFA is a TG with a unique start state and a property of having single letter as label of transitions. An NFA is a collection of three things

Finite many states with one initial and some final states

Finite set of input letters, say, Σ = {a, b, c}

Finite set of transitions, showing where to move if a letter is input at certain state (∧ is not a valid transition), there may be more than one transition for certain letters and there may not be any transition for certain letters.

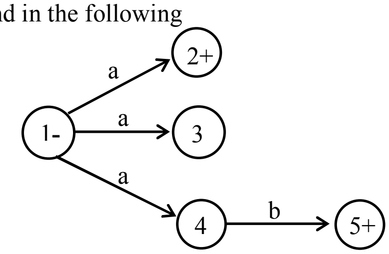
Observations

It may be observed, from the definition of NFA, that the string is supposed to be accepted, if there exists at least one successful path, otherwise rejected.

It is to be noted that an NFA can be considered to be an intermediate structure between FA and TG.

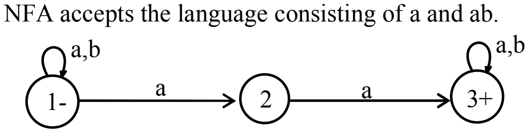
The examples of NFAs can be found in the following

Example



It is to be noted that the above NFA accepts the language consisting of a and ab.

Example



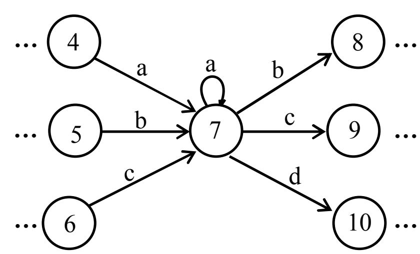
It is to be noted that the above NFA accepts the language of strings, defined over Σ = {a, b}, containing aa.

Note

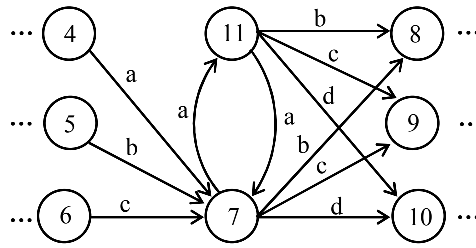
It is to be noted that NFA helps to eliminate a loop at certain state of an FA. This process is done converting the loop into a circuit. But during this process the FA remains no longer FA and is converted to a corresponding NFA, which is shown in the following example.

Example

Consider a part of the following FA with an alphabet Σ = {a,b,c,d}



To eliminate the loop at state 7, the corresponding NFA may be as follows

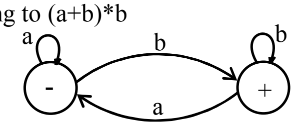


Converting an FA to an equivalent NFA

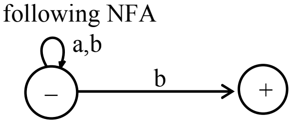
It is to be noted that according to the Kleene's theorem, if a language can be accepted by an FA, then there exists a TG accepting that language. Since, an NFA is a TG as well, therefore there exists an NFA accepting the language accepted by the given FA. In this case these FA and NFA are said to be equivalent to each others. Following are the examples of FAs to be converted to the equivalent NFAs

Example

Consider the following FA corresponding to (a+b)*b



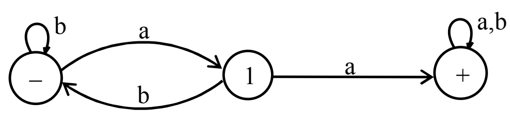
The above FA may be equivalent to the following NFA



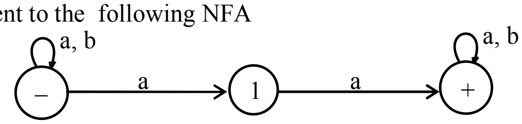
Can the structure of above NFA be compared with the corresponding RE ?

Example

Consider the following FA



The above FA may be equivalent to the following NFA



Can the structure of above NFA be compared with the corresponding RE ?

Application of an NFA

There is an important application of an NFA in artificial intelligence, which is discussed in the following example of a maze

-	1	2	3
4	L	5	O
6	M	7	P
8	N	9	+

Theory of Automata

Lecture N0. 16
Reading Material

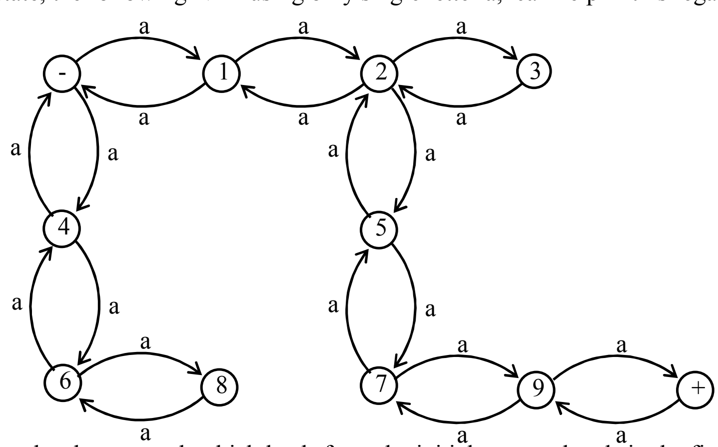
Introduction to Computer Theory Chapter 7

Summary
Applying an NFA on an example of maze, NFA with null string, examples, RE corresponding to NFA with null string (task), converting NFA to FA (method 1,2,3) examples

Application of an NFA
There is an important application of an NFA in artificial intelligence, which is discussed in the following example of a maze

-	1	2	3
4	L	5	O
6	M	7	P
8	N	9	+

- and + indicate the initial and final states respectively. One can move only from a box labeled by other then L, M, N, O, P to such another box. To determine the number of ways in which one can start from the initial state and end in the final state, the following NFA using only single letter a, can help in this regard



It can be observed that the shortest path which leads from the initial state and ends in the final state, consists of six steps i.e. the shortest string accepted by this machine is aaaaaa. The next larger accepted string is aaaaaaaa. Thus if this NFA is considered to be a TG then the corresponding regular expression may be written as
aaaaaa(aa)*
Which shows that there are infinite many required ways

Note
It is to be noted that every FA can be considered to be an NFA as well , but the converse may not true.
It may also be noted that every NFA can be considered to be a TG as well, but the converse may not true.
It may be observed that if the transition of null string is also allowed at any state of an NFA then what will be the behavior in the new structure. This structure is defined in the following

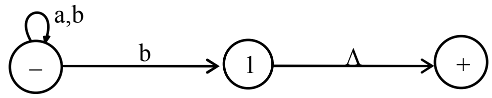
NFA with Null String

Definition

If in an NFA, Λ is allowed to be a label of an edge then the NFA is called NFA with Λ (NFA-Λ).
An NFA-Λ is a collection of three things
Finite many states with one initial and some final states.
Finite set of input letters, say, $\Sigma = \{a, b, c\}$.

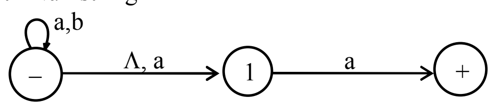
Finite set of transitions, showing where to move if a letter is input at certain state.
There may be more than one transitions for certain letter and there may not be any transition for a certain letter. The transition of ∧ is also allowed at any state.

Example
Consider the following NFA with Null string



The above NFA with Null string accepts the language of strings, defined over Σ = {a, b}, **ending in b**.

Example
Consider the following NFA with Null string



The above NFA with Null string accepts the language of strings, defined over Σ = {a, b}, **ending in a**.

Note
It is to be noted that every FA may be considered to be an NFA-∧ as well, but the converse may not true.
Similarly every NFA-∧ may be considered to be a TG as well, but the converse may not true.

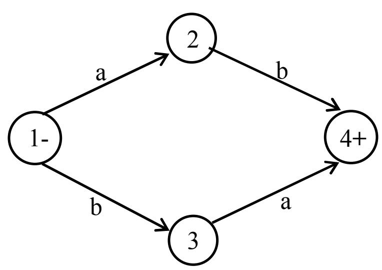
NFA to FA

Two methods are discussed in this regard.

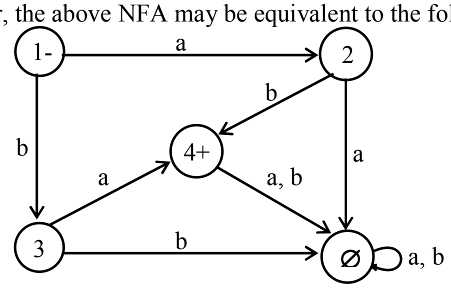
Method 1: Since an NFA can be considered to be a TG as well, so a RE corresponding to the given NFA can be determined (using Kleene's theorem). Again using the methods discussed in the proof of Kleene's theorem, an FA can be built corresponding to that RE. Hence for a given NFA, an FA can be built equivalent to the NFA. Examples have, indirectly, been discussed earlier.

Method 2: Since in an NFA, there may be more than one transition for a certain letter and there may not be any transition for certain letter, so starting from the initial state corresponding to the initial state of given NFA, the transition diagram of the corresponding FA, can be built introducing an empty state for a letter having no transition at certain state and a state corresponding to the combination of states, for a letter having more than one transitions. Following are the examples

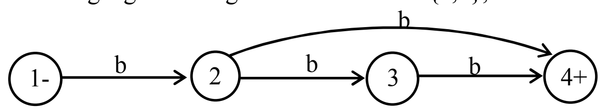
Example
Consider the following NFA



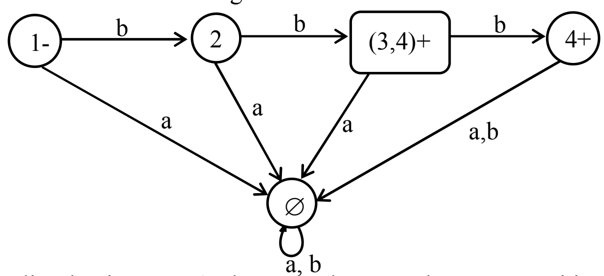
Using the method discussed earlier, the above NFA may be equivalent to the following FA



<u>Example</u>
A simple NFA that accepts the language of strings defined over Σ = {a,b}, **consists of bb and bbb**



The above NFA can be converted to the following FA



<u>Method 3</u>: As discussed earlier that in an NFA, there may be more than one transition for a certain letter and there may not be any transition for certain letter, so starting from the initial state corresponding to the initial state of given NFA, the transition table along with new labels of states, of the corresponding FA, can be built introducing an empty state for a letter having no transition at certain state and a state corresponding to the combination of states, for a letter having more than one transitions. Further examples are discussed in the next lecture.

Theory of Automata

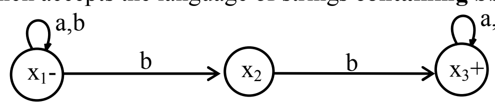
Lecture N0. 17
Reading Material

Introduction to Computer Theory Chapter 7

Summary
converting NFA to FA (method 3), example, NFA and Kleene's theorem method 1, examples, NFA and Kleene's theorem method 2 , NFA corresponding to union of FAs, example

Method 3: As discussed earlier that in an NFA, there may be more than one transition for a certain letter and there may not be any transition for certain letter, so starting from the initial state corresponding to the initial state of given NFA, the transition table along with new labels of states, of the corresponding FA, can be built introducing an empty state for a letter having no transition at certain state and a state corresponding to the combination of states, for a letter having more than one transitions. Following are the examples

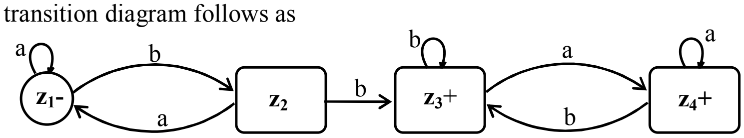
Example
Consider the following NFA which accepts the language of strings **containing bb**



Using the method discussed earlier, the transition table corresponding to the required FA may be constructed as

Old States	New States after reading a	New States after reading b
$z_1- \equiv x_1$	$x_1 \equiv z_1$	$(x_1,x_2) \equiv z_2$
$z_2 \equiv (x_1,x_2)$	$(x_1 , \varnothing) \equiv x_1 \equiv z_1$	$(x_1 ,x_2,x_3) \equiv z_3$
$z_3+ \equiv (x_1,x_2,x_3)$	$(x_1,x_3) \equiv z_4$	$(x_1 ,x_2,x_3) \equiv z_3$
$z_4+ \equiv (x_1,x_3)$	$(x_1,x_3) \equiv z_4$	$(x_1 ,x_2,x_3) \equiv z_3$

The corresponding transition diagram follows as

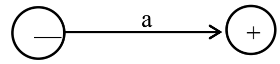


NFA and Kleene's Theorem
It has been discussed that, by Kleene's theorem part III, there exists an FA corresponding to a given RE. If the given RE is as simple as r = aa+bbb or r = $a(a+b)^*$, the corresponding FAs can easily be constructed. However, for a complicated RE, the RE can be decomposed into simple REs corresponding to which the FAs can easily be constructed and hence, using the method, constructing the FAs corresponding to sum, concatenation and closure of FAs, the required FA can also be constructed. It is to be noted that NFAs also help in proving Kleene's theorem part III, as well. Two methods are discussed in the following.

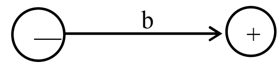
NFA and Kleene's Theorem
Method 1:
The method is discussed considering the following example.

Example
To construct the FAs for the languages L_1 = {a}, L_2 = {b} and L_3 = {Λ}
Step 1: Build NFA_1, NFA_2 and NFA_3 corresponding to L_1, L_2 and L_3 , respectively as shown in the following diagram

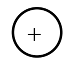
NFA$_1$



NFA$_2$

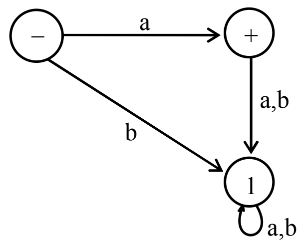


NFA$_3$

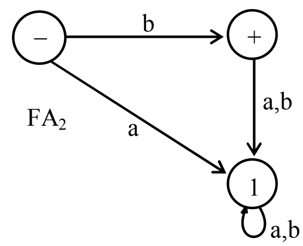


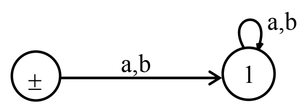
Step 2:
As discussed earlier for every NFA there is an FA equivalent to it, hence there must be FAs for the above mentioned NFAs as well. The corresponding FAs can be considered as follows

FA$_1$



FA$_2$





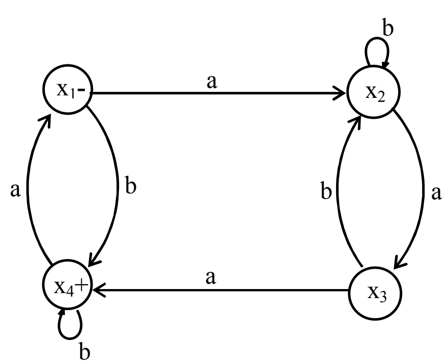
FA$_3$

NFA and Kleene's Theorem method 2
It may be observed that if an NFA can be built corresponding to union, concatenation and closure of FAs corresponding to the REs, then converting the NFA, thus, obtained into an equivalent FA, this FA will correspond to the given RE.
Followings are the procedures showing how to obtain NFAs equivalent to union, concatenation and closure of FAs

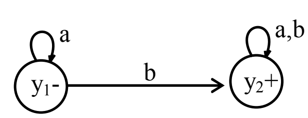
NFA corresponding to Union of FAs
Method
Introduce a new start state and connect it with the states originally connected with the old start state with the same transitions as the old start state, then remove the –ve sign of old start state. This creates non-determinism and hence results in an NFA.

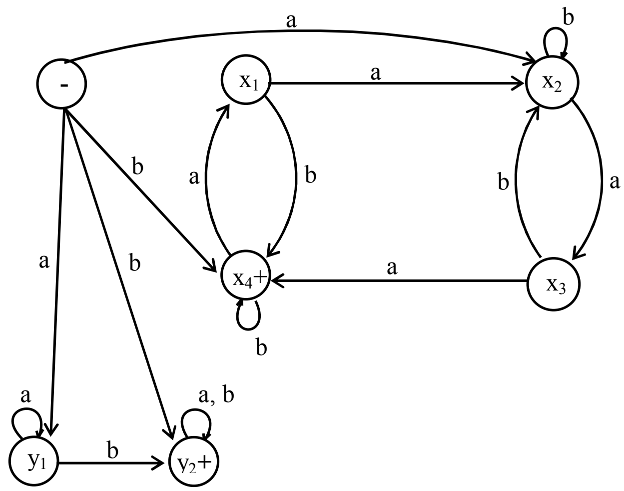
Example

FA$_1$



FA$_2$





NFA equivalent to $FA_1 \cup FA_2$

Theory of Automata

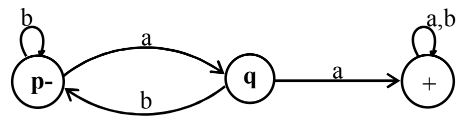
Lecture N0. 18
Reading Material

Introduction to Computer Theory Chapter 7

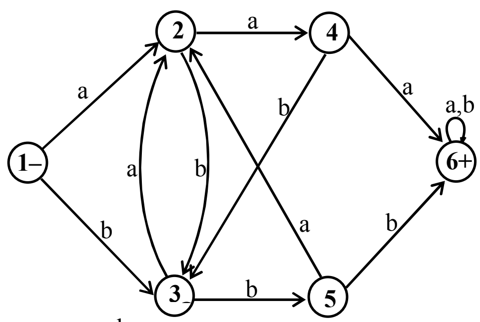
Summary
NFA corresponding to union of FAs, example, NFA corresponding to concatenation of FAs, examples, NFA corresponding to closure of an FA, example

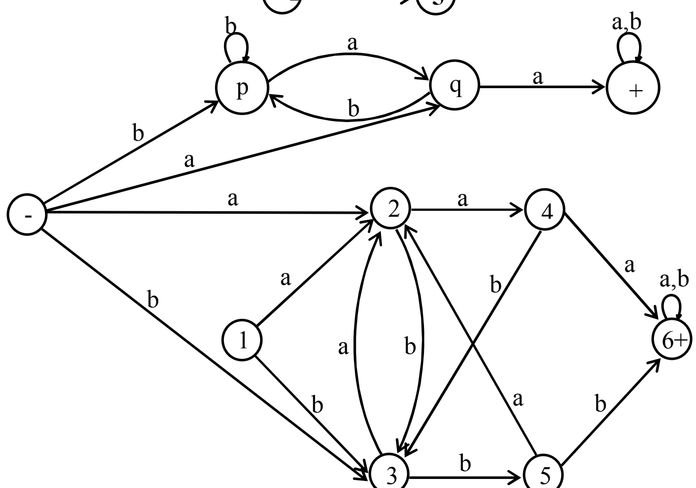
Example

FA_1



FA_2





NFA equivalent to $FA_1 \cup FA_2$

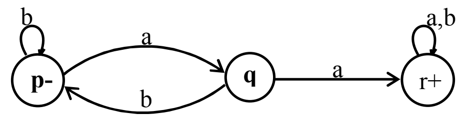
NFA corresponding to Concatenation of FAs
Method
Introduce additional transitions for each letter connecting each final state of the first FA with the states of second FA that are connected with the initial state of second FA corresponding to each letter of the alphabet. Remove the +ve sign of each of final states of first FA and –ve sign of the initial state of second FA. It will create non-determinism at final states of first FA and hence NFA, thus obtained, will be the required NFA.

Note
It may be noted that if first FA accepts the Null string then every string accepted by second FA must be accepted by the concatenation of FAs as well. This situation will automatically be accommodated using the method discussed earlier. However if the second FA accepts Null string, then every string accepted by first FA must be accepted by the required FA as well. This target can be achieved as, while introducing new transitions at final states of first FA the +ve sign of these states will not be removed.

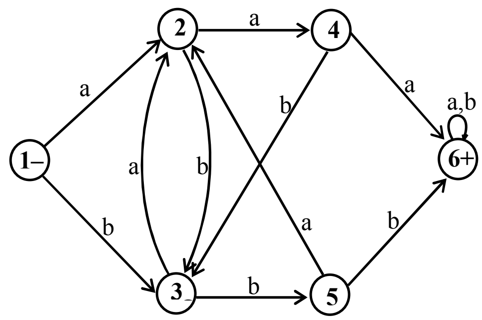
Lastly if both FAs accepts the Null string, then the Null string must be accepted by the required FA. This situation will automatically be accommodated as the second FA accepts the Null string and hence the +ve signs of final states of first FA will not be removed.

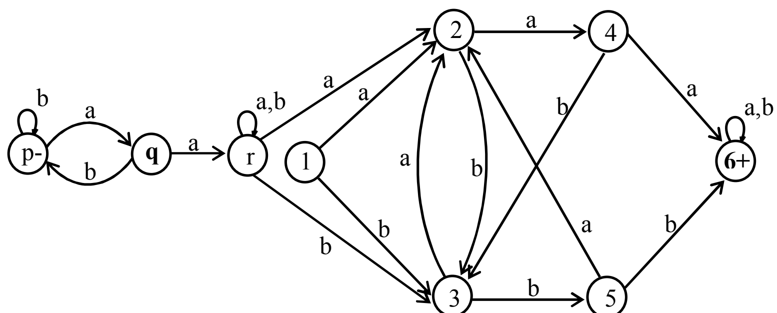
Example (No FA accepts Null string)

FA$_1$



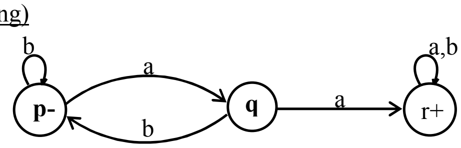
FA$_2$



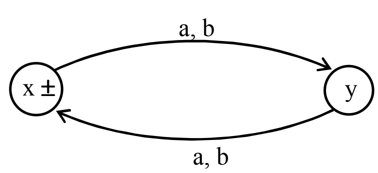


NFA equivalent to FA$_1$FA$_2$

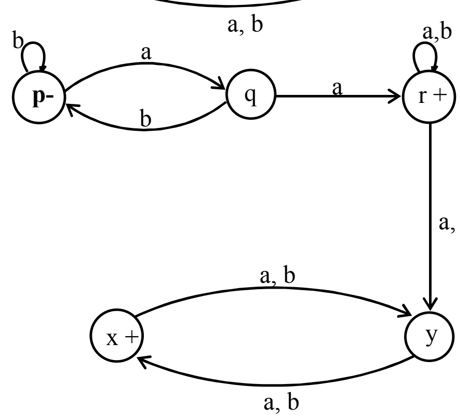
Example (FA$_2$ accepts Null string)



FA$_1$



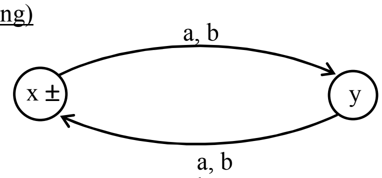
FA$_2$



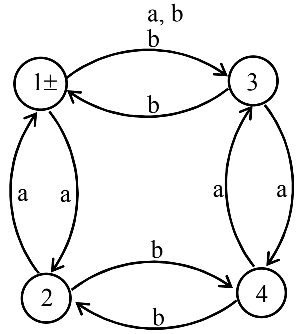
NFA equivalent to FA_1FA_2

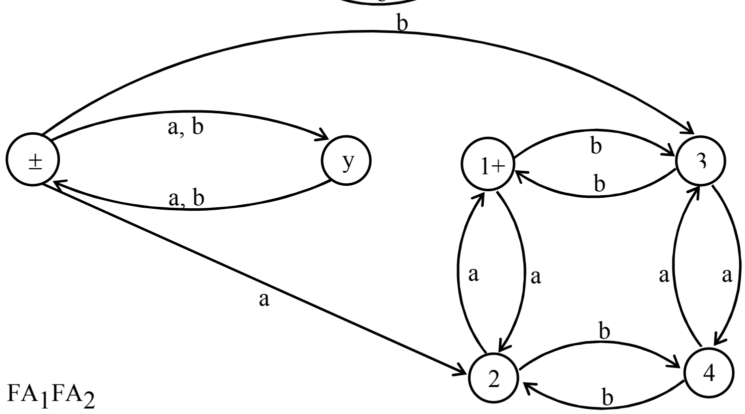
Example (Both FAs accept Null string)

FA_1



FA_2





NFA equivalent to FA_1FA_2

NFA corresponding to the Closure of an FA

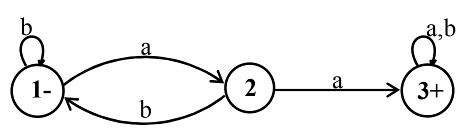
Apparently, it seems that since closure of an FA accepts the Null string, so the required NFA may be obtained considering the initial state of given FA to be final as well, but this may allow the unwanted string to be accepted as well. For example, an FA, with two states, accepting the language of strings, defined over. Σ = {a, b}, **ending in a**, will accept all unwanted strings, if the initial state is supposed to be final as well.

Method

Thus, to accommodate this situation, introduce an initial state which should be final as well (so that the Null string is accepted) and connect it with the states originally connected with the old start state with the same transitions as the old start state, then remove the –ve sign of old start state. Introduce new transitions, for each letter, at each of the final states (including new final state) with those connected with the old start state.This creates non-determinism and hence results in the required NFA.

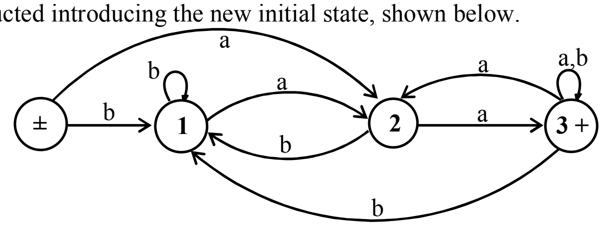
Example

Consider the following FA

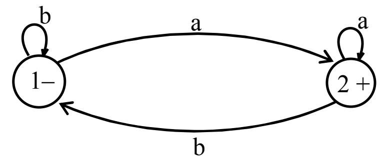


It may be observed that the FA^* accepts only the additional string which is the Null string.

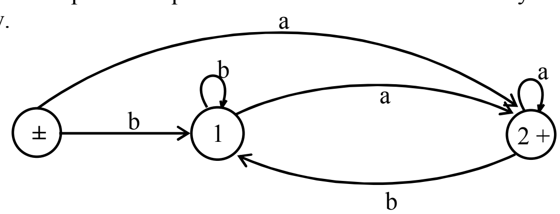
Considering the state 1 to be final as well, will allow the unwanted strings be accepted as well. Hence the required NFA is constructed introducing the new initial state, shown below.



Example
Consider the following FA



It may be observed that the FA^* accepts only the additional string which is the Null string
As observed in the previous example the required NFA can be constructed only if the new initial state is introduced as shown below.



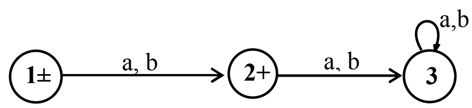
Theory of Automata

Lecture N0. 19
Reading Material

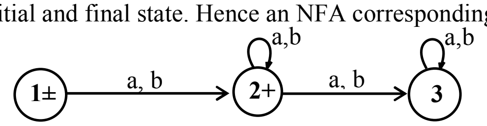
Introduction to Computer Theory Chapter 7

Summary
NFA corresponding to Closure of FA, Examples, Memory required to recognize a language, Example, Distinguishing one string from another, Example, Theorem, Proof

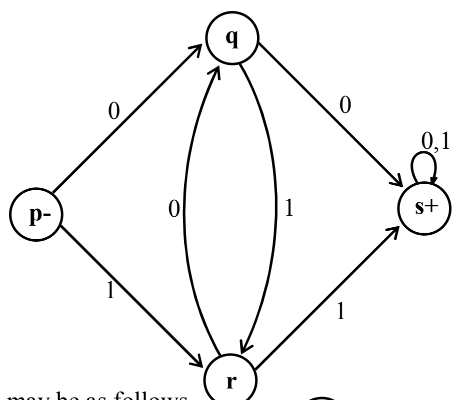
Example
Consider the following FA



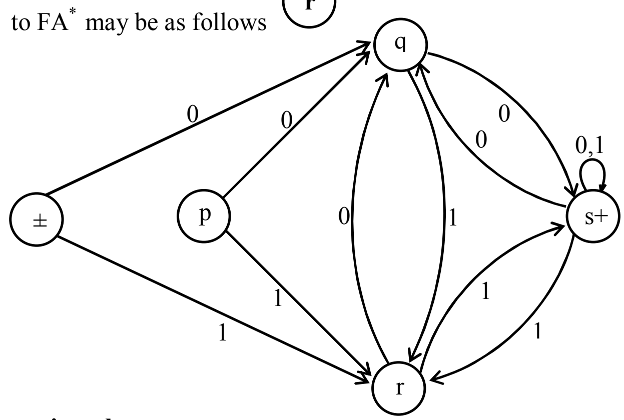
It can be observed that FA* not only accepts the Null string but every other string as well.
Here we don't need separate initial and final state. Hence an NFA corresponding to FA* may be



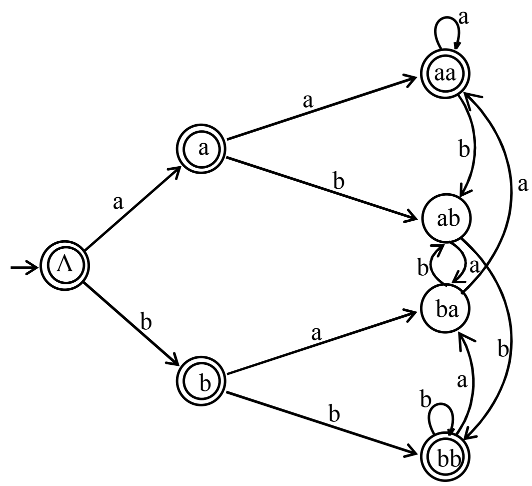
Example
Consider the following FA



The NFA corresponding to FA* may be as follows



Memory required to recognize a language
Memory required to recognize a language means to look at the machine which can recognize a language. As an FA can be considered to be a machine which is simple model of computation and every regular language is associated with certain FA, so to recognize a language there is a restriction that there is a single pass from left to right for any string to decide whether it belongs to certain language ? This helps to remember the information about the initial part of the string read so far.
By this process the input string is examined and the string is decided either to be in a certain language or not.
Consider L = {w ∈ $\{a,b\}^*$: w neither ends in **ab** nor in **ba**}. *i.e.* L is the language of strings, defined over Σ = {a,b}, consisting of Λ, a, b and strings ending in aa or bb. L may be accepted by the following FA



As seen in the above FA, seven states are required to recognize the language L, while on the other hand it is very hard to recognize the language PALINDROME.
As seen in the above example of FA, seven states are required to recognize that language. Now consider another language L_3 of strings of length three or more, defined over $\Sigma = \{a,b\}$, **and the third letter from the right is a.** As discussed by Martin, there is a straight forward method to build an FA recognizing L_3 *i.e.* a distinct state for every possible substring of length less then or equal to 3. It is obvious that for each length *i*, *i*=0,1,2,3, of substring, the number of states are 2^i and thus total number of states required to recognize the language L_3 are $2^0+2^1+2^2+2^3 = 2^{3+1}-1=15$ (using $2^0+2^1+2^2+\ldots+ 2^n= 2^{n+1}-1$)

Remark: Let L_{20} be the language of strings of length 20 or more, defined over $\Sigma = \{a,b\}$, **and the 20th letter from the right is 1,** then following the previous method, number of states for the corresponding FA is $\mathbf{2^{20+1}-1=2,097,151.}$
However, it may be noted that any portion of memory of a computer that can accommodate 21 bits can be in $\mathbf{2^{21}}$ possible states *i.e.* $\mathbf{2^{21}}$ possible choices for the informational content.

Distinguishable strings and Indistinguishable strings
Two strings x and y, belonging to Σ^*, are said to be **distinguishable** w.r.t a language $L \subseteq \Sigma^*$ if there exists a string z belonging to Σ^* s.t. $xz \in L$ but $yz \notin L$ or $xz \notin L$ but $yz \in L$.
Two strings x and y, belonging to Σ^*, are said to be **indistinguishable** with respect to a language $L \subseteq \Sigma^*$ if for every string z belonging to Σ^*, either both xz or $yz \in L$ or both don't belong to L.

Example
Let L be the language of strings, defined over $\Sigma = \{0,1\}$, **ending in 01.**
The strings 110 and 010011 are **distinguishable** w.r.t L, as there exists 1 belonging to Σ^* s.t. 1101 belongs to L but 0100111 doesn't belong to L.
But 111 and 010011 are **indistinguishable**, for 1 belonging to Σ^* s.t. both 1111 and 010011 don't belong to L *i.e.* for every z belonging to Σ^*, either both 111z and 01001z belong to L, or both don't belong to L.

Theorem
Statement
If L is a language over an alphabet Σ and for integer n there are n strings from Σ^*, any two of which are distinguishable w.r.t. language L, then any FA recognizes L must have at least n states.
(Note: There may not exist any FA which recognizes the given language.)

Proof
Let S be set of strings, any two of which are distinguishable w.r.t. language L. Let F_1 be the FA which recognizes the language L. To prove the theorem, it is sufficient to show that any two strings under F_1 must be ended in different states *i.e.* corresponding to each string x belonging to S, F_1 ends in distinct states.
Thus if S has n strings then it is to be shown that F_1 has at least n states.

Let x and y be any two strings from S. By supposition any two strings of S are distinguishable w.r.t. L, so there exists a string z belonging to $\sum^*$such that only one of xz and yz belongs to L *i.e.* F_1 ends in a final state either for xz or yz which shows that F_1 ends in distinct states for xz and yz.
Let F_1 be ended in same state for both the strings x and y, which shows that F_1ends in same state for both xz and yz, a contradiction as x and y being distinguishable implies xz and yz are ended at distinct states of F_1.
Hence F_1 does not end in a same state for both strings x and y, which shows that each pair of strings belonging to S ends in different states. Hence F_1 must contain at least n states.

Theory of Automata

Lecture N0. 20
Reading Material

Introduction to Computer Theory Chapter 8

Summary
Example of previous Theorem, Finite Automaton with output, Moore machine, Examples

Example
Let L_{20}={w ∈ $\{0,1\}^*$: |w| ≥ 20 and the 20^{th} letter of w, from right is, 1}. Let S be the set of all strings of length 20, defined over Σ, any two of which are distinguishable *w.r.t.* L_{20}. Obviously the number of strings belonging to S, is 2^{20}. Let x and y be any two distinct strings *i.e.* they differ in ith letter, i=1,2,3,…20, from left. For i=1, they differ by first letter from left.
Then by definition of L_{20}, one is in L_{20} while other is not as shown below

0	.	…	.

1	.	…	.

So they are distinct *w.r.t.* L_{20} for z = Λ *i.e.* one of xz and yz belongs to L_{20}.
Similarly if i=2 they differ by 2^{nd} letter from left and are again distinguishable and hence for z belonging to Σ^*, |z|=1, either xz or yz belongs to L_{20} because in this case the 20^{th} letter from the right of xz and yz is exactly the 2^{nd} letter from left of x and y as shown below

.	0	…	.	z

.	1	…	.	z

Hence x and y will be distinguishable *w.r.t.* L_{20} for i=2, as well. Continuing the process it can be shown that any pair of strings x and y belonging to S, will be distinguishable *w.r.t.* L_{20}. Since S contains 2^{20} strings, any two of which are distinguishable *w.r.t.* L_{20}, so using the theorem any FA accepting L_{20} must have at least 2^{20} states.

Note
It may be observed from the above example that using Martin's method, there exists an FA having 2^{20+1}-1=2,097,151 states. This indicates the memory required to recognize L_{20} will be the memory of a computer that can accommodate 21-bits *i.e.*the computer can be in 2^{21} possible states.

Finite Automaton with output
Finite automaton discussed so far, is just associated with the RE or the language.
There is a question whether does there exist an FA which generates an output string corresponding to each input string ? The answer is yes. Such machines are called machines with output.
There are two types of machines with output. Moore machine and Mealy machine

Moore machine
A Moore machine consists of the following
A finite set of states q_0, q_1, q_2, … where q_0 is the initial state.
An alphabet of letters Σ = {a,b,c,…} from which the input strings are formed.
An alphabet Γ={x,y,z,…} of output characters from which output strings are generated.
A transition table that shows for each state and each input letter what state is entered the next.
An output table that shows what character is printed by each state as it is entered.

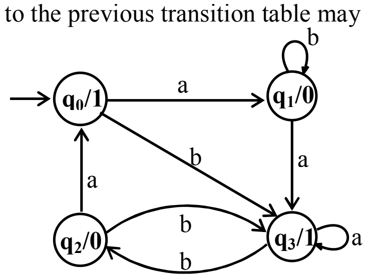
Note
It is to be noted that since in Moore machine no state is designated to be a final state, so there is no question of accepting any language by Moore machine. However in some cases the relation between an input string and the corresponding output string may be identified by the Moore machine. Moreover, the state to be initial is not important as if the machine is used several times and is restarted after some time, the machine will be started from the state where it was left off. Following are the examples

<u>Example</u>

Consider the following Moore machine having the states q_0, q_1, q_2, q_3 where q_0 is the start state and
$\Sigma = \{a,b\}$,
$\Gamma=\{0,1\}$
the transition table follows as

Old States	**New States after reading**		Characters to be printed
	a	**b**	
q_0**-**	q_1	q_3	1
q_1	q_3	q_1	0
q_2	q_0	q_3	0
q_3	q_3	q_2	1

the transition diagram corresponding to the previous transition table may be



It is to be noted that the states are labeled along with the characters to be printed. Running the string abbabbba over the above machine, the corresponding output string will be 100010101, which can be determined by the following table as well

Input		a	b	b	a	b	b	b	a
State	q_0	q_1	q_1	q_1	q_3	q_2	q_3	q_2	q_0
output	1	0	0	0	1	0	1	0	1

It may be noted that the length of output string is l more than that of input string as the initial state prints out the extra character 1, before the input string is read.

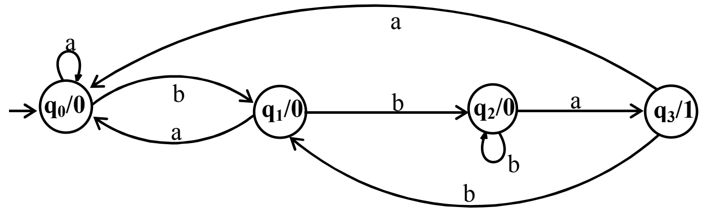
Theory of Automata

Lecture N0. 21
Reading Material

Introduction to Computer Theory Chapter 8

Summary
Example of Moore machine, Mealy machine, Examples, complementing machine, Incrementing machine.

Example
To identify the relation between the input strings and the corresponding output strings in the following Moore machine,



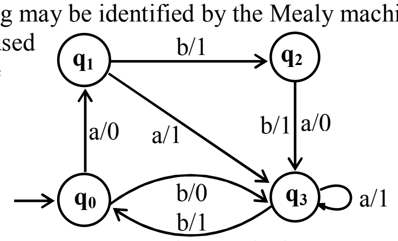
if the string bbbabaabbaa is run, the output string will be 000010000010, as shown below

Input		b	b	b	a	b	a	a	b	b	a	a
State	q_0	q_1	q_2	q_2	q_3	q_1	q_0	q_0	q_1	q_2	q_3	q_0
output	0	0	0	0	1	0	0	0	0	0	1	0

It can be observed from the given Moore machine that q_3 is the only state which prints out the character 1 which shows that the moment the state q_3 is entered, the machine will print out 1. To enter the state q_3, starting from q_0 the string must contain bba. It can also be observed that to enter the state q_3 once more the string must contain another substirng bba. In general the input string will visit the state q_3 as many times as the number of substring bba occurs in the input string. Thus the number of 1's in an output string will be same as the number of substring bba occurs in the corresponding input string.

Mealy machine
A Mealy machine consists of the following
A finite set of states q_0, q_1, q_2, … where q_0 is the initial state.
An alphabet of letters $\Sigma = \{a,b,c,…\}$ from which the input strings are formed.
An alphabet $\Gamma=\{x,y,z,…\}$ of output characters from which output strings are generated.
A pictorial representation with states and directed edges labeled by an input letter along with an output character. The directed edges also show how to go from one state to another corresponding to every possible input letter.
(It is not possible to give transition table in this case.)

Note
It is to be noted that since, similar to Moore machine, in Mealy machine no state is designated to be a final state, so there is no question of accepting any language by Mealy machine. However in some cases the relation between an input string and the corresponding output string may be identified by the Mealy machine. Moreover, the state to be initial is not important as if the machine is used several times and is restarted after some time, the machine will be started from the state where it was left off. Following are the examples



Example
Consider the Mealy machine shown aside, having the states q_0, q_1, q_2, q_3 , where q_0 is the start state and

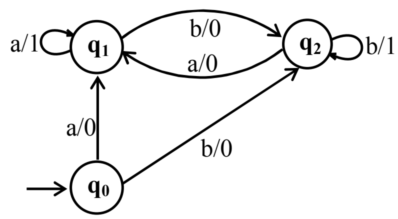
$\Sigma = \{a,b\}$,
$\Gamma=\{0,1\}$

Running the string abbabbba over the above machine, the corresponding output string will be 11011010, which can be determined by the following table as well

Input		a	b	b	a	b	b	b	a
States	q_0	q_1	q_2	q_3	q_3	q_0	q_3	q_0	q_1
output		0	1	1	1	1	0	1	0

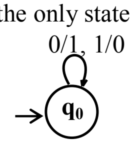
It may be noted that in Mealy machine, the length of output string is equal to that of input string.

Example
Consider the following Mealy machine having the states q_0, q_1, q_2 , where q_0 is the start state and
$\Sigma = \{a,b\}$,
$\Gamma=\{0,1\}$



It is observed that in the above Mealy machine, if in the output string the nth character is 1, it shows that the nth letter in the input string is the second in the pair of double letter.
For babaababba as input string the machine will print 0000100010.

Example
Consider the following Mealy machine having the only state q_0 as the start state and
$\Sigma = \{0,1\}$,
$\Gamma= \{0,1\}$



If 0011010 is run on this machine then the corresponding output string will be 1100101.
This machine is called **Complementing machine.**

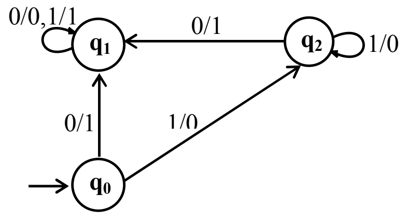
Constructing the incrementing machine
In the previous example of complementing machine, it has been observed that the input string and the corresponding output string are 1's complement of each other. There is a question whether the Mealy machine can be constructed, so that the output string is increased, in magnitude, by 1 than the corresponding input string? The answer is yes.
This machine is called the incrementing machine. Following is how to construct the incrementing machine.
Before the incrementing machine is constructed, consider how 1 is added to a binary number.
Since, if two numbers are added, the addition is performed from right to left, so while increasing the binary number by 1, the string (binary number) must be read by the corresponding Mealy machine from right to left, and hence the output string (binary number) will also be generated from right to left.
Consider the following additions

a)
```
 100101110
       + 1
 ---------
 100101111
```

b)
```
 1001100111
        + 1
 ----------
 1001101000
```

It may be observed from the above that
If the right most bit of binary number, to be incremented, is 0, the output binary number can be obtained by converting the right most bit to 1 and remaining bits unchanged.
If the right most bit of binary number is 1 then the output can be obtained, converting that 1 along with all its concatenated 1's to 0's, then converting the next 0 to 1 and remaining bits unchanged.
The observations (a) and (b) help to construct the following Incrementing (Mealy) machine.
The Mealy machine have the states q_0, q_1, q_2 , where q_0 is the start state and

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



It may be observed that, in the incrementing machine, if 0 is read at initial state $\mathbf{q_0}$, that 0 is converted to 1 and a no change state $\mathbf{q_1}$ (no carry state) is entered where all 0's and all 1's remain unchanged. If 1 is read at initial state, that 1 is converted to 0 and the state q_2(owe carry state) is entered, where all 1's are converted to 0's and at that state if 0 is read that 0 is converted to 1 and the machine goes to no change state.
If the strings 100101110 and 1001100111 are run over this machine, the corresponding output strings will be 100101111 and 1001101000 respectively.

Note
It is to be noted that if the string 111111 is run over the incrementing machine, the machine will print out 000000, which is not increased in magnitude by 1. Such a situation is called an overflow situation, as the length of output string will be same as that of input string.
It may also be noted that there exists another incrementing machine with two states.

Theory of Automata

Lecture N0. 22
Reading Material

Introduction to Computer Theory Chapter 8

Summary
Applications of complementing and incrementing machines, Equivalent machines, Moore equivalent to Mealy, proof, example, Mealy equivalent to Moore, proof, example

Applications of Incrementing and Complementing machines
1's complementing and incrementing machines which are basically Mealy machines are very much helpful in computing.
The incrementing machine helps in building a machine that can perform the addition of binary numbers.
Using the complementing machine along with incrementing machine, one can build a machine that can perform the subtraction of binary numbers, as shown in the following method

Subtracting a binary number from another
Method
To subtract a binary number b from a binary number a
Add 1's complement of b to a (ignoring the overflow, if any)
Increase the result, in magnitude, by 1 (use the incrementing machine). Ignoring the overflow if any.
Note: If there is no overflow in (1). Take 1's complement once again in (2), instead. This situation occurs when b is greater than a, in magnitude. Following is an example of subtraction of binary numbers

Example
To subtract the binary number 101 from the binary number 1110, let
a = 1110 and b = 101 = 0101.
(Here the number of digits of b are equated with that of a)
Adding 1's complement (1010) of b to a.

```
 1110
+1010
11000  which gives 1000 (ignoring the overflow)
```

Using the incrementing machine, increase the above result 1000, in magnitude, by 1

```
1000
  +1
1001 which is the same as obtained by ordinary subtraction.
```

Note
It may be noted that the above method of subtraction of binary numbers may be applied to subtraction of decimal numbers with the change that 9's complement of b will be added to a, instead in step (1).

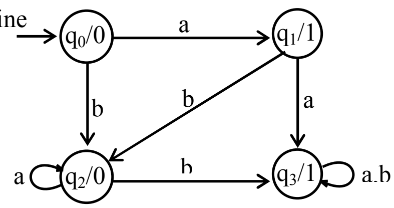
Equivalent machines
Two machines are said to be **equivalent** if they print the same output string when the same input string is run on them.
Remark:
Two Moore machines may be equivalent. Similarly two Mealy machines may also be equivalent, but a Moore machine can't be equivalent to any Mealy machine. However, ignoring the extra character printed by the Moore machine, there exists a Mealy machine which is equivalent to the Moore machine.

Theorem
Statement
For every Moore machine there is a Mealy machine that is equivalent to it (ignoring the extra character printed by the Moore machine).

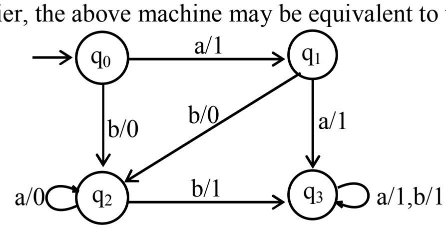
Proof:
Let M be a Moore machine, then shifting the output characters corresponding to each state to the labels of corresponding incoming transitions, machine thus obtained will be a Mealy machine equivalent to M.

Note
It may be noted that while converting a Moore machine into an equivalent Mealy machine, the output character of a state will be ignored if there is no incoming transition at that state. A loop at a state is also supposed to be an incoming transition.
Following is the example of converting a Moore machine into an equivalent Mealy machine

Example
Consider the following Moore machine



Using the method described earlier, the above machine may be equivalent to the following Mealy machine



Running the string abbabbba on both the machines, the output string can be determined by the following table

Input		a	b	b	a	b	b	b	a
States	q_0	q_1	q_2	q_3	q_3	q_3	q_3	q_3	q_3
Moore	0	1	0	1	1	1	1	1	1
Mealy		1	0	1	1	1	1	1	1

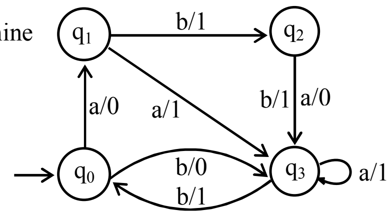
Theorem
Statement
For every Mealy machine there is a Moore machine that is equivalent to it (ignoring the extra character printed the Moore machine).

Proof
Let M be a Mealy machine. At each state there are two possibilities for incoming transitions
The incoming transitions have the same output character.
The incoming transitions have different output characters.
If all the transitions have same output characters, then shift that character to the corresponding state.
If all the transitions have different output characters, then the state will be converted to as many states as the number of different output characters for these transitions, which shows that if this happens at state q_i then q_i will be converted to q_i^1 and q_i^2 *i.e.* if at q_i there are the transitions with two output characters then q_i^1 for one character and q_i^2 for other character.
Shift the output characters of the transitions to the corresponding new states q_i^1 and q_i^2. Moreover, these new states q_i^1 and q_i^2 should behave like q_i as well. Continuing the process, the machine thus obtained, will be a Moore machine equivalent to Mealy machine M.
Following is a note

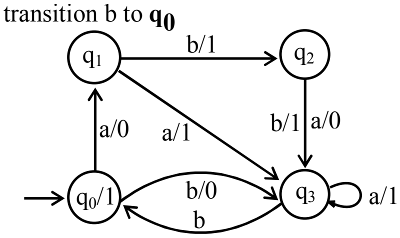
Note
It may be noted that if there is no incoming transition at certain state then any of the output characters may be associated with that state.
It may also be noted that if the initial state is converted into more than one new states then only one of these new states will be considered to be the initial state. Following is an example

Example

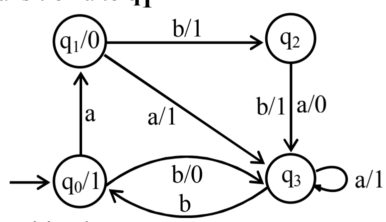
Consider the following Mealy machine



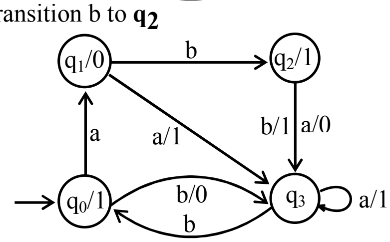
Shifting the output character 1 of transition b to q_0



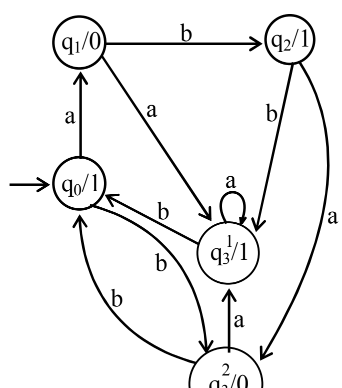
Shifting the output character 0 of transition a to q_1



Shifting the output character 1 of transition b to q_2



Splitting q_3 into q^1_3 and q^2_3



Running the string abbabbba on both the machines, the output strings can be determined by the following table

Input		a	b	b	a	b	b	b	a
States	q_0	q_1	q_2	q_3	q_3	q_0	q_3	q_0	q_1
Mealy		0	1	1	1	1	0	1	0
Moore	1	0	1	1	1	1	0	1	0

Virtual University	CS402- THEORY OF AUTOMETA (SOLVED MCQs) FROM MIDTERM PAPERS LECTURE (1-22)	VU LMS HELP vulmshelp.com
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1.Which of the following steps replaces multiple incoming transition edges with a single one proving Kleene's theorem part II?

a. Step 1
b. Step 2
c. Step 3
d. Step 4

2. Let FA1 accepts many strings and FA2 accepts no strings, then FA1+FA2 will be equal to:

a.FA1

b.FA2

C.FA2-FA1

d.(FA2)*

3. Let L be the language of all strings, defined over ∑ =(0,1), ending in 10. Which of the following strings are indistinguishable w.r.t L with z being 0?

a.100.101

b.111.101

c. 110 .101

d.010.101

4. If r1=(aa+bb)and r2=(a+b) then the language (aa+bb)(a+b) will bhe generated by_______

a.(r1)(r2)

b.(r1 +r2)

c.(r2)(r1)

d.(r1)*

5. Introducing a new start state in the case of multiple states is step no.______ of proving Kleen's theorem part II.

a.1

b.2

c.3

d.4

6. The language having even numbers of a's and even number of b's defined over S={a,b} is called ______

a. EVEN-EVEN

B.ODD-ODD

c. PALINDROME

d. FACTORIAL

7. In NFA having no transition at a certain state, FA can be built by introducing :

a.Empty state

b. Combination of states

c .initial state

d. final state

8. For every three regular expression R, S, and T. the language denoted by R(S U T) and (RS)U(RT) are the _______

a .same

b. Different

c. R(SUT)is greater

d. none of the given options

9. Which of the following string belongs to the language of the regular expression (aa*b)?

a. baabab

b. abbbaa

c.aaaaaa

d.aabaab

10. If L1' and L2' are regular languages, then L1, L2 will be

a. non regular

b. may be regular

c. Regular

d. none of the mentioned

11. Suppose the language L1 has 2 L2 has 2 states. If we have a machine M that accepts L1∩L2. Then the total number of states in M is equal to_______

a. 2

b. 4

c. 6

d. 8

12. If L is a regular language, then (L')' U L will be:

a. L

b.

c.

d.

13. In Mealy machine, the output depends on______

a. Only present state

b. Present state and Present output

c. Nothing

d. Type of input

14. Strings x,y,z belongs to ∑* such that xz∈ L but yz∉ L where L ⊆∑* are:

a. indistinguishable

b. Undetermined

c. Both distinguishable and indistinguishable

d. Distinguishable

15. Melay machine to increase the output string in magnitude by 1 is called:

a. Complementing machine

b. Decrementing machine

c. Incrementing machine

d. Converting machine

16. Suppose we have FA3 (which is to FA1+FA2) then the final state of FA3 will be declared final if:

a. it corresponds to final states of both FA1 and FA2

b. it corresponds to final states FA1 only

c. it corresponds to final states FA2 only

d. It corresponds to any of the final states of FA1 or FA2

17. If we have the finite language and the number of states in the FA is n then the maximum number of letter in each word of the language that will be accepted by the given FA will be :

a. 1

b. n+1

c. n-1

d. n

18. Which of the following state is introduced while developing NFA for the closure of FA?

a. An initial state which should be final as well

b. simply an initial

c. Final states

d. An initial state with loop for all letters

19. Length of EVEN-EVEN language is_______

a. Odd

b. such language doesn't exist

c. Even

d. sometimes even & sometimes odd

20. If FA1 corresponds to (a+b)* then FA1 must accept_______ strings/strings.

a. No

b. Odd length

c. Every

d. Even length

21. In FA, initial stage is represented by :

a. leaveenth state empty

b. drawing a circle in that state

c. drawing '+'sign in transtate

d. Drawing an arrowhead before the state

22. Which one of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

a. Moore machine

b. Finite state machine

c. Mealy machine

d. Deterministic finite state machine

23. Length of machine "AbBAbcd" defined over ∑=(Ab,B,c,d) is_______.

a. three

b. four

c. five

d. six

24. An FA is a collection of:

a. Finite states , finite transition and finite input letters

b. infinite states , infinite transition and infinite input letters

c. Only finite states , finite transition

d. Only infinite states , infinite transition

25. Given the language L={ab, aa, baa}, which of the following strings are in L*?

i) abaabaaabaa
ii) aaaabaaaa
iii) baaaaabaaaab
iv) baaaaabaa

a. 1,2 & 3

b. 2, 3&4

c. 1,2 & 4

d. 1, 3&4

26. In the context to make NFA for the concentration of FA1 and FA2 (FA1 accepting null string) which of the following option is correct?

a. initial states in both FAs

b. FA2 having initial state only

c. FA2 having final state only

d. Final states in both FAs

27. Every ___ is a ___ as well, but the converse may not be true.

a. TG ,FA

b. TG, GTG

c. FA ,GTG

d. FA, TG

28. NFA with null string has ____ initial state(s).

a. One

b. Two

c. Three

d. Many

29. While finding RE corresponding to a TG, we connect the new start state with the old start state by____ transition.

a. a

b. b

c. Null

d. Re

30. If S=(x). then S* will be_____.

a. {^,x,xxx,xxxx,xxxx….}

b. {^,x,xxx,xxxx,xxxxx….}

c. {^,x,xx,xxx,xxxx….}

d. {^,x,xxxx,xxxxx,xxxxxx….}

31. The minimum length of string (except null string) of a language that starts and ends in the same letter will be:

a.1

b. 2

c.3

d. 4

32. If S={ab, bb} , then S* will not contain______.

a. abbbab

b. bbbbab

c. ababbb

d. bbba

33. Which of the following machine has only one initial state?

a. Moore machine

b. Finite state machine

c. Deterministic finite state machine

d. Non deterministic finite state machine

34. Which of the following diagram is very rigid in order to express any language?

a. TG

b NFA

c GTG

d FA

35. Let L be the language of all strings, defined over ∑ =(0,1), ending in 111. Which of the following strings are indistinguishable w.r.t L with z being 11?

a 111, 101

b 100, 101

c110, 101

d 010, 101

36. Mealy machine can have ______ final states.

a. One

b More than one but finite

c More than one but infinite

d. Zero

37. In Moore machine , output is produced over the change of:

a. transition

b. transition and states

c. States

d. None of the mentioned

38. Lets we have two regular expressions R1 ={xx+yy}and R2={x+y} . Which one of the following is the correct regular expression for the union of R1 and R2?

a. (xx +yy) (x +y)

b. (xx +yy) +(x +y)*

c. (xx+ yy) +(x+ y)

d. ((xx +yy)+(x+ y))*

39. FA corresponding to an NFA can be built by introducing a state corresponding to the combination of states, for a letter having

a. no transition at certain state

b. one transition at certain state

c. more than one transitions at certain state

d. none of the given options

40. The situation there is no way to leave after entry is called

a Davey John locker

b. initial state

c. finial state

d. non- final state

41. Which one of the following word is not accepted by the given regular expression?

a. aaabab

b. aaaababb

c. abbaab

d. aabbabb

42. According to the theory of automata, there are ________ types of languages.

a. one

b. Two

c. three

d. four

43. Which of the following word is not accepted by the given regular expression?

a. ababaaaab

b. bababbbba

c. baabaabba

d. abbaaabba

44. Regular languages are closed under the following operations.

a. Union only

b. Concatenation, closure only

c. Union, Concatenation and closure

d. Regular languages are not closed under any operation.

45. There can be more than ____ FA for a certain language but for ____FA there is only one language associated with it.

a. one, one AL-JUNAID INSTITUTE OF GROUP

b. one, two

c. two, three

d. two ,one

46. There is no compulsion that each state must have an on outdoing edge for every input variable in:

a. Finite automata

b. Transition graph

c. Both finite Automata and Transition Graph

d. Transition Table

47. FA is also called_____.

a. TG

b. GTG

c. NFA

d. DFA

48. If r1 and r2 are regular expressions then (r1*r2) is______

a. FA

b. RE (Regular expression

c. TG

d. GTG

49. Which of the following is the minimal number of states for a finite automaton accepting the language of all strings defined over any alphabet set?

a. 1

b. 2

c. 3

d. 4

50. Keeping view language of all strings ending with ‘a’ for which symbol we will take a loop on the final state of its transition diagram?

a. A

b. B

c. C

d. D

51. Which of the following statements is true about NFA with Null String?

a. Infinite state

b. Infinite set of letters

c. Infinite set of transitions

d. Transition of null string is allowed at any stage

52. Which one of the following diagrams expresses languages more simply?

a. FA

b. NFA

c. TG

d. GTG

53. The language of all strings defined over alphabet set={a,b} that does not end with 'a' actually end with:

a. a and ^

b. b

c. b and^

d ^

54. Let S={aa,bb}, then S* will have the _____ string.

a. abba

b. aabbbaa

c. bbaab

d. ^

55. Formal is also known as_____.

a. Syntactic language

b. Semantic language

c. informal language

d. none of these

56. There may be more than one transition for a certain letter on a state in:

a. Non-Deterministic finite automata

b. finite automata

c. transition table

d. Moore Machine

57. A loop at a state is supposed to be____ transition while converting Moore machine into an equivalent Maley machine.

a. incoming

b. outgoing

c. Both Incoming and incoming

d. Complex

58. FA of EVEN language shows null string when______.

a. initial state is final as well

b EVEN does not accept null

C One state is declared null

d. None of these

59. Which of the following statement is true about GTG?

a Transitions are based on input letters

b Transitions are based on specified substrings

c Transitions are based on regular expressions

d Transitions are based on alphabet set

60. Which of the following is the bypass and state elimination step in the context of Kleene's theorem part II proof?

a.1

b.2

c.3

d.4

61. Which of the following is free of non-determinism?

a. TG

b. NFA

c. NFA-^

d. FA

62. There is no question of accepting any language in:

a. FA

b. TG

c.GTG

d. Moore machine

63. A string will be accepted by an NFA if there exist_______one successful path.

a. Atmost

b. Maximum

c. atleast

d. None of these

64. Kleene's theorem part I expresses the relationship between_______

a. FA and TG

b. TG and RE

c. RE and FA

d. FAand RE

65. Keeping in view the discussion by Martin, how any states are required to recognize the language of all strings of length 2 or more defined over ∑={a,b} with 'b' being the second letter from right?

a. 6

b. 7

c. 8

d. 9

66. FA and _____ are same excepts that ______has unique symbol for each transition.

a. FA, TG

b. NFA, TG

c. GTG, NFA

d. NFA,FA

67. Subtraction of binary number is possible through.

a. Both complementing and incrementing machine

b. incrementing machine

c. complementing machine

d. Converting machine

68. Which of the following is the bypass and state elimination step in the context of Kleene's theorem part II proof?

a. 1

b. 2

c. 3

d. 4

69. Keeping in view the discussion by Martin, how any states are required to recognize the language of all strings of length 2 or more defined over ∑={a,b} with 'b' being the second letter from right?

a.6

b. 7

c. 8

d.9

70.let L be the language of all strings. Defined over ∑ (0,1) ,ending in 10.which of the following strings

Are indistinguishable with respect to L with z being 0

a.100.101

b.111.101

c. 110 .101

d.010.101

71.IF r1 =(aa +bb)and r2 =(a+ b) then the language(aa +bb)(a+ b) will be generated by ____________

a.(r1)(r2)

b.(r1 +r2)

c.(r2)(r1)

d.(r1)*

72. Indroducing new start state in case of multiple start states in the step no________ a.1

b.2

c.3

d.4

73 THE language having even number of a ‘ s and even number of b’ s defined over S=(a, b) is called____

a. EVEN-EVEN

B.ODD-ODD

c. PALINDROME

d. FACTORIAL

74 In NFA having no transition at certain state .FA can be build by introducing.

A .Empty state

b. Combination of states

c .initial state

d. final state

75 .for every three regular expressions R,S. and T. the languages denoted by R(S U T)and (RS)U(RT)are the_______

a .same

b. Different

c. R(SUT)is greater

d. none of the given options

76. Null strings can be specified on edges in:

a. Finite Automata

b Non-Deterministic Finite Automata

c. Melay Machine

d. Transition graph

77. What is false about the PLAINDROME LANGUAGE?

A Every word is reverse of itself.

B It is an infinite language.

C FA can be build for it.

D None of the given option

78. While finding RE corresponding to a TG, if TG has more than one start state then.

a Eliminate the old start state
b Replace the old start state with final state
c Replace the old final state with new start state

d. Introduce the new start state

79. All possible combination of string of a language including null string is referred as..

Kleene star closure of a languagec.

80.N! will be equal to:

c. n*(n-1)!cfd

81.Every NFA can be considered to be a____ as well, but the converse may not be true.

a. TG

b. FA

c. RE

d. GTG

82.In proving Kleene theorem II , if three statuses are connected then middle state is removed btconnecting first and third and writing corresponding RE in:

a.

b.

c. Concentration

d.

83.In ______ there must be transition for all the letters of the string.

a. NFA

b.GTG

c TG

d. FA AL-JUNAID INSTITUTE OF GROUP

84.For a given Moore Machine , the input string is '101010' , thus the output string would be of length:
a. |Input|
b. |Input-1|
c. Cannot be predicted
d. Length of input string+1

85.The FA can be drawn for the regular expression (a+b)* with minimum________ state(s).
a. 1
b.2
c. 3
d. 4

86.Which of the following does not contribute while finding out the length of strings?
^ ANSEWR

87.The language of all strings defined over alphabet set ={x,y} that ends with same letters will have the maximum length of:
a. Finate
b. non of these
c. Infinite
d. Equal

88.Considering FA1 and FA2 having 2 states each. Now FA1+FA2 can have maximum__________ number of states.
a. 2
b. 3
c. More than 3
d. Non of them

89.Which one of the following is RE for the language defined over ∑={a,b} having all the words starting with a?

a(a+b)*

90.An ________ can be considered to be an intermediate structure between finite automaton and transition graph.
a. RE
b. NFA
c. GTG
d. None

91.In order to make NFA for the union of FA1 and FA2, the new initial state should be liked to:
a. initial state of FA1 only
b. initial and final states of FA1 and FA2 respectively
c. final and initial states of FA1 and FA2 respectively
d. Initial states of both FAs

92.We cannot construct an NFA for the language of _______ defined over alphabet set{a,b}.
a. Palindromes
b. Even
c. Odd
d. Integers

93.The CFG is said to be ambiguous if there exist at least one word of its language that can be generated by the ……….. production trees
a. one
b. Two
c. More then one / Different
d. At most one

94.What do automata mean?
a. something done manually
b. something that works automatically / "something are done automatically
c. something done automatically

95.According to theory of automata there
a. 1
b. 2
c. 3

d. 4

96.The Minimum length of the string (except bull string) of a language that starts and ends in the same letters will be:

a.1

b. 2

c. 3

d. All of above

97. If S= {ab,bb} then S* will not contain_________

a. Babb

b. Bbb

c. Bbba

d abbb

98.Which of the following machines has only one initial state and no final state?

a. More machine

b. Finite state machine

c.Deterministic finite state machine

d.Non deterministic finite state machine

98.Which of the following machines has only one initial state and no final state?

a. More machine

b. Finite state machine

c.Deterministic finite state machine

d.Non deterministic finite state machine

99.Which of the following diagram is very rigid in order to express any language ?

a.TG

b.NFA-^

c.GTG

d.FA

100.If S={a},then S+will be______
a.{a,aa ,aaa , aaaa…}
b.{a,aa,aaa,aaaa…}

c.{a,aaa,aaaaa,aaaaaaa,…..}

d. {aa, aaaa,aaaaaa,aaaaaaaa,…}

101.Let L be the language of the all string defined over over$\sum = \{0,1\}$ ending in10. Which of the following string are indistinguishable with respect to L with z being 11?
a.111,101
b.001,101
c.010,101
d.111,111
102.Melay machine can have _____final state
1) Zero
2) One
3) More than one but finite
4) More than one but infinite

103.Given the Language L = {ab, aa,baa},which of the following string are in L*?
5) Abaabaaaabaa
6) Aaaabaaaa
7) Baaaaabaaaaab
8) Baaaabaa
 a)1,2 and 3
 b)2,3 and 4
 c)1,2 and 4

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d)1,3 and 4

104.If L1 and L2 are regular Language L1∩ $(L2 \cup L1)$ will be
a.non regular
b.may be regular
c. Regular
d.none of the mentioned
105.In Mealy Machine the out put depends on_______
a. state
b.previous state
c.state and input
d.only input
106.There is no question of accepting any language in.
a.Mealy machine
b. Moore Machine
c.Moore and mealy
d.none of these.ge
107.Thestate where there is no way to leave after entry is called___
a.Davey john Locker
b.Initial State

c.Final state

d.Non-final state

108.FA corresponding to an NFA can be built by introducing an empty state for a letter having
a.No transaction at certain state
b.More than one transition at certain state

c.None of the given option

109.Which of the following diagram express language more simply?
a.Tg
B.Gt
c.GTG
d.All of above
110.Automata is the plural of______
a.Auto
b. Automation

c.Meta
d.All of above

111.If A and B are regular Language !(A∪B) is
a.Regular
b.none regular
c.may be regular
d.none of the mentioned
112.In NFA having no transition at certain state FA can be built by introducing.
a. Empty state.
B.Final state
C.initial state
D none of these

113.Consuming FA1 and FA2 having 2 STATES each. Now FA1+FA2 can have maximum______number of state
a.2
b.3
c. More then 3
d. None of the given
114.In an FA when there is no path starting from initial state and ending state in final state then that FA______
a.Reject all
b. Accept all string
c.Reject and accept all
d.None of above
115.According to theory of automation there are_____type if language
a. Two
b.Three
c.One
d.Four
116.In Moore machine if the length of input string is 9 then the length of output string will be.
a.20
b.60
c.10

d.40

117.When ODD language is expressed by an FA,then it will have minimum ____ state

a. One

b TWO

c THREE

d FOUR

118.[(a+b)(a+b)]*.given RE contact generate the string________

a. aaabbbbccc

b. Bbbbbb

c. aabbcc

d aaabcbbcbacc

119.Which of the following state is true about GTG?

a. Transaction are based on regular expression

120.Every_____is a _____ as will, but the converts may not be true.

a. FA ,TG

b. TG RE

c. GTG

d TG

121.Which of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

a.TG andRE

b.REand FA

c.FA and RE

d. Mealy Machine

122.The recursive method for defining a language has ____ steps

a. two

b. Three

c. four

d. five

123.Consider the following RE.

.A(a+b)b*

All of the following word are accepted except______

A Aa

b.Aabb
c.Bbbba
d.None of these

124.Which of the following regular expression represented same language?

1. (a+ab)*
2. 2(ba+a)*
3. A*(aa*b)*
4. (a*b)*

a.2 and 1
b.3 and 2
c.1 and 2
d.3 and 4

125 For every there regular expression R,S and T the Language denoted by R(S∪T) and (RS) ∪(RT) are the

a.Different
b. Same
c.Equal
d.All of above

126 Alphabet S={a,bc,cc} has____number of letters.

a. two
b. three
c. four
d. five

127 An____can be considered to be an intermediate structure between Finite automation and Transition Graph.

a.FA
b.RE
cBoth a and b
d.NFA

128 Two FAs are said to be equivalent if they______

a.Simple langue
b.Accept different language
c. Accept same language

d. All of above

129 There may be more then one transition for a certain letter on a state in

a. Finite Automata

b.In finite automata

d. None of these

130 _____can also help in proving Kleene Theorem III.

A. RE

b.Rna

c.FA

d.NFA

131 Kleene Theorem Part II expression the relationship between____

a.TG and FA

b. TG and RE

c.TG and NFA

d.None of these

132 FA corresponding to an NFA can be built by introducing an empty state for a letter having.

a. No transition at certain state

b.Transition at certain state

c.Transition at final state

d. None of these

133 FA is also called

a.FA

b.RE

c. DFA

d.All of above

134 If two Res generated same language then these Res are called ____

a.Equivalent FA

b. Equivalent RE

c.Equivalent DFA

d.none of these

135 We cannot an NFA for the language of ____ defend over alphabet set{a,b}

Palindromes (**answer**)

136 Kleene Theorem Part II expression the relationship between____

a. RE and FA

b.DFA and RE

c.FA and DFA

d.None of these

137 Let FA3 an FA corresponding to FA1 FA2 then the initial state of FA3 must correspond to the initial state of

a.Dfa

b.FA2 only

c. FA1 only

ddnone of these

138 Every FA should be___

a.Simple

b.Accurate

c.Non-deterministic

d. Deterministic

139 The minimum length of string (except null string) of a language that starts and ends in the different letter will be:

a.2

b.3

c.4

d.1

140 Which of the following will be the final state of FA3 obtained from the union of FA1 and FA2?

a.Initial state

B.Final states of FA1 or FA2

c.Initial state of FA1 orFA 2

d.None of the given

141.In concatenation we accept the initial state of FA2 automatically after the final state of FA1 because of:

a.initial state

b.Final state

c.We need just one final state

d.We need just one initial state

142 Let FA1 accepts many strings and FA2 accepts none then FA1+FA2 will be equal to:

a. FA2-FA1 (ANSWER)

143 The language {a ab aba bab} is _____ .

a.Irregular

b.Normal

c. Regular

d.All of above

144 Decomposing a string into its valid units is referred as:

a.Customizing

b. Tokenizing

c. Decomposing

d. Splitting

145 Let FA3 be an FA corresponding to FA1+FA2, then the initial state of FA3Must corresponds to the initial state of

a.NFA

b.DFA

c.RE

d.FA1 or FA2

146 If FA1 corresponds to (a+b)* then FA1 must accept ___________ string/strings. Select correct option: No Oddlength

a.Some

b. EVERY

c.Just one

d.None of these

147 A regular language can be:

a. irregular

b. infinite

c. non-deterministic

d. None of the given options

148 N into its valid units is referred as:

d. Tokenizing

149 The strings of FA2 are accepted first before the strings of FA1

a.FA

b.NA

c. Palindromes

d.Non of these

150 There ______ a language for which only FA can be built but not the RE.

a.Is

b.Are

c.Be may

d.None of above

151 Kleene's Theorem part I expresses the relationship between ___

a.TG and Na

b.NA and FA

c.TG and TG

d. FA and TG

152 We can create an equivalent ___ for a language for which we create an ___

a.NA

b.NFA, FA

c.RNA

d.None of these

CS402 Theroy Of Automata Update MCQS For MidTerm Solve By Vu Topper RM

80 To 100% Marks

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Question No:1 **(Marks:1)** **Vu-Topper RM**

Σ={a,Aa,Abb}, then string aAaAbbAa has__length.

A. One
B. Two
C. Three
D. Four **Page 4**

Question No:2 **(Marks:1)** **Vu-Topper RM**

Languages generated by kleene star are always___.

A. Finite
B. Infinite **Page 7**
C. Sometimes finite & sometimes infinite
D. None of the these

Question No:3 **(Marks:1)** **Vu-Topper RM**

Let S = {aa, bb}, then S* will have the _______ string.

A. Λ **Page 7**
B. abba
C. aabbbaa
D. bbaab

Question No:4 **(Marks:1)** **Vu-Topper RM**

If r1 = (aa + bb) and r2 = (a + b) then the language (aa + bb)* will be generated by

A. (r1)(r2)
B. (r1 + r2)
C. (r2)*
D. (r1)* **Page 10**

Question No:5 **(Marks:1)** **Vu-Topper RM**

If a language can be expressed through FA, then it can also be expressed through TG.

A. True **Page 25**

B. False

Question No:6 **(Marks:1)** **Vu-Topper RM**

If an alphabet has n number of letter, then number of strings of length m will be

A. n+m
B. (n)(m)
C. m^n
D. n^m Page 6

Question No:7 **(Marks:1)** **Vu-Topper RM**

In GTG, if a state has more than one incoming transitions from a state. Then all those incoming transitions can be reduced to one transition using sign

A. -
B. + Page 27
C. *
D. ( )

Question No:8 **(Marks:1)** **Vu-Topper RM**

Above given FA accepts___strings defined over Σ={a , b}

A. All Page 15
B. Some
C. All but not null
D. None of these

Question No:9 **(Marks:1)** **Vu-Topper RM**

One FA has 3 states and 2 letters in the alphabet. Then FA will have _____number of transitions in the diagram

A. 4
B. 5
C. 7
D. 6 Page 14

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Question No:10 **(Marks:1)** **Vu-Topper RM**

Every FA should be

A. **Deterministic** **Page 25**
B. Non- Deterministic
C. Deterministic & Non- Deterministic
D. None of these

Question No:11 **(Marks:1)** **Vu-Topper RM**

Auto Meta mean

A. Manual work
B. **Automatic work** **Page 3**
C. Both
D. None of these

Question No:12 **(Marks:1)** **Vu-Topper RM**

NFA to FA will

A. **Equal** **Page 43**
B. Not equal
C. Not valid
D. None of given

Question No:13 **(Marks:1)** **Vu-Topper RM**

The length of output string in case of__is one more than the length of corresponding input string.

A. **Finite Automaton** **Page 55**
B. TG
C. GTG
D. NFA

Question No:14 **(Marks:1)** **Vu-Topper RM**

The_machine helps in building a machine that can perform the addition of binary numbers.

A. **Incrementing** **Page 60**

B. Complementing
C. Decrementing
D. None of the given

Question No:15 **(Marks:1)** **Vu-Topper RM**

In proving Kleene Theorem II, if a state has two incoming transition edges labelled by RE from the same state, then replace all the edges with a single transition edge labelled by ------- of corresponding RE.

A. Sum **Page 27**
B. Edge
C. FA
D. RE

Question No:16 **(Marks:1)** **Vu-Topper RM**

Kleene Theorem III states that if the language can be expressed by RE then there exist -------- accepting the language.

A. FA **Page 32**
B. DFA
C. NFA
D. None

Question No:17 **(Marks:1)** **Vu-Topper RM**

If L1 and L2′ are regular languages, L1 ∩ (L2′ U L1′)’ will be

A. Regular **Page 10**
B. Ir-regular
C. Can’t be decided
D. Another Language which is not listed here

Question No:18 **(Marks:1)** **Vu-Topper RM**

A regular language can be:

A. irregular
B. infinite
C. non-deterministic

D. **None of the given options**

Question No:19 **(Marks:1)** **Vu-Topper RM**

There ______ a language for which only FA can be built but not the RE.

A. is cannot be
B. may be
C. may not be

Question No:20 **(Marks:1)** **Vu-Topper RM**

For every three regular expressions R, S, and T, the languages denoted by R(S U T) and (RS) U (RT) are the ______ .

A. **Same**
B. Different
C. None of these

Question No:21 **(Marks:1)** **Vu-Topper RM**

In _______ there must be transition for all the lettersof a string.

A. NFA
B. GTG
C. TG
D. FA

Question No:22 **(Marks:1)** **Vu-Topper RM**

We cannot construct an NFA for the language of ______ defined over alphabet set {a,b}.

A. Even
B. odd
C. Palindromes
D. Integers

Question No:23 **(Marks:1)** **Vu-Topper RM**

Decomposing a string into its valid units is referred as:

A. Decomposing

B. Splitting
C. Tokenizing
D. Dividing

Question No:24 **(Marks:1)** **Vu-Topper RM**
Choose the correct word produced by RE (a + b)* (aa+bb).
A. Abab
B. Babab
C. aaaa
D. Ab

Question No:25 **(Marks:1)** **Vu-Topper RM**
Considering FA1 and FA2 having 2 states each. Now FA1+FA2 can have maximum _______________ number of states.
A. 2
B. 3
C. more than 3
D. None of these

Question No:26 **(Marks:1)** **Vu-Topper RM**
If R is a regular language and L is some language, and L U R is a ________, then L must be a _________.
A. Regular language
B. Finite Auto

Question No:27 **(Marks:1)** **Vu-Topper RM**
The minimum length of the strings(except null string) of a language that starts and ends in different letters will be:
A. 1
B. 2
C. 3
D. 4

Question No:28 (Marks:1) Vu-Topper RM

Consider we have languages L7 and L6. Which of the following represents their concatenation?

A. **L7+L6**
B. L7/L6
C. L6L7
D. L7L6

Question No:29 (Marks:1) Vu-Topper RM

Let FA1 has x number of states and FA2 has y number of states. Now FA1+FA2 can have maximum **_______________ number of states.**

A. x+y
B. x-y
C. x/y
D. **None**

Question No:30 (Marks:1) Vu-Topper RM

The language {a ab aba bab} is _____ .

A. Irregular
B. **Regular**
C. Recursive
D. None of the given options

Question No:31 (Marks:1) Vu-Topper RM

If we have a finite language and the number of states in the FA is n then the maximum number of letters in the each word of the language that will be accepted by the given FA will be:

A. N
B. **n-1**
C. n+1
D. 1

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Question No:32 **(Marks:1)** **Vu-Topper RM**

Moore machine can have -------- final states.

A. 2
B. 4
C. 6
D. 8

Question No:33 **(Marks:1)** **Vu-Topper RM**

There ________ be dead states in NFA.

A. may not
B. must
C. should not
D. will

Question No:34 **(Marks:1)** **Vu-Topper RM**

Let L be the language of all strings, defined over $\Sigma = \{0,1\}$, ending in 10. Which of the following strings are distinguishable with respect to L with z being 0?

A. 010, 101
B. 111, 101
C. 001, 101
D. 111, 111

Question No:35 **(Marks:1)** **Vu-Topper RM**

There _____ be a unique path for each valid string (called a word) in NFA.

A. May not
B. Must
C. Should not
D. Will

Question No:36 **(Marks:1)** **Vu-Topper RM**

If we have only one state, having no transition for input letters, then it is an example of:

A. RE
B. FA
C. TG
D. NFA

Question No:37 (Marks:1) Vu-Topper RM
Strings x,y,z belongs to Σ * such that xz $\in$ L but yz $\notin$ L where L $\subseteq$ Σ^* are:
A. Undetermined
B. Distinguishable
C. Indistinguishable
D. Both distinguishable and indistinguishable

Question No:38 (Marks:1) Vu-Topper RM
A ________ with "n" states must accept at least one string of length greater than "n".
A. DFA
B. RE
C. Irregular language
D. Irrelevant language

Question No:39 (Marks:1) Vu-Topper RM
In Moore machine, output is produced over the change of:
A. Transitions
B. Transitions and states
C. None of the mentioned
D. States

Question No:40 (Marks:1) Vu-Topper RM
Keeping in view the discussion by Martin, how many states are required to recognize the language of all strings of length 3 or more defined over $\sum$= {a,b}, with ‘a’ being the third letter from right?
A. 10

B. 12
C. 14
D. 16

Question No:41 (Marks:1) Vu-Topper RM
Every ________ can be considered to be _______ as well, but the converse may not be true.
A. TG, FA Page 19
B. GTG
C. PDA
D. FA, TG

Question No:42 (Marks:1) Vu-Topper RM
In the context of make NFA for the concatenation of FA1 and FA2 (Both FAs accepting null string), which of the following option is correct?
A. Final states in both FAs
B. Initial states in both FAs
C. FA2 having initial state only
D. FA2 having final state only

Question No:43 (Marks:1) Vu-Topper RM
In order to make NFA for the union of FA1 and FA2, the new initial state should be linked to:
A. Initial states of both FAs
B. Initial and final states of FA1 and FA2 respectively
C. Initial state of FA1 only
D. Final and initial states of FA1 and FA2 respectively

Question No:44 (Marks:1) Vu-Topper RM
Keeping in view the discussion by Martin, how many states are required to recognize the language of all strings of length 2 or more defined over ∑= {a,b}, with ‘b’ being the second letter from right?
A. 9

B. 6
C. 7
D. 8

Question No:45 (Marks:1) Vu-Topper RM

If we have an NFA having 3 states, and we convert that NFA to an FA. The resultant FA will contains _______ states.

A. 1
B. 2
C. 3
D. 4

Question No:46 (Marks:1) Vu-Topper RM

Let FA3 be an FA corresponding to FA1FA2, then initial state of FA3 must correspond to the initial state of

A. FA1 only
B. FA2 only
C. FA1 and FA2
D. FA1 or FA2

Question No:47 (Marks:1) Vu-Topper RM

In which of the following machine, the length of output string is the same to that of input string?

A. Mealy machine
B. Moore machine
C. Finite automaton with output
D. Non-deterministic finite automaton

Question No:48 (Marks:1) Vu-Topper RM

Moore Machine is an application of:

A. Finite automata with output
B. Finite automata with input
C. None

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Question No:49 (Marks:1) Vu-Topper RM

In NFA having multiple transitions at certain state, FA can be built by introducing:

A. **Empty state**
B. Combination of states
C. Initial state
D. Final state

Question No:50 (Marks:1) Vu-Topper RM

In Mealy machine the output depends on ___________________

A. **Present state and Present input**
B. Only present state
C. Nothing
D. Type of input

Question No:51 (Marks:1) Vu-Topper RM

If L is a regular language, then (L')' U L will be:

A. **L**
B. C
C. P
D. F

Question No:52 (Marks:1) Vu-Topper RM

A string will be accepted by an NFA if there exists _______ one successful path.

A. **Atleast**
B. Atmost
C. Maximum
D. None of the given options

Question No:53 (Marks:1) Vu-Topper RM

If A and B are regular languages, !(A' U B') is:

A. Non regular

B. May be regular
C. None of the mentioned
D. Regular

Question No:54 **(Marks:1)** **Vu-Topper RM**
There is no question of accepting any language in:
A. Moore machine
B. FA
C. TG
D. GTG

Question No:55 **(Marks:1)** **Vu-Topper RM**
In _______ there must be transitions for all the alphabets over which a language is defined.
A. FA
B. TG
C. NFA
D. GTG

Question No:56 **(Marks:1)** **Vu-Topper RM**
Let FA3 be an FA corresponding to FA1FA2, then final state of FA3 must correspond to the final state of
A. FA2 only
B. FA1 only
C. FA1 or FA2
D. FA1 and FA2

Question No:57 **(Marks:1)** **Vu-Topper RM**
How many new states are introduced while developing NFA for the closure of an FA?
A. 2
B. 4
C. 6

D. 8

Question No:58 **(Marks:1)** **Vu-Topper RM**

Subtraction of binary numbers is possible through:

A. Both complementing and incrementing machine
B. Complementing machine
C. Incrementing machine
D. Converting machine

Question No:59 **(Marks:1)** **Vu-Topper RM**

For a given Moore Machine, the input string is '101010', thus the output string would be of length:

A. Length of input string + 1
B. Length of input string – 1
C. Length of input string + 2
D. Length of input string -2

Question No:60 **(Marks:1)** **Vu-Topper RM**

Which one of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

A. Mealy machine
B. Moore machine
C. Finite state machine
D. Deterministic finite state machine

Question No:61 **(Marks:1)** **Vu-Topper RM**

If FA1 corresponds to (a+b)* then FA1 must accept ___________ string/strings.

A. No
B. Odd length
C. Even length
D. Every

Question No:62 (Marks:1) Vu-Topper RM

Closure of an FA is the same as ___________ of an FA with itself except that the initial state of the required FA is a final state as well.

A. Sum
B. Union
C. Intersection
D. Concatenation

Question No:63 (Marks:1) Vu-Topper RM

Given the language L = {ab, aa, baa}, which of the following strings are inL*?

abaabaaabaa
aaaabaaaa
baaaaabaaaab
baaaabaa

A. 1, 2 and 3
B. 2, 3 and 4
C. 1, 2 and 4
D. 1, 3 and 4

Question No:64 (Marks:1) Vu-Topper RM

FA and _______ are same except that _______ has unique symbol for each transition.

A. FA,TG
B. NFA,TG
C. NFA,FA
D. GTG,NFA

Question No:65 (Marks:1) Vu-Topper RM

How many states of a finite automaton will be final for accepting the only string 'abb', if Σ= {a, b}?

A. 1

B. 2
C. 3
D. 4

Question No:66 (Marks:1) Vu-Topper RM

Two machines are said to be equivalent if they print the_output string when the__input string is run on them.

A. Same, Same
B. Same, different
C. Different, same
D. Unique, different

Question No:67 (Marks:1) Vu-Topper RM

Every NFA can be considered to be a - as well, but the converse may not be true.

A. TG
B. FA
C. GTG
D. PDA

Question No:68 (Marks:1) Vu-Topper RM

In which of the following machine, the length of output string is 1 more than that of input string?

A. Mealy machine
B. Non-deterministic finite automaton
C. Finite automaton with output
D. Moore machine

Question No:69 (Marks:1) Vu-Topper RM

If S = {aa, bb} then S* will not contain ___________.

A. abbbab
B. bbba
C. bbbbab

D. ababbb

Question No:70 (Marks:1) Vu-Topper RM

Which of the following machine has only one initial state and no final state?

A. Moore machine
B. Finite state machine
C. Deterministic finite state machine

Question No:71 (Marks:1) Vu-Topper RM

Which of the following diagram is very rigid in order to express any language?

A. TG
B. NFA
C. GTG
D. FA

Question No:72 (Marks:1) Vu-Topper RM

If S = {a}, then S+ will be

A. {a, aaa, aaaa, aaaaa,…}
B. {a, aa, aaa, aaaa,…}
C. {a, aaa, aaaaa, aaaaaaa,…}
D. {aa, aaaa, aaaaaa, aaaaaaaa,…}

Question No:73 (Marks:1) Vu-Topper RM

Let L be the language of all strings. defined over ∑ = {0,1}. ending in 111. Melay machine can have final states.

A. Zero
B. One
C. More than one but finite
D. More than one but infinite

Question No:74 (Marks:1) Vu-Topper RM

Let's we have two regular expressions R1=(xx+yy) and R2=(x+ y). Which one of the following is the correct regular expression for the Union of R1 and R2?

A. (xx+yy)(x+y)
B. (xx+yy)+(x+y)*
C. (xx+yy)+(x+y)
D. ((xx+yy)+(x+y))*

Question No:75 (Marks:1) Vu-Topper RM

The state where there is no way to leave after entry, is called _____________.

A. Davey John locker
B. initial state
C. final state
D. non-final state

Question No:76 (Marks:1) Vu-Topper RM

Which one of the following word is not accepted by the given regular expression?

A. aaabab
B. aaaababb
C. abbaab
D. aabbabb

Question No:77 (Marks:1) Vu-Topper RM

According to theory of automata there are___types of languages

A. One
B. Two
C. Three
D. Four

Question No:78 (Marks:1) Vu-Topper RM

Regular languages are closed under the following operations.

A. Union only
B. Concatenation, Closure only
C. Union, Concatenation and Closure

Question No:79 (Marks:1) Vu-Topper RM

Regular languages are closed under the following operations.

A. Union only
B. Concatenation, Closure only
C. Union, Concatenation and Closure
D. Regular languages are not closed under any operation

Question No:80 (Marks:1) Vu-Topper RM

There can be more than____FA for a certain language but for_FA there is only one language associated with it:

A. one, one
B. one, two
C. two, three
D. two, one

Question No:81 (Marks:1) Vu-Topper RM

There is one compulsion that each state must have an on outgoing edge forevery input variable in:

A. Finite Automata
B. Transition Graph
C. Both Finite Automata and Transition Graph
D. Transition Table

Question No:82 (Marks:1) Vu-Topper RM

FA is also called

A. TG
B. GTG

C. NFA
D. DFA

Question No:83 (Marks:1) Vu-Topper RM
If r1 and r2 are regular expressions then (r1 * r2) is ___________ .
A. FA
B. TG
C. GTG
D. RE

Question No:84 (Marks:1) Vu-Topper RM
Keep in view the language of all strings ending with ‘a’ defined over Σ = {a, b, c, d}. For which input letter, we will take a loop on the final state of its transition diagram?
A. a
B. b
C. c
D. d

Question No:85 (Marks:1) Vu-Topper RM
Which of the following statements is true about NFA with Null String?
A. Infinite states
B. Infinite set of letters
C. Infinite set of transitions
D. Transition of null string is allowed at any stage

Question No:86 (Marks:1) Vu-Topper RM
Introducing new start state in case of multiple start states is the step no. of proving Kleene’s theorem part ||.
A. 1
B. 2
C. 3
D. 4

Question No:87 (Marks:1) Vu-Topper RM

Which of the following diagrams expresses languages more simply?

A. FA
B. NFA
C. TG
D. GTG

Question No:88 (Marks:1) Vu-Topper RM

The language of all strings defined over alphabet set = {a, b} that does not end with ‘a’ actually ends with:

A. b
B. b and ^
C. ^
D. ^ and a

Question No:89 (Marks:1) Vu-Topper RM

In NFA having no transition at certain state, FA can be built by introducing:

A. Empty state
B. Combination of states
C. Initial state
D. Final state

Question No:90 (Marks:1) Vu-Topper RM

Formal is also known as

A. Syntactic language
B. Semantic language
C. Informal language
D. None of these

Question No:91 (Marks:1) Vu-Topper RM

There may be more than one transition for a certain letter on a state in:

A. Finite automata

B. **Non-Deterministic Finite Automata**
C. Transition Table
D. Moore Machine

Question No:92 (Marks:1) Vu-Topper RM
FA of EVEN language shows null string when
A. **Initial state is final as well**
B. EVEN does not accept null
C. One state is declared null
D. None of the these

Question No:93 (Marks:1) Vu-Topper RM
Which of the following statement is true about GTG?
A. Transitions are based on input letters
B. Transitions are based on specified substrings
C. **Transitions are based on regular expressions**
D. Transitions are based on alphabet set

Question No:94 (Marks:1) Vu-Topper RM
In GTG, there can be more than one:
A. Start state
B. Final state
C. **Start state and final state**
D. Null state

Question No:95 (Marks:1) Vu-Topper RM
GTG for the expression (aa+aba)* may have minimum number of states:
A. **1**
B. 2
C. 3
D. 4

Question No:96 **(Marks:1)** **Vu-Topper RM**

In regular expressions, the operator '*' stands for

- **A. Concatenation**
- B. Iteration
- C. Selection
- D. Add

Question No:97 **(Marks:1)** **Vu-Topper RM**

If r1 is a regular expression then (r1)* is____.

- A. A generalized transition graph
- B. A non-deterministic finite automaton
- C. A finite automaton
- **D. Also, a regular expression**

Question No:98 **(Marks:1)** **Vu-Topper RM**

Which of the following is the bypass and state elimination step in the context of Kleene's theorem part || proof?

- A. 1
- B. 2
- C. 3
- **D. 4**

Question No:99 **(Marks:1)** **Vu-Topper RM**

Which of the following is free of non-determinism?

- A. TG
- **B. FA**
- C. NFA
- D. NFA-^

Question No:100 **(Marks:1)** **Vu-Topper RM**

Melay machine to increase the output string in magnitude by 1 is called:

- A. Complementing machine
- **B. Incrementing machine**

C. Decrementing machine
D. Converting machine

Question No:101 **(Marks:1)** **Vu-Topper RM**

Kleene's Theorem Part I expresses the relationship between________.

A. FA and TG
B. TG and RE
C. RE and FA
D. FA and RE

Question No:102 **(Marks:1)** **Vu-Topper RM**

Suppose we have FA3 (which is equal to FA1 + FA2), then the final state of FA3 will be declared final if:

A. It corresponds to final states of both FA1 and FA2
B. It corresponds to final states of FA1 only
C. It corresponds to final states of FA2 only
D. It corresponds to any of the final states in FA1 or FA2

Question No:103 **(Marks:1)** **Vu-Topper RM**

Null strings can be specified on edges in:

A. Finite Automata
B. Non-Deterministic Finite Automata
C. Transition Graph
D. Melay Machine

Question No:104 **(Marks:1)** **Vu-Topper RM**

What is false about the PALINDROME LANGUAGE?

A. Every word is reverse of itself.
B. It is an infinite language.
C. FA can be build for it.
D. None of the given option

Question No:105 **(Marks:1)** **Vu-Topper RM**

While finding RE corresponding to TG, If TG has more than one startstate then

A. Introduce the new start state
B. Eliminate the old start state
C. Replace the old start stat with final state
D. Replace the old final state with new start state

Question No:106 **(Marks:1)** **Vu-Topper RM**

All possible combinations of strings of a language including null string is referred as:

A. Concatenation of a language with itself
B. Kleene star closure of a language
C. Multiplication of language with itself
D. Addition of a language with itself

Question No:107 **(Marks:1)** **Vu-Topper RM**

n! will be equal to:

A. n*n
B. n*(-n)!
C. n*(n-1)
D. n*(n-1)!

Question No:108 **(Marks:1)** **Vu-Topper RM**

While finding RE corresponding to a TG, we connect the new start state with the old start state by___transition.

A. a
B. b
C. Null
D. RE

Question No:109 **(Marks:1)** **Vu-Topper RM**

In proving Kleene Theorem II, if three states are connected then middle state is removed by connecting first and third state and writing corresponding RE in:

A. Sum
B. Concatenation
C. Difference
D. Asterisk

Question No:110 (Marks:1) Vu-Topper RM

In___there must be transition for all the letters of a string.

A. NFA
B. GTG
C. TG
D. FA

Question No:111 (Marks:1) Vu-Topper RM

There is no question accepting any language in:

A. FA
B. TG
C. GTG
D. Moore machine

Question No:112 (Marks:1) Vu-Topper RM

The FA can be drawn for the regular expression (a+b)* with minimum state(s).

A. 1
B. 2
C. 3
D. 4

Question No:113 (Marks:1) Vu-Topper RM

Which of the following does not contribute while finding out the length of strings?

A. ^

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B. a
C. b
D. a+b

Question No:114 (Marks:1) Vu-Topper RM

The language of all strings defined over alphabet set = {x, y} that ends with same letters will have the maximum length of:

A. 1
B. 2
C. 3
D. Infinite

Question No:115 (Marks:1) Vu-Topper RM

Considering FA1 and FA2 states each. Now FA1+FA2 can have maximum_number of states.

A. 2
B. 3
C. More than 3
D. None of the given option

Question No:116 (Marks:1) Vu-Topper RM

Which one of the following is the RE for the language defined over ∑= {a,b} having all the words starting with a?

A. (a + b)*
B. aa(a + b)+
C. a(a + b)*
D. a*(a + b)

Question No:117 (Marks:1) Vu-Topper RM

An__can be considered to be an intermediate structure between Finite automaton and Transition Graph.

A. RE
B. GTG

C. NFA
D. None of the given options

Question No:118 (Marks:1) Vu-Topper RM
Suppose a language L1 has 2 states and L2 has2 states. If we have a machine M that accepts L1 ∩ L2. Then, the total number of states in M is equal to
A. 2
B. 4
C. 6
D. 8

Question No:119 (Marks:1) Vu-Topper RM
FA corresponding to an NFA can be built by introducing an empty state fora letter having
A. No transition at certain state
B. One transition at certain state
C. Two transitions at certain state
D. More than two transitions at certain state

Question No:120 (Marks:1) Vu-Topper RM
Automata is the plural of___.
A. Automate
B. Automaton
C. Automation
D. Automatic

Question No:121 (Marks:1) Vu-Topper RM
In NFA having no transition at certain. FA can be built by introducing:
A. Empty state
B. Combination of states
C. Initial state
D. Final state

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Question No:122 **(Marks:1)** **Vu-Topper RM**

If S = { x }, then S* will be ____________.

A. {^,x,xxx,xxxx,xxxxx,…}
B. {^,x,xx,xxx,xxxx,…}
C. {^,x,xxx,xxxxx,xxxxxxx,…}
D. {^,xx,xxxx,xxxxxx,xxxxxxxx,…}

Question No:123 **(Marks:1)** **Vu-Topper RM**

In TG, the string is supposed to be ______________ if there is no path for a string from initial to final state.

A. Accept null string
B. Accept all strings
C. Accept all non-empty strings
D. Does not accept any string

Question No:124 **(Marks:1)** **Vu-Topper RM**

In Moore machine, if the length of input string is 9, then the length of output string will be:

A. 7
B. 8
C. 9
D. 10

Question No:125 **(Marks:1)** **Vu-Topper RM**

When ODD language is expressed by an FA, then it will have minimum states.

A. One
B. Two
C. Three
D. Four

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Question No:126 **(Marks:1)** **Vu-Topper RM**

[(a + b)(a + b)]*, given RE cannot generate the string __.

A. abbaabab
B. abbbaa
C. bbbbbb
D. abbbaaaaa

Question No:127 **(Marks:1)** **Vu-Topper RM**

The recursive method for defining a language has_steps.

A. One
B. Two
C. Three
D. Four

Question No:128 **(Marks:1)** **Vu-Topper RM**

Consider the following RE:
a(a + b)b*
All of the following words are accepted except___.

A. aab
B. abb
C. aa
D. aba

Question No:129 **(Marks:1)** **Vu-Topper RM**

For every three regular expressions R, S, T, the languages denoted byR(S U T) and (RS) U (RT) are the____.

A. Same
B. Different
C. R(S U T) is greater
D. None of the given options

Question No:130 **(Marks:1)** **Vu-Topper RM**

Alphabet S = {a, bc, cc} has_____number of letters.

A. One
B. Two
C. Three
D. Four

Question No:131 (Marks:1) Vu-Topper RM
Two FAs are said to be equivalent, if they
A. Accept null string
B. Accept same language
C. Accept different language
D. None of the given options

Question No:132 (Marks:1) Vu-Topper RM
_____can also help in proving Kleene Theorem III.
A. NFA
B. PDA
C. Moore machine
D. Melay machine

Question No:133 (Marks:1) Vu-Topper RM
Kleene’s Theorem Part II expresses the relationship between _____.
A. FA and TG
B. TG and RE
C. RE and FA
D. FA and RE

Question No:134 (Marks:1) Vu-Topper RM
If two RE’s generate same language then these RE’s are called____.
A. Same RE
B. Equal RE
C. Similar RE
D. Equivalent RE

Question No:135 **(Marks:1)** **Vu-Topper RM**

Every FA should be__.

A. **Deterministic**
B. Non-deterministic
C. Deterministic and non-deterministic
D. Not depends on language

Question No:136 **(Marks:1)** **Vu-Topper RM**

What statement is true?

A. **A letter is always a combination of symbols**
B. A letter may consist of one symbol
C. There is no difference between symbol and letter
D. Letters and symbols are the same thing

Question No:137 **(Marks:1)** **Vu-Topper RM**

If ∑= {ab, bb}, then ∑* will not contain

A. abbbab
B. **bbba**
C. bbbbab
D. ababbb

Question No:138 **(Marks:1)** **Vu-Topper RM**

Choose the correct word produced by RE (a + b)* ab

A. abb
B. **abab**
C. bbbb
D. aaaa

Question No:139 **(Marks:1)** **Vu-Topper RM**

According to 1st part of the Kleene's theorem, If a language can be accepted by an FA then it can be accepted by a___as well

A. FA
B. CFG

C. GTG
D. TG

Question No:140 (Marks:1) Vu-Topper RM
“One language can be expressed by___GTG”.
A. Only one
B. Only two
C. **More than one**

Question No:141 (Marks:1) Vu-Topper RM
If a TG has more than one start states, then we can make a single startstate by introducing a new state and connecting it with all the previously existing start states by using.
A. Any infinite string
B. Single letter string
C. Null string
D. Any finite string

Question No:142 (Marks:1) Vu-Topper RM
If in a NFA, ^ is allowed to be a label of an edge then that NFA iscalled _____.
A. TG
B. RE
C. NFA with null string
D. RE

Question No:143 (Marks:1) Vu-Topper RM
If we want to make a Moore machine equivalent to mealy machinethen
A. We should ignore the extra character printed by the Moore machine.
B. We should ignore the extra character printed by the Mealy machine.
C. We will make the initial state as a no carry state.
D. We should not ignore the extra character printed by the Moore

machine.

Question No:144 **(Marks:1)** **Vu-Topper RM**

Two machines are said to be equivalent if they print the_output string when same input string is run no them.

A. Same
B. Different
C. Inverse
D. Null

Question No:145 **(Marks:1)** **Vu-Topper RM**

The length of output in case of___is one more than the length of corresponding input string

A. Moore machine
B. Mealy machine
C. Incremental machine
D. Adding machine

Question No:146 **(Marks:1)** **Vu-Topper RM**

A is not a valid transition in

A. TG
B. GTG
C. NFA
D. RE

Question No:147 **(Marks:1)** **Vu-Topper RM**

Dead states are also called

A. John Davey Lockers
B. Davey John Lockers
C. Mutex Lockers
D. Semaphores

Question No:148 **(Marks:1)** **Vu-Topper RM**

Language of all strings whose length is odd and number of y's even defined over alphabet set ∑ = {x, y} ._will be accepted by the given language.

A. xxyxyxyyyx
B. xxyxyxyyyxy
C. xxyxyxyyyxx
D. xxyxyxyyy

Question No:149 **(Marks:1)** **Vu-Topper RM**

If an effectively solvable problem has answer in Yes or NO. then the solution is called

A. Infinite problem
B. Decision procedure
C. Finite solution
D. Optimal procedure

Question No:150 **(Marks:1)** **Vu-Topper RM**

If the intersection of two regular languages is regular then thecomplement of the intersection of these two languages is

A. Regular
B. Irregular
C. Irregular but finite
D. Irregular but infinite

Question No:151 **(Marks:1)** **Vu-Topper RM**

If R is regular language and Q is any language (regular/non-regular). Then Pref(_in___) is regular.

A. Q, Q
B. Q, R
C. R, Q
D. R, R

Question No:152 (Marks:1) Vu-Topper RM

The strings or words which do not belong to a language are called of that language

A. Intersection
B. Union
C. Complement
D. Quotient

Question No:153 (Marks:1) Vu-Topper RM

Prime is a_language.

A. Finite
B. Both context free and regular
C. Regular
D. Non-regular

Question No:154 (Marks:1) Vu-Topper RM

Finite Automaton (FA) must have____number of states while alanguage has__words.

A. Infinite, finite
B. Finite, finite
C. Finite, infinite
D. Infinite, infinite

Question No:155 (Marks:1) Vu-Topper RM

The language “PRIME” is an example of___language.

A. Regular but finite
B. Regular
C. Non regular but finite
D. Non regular

Question No:156 (Marks:1) Vu-Topper RM

If L1 and L2 are regular languages then which statement is NOT true?

A. L1 + L2 is always regular

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B. L1 L2 is always regular
C. L1/L2 is always regular
D. L1* is always regular

Question No:157 (Marks:1) Vu-Topper RM

If a language is regular it must generate_____number of distinctclasses.

A. Finite
B. Infinite
C. Two
D. three

Question No:158 (Marks:1) Vu-Topper RM

The operators like (* . +) in the parse tree are considered as

A. Terminals
B. Non-terminals
C. Productions
D. Intermediates

Question No:159 (Marks:1) Vu-Topper RM

Set of all palindromes over {a,b} is:

A. Regular
B. Regular and finite
C. Regular and infinite
D. Non-regular

Question No:160 (Marks:1) Vu-Topper RM

Which one of the following languages is a non-regular language?

A. Even-even
B. Containing double a
C. Start and end with same letter
D. Palindrome

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Question No:161 **(Marks:1)** **Vu-Topper RM**

The language of all strings partition ∑* into_class(es).

A. One
B. Two
C. Three
D. Four

Question No:162 **(Marks:1)** **Vu-Topper RM**

The language of all strings not beginning with ‘b’ partitions ∑* into distinct classes.

A. Two
B. Three
C. Four
D. Five

Question No:163 **(Marks:1)** **Vu-Topper RM**

The values of input (say a & b) do not remain same in one cycle dueto

A. NAND gate
B. Clock pulse
C. OR gate
D. NOT gate

Question No:164 **(Marks:1)** **Vu-Topper RM**

In a CFG, the non-terminals are denoted by

A. Small letters
B. Numbers
C. Capital letters
D. Small letters and numbers

Question No:165 **(Marks:1)** **Vu-Topper RM**

a* + b* = (a + b)* this expression is

A. True
B. False

Question No:166 **(Marks:1)** **Vu-Topper RM**

Length of EVEN-EVEN language is

A. **Even**
B. Odd
C. Sometimes even & sometimes odd
D. Such language doesn't exist

Question No:167 **(Marks:1)** **Vu-Topper RM**

While finding RE corresponding to TG, we connect the new start stateto the old start state by the transition labeled by

A. a
B. b
C. null
D. **none of the given options**

Question No:168 **(Marks:1)** **Vu-Topper RM**

Given S, Kleene star closure is denoted by

A. **S***
B. S+
C. S-
D. None of these

Question No:169 **(Marks:1)** **Vu-Topper RM**

Which of the following steps replaces multiple incoming transitionedges with a single one in proving Kleene's theorem part ||?

A. 1
B. 2
C. 3
D. **4**

Question No:170 **(Marks:1)** **Vu-Topper RM**

If r1 = (aa + bb) and r2 = (a + b) then the language (aa + bb)(a + b)will be generated by

- **A. (r1)(r2)**
- B. (r1 + r2)
- C. (r2)(r1)
- D. (r1)*

Question No:171 (Marks:1) Vu-Topper RM

The language having even number of a's and even number of b's defined over S = {a, b} is called _______________.

- **A. EVEN-EVEN**
- B. ODD-ODD
- C. PALINDROME
- D. FACTORIAL

Question No:172 (Marks:1) Vu-Topper RM

If L1' and L2' are regular languages. Then L1,L2 will be

- **A. Regular**
- B. Non regular
- C. May be regular
- D. None of the mentioned

Question No:173 (Marks:1) Vu-Topper RM

f FA1 corresponding to (a+b)* then FA1 must accept string/strings

- A. No
- B. Odd length
- C. Even length
- **D. Every**

Question No:174 (Marks:1) Vu-Topper RM

In FA, initial state can be represented by:

- **A. Drawing an arrow head before that state**
- B. Drawing a circle in that state

C. Drawing '+' sign in that state

Question No:175 **(Marks:1)** **Vu-Topper RM**

An FA is a collection of:

A. Finite states, finite transition and finite input letters
B. Infinite states, infinite transition and infinite input letters
C. Only finite states and finite transitions
D. Only infinite states and infinite transitions

Question No:176 **(Marks:1)** **Vu-Topper RM**

NFA with null string has   initial state(s)

A. One
B. Two
C. Four
D. Three

Question No:177 **(Marks:1)** **Vu-Topper RM**

The difference between number of states with regular expression (a +b) and (a + b)* is:

A. 0
B. 1
C. 2
D. 3

Question No:178 **(Marks:1)** **Vu-Topper RM**

A transition graph is converted into a(n)____in order to obtain regular expression.

A. FA
B. GTG
C. NFA
D. NFA

Question No:179 **(Marks:1)** **Vu-Topper RM**

Consider the languages L1 = and L2 = {a}. Which one of the following represents L1 L2* ∪ L1*

A. ^
B. a*
C. All of the mentioned
D. None of the mentioned

Question No:180 **(Marks:1)** **Vu-Topper RM**

If S = {a, b} then which of the following RE will generate all possible strings?

A. a* + b*
B. (ab)*
C. (a + b)*
D. (ab + ba)*

Question No:181 **(Marks:1)** **Vu-Topper RM**

In drawing FA3 (which is equal to FA1 + FA2), a state will bedeclared final if

A. It corresponds to final states of both FA1 and FA2
B. It corresponds to final states of FA1
C. It corresponds to final states of FA2
D. It corresponds to any of the final states in FA1 or FA2

Question No:182 **(Marks:1)** **Vu-Topper RM**

Let S = {a, bb, bab, baabb} be a set of strings, which one of the following will not be included in S*?

A. baba
B. baabbabb
C. bbaaabb
D. bbbaabaabb

Question No:183 **(Marks:1)** **Vu-Topper RM**

The length of string "AbBAbcd" defined over Σ ={Ab,B,c,d} is ___.

A. One
B. Two
C. Five
D. Four

Question No:184 **(Marks:1)** **Vu-Topper RM**

In case of finite automaton there ________ be a transition on each ________ for every letter of the alphabet set.

A. Must, state
B. May be, state
C. Often, edge
D. Must, edge

Question No:185 **(Marks:1)** **Vu-Topper RM**

Which one of the following word is not accepted by the given regular expression?

(a+b)*(aaa+bbb)(a+b)*

A. Ababaaaab
B. Bababbbba
C. Baabaabba
D. Abbaaabba

Question No:186 **(Marks:1)** **Vu-Topper RM**

1 Let FA1 accepts many strings and FA2 accepts none then FA1+FA2 will be equal to:

A. FA1
B. FA2
C. FA2-FA1
D. (FA2)

Question No:187 (Marks:1) Vu-Topper RM

Edges are expressed with a regular expression in:

A. **GTG Page 23**
B. FA
C. NFA
D. TG

Question No:188 (Marks:1) Vu-Topper RM

NFA corresponding to union of FAs is built by introducing a new start state and connect it to the states originally connected to the old start state with the --------- transitions as the old start state:

Same

Different

Question No:189 (Marks:1) Vu-Topper RM

---------- state is not important in Moore machine.

Final

Start

Question No:190 (Marks:1) Vu-Topper RM

If we subtract a binary number 1010 from the binary number 1101(ignore the overflow), then the result will be:

1100

0011

Question No:191 (Marks:1) Vu-Topper RM

In concatenation, we include the initial state of FA2 automatically after the final state of FA1 because of:

We need just one initial state

Question No:192 (Marks:1) Vu-Topper RM

a(a+b)*b + b(a+b)*a is the regular expression of language defined over Σ={a,b}

that is ________.
starting with a and ending in a

Question No:193 (Marks:1) Vu-Topper RM
GTG for the expression (a+b)*bb may have minimum number of states:
Aaabcbbcbacc

Question No:194 (Marks:1) Vu-Topper RM
Which of the following state is introduced while developing NFA for the closure of an FA?
An initial state which should be final as well

Question No:195 (Marks:1) Vu-Topper RM
In NFA,if null word (lambda) is allowed to be a label of an edge, then that NFA is called _________.
NFA with null string

Question No:196 (Marks:1) Vu-Topper RM
Which one of the following is a correct word produced by the RE (a*b*)ab?
abab

Question No:197 (Marks:1) Vu-Topper RM
While developing NFA for the union of FA1 and FA2, if there is a loop of 'a' at the initial state of FA1 then the new initial state will have a transition for 'a' that goes straight to:
The initial state of FA1

Question No:198 (Marks:1) Vu-Topper RM
Let L be the language of all strings, defined over Σ = {0,1}, ending in 111. Which of the following strings are distinguishable with respect to L with z being 11?
111, 101

Question No:199 **(Marks:1)** **Vu-Topper RM**
Which one of the following word is not accepted by the given regular expression?
abbbbaa

Question No:200 **(Marks:1)** **Vu-Topper RM**
Which of the following is not a step-in elimination of states procedure?
Unify single transitions to multi transitions that contains union of input

Question No:201 **(Marks:1)** **Vu-Topper RM**
In Moore machine the output depends on
The state

Question No:202 **(Marks:1)** **Vu-Topper RM**
While developing NFA for the union of FA1 and FA2, there will be
The initial state of FA1

Question No:203 **(Marks:1)** **Vu-Topper RM**
Let FA3 be an FA corresponding to FA1FA2, then the final state of FA3 must correspond to the final state of
FA2 only

Question No:204 **(Marks:1)** **Vu-Topper RM**
Let FA3 be an FA corresponding to FA1FA2, then the initial state of FA3 must correspond to the initial state of
FA1 or FA2

Question No:205 **(Marks:1)** **Vu-Topper RM**
Mealy machine is equivalent to Moore machine, if we:
Applications of complementing and incrementing machines

Question No:206 **(Marks:1)** **Vu-Topper RM**

In the context of make NFA for the concatenation of FA1 and FA2 (FA2 accepting null string), which of the following option is correct?

Final states in both FAs

Question No:207 **(Marks:1)** **Vu-Topper RM**

In the context of make NFA for the concatenation of FA1 and FA2 (none accepting null string), which of the following option is correct?

No initial state in FA1 only

CS402 Midterm

MCQS

1. In the context of make NFA for the concatenation of FA1 and FA2 (none accepting null string), which of the following option is correct?
   No initial state in FA1 only

2. In the context of make NFA for the concatenation of FA1 and FA2 (FAs accepting null string), which of the following option is correct?
   Final states in both FAs

3. In the context of make NFA for the concatenation of FA1 and FA2 (Both FAs accepting null string), which of the following option is correct?
   Final states in both FAs

4. In the context of make NFA for the concatenation of FA1 and FA2 (FA2 accepting null string), which of the following option is correct?
   Final states in both FAs

5. In the context of make NFA for the concatenation of FA1 and FA2 (FA1 accepting null string), which of the following option is correct?

   final states in both FAs

6. Let FA3 be an FA corresponding to FA1FA2, then the initial state of FA3 must correspond to the initial state of

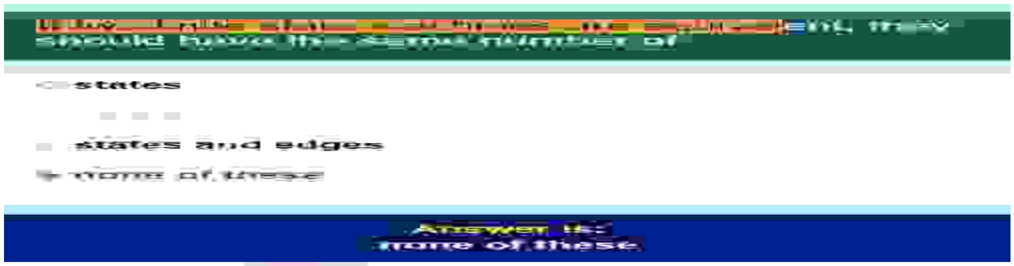
   FA1…..confirm

7. Let FA3 be an FA corresponding to FA1FA2, then the initial state of FA3 must correspond to the Final state of

   FA2 only…..confirm

8. If two finite state machines are equivalent they should have the same number of _____.

None of these….confirm



9. Let FA1 accepts many strings and FA2 accepts none then FA1+FA2 will be equal to:

FA2 - FA1……confirm

10. Corresponding to union of FAs is built introducing a new start state and connect it to the states originally connected to the old start state with the ___ transition as the old start state.

Same…..confirm

11. While developing NFA for the union of FA1 and FA2 if there is a loop of a at the initial state of FA1 then the new initial state will have a transition for a that goes straight to

The initial state of FA1

12. Let L be the language of all strings, defined over ∑= (0,1) ,ending in 111.which of the following strings Are indistinguishable with respect to L with z being 111?

111,010

13. Moore machine can have ________ final state

Zero

Note:

14. **If we have an NFA having 3 states and we convert that NFA to an FA. The resultant FA will contains _______ states**

2

15. **Let FA1 has x number of states and FA2 has y number of states. Now FA1+FA2 can have maximum ____ number of states.**

None of the given option….confirm

16. **If we have only one state, having no transition for input letters then it is an example of:**

NFA….confirm

Let L be the language of all strings, defined over ∑= (0,1) ,ending in 111.which of the following strings Are distinguishable with respect to L with z being 111?

010,101

17. **_______ state is not important in Melay machine.**

Final…..confirm

18. **Which of the following is not a step in elimination of states procedure?**

Unify single transitions to multi transitions that contains union of input…confirm

Which of the following is not a step in elimination of states procedure?

Explanation: While eliminating the states, we unify multiple transitions to one transition that contains union of input and not the vice versa.

19. **If we have input 110010111 and the machine generates the 001101000 as an output, then that machine will be called?**

Moore machine….confirm

Design a … 1's complement of a given binary number.

Solution: To generate 1's complement of a given binary number the simple logic is that …

20. 1's complement for 01101 will be

10010….confirm

Binary number	1's complement
000	111
001	110
010	101
011	100

21. Dead states are defined as:

None of the given option…..confirm

22. In the context of make NFA for the concatenation of FA1 and FA2 (FA2 accepting null string) which of the following option is correct?

FA2 having final state only

23. Strings x,y,z belongs to ∑* such that xz∈ L but yz∉ L or yz ∉ L but yz ∈ L where L ⊆∑* are:

Distinguishable…..confirm

24. Strings x,y,z belongs to ∑* such that both xz or yz ∈ L or both don't belong where L⊆∑* are:

Indistinguishable……confirm

25. Let FA3 be an corresponding to FA1FA2 then the initial state of FA3 must correspond to the initial state of

FA1 only…..confirm

26. **Let FA3 be an corresponding to FA1FA2 then the final state of FA3 must correspond to the initial state of**

FA2 only…..confirm

27. **NFA corresponding to union of FAs is built by introducing a new state and connect it to the states originally connected to the old start state with the ____ transition as the old start state.**

Same…..confirm

28. **Consider we have languages L7 and L6. Which of the following represents their concatenation?**

L7+L6…..confirm

Consider we have languages L7 and L6. Which of the following represents their concatenation?

Select correct option:

L7+L6

29. **There _______ be dead states in NFA.**

Will

30. **1 Let FA1 accepts many strings and FA2 accepts none then FA1+FA2 will be equal to**

FA2-FA1

31. **If FA1 corresponds to (a+b)* then FA1 must accept ___________ string/strings.**

Every

32. **The minimum length of the strings(except null string) of a language that starts and ends in the same letters will be:**

33. **A regular language can be:**

None of the given options

34. There ______ a language for which only FA can be built but not the RE.

may not be

35. **For every three regular expressions R, S, and T, the languages denoted by R(S U T) and (RS) U (RT) are the ______ .**
Same

36. **In _______ there must be transition for all the lettersof a string.**
FA

37. **We cannot construct an NFA for the language of ______ defined over alphabet set {a,b}.**
Palindromes

38. **Decomposing a string into its valid units is referred as:**
Tokenizing

39. **In concatenation we accept the initial state of FA2 automatically after the final state of FA1 because of:**
We need just one initial state (correct)

40. **Considering FA1 and FA2 having 2 states each. Now FA1+FA2 can have maximum ______________ number of states.**
None of these

41. Let FA3 be an FA corresponding to FA1FA2, then the initial state of FA3 must correspond to the initial state of Select correct option:

FA1

42. **Let FA1 accepts many strings and FA2 accepts none then FA1+FA2 will be equal to:** Select correct option:

FA2-FA1

43. FA and _______ are same except that _______ has unique symbol for each transition.

FA,TG

44. If R is a regular language and L is some language, and L U R is a _______, then L must be a ________.

Regular language

45. The minimum length of the strings(except null string) of a language that starts and ends in the same letters will be:

2

46. For every three regular expressions R, S, and T, the languages denoted by R(S U T) and (RS) U (RT) are the ______.

Same

47. There _______ be dead states in NFA.

will

48. **In _______ there must be transition for all the letters of a string.**

FA

49. The minimum length of the strings(except null string) of a language that starts and ends in different letters will be:

1

50. Consider we have languages L7 and L6. Which of the following represents their concatenation?

L7+L6

51. In concatenation, we accept the initial state of FA2 automatically after the final state of FA1 because of:

We need just one init

52. **There _______ be dead states in NFA.**

will

53. If we have a finite language and the number of states in the FA is n then the maximum number of letters in the each word of the language that will be ac

N

54. **FA3 be an FA corresponding to FA1FA2, then the initial state of FA3 must correspond to the initial state of**

Select the correct option:

FA1 only

55. **Consider we have languages L7 and L6. Which of the following represents their concatenation?**
    L7+L6
56. **Let FA1 has x number of states and FA2 has y number of states. Now FA1+FA2 can have maximum ________________ number of states.** Select correct option**:**
    None

57. **The language {a ab aba bab} is ______ .**
    Regular

58. **The minimum length of the strings(except null string) of a language that starts and ends in the same letters will be:**
    Select the correct option:

    2

59. The minimum length of the strings(except null string) of a language that starts and ends in different letters will be:

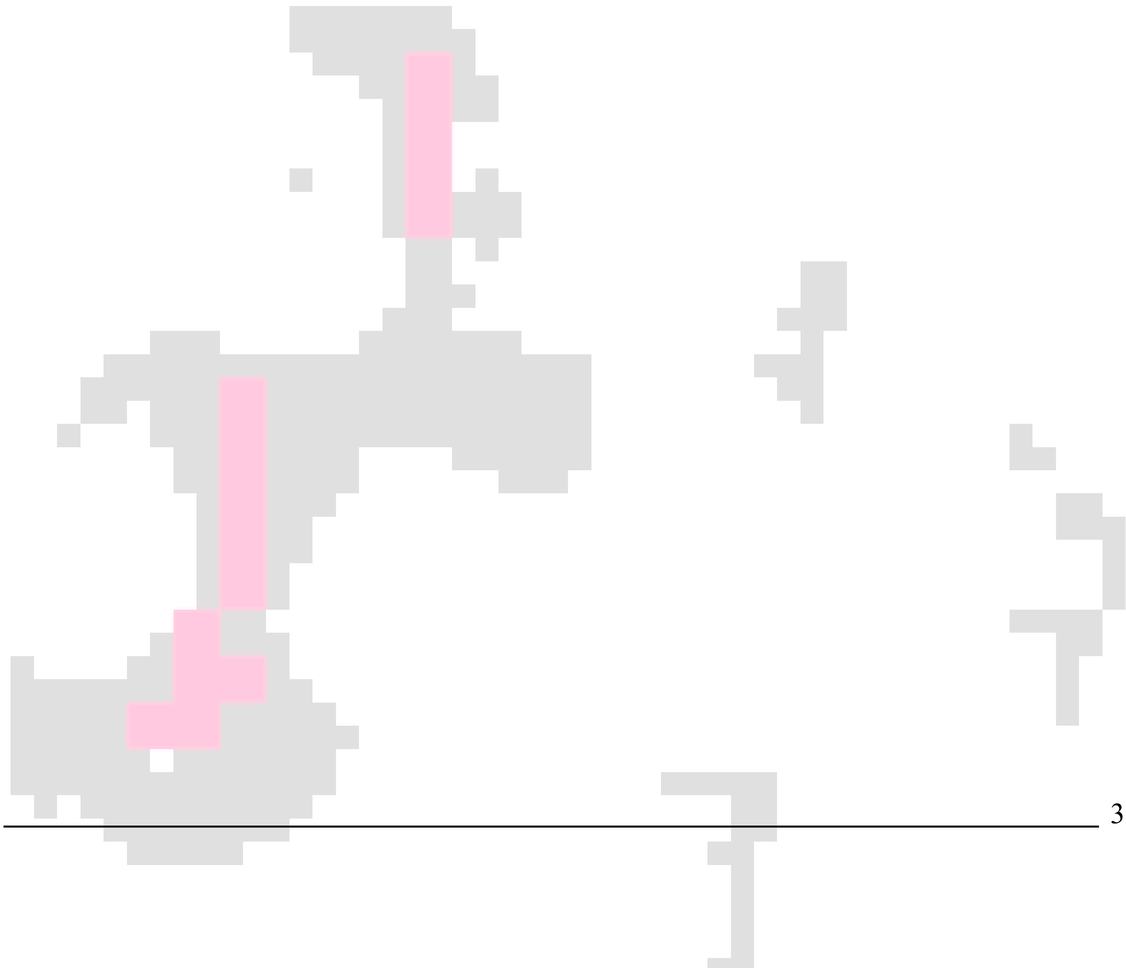
    1

60. **In ________ there must be transition for all the lettersof a string.**
    FA

Thoery of Automata
CS402

Table of contents:

4



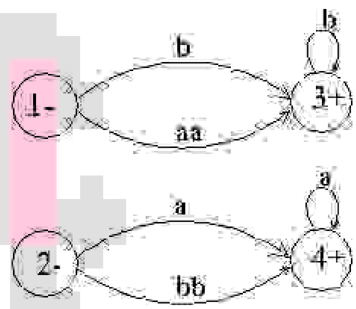
Theory of Automata

Lecture N0. 12
Reading Material

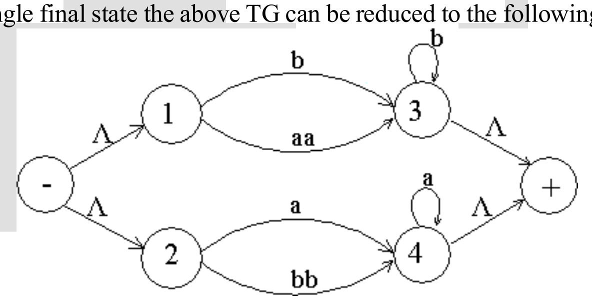
Introduction to Computer Theory Chapter 7

Summary
Examples of writing REs to the corresponding TGs, RE corresponding to TG accepting EVEN-EVEN language, Kleene's theorem part III (method 1:union of FAs), examples of FAs corresponding to simple REs, example of Kleene's theorem part III (method 1) continued

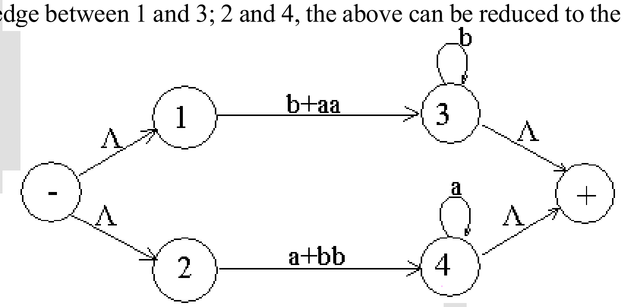
Example
Consider the following TG



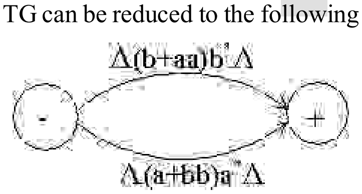
To have single initial and single final state the above TG can be reduced to the following



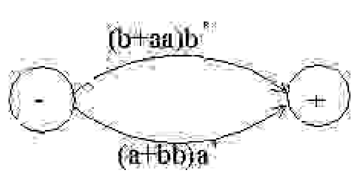
To obtain single transition edge between 1 and 3; 2 and 4, the above can be reduced to the following



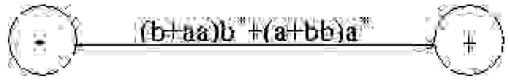
To eliminate states 1,2,3 and 4, the above TG can be reduced to the following TG



OR

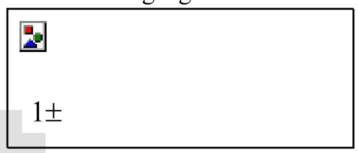


To connect the initial state with the final state by single transition edge, the above TG can be reduced to the following

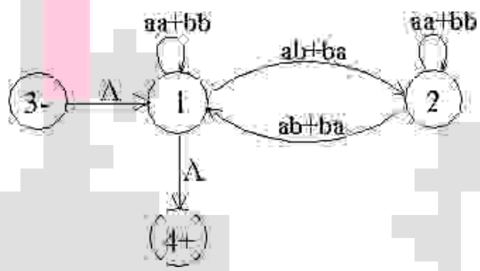


Hence the required RE is (b+aa)b^*+(a+bb)a^*

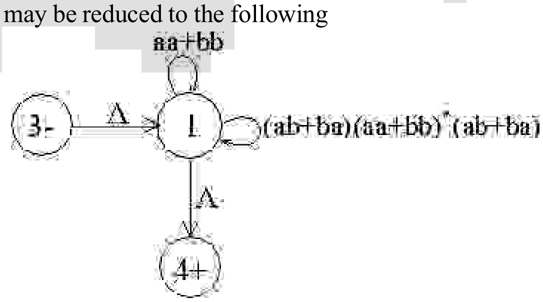
Example
Consider the following TG, accepting EVEN-EVEN language



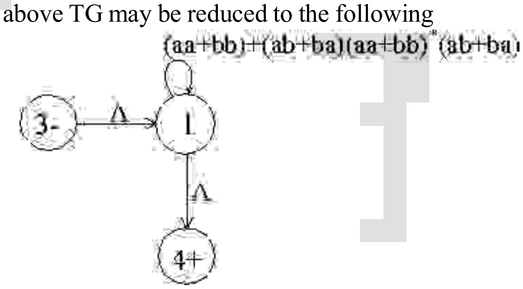
It is to be noted that since the initial state of this TG is final as well and there is no other final state, so to obtain a TG with single initial and single final state, an additional initial and a final state are introduced as shown in the following TG



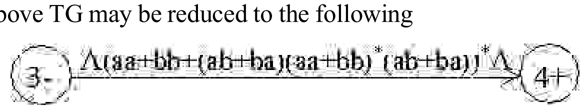
To eliminate state 2, the above TG may be reduced to the following



To have single loop at state 1, the above TG may be reduced to the following



To eliminate state 1, the above TG may be reduced to the following



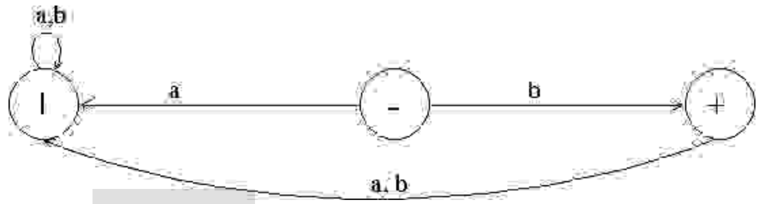
Hence the required RE is (aa+bb+(ab+ba)$(aa+bb)^*$(ab+ba)$)^*$

Kleene's Theorem Part III
Statement:
If the language can be expressed by a RE then there exists an FA accepting the language.

As the regular expression is obtained applying addition, concatenation and closure on the letters of an alphabet and the Null string, so while building the RE, sometimes, the corresponding FA may be built easily, as shown in the following examples

Example

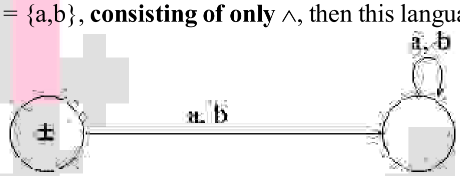
Consider the language, defined over Σ = {a,b}, **consisting of only b**, then this language may be accepted by the following FA



which shows that this FA helps in building an FA accepting only one letter

Example

Consider the language, defined over Σ = {a,b}, **consisting of only** ∧, then this language may be accepted by the following FA

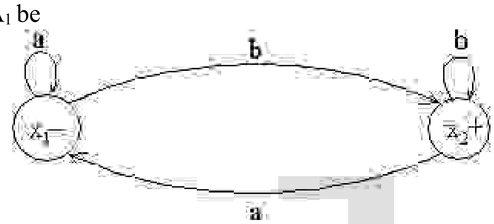


As, if r_1 and r_2 are regular expressions then their sum, concatenation and closure are also regular expressions, so an FA can be built for any regular expression if the methods can be developed for building the FAs corresponding to the sum, concatenation and closure of the regular expressions along with their FAs. These three methods are explained in the following discussion

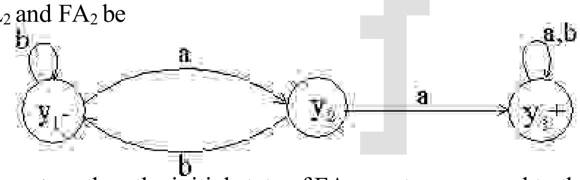
Method1 (Union of two FAs): Using the FAs corresponding to r_1 and r_2 an FA can be built, corresponding to $r_1 + r_2$. This method can be developed considering the following examples

Example

Let $r_1 = (a+b)^*b$ defines L_1 and the FA_1 be



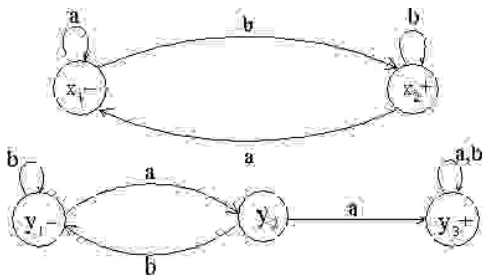
and $r_2 = (a+b)^*aa(a+b)^*$ defines L_2 and FA_2 be



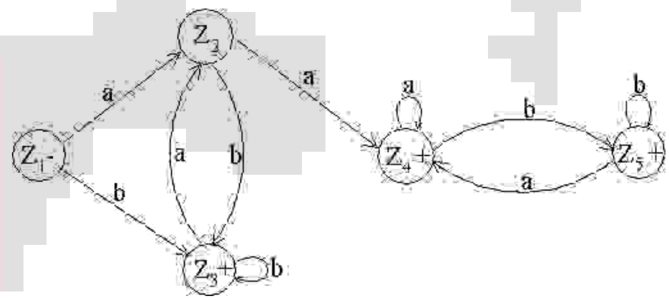
Let FA_3 be an FA corresponding to $r_1 + r_2$, then the initial state of FA_3 must correspond to the initial state of FA_1 and the initial state of FA_2.

Since the language corresponding to $r_1 + r_2$ is the union of corresponding languages L_1 and L_2, consists of the strings belonging to L_1or L_2 or both, therefore a final state of FA_3 must correspond to a final state of FA_1 or FA_2 or both.

Since, in general, FA_3 will be different from both FA_1 and FA_2, so the labels of the states of FA_3 may be supposed to be z_1,z_2, z_3, …, where z_1 is supposed to be the initial state. Since z_1 corresponds to the states x_1 or y_1, so there will be two transitions separately for each letter read at z_1. It will give two possibilities of states either z_1 or different from z_1. This process may be expressed in the following transition table for all possible states of FA_3.



Old States	New States after reading	
	a	b
$z_1 - \equiv(x_1,y_1)$	$(x_1,y_2) \equiv z_2$	$(x_2,y_1) \equiv z_3$
$z_2 \equiv(x_1,y_2)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_1) \equiv z_3$
$z_3+ \equiv(x_2,y_1)$	$(x_1,y_2) \equiv z_2$	$(x_2,y_1) \equiv z_3$
$z_4+ \equiv(x_1,y_3)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_3) \equiv z_5$
$z_5+ \equiv(x_2,y_3)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_3) \equiv z_5$



RE corresponding to the above FA may be $r_1+r_2 = (a+b)^*b + (a+b)^*aa(a+b)^*$.
Note: Further examples are discussed in the next lecture.

Theory of Automata

Lecture N0. 13
Reading Material

Introduction to Computer Theory Chapter 7

Summary

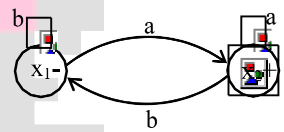
Examples of Kleene's theorem part III (method 1) continued, Kleene's theorem part III (method 2: Concatenation of FAs), Example of Kleene's theorem part III (method 2 : Concatenation of FAs)

Note

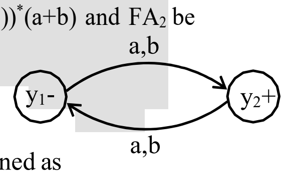
It may be noted that the example discussed at the end of previous lecture, FA_1 contains two states while FA_2 contains three states. Hence the total number of possible combinations of states of FA_1 and FA_2, in sequence, will be six. For each combination the transitions for both a and b can be determined, but using the method in the example, number of states of FA_3 was reduced to five.

Example

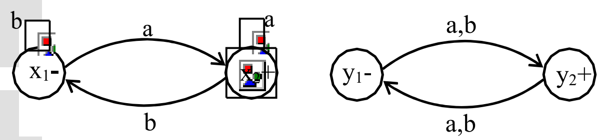
Let $r_1 = (a+b)^*a$ and the corresponding FA_1 be



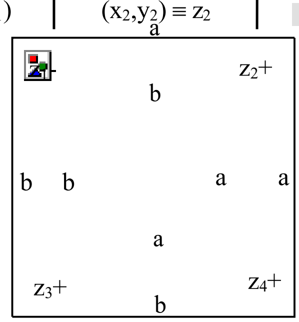
also $r_2 = (a+b)((a+b)(a+b))^*$ or $((a+b)(a+b))^*(a+b)$ and FA_2 be



FA corresponding to r_1+r_2 can be determined as

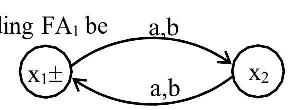


Old States	New States after reading	
	a	b
$z_1- \equiv (x_1,y_1)$	$(x_2,y_2) \equiv z_2$	$(x_1,y_2) \equiv z_3$
$z_2+ \equiv (x_2,y_2)$	$(x_2,y_1) \equiv z_4$	$(x_1,y_1) \equiv z_1$
$z_3+ \equiv (x_1,y_2)$	$(x_2,y_1) \equiv z_4$	$(x_1,y_1) \equiv z_1$
$z_4+ \equiv (x_2,y_1)$	$(x_2,y_2) \equiv z_2$	$(x_1,y_2) \equiv z_3$

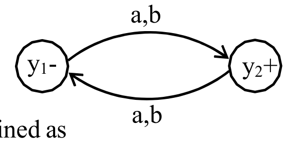


Example

Let $r_1 = ((a+b)(a+b))^*$ and the corresponding FA_1 be



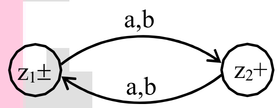
also $r_2 = (a+b)((a+b)(a+b))^*$ or $((a+b)(a+b))^*(a+b)$ and FA_2 be



FA corresponding to r_1+r_2 can be determined as

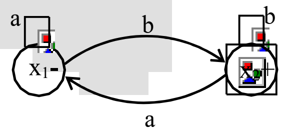
Old States	New States after reading a	New States after reading b
$z_1\pm \equiv (x_1,y_1)$	$(x_2,y_2) \equiv z_2$	$(x_2,y_2) \equiv z_2$
$z_2+ \equiv (x_2,y_2)$	$(x_1,y_1) \equiv z_1$	$(x_1,y_1) \equiv z_1$

Hence the required FA will be as follows

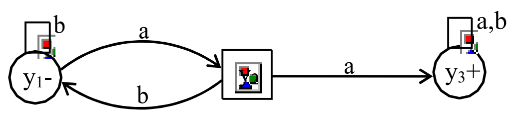


<u>Method2 (Concatenation of two FAs):</u>
Using the FAs corresponding to r_1 and r_2, an FA can be built, corresponding to r_1r_2. This method can be developed considering the following examples

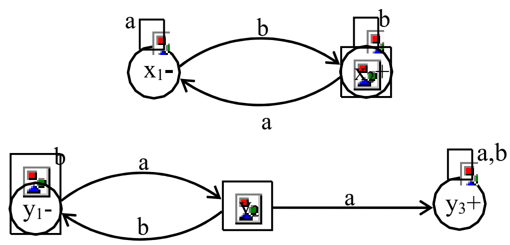
<u>Example</u>
Let $r_1 = (a+b)^*b$ defines L_1 and FA_1 be



and $r_2 = (a+b)^*aa(a+b)^*$ defines L_2 and FA_2 be

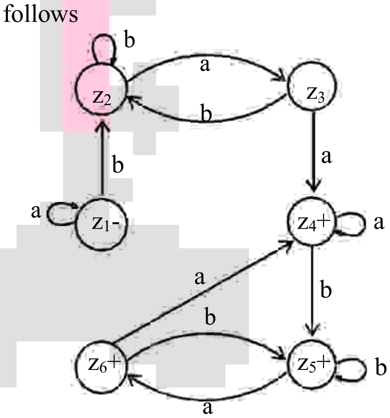


Let FA_3 be an FA corresponding to r_1r_2, then the initial state of FA_3 must correspond to the initial state of FA_1 and the final state of FA_3 must correspond to the final state of FA_2.Since the language corresponding to r_1r_2 is the concatenation of corresponding languages L_1 and L_2, consists of the strings obtained, concatenating the strings of L_1 to those of L_2 , therefore ***the moment a final state of first FA is entered, the possibility of the initial state of second FA will be included as well.***
Since, in general, FA_3 will be different from both FA_1 and FA_2, so the labels of the states of FA_3 may be supposed to be z_1, z_2, z_3, …, where z_1 stands for the initial state. Since z_1 corresponds to the states x_1, so there will be two transitions separately for each letter read at z_1. It will give two possibilities of states which correspond to either z_1 or different from z_1. This process may be expressed in the following transition table for all possible states of FA_3



Old States	New States after reading	
	a	b
z_1-≡x_1	x_1≡z_1	(x_2,y_1)≡ z_2
z_2≡(x_2,y_1)	(x_1,y_2)≡z_3	(x_2,y_1)≡ z_2
z_3≡(x_1,y_2)	(x_1,y_3)≡z_4	(x_2,y_1)≡ z_2
z_4+≡(x_1,y_3)	(x_1,y_3)≡ z_4	(x_2,y_1,y_3)≡ z_5
z_5+≡(x_2,y_1,y_3)	(x_1,y_2,y_3)≡ z_6	(x_2,y_1,y_3)≡ z_5
z_6+≡(x_1,y_2,y_3)	(x_1,y_3)≡ z_4	(x_2,y_1,y_3)≡ z_5

Hence the required FA will be as follows



Note: Another example is discussed in the next lecture.

Theory of Automata

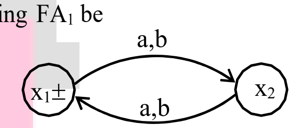
Lecture N0. 14
Reading Material

Introduction to Computer Theory Chapter 7

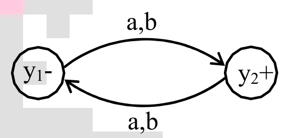
Summary

Examples of Kleene's theorem part III (method 1) continued ,Kleene's theorem part III (method 2: Concatenation of FAs), Examples of Kleene's theorem part III(method 2:concatenation FAs) continued, Kleene's theorem part III (method 3:closure of an FA), examples of Kleene's theorem part III(method 3:Closure of an FA) continued

Example
Let $r_1 = ((a+b)(a+b))^*$ and the corresponding FA_1 be



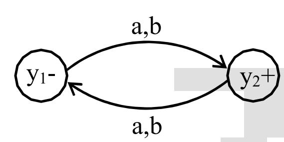
also $r_2 = (a+b)((a+b)(a+b))^*$ or $((a+b)(a+b))^*(a+b)$ and FA_2 be



FA corresponding to r_1r_2 can be determined as

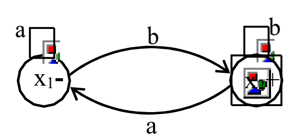
Old States	New States after reading a	New States after reading b
$z_1-\equiv(x_1,y_1)$	$(x_2,y_2)\equiv z_2$	$(x_2,y_2)\equiv z_2$
$z_2+\equiv(x_2,y_2)$	$(x_1,y_1)\equiv z_1$	$(x_1,y_1)\equiv z_1$

Hence the required FA will be as follows

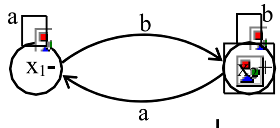


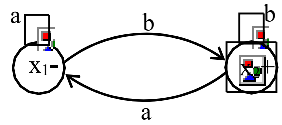
Method3: (Closure of an FA)
Building an FA corresponding to r^*, using the FA corresponding to r.
It is to be noted that if the given FA already accepts the language expressed by the closure of certain RE, then the given FA is the required FA. However the method, in other cases, can be developed considering the following examples
Closure of an FA, is same as concatenation of an FA with itself, except that the initial state of the required FA is a final state as well. Here the initial state of given FA, corresponds to the initial state of required FA and a non final state of the required FA as well.

Example
Let $r = (a+b)^*b$ and the corresponding FA be



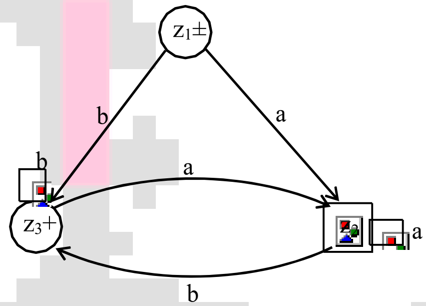
then the FA corresponding to r^* may be determined as under





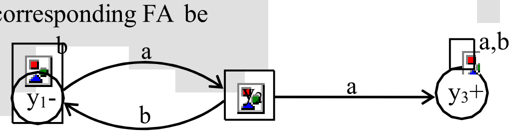
Old States	New States after reading a	b
Final $z_1 \pm \equiv x_1$	$x_1 \equiv z_2$	$(x_2,x_1) \equiv z_3$
Non-final $z_2 \equiv x_1$	$x_1 \equiv z_2$	$(x_2,x_1) \equiv z_3$
$z_3 + \equiv (x_2,x_1)$	$x_1 \equiv z_2$	$(x_2,x_1) \equiv z_3$

The corresponding transition diagram may be as under



<u>Example</u>

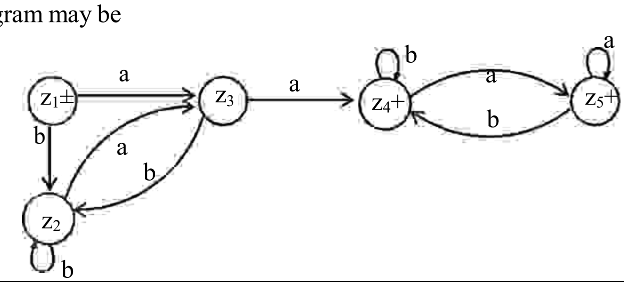
Let $r = (a+b)^*aa(a+b)^*$ and the corresponding FA be



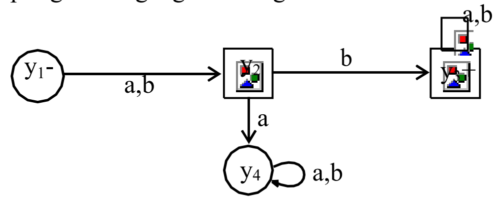
then the FA corresponding to r^* may be determined as under

Old States	New States after reading a	b
Final $z_1 \pm \equiv y_1$	$y_2 \equiv z_3$	$y_1 \equiv z_2$
Non-Final $z_2 \equiv y_1$	$y_2 \equiv z_3$	$y_1 \equiv z_2$
$z_3 \equiv y_2$	$(y_3,y_1) \equiv z_4$	$y_1 \equiv z_2$
$z_4 + \equiv (y_3,y_1)$	$(y_3,y_1,y_2) \equiv z_5$	$(y_3,y_1) \equiv z_4$
$z_5 + \equiv (y_3,y_1,y_2)$	$(y_3,y_1,y_2) \equiv z_5$	$(y_3,y_1) \equiv z_4$

The corresponding transition diagram may be



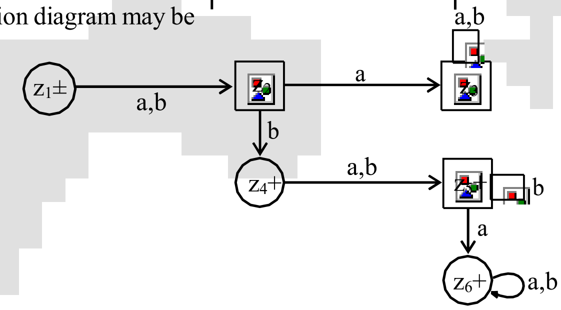
Example
Consider the following FA, accepting the language of strings with **b as second letter**



then the FA corresponding to r^* may be determined as under

Old States	New States after reading a	New States after reading b
$z_1\pm \equiv y_1$	$y_2 \equiv z_2$	$y_2 \equiv z_2$
$z_2 \equiv y_2$	$y_4 \equiv z_3$	$(y_3,y_1) \equiv z_4$
$z_3 \equiv y_4$	$y_4 \equiv z_3$	$y_4 \equiv z_3$
$z_4+ \equiv (y_3,y_1)$	$(y_3 ,y_1 ,y_2) \equiv z_5$	$(y_3 ,y_1 ,y_2) \equiv z_5$
$z_5+ \equiv (y_3,y_1,y_2)$	$(y_3,y_1 ,y_2 ,y_4) \equiv z_6$	$(y_3,y_1,y_2) \equiv z_5$
$z_6 \equiv (y_1,y_1 ,y_2 ,y_4)$	$(y_1,y_1 ,y_2 ,y_4) \equiv z_6$	$(y_1,y_1 ,y_2 ,y_4) \equiv z_6$

The corresponding transition diagram may be



Theory of Automata

Lecture N0. 15
Reading Material

Introduction to Computer Theory Chapter 7

Summary

Examples of Kleene's theorem part III (method 3), NFA, examples, avoiding loop using NFA, example, converting FA to NFA, examples, applying an NFA on an example of maze

Note

It is to be noted that as observed in the examples discussed in previous lecture, if at the initial state of the given FA, there is either a loop or an incoming transition edge, the initial state corresponds to the final state and a non-final state as well, of the required FA, otherwise the initial state of given FA will only correspond to a single state of the required FA (*i.e.* the initial state which is final as well).

Nondeterministic Finite Automaton (NFA)

Definition

An NFA is a TG with a unique start state and a property of having single letter as label of transitions. An NFA is a collection of three things

Finite many states with one initial and some final states

Finite set of input letters, say, Σ = {a, b, c}

Finite set of transitions, showing where to move if a letter is input at certain state (∧ is not a valid transition), there may be more than one transition for certain letters and there may not be any transition for certain letters.

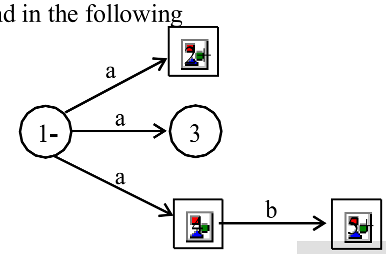
Observations

It may be observed, from the definition of NFA, that the string is supposed to be accepted, if there exists at least one successful path, otherwise rejected.

It is to be noted that an NFA can be considered to be an intermediate structure between FA and TG.

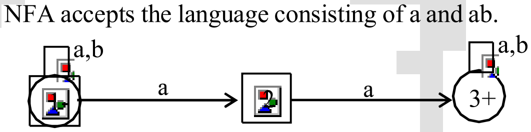
The examples of NFAs can be found in the following

Example



It is to be noted that the above NFA accepts the language consisting of a and ab.

Example



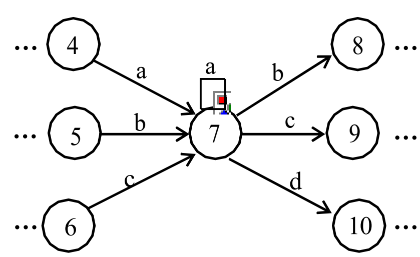
It is to be noted that the above NFA accepts the language of strings, defined over Σ = {a, b}, containing aa.

Note

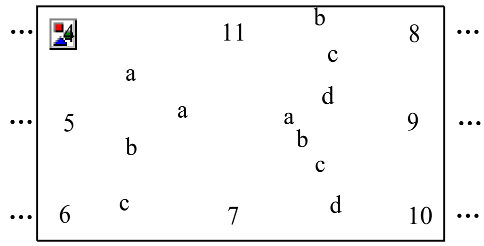
It is to be noted that NFA helps to eliminate a loop at certain state of an FA. This process is done converting the loop into a circuit. But during this process the FA remains no longer FA and is converted to a corresponding NFA, which is shown in the following example.

Example

Consider a part of the following FA with an alphabet Σ = {a,b,c,d}



To eliminate the loop at state 7, the corresponding NFA may be as follows

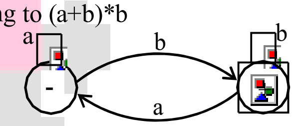


Converting an FA to an equivalent NFA

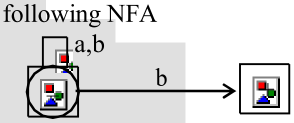
It is to be noted that according to the Kleene's theorem, if a language can be accepted by an FA, then there exists a TG accepting that language. Since, an NFA is a TG as well, therefore there exists an NFA accepting the language accepted by the given FA. In this case these FA and NFA are said to be equivalent to each others. Following are the examples of FAs to be converted to the equivalent NFAs

Example

Consider the following FA corresponding to (a+b)*b



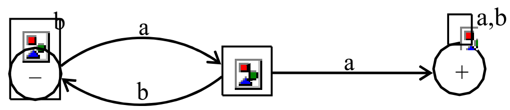
The above FA may be equivalent to the following NFA



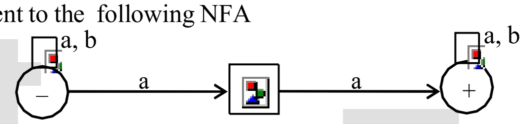
Can the structure of above NFA be compared with the corresponding RE ?

Example

Consider the following FA



The above FA may be equivalent to the following NFA



Can the structure of above NFA be compared with the corresponding RE ?

Application of an NFA

There is an important application of an NFA in artificial intelligence, which is discussed in the following example of a maze

-	1	2	3
4	L	5	O
6	M	7	P
8	N	9	+

Theory of Automata

Lecture N0. 16
Reading Material

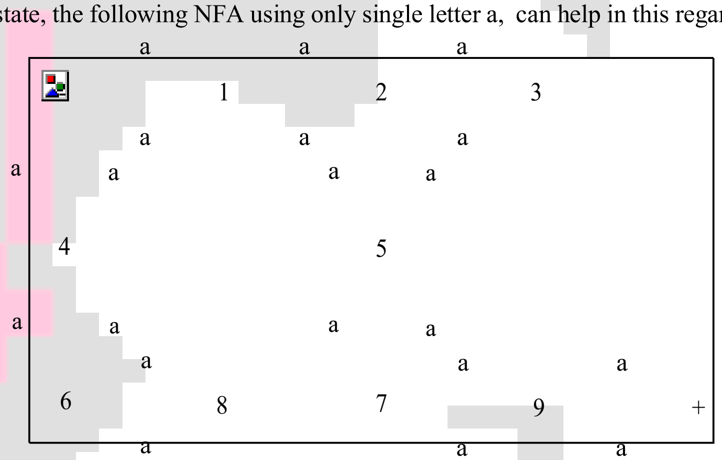
Introduction to Computer Theory Chapter 7

Summary
Applying an NFA on an example of maze, NFA with null string, examples, RE corresponding to NFA with null string (task), converting NFA to FA (method 1,2,3) examples

Application of an NFA
There is an important application of an NFA in artificial intelligence, which is discussed in the following example of a maze

-	1	2	3
4	L	5	O
6	M	7	P
8	N	9	+

- and + indicate the initial and final states respectively. One can move only from a box labeled by other then L, M, N, O, P to such another box. To determine the number of ways in which one can start from the initial state and end in the final state, the following NFA using only single letter a, can help in this regard



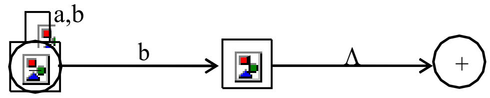
It can be observed that the shortest path which leads from the initial state and ends in the final state, consists of six steps i.e. the shortest string accepted by this machine is aaaaaa. The next larger accepted string is aaaaaaaa. Thus if this NFA is considered to be a TG then the corresponding regular expression may be written as aaaaaa(aa)*
Which shows that there are infinite many required ways

Note
It is to be noted that every FA can be considered to be an NFA as well , but the converse may not true.
It may also be noted that every NFA can be considered to be a TG as well, but the converse may not true.
It may be observed that if the transition of null string is also allowed at any state of an NFA then what will be the behavior in the new structure. This structure is defined in the following

NFA with Null String
Definition
If in an NFA, $\wedge$ is allowed to be a label of an edge then the NFA is called NFA with $\wedge$ (NFA-$\wedge$).
An NFA-$\wedge$ is a collection of three things
Finite many states with one initial and some final states.
Finite set of input letters, say, $\Sigma = \{a, b, c\}$.

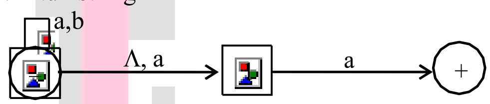
Finite set of transitions, showing where to move if a letter is input at certain state.
There may be more than one transitions for certain letter and there may not be any transition for a certain letter. The transition of ∧ is also allowed at any state.

Example
Consider the following NFA with Null string



The above NFA with Null string accepts the language of strings, defined over Σ = {a, b}, **ending in b**.

Example
Consider the following NFA with Null string



The above NFA with Null string accepts the language of strings, defined over Σ = {a, b}, **ending in a**.

Note
It is to be noted that every FA may be considered to be an NFA-∧ as well, but the converse may not true. Similarly every NFA-∧ may be considered to be a TG as well, but the converse may not true.

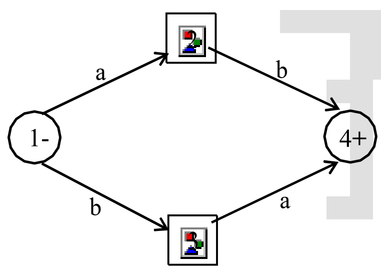
NFA to FA

Two methods are discussed in this regard.

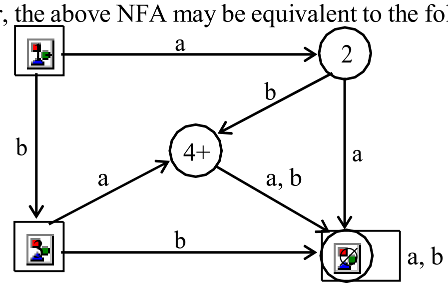
Method 1: Since an NFA can be considered to be a TG as well, so a RE corresponding to the given NFA can be determined (using Kleene's theorem). Again using the methods discussed in the proof of Kleene's theorem, an FA can be built corresponding to that RE. Hence for a given NFA, an FA can be built equivalent to the NFA. Examples have, indirectly, been discussed earlier.

Method 2: Since in an NFA, there may be more than one transition for a certain letter and there may not be any transition for certain letter, so starting from the initial state corresponding to the initial state of given NFA, the transition diagram of the corresponding FA, can be built introducing an empty state for a letter having no transition at certain state and a state corresponding to the combination of states, for a letter having more than one transitions. Following are the examples

Example
Consider the following NFA

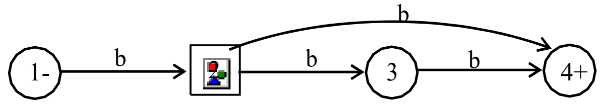


Using the method discussed earlier, the above NFA may be equivalent to the following FA

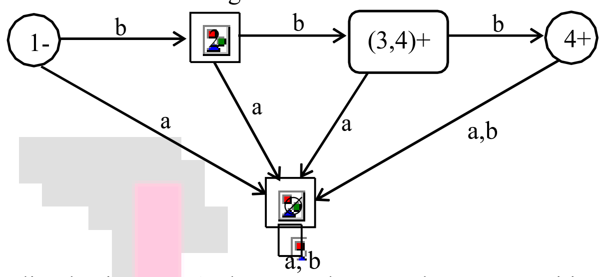


Example

A simple NFA that accepts the language of strings defined over Σ = {a,b}, **consists of bb and bbb**



The above NFA can be converted to the following FA



Method 3: As discussed earlier that in an NFA, there may be more than one transition for a certain letter and there may not be any transition for certain letter, so starting from the initial state corresponding to the initial state of given NFA, the transition table along with new labels of states, of the corresponding FA, can be built introducing an empty state for a letter having no transition at certain state and a state corresponding to the combination of states, for a letter having more than one transitions. Further examples are discussed in the next lecture.

Theory of Automata

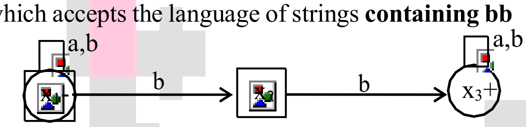
Lecture N0. 17
<u>Reading Material</u>

<u>Introduction to Computer Theory</u> Chapter 7

Summary
converting NFA to FA (method 3), example, NFA and Kleene's theorem method 1, examples, NFA and Kleene's theorem method 2 , NFA corresponding to union of FAs, example

<u>Method 3</u>: As discussed earlier that in an NFA, there may be more than one transition for a certain letter and there may not be any transition for certain letter, so starting from the initial state corresponding to the initial state of given NFA, the transition table along with new labels of states, of the corresponding FA, can be built introducing an empty state for a letter having no transition at certain state and a state corresponding to the combination of states, for a letter having more than one transitions. Following are the examples

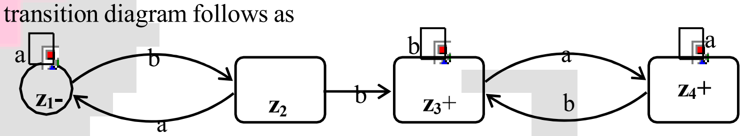
<u>Example</u>
Consider the following NFA which accepts the language of strings **containing bb**



Using the method discussed earlier, the transition table corresponding to the required FA may be constructed as

Old States	New States after reading a	New States after reading b
$z_1- \equiv x_1$	$x_1 \equiv z_1$	$(x_1,x_2) \equiv z_2$
$z_2 \equiv (x_1,x_2)$	$(x_1 , \varnothing) \equiv x_1 \equiv z_1$	$(x_1 ,x_2,x_3) \equiv z_3$
$z_3+ \equiv (x_1,x_2,x_3)$	$(x_1,x_3) \equiv z_4$	$(x_1 ,x_2,x_3) \equiv z_3$
$z_4+ \equiv (x_1,x_3)$	$(x_1,x_3) \equiv z_4$	$(x_1 ,x_2,x_3) \equiv z_3$

The corresponding transition diagram follows as

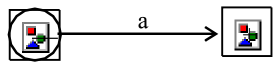


<u>NFA and Kleene's Theorem</u>
It has been discussed that, by Kleene's theorem part III, there exists an FA corresponding to a given RE. If the given RE is as simple as r = aa+bbb or r = a(a+b)*, the corresponding FAs can easily be constructed. However, for a complicated RE, the RE can be decomposed into simple REs corresponding to which the FAs can easily be constructed and hence, using the method, constructing the FAs corresponding to sum, concatenation and closure of FAs, the required FA can also be constructed. It is to be noted that NFAs also help in proving Kleene's theorem part III, as well. Two methods are discussed in the following.

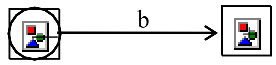
NFA and Kleene's Theorem
<u>Method 1</u>:
The method is discussed considering the following example.

<u>Example</u>
To construct the FAs for the languages L_1 = {a}, L_2 = {b} and L_3 = {Λ}
<u>Step 1</u>: Build NFA_1, NFA_2 and NFA_3 corresponding to L_1, L_2 and L_3 , respectively as shown in the following diagram

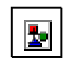
NFA$_1$



NFA$_2$

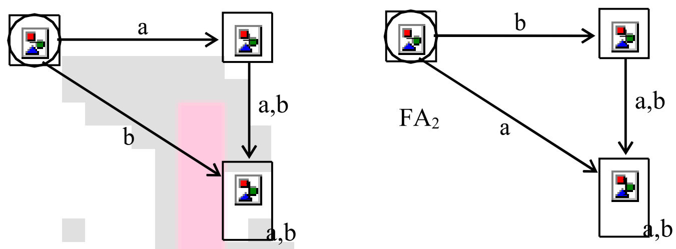


NFA$_3$

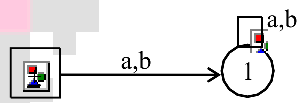


Step 2:
As discussed earlier for every NFA there is an FA equivalent to it, hence there must be FAs for the above mentioned NFAs as well. The corresponding FAs can be considered as follows

FA$_1$



FA$_2$



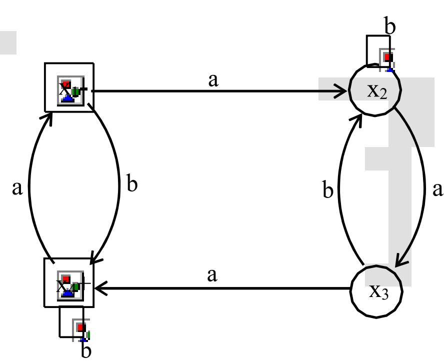
FA$_3$

NFA and Kleene's Theorem method 2
It may be observed that if an NFA can be built corresponding to union, concatenation and closure of FAs corresponding to the REs, then converting the NFA, thus, obtained into an equivalent FA, this FA will correspond to the given RE.
Followings are the procedures showing how to obtain NFAs equivalent to union, concatenation and closure of FAs

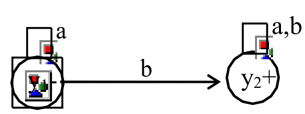
NFA corresponding to Union of FAs
Method
Introduce a new start state and connect it with the states originally connected with the old start state with the same transitions as the old start state, then remove the –ve sign of old start state. This creates non-determinism and hence results in an NFA.

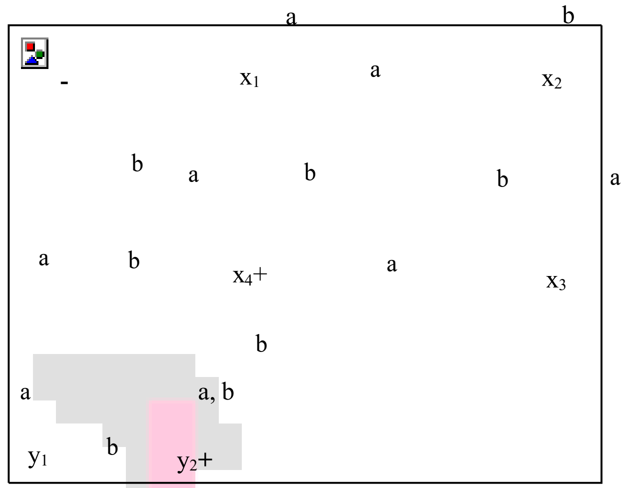
Example

FA$_1$



FA$_2$





NFA equivalent to $FA_1 \cup FA_2$

Theory of Automata

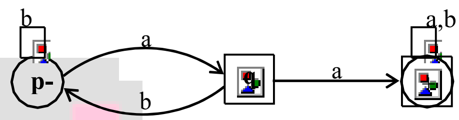
Lecture N0. 18
Reading Material

Introduction to Computer Theory Chapter 7

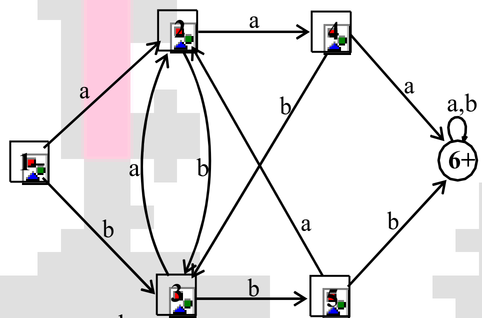
Summary
NFA corresponding to union of FAs, example, NFA corresponding to concatenation of FAs, examples, NFA corresponding to closure of an FA, example

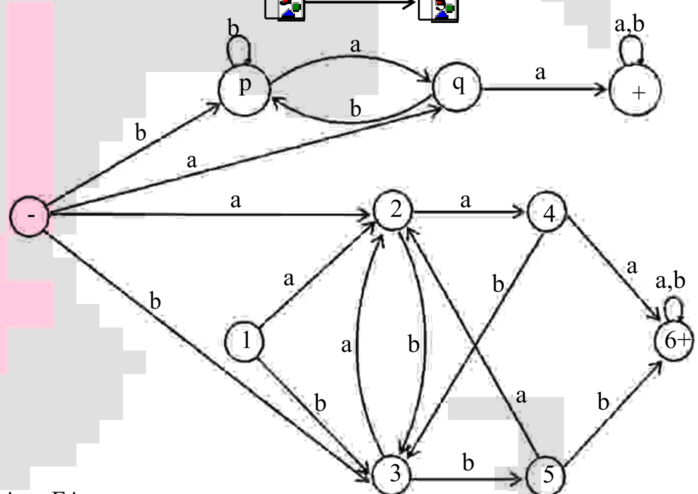
Example

FA_1



FA_2





NFA equivalent to $FA_1 \cup FA_2$

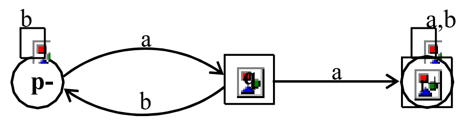
NFA corresponding to Concatenation of FAs
Method
Introduce additional transitions for each letter connecting each final state of the first FA with the states of second FA that are connected with the initial state of second FA corresponding to each letter of the alphabet. Remove the +ve sign of each of final states of first FA and –ve sign of the initial state of second FA. It will create non-determinism at final states of first FA and hence NFA, thus obtained, will be the required NFA.

Note
It may be noted that if first FA accepts the Null string then every string accepted by second FA must be accepted by the concatenation of FAs as well. This situation will automatically be accommodated using the method discussed earlier. However if the second FA accepts Null string, then every string accepted by first FA must be accepted by the required FA as well. This target can be achieved as, while introducing new transitions at final states of first FA the +ve sign of these states will not be removed.

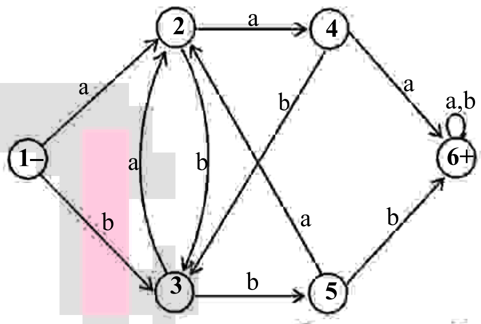
Lastly if both FAs accepts the Null string, then the Null string must be accepted by the required FA. This situation will automatically be accommodated as the second FA accepts the Null string and hence the +ve signs of final states of first FA will not be removed.

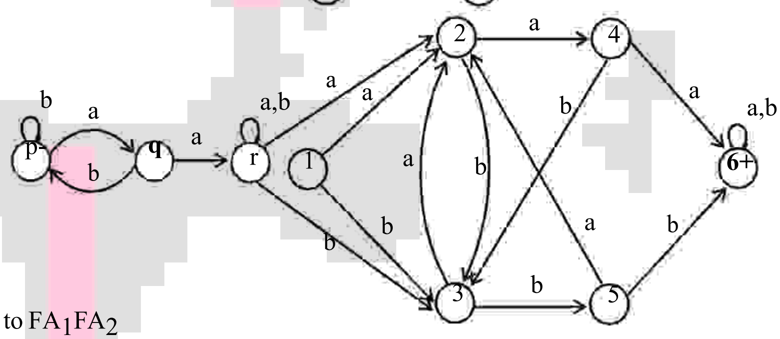
Example (No FA accepts Null string)

FA_1



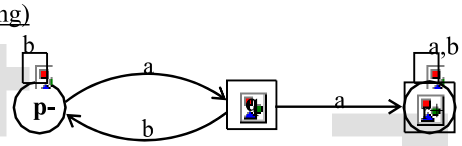
FA_2



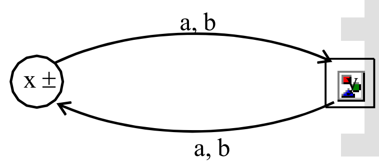


NFA equivalent to FA_1FA_2

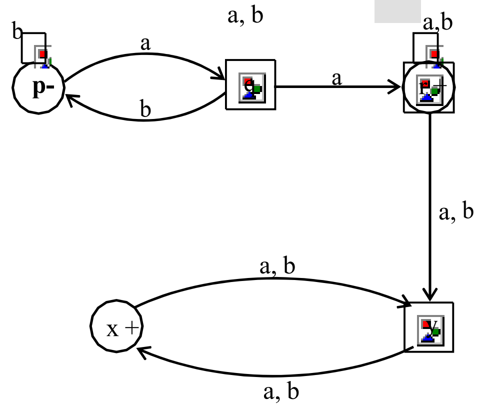
Example (FA_2 accepts Null string)



FA_1



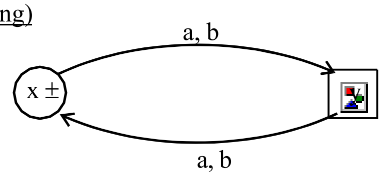
FA_2



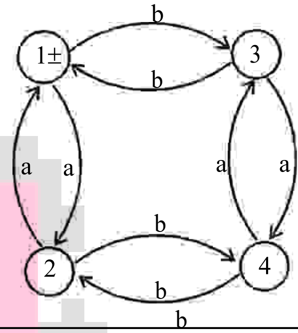
NFA equivalent to FA_1FA_2

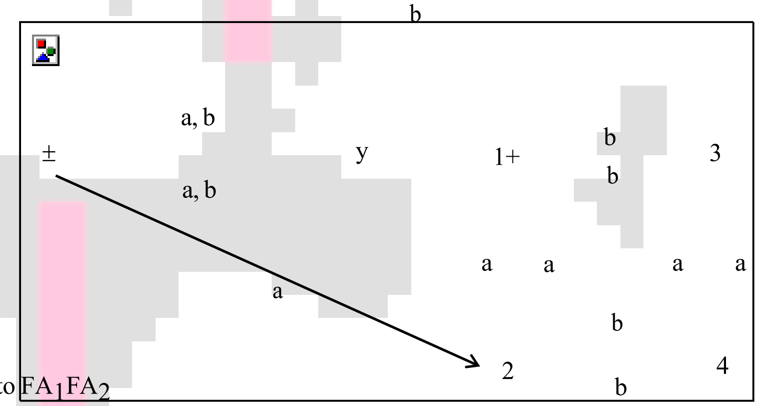
Example (Both FAs accept Null string)

FA_1



FA_2





NFA equivalent to FA_1FA_2

NFA corresponding to the Closure of an FA

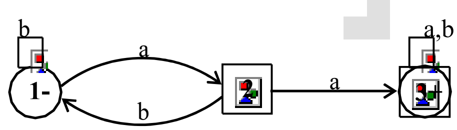
Apparently, it seems that since closure of an FA accepts the Null string, so the required NFA may be obtained considering the initial state of given FA to be final as well, but this may allow the unwanted string to be accepted as well. For example, an FA, with two states, accepting the language of strings, defined over. Σ = {a, b}, **ending in a**, will accept all unwanted strings, if the initial state is supposed to be final as well.

Method

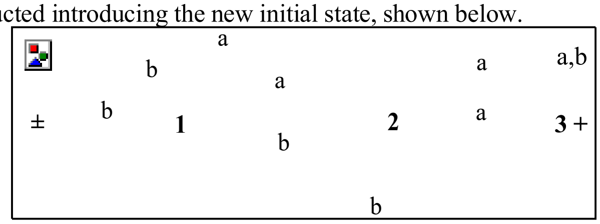
Thus, to accommodate this situation, introduce an initial state which should be final as well (so that the Null string is accepted) and connect it with the states originally connected with the old start state with the same transitions as the old start state, then remove the –ve sign of old start state. Introduce new transitions, for each letter, at each of the final states (including new final state) with those connected with the old start state.This creates non-determinism and hence results in the required NFA.

Example

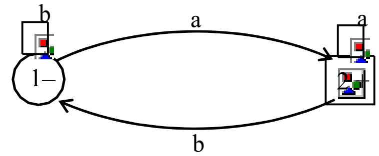
Consider the following FA



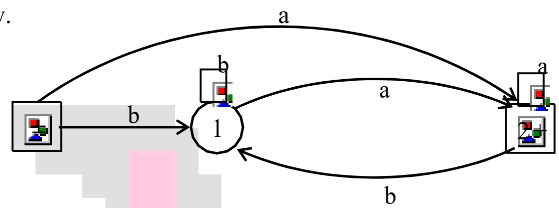
It may be observed that the FA^* accepts only the additional string which is the Null string.
Considering the state 1 to be final as well, will allow the unwanted strings be accepted as well. Hence the required NFA is constructed introducing the new initial state, shown below.



Example
Consider the following FA



It may be observed that the FA* accepts only the additional string which is the Null string
As observed in the previous example the required NFA can be constructed only if the new initial state is introduced as shown below.



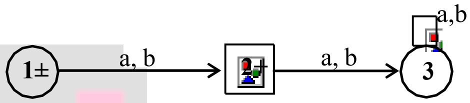
Theory of Automata

Lecture N0. 19
Reading Material

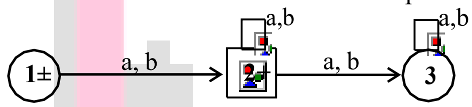
Introduction to Computer Theory Chapter 7

Summary
NFA corresponding to Closure of FA, Examples, Memory required to recognize a language, Example, Distinguishing one string from another, Example, Theorem, Proof

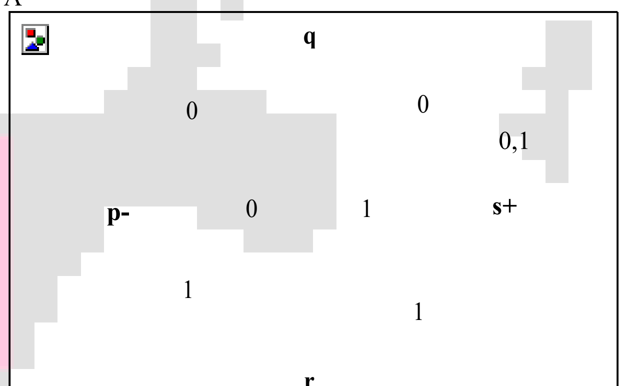
Example
Consider the following FA



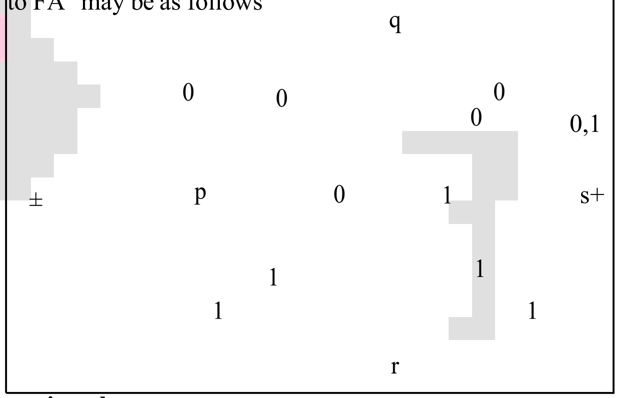
It can be observed that FA* not only accepts the Null string but every other string as well.
Here we don't need separate initial and final state. Hence an NFA corresponding to FA* may be



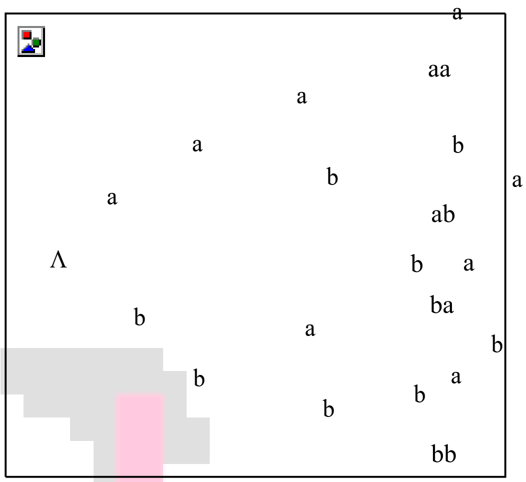
Example
Consider the following FA



The NFA corresponding to FA* may be as follows



Memory required to recognize a language
Memory required to recognize a language means to look at the machine which can recognize a language. As an FA can be considered to be a machine which is simple model of computation and every regular language is associated with certain FA, so to recognize a language there is a restriction that there is a single pass from left to right for any string to decide whether it belongs to certain language ? This helps to remember the information about the initial part of the string read so far.
By this process the input string is examined and the string is decided either to be in a certain language or not.
Consider L = $\{w \in \{a,b\}^*$: w neither ends in **ab** nor in **ba**$\}$. *i.e.* L is the language of strings, defined over Σ = {a,b}, consisting of Λ, a, b and strings ending in aa or bb. L may be accepted by the following FA



As seen in the above FA, seven states are required to recognize the language L, while on the other hand it is very hard to recognize the language PALINDROME.
As seen in the above example of FA, seven states are required to recognize that language. Now consider another language L_3 of strings of length three or more, defined over $\Sigma = \{a,b\}$, **and the third letter from the right is a.** As discussed by Martin, there is a straight forward method to build an FA recognizing L_3 *i.e.* a distinct state for every possible substring of length less then or equal to 3. It is obvious that for each length *i*, *i*=0,1,2,3, of substring, the number of states are 2^i and thus total number of states required to recognize the language L_3 are $2^0+2^1+2^2+2^3 = 2^{3+1}-1=15$ (using $2^0+2^1+2^2+\ldots+ 2^n= 2^{n+1}-1$)

Remark: Let L_{20} be the language of strings of length 20 or more, defined over $\Sigma = \{a,b\}$, **and the 20th letter from the right is 1,** then following the previous method, number of states for the corresponding FA is $\mathbf{2^{20+1}-1=2{,}097{,}151}$.
However, it may be noted that any portion of memory of a computer that can accommodate 21 bits can be in $\mathbf{2^{21}}$ possible states *i.e.* $\mathbf{2^{21}}$ possible choices for the informational content.

Distinguishable strings and Indistinguishable strings

Two strings x and y, belonging to Σ^*, are said to be **distinguishable** w.r.t a language $L \subseteq \Sigma^*$ if there exists a string z belonging to Σ^* s.t. $xz \in L$ but $yz \notin L$ or $xz \notin L$ but $yz \in L$.
Two strings x and y, belonging to Σ^*, are said to be **indistinguishable** with respect to a language $L \subseteq \Sigma^*$ if for every string z belonging to Σ^*, either both xz or $yz \in L$ or both don't belong to L.

Example

Let L be the language of strings, defined over $\Sigma = \{0,1\}$, **ending in 01.**
The strings 110 and 010011 are **distinguishable** w.r.t L, as there exists 1 belonging to Σ^* s.t. 1101 belongs to L but 0100111 doesn't belong to L.
But 111 and 010011 are **indistinguishable**, for 1 belonging to Σ^* s.t. both 1111 and 010011 don't belong to L *i.e.* for every z belonging to Σ^*, either both 111z and 01001z belong to L, or both don't belong to L.

Theorem

Statement

If L is a language over an alphabet Σ and for integer n there are n strings from Σ^*, any two of which are distinguishable w.r.t. language L, then any FA recognizes L must have at least n states.
(Note: There may not exist any FA which recognizes the given language.)

Proof

Let S be set of strings, any two of which are distinguishable w.r.t. language L. Let F_1 be the FA which recognizes the language L. To prove the theorem, it is sufficient to show that any two strings under F_1 must be ended in different states *i.e.* corresponding to each string x belonging to S, F_1 ends in distinct states.
Thus if S has n strings then it is to be shown that F_1 has at least n states.

Let x and y be any two strings from S. By supposition any two strings of S are distinguishable w.r.t. L, so there exists a string z belonging to $\sum^*$such that only one of xz and yz belongs to L *i.e.*F_1 ends in a final state either for xz or yz which shows that F_1 ends in distinct states for xz and yz.
Let F_1 be ended in same state for both the strings x and y, which shows that F_1ends in same state for both xz and yz, a contradiction as x and y being distinguishable implies xz and yz are ended at distinct states of F_1.
Hence F_1 does not end in a same state for both strings x and y, which shows that each pair of strings belonging to S ends in different states. Hence F_1 must contain at least n states.

Theory of Automata

Lecture N0. 20
Reading Material

Introduction to Computer Theory Chapter 8

Summary
Example of previous Theorem, Finite Automaton with output, Moore machine, Examples

Example
Let $L_{20}=\{w \in \{0,1\}^*: |w| \geq 20$ and the 20^{th} letter of w, from right is, $1\}$. Let S be the set of all strings of length 20, defined over Σ, any two of which are distinguishable *w.r.t.* L_{20}. Obviously the number of strings belonging to S, is 2^{20}. Let x and y be any two distinct strings *i.e.* they differ in ith letter, i=1,2,3,…20, from left. For i=1, they differ by first letter from left.
Then by definition of L_{20}, one is in L_{20} while other is not as shown below

0	.	…	.

1	.	…	.

So they are distinct *w.r.t.* L_{20} for z = Λ *i.e.* one of xz and yz belongs to L_{20}.
Similarly if i=2 they differ by 2^{nd} letter from left and are again distinguishable and hence for z belonging to Σ^*, |z|=1, either xz or yz belongs to L_{20} because in this case the 20^{th} letter from the right of xz and yz is exactly the 2^{nd} letter from left of x and y as shown below

.	0	…	.	z

.	1	…	.	z

Hence x and y will be distinguishable *w.r.t.* L_{20} for i=2, as well. Continuing the process it can be shown that any pair of strings x and y belonging to S, will be distinguishable *w.r.t.* L_{20}. Since S contains 2^{20} strings, any two of which are distinguishable *w.r.t.* L_{20}, so using the theorem any FA accepting L_{20} must have at least 2^{20} states.

Note
It may be observed from the above example that using Martin's method, there exists an FA having 2^{20+1}-1=2,097,151 states. This indicates the memory required to recognize L_{20} will be the memory of a computer that can accommodate 21-bits *i.e.*the computer can be in 2^{21} possible states.

Finite Automaton with output
Finite automaton discussed so far, is just associated with the RE or the language.
There is a question whether does there exist an FA which generates an output string corresponding to each input string ? The answer is yes. Such machines are called machines with output.
There are two types of machines with output. Moore machine and Mealy machine

Moore machine
A Moore machine consists of the following
A finite set of states q_0, q_1, q_2, … where q_0 is the initial state.
An alphabet of letters Σ = {a,b,c,…} from which the input strings are formed.
An alphabet Γ={x,y,z,…} of output characters from which output strings are generated.
A transition table that shows for each state and each input letter what state is entered the next.
An output table that shows what character is printed by each state as it is entered.

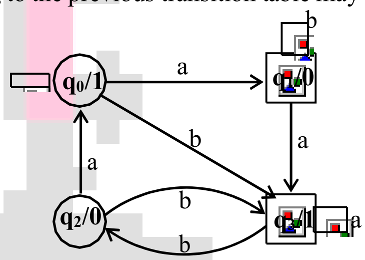
Note
It is to be noted that since in Moore machine no state is designated to be a final state, so there is no question of accepting any language by Moore machine. However in some cases the relation between an input string and the corresponding output string may be identified by the Moore machine. Moreover, the state to be initial is not important as if the machine is used several times and is restarted after some time, the machine will be started from the state where it was left off. Following are the examples

Example

Consider the following Moore machine having the states q_0, q_1, q_2, q_3 where q_0 is the start state and
$\Sigma = \{a,b\}$,
$\Gamma=\{0,1\}$
the transition table follows as

Old States	**New States after reading**		Characters to be printed
	a	**b**	
q_0-	**q_1**	**q_3**	1
q_1	**q_3**	**q_1**	0
q_2	**q_0**	**q_3**	0
q_3	**q_3**	**q_2**	1

the transition diagram corresponding to the previous transition table may be



It is to be noted that the states are labeled along with the characters to be printed. Running the string abbabbba over the above machine, the corresponding output string will be 100010101, which can be determined by the following table as well

Input		a	b	b	a	b	b	b	a
State	**q_0**	**q_1**	**q_1**	**q_1**	**q_3**	**q_2**	**q_3**	**q_2**	**q_0**
output	1	0	0	0	1	0	1	0	1

It may be noted that the length of output string is l more than that of input string as the initial state prints out the extra character 1, before the input string is read.

Theory of Automata

Lecture N0. 21
Reading Material

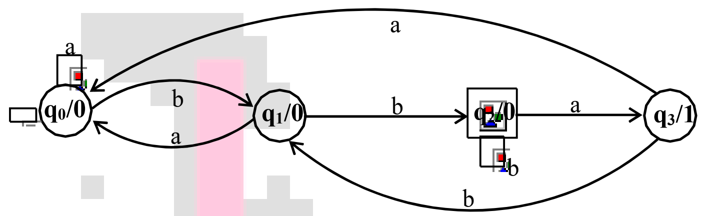
Introduction to Computer Theory Chapter 8

Summary

Example of Moore machine, Mealy machine, Examples, complementing machine, Incrementing machine.

Example

To identify the relation between the input strings and the corresponding output strings in the following Moore machine,



if the string bbbabaabbaa is run, the output string will be 000010000010, as shown below

Input		b	b	b	a	b	a	a	b	b	a	a
State	q_0	q_1	q_2	q_2	q_3	q_1	q_0	q_0	q_1	q_2	q_3	q_0
output	0	0	0	0	1	0	0	0	0	0	1	0

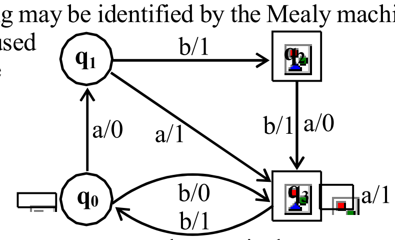
It can be observed from the given Moore machine that q_3 is the only state which prints out the character 1 which shows that the moment the state q_3 is entered, the machine will print out 1. To enter the state q_3, starting from q_0 the string must contain bba. It can also be observed that to enter the state q_3 once more the string must contain another substirng bba. In general the input string will visit the state q_3 as many times as the number of substring bba occurs in the input string. Thus the number of 1's in an output string will be same as the number of substring bba occurs in the corresponding input string.

Mealy machine

A Mealy machine consists of the following
A finite set of states q_0, q_1, q_2, … where q_0 is the initial state.
An alphabet of letters $\Sigma = \{a,b,c,\ldots\}$ from which the input strings are formed.
An alphabet $\Gamma=\{x,y,z,\ldots\}$ of output characters from which output strings are generated.
A pictorial representation with states and directed edges labeled by an input letter along with an output character. The directed edges also show how to go from one state to another corresponding to every possible input letter.
(It is not possible to give transition table in this case.)

Note

It is to be noted that since, similar to Moore machine, in Mealy machine no state is designated to be a final state, so there is no question of accepting any language by Mealy machine. However in some cases the relation between an input string and the corresponding output string may be identified by the Mealy machine. Moreover, the state to be initial is not important as if the machine is used several times and is restarted after some time, the machine will be started from the state where it was left off. Following are the examples



Example

Consider the Mealy machine shown aside, having the states q_0, q_1, q_2, q_3 , where q_0 is the start state and

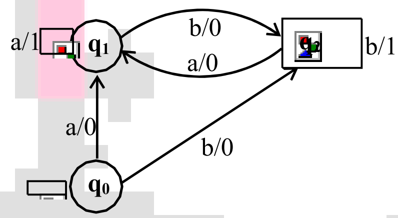
$\Sigma = \{a,b\}$,
$\Gamma=\{0,1\}$

Running the string abbabbba over the above machine, the corresponding output string will be 11011010, which can be determined by the following table as well

Input		a	b	b	a	b	b	b	a
States	q_0	q_1	q_2	q_3	q_3	q_0	q_3	q_0	q_1
output		0	1	1	1	1	0	1	0

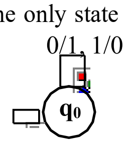
It may be noted that in Mealy machine, the length of output string is equal to that of input string.

Example
Consider the following Mealy machine having the states q_0, q_1, q_2 , where q_0 is the start state and
$\Sigma = \{a,b\}$,
$\Gamma=\{0,1\}$



It is observed that in the above Mealy machine, if in the output string the nth character is 1, it shows that the nth letter in the input string is the second in the pair of double letter.
For babaababba as input string the machine will print 0000100010.

Example
Consider the following Mealy machine having the only state q_0 as the start state and
$\Sigma = \{0,1\}$,
$\Gamma= \{0,1\}$



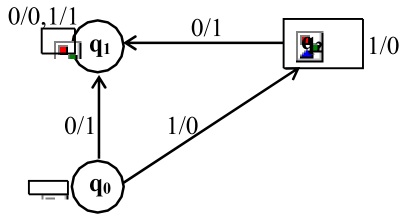
If 0011010 is run on this machine then the corresponding output string will be 1100101.
This machine is called **Complementing machine.**

Constructing the incrementing machine
In the previous example of complementing machine, it has been observed that the input string and the corresponding output string are 1's complement of each other. There is a question whether the Mealy machine can be constructed, so that the output string is increased, in magnitude, by 1 than the corresponding input string? The answer is yes.
This machine is called the incrementing machine. Following is how to construct the incrementing machine.
Before the incrementing machine is constructed, consider how 1 is added to a binary number.
Since, if two numbers are added, the addition is performed from right to left, so while increasing the binary number by 1, the string (binary number) must be read by the corresponding Mealy machine from right to left, and hence the output string (binary number) will also be generated from right to left.
Consider the following additions

```
a)   100101110          b)  1001100111
          + 1               + 1
     100101111              1001101000
```

It may be observed from the above that
If the right most bit of binary number, to be incremented, is 0, the output binary number can be obtained by converting the right most bit to 1 and remaining bits unchanged.
If the right most bit of binary number is 1 then the output can be obtained, converting that 1 along with all its concatenated 1's to 0's, then converting the next 0 to 1 and remaining bits unchanged.
The observations (a) and (b) help to construct the following Incrementing (Mealy) machine.
The Mealy machine have the states q_0, q_1, q_2 , where q_0 is the start state and

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



It may be observed that, in the incrementing machine, if 0 is read at initial state q_0, that 0 is converted to 1 and a no change state q_1 (no carry state) is entered where all 0's and all 1's remain unchanged. If 1 is read at initial state, that 1 is converted to 0 and the state q_2(owe carry state**)** is entered, where all 1's are converted to 0's and at that state if 0 is read that 0 is converted to 1 and the machine goes to no change state.
If the strings 100101110 and 1001100111 are run over this machine, the corresponding output strings will be 100101111 and 1001101000 respectively.

Note
It is to be noted that if the string 111111 is run over the incrementing machine, the machine will print out 000000, which is not increased in magnitude by 1. Such a situation is called an overflow situation, as the length of output string will be same as that of input string.
It may also be noted that there exists another incrementing machine with two states.

Theory of Automata

Lecture N0. 22
Reading Material

Introduction to Computer Theory Chapter 8

Summary
Applications of complementing and incrementing machines, Equivalent machines, Moore equivalent to Mealy, proof, example, Mealy equivalent to Moore, proof, example

Applications of Incrementing and Complementing machines
1's complementing and incrementing machines which are basically Mealy machines are very much helpful in computing.
The incrementing machine helps in building a machine that can perform the addition of binary numbers.
Using the complementing machine along with incrementing machine, one can build a machine that can perform the subtraction of binary numbers, as shown in the following method

Subtracting a binary number from another
Method
To subtract a binary number b from a binary number a
Add 1's complement of b to a (ignoring the overflow, if any)
Increase the result, in magnitude, by 1 (use the incrementing machine). Ignoring the overflow if any.
Note: If there is no overflow in (1). Take 1's complement once again in (2), instead. This situation occurs when b is greater than a, in magnitude. Following is an example of subtraction of binary numbers

Example
To subtract the binary number 101 from the binary number 1110, let
a = 1110 and b = 101 = 0101.
(Here the number of digits of b are equated with that of a)
Adding 1's complement (1010) of b to a.

```
  1110
 +1010
 11000  which gives 1000 (ignoring the overflow)
```

Using the incrementing machine, increase the above result 1000, in magnitude, by 1

```
 1000
   +1
 1001 which is the same as obtained by ordinary subtraction.
```

Note
It may be noted that the above method of subtraction of binary numbers may be applied to subtraction of decimal numbers with the change that 9's complement of b will be added to a, instead in step (1).

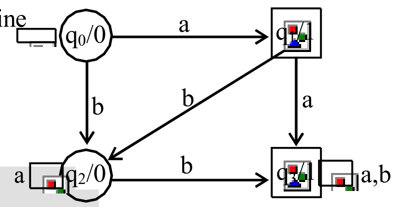
Equivalent machines
Two machines are said to be **equivalent** if they print the same output string when the same input string is run on them.
Remark:
Two Moore machines may be equivalent. Similarly two Mealy machines may also be equivalent, but a Moore machine can't be equivalent to any Mealy machine. However, ignoring the extra character printed by the Moore machine, there exists a Mealy machine which is equivalent to the Moore machine.

Theorem
Statement
For every Moore machine there is a Mealy machine that is equivalent to it (ignoring the extra character printed by the Moore machine).

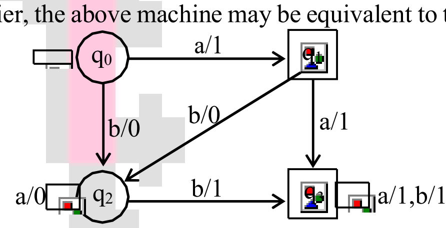
Proof:
Let M be a Moore machine, then shifting the output characters corresponding to each state to the labels of corresponding incoming transitions, machine thus obtained will be a Mealy machine equivalent to M.

Note
It may be noted that while converting a Moore machine into an equivalent Mealy machine, the output character of a state will be ignored if there is no incoming transition at that state. A loop at a state is also supposed to be an incoming transition.
Following is the example of converting a Moore machine into an equivalent Mealy machine

Example
Consider the following Moore machine



Using the method described earlier, the above machine may be equivalent to the following Mealy machine



Running the string abbabbba on both the machines, the output string can be determined by the following table

Input		a	b	b	a	b	b	b	a
States	**q_0**	**q_1**	**q_2**	**q_3**	**q_3**	**q_3**	**q_3**	**q_3**	**q_3**
Moore	0	1	0	1	1	1	1	1	1
Mealy		1	0	1	1	1	1	1	1

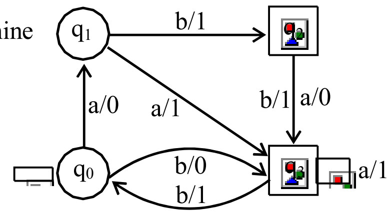
Theorem
Statement
For every Mealy machine there is a Moore machine that is equivalent to it (ignoring the extra character printed the Moore machine).

Proof
Let M be a Mealy machine. At each state there are two possibilities for incoming transitions
The incoming transitions have the same output character.
The incoming transitions have different output characters.
If all the transitions have same output characters, then shift that character to the corresponding state.
If all the transitions have different output characters, then the state will be converted to as many states as the number of different output characters for these transitions, which shows that if this happens at state q_i then q_i will be converted to q_i^1 and q_i^2 *i.e.* if at q_i there are the transitions with two output characters then q_i^1 for one character and q_i^2 for other character.
Shift the output characters of the transitions to the corresponding new states q_i^1 and q_i^2. Moreover, these new states q_i^1 and q_i^2 should behave like q_i as well. Continuing the process, the machine thus obtained, will be a Moore machine equivalent to Mealy machine M.
Following is a note

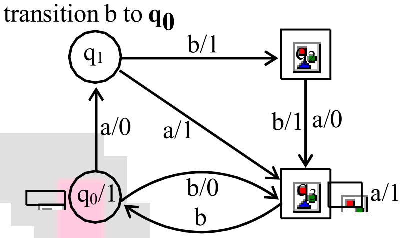
Note
It may be noted that if there is no incoming transition at certain state then any of the output characters may be associated with that state.
It may also be noted that if the initial state is converted into more than one new states then only one of these new states will be considered to be the initial state. Following is an example

<u>Example</u>

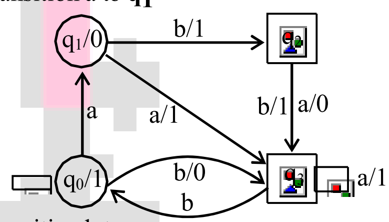
Consider the following Mealy machine



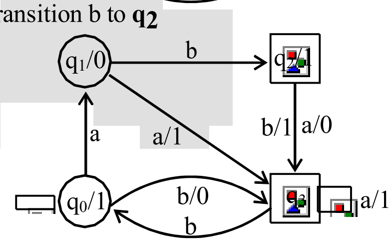
Shifting the output character 1 of transition b to q_0



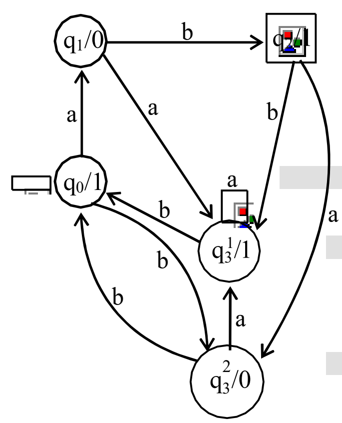
Shifting the output character 0 of transition a to q_1



Shifting the output character 1 of transition b to q_2



Splitting q_3 into q^1_3 and q^2_3



Running the string abbabbba on both the machines, the output strings can be determined by the following table

Input		a	b	b	a	b	b	b	a
States	q_0	q_1	q_2	q_3	q_3	q_0	q_3	q_0	q_1
Mealy		0	1	1	1	1	0	1	0
Moore	1	0	1	1	1	1	0	1	0

CS402 Grand Quiz (Screenshots) Mega File

1. The minimum length of the strings(except null string) of a language that starts and ends in the same letter will be:

- **1**
- 2
- 3
- 4

2. If S = {ab,bb} then S* will not contain ________.

- abbbab
- **bbba**
- bbbbab
- ababbb

3. Which of the following machine has only one initial state and no final state?

- **Moore machine**
- Finite state machine
- Deterministic finite state machine

- Non deterministic finite state machine

4. Which of the following diagram is very rigid in order to express any language?

- TG
- NFA^
- GTG
- **FA**

5. If S = {a}, then S+ will be _____

  - {a, aaa, aaaa, aaaaa,…}
  - **{a, aa, aaa, aaaa,…}**
  - {a, aaa, aaaaa, aaaaaaa,…}
  - {aa, aaaa, aaaaaa, aaaaaaaa,…}

6. Let L be the language of all strings. defined over ∑ = {0,1}. ending in 111. Which of the following strings are indistinguishable with respect to L with z being 11?

  - **111, 101**
  - 100, 101
  - 110, 101
  - 010, 101

7. Melay machine can have ------- final states.

- **Zero**
- One
- More than one but finite
- More than one but infinite

8. In Moore machine, output is produced over the change of:

- Transitions
- **States**
- Transitions and states
- None of the mentioned

9. Given the language L = {ab, aa, baa}, which of the following strings are in L*?

1) abaabaaabaa
2) aaaaaaaaa
3) baaaaabaaaab
4) baaaaabaa

- 1, 2 and 3
- 2, 3 and 4
- **1, 2 and 4**

- 1, 3 and 4

10. Let L be the language of all strings, defined over ∑ = {0,1}, ending in 10. Which of the following strings are distinguishable with respect to L with z being 0?
   - 111, 101
   - 001, 101
   - 111, 111
   - **010, 101**

11. Let's we have two regular expressions R1=(xx+yy) and R2=(x+ y). Which one of the following is the correct regular expression for the Union of R1 and R2?
   - (xx+yy)(x+y)
   - (xx+yy)+(x+y)*
   - **(xx+yy)+(x+y)**
   - ((xx+yy)+(x+y))*

12. FA corresponding to an NFA can be built by introducing a state corresponding to the combination of states, for a letter having

- **no transition at certain state**
- one transition at certain state
- more than one transitions at certain state
- none of the given options

13. The state where there is no way to leave after entry called ______

- **Davey John locker**
- initial state
- final state
- non-final state

14. Which one of the following word is not accepted by the given regular expression?

- aaabab
- aaaababb
- **abbaab**
- aabbabb

15. The minimum length of the strings(except null string) of a language that starts and ends in different letters will be:

- 1
- **2**

- 3
- 4

16.According to theory of automata there are ______ types of languages

- One
- **Two**
- Three
- Four

17.Which one of the following word is not accepted by the given regular expression?

(a+b)*(aaa+bbb)(a+b)*

- ababaaaab
- bababbbba
- **baabaabba**
- abbaaabba

18.Regular languages are closed under the following operations.

- Union only
- Concatenation, Closure only
- **Union, Concatenation and Closure**
- Regular languages are not closed under any operation.

19.If S = {x}, then S* will be _________.

- {^,x,xxx,xxxx,xxxxx,…}
- **{^,x,xx,xxx,xxxx,…}**
- {^,x,xxx,xxxxx,xxxxxxx,…}
- {^,xx,xxxx,xxxxxx,xxxxxxxx,…}

20. There can be more than _____ FA for a certain language but for _____ FA there is only one language associated with it:

- **one, one**
- one, two
- two, three
- two, one

21. There is one compulsion that each state must have an on outgoing edge for every input variable in:

- Finite Automata
- **Transition Graph**
- Both Finite Automata and Transition Graph
- Transition Table

22. FA is also called

- TG
- GTG
- NFA
- **DFA**

23. In the context of make NFA for the concatenation of FA1 and FA2 (Both FAs accepting null string), which of the following option is correct?

- **Final states in both FAs**
- Initial states in both FAs
- FA2 having initial state only
- FA2 having final state only

24. If r1 and r2 are regular expression then (r1 * r2) is _______

- FA
- TG
- GTG
- **RE**

25. Which of the following is the minimal number of states for a finite automaton accepting the language of all strings defined over any alphabet set?

- **1**

- 2
- 3
- 4

26. Keeping in view the language of all strings ending with ‘a’, for which symbol we will take a loop on the final state of its transition diagram?

    - **a**
    - b
    - c
    - d

27. Which of the following statements is true about NFA with Null String?

    - Infinite states
    - Infinite set of letters
    - Infinite set of transitions
    - **Transition of null string is allowed at any stage**

28. Introducing new start state in case of multiple start states is the step no. ____ of proving Kleene’s theorem part ||.

    - **1**
    - 2
    - 3
    - 4

29. Which of the following diagrams expresses languages more simply?

- FA
- NFA
- TG
- **GTG**

30.The language of all strings defined over alphabet set = {a, b} that does not end with 'a' actually ends with:

- b
- **b and ^**
- ^
- ^ and a

31. Let L be the language of all strings, defined over ∑ = {0,1}, ending in 10. Which of the following strings are indistinguishable with respect to L with z being 0?

- 100, 101
- **111, 101**
- 110, 101
- 010, 101

32. Let S = {aa, bb}, then S* will have the ____ string.

  - ^

- abba
- aabbbaa
- bbaab

33. In NFA having no transition at certain state, FA can be built by introducing:

- **Empty state**
- Combination of states
- Initial state
- Final state

34. Formal is also known as ______

- **Syntactic language**
- Semantic language
- Informal language
- None of these

35. There may be more than one transition for a certain letter on a state in:

- Finite automata
- **Non-Deterministic Finite Automata**
- Transition Table
- Moore Machine

36. A loop at a state is supposed to be ------- transition while converting Moore machine into an equivalent Melay machine.

- **Incoming**
- Outgoing
- Both incoming and outgoing
- Complex

37. FA of EVEN language shows null string when ____

- **Initial state is final as well**
- EVEN does not accept null
- One state is declared null
- None of the these

38. Which of the following statement is true about GTG?

- Transitions are based on input letters
- Transitions are based on specified substrings
- **Transitions are based on regular expressions**
- Transitions are based on alphabet set

39. Which one of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

- Moore machine
- **Mealy machine**
- Finite state machine
- Deterministic finite state machine

40. In GTG, there can be more than one:

- Start state
- Final state
- **Start state and final state**
- Null state

41. GTG for the expression (aa+aba)* may have minimum number of states:

- **1**
- 2
- 3
- 4

42. In regular expressions, the operator '*' stands for

- **Concatenation**
- Iteration
- Selection
- Addition

43. If we have only one state, having no transition for input letters, then it is an example of:

- RE
- FA
- TG
- **NFA**

44. If A and B are regular languages, !(A’ U B’) is:

- **Regular**
- Non regular
- May be regular
- None of the mentioned

45. A ______ with “n” states must accept at least one string of length greater than “n”.

- **DFA**
- RE
- Irregular language
- Irrelevant language

46. If r1 is a regular expression then (r1)* is _______.

- A generalized transition graph
- A non-deterministic finite automaton

- A finite automaton
- **Also a regular expression**

47.Which of the following is the bypass and state elimination step in the context of Kleene's theorem part || proof?

- 1
- 2
- 3
- **4**

48. Every ________ is a _____ as well, but the converse may not be true.

- TG, FA
- **FA, TG**
- TG, GTG
- FA, GTG

49. Which of the following is free of non-determinism?

- TG
- **FA**
- NFA
- NFA-^

50. There is no question of accepting any language in:

- FA
- TG
- GTG
- **Moore machine**

51. There state where there is no way to leave after entry is called ____.

- **Davey john locker**
- Initial state
- Final state
- Non-final state

52. A string will be accepted by an NFA if there exists _____ one successful path.

- **Atleast**
- Atmost
- Maximum
- None of the given options

53. Melay machine to increase the output string in magnitude by 1 is called:

- Complementing machine
- **Incrementing machine**
- Decrementing machine

- Converting machine

54. Kleene's Theorem part | expresses the relationship between ____.

- **FA and TG**
- TG and RE
- RE and FA
- FA and RE

55.Keeping in view the discussion by martin, how many states are required to recognize the language of all strings of length 2 or more defined over ∑ = {a,b}, with 'b' being the second letter from right?

- 6
- **7**
- 8
- 9

56. Suppose we have FA3 (which is equal to FA1 + FA2), then the final state of FA3 will be declared final if:

- It corresponds to final states of both FA1 and FA2
- It corresponds to final states of FA1 only
- It corresponds to final states of FA2 only
- **It corresponds to any of the final states in FA1 or FA2**

57. FA and _____ are same except that ____ has unique symbol for each transition.

- FA, TG
- NFA, TG
- **NFA, FA**
- GTG, NFA

58. In NFA having no transition at certain state, FA can be built by introducing:

- **Empty state**
- Combination of states
- Initial state
- Final state

59. Subtraction of binary numbers is possible through:

- Complementing machine
- Incrementing machine
- **Both complementing and incrementing machine**
- Converting machine

60. Null strings can be specified on edges in:

- Finite Automata
- Non-Deterministic Finite Automata

- **Transition Graph**
- Melay Machine

61. What is false about the PALINDROME LANGUAGE?

- Every word is reverse of itself.
- It is an infinite language.
- FA can be build for it.
- **None of the given option**

62. While finding RE corresponding to TG, If TG has more than one start state then

- **Introduce the new start state**
- Eliminate the old start state
- Replace the old start stat with final state
- Replace the old final state with new start state

63. All possible combinations of strings of a language including null string is referred as:

- Concatenation of a language with itself
- **Kleene star closure of a language**
- Multiplication of language with itself
- Addition of a language with itself

64. n! will be equal to:

- n*n
- n*(-n)!
- n*(n-1)
- **n*(n-1)!**

65. Every NFA can be considered to be a ----- as well, but the converse may not be true.

- FA
- **TG**
- GTG
- PDA

66. While finding RE corresponding to a TG, we connect the new start state with the old start state by ______ transition.

- a
- b
- **Null**
- RE

67. In proving Kleene Theorem ||, if three states are connected then middle state is removed by connecting first and third state and writing corresponding RE in:

- Sum
- **Concatenation**
- Difference
- Asterisk

68. In ______ there must be transition for all the letters of a string.

- NFA
- GTG
- TG
- **FA**

69. There is no question accepting any language in:

- FA
- TG
- GTG
- **Moore machine**

70. For a given Moore Machine, the input string is ‘101010’, thus the output string would be of length:

- **Length of input string + 1**
- Length of input string – 1
- Length of input string + 2
- Length of input string -2

71. The FA can be drawn for the regular expression (a+b)* with minimum ______ state(s).

- **1**
- 2
- 3
- 4

72. Which of the following does not contribute while finding out the length of strings?

- ^
- a
- b
- a+b

73. The language of all strings defined over alphabet set = {x, y} that ends with same letters will have the maximum length of:

- 1
- 2
- 3
- **Infinite**

74. Considering FA1 and FA2 states each. Now FA1+FA2 can have maximum _______ number of states.

- 2
- 3
- More than 3
- **None of the given option**

75. Which one of the following is the RE for the language defined over ∑= {a, b} having all the words starting with a?

- (a + b)*
- aa(a + b)+
- **a(a + b)***
- a*(a + b)

76. An ______ can be considered to be an intermediate structure between Finite automaton and Transition Graph.

- RE
- GTG
- **NFA**
- None of the given options

77. Given the language L = {ab, aa, baa}, which of the following strings are in L*?

1) abaabaaabaa
2) aaaabaaaa
3) baaaaabaaaab
4) baaaaabaa

- 1, 2 and 3
- 2, 3 and 4
- **1, 2 and 4**
- 1, 3 and 4

78. In order to make NFA for the union of FA1 and FA2, the new initial state should be linked to:

- Initial and final states of FA1 and FA2 respectively

- **Initial states of both FAs**
- Initial state of FA1 only
- Final and initial states of FA1 and FA2 respectively

79. We cannot construct an NFA for the language of ____ defined over alphabet set {a,b}.

- Even even
- Odd
- **Palindromes**
- Integers

80. FA and ____ are same except that ____ has unique symbol for each transition.

- FA, TG
- NFA, TG
- **NFA, FA**
- GTG, NFA

81. If L is regular language, then (L')' U L will be:

- L
- L'
- ^
- None of the mentioned

82. Suppose a language L1 has 2 states and L2 has2 states. If we have a machine M that accepts L1 ∩ L2. Then, the total number of states in M is equal to______

- 2
- **4**
- 6
- 8

83.If L1 and L2' are regular languages. L1 ∩ (L2' ∪ L1')' will be

- **Regular**
- Non regular
- May be regular
- None of the mentioned

84.In mealy machine the output depends on ______

- Only present state
- **Present state and Present input**
- Nothing
- Type of input

85.There is no question of accepting any language in:

- FA
- Moore machine

- Melay machine
- **Both moore and melay machine**

86.The state where there is no way to leave after entry is called _______

- **Davey John Locker**
- Initial state
- Final state
- Non-final state

87.FA corresponding to an NFA can be built by introducing an empty state for a letter having

- **No transition at certain state**
- One transition at certain state
- Two transitions at certain state
- More than two transitions at certain state

88.Which of the following diagrams expresses languages more simply?

- FA
- NFA
- TG
- **GTG**

89.Automata is the plural of _____.

- Automate

- **Automaton**
- Automation
- Automatic

90.If A and B are regular languages. !(A' ∪ B') is:

- **Regular**
- Non regular
- May be regular
- None of the mentioned

91.In NFA having no transition at certain. FA can be built by introducing:

- **Empty state**
- Combination of states
- Initial state
- Final state

92. If S = {x}, then S* will be ________.

- {^,x,xxx,xxxx,xxxxx,…}
- **{^,x,xx,xxx,xxxx,…}**
- {^,x,xxx,xxxxx,xxxxxxx,…}
- {^,xx,xxxx,xxxxxx,xxxxxxxx,…}

93. Considering FA1 and FA2 states each. Now FA1+FA2 can have maximum ______ number of states.

- 2
- 3
- **More than 3**
- None of the given option

94. In an FA. When there is no path starting from initial state and ending n final state then that FA________

- Accept null string
- Accept all strings
- Accept all non-empty strings
- **Does not accept any string**

95. According to theory of automata there are _____ types of languages.

- One
- **Two**
- Three
- Four

96. In Moore machine. If the length of input is 9, then the length of output sring will be:

- 7
- 8
- 9

- **10**

97. When ODD language is expressed by an FA, then it will have minimum ____ states.

- **One**
- Two
- Three
- Four

98. [(a + b)(a + b)]*, given RE cannot generate the string ____.

- abbaabab
- abbbaa
- **bbbbbb**
- abbbaaaaa

99. Which of the following statement is true about GTG?

- Transitions are based on input letters
- Transitions are based on specified substrings
- **Transitions are based on regular expressions**
- Transitions are based on alphabet set

100. Every ________ is a _____ as well, but the converse may not be true.

- TG, FA
- **FA, TG**

- TG, GTG
- FA, GTG

101. Which one of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

- Moore machine
- **Mealy machine**
- Finite state machine
- Deterministic finite state machine

102. The recursive method for defining a language has ____ steps.

- One
- Two
- **Three**
- Four

103. Consider the following RE:

a(a + b)b*

All of the following words are accepted except _____.

- aab
- abb

- aa
- **aba**

104. Which of the following regular expressions represent same language?

1. (a+ab)*
2. (ba+a)*
3. a*(aa*b)*
4. (a*b*)*

- **1 and 2**
- 1 and 3
- 3 and 4
- 1 and 4

105. For every three regular expressions R, S, T, the languages denoted by R(S U T) and (RS) U (RT) are the ____.

- **Same**
- Different
- R(S U T) is greater
- None of the given options

106. Alphabet S = {a, bc, cc} has _____ number of letters.

- One
- Two

- **Three**
- Four

107. An _______ can be considered to be an intermediate structure between Finite automaton and Transition Graph.

- RE
- GTG
- **NFA**
- None of the given options

108. Two FAs are said to be equivalent, if they ______

- Accept null string
- **Accept same language**
- Accept different language
- None of the given options

109. There may be more than one transition for a certain letter on a state in:

  - Finite automata
  - **Non-Deterministic Finite Automata**
  - Transition Table
  - Moore Machine

110. -------- can also help in proving Kleene Theorem |||.

- **NFA**
- PDA
- Moore machine
- Melay machine

111. Kleene's Theorem part || expresses the relationship between ____.

- FA and TG
- **TG and RE**
- RE and FA
- FA and RE

112. FA corresponding to an NFA can be built by introducing an empty state for a letter having

- **No transition at certain**
- One transition at certain state
- Two transitions at certain state
- More than two transitions at certain state

113. Let L be the language of all strings, defined over $\sum = \{0,1\}$, ending in 10. Which of the following strings are distinguishable with respect to L with z being 0?

- **111, 101**
- 001, 101

- 111, 111
- 010, 101

114. FA is also called

- TG
- GTG
- NFA
- **DFA**

115. If two RE's generate same language then these RE's are called ____.

- Same RE
- Equal RE
- Similar RE
- **Equivalent RE**

116. We cannot construct an NFA for the language of ____ defined over alphabet set {a,b}.

- Even even
- Odd
- **Palindromes**
- Integers

117. Kleene's Theorem part ||| expresses the relationship between ____.

- FA and TG

- TG and RE
- **RE and FA**
- FA and RE

118. Let FA3 be an FA corresponding to FA1FA2, then initial state of FA3 must correspond to the initial state of

- FA1 only
- FA2 only
- **FA1 or FA2**
- FA1 and FA2

119. Every FA should be________.

- **Deterministic**
- Non-deterministic
- Deterministic and non-deterministic
- Not depends on language

120. What statement is true?

- **A letter is always a combination of symbols**
- A letter may consist of one symbol
- There is no difference between symbol and letter
- Letters and symbols are the same thing

121. If ∑= {ab, bb}, then ∑* will not contain

- abbbab
- **bbba**
- bbbbab
- ababbb

122. Choose the correct word produced by RE (a + b)* ab

- abb
- **abab**
- bbbb
- aaaa

123. According to 1st part of the Kleene's theorem, If a language can be accepted by an FA then it can be accepted by a ______ as well

- FA
- CFG
- GTG
- **TG**

124. "One language can be expressed by ______ GTG".

- Only one
- Only two
- Only three
- **More than one**

125. In GTG, if a state has more than one incoming transitions from a state. Then all those incoming transitions can be reduced to one transition using _____ sign

- -
- +
- *
- ( )

126. If a TG has more than one start states, then we can make a single start state by introducing a new state and connecting it with all the previously existing start states by using _____.

- Any infinite string
- Single letter string
- **Null string**
- Any finite string

127. If in a NFA, ^ is allowed to be a label of an edge then that NFA is called _____.

- TG
- RE
- **NFA with null string**
- RE

128. If we want to make a Moore machine equivalent to mealy machine then _____

- **We should ignore the extra character printed by the Moore machine.**
- We should ignore the extra character printed by the Mealy machine.
- We will make the initial state as a no carry state.
- We should not ignore the extra character printed by the Moore machine.

129. Two machine are said to be equivalent if they print the ______ output string when same input string is run no them.

- **Same**
- Different
- Inverse
- Null

130. The length of output in case of _____ is one more than the length of corresponding input string

- Moore machine
- **Mealy machine**
- Incremental machine
- Adding machine

131. A is not a valid transition in _____

- TG

- GTG
- **NFA**
- RE

132. Dead states are also called ____

- John Davey Lockers
- **Davey John Lockers**
- Mutex Lockers
- Semaphores

133. Language of all strings whose length is odd and number of y's even defined over alphabet set ∑ = {x, y} . ______ will be accepted by the given language.

- xxyxyxyyyx
- **xxyxyxyyyxy**
- xxyxyxyyyxx
- xxyxyxyyy

134. If an effectively solvable problem has answer in Yes or NO. then the solution is called ____

- Infinite problem
- **Decision procedure**
- Finite solution

- Optimal procedure

135. If the intersection of two regular languages is regular then the complement of the intersection of these two languages is _____

- **Regular**
- Irregular
- Irregular but finite
- Irregular but infinite

136. If R is regular language and Q is any language (regular/non-regular). Then Pref(_______in _______) is regular.

- Q, Q
- **Q, R**
- R, Q
- R, R

137. The strings or words which do not belong to a language are called ____ of that language

- Intersection
- Union
- **Complement**
- Quotient

138. Prime is a ______ language.

- Finite
- Both context free and regular
- Regular
- **Non-regular**

139. Finite Automaton (FA) must have _____ number of states while a language has ___ words.

- Infinite, finite
- Finite, finite
- **Finite, infinite**
- Infinite, infinite

140. The language "PRIME" is an example of ____ language.

- Regular but finite
- Regular
- Non regular but finite
- **Non regular**

141. If L1 and L2 are regular languages then which statement is NOT true?

- L1 + L2 is always regular
- L1 L2 is always regular
- **L1/L2 is always regular**
- L1* is always regular

142. If a language is regular it must generate ______ number of distinct classes.

- **Finite**
- Infinite
- Two
- three

143. The operators like (* . +) in the parse tree are considered as _____

- **Terminals**
- Non-terminals
- Productions
- Intermediates

144. Set of all palindromes over {a,b} is:

- Regular
- Regular and finite
- Regular and infinite
- **Non-regular**

145. Which one of the following languages is a non-regular language?

- Even-even
- Containing double a
- Start and end with same letter

- **Palindrome**

146. The language of all strings partition ∑* into _______ class(es).

- **One**
- Two
- Three
- Four

147. The language of all strings not beginning with ‘b’ partitions ∑* into _______ distinct classes.

- Two
- **Three**
- Four
- Five

148. The values of input (say a & b) do not remain same in one cycle due to

- NAND gate
- **Clock pulse**
- OR gate
- NOT gate

149. In a CFG, the non-terminals are denoted by _____

- Small letters

- Numbers
- **Capital letters**
- Small letters and numbers

150. Which of the following statement is true about GTG?

- Transitions are based on input letter
- Transitions are based on specified substring
- **Transitions are based on regular expression**
- None of the given options

151. a* + b* = (a + b)* this expression is _____

- True
- **False**

152. Length of EVEN-EVEN language is _____

- **Even**
- Odd
- Sometimes even & sometimes odd
- Such language doesn't exist

153. While finding RE corresponding to TG, we connect the new start state to the old start state by the transition labeled by

- a
- b

- null
- **none of the given options**

154. If S = {aa, bb}, then S* will not contain

- aabbaa
- bbaabbbb
- **aaabbb**
- aabbbb

155. Regular language are closed under the following operations.

- Union only
- Concatenation, Closure only
- **Union, concatenation and closure**
- Regular languages are not closed under any operation

156. [(a + b)(a + b)]*, given RE cannot generate the string___

- abbaabab
- abbbaa
- bbbbbb
- **abbbaaaaa**

157. while finding RE corresponding to TG, if TG has more than one start state then

- **Introduce the new start state**

- Eliminate the old start state
- Replace the old start state with final state
- Replace the old final state with new start state

158. The states in which there is no way to leave after entry are called

- **Davey john lockers**
- Dead states
- Waste baskets
- All of the given options

159. Every TG is an FA

- True
- **False**

160. Which of following string(s) belongs to the language of the regular expression (aa*b)*?

- baabab
- abbbaa
- aaaaaa
- **aabaab**

161. If S = {ab, bb}, then S* will not contain

- abbbab
- **bbba**

- bbbbab
- ababbb

162. Given S, Kleene star closure is denoted by
- **S***
- S+
- S-
- None of these

163. Which of the following steps replaces multiple incoming transition edges with a single one in proving Kleene's theorem part ||?
- 1
- 2
- 3
- **4**

164. Let FA1 accepts many strings and FA2 accepts no string, then FA1+FA2 will be equal to:
- **FA1**
- FA2
- FA2+FA1
- (FA2)*

165. If r1 = (aa + bb) and r2 = (a + b) then the language (aa + bb)(a + b) will be generated by _____

- **(r1)(r2)**
- (r1 + r2)
- (r2)(r1)
- (r1)*

166. The language having even numbers of a's and even number b's defined over S = {a, b} is called ____

- **EVEN-EVEN**
- ODD-ODD
- PALINDROME
- FACTORIAL

167. If L1' and L2' are regular languages. Then L1,L2 will be

- **Regular**
- Non regular
- May be regular
- None of the mentioned

168. If we have a finite language and the number of states in the FA is n then the maximum numbers of letters in the each word of the language that will be accepted by the given FA will be:

- 1
- **n-1**
- n+1
- n

169. Which of the following state is introduced while developing NFA for the closure of an FA?

- Simply an initial state
- Final state
- **An initial state which should be final as well**
- An initial state with loop for all letters

170. If FA1 corresponding to (a+b)* then FA1 must accept ____ string/strings

- No
- Odd length
- Even length
- **Every**

171. In FA, initial state can be represented by:

- **Drawing an arrow head before that state**
- Drawing a circle in that state
- Drawing '+' sign in that state

- Leaving state empty

172. The length of string “AbBAbcd” defined over $\sum$ = {Ab,B,c,d} is ______

- Three
- Four
- **Five**
- Six

173. An FA is a collection of:

- **Finite states, finite transition and finite input letters**
- Infinite states, infinite transition and infinite input letters
- Only finite states and finite transitions
- Only infinite states and infinite transitions

174. NFA with null string has ------ initial state(s)

- **One**
- Two
- Three
- Many

175. String x,y,z belongs to $\sum$*such that xz $\in$ L but yz $\notin$ L where L $\subseteq$ $\sum$*are:

- **Distinguishable**
- Indistinguishable

- Both distinguishable and indistinguishable
- Undetermined

176. In which of the following machine, the length of output string is the same to that of input string?

- Moore machine
- Finite automaton with output
- **Mealy machine**
- Non-deterministic finite automaton

177. There ____ a language for which only FA can be built but not the RE.

- Is
- **Cannot be**
- May be
- May not be

178. Reverse of string “YxwzYz” defined over $\sum=\{w,x,Y,z\}$ is

- zYzxwy
- zYwzxY
- zYzwyx
- **zYzwxY**

179. Which one of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

- Moore machine
- **Mealy machine (rep)**
- Finite state machine
- Deterministic finite state machine

180. While finding RE corresponding to TG, If TG has more than one start state then

- **Introduce the new start state (rep)**
- Eliminate the old start state
- Replace the old start stat with final state
- Replace the old final state with new start state

181. For every three regular expressions R, S, T, the languages denoted by R(S ∪ T) and (RS) ∪ (RT) are the ____.

- **Same (rep)**
- Different
- R(S ∪ T) is greater
- None of the given options

182. Which of the following is the minimal number of states for a finite automaton accepting the language of all strings defined over any alphabet set?

- **1 (rep)**
- 2
- 3
- 4

183. Every FA should be________.

- **Deterministic (rep)**
- Non-deterministic
- Deterministic and non-deterministic
- Not depends on language

184. The difference between number of states with regular expression (a + b) and (a + b)* is:

- **0**
- 1
- 2
- 3

185. If S = {x}, then S* will be ________.

- {^,x,xxx,xxxx,xxxxx,…}

- **{^,x,xx,xxx,xxxx,…} (rep)**
- {^,x,xxx,xxxxx,xxxxxxx,…}
- {^,xx,xxxx,xxxxxx,xxxxxxxx,…}

186. The recursive method for defining a language has _____ steps.

- One
- Two
- **Three (rep)**
- Four

187. The language of all strings defined over alphabet set = {x, y} that ends with same letters will have the maximum length of:

- 1
- 2
- 3
- **Infinite (rep)**

188. Given S, Kleene star closure is denoted by

- **S***
- S**
- S+
- S-

189. Kleene’s Theorem part ||| expresses the relationship between _____.

- FA and TG
- TG and RE
- **RE and FA (rep)**
- FA and RE

190. In order to make NFA for the union of FA1 and FA2, the new initial state should be linked to:

- Initial and final states of FA1 and FA2 respectively
- **Initial states of both FAs (rep)**
- Initial state of FA1 only
- Final and initial states of FA1 and FA2 respectively

191. If S = {a,b} then which of the following RE will generate all possible strings?

- a* + b*
- (ab)*
- **(a + b)***
- (ab + ba)*

192. Choose the correct word produced by RE (a + b)* (aa+bb).

- abab
- babab
- **aaaa**

- ab

193. While developing NFA for the union of FA1 and FA2, there will be ______ transition/transitions for both ‘a’ and ‘b’ on the new initial state.

- Single
- Only one
- Only three
- **Multiple**

194. Keeping in view the discussion by martin, how many states are required to recognize the language of all strings defined over ∑ = {a,b}, with ‘a’ being the third letter from right?

- 13
- 14
- **15**
- 16

195. Consider FA1 and FA2 are two finite automata representing two different languages. Now FA3 which is the sum of FA1 and FA2 will accept all strings accepted by:

- **FA1 and FA2**
- FA1 or FA2
- FA1 but not FA2

- ➢ FA2 but not FA1

196. A transition graph is converted into a(n) _____ in order to obtain regular expression.

- ➢ FA
- ➢ GTG
- ➢ **NFA**
- ➢ NFA-^

197. All possible combinations of strings of a language including null string is referred as:

- ➢ Concatenation of a language with itself
- ➢ **Kleene star closure of a language (rep)**
- ➢ Multiplication of language with itself
- ➢ Addition of a language with itself

198. There ____ be dead state in NFA.

- ➢ May not
- ➢ Must
- ➢ Should not
- ➢ **Will**

199. In which of the following machine, the length of output string is 1 more than that of input string?

- Mealy machine
- **Moore machine**
- Finite automaton with output
- Non-deterministic finite automaton

200. Consider the languages L1 = and L2 = {a}. Which one of the following represents L1 L2* ∪ L1*

  - ^
  - **a***
  - All of the mentioned
  - None of the mentioned

201. The length of string "AbBAbcd" defined over ∑ = {Ab,B,c,d} is ______

  - Three
  - Four
  - **Five (rep)**
  - Six

202. What is false about the PALINDROME LANGUAGE?

- Every word is reverse of itself.
- It is an infinite language.
- FA can be build for it.

- **None of the given option (rep)**

203. The language of all strings defined over alphabet set = {x, y} that ends with same letters will have the maximum length of:

- 1
- 2
- 3
- **Infinite**

204. In the context of make NFA for the concatenation of FA1 and FA2 (none accepting null string), which of the following option is correct?

- No Initial and final states in FA1 and FA2 respectively
- No final and initial states in FA1 and FA2 respectively
- **No initial state in FA1 only**
- No final state in FA2 only

205. Let FA3 be an FA corresponding to FA1FA2, then final state of FA3 must correspond to the final state of

- FA1 only
- **FA2 only**
- FA1 or FA2
- FA1 and FA2

206. In regular expressions, the operator '*' stands for

- **Concatenation (rep)**
- Iteration
- Selection
- Addition

207. Statement if ∑ is finite then ∑* is finite is ____

- True
- **False**
- ∑ and ∑* has no relationship
- None of the above

208. Closure of an FA is the same as _____ of an FA with itself except that the initial state of the required FA is a final state as well.

- Union
- Sum
- **Concatenation**
- Intersection

209. There can be more than _____ FA for a certain language but for _____ FA there is only one language associated with it:

- **one, one**
- one, two
- two, three

- two, one

210. An FA is a collection of:

- **Finite states, finite transition and finite input letters (rep)**
- Infinite states, infinite transition and infinite input letters
- Only finite states and finite transitions
- Only infinite states and infinite transitions

211. If ∑= {ab, bb}, then ∑* will not contain

- abbbab
- **bbba (rep)**
- bbbbab
- ababbb

212. In ______ there must be transition for all the letters of a string.

- NFA
- GTG
- TG
- **FA (rep)**

213. Choose the correct word produced by RE (a + b)* ab

- abb
- **abab (rep)**
- bbbb

- aaaa

214. Length of EVEN-EVEN language is _____

  - **Even (rep)**
  - Odd
  - Sometimes even & sometimes odd
  - Such language doesn’t exist

215. All possible combinations of strings of a language including null string is referred as:

- Concatenation of a language with itself
- **Kleene star closure of a language (rep)**
- Multiplication of language with itself
- Addition of a language with itself

216. Kleene's theorem states that

- **All representations of a regular language are equivalent**
- All representations of a context free language are equivalent
- All representations of a recursive language are equivalent
- Finite automate are less powerful than pushdown automata

217. Let S = {a, bb, bab, baabb}be a set of strings, which one of the following will not be include in S*?

  - baba

- baabbabb
- **bbaaabb**
- bbbaabaabb

218. Which of the following state is introduced while developing NFA for the closure of an FA?

- Simply an initial state
- Final state
- **An initial state which should be final as well (rep)**
- An initial state with loop for all letters

219. In the context of make NFA for the concatenation of FA1 and FA2 (Both FAs accepting null string), which of the following option is correct?

- **Final states in both FAs (rep)**
- Initial states in both FAs
- FA2 having initial state only
- FA2 having final state only

220. Consider the following RE:

a(a + b)b*

All of the following words are accepted except _____.

- aab
- abb

- aa
- **aba (rep)**

221. In drawing FA3 (which is equal to FA1 + FA2), a state will be declared final if _______

- It corresponds to final states of both FA1 and FA2
- It corresponds to final states of FA1
- It corresponds to final states of FA2
- **It corresponds to any of the final states in FA1 or FA2**

222. An _______ can be considered to be an intermediate structure between Finite automaton and Transition Graph.

- RE
- GTG
- **NFA (rep)**
- None of the given options

223. Statement 1: string is accept in Moore Machine.

Statement 2: there are more than 5-Tuples in the definition of Moore Machine.

Choose the correct option:

- Statement 1 is true and Statement 2 is true
- **Statement 1 is true while Statement 2 is false**

- Statement 1 is false while Statement 2 is true
- Statement 1 and Statement 2. Both are false

224. If two RE's generate same language then these RE's are called ____.

- Same RE
- Equal RE
- Similar RE
- **Equivalent RE (rep)**

225. If we have more than one accepting states or an accepting state with an outdegree. Which of the following actions will be taken?

- **Addition of new state**
- Removal of a state
- Make the newly added state as final
- More than one option is correct

226. Which of the following string is a part of EQUAL language?

- aabbba
- babab
- **ababab**
- aabbaa

227. Moore machine is an application of:

- Finite automata without input

- **Finite automata with output**
- Non-finite automata with output
- None of the mentioned

228. Which of the following word is not accepted by the regular expressions (a + b)*(aa)(a+b)*?

  - aaaa
  - baaa
  - aa
  - **bab**

229. Keeping in view the language of all strings ending with 'a', for which symbol we will take a loop on the final state of its transition diagram?

- **a**
- b
- c
- d

230. Two machines are said to be equivalent if they print the ___output string when the ____ input string is run on them.

  - Same, different
  - Different, same
  - Unique, different

- **Same, same**

231. In NFA, if null word (lambda) is allowed to be a label of an edge, then that NFA is called

- NFA with one string
- NFA with two strings
- NFA without null string
- **NFA with null string**

232. The language having even numbers of a's and even number b's defined over S = {a, b} is called _____

- **EVEN-EVEN (rep)**
- ODD-ODD
- PALINDROME
- FACTORIAL

233. FA stands for ______

- **Finite automation**
- Fixed automation
- False automation
- Functional Automation

234. When ODD language is expressed by an FA, then it will have minimum _____ states.

- **One (rep)**
- Two
- Three
- Four

235. Which of the following doesn't accept any language?

- Finite state machine
- Deterministic finite state machine
- Regular expression
- **Moore machine**

236. How many states of a finite automation will be final for accepting the only string 'abb'?

- **1**
- 2
- 3
- 4

237. Null strings can be specified on edges in:

- Finite Automata
- Non-deterministic finite automata
- **Transition graph**
- Melay machine

238. Which of the following is an utility of state elimination phenomenon?

- DFA to NFA

  NFA to DFA

- **DFA to Regular Expression**
- All of the mentioned

239. There _____ be a unique path for each valid string (called a word) in NFA.

- Must
- **May not**
- Should not
- Will

240. FA is also called

- TG
- GTG
- NFA
- **DFA (rep)**

241. In case of finite automation there, ____ be a transition on each ____ for every letter of the alphabet set.

- **Must, state**
- May be, state

- Often, edge
- Must, edge

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CS402 QUIZ FILE

MID & FINAL

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Quiz no 1

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1. **A non-regular language can be represented by:**

   one of the given options

2. **The strings or words which do not belong to a language are called of ______ that language.**

   Complement

3. **The complement of a regular language is also_____**

   Regular

4. **If the intersection of two regular languages is regular then the complement of the intersection of these two languages is**

   Regular

5. **The production S->SS|a|b|^can be expressed by Regular expression_____**

   (a+b)*

6. **Which of the following represent the absence and presence of current in sequential circuit respectively?**

   0,1

7. **A problem is said to be ______ if there exists an algorithm that provides the solution in___________ number of the steps.**

   Effectively, solvable finite

8. **Which of the following is a non-regular language?**

   prime

9. **The grammatical rules which involve meaning of words are Called_____**

   sematics

10. **Which of the following refers to the set of strings of letters that when concatenated to the front of some word in Q produces some word in R?**

    PREF(Q IN R)

11. **If there is no final state of two FAs then their ______ also have no ______ state**

    Union, final

12. **The CFG S -> asb|ab|A is used to express the language____**

    equal

13. **A non-regular language can be represented by:**

    None of the given options

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14. problem that has decision procedure is called ______ problem

decidable

15. In pref(Q in R), Q is to/than R.

Not equal

Quiz no 2

1. To write the expression from the tree, it is required to travel from____

 Left side of the tree

2. In conversion from of PDA, no two ___ states exit in a row without ___ state.

 POP, READ

3. The CFG-S→aSa|a|b|^represents ____ language.

 PALINDROME

4. The CFG that generates the regular language is called____

 Regular grammar

5. Null production is a____

 All of the given option

6. The CFG is said to be ambiguous if there exist at least one word of its language that can be generated by___ production trees

more than one

7. The structure given below is called
S->aA|bB
A->aS|a
B->bS|b

CFG

8. Identify the TRUE statement.

 Like TG, A PDA can also be non- deterministic

9. In new format of an FA (discussed in Lecture 37)._____state is like a final state of an FA

 ACCEPT

10. In new format of an FA (discussed in Lecture 37)._____state is like a Initial state of an FA

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MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

□ START

11. Consider the Following CFG (NOTE: ^means NULL)
S->Xa
X->aX|bx|^
Above given CFG can be represented by RE___

□ (a+b)*a

12. The major problem in the earliest computers was____

□ To display mathematically formula

13. Identify the correct statement from the following:

□ There always exists a corresponding PDA for every CFG

14. The PDA is called non-deterministic PDA when there are more than one out going edges from ___ state.

□ READ or POP

15. Identifying the FALSE statement about following CFG.
S->SB|AB
A->CC
B->b
C->a

□ All of the given option

16. In nondeterministic PDA, a string is supposed to be accepted if there exists at least one path traced by the string, leading to ____ state.

□ ACCEPT

17. In a CFG the non-terminal that occurs first from the left in the working string.is said to be___

□ Left most nonterminal

18. Identifying the TRUE statement about following CFG.
S->SB|AB
A->CC
B->b
C->a

□ The given CFG is in CNF

19. The derivation of word w, generated by a CFG, such that at each step, a production is applied to the left most nonterminal in the following string is said to be_____

□ Left most derivation

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FOR QUIZ CONTECT
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YOUTUBE CHANNEL: S KHAN ACADEMY

20. “CFG” stand for_____

 Context Free Grammar

21. The production of the from non-terminal->^ is said to be ____production.

 NULL

22. In nondeterministic PDA, a string is supported to be accepted if there exists at least one path traced by the string, leading to ___ state, leading to ___ state.

 ACCEPT

23. One GTG can generate _______Language

 Only one

24. In STACK

 The element PUSHed first is POPed in the last

25. Before the PDA is converted into conversion form, a new state ___ is define which is placed in the middle of any edge.

 HERE

26. ____stateS are called the halt states

 ACCEPT and REJECT

27. ACCEPT AND WRITE If the intersection of two regular languages is regular, then the complement of the intersection of these two languages are __________.

Regular

28. The language of all strings partition Σ* into ___________ class(es).

Two

29. The language of all strings not beginning with ‘b’ partitions Σ* into ___________distinct classes.

Two

30. If Q = {xx, xyxxxy }, and R = {xyxyxyxxyy, xyxyyyxx} then Pref(Q in R) = ____________

Xyxyyy

31. A language ending with ‘b’ partitions Σ* into ___________distinct classes.

Three

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FOR QUIZ CONTECT
(03066793776)

32. If R is regular language and Q is any language (regular/ nonregular), then Pref(_______in _______) is regular.

Q,R

33. The reverse of the string sbfsbb over { sb, f, b }
Sb, f, sb, b

Bsbfsb

34. The basic approach of Myhill Nerode theorem is similar to the concept of:

concatenation of FAs

35. If there is no final state of two FAs then their ______ also have no _____ state

union, final

36. If an FA has N states then it must accept the word of length

N

37. For a machine with N number of sta., the total number of strings to be tested, defined over an alphabet of m letters, is

mN +mN+1+ mN,-2 ,m2N-1

38. Which of the following is not a true theorem?

Pseudo theorem

39. The language "PRIME" is an example of language.

non regular

40. The product of two regular languages is

Regular

41. One language can have _______ CFG(s).

More than one

42. Which of the following is a non-regular language?

Prime

43. If the FA has N states. then test the words of length less than N. If no word is accepted by this FA. then it will _____ word/words.

accept no

44. In large FA with thousands of states and millions of directed

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

edges, without an effective procedure it is ______ to find a path from initial to final state.

Impossible

45. A problem that has decision procedure is called problem.

Decidable problem

46. Which one of the following languages is a non regular language?

Palindrome

47. Using Mayhill Nerode theorem we partition sigma star into distinct

Classes

48. In pumping lemma theorem (x y"n z) the range of n is

n=1. 2, 3, 4.......

49. The values of input (say a & b) do not remain same in one cycle due to

NOT gate

50. The operators like (*" +) in the parse tree are considered as

Terminals

51. Even-Even language partitions Σ* into _________ distinct classes.

Four

52. The strings or words which do not belong to a language are called _________ of that language.

Complement

53. The production S —> SS lalbl^ can be expressed by Regular expression

(a+b)+

54. if L1 and L2 are two regular languages. then they expressed by FAs.

can be

55. The grammatical rules which involve meaning of words are called

Semantics

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FOR QUIZ CONTECT
(03066793776)

YOUTUBE CHANNEL: S KHAN ACADEMY

56. Set of all palindromes over (a,b) is:

Regular and finite

57. The language of all strings not beginning with partitions "b" into distinct classes.

Two

58. The CFG is said to be ambiguous if there exist at least one word of its language that can be generated by production trees.

More than one

59. The CFG S —> aSb|abl^ is used to express the language

Palindrome

60. A non-regular language can be represented by

None of the given options

61. In large FA with thousands of states and millions of directed edges, without an effective procedure it is ________ to find a path from initial to final state.

Impossible

62. In polish notation, (o-o-o) is the abbreviation of _________.

Operator - Operand – Operand

63. If an FA has N states then it must accept the word of length

N

64. Using Myhill Nerode theorem we partition sigma star into distinct __________.

Classes

65. If a language is regular it must generate ____________ number of distinct classes.

Finite

66. If L1 and L2 are regular languages then which statement is NOT true?

L1/L2 is always regular

67. If the FA has N states, then test the words of length less than N. If no word is accepted by this FA, then it will _________ word/words.

accept no

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MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

68. A problem that has decision procedure is called _________ problem.

Decidable

69. If L1 and L2 are two regular languages, then they _______ expressed by FAs.

can be

70. A language that can be expressed by RE, is said to be a _______ language.

Regular

71. The values of input (say a & b) do not remain same in one cycle due to

NOT gate

72. Prime is a ______________ language.

non-regular

73. If an effectively solvable problem has answer in YES or NO, then the solution is called _________.

decision procedure

74. To write the expression from the tree, it is required to traverse from ___________.

Left side of the tree

75. If there is no final state of two FAs then their ______ also have no _____ state

union,final

76. In CFG, symbols that cannot be replaced by anything are called __________.

Terminals

77. Finite Automaton (FA) must have __________ number of states while a language has _________ words.

finite, infinite

78. The language "PRIME" is an example of ________ language.

non regular

79. Using Myhill Nerode theorem we partition sigma star into distinct __________.

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MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

Classes

80. Even-Even language partitions Σ* into ___________ distinct classes.

Four

81. What will be the 9's complement of the number 872?

127

82. In pref(Q in R), Q is _______ to/than R.

Not equal

83. There is at least one production in CFG that has one _________ on its left side.

Non terminal

84. In pumping lemma theorem (x y^n z) the range of n is

n=1, 2, 3, 4……….

85. A language ending with 'b' partitions Σ* into ___________distinct classes.

Three

86. The operators like (* , +) in the parse tree are considered as ________.

Terminals

87. For a machine with N number of states, the total number of strings to be tested, defined over an alphabet of m letters, is _____________.

mN +mN+1+ mN+2 +… +m2N-1

88. In a CFG, the non-terminals are denoted by _________.

Capital letters

89. Incase of Myhill Nerode theorem, if a language L partitions sigma star into distinct classes and L is also regular then L generates ___________ number of classes.

Finite

90. Which of the following is pumped to generate further strings in the definition of Pumping Lemma?

Y

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MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

91. The complement of a regular language is also __________.

Regular

1. In new format of an FA (discussed in lecture 37):……state is like a final state of an FA

➢ ACCEPT (Handouts Page # 119)

2. In conversion form of PDA there is no……………. state

➢ REJECT (Handouts Page # 119)

3. Given a PDA that accepts the language L

➢ There exists a CFG that generates exactly L (Handouts Page # 118)

4. In a CFG the non-terminal that occurs first from the left in the working string. is said to be

➢ Left most nonterminal (Handouts Page # 103)

5. The structure given below is called

S -> aAlbB
A -> aSla
B -> bSlb

➢ CFG (It is form of CFG)

6. An FA has N states then it must accept the word of length

➢ N-1

7. To examine whether a certain FA accepts any words. it is required to seek the paths……..state.

➢ from initial to final (Handouts Page # 81)

8. In nondeterministic PDA. a string is supposed to be accepted if there exists at least one path
traced by the string. leading to………..state.

➢ ACCEPT (Handouts Page # 111)

9. If a CFG has a null production, then it is

➢ Possible to construct another CFG without null production accepting the same language with the exception of the word

10. There is at least one production in CFG that has one……………. on its left side.

➢ Non terminal (Handouts Page # 87)

11. In large FA with thousands of states and millions of directed edges, without an effective

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

procedure it is…………to find a path from initial to final state.

➢ Impossible (Handouts Page # 81)

12. By removing null and unit productions__________.

➢ CFG can be converted into CNF (Handouts Page # 102)

13. A………is the one for which every input string has a unique path through the machine

➢ deterministic PDA

14. PDA stands for

➢ Push Down Automaton (Handouts Page # 112)

15. A PDA is called nondeterministic PDA if

➢ there are more than one outgoing edges at READ or POP states with one label

16. Which of the following cannot be represented by a regular expression?

➢ String of 0s with a prime length (Because Prime is not regular Langue)

17. In conversion form of PDA. there is………..accept state(s).

➢ Exactly one (Handouts Page # 119)

18. If there is no final state of two FAs, then their……….also have no………..state

➢ union. Final (Handouts Page # 83)

19. The tree which produces all the strings of a language is called

➢ Total language tree (Handouts Page # 96)

20. In new format of an FA (discussed in lecture 37), …………state is like dead-end non final state.

➢ REJECT (Handouts Page # 105)

21. To write the expression from the tree, it is required to traverse from

➢ Left side of the tree (Handouts Page # 94)

22. A PDA consists of the following:

➢ All the given options (Handouts Page 105)

23. If R is regular language and Q is any language (regular/ non-regular), then Pref……….in ………….. is regular.

➢ Q.R (Handouts Page # 79)

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

YOUTUBE CHANNEL: S KHAN ACADEMY

24. ………….is an operation that takes out a letter from the top of the STACK.

➢ **POP (Handouts Page # 107)**

25. Before the CFG corresponding to the given PDA is determined, the PDA is converted into the
standard form which is called.

➢ **Conversion form (Handouts Page # 118)**

26. The part of an FA, where the input string is placed before it is run, is called

➢ **Input Tape (Handouts Page # 105)**

27. A problem is said to be ……………….if there exists an algorithm that provides the solution in…………. number of steps.

➢ **Effectively solvable, finite (Handouts Page # 80)**

28. ……………… states are called the halt states.

➢ **ACCEPT and REJECT (Handouts Page # 105)**

29. The grammatical rules which involve meaning of words are called

➢ **Semantics (Handouts Page # 87)**

30. The PDA is called non-deterministic PDA when there are more than one out going edges from
state

➢ **READ or POP (Handouts Page # 111)**

31. Which of the following states is not part of PDA?

➢ **WRITE (All other are parts of PDA)**

32. The major problem in the earliest computers was

➢ **To display mathematical formulas (Handouts Page # 87)**

33. The operators like (` +) in the parse tree are considered as

➢ **Terminals (Handouts Page # 93)**

34. If L1 and L2 are two regular languages, then they……………expressed by FAs.

➢ **can be (Handouts Page # 68)**

35. Before running the input string on PDA it is first placed on

➢ **Tape (Handouts Page # 107)**

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

36. Which is the correct option

➢ The element PUSHED first is POPED in the last (LIFO Method, from Book)

37. Null production is a

➢ Word (Handouts Page # 97)

38. A/an…………operator adds a new letter at the top of STACK

➢ Push (Handouts Page # 107)

39. In conversion form of PDA, no two………….states exist in a row without state

➢ POP. READ (Handouts Page # 119)

40. Given a PDA that accepts the language L

➢ There exists a CFG that generates exactly L (Handouts Page # 118)

41. In large FA with thousands of states and millions of directed edges, without an effective procedure it is ………. to find a path from initial to final state.

➢ Impossible (Handouts Page # 81)

42. The CFG there generates the regular language is called

➢ regular grammars (Handouts Page # 97)

43. Consider the following CFG: (Note: ^ means NULL)
S-->Xa
X->aX|bX|^

➢ A*b*a

44. For a machine with N number of states, the total number of strings to be tested, defined over
an alphabet of m letters is

➢ mN +mN+1 + mN+2 +… +m2N-1 (Handouts Page # 86)

45. Consider the CFG given below.
A->B|b
B->a
Which of the following is a unit production?

➢ A->B

46. The CFG is said to be ambiguous if there exist at least one word of its language that can be
generated by the ………… production trees

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

YOUTUBE CHANNEL: S KHAN ACADEMY

➢ More than one (Handouts Page # 95)

47. If Q = {xx, xyxxxy} and R = { xyxyxyxxyy, xyxyyyxx} then Pref {Q in R} = ________

➢ Xyxyyy (Solved by my self 100% sure)

48. The unit production is

➢ Non terminal --> Non-Terminal (Hand out Page # 100)

49. Which of the following statement is FALSE?

➢ For every PDA, there always exists a regular expression (Not sure)

50. The CFG S ->aSb|ab|^

➢ Equal

51. Before the PDA is converted into conversion form, a new state ------------- is defined which is
placed in the middle of any edge.

➢ HERE (Hand out Page # 118)

52. A PDA is in conversion form if it fulfills the following conditions:

➢ There is only one ACCEPT state. (Hand out Page # 119)

53. Identify the false statement about the following CFG
S->SB|AB
A->CC
B->
C->a

➢ all the given option (All are false as There are 4 terminals, It is in CNF and it does not generate any null string)

54. This CFG there generates to the regular language is called

➢ Regular grammar (Hand out Page # 97)

55. The derivation of the word W generated by CFG such that at each step a production is applied to the leftmost nonterminal in the working string is said to be

➢ left most derivation (Hand out Page # 103)

56. If the FA has N states, then test these words of length less than N. If no word is accepted by
this FA, then it will word/words

➢ Accept no (Hand out Page # 85)

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

57. In a CFG then non terminals are denoted by

➢ **capital letters (Hand out Page # 87)**

58. "CFG"stands for_____________

➢ **Context free grammar (Hand out Page # 87)**

59. Consider the following production (of a CFG) S->XYZ Here ______is left most non terminals in working string note XY and Z are all known terminals

➢ **X (X is on the most left side)**

60. Consider the following CFG
S->a|Xb|aYa
X->Y|^ (Note: ^ means NULL)
Y-> b|X
which nonterminal is/are not nullable

➢ **X (X is Null Production and not a nullable)**

1. **The minimum length of the strings(except null string) of a language that starts and ends in the same letter will be:**
   - **1**
   - 2
   - 3
   - 4
2. **If S = {ab,bb} then S* will not contain____.**
   - abbbab
   - **bbba**

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

- bbbbab
- ababbb

3. Which of the following machine has only one initial state and no final state?

- Moore machine
- Finite state machine
- Deterministic finite state machine
- Non deterministic finite state machine

4. Which of the following diagram is very rigid in order to express any language?

- TG
- NFA^
- GTG
- FA

5. If S = {a}, then S+ will be ___

- {a, aaa, aaaa, aaaaa,…}
- {a, aa, aaa, aaaa,…}
- {a, aaa, aaaaa, aaaaaaa,…}
- {aa, aaaa, aaaaaa, aaaaaaaa,…}

6. Let L be the language of all strings. defined over ∑ = {0,1}. ending in 111.

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

Which of the following strings are indistinguishable with respect to L with z being 11?

- 111, 101
- 100, 101
- 110, 101
- 010, 101

7. Melay machine can have -- final states.

- Zero
- One
- More than one but finite
- More than one but infinite

8. In Moore machine, output is produced over the change of:

- Transitions
- States
- Transitions and states
- None of the mentioned

9. Given the language L = {ab, aa, baa}, which of the following strings are in L*?

1) abaabaaabaa

2) aaaaaaaaa

3) baaaaabaaaab

4) baaaaabaa

- 1, 2 and 3
- 2, 3 and 4
- **1, 2 and 4**
- 1, 3 and 4

10. Let L be the language of all strings, defined over ∑ = {0,1}, ending in 10. Which of the following strings are distinguishable with respect to L with z being 0?

- 111, 101
- 001, 101
- 111, 111
- **010, 101**

11. Let's we have two regular expressions R1=(xx+yy) and R2=(x+ y). Which one of the following is the correct regular expression for the Union of R1 and R2?

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

- (xx+yy)(x+y)
- (xx+yy)+(x+y)*
  - (xx+yy)+(x+y)
- ((xx+yy)+(x+y))*

12. FA corresponding to an NFA can be built by introducing a state corresponding to the combination of states, for a letter having
  - no transition at certain state
- one transition at certain state
- more than one transitions at certain state
- none of the given options

13. The state where there is no way to leave after entry called ___________
  - Davey John locker
  -
- initial state
- final state
- non-final state

14. Which one of the following word is not accepted by the given regular expression?
- aaabab
- aaaababb

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

- abbaab

- aabbabb

15. The minimum length of the strings(except null string) of a language that starts and ends in different letters will be:

- 1
- 2

16. According to theory of automata there are____________________________types of languages

- One
- Two
- Three
- Four

17. Which one of the following word is not accepted by the given regular expression?

(a+b)*(aaa+bbb)(a+b)*

- ababaaaab
- bababbbba
- baabaabba

- abbaaabba

18. Regular languages are closed under the following operations.

- Union only
- Concatenation, Closure only
- Union, Concatenation and Closure
- Regular languages are not closed under any operation.

If S = {x}, then S* will be___

- {^,x,xxx,xxxx,xxxxx,…}
- {^,x,xx,xxx,xxxx,…}
- {^,x,xxx,xxxxx,xxxxxxx,…}
- {^,xx,xxxx,xxxxxx,xxxxxxxx,…}

19. There can be more than_________FA for a certain language but for__FA there is only one language associated with it:

- one, one
- one, two
- two, three
- two, one

20. There is one compulsion that each state must have an on outgoing edge

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

for every input variable in:

- Finite Automata
- • Transition Graph
- Both Finite Automata and Transition Graph
- Transition Table

21. FA is also called
- TG
- GTG
- NFA
- • DFA

22. In the context of make NFA for the concatenation of FA1 and FA2 (Both FAs accepting null string), which of the following option is correct?
- • Final states in both FAs
- Initial states in both FAs
- FA2 having initial state only
- FA2 having final state only

23. If r1 and r2 are regular expression then (r1 * r2) is ____________________
- FA

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

- TG
- GTG
  - RE

24. Which of the following is the minimal number of states for a finite automaton accepting the language of all strings defined over any alphabet set?
  - 1

- Keeping in view the language of all strings ending with ‘a’, for which symbol we will take a loop on the final state of its transition diagram?
  - a
  - b
  - c
  - d

- Which of the following statements is true about NFA with Null String?
  - Infinite states
  - Infinite set of letters
  - Infinite set of transitions
  - Transition of null string is allowed at any stage

- Introducing new start state in case of multiple start states is the step no. ____of proving Kleene's theorem part ||.
  - 1
  - 2
  - 3
  - 4
- Which of the following diagrams expresses languages more simply?
  - FA
  - NFA
  - TG
  - GTG
- The language of all strings defined over alphabet set = {a, b} that does not end with 'a' actually ends with:
  - b
  - b and ^
  - ^
  - ^ and a
- Let L be the language of all strings, defined over ∑ = {0,1}, ending in 10. Which of the following strings are indistinguishable with respect to L with z

being 0?

- 100, 101
- 111, 101
- 110, 101
- 010, 101

 Let S = {aa, bb}, then S* will have the___string.

- ^

 In NFA having no transition at certain state, FA can be built by introducing:

- Empty state
- Combination of states
- Initial state
- Final state

 Formal is also known as ___

- Syntactic language
- Semantic language
- Informal language
- None of these

 There may be more than one transition for a certain letter on a state in:

- Finite automata

- Non-Deterministic Finite Automata
- Transition Table
- Moore Machine

25. A loop at a state is supposed to be ___ transition while converting Moore machine into an equivalent Melay machine.

- Incoming
- Outgoing
- Both incoming and outgoing
- Complex

26. FA of EVEN language shows null string when ___

- Initial state is final as well
- EVEN does not accept null
- One state is declared null
- None of the these

27. Which of the following statement is true about GTG?

- Transitions are based on input letters
- Transitions are based on specified substrings
- Transitions are based on regular expressions
- Transitions are based on alphabet set

28. Which one of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

- Moore machine
- Mealy machine
- Finite state machine
- Deterministic finite state machine

29. In GTG, there can be more than one:

- Start state
- Final state
- Start state and final state
- Null state

30. GTG for the expression (aa+aba)* may have minimum number of states:

- 1
- 2
- 3
- 4

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31. In regular expressions, the operator '*' stands for

- Concatenation
- Iteration
- Selection
- Addition

1. If we have only one state, having no transition for input letters, then it is an example of:

- RE
- FA
- TG
- NFA

2. If A and B are regular languages, !(A' U B') is:

- Regular
- Non regular
- May be regular
- None of the mentioned

3. A_____with "n" states must accept at least one string of length greater than "n".

- DFA
- RE

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- Irregular language
- Irrelevant language

4. If r1 is a regular expression then (r1)* is__.

- A generalized transition graph
- A non-deterministic finite automaton
- A finite automaton
- Also a regular expression

5. Which of the following is the bypass and state elimination step in the context of Kleene’s theorem part || proof?

- 1
- 2
- 3
- 4

6. Every________is a_____as well, but the converse may not be true.

- TG, FA
- FA, TG
- TG, GTG
- FA, GTG

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7. Which of the following is free of non-determinism?
    - TG
    - FA
    - NFA
    - NFA-^
8. There is no question of accepting any language in:
    - FA
    - TG
    - GTG
    - Moore machine
9. There state where there is no way to leave after entry is called___.
    - Davey john locker
    - Initial state
    - Final state
    - Non-final state
10. A string will be accepted by an NFA if there exists____one successful path.
    - Atleast
    - Atmost

- Maximum
- None of the given options

11. Melay machine to increase the output string in magnitude by 1 is called:

- Complementing machine
- Incrementing machine

Decrementing machine

1. Kleene's Theorem part | expresses the relationship between_____.

- FA and TG
- TG and RE
- RE and FA
- FA and RE

2. Keeping in view the discussion by martin, how many states are required to recognize the language of all strings of length 2 or more defined over ∑=

{a,b}, with 'b' being the second letter from right?

- 6
- 7
- 8

- 9

3. Suppose we have FA3 (which is equal to FA1 + FA2), then the final state of FA3 will be declared final if:

- It corresponds to final states of both FA1 and FA2
- It corresponds to final states of FA1 only
- It corresponds to final states of FA2 only
- It corresponds to any of the final states in FA1 or FA2

4. FA and_____are same except that_has unique symbol for each transition.

- FA, TG
- NFA, TG
- NFA, FA
- GTG, NFA

5. In NFA having no transition at certain state, FA can be built by introducing:

- Empty state
- Combination of states
- Initial state
- Final state

6. Subtraction of binary numbers is possible through:

- Complementing machine
- Incrementing machine
- Both complementing and incrementing machine
- Converting machine

7. Null strings can be specified on edges in:

- Finite Automata
- Non-Deterministic Finite Automata
- Transition Graph
- Melay Machine

32. What is false about the PALINDROME LANGUAGE?

- Every word is reverse of itself.
- It is an infinite language.
- FA can be build for it.
- None of the given option

33. While finding RE corresponding to TG, If TG has more than one start state then

- Introduce the new start state
- Eliminate the old start state

- Replace the old start stat with final state
- Replace the old final state with new start state

34. All possible combinations of strings of a language including null string is referred as:

- Concatenation of a language with itself
- Kleene star closure of a language
- Multiplication of language with itself
- Addition of a language with itself

35. n! will be equal to:

- n*n
- n*(-n)!
- n*(n-1)
- n*(n-1)!

36. Every NFA can be considered to be a as well, but the converse may not be true.

- FA
- TG
- GTG
- PDA

37. While finding RE corresponding to a TG, we connect the new start state with the old start state by_____transition.

- a
- b
- Null
- RE

1. In proving Kleene Theorem ||, if three states are connected then middle state is removed by connecting first and third state and writing corresponding RE in:

- Sum
- Concatenation
- Difference
- Asterisk

2. In______there must be transition for all the letters of a string.

- NFA
- GTG
- TG

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FOR QUIZ CONTECT
(03066793776)

 FA

3. There is no question accepting any language in:

 FA

 TG

 GTG

 Moore machine

4. For a given Moore Machine, the input string is ‘101010’, thus the output string would be of length:

 Length of input string + 1

 Length of input string – 1

 Length of input string + 2

 Length of input string -2

5. The FA can be drawn for the regular expression (a+b)* with minimum ______state(s).

 1

 2

 3

 4

6. Which of the following does not contribute while finding out the length of

strings?

- ^
- a
- b
- a+b

7. The language of all strings defined over alphabet set = {x, y} that ends with same letters will have the maximum length of:

- 1
- 2
- 3
- Infinite

38. Considering FA1 and FA2 states each. Now FA1+FA2 can have maximum__number of states.

- 2
- 3
- More than 3

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MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

- None of the given option

39. Which one of the following is the RE for the language defined over ∑= {a, b} having all the words starting with a?

- (a + b)*
- aa(a + b)+
- a(a + b)*
- a*(a + b)

40. An___can be considered to be an intermediate structure between Finite automaton and Transition Graph.

- RE
- GTG
- NFA
- None of the given options

41. Given the language L = {ab, aa, baa}, which of the following strings are in L*?

1) abaabaaabaa
2) aaaabaaaa
3) baaaaabaaaab
4) baaaabaa

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MSc. MATHEMATICS
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(03066793776)

- 1, 2 and 3
- 2, 3 and 4
- 1, 2 and 4
- 1, 3 and 4

42. In order to make NFA for the union of FA1 and FA2, the new initial state should be linked to:

- Initial and final states of FA1 and FA2 respectively
- Initial states of both FAs
- Initial state of FA1 only
- Final and initial states of FA1 and FA2 respectively

43. We cannot construct an NFA for the language of_______________defined over alphabet set {a,b}.

- Even even
- Odd
- Palindromes
- Integers

44. FA and_____________are same except that____has unique symbol for each transition.

- FA, TG
- NFA, TG
- NFA, FA
- GTG, NFA

45. If L is regular language, then (L')' U L will be:

- L
- L'
- ^

None of the mentioned

1. Suppose a language L1 has 2 states and L2 has2 states. If we have a machine M that accepts L1 ∩ L2. Then, the total number of states in M is equal to_____

- 2
- 4
- 6
- 8

2. If L1 and L2' are regular languages. L1 ∩ (L2' U L1')' will be

- Regular
- Non regular

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FOR QUIZ CONTECT
(03066793776)

- May be regular
- None of the mentioned

3. In mealy machine the output depends on _

- Only present state
- Present state and Present input
- Nothing
- Type of input

4. There is no question of accepting any language in:

- FA
- Moore machine
- Melay machine
- Both moore and melay machine

5. The state where there is no way to leave after entry is called _____

- Davey John Locker
- Initial state
- Final state
- Non-final state

6. FA corresponding to an NFA can be built by introducing an empty state for a letter having

- No transition at certain state

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FOR QUIZ CONTECT
(03066793776)

- One transition at certain state
- Two transitions at certain state
- More than two transitions at certain state

7. Which of the following diagrams expresses languages more simply?

- FA
- NFA
- TG
- GTG

8. Automata is the plural of__.

- Automate
- Automaton
- Automation
- Automatic

46. If A and B are regular languages. !(A' U B') is:

- Regular
- Non regular
- May be regular
- None of the mentioned

47. In NFA having no transition at certain. FA can be built by introducing:

 Empty state

 Combination of states

 Initial state

 Final state

48. If S = {x}, then S* will be______.

 {^,x,xxx,xxxx,xxxxx,…}

 {^,x,xx,xxx,xxxx,…}

 {^,x,xxx,xxxxx,xxxxxxx,…}

 {^,xx,xxxx,xxxxxx,xxxxxxxx,…}

49. Considering FA1 and FA2 states each. Now FA1+FA2 can have maximum__number of states.

 2

 3

 More than 3

 None of the given option

50. In an FA. When there is no path starting from initial state and ending n final state then that FA____

 Accept null string

 Accept all strings

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MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

- Accept all non-empty strings
- Does not accept any string

51. According to theory of automata there are_types of languages.

- One
- Two
- Three
- Four

52. In Moore machine. If the length of input is 9, then the length of output sring will be:

- 7
- 8
- 9
- 10

53. When ODD language is expressed by an FA, then it will have minimum ____states.

- One
- Two
- Three
- Four

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FOR QUIZ CONTECT
(03066793776)

54. [(a + b)(a + b)]*, given RE cannot generate the string __.

- abbaabab
- abbbaa
- bbbbbb
- abbbaaaaa

55. Which of the following statement is true about GTG?

- Transitions are based on input letters
- Transitions are based on specified substrings
- Transitions are based on regular expressions
- Transitions are based on alphabet set

56. Every________is a_____as well, but the converse may not be true.

- TG, FA
- FA, TG

1. Which one of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

- Moore machine
- Mealy machine
- Finite state machine
- Deterministic finite state machine

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FOR QUIZ CONTECT
(03066793776)

2. The recursive method for defining a language has_steps.

- One
- Two
- Three
- Four

3. Consider the following RE:

a(a + b)b*

All of the following words are accepted except____.

- aab
- abb
- aa
- aba

57. Which of the following regular expressions represent same language?

1. (a+ab)*
2. (ba+a)*
3. a*(aa*b)*
4. (a*b*)*

- 1 and 2

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MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

- 1 and 3
- 3 and 4
- 1 and 4

58. For every three regular expressions R, S, T, the languages denoted by R(S U T) and (RS) U (RT) are the_.

- Same
- Different
- R(S U T) is greater
- None of the given options

59. Alphabet S = {a, bc, cc} has__number of letters.

- One
- Two
- Three
- Four

60. An______can be considered to be an intermediate structure between Finite automaton and Transition Graph.

- RE
- GTG
- NFA

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FOR QUIZ CONTECT
(03066793776)

 None of the given options

61. Two FAs are said to be equivalent, if they ___

 Accept null string

 Accept same language

 Accept different language

 None of the given options

62. There may be more than one transition for a certain letter on a state in:

 Finite automata

 Non-Deterministic Finite Automata

 Transition Table

 Moore Machine

63. can also help in proving Kleene Theorem |||.

 NFA

 PDA

 Moore machine

 Melay machine

64. Kleene's Theorem part || expresses the relationship between_____.

 FA and TG

 TG and RE

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FOR QUIZ CONTECT
(03066793776)

- RE and FA
- FA and RE

65. FA corresponding to an NFA can be built by introducing an empty state for a letter having

- No transition at certain
- One transition at certain state
- Two transitions at certain state
- More than two transitions at certain state

66. Let L be the language of all strings, defined over ∑ = {0,1}, ending in 10. Which of the following strings are distinguishable with respect to L with z being 0?

- 111, 101
- 001, 101

67. FA is also called

- TG
- GTG
- NFA
- DFA

68. If two RE's generate same language then these RE's are called___.

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FOR QUIZ CONTECT
(03066793776)

- Same RE
- Equal RE
- Similar RE
- Equivalent RE

69. We cannot construct an NFA for the language of__defined over alphabet set {a,b}.

- Even even
- Odd
- Palindromes
- Integers

70. Kleene's Theorem part ||| expresses the relationship between_____.

- FA and TG

Final term quiz

1. If Σ = {aa, bb} , then Σ* will not contain

aaabbb

2. "One language can have _________ TG"s".

►More than one

3. According to 1st part of the Kleene"s theorem, If a language can be accepted by an FA then it can be accepted by a ________ as well.

►TG

4. Even-palindrome is a _______ language.

►Non-regular

5. If L is a regular language then, Lc is also a _____ language.

► Regular (Page 66)

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MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

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6. Pumping lemma is generally used to prove that:

► A given language is not regular

7. the FA has N states, then test the words of length less than N. If no word is accepted by this FA, then it will _________ word/words.

►accept no (Page 85)

8. In CFG, the symbols that can"t be replaced by anything are called________.

► Terminal (Page 87)

9. Which of the following is a regular language?

► String of odd number of zeroes

10. Which of the following pairs of regular expressions are equivalent?

►x(xx)* and (x)*x

11. An alphabet of Σ is valid if

►No letter of Σ appears at start of any other letter

12. Which of the following statement is true

►The length of the output string is greater than length of input string in moore machine.

13. If a CFG has only productions of the form nonterminal → string of two nonterminal or nonterminal → one terminal then the CFG is said to be in________

►Chomsky Normal Form

14. We can also represent an FA using different states e.g Accept state; Reject state, Read state etc. The ________ state behaves as final state of an FA

►Accept (Page 105)

15. where the input string is placed before it is run, is called _______

►Input Tape (Page 105)

16. An FSM can be considered as TM

►Of finite tape length, without rewinding capability and unidirectional tape movement

17. The process of finding the derivation of the word generated by particular grammar is called _____ ►Processing

►Parsing (Page 136)

18. The first rule of converting the given "CFG in CNF", is _______

►CYK algorithm (Page 135) Algorithm 4 (The CYK algorithm)

19. Alphabet Σ = {a, bc, cc} has number of letters

►Three

20. If r1 is a regular expression then r1* is a ______

►RE (Page 9)

21. We cannot write regular expressions for all _______.

►CFG's (Page 97)

22. For every Context Free Grammar (CFG), we can make the corresponding______.

►PDA

23. Pumping Lemma II says that length(x) + length(y) should be ______.

►Less than number of states (Page 75)

24. Chomsky normal form (CYK) algorithm was proposed by ______.

►John cock (Page 135)

25. The language of Palindromes defined over an alphabet set {a, b} can be recognized by ______.

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

YOUTUBE CHANNEL: S KHAN ACADEMY

►PDA

26. Which of the following is the first phase of compiler on the basis of functionality?

►Scanner

27. (Σ* - L) represent the _______ of a language L.

►Complement (Page 66)

28. If we have two transition graphs then their union will be expressed by

►taking a common start state and joining them by two null transitions

29. _____ and _______ are removed in order to make a CFG in Chomsky Normal Form (CNF).

►Null, unit productions (Page 102)

30. If L1 and L2 are expressed by regular languages then L1 + L2 is also a_________ Language.

► Regular (Page 10)

31. Which of the following is a regular Context Free Grammar:

►S → abS| baS | ^ ab(ab+ba)*ba + ba(ab+ba)*ab

32. A read state can have _______ outgoing edge/ edges.

►Any number of (Page 111)

33. Finite Automation (FA) and Nondeterministic Finite Automation (NFA) are equivalent if

►FA and NFA accept the same language (Page 43)

34. _______ is always Deterministic.

►Finite Automation (Page 25)

35. If r1 = (aa + bb) and r2 = (a + b) then the language (aa + bb)(a +b) will be generated by

► (r1)(r2) (Page 10)

36. "One language can be expressed by more than one FA". This statement is_____

► True (Page 14)

37. Who did not invent the Turing machine?

► A. M. Turing (Page 140)

38. Which statement is true?

► The tape of turing machine is infinite. (Page 140)

39. A regular language:

► Must be finite (Page 11)

40. Every regular expression can be expressed as CFG but every CFG cannot be expressed as a regular expression. This statement is:

► True (Page 97)

41. Consider the language L of strings, defined over Σ = {a,b}, ending in a

► There are finite many classes generated by L, so L is regular

42. The word „formal" in formal languages means

► Only the form of the string of symbols is significant

43. Let A = {0, 1}. The number of possible strings of length „n" that can be formed by the elements of the set A is

► 2n

44. Choose the correct statement.

► All of these

45. TM is more powerful than FSM because

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MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

► It has the capability to remember arbitrary long sequences of input symbols

46. If L1 and L2 are expressed by regular expressions r1 and r2, respectively then the language expressed by r1 + r2 will be _________

► Regular (Page 10)

47. Like TG, a PDA can also be non-deterministic

► True (Page 111)

48. The language of all words (made up of a‟s and b‟s) with at least two a‟s cannot be described by the regular expression.

► none of these

49. In FA, if one enters in a specific state but there is no way to leave it, then that specific state is called

► All of these (Page 17)

50. If L is a regular language, then, Lc is also a _____ language.

► Regular (Page 66) rep

51. In CFG, the symbols that can‟t be replaced by anything are called___

► Terminal (Page 87) rep

52. Which of the following is NOT a regular language?

► All of the given options

53. Choose the incorrect (FALSE) statement.

► For a given input string, length of the output string generated by a Moore machine is not more than the length of the output string generated by that of a Mealy machine

54. Choose the incorrect statement:

► A language consisting of all strings over Σ={a,b} having equal number of a's and b's is a regular language

Left hand side of a production in CFG consists of:

► One non-terminal (Page 87)

55. PDA is only used to represent a regular language.

► False

56. A production of the form non-terminal string of two non-terminal is called a live Production.

► True (Page 127)

57. We can find a CFG corresponding to a DFA.

► True (Page 97)

58. START, READ, HERE and ACCEPTS are conversions of the machine

► True (Page 122)

59. A CFG is said to be ambiguous if there exists at least one word of its language that can be generated by different production trees

► True (Page 95)

60. Syntax tree or Generation tree or Derivation tree are same tree

► True (Page 92)

61. The symbols that cannot be replaced by anything are called terminals

► True (Page 87) repeat

62. The production of the form non-terminal one non-terminal is called unit production

 ► True (Page 100)

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

YOUTUBE CHANNEL: S KHAN ACADEMY

63. DFA and PDA are equal in power.

□ ► False (Page 105)

64. A production of the form non-terminal □ non-terminal is called a dead Production.

□ False (Page 127)

65. Semi-word is a string having some terminals and one non-terminal at the right of string.

□ True (Page 97)

66. Two FAs are equivalent if they have same no. of states.

□ True (Page 15)

67. There exist exactly two different derivations in an ambiguous CFG for a word.

□ True (Page 93)

68. Regular languages are closed under Union, Concatenation and Kleene star.

□ True (Page 10)

69. CFG may also represent a regular language.

□ True (Page 97)

70. PDA is stronger than FA.

□ True (Page 105)

71. A Total Language Tree has

□ All strings over Σ (Page 96)

72. What Turing Machine does not have?

□ Word

73. CFG given S -> bS|Sb|aa represents language b*aa

□ b*(aa)*b*

74. The values of input (say a & b) does not remain same in one cycle due to

□ NOT gate

75. Set of all palindromes over {a,b}is regular

□ False (Page 74)

76. In CFG, the symbols that cannot be replaced by anything are called

□ Terminals (Page 87) rep

77. a^n b^n generates the ………… language

□ EQUAL and non-regular (Page 71)

78. The grammatical rules which involves meaning of words are called:

□ Semantic (Page 87)

79. If an FA has N state, then it must accept the word of length

□ N-1

80. Two languages are said to belong to same class if they end in the same state when they run over an FA, that state

□ May be final state or not (Page 75)

81. In pref(Q in R) Q is …… to (than) R

□ Not Equal (Page 79)

82. According to Myhill Nerode theorem, if L generates finite no. of classes then L is.......

□ Regular (Page 76)

83. If the intersection of two regular languages is regular then the complement of the intersection of these two languages is also regular

□ True (Page 68)

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

84. In pumping lemma theorem (x y^n z) the range of n is

 n=1,2,3,4..... (Page 74)

85. The complement of a regular language is also a regular

 True repeat

86. For a non regular language there exist …… FA

 No (Page 71)

87. The strings or words which do not belong to a language is called………… of that language

 Complement (Page 66)

88. A non-regular language can be represented by

 None of the given options (Page 71)

89. For language L defined over {a, b}, then L partitions {a, b}* into …… classes

 Distinct (Page 75)

90. If an FA accept a word then there must exist a path from

 Initial to final state (Page 81)

91. Does the empty string match the regular expression |y+a|?

 No (Page 3)

92. If an FA already accepts the language expressed by the closure of certain RE, then the given FA is the required FA.

 True (Page 37)

93. Which of the following statement is true about NFA with Null String?

 Transition of null string is allowed at any stage (Page 71)

94. If R is a regular language and L is some language, and L U R is a regular language, then L must be a regular language.

 True (page 10)

95. FA corresponding to an NFA can be built by introducing an empty state for a letter having

 no transition at certain state (Page 43)

96. Let FA3 be an FA corresponding to FA1FA2, then the initial state of FA3 must correspond to the initial state of

 FA1 only (Page 35)

97. (a* + b*)* = (a + b)* this expression is __________

 False

98. If S = { x }, then S* will be

 {^ ,x,xx,xxx,xxxx,…} (Page 10)

99. The states in which there is no way to leave after entry are called

 All of the given options (Page 17)

100. If S = {ab, bb}, then S* will not contain

 Bbba

101. According to theory of automata there are _________ types of languages

 2 (Page 3)

102. What do automata mean?

 Something done automatically

103. It is usually denoted by Greek letter sigma

SANAULLAH KHAN
MSc. MATHEMATICS
FOR QUIZ CONTECT
(03066793776)

 It can be an empty set. (Page 3)

104. Formal is also known as _________

 Syntactic language (page 3)

105. Consider the following production (of a CFG): S->XYZ Here ______ is left most nonterminal in working string. Note: S, X, Y and Z are all nonterminal

 X

106. A PDA is called nondeterministic PDA if ___________

 There are more than one outgoing edges at READ or POP states with one label (Page 111)

107. A PDA consists of the following:

 All of the given options (Page 105)

108. The CFG S --> aSa | bSb | a | b | ^ represents the language

 PALINDROM (Page 91)

109. Halt states are

 Accept and Reject (Page 105)

110. Choice of path can be determined by left most derivation of the string belonging to CFL at………… state

 Accept (Page 104)

111. The unit and null productions can be deleted from a CFG

 True (Page 99-100)

112. Identify the TRUE statement about following CFG: S -> SB|AB A -> CC B -> b C -> a

 The given CFG is in CNF (Page 101)

113. The structure given below is called _________ S -> aA|bB A -> aS|a B -> bS|b

 CFG (Page 87)

114. Which of the following states is not part of PDA

 WRITE (Page 107)

115. The production of the form: nonterminal --> one nonterminal is called the __________

 Unit production (Page 100)

116. A _________ is the one for which every input string has a unique path through the machine.

 Deterministic PDA (Page 111)

117. In the null production N --> ^ , N is a

 Non terminal (Page 99)

118. The major problem in the earliest computers was

 To display mathematical formulae (Page 87)

119. In polish notation, (o-o-o) is the abbreviation of………?

 Operator -Operand – Operand (Page 94)

120. The CFG is said to be ambiguous if there exist at least one word of its language that can be generated by the ………… production trees

 More than one (Page 95)

121. The input string is placed, before it runs, in

 Tape (Page 105)

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FOR QUIZ CONTECT
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122. The production S --> SS | a | b | ^ can be expressed by RE

 (a+b)* (Page 88)

123. The locations into which we put the input letters on "Input Tap" are called ___________

 cells (Page 105)

124. "CFG" stands for __________

 Context Free Grammer (Page 87)

125. In a CFG the nonterminal that occurs first from the left in the working string, is said to be _________

 Left most nonterminal (Page 103)

126. The unit production is

 Non terminal --> Non Terminal (Page 100)

127. A _____ operator adds a new letter at the top of STACK

 PUSH (Page 107)

128. PDA stands for _________

 Push Down Automaton (Page 112)

129. The production of the form: Nonterminal-> ^ is said to be ______ production

 NULL (Page 99)

130. In a STACK:

 The element PUSHed first is POPed in the last (Page 107 concept)

131. Kleene star closure can be defined

 Over any set of string (Page 7)

132. While finding RE corresponding to TG, we connect the new start state to the old start state by the transition labeled by

 null string (Page 26)

133. For a given input, it provides the compliment of Boolean AND output.

 NAND box (NOT AND) (Page 63)

134. It delays the transmission of signal along the wire by one step (clock pulse).

 DELAY box (Page 63)

135. Any language that can not be expressed by a RE is said to be regular language.

 False

136. The current in the wire is indicated by 1 and 0 indicates the absence of the current.

 True (Page 63)

137. For the given input, AND box provides the Boolean AND output.

 True (Page 63)

138. If L1 and L2 are regular languages_____ is/are also regular language(s).

 All of above (Page 10)

139. Let L be a language defined over an alphabet Σ, then the language of strings, defined over Σ, not belonging to L, is called Complement of the language L, denoted by Lc or L‟.

 True (Page 66)

140. To describe the complement of a language, it is very important to

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describe the ----------- of that language over which the language is defined.

 Alphabet (Page 66)

141. For a certain language L, the complement of Lc is the given language L i.e. (Lc)c = Lc

 False (Page 66)

142. If L is a regular language then, --------- is also a regular language.

 Lc (Page 66)

143. Converting each of the final states of F to non-final states and old non-final states of F to final states, FA thus obtained will reject every string belonging to L and will accept every string, defined over Σ, not belonging to L. is called

 Complement of L (Page 66)

144. If L1 and L2 are two regular languages, then L1 U L2 is not a regular.

 False (Page 65)

145. If L1 and L2 are regular languages, then these can be expressed by the corresponding FAs.

 True (Page 68)

146. The language that can be expressed by any regular expression is called a Non regular language.

 False (Page 71)

147. The languages -------------- are the examples of non-regular languages.

 PALINDROME and PRIME (Page 71)

148. Let L be any infinite regular language, defined over an alphabet Σ then there exist three strings x, y and z belonging to Σ* such that all the strings of the form xy z n for n=1,2,3, … are the words in L. called.

 Pumping Lemma (Page 72)

149. Languages are proved to be regular or non-regular using pumping lemma.

 True (Page 74)

150. ------------------ is obviously infinite language.

 PALINDROME (Page 75)

151. If, two strings x and y, defined over Σ, are run over an FA accepting the language L, then x and y are said to belong to the same class if they end in the same state, no matter that state is final or not.

 True (Page 75)

152. Myhill Nerode theorem is consisting of the followings,

 All of above (Page 75)

153. The language Q is said to be quotient of two regular languages P and R, denoted by--- if PQ=R.

 Q=R/P (Page 78)

154. If two languages R and Q are given, then the prefixes of Q in R denoted by Pref(Q in R).

 True (Page 78)

155. Let Q = {aa, abaaabb, bbaaaaa, bbbbbbbbbb} and R = {b, bbbb, bbbaaa, bbbaaaaa} Pref (Q in R) is equal to,

 {b,bbba,bbbaaa} (Page 78)

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FOR QUIZ CONTECT
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156. If R is regular language and Q is any language (regular/ non regular), then Pref (Q in R) is ---------.

 Regular (Page 79)

157. ___________ states are called the halt states.

 ACCEPT and REJECT (Page 105)

158. The part of an FA, where the input string is placed before it is run, is called _______

 Input Tape (Page 105)

159. In new format of an FA (discussed in lecture 37), This state is like dead-end non final state

 REJECT (Page 105)

160. Between the two consecutive joints on a path:

 Any no. of characters can be pushed and one character can be popped

161. The PDA is called non-deterministic PDA when there are more than one out going edges from……… state

 READ or POP (Page 111)

162. Identify the TRUE statement:

 Like TG, A PDA can also be non-deterministic (Page 111)

163. There is a problem in deciding whether a state of FA should be marked or not when the language Q is infinite.

 True (Page 79)

164. If an effectively solvable problem has answered in yes or no, then this solution is called ---------

 Decision procedure (Page 80)

165. The following problem(s) ------------- is/are called decidable problem(s).

 Both a and b (Page 80)

166. To examine whether a certain FA accepts any words, it is required to seek the paths from ------- state.

 Initial to final (Page 81)

167. The high-level language is converted into assembly language codes by a program called compiler.

 TRUE (Page 87)

168. Grammatical rules which involve the meaning of words are called ---------------

 Semantics (Page 87)

169. Grammatical rules which do not involve the meaning of words are called ---------------

 Syntactic (Page 87)

170. The symbols that must be replaced by other things are called __________

 Non-terminals (Page 87)

171. The grammatical rules are often called_____________

 Productions (Page 87)

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172. The terminals are designated by ________ letters, while the nonterminal are designated by ________ letters.

 Small, capital (Page 87)

173. The language generated by __________ is called Context Free Language (CFL).

 CFG (Page 87)

174. S → aXb|bXa X → aX|bX|Λ the given CFG generates the language in English __________

 Beginning and ending in different letters (Page 91)

175. The CFG is not said to be ambiguous if there exists at least one word of its language that can be generated by the different production trees,

 FALSE (Page 95)

176. The language generated by that CFG is regular if _________

 Both a and b (Page 97)

177. The production of the form no terminal → Λ is said to be null production.

 TRUE (Page 99)

178. CNF is stands for

 Chomsky Normal Form (Page 102)

179. Kleene"s theorem states

 Finite Automata are less powerful than Pushdown Automata.

180. Null production is a

 All of the given options

181. In nondeterministic PDA a string is supposed to be accepted, if there exists at least one path traced by the string, leading to ______ state.

 ACCEPT (Page 111)

182. The CFG which generates the regular language is called:

 Regular grammar (Page 97)

183. If a CFG has a null production, then it is possible to construct another CFG accepting the same language without null production

 FALSE (Page 99)

184. In large FA with thousands of states and millions of directed edges, without an effective procedure it is ________ to find a path from initial to final state.

 Impossible (Page 81)

185. If there is no final state of two FAs then their ______ also have no _____ state

 union,final (Page 83)

186. Set of all palindromes over {a,b} is:

 Non-regular (Page 71)

187. In the context of Myhill Nerode theorem, for even-even language sigma star can be partitioned into __________ number of classes.

 4 (Page 77)

188. The product of two regular languages is __________.

 Regular (Page 78)

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189. in case of Myhill Nerode theorem, if a language L partitions sigma star into distinct classes and L is also regular then L generates_________ number of classes.

 finite (Page 75)

190. While determining regular expression for a given FA, it is _________ to write its regular expression.

 Sometime impossible (Page 80)

191. If (L1 ∩ L2c) ∪ (L1c ∩ L2) is regular language that accepts the words which are in L1 but not in L2 or else in L2 but not in L1 . The corresponding FA cannot accept any word which is in _______ L1 and L2.

 Both (Page 80)

192. A problem that has decision procedure is called _________ problem.

 Decidable (Page 80)

193. The product of two regular languages is __________.

 Regular (Page 78)

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CS402-THORY OF AUTOMATA

SOLVED SUBJECTIVE FROM MID TERMS PAPERS

SOLVED BY JUNAID MALIK AND TEAM

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1.Which of the following steps replaces multiple incoming transition edges with a single one proving Kleene's theorem part II?

a. Step 1
b. Step 2
c. Step 3
d. Step 4

2. Let FA1 accepts many strings and FA2 accepts no strings, then FA1+FA2 will be equal to:

a.FA1

b.FA2

C.FA2-FA1

d.(FA2)*

3. Let L be the language of all strings, defined over ∑ =(0,1), ending in 10. Which of the following strings are indistinguishable w.r.t L with z being 0?

a.100.101

b.111.101

c. 110 .101

d.010.101

4. If r1=(aa+bb)and r2=(a+b) then the language (aa+bb)(a+b) will bhe generated by_______

a.(r1)(r2)

b.(r1 +r2)

c.(r2)(r1)

d.(r1)*

5. Introducing a new start state in the case of multiple states is step no.______ of proving Kleen's theorem part II.

a.1

b.2

c.3

d.4

6. The language having even numbers of a's and even number of b's defined over S={a,b} is called ______

a. EVEN-EVEN

B.ODD-ODD

c. PALINDROME

d. FACTORIAL

7. In NFA having no transition at a certain state, FA can be built by introducing :

a.Empty state

b. Combination of states

c .initial state

d. final state

8. For every three regular expression R, S, and T. the language denoted by R(S U T) and (RS)U(RT) are the _______

a .same

b. Different

c. R(SUT)is greater

d. none of the given options

9. Which of the following string belongs to the language of the regular expression (aa*b)?

a. baabab

b. abbbaa

c.aaaaaa

d.aabaab

10. If L1' and L2' are regular languages, then L1, L2 will be

a. non regular

b. may be regular

c. Regular

d. none of the mentioned

11. Suppose the language L1 has 2 L2 has 2 states. If we have a machine M that accepts L1∩L2. Then the total number of states in M is equal to_______

a. 2

b. 4

c. 6

d. 8

12. If L is a regular language, then (L')' U L will be:

a. L

b.

c.

d.

13. In Mealy machine, the output depends on______

a. Only present state

b. Present state and Present output

c. Nothing

d. Type of input

14. Strings x,y,z belongs to ∑* such that xz∈ L but yz∉ L where L ⊆∑* are:

a. indistinguishable

b. Undetermined

c. Both distinguishable and indistinguishable

d. Distinguishable

15. Melay machine to increase the output string in magnitude by 1 is called:

a. Complementing machine

b. Decrementing machine

c. Incrementing machine

d. Converting machine

16. Suppose we have FA3 (which is to FA1+FA2) then the final state of FA3 will be declared final if:

a. it corresponds to final states of both FA1 and FA2

b. it corresponds to final states FA1 only

c. it corresponds to final states FA2 only

d. It corresponds to any of the final states of FA1 or FA2

17. If we have the finite language and the number of states in the FA is n then the maximum number of letter in each word of the language that will be

accepted by the given FA will be :

a. 1

b. n+1

c. n-1

d. n

18. Which of the following state is introduced while developing NFA for the closure of FA?

a. An initial state which should be final as well

b. simply an initial

c. Final states

d. An initial state with loop for all letters

19. Length of EVEN-EVEN language is_______

a. Odd

b. such language doesn't exist

c. Even

d. sometimes even & sometimes odd

20. If FA1 corresponds to (a+b)* then FA1 must accept_______ strings/strings.

a. No

b. Odd length

c. Every

d. Even length

21. In FA, initial stage is represented by :

a. leaventh state empty

b. drawing a circle in that state

c. drawing '+'sign in transtate

d. Drawing an arrowhead before the state

22. Which one of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

a. Moore machine

b. Finite state machine

c. Mealy machine

d. Deterministic finite state machine

23. Length of machine "AbBAbcd" defined over ∑=(Ab,B,c,d) is_______.

a. three

b. four

c. five

d. six

24. An FA is a collection of:

a. Finite states , finite transition and finite input letters

b. infinite states , infinite transition and infinite input letters

c. Only finite states , finite transition

d. Only infinite states , infinite transition

25. Given the language L={ab, aa, baa}, which of the following strings are in L*?

i) abaabaaabaa
ii) aaaabaaaa
iii) baaaaabaaaab
iv) baaaaabaa

a. 1,2 & 3

b. 2, 3&4

c. 1,2 & 4

d. 1, 3&4

26. In the context to make NFA for the concentration of FA1 and FA2 (FA1 accepting null string) which of the following option is correct?

a. initial states in both FAs

b. FA2 having initial state only

c. FA2 having final state only

d. Final states in both FAs

27. Every ___ is a ___ as well, but the converse may not be true.

a. TG ,FA

b. TG, GTG

c. FA ,GTG

d. FA, TG

28. NFA with null string has ____ initial state(s).

a. One

b. Two

c. Three

d. Many

29. While finding RE corresponding to a TG, we connect the new start state with the old start state by____ transition.

a. a

b. b

c. Null

d. Re

30. If S=(x). then S* will be_____.

a. {^,x,xxx,xxxx,xxxx….}

b. {^,x,xxx,xxxx,xxxxx….}

c. {^,x,xx,xxx,xxxx….}

d. {^,x,xxxx,xxxxx,xxxxxx….}

31. The minimum length of string (except null string) of a language that starts and ends in the same letter will be:

a.1

b. 2

c.3

d. 4

32. If S={ab, bb} , then S* will not contain______.

a. abbbab

b. bbbbab

c. ababbb

d. bbba

33. Which of the following machine has only one initial state?

a. Moore machine

b. Finite state machine

c. Deterministic finite state machine

d. Non deterministic finite state machine

34. Which of the following diagram is very rigid in order to express any language?

a. TG

b NFA

c GTG

d FA

35. Let L be the language of all strings, defined over ∑ =(0,1), ending in 111. Which of the following strings are indistinguishable w.r.t L with z being 11?

a 111, 101

b 100, 101

c110, 101

d 010, 101

36. Mealy machine can have _______ final states.

a. One

b More than one but finite

c More than one but infinite

d. Zero

37. In Moore machine , output is produced over the change of:

a. transition

b. transition and states

c. States

d. None of the mentioned

38. Lets we have two regular expressions R1 ={xx+yy}and R2={x+y} . Which one of the following is the correct regular expression for the union of R1 and R2?

a. (xx +yy) (x +y)

b. (xx +yy) +(x +y)*

c. (xx+ yy) +(x+ y)

d. ((xx +yy)+(x+ y))*

39. FA corresponding to an NFA can be built by introducing a state corresponding to the combination of states, for a letter having

a. no transition at certain state

b. one transition at certain state

c. more than one transitions at certain state

d. none of the given options

40. The situation there is no way to leave after entry is called

a Davey John locker

b. initial state

c. finial state

d. non- final state

41. Which one of the following word is not accepted by the given regular expression?

a. aaabab

b. aaaababb

c. abbaab

d. aabbabb

42. According to the theory of automata, there are ________ types of languages.

a. one

b. Two

c. three

d. four

43. Which of the following word is not accepted by the given regular expression?

a. ababaaaab

b. bababbbba

c. baabaabba

d. abbaaabba

44. Regular languages are closed under the following operations.

a. Union only

b. Concatenation, closure only

c. Union, Concatenation and closure

d. Regular languages are not closed under any operation.

45. There can be more than ____ FA for a certain language but for ____FA there is only one language associated with it.

a. one, one

b. one, two

c. two, three

d. two ,one

46. There is no compulsion that each state must have an on outdoing edge for every input variable in:

a. Finite automata

b. Transition graph

c. Both finite Automata and Transition Graph

d. Transition Table

47. FA is also called_____.

a. TG

b. GTG

c. NFA

d. DFA

48. If r1 and r2 are regular expressions then (r1*r2) is______

a. FA

b. RE (Regular expression

c. TG

d. GTG

49. Which of the following is the minimal number of states for a finite automaton accepting the language of all strings defined over any alphabet set?

a. 1

b. 2

c. 3

d. 4

50. Keeping view language of all strings ending with 'a' for which symbol we will take a loop on the final state of its transition diagram?

a. A

b. B

c. C

d. D

51. Which of the following statements is true about NFA with Null String?

a. Infinite state

b. Infinite set of letters

c. Infinite set of transitions

d. Transition of null string is allowed at any stage

52. Which one of the following diagrams expresses languages more simply?

a. FA

b. NFA

c. TG

d. GTG

53. The language of all strings defined over alphabet set={a,b} that does not end with ‘a’ actually end with:

a. a and ^

b. b

c. b and^

d ^

54. Let S={aa,bb}, then S* will have the _____ string.

a. abba

b. aabbbaa

c. bbaab

d. ^

55. Formal is also known as_____.

a. Syntactic language

b. Semantic language

c. informal language

d. none of these

56. There may be more than one transition for a certain letter on a state in:

a. Non-Deterministic finite automata

b. finite automata

c. transition table

d. Moore Machine

57. A loop at a state is supposed to be____ transition while converting Moore machine into an equivalent Maley machine.

a. incoming

b. outgoing

c. Both Incoming and incoming

d. Complex

58. FA of EVEN language shows null string when______.

a. initial state is final as well AL-JUNAID INSTITUTE OF GROUP

b EVEN does not accept null

C One state is declared null

d. None of these

59. Which of the following statement is true about GTG?

a Transitions are based on input letters

b Transitions are based on specified substrings

c Transitions are based on regular expressions

d Transitions are based on alphabet set

60. Which of the following is the bypass and state elimination step in the context of Kleene's theorem part II proof?

a.1

b.2

c.3

d.4

61. Which of the following is free of non-determinism?

a. TG

b. NFA

c. NFA-^

d. FA

62. There is no question of accepting any language in:

a. FA

b. TG

c.GTG

d. Moore machine

63. A string will be accepted by an NFA if there exist_______one successful path.

a. Atmost

b. Maximum

c. atleast

d. None of these

64. Kleene's theorem part I expresses the relationship between_______

a. FA and TG

b. TG and RE

c. RE and FA

d. FAand RE

65. Keeping in view the discussion by Martin, how any states are required to recognize the language of all strings of length 2 or more defined over ∑={a,b} with 'b' being the second letter from right?

a. 6

b. 7

c. 8

d. 9

66. FA and _____ are same excepts that ______has unique symbol for each transition.

a. FA, TG

b. NFA, TG

c. GTG, NFA

d. NFA,FA

67. Subtraction of binary number is possible through.

a. Both complementing and incrementing machine

b. incrementing machine

c. complementing machine

d. Converting machine

68. Which of the following is the bypass and state elimination step in the context of Kleene's theorem part II proof?

a. 1

b. 2

c. 3

d. 4

69. Keeping in view the discussion by Martin, how any states are required to recognize the language of all strings of length 2 or more defined over ∑={a,b} with 'b' being the second letter from right?

a.6

b. 7

c. 8

d.9

70.let L be the language of all strings. Defined over ∑ (0,1) ,ending in 10.which of the following strings

Are indistinguishable with respect to L with z being 0

a.100.101

b.111.101

c. 110 .101

d.010.101

71.IF r1 =(aa +bb)and r2 =(a+ b) then the language(aa +bb)(a+ b) will be generated by ___________

a.(r1)(r2)

b.(r1 +r2)

c.(r2)(r1)

d.(r1)*

72. Indroducing new start state in case of multiple start states in the step no________ a.1

b.2

c.3

d.4

73 THE language having even number of a ' s and even number of b' s defined over S=(a, b) is called____

a. EVEN-EVEN

B.ODD-ODD

c. PALINDROME

d. FACTORIAL

74 In NFA having no transition at certain state .FA can be build by introducing.

A .Empty state

b. Combination of states

c .initial state

d. final state

75 .for every three regular expressions R,S. and T. the languages denoted by R(S U T)and (RS)U(RT)are the_______

a .same

b. Different

c. R(SUT)is greater

d. none of the given options

76. Null strings can be specified on edges in:

a. Finite Automata

b Non-Deterministic Finite Automata

c. Melay Machine

d. Transition graph

77. What is false about the PLAINDROME LANGUAGE?

A Every word is reverse of itself.

B It is an infinite language.

C FA can be build for it.

D None of the given option

78. While finding RE corresponding to a TG, if TG has more than one start state then.

a Eliminate the old start state
b Replace the old start state with final state
c Replace the old final state with new start state

d. Introduce the new start state

79. All possible combination of string of a language including null string is referred as..

Kleene star closure of a languagec.

80.N! will be equal to:

c. n*(n-1)!cfd

81.Every NFA can be considered to be a____ as well, but the converse may not be true.

a. TG

b. FA

c. RE

d. GTG

82.In proving Kleene theorem II , if three statuses are connected then middle state is removed btconnecting first and third and writing corresponding RE in:

a.

b.

c. Concentration

d.

83.In ______ there must be transition for all the letters of the string.

a. NFA

b.GTG

c TG

d. FA

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84.For a given Moore Machine , the input string is '101010' , thus the output string would be of length:
a. |Input|
b. |Input-1|
c. Cannot be predicted
d. Length of input string+1

85.The FA can be drawn for the regular expression (a+b)* with minimum________ state(s).
a. 1
b.2
c. 3
d. 4

86.Which of the following does not contribute while finding out the length of strings?
^ ANSEWR

87.The language of all strings defined over alphabet set ={x,y} that ends with same letters will have the maximum length of:
a. Finate
b. non of these
c. Infinite
d. Equal

88.Considering FA1 and FA2 having 2 states each. Now FA1+FA2 can have maximum__________ number of states.
a. 2
b. 3
c. More than 3
d. Non of them

89.Which one of the following is RE for the language defined over ∑={a,b} having all the words starting with a?

a(a+b)*

90.An ________ can be considered to be an intermediate structure between finite automaton and transition graph.
a. RE
b. NFA
c. GTG
d. None

91.In order to make NFA for the union of FA1 and FA2, the new initial state should be liked to:
a. initial state of FA1 only
b. initial and final states of FA1 and FA2 respectively
c. final and initial states of FA1 and FA2 respectively
d. Initial states of both FAs

92.We cannot construct an NFA for the language of _______ defined over alphabet set{a,b}.
a. Palindromes
b. Even
c. Odd
d. Integers

93.The CFG is said to be ambiguous if there exist at least one word of its language that can be generated by the ………… production trees
a. one
b. Two
c. More then one / Different
d. At most one

94.What do automata mean?
a. something done manually
b. something that works automatically / "something are done automatically
c. something done automatically

95.According to theory of automata there
a. 1
b. 2
c. 3

d. 4

96.The Minimum length of the string (except bull string) of a language that starts and ends in the same letters will be:

a.1
b. 2
c. 3
d. All of above

97. If S= {ab,bb} then S* will not contain_________

a. Babb
b. Bbb
c. Bbba
d abbb

98.Which of the following machines has only one initial state and no final state?

a. More machine
b. Finite state machine

c.Deterministic finite state machine

d.Non deterministic finite state machine

98.Which of the following machines has only one initial state and no final state?

a. More machine
b. Finite state machine

c.Deterministic finite state machine

d.Non deterministic finite state machine

99.Which of the following diagram is very rigid in order to express any language ?

a.TG

b.NFA-^

c.GTG

d.FA

100.If S={a},then S+will be______
a.{a,aa ,aaa , aaaa…}
b.{a,aa,aaa,aaaa…}

c.{a,aaa,aaaaa,aaaaaaa,…..}

d. {aa, aaaa,aaaaaa,aaaaaaaa,…}

101.Let L be the language of the all string defined over over∑ = {0,1} ending in10. Which of the following string are indistinguishable with respect to L with z being 11?
a.111,101
b.001,101
c.010,101
d.111,111
102.Melay machine can have _____final state
1) Zero
2) One
3) More than one but finite
4) More than one but infinite

103.Given the Language L = {ab, aa,baa},which of the following string are in L*?
5) Abaabaaaabaa
6) Aaaabaaaa
7) Baaaaabaaaab
8) Baaaabaa
a)1,2 and 3
b)2,3 and 4
c)1,2 and 4

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d)1,3 and 4

104.If L1 and L2 are regular Language L1∩ $(L2 \cup L1)$ will be
a.non regular
b.may be regular
c. Regular
d.none of the mentioned
105.In Mealy Machine the out put depends on_______
a. state
b.previous state
c.state and input
d.only input
106.There is no question of accepting any language in.
a.Mealy machine
b. Moore Machine
c.Moore and mealy
d.none of these.ge
107.Thestate where there is no way to leave after entry is called___
a.Davey john Locker
b.Initial State

c.Final state

d.Non-final state

108.FA corresponding to an NFA can be built by introducing an empty state for a letter having
a.No transaction at certain state
b.More than one transition at certain state

c.None of the given option

109.Which of the following diagram express language more simply?
a.Tg
B.Gt
c.GTG
d.All of above
110.Automata is the plural of______
a.Auto
b. Automation

c.Meta
d.All of above

111.If A and B are regular Language !(A∪B) is
a.Regular
b.none regular
c.may be regular
d.none of the mentioned
112.In NFA having no transition at certain state FA can be built by introducing.
a. Empty state.
B.Final state
C.initial state
D none of these

113.Consuming FA1 and FA2 having 2 STATES each. Now FA1+FA2 can have maximum______number of state
a.2
b.3
c. More then 3
d. None of the given
114.In an FA when there is no path starting from initial state and ending state in final state then that FA______
a.Reject all
b. Accept all string
c.Reject and accept all
d.None of above
115.According to theory of automation there are_____type if language
a. Two
b.Three
c.One
d.Four
116.In Moore machine if the length of input string is 9 then the length of output string will be.
a.20
b.60
c.10

d.40

117.When ODD language is expressed by an FA,then it will have minimum ____ state

a. One

b TWO

c THREE

d FOUR

118.[(a+b)(a+b)]*.given RE contact generate the string________

a. aaabbbbccc

b. Bbbbbb

c. aabbcc

d aaabcbbcbacc

119.Which of the following state is true about GTG?

a. Transaction are based on regular expression

120.Every_____is a _____ as will, but the converts may not be true.

a. FA ,TG

b. TG RE

c. GTG

d TG

121.Which of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

a.TG andRE

b.REand FA

c.FA and RE

d. Mealy Machine

122.The recursive method for defining a language has ____ steps

a. two

b. Three

c. four

d. five

123.Consider the following RE.

.A(a+b)b*

All of the following word are accepted except______

A Aa

b.Aabb
c.Bbbba
d.None of these

124.Which of the following regular expression represented same language?

1. (a+ab)*
2. 2(ba+a)*
3. A*(aa*b)*
4. (a*b)*

a.2 and 1
b.3 and 2
c.1 and 2
d.3 and 4

125 For every there regular expression R,S and T the Language denoted by R(S∪T) and (RS) ∪(RT) are the

a.Different

b. Same

c.Equal

d.All of above

126 Alphabet S={a,bc,cc} has____number of letters.

a. two

b. three

c. four

d. five

127 An____can be considered to be an intermediate structure between Finite automation and Transition Graph.

a.FA

b.RE

cBoth a and b

d.NFA

128 Two FAs are said to be equivalent if they______

a.Simple langue

b.Accept different language

c. Accept same language

d. All of above

129 There may be more then one transition for a certain letter on a state in

a. Finite Automata

b.In finite automata

d. None of these

130 _____can also help in proving Kleene Theorem III.

A. RE

b.Rna

c.FA

d.NFA

131 Kleene Theorem Part II expression the relationship between____

a.TG and FA

b. TG and RE

c.TG and NFA

d.None of these

132 FA corresponding to an NFA can be built by introducing an empty state for a letter having.

a. No transition at certain state

b.Transition at certain state

c.Transition at final state

d. None of these

133 FA is also called

a.FA

b.RE

c. DFA

d.All of above

134 If two Res generated same language then these Res are called ____

a.Equivalent FA

b. Equivalent RE

c.Equivalent DFA

d.none of these

135 We cannot an NFA for the language of ____ defend over alphabet set{a,b}

Palindromes (**answer**)

136 Kleene Theorem Part II expression the relationship between____
a. RE and FA
b.DFA and RE
c.FA and DFA
d.None of these

137 Let FA3 an FA corresponding to FA1 FA2 then the initial state of FA3 must correspond to the initial state of
a.Dfa
b.FA2 only
c. FA1 only
ddnone of these

138 Every FA should be___
a.Simple
b.Accurate
c.Non-deterministic
d. Deterministic

139 The minimum length of string (except null string) of a language that starts and ends in the different letter will be:
a.2
b.3
c.4
d.1

140 Which of the following will be the final state of FA3 obtained from the union of FA1 and FA2?
a.Initial state
B.Final states of FA1 or FA2
c.Initial state of FA1 orFA 2
d.None of the given

141.In concatenation we accept the initial state of FA2 automatically after the final state of FA1 because of:
a.initial state

b.Final state

c.We need just one final state

d.We need just one initial state

142 Let FA1 accepts many strings and FA2 accepts none then FA1+FA2 will be equal to:

a. FA2-FA1 (ANSWER)

143 The language {a ab aba bab} is _____ .

a.Irregular

b.Normal

c. Regular

d.All of above

144 Decomposing a string into its valid units is referred as:

a.Customizing

b. Tokenizing

c. Decomposing

d. Splitting

145 Let FA3 be an FA corresponding to FA1+FA2, then the initial state of FA3Must corresponds to the initial state of

a.NFA

b.DFA

c.RE

d.FA1 or FA2

146 If FA1 corresponds to (a+b)* then FA1 must accept ___________ string/strings. Select correct option: No Oddlength

a.Some

b. EVERY

c.Just one

d.None of these

147 A regular language can be:

a. irregular

b. infinite

c. non-deterministic

d. None of the given options

148 N into its valid units is referred as:

d. Tokenizing

149 The strings of FA2 are accepted first before the strings of FA1

a.FA

b.NA

c. Palindromes

d.Non of these

150 There ______ a language for which only FA can be built but not the RE.

a.Is

b.Are

c.Be may

d.None of above

151 Kleene's Theorem part I expresses the relationship between ___

a.TG and Na

b.NA and FA

c.TG and TG

d. FA and TG

152 We can create an equivalent ___ for a language for which we create an ___

a.NA

b.NFA, FA

c.RNA

d.None of these

CS402 Grand Quiz

Quiz Start Time: 11:29 AM, 30 December 2020

Question # 1 of 30 (Start time: 11:29:54 AM, 30 December 2020)

Total Marks: 1

If L1 and L2' are regular languages, L1 ∩ (L2' ∪ L1)' will be

Select the correct option

- (selected) regular
- non regular
- may be regular
- none of the mentioned

CS402 Grand Quiz

Quiz Start Time: 11:29 AM, 30 December 2020

Question # 4 of 30 (Start time: 11:34:05 AM, 30 December 2020)

Total Marks: 1

In Mealy machine the output depends on________________

Select the correct option

○	Only present state
●	Present state and Present input
○	Nothing
○	Type of input

CS402:Grand Quiz

Quiz Start Time: 11:29 AM 30 December 2020

Question # 21 of 30 (Start time: 11:54:22 AM 30 December 2020)

Total Marks: 1

There is no question of accepting any language in

Select the correct option

- FA
- Moore machine
- Mealy machine
- Both moore and mealy machine

Question # 25 of 30 (Start time: 12:00:13 PM, 30 December 2020)

Total Marks:

The state where there is no way to leave after entry is called ____________

Select the correct option

- (●) Davey, John locket
- ( ) initial state
- ( ) final state
- ( ) non-final state

Question # 8 of 30 (Start time: 12:29:12 PM, 30 December 2020) **Total Marks: 1**

FA corresponding to an NFA can be built by introducing an empty state for a letter having

Select the correct option

- (●) no transition at certain state
- ( ) one transition at certain state
- ( ) two transitions at certain state
- ( ) more than two transitions at certain state

Question # 23 of 36 (Start time: 11:57:00 AM, 30 December 2020) **Total Marks: 1**

Which of the following diagrams expresses languages more simply?

Select the correct option

- ○ FA
- ○ NFA
- ○ TG
- ● GTG

CS402:Grand Quiz

Quiz Start Time: 11:29 AM, 30 December 2020

Question # 28 of 30 (Start time: 12:03:35 PM, 30 December 2020)

Total Marks: 1

Automata is the plural of ________

Select the correct option

- ( ) automate
- (•) automaton
- ( ) automation
- ( ) automatic

CS402:Grand Quiz

Quiz Start Time: 11:29 AM 30 December 2020

Question # 5 of 30 (Start time: 11:35:31 AM 30 December 2020)

Total Marks: 1

If A and B are regular languages, !(A' U B') is:

Select the correct option

- ● regular
- ○ non-regular
- ○ may be regular
- ○ none of the mentioned

Question # 12 of 30 (Start time: 11:44:27 AM, 30 December 2020)

Total Marks: 1

In NFA having no transition at certain state, FA can be built by introducing:

Select the correct option

- (selected) Empty state
- Combination of states
- Initial state
- Final state

CS402 Grand Quiz

Quiz Start Time: 01:51 PM, 30 December 2020

Question # 2 of 30 (Start time: 01:52:39 PM, 30 December 2020)

Total Marks

If S = { x }, then S* will be___________

Select the correct option

- ( ) { x,xxx,xxxx,xxxxx,...}
- (•) { x,xx,xxx,xxxx,...}
- ( ) { x,xxx,xxxxx,xxxxxxx,...}
- ( ) { xx,xxxx,xxxxxx,xxxxxxxx,...}

CS402:Grand Quiz Quiz Start Time: 11:29 AM, 30 December 2020

Question # 14 of 30 (Start time: 11:46:58 AM, 30 December 2020) Total Marks: 1

Considering FA1 and FA2 having 2 states each. Now FA1+FA2 can have maximum ____________ number of states.

Select the correct option

- ○ 2
- ○ 3
- ○ more than 3
- ● None of the given options

Question # 1 of 30 (Start time: 01:51:55 PM, 30 December 2020)

Total Marks:

In an FA, when there is no path starting from initial state and ending in final state then that FA ____________.

Select the correct option

- ○ accept null string
- ● accept all strings
- ○ accept all non empty strings
- ○ does not accept any string

CS402 Grand Quiz

Quiz Start Time: 12:22 PM, 30 December 2020

Question # 2 of 30 (Start time: 12:23:51 PM, 30 December 2020)

Total Marks: 1

According to theory of automata there are________ types of languages.

Select the correct option

- One
- Two
- Three
- Four

CS402:Grand Quiz

Quiz Start Time: 12:22 PM, 30 December 2020

Question # 25 of 30 (Start time: 12:57:10 PM, 30 December 2020)

Total Marks: 1

In Moore machine, if the length of input string is 9, then the length of output string will be.

Select the correct option

- ○ 7
- ○ 4
- ○ 9
- ● 10

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Question # 23 of 30 (Start time: 12:45:41 PM, 30 December 2020) **Total Marks: 1**

When ODD language is expressed by an FA, then it will have minimum ________ states.

Select the correct option

- (●) one
- ( ) two
- ( ) three
- ( ) four

Question # 30 of 30 (Start time: 12:05:52 PM, 30 December 2020)

Total Marks: 1

((a + b)(a + b))* given RE cannot generate the string ________

Select the correct option

- ( ) abbaabab
- ( ) abbbaa
- (●) bbbbab
- ( ) abbaaaaa

Question # 22 of 30 (Start time: 02:07:50 PM, 30 December 2020) Total Marks: 1

Which of the following statement is true about GTG?

Select the correct option

- ○ Transitions are based on input letters
- ○ Transitions are based on specified substrings
- ● Transitions are based on regular expressions
- ○ Transitions are based on alphabet set

CS402 Grand Quiz

Quiz Start Time: 01:51 PM, 30 December 2020

Question # 5 of 30 (Start time: 01:54:20 PM, 30 December 2020)

Total Marks: 1

Every ____________ is a ____________ as well, but the converse may not be true.

Select the correct option

- TG, FA
- FA, TG
- TG, GTG
- FA,GTG

Question # 18 of 30 (Start time: 12:49:12 PM, 30 December 2020) **Total Marks: 1**

Which one of the following machine is represented as a pictorial representation with states and directed edges labeled by an input letter along with an output character?

Select the correct option

- ○ Moore machine
- ● Mealy machine
- ○ Finite state machine
- ○ Deterministic finite state machine

CS402 Grand Quiz

Quiz Start Time: 11:51 PM, 30 December 2020

Question # 24 of 30 (Start time: 02:10:14 PM, 30 December 2020)

Total Marks: 1

The recursive method for defining a language has ______________ steps.

Select the correct option

- one
- two
- three (selected)
- four

Question # 6 of 30 (Start time: 01:55:05 PM, 30 December 2020) **Total Marks: 1**

Consider the following RE
a(a + b)*
All of the following words are accepted except ____________

Select the correct option

- ○ aab
- ○ abb
- ● aa
- ○ abc

Question # 29 of 30 (Start time: 12:05:01 PM, 30 December 2020) **Total Marks: 1**

Which of the following regular expressions represent same language?

1. (a+ab)*
2. (ba+a)*
3. a*(aa*b)*
4. (a*b)*

Select the correct option

- (●) 1 and 2
- ( ) 1 and 3
- ( ) 1 and 4
- ( ) 1 and 4

CS402:Grand Quiz

Quiz Start Time: 01:51 PM 30 December 2020

Question # 10 of 30 (Start time: 01:57:43 PM, 30 December 2020)

Total Marks: 1

For every three regular expressions R, S, and T, the languages denoted by R(S U T) and (RS) U (RT) are the ______

Select the correct option

- (selected) Same
- Different
- R(S U T) is Greater
- None of the given options

CS402:Grand Quiz

Quiz Start Time: 01:51 PM, 30 December 2020

Question # 27 of 30 (Start time: 02:10:28 PM, 30 December 2020)

Total Marks: 1

Alphabet Σ = {a, bc, cc} has ________ number of letters

Select the correct option

- One
- Two
- Three (selected)
- Four

Question # 22 of 30 (Start time: 11:58:00 AM, 30 December 2020) Total Marks: 1

An __________ can be considered to be an intermediate structure between Finite automaton and Transition Graph

Select the correct option

- ○ RE
- ○ GTG
- ● NFA
- ○ None of the given options

CS402:Grand Quiz

Quiz Start Time: 11:29 AM 30 December 2020

Question # 2 of 30 (Start time: 11:31:21 AM 30 December 2020)

Total Marks: 1

Two FAs are said to be equivalent, if they ________

Select the correct option

- accept null string
- accept same language
- accept different language
- none of the given options

CS402 Grand Quiz

Quiz Start Time: 12:22 PM, 30 December 2020

Question # 20 of 30 (Start time: 12:42:40 PM, 30 December 2020)

Total Marks: 1

There may be more than one transition for a certain letter on a state in

Select the correct option

- Finite Automata
- Non-Deterministic Finite Automata
- Transition Table
- Moore Machine

CS402 Grand Quiz | Quiz Start Time: 01:51 PM, 30 December 2020

Question # 7 of 30 (Start time: 01:55:32 PM, 30 December 2020) | Total Marks: 1

_______ can also help in proving Kleene Theorem III.

Select the correct option

- (selected) NFA
- PDA
- Moore machine
- Mealy machine

Question # 21 of 30 (Start time: 02:07:18 PM, 30 December 2020)

Total Marks:

Kleene's Theorem Part I expresses the relationship between __________

Select the correct option

- ○ FA and TG
- ● TG and RE
- ○ RE and FA
- ○ FA and RE

CS402 Grand Quiz

Quiz Start Time: 01:51 PM, 30 December 2020

Question # 14 of 30 (Start time: 02:01:23 PM, 30 December 2020)

Total Marks: 1

When ODD language is expressed by an FA, then it will have minimum ________ states.

Select the correct option

- (●) one
- ( ) two
- ( ) three
- ( ) four

CS402 Grand Quiz

Quiz Start Time: 01:51 PM, 30 December 2020

Question # 12 of 30 (Start time: 01:59:05 PM, 30 December 2020) **Total Marks: 1**

FA corresponding to an NFA can be built by introducing an empty state for a letter having

Select the correct option

- (●) no transition at certain state
- ( ) one transition at certain state
- ( ) two transitions at certain state
- ( ) more than two transitions at certain state

Question # 26 of 30 (Start time: 12:40:01 PM, 30 December 2020)

Total Marks: 1

Let L be the language of all strings, defined over Σ = {0,1}, ending in 10. Which of the following strings are distinguishable with respect to L with z being 0?

Select the correct option

- (selected) 111, 101
- 001, 101
- 110, 111
- 010, 101

CS402:Grand Quiz

Quiz Start Time: 12:22 PM, 30 December 2020

Question # 3 of 30 (Start time: 12:24:29 PM, 30 December 2020)

Total Marks: 1

FA is also called

Select the correct option

- TG
- GTG
- NFA
- DFA

CS402:Grand Quiz

Quiz Start Time: 11:29 AM 30 December 2020

Question # 13 of 30 (Start time: 11:48:49 AM 30 December 2020)

Total Marks: 1

If two RE's generate same language then these RE's are called ________

Select the correct option

- Same RE
- Equal RE
- Similar RE
- Equivalent RE

CS402 Grand Quiz | Quiz Start Time: 11:29 AM, 30 December 2020

Question # 24 of 30 (Start time: 11:53:08 AM, 30 December 2020) | Total Marks: 1

We cannot construct an NFA for the language of ______ defined over alphabet set {a,b}

Select the correct option

- ○ Even even
- ○ odd
- ● Palindromes
- ○ Integers

CS402 Grand Quiz

Quiz Start Time: 11:29 AM, 30 December 2020

Question # 18 of 30 (Start time: 11:52:00 AM, 30 December 2020)

Total Marks: 1

Kleene's Theorem Part III expresses the relationship between __________

Select the correct option

- FA and TG
- TG and RE
- RE and FA
- FA and RE

CS402 Grand Quiz

Quiz Start Time: 12:22 PM, 30 December 2020

Question # 1 of 30 (Start time: 12:22:39 PM, 30 December 2020)

Total Marks: 1

Let FA3 be an FA corresponding to FA1FA2, then the initial state of FA3 must correspond to the initial state of

Select the correct option

- (●) FA1 only
- ( ) FA2 only
- ( ) FA1 or FA2
- ( ) FA1 and FA2

CS402:Grand Quiz

Quiz Start Time: 11:29 AM, 30 December 2020

Question # 20 of 30 (Start time: 11:53:58 AM, 30 December 2020)

Total Marks: 1

Every FA should be __________

Select the correct option

- [x] deterministic
- [ ] non-deterministic
- [ ] deterministic and non-deterministic
- [ ] not depends on language


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3) GDB
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CS402

Question No: 1 (Marks: 1) - Please choose one

Auto Meta mean

- Manual work
- **Automatic work**

Question No: 2 (Marks: 1) - Please choose one

S= {a,bc,cc} has the latters

- 1
- 2
- **3**
- 4

Question No: 3 (Marks: 1) - Please choose one

S={a,bb,bab,baabb} set of strings then S* will not have

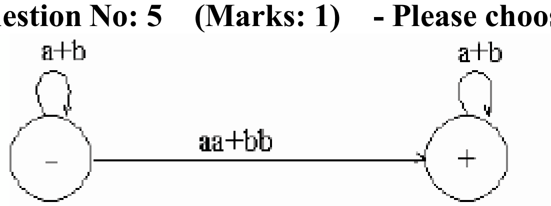
- Baba
- Baabbab
- Bbaaabb
- **bbbaabaabb(not confirmed)**

Question No: 4 (Marks: 1) - Please choose one

One language can represents more then one RE.

- **True**
- Falss
- Can't be assumed
- Non of given

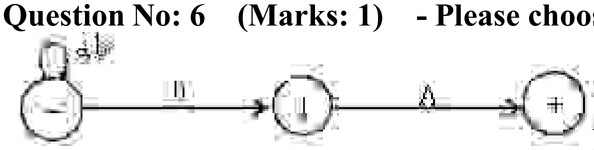
Question No: 5 (Marks: 1) - Please choose one



Given GTG has RE

- **(a+b)* (aa+bb)(a+b)***
- None of option

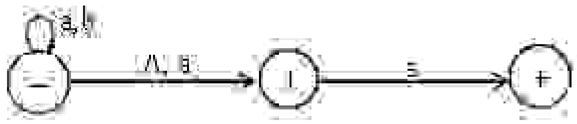
Question No: 6 (Marks: 1) - Please choose one



NFA accept ______String

- b
- babab
- baaab
- **all**

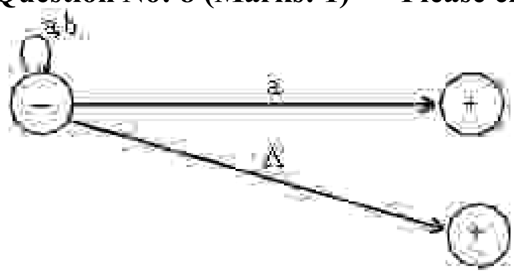
Question No:7 (Marks: 1) - Please choose one



NFA accept ______String

- bab
- a
- aba
- **a & aba**

Question No: 8 (Marks: 1)   - Please choose one



TG has

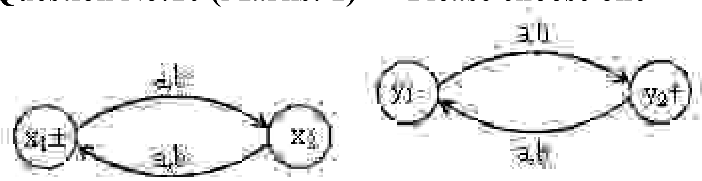
- (a+b)*
- **Λ+(a+b)*a**
- Λ+(a+b)*a*
- None of given

Question No: 9 (Marks: 1)   - Please choose one

TG can more then one initial state

- **True**
- False
- Depend on alphabets
- None of given

Question No:10 (Marks: 1)   - Please choose one



RE will be

- (a+b)*
- (a+b)*(a*+b*)
- **None of the given**

Question No: 11 (Marks: 1)   - Please choose one

The clouser FA*(on an FA) always accept ______string

- Null
- aa
- bb
- **None of given**

Question No: 12 (Marks: 1)   - Please choose one

In FA final state represent by _________sign

- **±**
- -
- =
- *

Question No: 13 (Marks: 1)   - Please choose one

In FA one enter in specific stat but there is no way to leave it then state is called

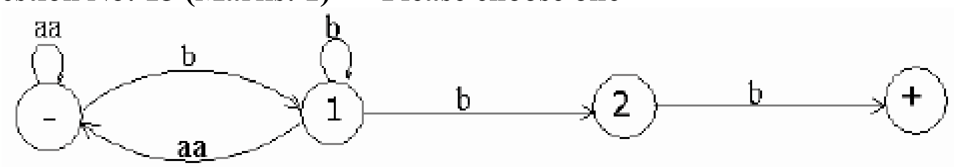
- Dead States
- Waste Baskets
- Davey John Lockers
- **All of above**

Question No: 14 (Marks: 1) - Please choose one

Using tree structure final state represent by

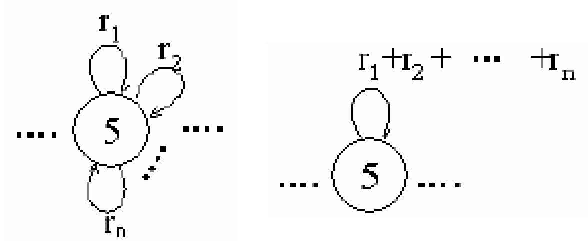
- *
- -
- **double circle**
- None of given

Question No: 15 (Marks: 1) - Please choose one



- **a's occur only in even clumps and that ends in three or more b's**
- length larger then 2
- it does not accept any language
- none of given option

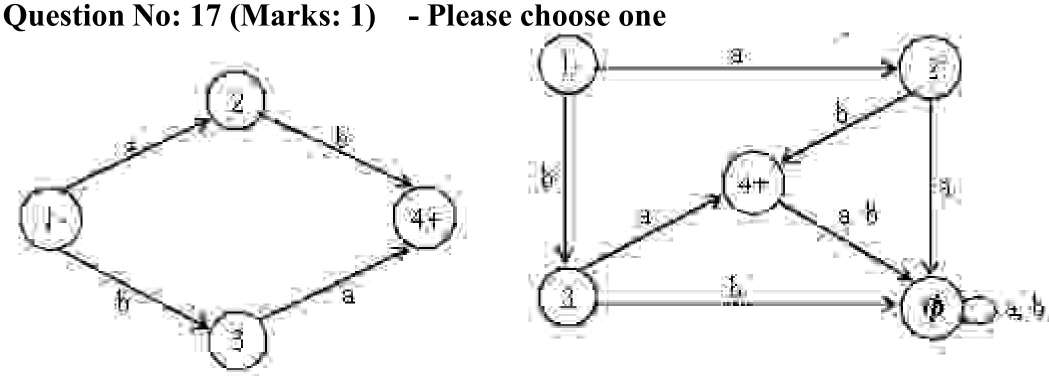
Question No: 16 (Marks: 1) - Please choose one



These GTG are ________

- **Equal**
- Not equal
- Not valid
- None of given

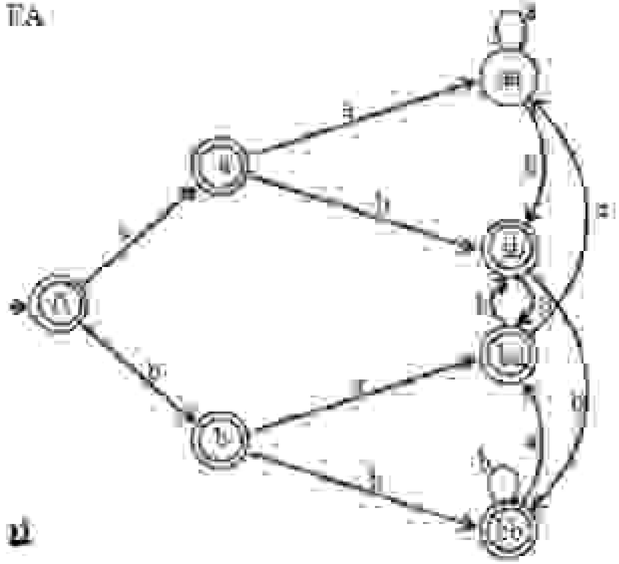
Question No: 17 (Marks: 1) - Please choose one



NFA to FA will_____________

- **Equal**
- Not equal
- Not valid
- None of given

Question No: 18 (Marks: 1) - Please choose one



FA having RE

[K + a + b + (a+b)*(ab+ba+bb).]

Question No: 19 (Marks: 1) - Please choose one

Question No: 20 (Marks: 1) - Please choose one

Question No: 21 (Marks: 2) - Please choose one

The language can express in FA then why we need NFA. Justify your answer.

Question No: 22 (Marks: 2) - Please choose one

Names of four type of autometa.

Question No: 23 (Marks: 3) - Please choose one

Check the given statements or correct or not if not then correct it.

1. **String in regular language can not be infinite**
2. **Concatenation of finite letters from alphabets called sigma**
3. **There cannot be more then on FA,s for same language.**

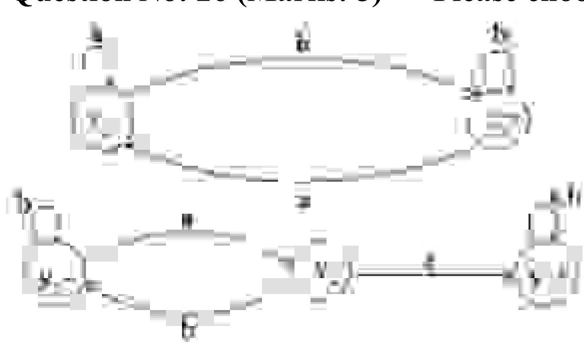
Question No: 24 (Marks: 3) - Please choose one

How can we know, what language a certain RE represent

Question No: 25 (Marks: 5) - Please choose one

Explain mealy machine

Question No: 26 (Marks: 5) - Please choose one



Show the transition table of FA_1+FA_2

[Answer]

Old States	New States after reading	
	a	b
$z_1- \equiv (x_1,y_1)$	$(x_1,y_2) \equiv z_2$	$(x_2,y_1) \equiv z_3$
$z_2 \equiv (x_1,y_2)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_1) \equiv z_3$
$z_3+ \equiv (x_2,y_1)$	$(x_1,y_2) \equiv z_2$	$(x_2,y_1) \equiv z_3$
$z_4+ \equiv (x_1,y_3)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_3) \equiv z_5$
$z_5+ \equiv (x_2,y_3)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_3) \equiv z_5$

MIDTERM FALL 2011
CS401 Assembly Language

Question No:1 (Marks: 1) - Please choose one
The first instruction of "COM" file must be at offset:
► 0x0010
► **0x0100** **(Page 19)**
► 0x1000
► 0x0000

Question No:2 (Marks: 1) - Please choose one
The execution of the instruction "mov word [ES : 0], 0x0741" will print character "A" on screen , background color of the screen will be
► **Black** **(Page 81)**
► White
► Red
► Blue

Question No:3 (Marks: 1) - Please choose one
The iAPX888 architecture consists of _______ register.
►12
►14
►**16** **(Page 15)**
►18

Question No:4 (Marks: 1) - Please choose one
The execution of the instruction "mov word [ES: 0], 0x0741" will print "A" on the screen, color of the character will be
►Black
►**White** **(Page 81)**
►Red
►Blue

Question No:5 (Marks: 1) - Please choose one
One screen location corresponds to a

► Byte
► **Word** **(Page 80)**
► Double byte
Double word

Question No:6 (Marks: 1) - Please choose one
When an item is pushed on the decrementing stack, the top of the stack is

► **First decremented and then element copied on to the stack** **(Page 68)**
► First incremented and then element copied on to the stack
► Decremented after the element copied on to the stack
► Incremented after the element copied on to the stack

Question No:7 (Marks: 1) - Please choose one
Each screen location corresponds to a word, the lower byte of this word contains ____

► **The character code** **(Page 81)**
► The attribute byte
► The parameters
► The dimensions

Question No:8 (Marks: 1) - Please choose one
if ax contains decimal -2 and BX contains decimal 2 then after the execution of instructions: CMP AX, BX ,JA label

► **Jump will be taken**
► Zero flag will set
► ZF will contain value -4
► Jump will not be taken

Question No:9 (Marks: 1) - Please choose one
If D is "35" is shift to left 2 bits the new value

► 35
► 70
► **140**
► 17

Question No:10 (Marks: 1) - Please choose one
When two 16bit numbers are added the answer can be 17 bits long, this extra bit that won't fit in the target register is placed in the where it can be used and tested
► **carry flag (Page 16)**
► Parity Flag
► Auxiliary Carry
► Zero Flag

Question No: 11 (Marks: 1) - Please choose one
Only instructions allow moving data from memory to memory.
► **string (Page 29)**
► word
► indirect
► stack

Question No:12 (Marks: 1) - Please choose one
When a 16 bit number is divided by an 8 bit number, the quotient will be in
► **AL (Page 85)**
► AX
► AH
► DX

Question No:13 (Marks: 1) - Please choose one
Which bit of the attributes byte represents the red component of background color ?
► 3
► 4
► 5
► **6 (Page 81)**

Question No:14 (Marks: 1) - Please choose one
| 0 |--›| 1 | 1 | 0 | 1 | 0 | 0 | 0 | --›| C | is a example of ______
► Shl
► sar
► **Shr (Page 52)**
► Sal

Question No:15 (Marks: 1) - Please choose one
allow changing specific processor behaviors and are used to play with it.
► **Special Instructions (Page 14)**
► Data Movement Instructions
► Program Control Instructions
► Arithmetic and Logic Instructions

Question No:16 (Marks: 1) - Please choose one
8088 is a 16bit processor with its accumulator and all registers of __________.
► 32 bits
► 6 bits
► 16 bits (Page 14)
► 64 bits

Question No:17 (Marks: 1) - Please choose one
decrements SP (the stack pointer) by two and then transfers a word from the source operand to the top of stack
► PUSH (Page 71)
► POP
► CALL
► RET

MIDTERM 2011
CS401 Assembly Language

1. **In instruction ADC the operands can be**
   - Two register only
   - Two register and one memory location
   - **CF and two other operands (Page 57)**
   - ZF and two other operands

2. **After the execution of instruction "RET"**
   - **SP is incremented by 2 (Page 66)**
   - SP is decremented by 2
   - SP is incremented by 1
   - SP is decremented by 1

3. **The extended ASCII has**
   - 64 characters
   - **128 characters (Page 79)**
   - 256 characters
   - 502 characters

4. The second byte in the word designated for screen location holds

- The dimension of the screen
- Character position on the screen
- **Character color on the screen** **(Page 81)**
- ACSII code of the character

5. REP will always

- Incremented CX by 1
- Incremented CX by 2
- **Decremented CX by 1** **(Page 92)**
- Decremented CX by 2

6. The routine that executes in response to an INT instruction is called

- **ISR** **(Page 103)**
- IRS
- ISP
- IRT

7. The iAPX888 architecture consists of _______ register.

- 12
- 14
- **16** **(Page 15) Rep**
- 18

8. In the instruction "CMP AX,BX" the contents of

- AX are changed
- BX are changed
- CX are changed
- **Flag register are changed** **(Page 39)**

9. All the addressing mechanisms iniAPX88 return a number called ______ address.

- **Effective** **(Page 33)**
- faulty
- indirect
- direct

10. The execution of the instruction "mov word [ES: DI], 0x0720"

- **will clear next character on screen** **(Page 82)**
- will print "20" at top left of the screen
- will print "20" at top right of the screen
- will move DI at location 0720 on the screen

11. “mov byte [num1],5” is _______ instruction.

- **legal (Page 30)**
- illegal
- stack based
- memory indirect

12. MOV instruction transfers a byte or word from which of the following source location.

- DS:DI
- ES:SI
- ES:DI
- **DS:SI (Page 92)**

13. The execution of the instruction “mov word [ES: 0], 0x0741” will print “A” on the screen, color of the character will be

- Black
- **White (Page 81) rep**
- Red
- Blue

14. If AX contains FFFFh, then after execution of instruction “SAL ax, 3”, the result will be

- -3
- +3
- -8
- +8

15. If the decimal number “35” is shifted by two bit to left, the new value will be

- 35
- 70
- **140 (**00100011 = 35 , 10001100=140)
- 17

16. While using STOBS, if DF=1 then

- The value of SI will be incremented by one
- The value of SI will be incremented by two
- **The value of SI will be decremented by one** click here for detail
- The value of SI will be decremented by two

17. After the execution of STOSW, the CX will be

- Decremented by 1
- **Decremented by 2 (Page 92)**
- Incremented by 1
- Incremented by 2

18. The memory address always move from

- **processor to memory**
- memory to processor
- memory to peripheral
- peripheral to processor

19. An offset alone is not complete without

- **Segment** **(Page 34)**
- code label
- index register
- data label

20. Code Segment is associated to _______ register by default.

- **IP** **(Page 34)**
- SS
- BP
- CX

MIDTERM SPRING 2011
CS401 Assembly Language

Question No:1 (Marks: 1) - Please choose one
After the execution of SAR instruction:

► MSB remain as it is
► MSB Will change
► **MSB move to left** **(Page 52)**
► No change will occur.

Question No:2 (Marks: 1) - Please choose one
ASCII stands for ____________.
The screen is two dimensional space having:

► 25 Rows and 25 Columns
► 25 Rows and 80 Columns
► 80 Rows and 80 Columns
► **80 Rows and 25 Columns** **(Page 80)**

Question No:3 (Marks: 1) - Please choose one
In the Rotate Right Operation every bit moves one position to right and the bit dropped from the right is inserted at the left and:
► **Dropped in CF** **(Page 53)**
► moves to AL
► Don't go anywhere.

Question No:4 (Marks: 1) - Please choose one
____________ of the following flags will be affected by MOVSB?
► **DF** Click here for detail
► ZF
► PF
► No effect on flags.

Question No:5 (Marks: 1) - Please choose one
The iAPX88 processor supports ___________ modes of memory access.
► 5
► 6
► **7** **(Page 35)**
► 8

Midterm Spring 2010
CS401 Assembly Language

Question No:1 (Marks: 1) - Please choose one
Stack is a ______ that behaves in a first in last out manner.
► Program
► **data structure** **(Page 67)**
► Heap
► None of the Given

Question No:2 (Marks: 1) - Please choose one
The physical address of the stack is obtained by
► SS:SI combination
► **SS:SP combination** **(Page 68)**
► ES:BP combination
► ES:SP combination

Question No:3 (Marks: 1) - Please choose one
Foreground and background parameter will be
► 32bits
► 16bits
► 8bits
► 4bits

Question No:4 (Marks: 1) - Please choose one
The clear screen operation initialize whole block of memory
► 0741
► 0417
► 0714
► 0174, 0720 (Page 91)

Question No:5 (Marks: 1) - Please choose one
In STOSB instruction, when DF is Set, SI is
► Incremented by 1
► Incremented by 2
► Decremented by 1 Click here for detail
► Decremented by 2

Question No:6 (Marks: 1) - Please choose one
Assembly language is:
► Low-level programming language Click here for detail
► High-level programming language
► Also known as machine language
► Not considered closer to the computer

Question No:7 (Marks: 1) - Please choose one
A 32 Bit processor has accumulator of ---------
► 8 bit
► 16 bit
► 32 bit (Page 12)
► 64 bit

Question No:8 (Marks: 1) - Please choose one
To transfer control back the RET instruction take
► 1 argument
► 1 argument
► 3 arguments (Page 72) (Not sure)
► No arguments

Question No:9 (Marks: 1) - Please choose one
RET is executed, it recovers the values from

► Register
► Stack (Page 71)
► Data segment
► Code segment

Question No:10 (Marks: 1) - Please choose one
To convert any digit to its ASCII representation
► Add 0x30 in the digit (Page 80)
► Subtract 0x30 from the digit
► Add 0x61 in the digit
► Subtract 0x61 from the digit

Question No:11 (Marks: 1) - Please choose one
The prevalent convention in most high level languages is stack clearing by the

► Caller
► Callee (Page 74)
► RET
► Stack

Question No:12 (Marks: 1) - Please choose one
After execution of JCXZ instruction CX will changed with flag affect.
► CF
► OF
► DF
► None of Above (Page 43)

Question No:13 (Marks: 1) - Please choose one
Execution of the instruction "mov word [ES : 0], 0x0741" will print
► "A" appear on the top left of screen (Page 81)
► "A" appear on the top right of screen
► "A" appear on the center of screen
► "A" appear on the bottom left of screen

Question No:14 (Marks: 1) - Please choose one
if contains decimal -2 and BX contains decimal 2 then after the execution of instructions:
CMP AX, BX
JA label
► Jump will be taken

► Zero flag will set
► ZF will contain value -4
► Jump will not be taken

Question No:15 (Marks: 1) - Please choose one
Which of the following options contain the set of instructions to open a window to the video memory?
► mov AX, 0xb008
mov ES, AX
► mov AX, 0xb800
mov ES, AX (Page 81) rep
► mov AX, 0x8b00
mov ES, AX
► mov AX, 0x800b
mov ES, AX

Question No:16 (Marks: 1) - Please choose one
If D is "35" is shift to left 2 bits the new value
► 35
► 70
► 140
► 17

Question No:17 (Marks: 1) - Please choose one
Execution of the instruction "mov word [ES : 0], 0x1230" will print the character color will
► Green
► White
► Red
► Black

MIDTERM EXAMINATION
Spring 2010

Question No: 1 (Marks: 1) - Please choose one
After the execution of SAR instruction

► The msb is replaced by a 0
► The msb is replaced by 1
► The msb retains its original value
► The msb is replaced by the value of CF (Page 52)

Question No: 2 (Marks: 1) - Please choose one
RETF will pop the offset in the
► BP
► **IP** **(Page 69)**
► SP
► SI

Question No: 3 (Marks: 1) - Please choose one
The routine that executes in response to an INT instruction is called

► **ISR** **(Page 103) rep**
► IRS
► ISP
► IRT

Question No: 4 (Marks: 1) - Please choose one
The first instruction of "COM" file must be at offset:
► 0x0010
► **0x0100** **(Page 19) rep**
► 0x1000
► 0x0000

Question No: 5 (Marks: 1) - Please choose one
"Far" jump is not position relative but is _______________
► memory dependent
► **Absolute** **(Page 46)**
► Temporary
► indirect

Question No: 6 (Marks: 1) - Please choose one
Only ___________ instructions allow moving data from memory to memory.

► **string** **(Page 29) rep**
► word
► indirect
► stack

Question No: 7 (Marks: 1) - Please choose one
After the execution of instruction "RET 2"

► SP is incremented by 2
► SP is decremented by 2

► **SP is incremented by 4 (Page 66)**
► SP is decremented by 4

Question No: 8 (Marks: 1) - Please choose one
DIV instruction has

► **Two forms (Page 85)**
► Three forms
► Four forms
► Five forms

Question No: 9 (Marks: 1) - Please choose one
When the operand of DIV instruction is of 16 bits then implied dividend will be of

► **8 bits (Page 85)**
► 16 bits
► 32 bits
► 64 bits

Question No: 10 (Marks: 1) - Please choose one
After the execution of MOVS instruction which of the following registers are updated

► SI only
► DI only
► **SI and DI only (Page 92)**
► SI, DI and BP only

Question No: 11 (Marks: 1) - Please choose one
In 8088 architecture, whenever an element is pushed on the stack

► SP is decremented by 1
► **SP is decremented by 2 (Page 68)**
► SP is decremented by 3
► SP is decremented by 4

Question No: 12 (Marks: 1) - Please choose one
When a very large number is divided by very small number so that the quotient is larger than the space provided, this is called

► Divide logical error

► Divide overflow error (Page 85)
► Divide syntax error
► An illegal instruction

Question No: 13 (Marks: 1) - Please choose one
In the word designated for one screen location, the higher address contains

► The character code
► The attribute byte (Page 81)
► The parameters
► The dimensions

Question No: 14 (Marks: 1) - Please choose one
Which of the following options contain the set of instructions to open a window to the video memory?
► mov AX, 0xb008
mov ES, AX
► mov AX, 0xb800
mov ES, AX (Page 81) rep
► mov AX, 0x8b00
mov ES, AX
► mov AX, 0x800b
mov ES, AX

Question No: 15 (Marks: 1) - Please choose one
In a video memory, each screen location corresponds to
► One byte
► Two bytes (Page 80)
► Four bytes
► Eight bytes

Question No: 16 (Marks: 1) - Please choose one
The execution of the instruction "mov word [ES : 0], 0x0741" will print character "A" on screen , background color of the screen will be

► Black (Page 81) rep
► White
► Red
► Blue

MIDTERM Fall 2011
CS401 Assembly Language

Question No:1 (Marks: 1) - Please choose one
One screen location corresponds to a
► Byte
► Word (Page 80) rep
► Double byte
► Double word

Question No:2 (Marks: 1) - Please choose one
After the execution of "PUSH AX" statement
► AX register will reside on the stack
► A copy of AX will go on the stack (Page 69)
► The value of AX disappear after moving on stack
► Stack will send an acceptance message

Question No:3 (Marks: 1) - Please choose one
physical address of the stack is obtained by
► SS:SP combination
► SS:SI combination
► SS:SP combination (Page 68) rep
► ES:BP combination
► ES:SP combination

Question No:4 (Marks: 1) - Please choose one
If the address of memory location Num1 is 0117 and its content is 0005 then after execution of the instruction " mov bx, Num1" bx will contain
► 0005
► 0117 (Page 30)
► Num1
► 1701

Question No:5 (Marks: 1) - Please choose one
In STOS instruction, the implied source will always be in

► AL or AX registers (Page 92)
► DL or DX registers
► BL or BX registers
► CL or CX registers

Question No:6 (Marks: 1) - Please choose one
The shift logical right operation inserts
A zero at right
A zero at left **(Page 52)**
A one at right
A one at right

Question No:7 (Marks: 1) - Please choose one
REP will always
Increment CX by 1
Increment CX by 2
Decrement CX by 1 **(Page 92) rep**
Decrement CX by 2

Question No:8 (Marks: 1) - Please choose one
When an item is pushed on the decrementing stack, the top of the stack is
► **First decremented and then element copied on to the stack** **(Page 68) rep**
► First incremented and then element copied on to the stack
► Decremented after the element copied on to the stack
► Incremented after the element copied on to the stack

Question No:9 (Marks: 1) - Please choose one
assembly the CX register is used normally as a ______________register.
► source
► **counter** **(Page 32)**
► index
► pointer

Which is the unidirectional bus ?
(I) Control Bus
(II) Data Bus
(III) Address Bus
► I only
► II only
► **III only** **(Page 9)**
► I and II only

Question No:10 (Marks: 1) - Please choose one
The basic function of SCAS instruction is to
► **Compare** **(Page 92)**
► Scan

►Sort
►Move data

Question No:11 (Marks: 1) - Please choose one
_______ register holds the address of next instruction is to be executed
►Base pointer
►Code segment
►Source index
►Program counter (Page 13)

Question No:12 (Marks: 1) - Please choose one
JC and JNC test the ____________ flag.
►carry (Page 41)
►parity
►zero
►sign

Question No:13 (Marks: 1) - Please choose one
After the execution of REP instruction CX will be decremented then which of the following flags will be affected?
►CF
►OF
►DF
►No flags will be affected (Page 93)

Question No:14 (Marks: 1) - Please choose one
In string manipulation whenever an instruction needs a memory source, which of the following will hold the pointer to it?

►ES: DI
►ES: BP
►DS:BP
►DS:SI (Page 91)

Question No:15 (Marks: 1) - Please choose one
which bit sets the character "blinking" on the screen?

►5
►6
►7 (Page 7)
►8

Question No:16 (Marks: 1) - Please choose one
If we want to divide a signed number by 2, this operation can better be accomplished by
► SHR
► **SAR (Page 52)**
► SHL
► SAL

Question No:17 (Marks: 1) - Please choose one
After the execution of STOSB,the CX wil be……..
► Incremented by 1
► Incremented by 2
► **Decremented by 1 (Page 92)**
► Decremented by 2

Question No:18 (Marks: 1) - Please choose one
Each screen location corresponds to a word, the lower byte of this word contains ____

► **The character code (Page 81) rep**
► The attribute byte
► The parameters
► The dimensions

Question No:19 (Marks: 1) - Please choose one
In a video memory, each screen location corresponds to
► One byte
► **Two bytes (Page 86)**
► Four bytes
► Eight bytes

MIDTERM EXAMINATION
Spring 2010

Question No:1 (Marks: 1) - Please choose one
Execution of the instruction "mov word [ES : 0], 0x0741" will print
► **"A" appear on the top left of screen (Page 81) rep**
► "A" appear on the top right of screen
► "A" appear on the center of screen
► "A" appear on the bottom left of screen

Question No:2 (Marks: 1) - Please choose one

After the execution of "PUSH AX" statement

► **AX register will reside on the stack (Page 69) rep**

► A copy of AX will go on the stack

► The value of AX disappear after moving on stack

► Stack will send an acceptance message

Question No:3 (Marks: 1) - Please choose one

If D is "35" is shift to left 2 bits the new value

► 35

► 70

► **140**

► 17

Question No:4 (Marks: 1) - Please choose one

When an item is pushed on the decrementing stack, the top of the stack is

► **First decremented and then element copied on to the stack (Page 68) rep**

► First incremented and then element copied on to the stack

► Decremented after the element copied on to the stack

► Incremented after the element copied on to the stack

Question No:5 (Marks: 1) - Please choose one

After the execution of REP instruction CX will be decremented then which of the following flags will be affected?

► CF

► OF

► DF

► **No flags will be affected (Page 93) rep**

Question No:6 (Marks: 1) - Please choose one

In a video memory, each screen location corresponds to

► One byte

► **Two bytes (Page 66)**

► Four bytes

► Eight bytes

Question No:7 (Marks: 1) - Please choose one

shifting the -15 two bit sAR

► -7

► -8

► 7

► 8

Question No:8 (Marks: 1) - Please choose one

mov ax,5 has

► 1 operand

► **2 opeand** **(Page 25)**

► 3 operand

► 4 opeand

MIDTERM EXAMINATION
Spring 2010

Question No: 1 (Marks: 1) - Please choose one

The physical address of the stack is obtained by

► **SS:SP combination**

► SS:SI combination

► **SS:SP combination** **(Page 68) rep**

► ES:BP combination

► ES:SP combination

Question No: 2 (Marks: 1) - Please choose one

After the execution of instruction "RET "

► **SP is incremented by 2**

► **SP is incremented by 2** **(Page 66) rep**

► SP is decremented by 2

► SP is incremented by 1

► SP is decremented by 1

Question No: 3 (Marks: 1) - Please choose one

The second byte in the word designated for one screen location holds

► **Character color on the screen**

► The dimensions of the screen

► Character position on the screen

► **Character color on the screen** **(Page 81) rep**

► ASCII code of the character

Question No: 4 (Marks: 1) - Please choose one
REP will always

- ► Increment CX by 1
- ► Increment CX by 2
- **► Decrement CX by 1 (Page 92)**
- ► Decrement CX by 2

Question No: 5 (Marks: 1) - Please choose one
The basic function of SCAS instruction is to

- **► Compare (Page 92) rep**
- ► Scan
- ► Sort
- ► Move data

Question No: 6 (Marks: 1) - Please choose one
Index registers are used to store __________

- ► Data
- ► Intermediate result
- **► Address (Page 16)**
- ► Both data and addresses

Question No: 7 (Marks: 1) - Please choose one
The bits of the _____________ work independently and individually

- ► index register
- ► base register
- **► flags register (Page 12)**
- ► accumulator

Question No: 8 (Marks: 1) - Please choose one
To convert any digit to its ASCII representation

- **► Add 0x30 in the digit (Page 80) rep**
- ► Subtract 0x30 from the digit
- ► Add 0x61 in the digit
- ► Subtract 0x61 from the digit

Question No: 9 (Marks: 1) - Please choose one
When a 32 bit number is divided by a 16 bit number, the quotient is of

- ► 32 bits
- **► 16 bits (Page 85)**
- ► 8 bits
- ► **4 bits**

Question No: 10 (Marks: 1) - Please choose one
When a 16 bit number is divided by an 8 bit number, the quotient will be in

- ► AX
- **► AL (Page 85) rep**
- ► AH
- ► DX

Question No: 11 (Marks: 1) - Please choose one
Which mathematical operation is dominant during the execution of SCAS instruction

- ► Division
- ► Multiplication
- ► Addition
- **► Subtraction (Page 92)**

Question No: 12 (Marks: 1) - Please choose one
If AX contains decimal -2 and BX contains decimal 2 then after the execution of instructions:
CMP AX, BX
JA label

- **► Jump will be taken**
- ► Zero flag will set
- ► ZF will contain value -4
- ► Jump will not be taken

Question No: 13 (Marks: 1) - Please choose one
The execution of the instruction "mov word [ES : 160], 0x1230" will print a character "0" on the screen at

- ► Second column of first row
- **► First column of second row (Page 81)**
- ► Second column of second row
- ► First column of third row

Question No: 14 (Marks: 1) - Please choose one
If the direction of the processing of a string is from higher addresses towards lower addresses then

- ► ZF is cleared
- ► DF is cleared
- ► ZF is set
- ► **DF is set** **(Page 91)**

Question No: 15 (Marks: 1) - Please choose one
The instruction ADC has________ Operand(s)

- ► 0
- ► 1
- ► 2
- ► **3** **(Page 56)**

Question No: 16 (Marks: 1) - Please choose one
Which bit of the attributes byte represents the red component of background color ?

- ► 3
- ► 4
- ► 5
- ► **6** **(Page 81)**

MIDTERM EXAMINATION
Spring 2010

Question No: 1 (Marks: 1) - Please choose one
Suppose AL contains 5 decimal then after two left shifts produces the value as

- ► 5
- ► **10**
- ► 15
- ► 20

Question No: 2 (Marks: 1) - Please choose one
In STOS instruction, the implied source will always be in

► **AL or AX registers** **(Page 92) rep**

▶ DL or DX registers
▶ BL or BX registers
▶ CL or CX registers

Question No: 3 (Marks: 1) - Please choose one
After the execution of STOSW the CX will be

▶ Decremented by 1
▶ **Decremented by 2** **(Page 92) rep**
▶ Incremented by 1
▶ Incremented by 2

Question No: 4 (Marks: 1) - Please choose one
The basic function of SCAS instruction is to

▶ **Compare** **(Page 92) rep**
▶ Scan
▶ Sort
▶ Move data

Question No: 5 (Marks: 1) - Please choose one
Which is the unidirectional bus ?
(I) Control Bus
(II) Data Bus
(III) Address Bus
▶ I only
▶ II only
▶ **III only** **(Page 9) rep**
▶ I and II only

Question No: 6 (Marks: 1) - Please choose one
The operation of CMP is to
▶ **Subtract Source from Destination** **(Page 39)**
▶ Subtract Destination to from Source
▶ Add 1 to the Destination
▶ Add Source and Destination

Question No: 7 (Marks: 1) - Please choose one
The registers IP, SP, BP, SI, DI, and BX all can contain a ________offset.
▶ 8-bit
▶ **16-bit** **(Page 21)**
▶ 32-bit
▶ 64-bit

Question No: 8 (Marks: 1) - Please choose one

In assembly the CX register is used normally as a ______________register.

- ► source
- ► **counter (Page 92)**
- ► index
- ► pointer

Question No: 9 (Marks: 1) - Please choose one

All the addressing mechanisms in iAPX88 return a number called _____________ *address*.

- ► **effective (Page 33)**
- ► faulty
- ► indirect
- ► direct

Question No: 10 (Marks: 1) - Please choose one

Which bit of the attributes byte represents the blue component of foreground color

- ► 3
- ► 2
- ► 1
- ► **0 (Page 81)**

Question No: 11 (Marks: 1) - Please choose one

When a 32 bit number is divided by a 16 bit number, the quotient will be stored in

- ► **AX (Page 85)**
- ► BX
- ► CX
- ► DX

Question No: 12 (Marks: 1) - Please choose one

“mov byte [num1], 5” is _________ instruction**.**

- ► **legal (Page 30) rep**
- ► illegal
- ► stack based
- ► memory indirect

Question No: 13 (Marks: 1) - Please choose one

Which of the following options contain the set of instructions to open a window to the video memory?

- ► mov AX, 0xb008

mov ES, AX

► **mov AX, 0xb800**
mov ES, AX **(Page 81) rep**
► mov AX, 0x8b00
mov ES, AX
► mov AX, 0x800b
mov ES, AX

Question No: 14 (Marks: 1) - Please choose one
The execution of the instruction "mov word [ES : 0], 0x0741" will print character "A" on screen, color of the character will be

► Black
► **White** **(Page 81) rep**
► Red
► Blue

Question No: 15 (Marks: 1) - Please choose one
Which of the following flags will be affected by MOVSW?

► DF
► PF
► ZF
► **No effect on flags**

Question No: 16 (Marks: 1) - Please choose one
Which bit of the attributes byte represents the blue component of background color ?
► 3
► **4** **(Page 81)**
► 5
► 6

MIDTERM EXAMINATION
Spring 2009

Question No: 1 (Marks: 1) - Please choose one
To transfer control back the RET instruction take
► 1 argument
► 1 argument
► **3 arguments** **(Page 72) rep**
► No arguments

Question No: 2 (Marks: 1) - Please choose one
In STOSB instruction SI is decremented or incremented by
► 4
► **1 (Page 92) SI and DI both are Index registers**
► 2
► 3

Question No: 3 (Marks: 1) - Please choose one
CMPS instruction subtracts the source location to the destination location.
Destination location always lies in
► DS:SI
► DS:DI
► ES:SI
► **ES:DI (Page 93)**

Question No: 4 (Marks: 1) - Please choose one
Regarding assembler, which statement is true:
► **Assembler converts mnemonics to the corresponding OPCODE (Page 13)**
► Assembler converts OPCODE to the corresponding mnemonics
► Assembler executes the assembly code all at once
► Assembler executes the assembly code step by step

Question No: 5 (Marks: 1) - Please choose one
If “BB” is the OPCODE of the instruction which states to “move a constant value to AX register”, the hexadecimal representation (Using little Endian notation) of the instruction “Mov AX,336” (“150” in hexadecimal number system) will be:
► 0xBB0150
► 0x5001BB
► 0x01BB50
► **0xBB5001 (Page 19)**

Question No: 6 (Marks: 1) - Please choose one
In the instruction MOV AX, 5 the number of operands are
► 1
► **2 (Page 25) rep**
► 3
► 4

Question No: 7 (Marks: 1) - Please choose one
The maximum parameters a subroutine can receive (with the help of registers) are
► 6
► **7 (Page 72)**
► 8

►9

Question No: 8 (Marks: 1) - Please choose one
In assembly the CX register is used normally as a ______________register.

► source
► counter (Page 92) rep
► index
► pointer

Question No: 9 (Marks: 1) - Please choose one
All the addressing mechanisms in iAPX88 return a number called _____________ *address*.

► effective (Page 33) rep
► faulty
► indirect
► direct

Question No: 10 (Marks: 1) - Please choose one
When a 16 bit number is divided by an 8 bit number, the dividend will be in

► AX (Page 85)
► BX
► CX
► DX

Question No: 11 (Marks: 1) - Please choose one
in Left-Shift-Operation the left most bit _______
► will drop
► will go into CF (Page 52)
► Will come to the right most
► will be always 1

Question No: 12 (Marks: 1) - Please choose one
Suppose the decimal number "35" after shifting its binary two bits to left, the new value becomes _________
► 35
► 70
► 140
► 17

Question No: 13 (Marks: 1) - Please choose one
When divide overflow occurs processor will be interrupted this type of interrupt is called
► **Hardware interrupt** **Click here for detail**
► Software interrupt
► Processor exception
► Logical interrupts

Question No: 14 (Marks: 1) - Please choose one
Which mathematical operation is dominant during the execution of SCAS instruction
► Division
► Multiplication
► Addition
► **Subtraction** **(Page 92) rep**

Question No: 15 (Marks: 1) - Please choose one
After the execution of REP instruction CX will be decremented then which of the following flags will be affected?
► CF
► OF
► DF
► **No flags will be affected** **(Page 93) rep**

Question No: 16 (Marks: 1) - Please choose one
__________ is one of the reasons due to which string instructions are used in 8088
► Efficiency and accuracy
► Reduction in code size and accuracy
► **Reduction in code size and speed** **(Page 91)**
► Reduction in code size and efficiency

MIDTERM FALL 2010

CS402

Question No: 1 (Marks: 1) - Please choose one

Auto Meta mean

- Manual work
- **Automatic work**

Question No: 2 (Marks: 1) - Please choose one

S= {a,bc,cc} has the latters

- 1
- 2
- **3**
- 4

Question No: 3 (Marks: 1) - Please choose one

S={a,bb,bab,baabb} set of strings then S* will not have

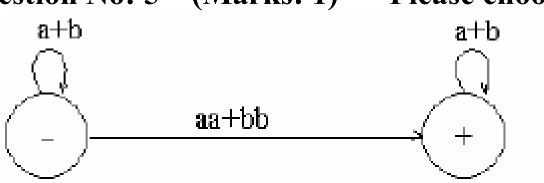
- Baba
- Baabbab
- Bbaaabb
- **bbbaabaabb(not confirmed)**

Question No: 4 (Marks: 1) - Please choose one

One language can represents more then one RE.

- **True**
- Falss
- Can't be assumed
- Non of given

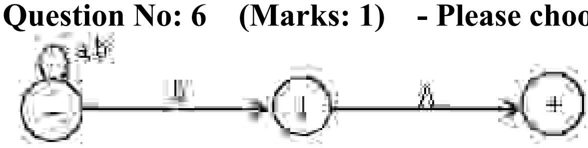
Question No: 5 (Marks: 1) - Please choose one



Given GTG has RE

- **(a+b)* (aa+bb)(a+b)***
- None of option

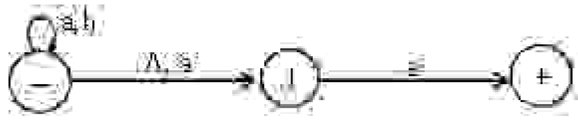
Question No: 6 (Marks: 1) - Please choose one



NFA accept ______String

- b
- babab
- baaab
- **all**

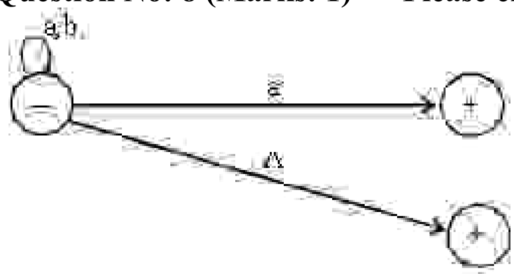
Question No:7 (Marks: 1) - Please choose one



NFA accept ______String

- bab
- a
- aba
- **a & aba**

Question No: 8 (Marks: 1) - Please choose one



TG has

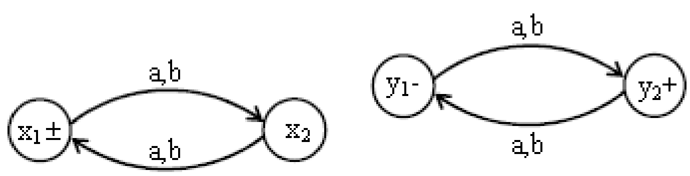
- (a+b)*
- **Λ+(a+b)*a**
- Λ+(a+b)*a*
- None of given

Question No: 9 (Marks: 1) - Please choose one

TG can more then one initial state

- **True**
- False
- Depend on alphabets
- None of given

Question No:10 (Marks: 1) - Please choose one



RE will be

- (a+b)*
- (a+b)*(a*+b*)
- **None of the given**

Question No: 11 (Marks: 1) - Please choose one

The clouser FA*(on an FA) always accept ______string

- Null
- aa
- bb
- **None of given**

Question No: 12 (Marks: 1) - Please choose one

In FA final state represent by _________sign

- **+**
- -
- =
- *

Question No: 13 (Marks: 1) - Please choose one

In FA one enter in specific stat but there is no way to leave it then state is called

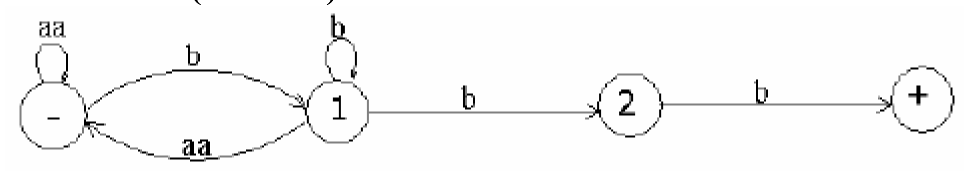
- Dead States
- Waste Baskets
- Davey John Lockers
- **All of above**

Question No: 14 (Marks: 1) - Please choose one

Using tree structure final state represent by

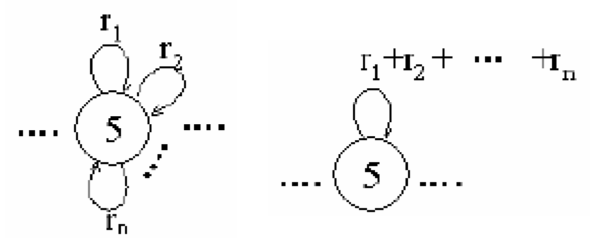
- *
- -
- **double circle**
- None of given

Question No: 15 (Marks: 1) - Please choose one



- **a's occur only in even clumps and that ends in three or more b's**
- length larger then 2
- it does not accept any language
- none of given option

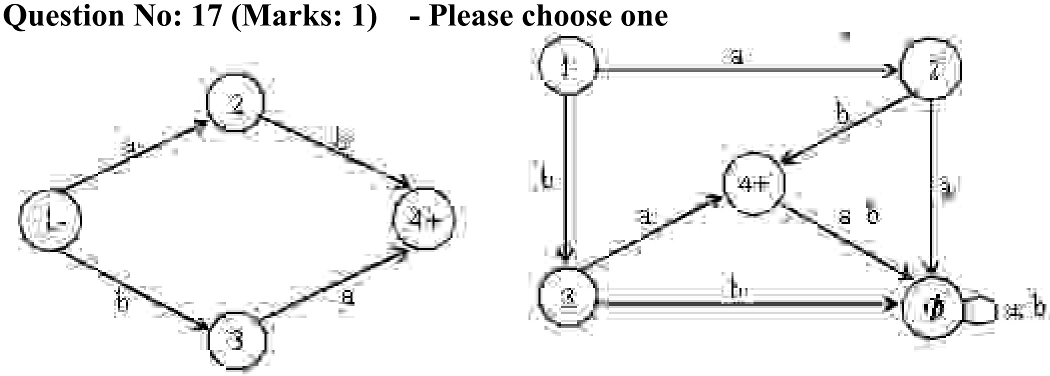
Question No: 16 (Marks: 1) - Please choose one



These GTG are ________

- **Equal**
- Not equal
- Not valid
- None of given

Question No: 17 (Marks: 1) - Please choose one

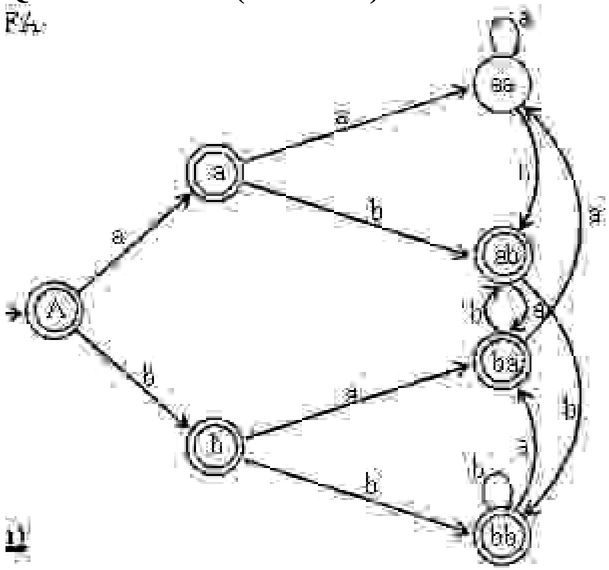


NFA

to FA will_____________

- **Equal**
- Not equal
- Not valid
- None of given

Question No: 18 (Marks: 1) - Please choose one



FA having RE

K + a + b + (a+b)*(ab+ba+bb).

Question No: 19 (Marks: 1) - Please choose one

Question No: 20 (Marks: 1) - Please choose one

Question No: 21 (Marks: 2) - Please choose one

The language can express in FA then why we need NFA. Justify your answer.

Question No: 22 (Marks: 2) - Please choose one

Names of four type of autometa.

Question No: 23 (Marks: 3) - Please choose one

Check the given statements or correct or not if not then correct it.

1. **String in regular language can not be infinite**
2. **Concatenation of finite letters from alphabets called sigma**
3. **There cannot be more then on FA,s for same language.**

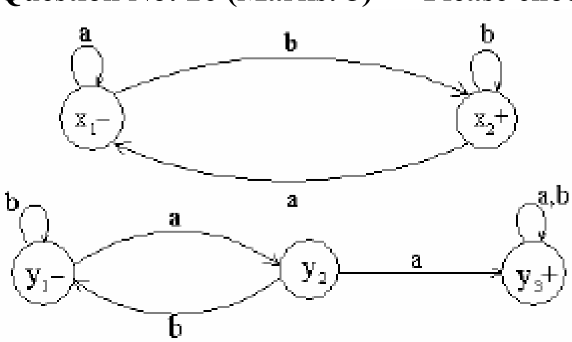
Question No: 24 (Marks: 3) - Please choose one

How can we know, what language a certain RE represent

Question No: 25 (Marks: 5) - Please choose one

Explain mealy machine

Question No: 26 (Marks: 5) - Please choose one



Show the transition table of FA_1+FA_2

Answer

Old States	New States after reading	
	a	b
$z_1- \equiv (x_1,y_1)$	$(x_1,y_2) \equiv z_2$	$(x_2,y_1) \equiv z_3$
$z_2 \equiv (x_1,y_2)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_1) \equiv z_3$
$z_3+ \equiv (x_2,y_1)$	$(x_1,y_2) \equiv z_2$	$(x_2,y_1) \equiv z_3$
$z_4+ \equiv (x_1,y_3)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_3) \equiv z_5$
$z_5+ \equiv (x_2,y_3)$	$(x_1,y_3) \equiv z_4$	$(x_2,y_3) \equiv z_5$

MID term Paper OF CS402
Theory of Automata

1) Can we use only the + and – symbols to show the initial and final states of the FA…… Marks2
2) State that the followings are true or false. … Marks2
   a. Kleen star and Kleen closure are different.
   b. Length of the output of the mealy machine is one less than the input string.
3) For mealy machine tell about $\sum$, Γ and what this machine will do. … Marks3
4) Name the two methods of the Kleen's theorem part III. … Marks3
5) Explain Moore Machine… Marks5
6) Show that two TG accept the same language of event number of states. … Marks5

an other paper

1) State that the followings are true or false. … Marks2
   a. Kleen star and Kleen closure are different.
   b. Length of the output of the mealy machine is one less than the input string.
2) complement melay machine (tataly) 2marks
3) one similtary and disimilarty in the DFA and FA
4) make the union of the given FAs (from hand out fist example)
5) diffrance between the TG FA and GTG

MIDTERM EXAMINATION

CS402- Theory of Automata (Session - 3)

Question No: 1 (Marks: 1) - Please choose one

Length of null string is

- Always not equal to 0
- Always equal to 0
- It has variable length
- All are true

Question No: 2 (Marks: 1) - Please choose one

If an alphabet has n number of letter, then number of strings of length m will be

- n+m
- (n)(m)
- m^n
- n^m

Question No: 3 (Marks: 1) - Please choose one

Languages generated by kleene star are always ______________.

- Finite
- Infinite
- Sometimes finite & sometimes infinite
- None of the these

Question No: 4 (Marks: 1) - Please choose one

“Every finite language can be expressed by FA”. This statement is __________.

- ► True
- ► False
- ► Depends on language
- ► None of these

Question No: 5 (Marks: 1) - Please choose one

In FA, if one enters in a specific state but there is no way to leave it, then that specific state is called

- ► Dead States
- ► Waste Baskets
- ► Davey John Lockers
- ► All of these

Question No: 6 (Marks: 1) - Please choose one

In TG there may exist no paths for certain string.

- ► True
- ► False
- ► Depends on the language
- ► None of these

Question No: 7 (Marks: 1) - Please choose one

In GTG's there may exist no path for a certain string.

- ► True
- ► False

► Depends on alphabet

► None of these

Question No: 8 (Marks: 1) - Please choose one

In drawing FA3 (which is equal to FA1 + FA2), a state will be declared final if

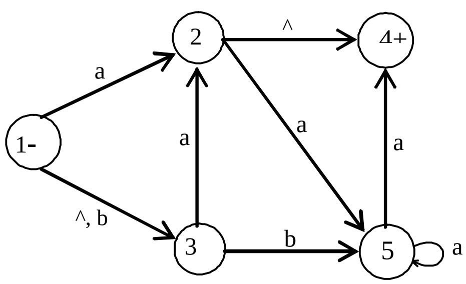
► States of both FA's are final

► At least one state is final

► Depends on language

► None of the given

Question No: 9 (Marks: 1) - Please choose one



Above given structure is an ________.

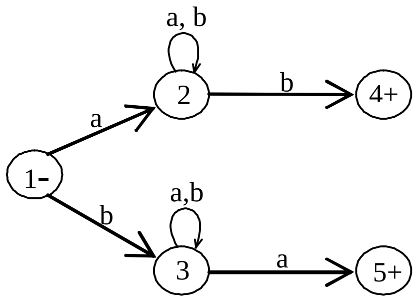
► FA

► NFA

► NFA -^

► TG

Question No: 10 (Marks: 1) - Please choose one



Above given TG represents the language____

- ▶ Begins and ends with same letters
- ▶ Begins and ends with different letters
- ▶ Begins with a
- ▶ None of these

Question No: 11 (Marks: 1) - Please choose one

In TG, there may be a transition for null string.

- ▶ True
- ▶ False
- ▶ Can't show transition for string
- ▶ None of these

Question No: 12 (Marks: 1) - Please choose one

The _______ machine helps in building a machine that can perform the addition of binary numbers.

- ▶ Incrementing
- ▶ Complementing
- ▶ Decrementing
- ▶ None of the given

Question No: 13 (Marks: 1) - Please choose one

GTG can have ______________ initial state.

- ▶ Zero
- ▶ One
- ▶ More than One
- ▶ One OR more than One

Question No: 14 (Marks: 1) - Please choose one

One FA has n states and m letters in the alphabet. Then FA will have _____ number of transitions in the diagram.

- ▶ (n)+(m)
- ▶ (m)(n) OR (n)(m)
- ▶ None of the given options
- ▶ (m)-(n)

Question No: 15 (Marks: 1) - Please choose one

If L1 and L2 are expressed by regular expressions r1 and r2, respectively then the language expressed by r1 + r2 will be _________

- ▶ Regular
- ▶ Ir-regular
- ▶ Can't be decided
- ▶ Another Language which is not listed here

Question No: 16 (Marks: 1) - Please choose one

Which statement is true?

- ▶ All words are strings
- ▶ All strings are words
- ▶ Both are always same
- ▶ None of these

Question No: 17 (Marks: 1)

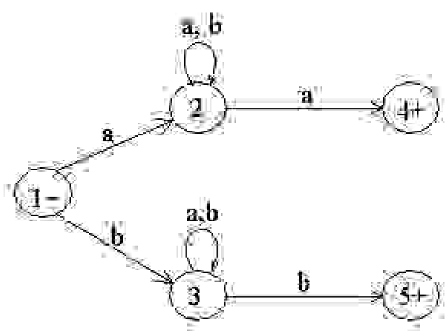
In transition diagram of an FA, how can we represent initail and final states?

Question No: 18 (Marks: 1)

What the Kleene's Theorem Part I says?

Question No: 19 (Marks: 2)

Describe the language for the following TG



Question No: 20 (Marks: 3)

Show that there are exactly 5832 different finite automat with three states x, y, z over the alphabet {a, b}, where x is always the start state.

Question No: 21 (Marks: 5)

For proving Kleen's theorm part-II:
"If there are more than one transition edges between two states then we can reduce all these transition edges with a single transition edge"

Explain this statement with the help of an example.

Question No: 22 (Marks: 10)

i) Let S = {ab, bb} and let T = {ab, bb, bbbb} Show that S* = T*
ii) Let S = {ab, bb} and let T = {ab, bb, bbb} Show that S* ≠ T*
iii) What principle does this illustrate?

MIDTERM EXAMINATION

CS402- Theory of Automata (Session - 3)

Question No: 1 (Marks: 1) - Please choose one

Alphabet S = {a,bc,cc} has _______ number of letters.

- ► One
- ► Two
- ► Three
- ► Four

Question No: 2 (Marks: 1) - Please choose one

One language can be represented by more than one RE" this statement is____

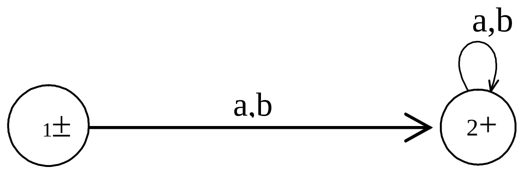
- ► False
- ► True
- ► Can't be assumed
- ► None of these

Question No: 3 (Marks: 1) - Please choose one

(a + b)*b is RE for the language defined over S={a,b} having words not ending in a

- ► True
- ► False
- ► Such a language is not regular
- ► None of these

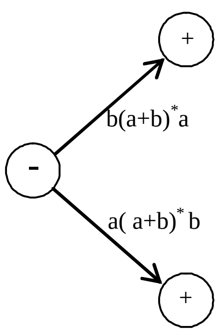
Question No: 4 (Marks: 1) - Please choose one



Above given FA accepts ___________ strings defined over S={a , b}

- ▶ All
- ▶ Some
- ▶ All but not null
- ▶ None of these

Question No: 5 (Marks: 1) - Please choose one



Above given GTG accepts the language in which strings

- ▶ Begins and ends with different letters
- ▶ Begins and ends with same letters
- ▶ Have length greater than 1
- ▶ None of these

Question No: 6 (Marks: 1) - Please choose one

According to 3rd part of the Kleene's theorem, If a language can be accepted by an RE then it can be accepted by a _________ as well

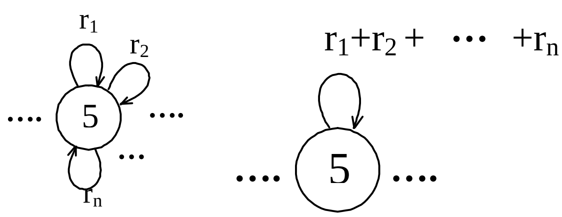
► TG

► FA

► TG and FA

► None of these

Question No: 7 (Marks: 1) - Please choose one



Above given GTG's are _______________

► Equivalent

► Non-equivalent

► Non-valid

► None of the given

Question No: 8 (Marks: 1) - Please choose one

If FA1 accepts no string and FA2 accepts many strings, then FA1 + FA2 will be equal to

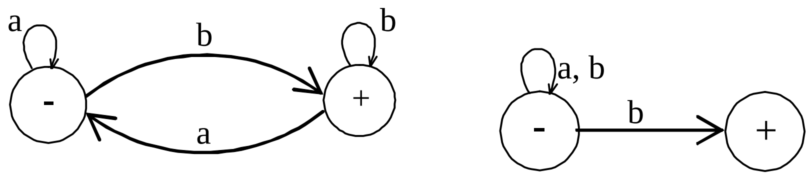
► FA1

► FA2

► May be both

► None of the given

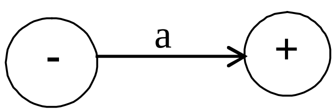
Question No: 9 (Marks: 1) - Please choose one



Above given NFA and FA generate same language.

- ▶ True
- ▶ False
- ▶ FA & NFA can’t be equivalent
- ▶ None of these

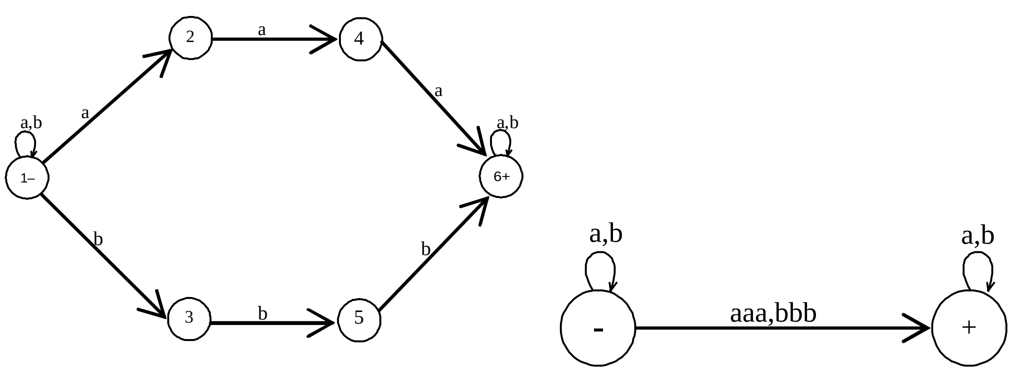
Question No: 10 (Marks: 1) - Please choose one



Above given structure is a ______________

- ▶ FA
- ▶ TG
- ▶ NFA
- ▶ FA and NFA

Question No: 11 (Marks: 1) - Please choose one



Above given TG’s are ______________.

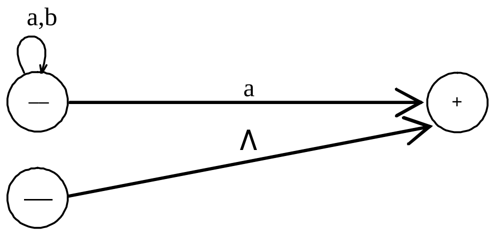
► Equivalent

► Non-equivalent

► TG's are not valid

► None of these

Question No: 12 (Marks: 1) - Please choose one



Above given TG has the _______________ RE.

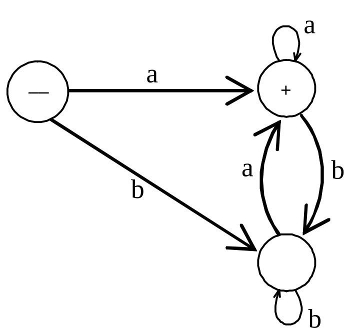
► (a + b)*a

► Λ + (a + b)*a

► None of these

► Λ + (a + b)*a*

Question No: 13 (Marks: 1) - Please choose one



Above given FA has __________ RE.

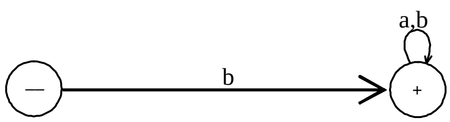
► (a + b)*a

► a(a + b)*

▶ ((a + b)*a)*

▶ (a + b)*a & ((a + b)*a)*

Question No: 14   (Marks: 1) - Please choose one



Above given TG accepts the _____________ string.

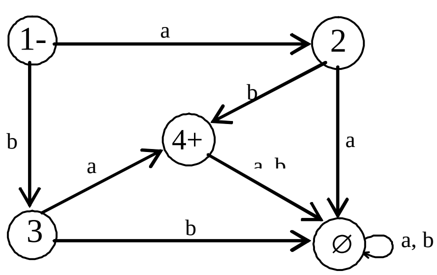
▶ bb

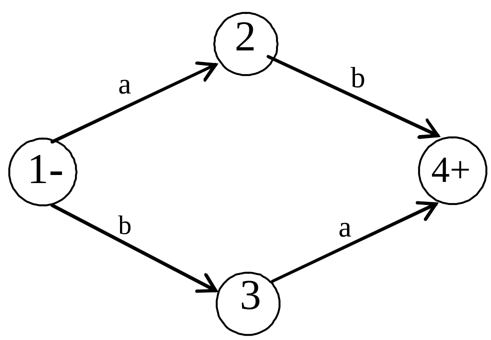
▶ baba

▶ bbba

▶ all of the given options

Question No: 15   (Marks: 1) - Please choose one





Above given FA and NFA are equivalent. This statement is ______________.

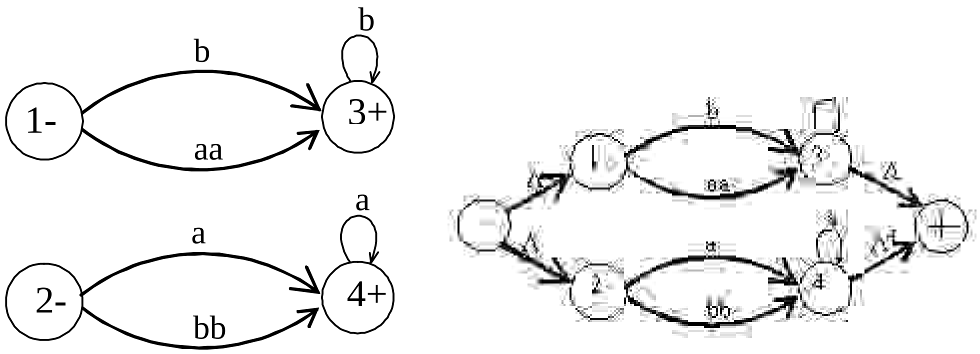
▶ True

▶ False

▶ FA & NFA can never be equivalent

▶ None of the given options

Question No: 16   (Marks: 1) - Please choose one



Above given two TG's are _______________.

► Equivalent

► None-equivalent

► Not valid

► None of the given

Question No: 17 (Marks: 1)

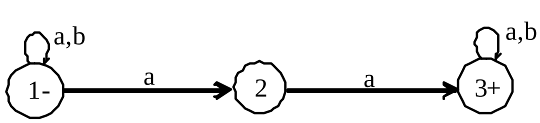
What is the difference between Regular Languages and Non Regular Languages?

Question No: 18 (Marks: 1)

What is meant by tokenizing a string?

Question No: 19 (Marks: 2)

Define the language for the following NFA also write the regular expression for the language?



Question No: 20 (Marks: 3)

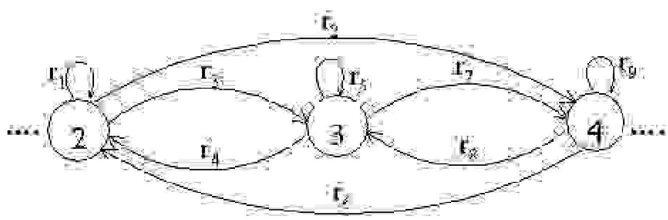
Describe the method of NFA corresponding to Concatenation of FAs.

Question No: 21 (Marks: 5)

(i) When asked to give a recursive definition for the language PALINDROM over the alphabet S = {a, b}, a student wrote:
Rule 1 a and b are in PALINDROM.
Rule 2 If x is in PALINDROM, then so are axa and bxb
Unfortunately all the words in the language defined above have an odd length and so it is not all of PALINDROM. Fix this problem.
(ii) Give a recursive definition for the language EVENPALINDROM of all palindromes of even length

Question No: 22 (Marks: 10)

What do you mean by "bypass and state elimination" Also reduce the following TG by eliminating state 3. (Draw reduced TG)



MIDTERM EXAMINATION

CS402- Theory of Automata (Session - 3)

Question No: 1 (Marks: 1) - Please choose one

If r1 and r2 are regular expressions then which of the following is not regular expression.

- r1 = r2
- r1r2
- r1*
- r1 – r2

Question No: 2 (Marks: 1) - Please choose one

Which of the following is not a word of language EQUAL?

- aaabbb
- abbbabaa
- abababa
- bbbaaa

Question No: 3 (Marks: 1) - Please choose one

If S = {aa, bb}, then S* will not contain..

- aabbaa
- bbaabbbb
- aaabbb
- aabbbb

Question No: 4 (Marks: 1) - Please choose one

One language can be represented by more than one RE" this statement is____

- ▶ False
- ▶ True
- ▶ Can't be assumed
- ▶ None of these

Question No: 5 (Marks: 1) - Please choose one

"Every Infinite language is regular" this statement is

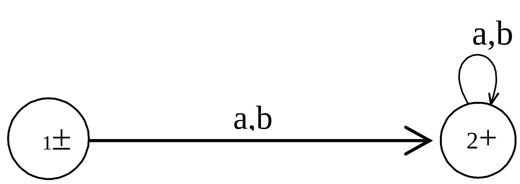
- ▶ True
- ▶ False
- ▶ Can't be supposed
- ▶ None of these

Question No: 6 (Marks: 1) - Please choose one

PALINDROME can be defined by more than one regular language

- ▶ True
- ▶ False
- ▶ By only one RE
- ▶ Some times By only one RE and Some times False

Question No: 7 (Marks: 1) - Please choose one



Above given FA can be expressed as ________

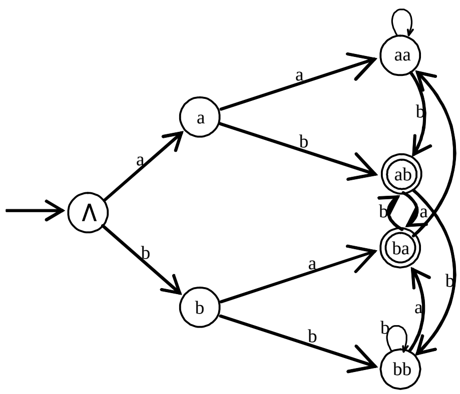
▶ (a + b)*

▶ a* + b*

▶ (ab + ba)*

▶ None of these

Question No: 8 (Marks: 1) - Please choose one



Above given FA is drawn using

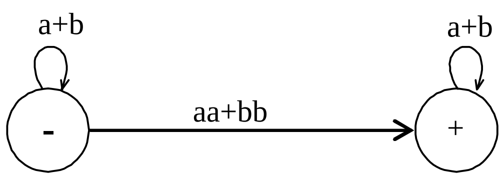
▶ Tree structure

▶ It is not an FA

▶ Graph structure

▶ None of these

Question No: 9 (Marks: 1) - Please choose one



Above given GTG accepts the language in which strings

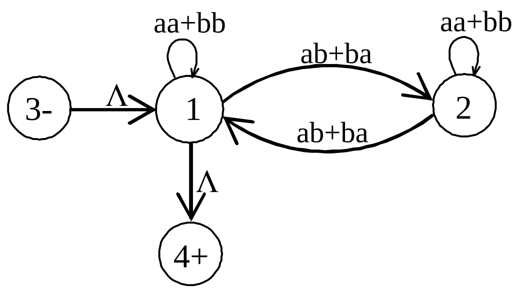
▶ Contains double a or double b

▶ Contains both a and double b

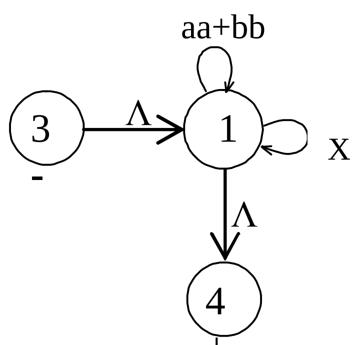
▶ Depends on the alphabet

▶ None of these

Question No: 10 (Marks: 1) - Please choose one



If above given TG is drawn like



Then what will be written in place of X.

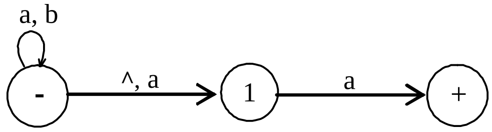
▶ (ab+ba)(aa+bb)(ba+ab)

▶ (ab+ba)(aa+bb)(ab+ba)

▶ (ab+ba)(aa+bb)*(ab+ba)

▶ (ab+ba)(aa+bb)(ab+ba)*

Question No: 11 (Marks: 1) - Please choose one



Above given NFA-^ accepts____

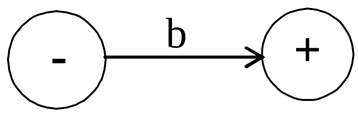
▶ bab

▶ a

▶ aba

▶ a & aba

Question No: 12 (Marks: 1) - Please choose one



Above given structure is a __________________.

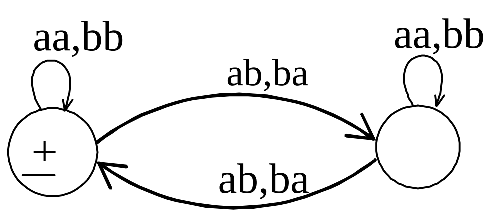
▶ FA

▶ TG

▶ FA & TG

▶ NFA

Question No: 13 (Marks: 1) - Please choose one



Above given TG has ______________ RE.

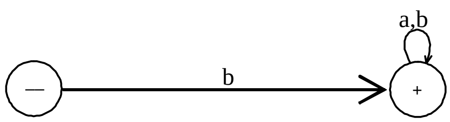
▶ (aa+aa+(ab+ab)(aa+ab)*(ab+ba))*

▶ (aa+bb+(ab+ba)(aa+bb)*(ab+ba))*

▶ (aa+bb+(ab+ba)(aa+bb)(ab+ba))*

▶ None of these

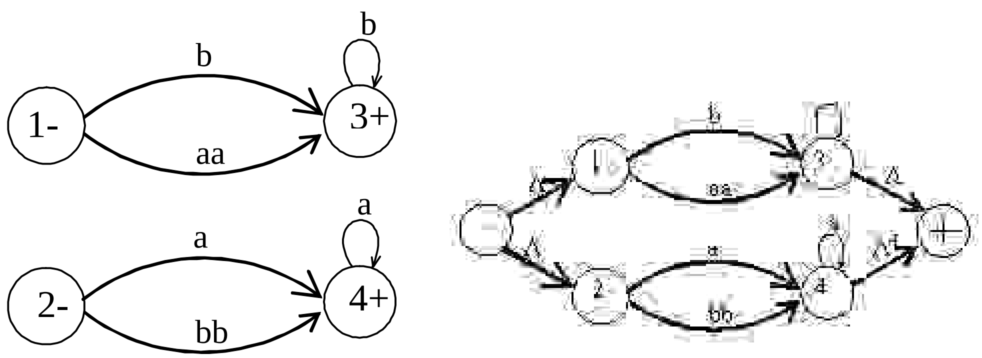
Question No: 14 (Marks: 1) - Please choose one



Above given TG has ________________ RE.

- b(a + b)*
- b*(a + b)*
- b*(a + b)
- None of these

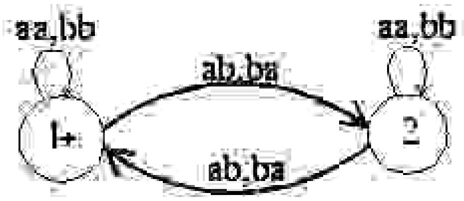
Question No: 15 (Marks: 1) - Please choose one



Above given two TG's are ________________.

- Equivalent
- None-equivalent
- Not valid
- None of the given

Question No: 16 (Marks: 1) - Please choose one



Above given TG has ____________________________ RE.

- (aa+bb+(ab+ba)(aa+bb)(ab+ba))*
- (aa+bb+(ab+ba)(aa+bb)*(ab+ba))*
- (aa+ba+(bb+ba)(ab+bb)(ab+aa))*
- (ab+ba+(ab+ba)(aa+bb)(ab+ba))*

Question No: 17 (Marks: 1)

How can we say that two REs are equal?

Question No: 18 (Marks: 1)

What is meant by Kleene star closure of a language?

Question No: 19 (Marks: 2)

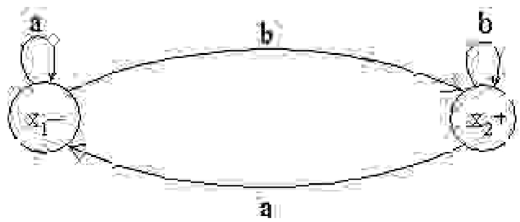
What the Pumping lemma II says about length(x) + length(y) must be:

Question No: 20 (Marks: 3)

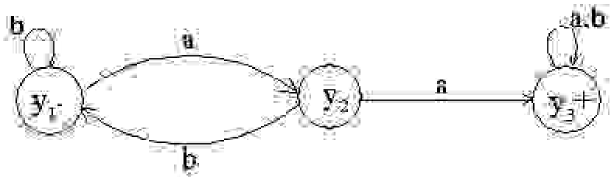
Consider the language S*, where S = {ab, ba}, Can any word in this language contain the substrings aaa or bbb? Why or why not?

Question No: 21 (Marks: 5)

Give the transition table of an FA3 corresponding to FA1+FA2, where FA1, FA2 are given below.
FA1



FA_2



Question No: 22 (Marks: 10)

What is meant by nondeterminism? Draw the TG for the following RE

$(aa)^{*}b(b^{*}+(\,(aa)^{+}b)^{*})\,bb$.

MIDTERM EXAMINATION
CS402- Theory of Automata (Session - 3)

Question No: 1 (Marks: 1) - Please choose one

S = {baa, ab}, then S* will not contain

- ► abbaab
- ► abab
- ► baabaa
- ► abbaa

Question No: 2 (Marks: 1) - Please choose one

1*(1 + Λ) = 1* this statement is

- ► True
- ► False
- ► Sometimes true & sometimes false
- ► None of these

Question No: 3 (Marks: 1) - Please choose one

One language can be represented by more than one RE" this statement is____

- ► False
- ► True
- ► Can't be assumed
- ► None of these

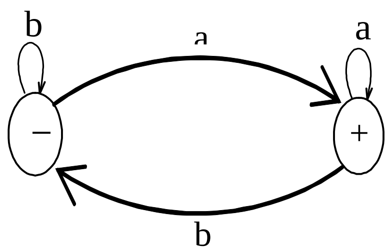
Question No: 4 (Marks: 1) - Please choose one

---

a(a+b)*a+b(a+b)*b is RE for the language defined over S={a,b} having words beginning and ending with same letters

- ▶ True
- ▶ False
- ▶ Such a language is not regular
- ▶ None of these

Question No: 5 (Marks: 1) - Please choose one



Above given FA can be expressed by

- ▶ (a + b)*a
- ▶ (a + b)*b
- ▶ a (a + b)*
- ▶ b (a + b)*

Question No: 6 (Marks: 1) - Please choose one

If a language has RE, then that language can be expressed through TG.

- ▶ True
- ▶ False
- ▶ Depends on language
- ▶ None of these

Question No: 7 (Marks: 1) - Please choose one

In TG there may exist no paths for certain string.

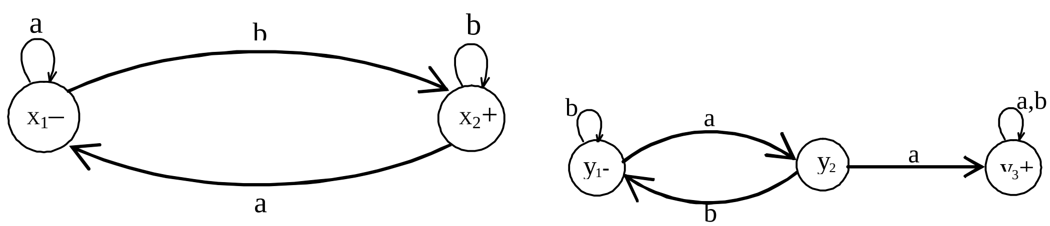
▶ True

▶ False

▶ Depends on the language

▶ None of these

Question No: 8 (Marks: 1) - Please choose one



FA1 FA2

FA3 will express r1r2. then F3 will have ____________________ number of states in its diagram.

▶ 8

▶ 7

▶ 6

▶ 5

Question No: 9 (Marks: 1) - Please choose one

FA1 corresponds to r*, then FA1 must accept _______________ string.

▶ Every

▶ Null

▶ Odd length

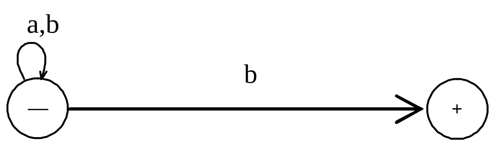
▶ Even length

Question No: 10 (Marks: 1) - Please choose one

In NFA, there may be more than one transition for certain letters and there may not be any transition for certain letters. This statement is ______________.

- ▶ False
- ▶ True
- ▶ Depends on language
- ▶ None of the given

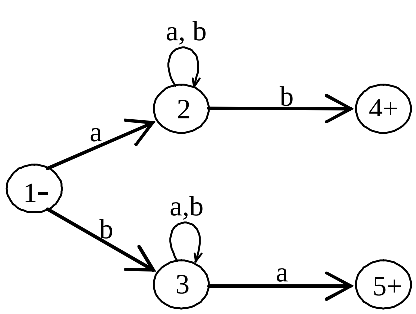
Question No: 11 (Marks: 1) - Please choose one



Above given TG accepts the language in which all strings

- ▶ Ends in b
- ▶ Begins with b
- ▶ Ends and begins with b
- ▶ None of the given

Question No: 12 (Marks: 1) - Please choose one



Above given TG represents the language____

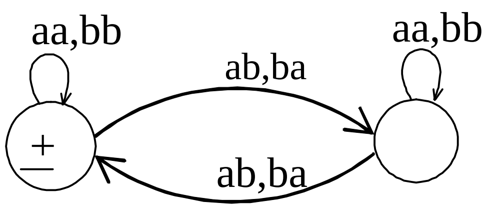
- ▶ Begins and ends with same letters

▶ Begins and ends with different letters

▶ Begins with a

▶ None of these

Question No: 13 (Marks: 1) - Please choose one



Above given TG represents the language i.e.

▶ EVEN-EVEN

▶ PALINDROME

▶ FACTORIAL

▶ None of these

Question No: 14 (Marks: 1) - Please choose one

FA1 and FA2 are two FA's representing two languages. Then FA3, which is sum of FA1 and FA2, will accept the strings which are

▶ Accepted by FA1 AND FA2

▶ Accepted by FA1 OR FA2

▶ Accepted by FA1 AND/OR FA2

▶ None of the given options

Question No: 15 (Marks: 1) - Please choose one

a (a + b)* is the RE of language defined over S = {a, b} having at least one a

- ▶ True
- ▶ False
- ▶ Such a language does not exist
- ▶ None of the given options

Question No: 16 (Marks: 1) - Please choose one

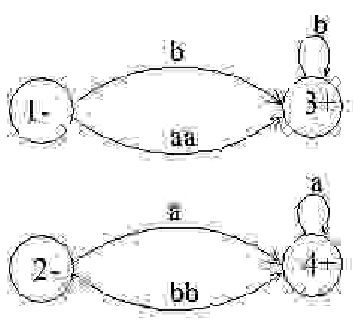
(a + b)* a is RE for the language defined over S={a,b} having words not ending in b

- ▶ True
- ▶ False
- ▶ Such a language is not regular
- ▶ None of the given options

Question No: 17 (Marks: 1)

What is meant by a "language" in automata?

Question No: 18 (Marks: 1)



For the above given TG draw an equivalent TG having only one final state.

Question No: 19 (Marks: 2)

Give the regular expression for EVEN-EVEN language?

Question No: 20 (Marks: 3)

Give an example of a set S such that S* only contains all possible string of a's and b's that has length divisible by 3

Question No: 21 (Marks: 5)

Construct a regular expression defining the following language over the alphabet S = {a, b}:
All words that contains at least one of the strings s_1, s_2, s_3 or s_4

Question No: 22 (Marks: 10)

What is meant by nondeterminism? Draw the TG for the following RE

$(aa)^{*}b(b^{*}+((aa)^{+}b)^{*})\, bb.$

MIDTERM EXAMINATION

CS402- Theory of Automata (Session - 1)

Question No: 1 (Marks: 1) - Please choose one

Alphabet S = {a,bc,cc} has _______ number of letters.

► One

► Two

► Three

► Four

Question No: 2 (Marks: 1) - Please choose one

In which of the following language Rev(s)=s

► EQUAL

► INTEGER

► PALINDROME

► FACTORIAL

Question No: 3 (Marks: 1) - Please choose one

If S = {ab, bb}, then S* will not contain

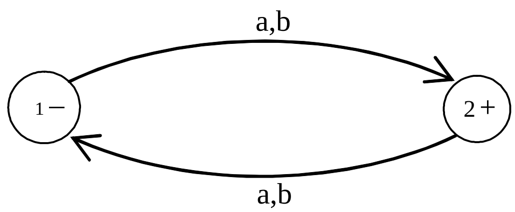
► abbbab

► bbba

► bbbbab

► ababbb

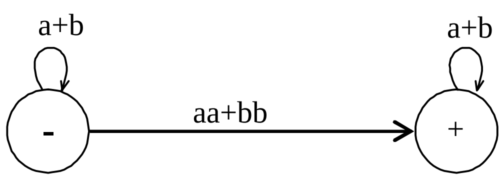
Question No: 4 (Marks: 1) - Please choose one



Above given FA generates the language having strings of _________

- ▶ ODD length
- ▶ EVEN length
- ▶ Equal number of a’s and b’s
- ▶ None of these

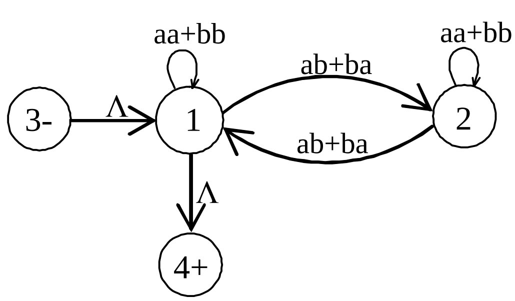
Question No: 5 (Marks: 1) - Please choose one



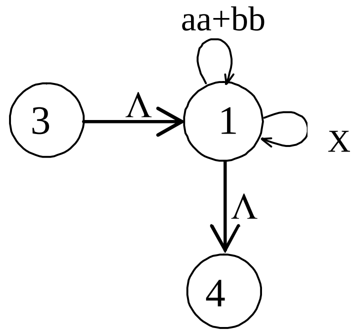
Above given GTG accepts the language in which strings

- ▶ Contains double a or double b
- ▶ Contains both a and double b
- ▶ Depends on the alphabet
- ▶ None of these

Question No: 6 (Marks: 1) - Please choose one



If above given TG is drawn like



Then what will be written in place of X.

- ▶ (ab+ba)(aa+bb)(ba+ab)
- ▶ (ab+ba)(aa+bb)(ab+ba)
- ▶ (ab+ba)(aa+bb)*(ab+ba)
- ▶ (ab+ba)(aa+bb)(ab+ba)*

Question No: 7 (Marks: 1) - Please choose one

FA3 expresses r1r2. Then initial state of FA3 will consist of

- ▶ Initial state of FA2
- ▶ Initial state of FA1
- ▶ Initial states of both FA1 & FA2
- ▶ Depends on FA's

Question No: 8 (Marks: 1) - Please choose one

FA3 expresses r1r2. Then there will be at least one final state of FA3 that consist of final state of FA1 and initial state of FA2.

- ▶ True
- ▶ False
- ▶ Depends on language
- ▶ None of these

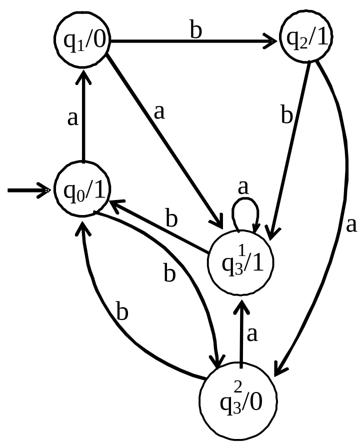
Question No: 9 (Marks: 1) - Please choose one

Two machines are said to be equivalent if they print the same output string when the different input string is run on them

- ▶ True
- ▶ False
- ▶ Depends on language
- ▶ May be or may not be

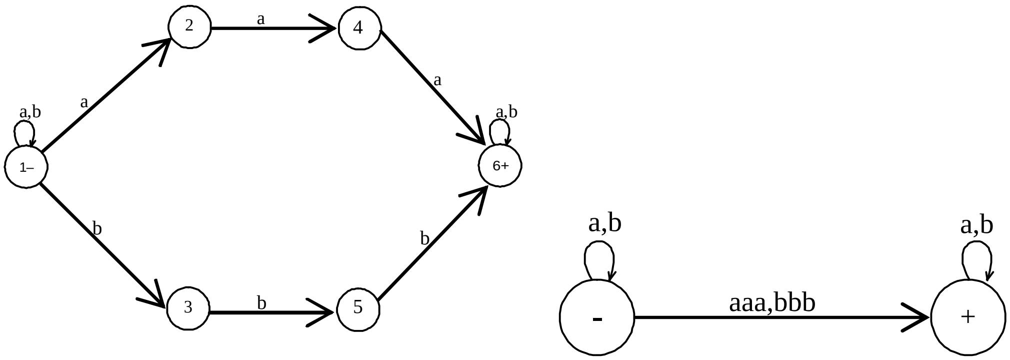
Question No: 10 (Marks: 1) - Please choose one

Running the string abbabbba on this Moore machine. The outputs will be_________



- ▶ 101111010
- ▶ 01111010
- ▶ 01011110
- ▶ 01010101

Question No: 11 (Marks: 1) - Please choose one



Above given TG's are ______________.

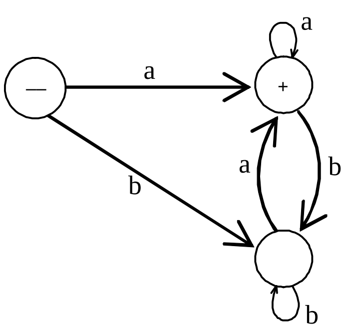
- ▶ None of these
- ▶ Equivalent
- ▶ Non-equivalent
- ▶ TG's are not valid

Question No: 12 (Marks: 1) - Please choose one

TG can have more than one initial state.

- ▶ True
- ▶ False
- ▶ Depends on alphabets
- ▶ None of these

Question No: 13 (Marks: 1) - Please choose one



MIDTERM EXAMINATION

CS402- Theory of Automata (Session - 2)

Question No: 1 (Marks: 1) - Please choose one

If an alphabet has n number of letter, then number of strings of length m will be

- n+m
- (n)(m)
- m^n
- n^m

Question No: 2 (Marks: 1) - Please choose one

Languages generated by kleene star are always _______________.

- Finite
- Infinite
- Sometimes finite & sometimes infinite
- None of the these

Question No: 3 (Marks: 1) - Please choose one

1*(1 +) = 1* this statement is

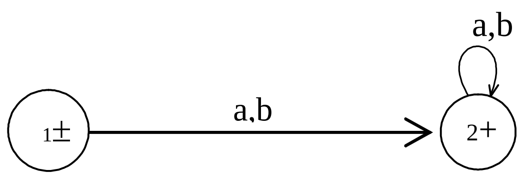
- True
- False
- Sometimes true & sometimes false
- None of these

Question No: 4 (Marks: 1) - Please choose one

a*b* = (ab)* this expression is___________

- ▶ True
- ▶ False
- ▶ Can’t be assumed
- ▶ None of these

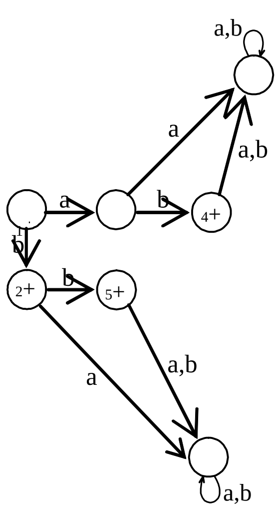
Question No: 5 (Marks: 1) - Please choose one



Above given FA can be expressed as ________

- ▶ (a + b)*
- ▶ a* + b*
- ▶ (ab + ba)*
- ▶ None of these

Question No: 6 (Marks: 1) - Please choose one



Above given FA accepts _____________ language.

- ▶ Finite
- ▶ Infinite
- ▶ Depends on alphabet
- ▶ None of these

Question No: 7 (Marks: 1) - Please choose one

If a language is expressed through TG, then that language will have its RE.

- ▶ True
- ▶ False
- ▶ Depends on language
- ▶ None of these

Question No: 8 (Marks: 1) - Please choose one

In TG there may exist more than one path for certain string.

- ▶ True
- ▶ False
- ▶ Depends on the language
- ▶ None of these

Question No: 9 (Marks: 1) - Please choose one

In TG there may exist no paths for certain string.

- ▶ True
- ▶ False
- ▶ Depends on the language

▶ None of these

Question No: 10 (Marks: 1) - Please choose one

GTG can have ________________ final state.

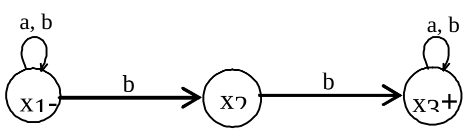
▶ 0

▶ 1

▶ More than 1

▶ All of the given

Question No: 11 (Marks: 1) - Please choose one



Above given diagram is an NFA. If we convert it into an FA using transition table, then new FA will be consisted on _______________ number of states.

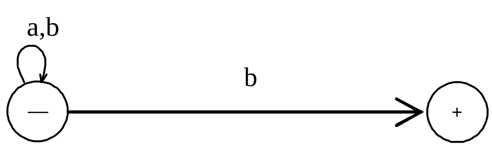
▶ 6

▶ 5

▶ 4

▶ 3

Question No: 12 (Marks: 1) - Please choose one



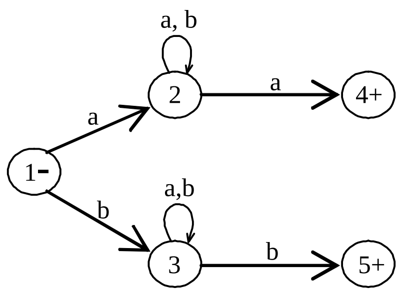
Above given TG accepts the language in which all strings

▶ Ends in b

▶ Begins with b

- ▶ Ends and begins with b
- ▶ None of the given

Question No: 13 (Marks: 1) - Please choose one



Above given TG has _____________ RE.

- ▶ a(a + b)*b + b(a + b)*a
- ▶ b(b + a)*a + b(a + b)*a
- ▶ None of these
- ▶ a(a + b)*a + b(a + b)*b

Question No: 14 (Marks: 1) - Please choose one

Every FA should be __________

- ▶ Deterministic
- ▶ Non- Deterministic
- ▶ Deterministic & Non- Deterministic
- ▶ None of these

Question No: 15 (Marks: 1) - Please choose one

If in an NFA, $\wedge$ is allowed to be a label of an edge then that NFA is called _________.

- ▶ Will not remain NFA

MIDTERM EXAMINATION

CS402- Theory of Automata (Session - 3)

Question No: 1 (Marks: 1) - Please choose one

Length of null string is

-
- Always not equal to 0
- Always equal to 0
- It has variable length
- All are true

Question No: 2 (Marks: 1) - Please choose one

If an alphabet has n number of letter, then number of strings of length m will be

-
- n+m
- (n)(m)
- m^n
- n^m

Question No: 3 (Marks: 1) - Please choose one

Languages generated by kleene star are always _______________.

-
- Finite
- Infinite
- Sometimes finite & sometimes infinite
- None of the these

Question No: 4 (Marks: 1) - Please choose one

"Every finite language can be expressed by FA". This statement is ___________.

▶ True

▶ False

▶ Depends on language

▶ None of these

Question No: 5 (Marks: 1) - Please choose one

In FA, if one enters in a specific state but there is no way to leave it, then that specific state is called

▶ Dead States

▶ Waste Baskets

▶ Davey John Lockers

▶ All of these

Question No: 6 (Marks: 1) - Please choose one

In TG there may exist no paths for certain string.

▶ True

▶ False

▶ Depends on the language

▶ None of these

Question No: 7 (Marks: 1) - Please choose one

In GTG's there may exist no path for a certain string.

▶ True

▶ False

► Depends on alphabet

► None of these

Question No: 8 (Marks: 1) - Please choose one

In drawing FA3 (which is equal to FA1 + FA2), a state will be declared final if

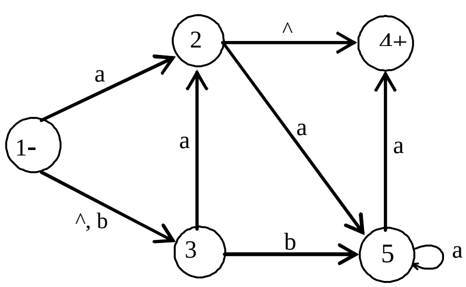
► States of both FA's are final

► At least one state is final

► Depends on language

► None of the given

Question No: 9 (Marks: 1) - Please choose one



Above given structure is an ________.

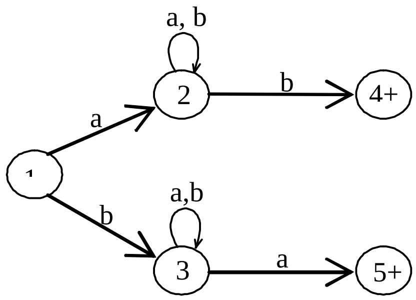
► FA

► NFA

► NFA -^

► TG

Question No: 10 (Marks: 1) - Please choose one



Above given TG represents the language____

- ▶ Begins and ends with same letters
- ▶ Begins and ends with different letters
- ▶ Begins with a
- ▶ None of these

Question No: 11 (Marks: 1) - Please choose one

In TG, there may be a transition for null string.

- ▶ True
- ▶ False
- ▶ Can’t show transition for string
- ▶ None of these

Question No: 12 (Marks: 1) - Please choose one

The _______ machine helps in building a machine that can perform the addition of binary numbers.

- ▶ Incrementing
- ▶ Complementing
- ▶ Decrementing
- ▶ None of the given

Question No: 13 (Marks: 1) - Please choose one

GTG can have ______________ initial state.

- ▶ Zero
- ▶ One
- ▶ More than One
- ▶ One OR more than One

Question No: 14 (Marks: 1) - Please choose one

One FA has n states and m letters in the alphabet. Then FA will have _____ number of transitions in the diagram.

- ▶ (n)+(m)
- ▶ (m)(n) OR (n)(m)
- ▶ None of the given options
- ▶ (m)-(n)

Question No: 15 (Marks: 1) - Please choose one

If L1 and L2 are expressed by regular expressions r1 and r2, respectively then the language expressed by r1 + r2 will be _________

- ▶ Regular
- ▶ Ir-regular
- ▶ Can't be decided
- ▶ Another Language which is not listed here

Question No: 16 (Marks: 1) - Please choose one

Which statement is true?

MIDTERM EXAMINATION
Spring 2009
CS402- Theory of Automata (Session - 1)

Question No: 1 (Marks: 1) - Please choose one

Alphabet S = {a,bc,cc} has ________ number of letters.

► One

► Two

► Three

► Four

Question No: 2 (Marks: 1) - Please choose one

In which of the following language Rev(s)=s

► EQUAL

► INTEGER

► PALINDROME

► FACTORIAL

Question No: 3 (Marks: 1) - Please choose one

If S = {ab, bb}, then S* will not contain

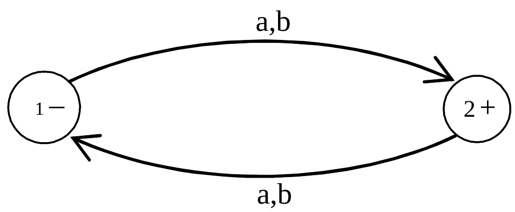
► abbbab

► bbba

► bbbbab

► ababbb

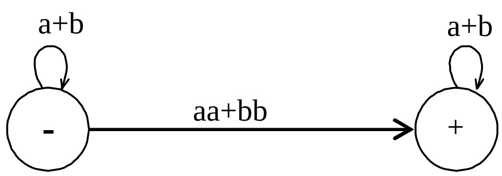
Question No: 4 (Marks: 1) - Please choose one



Above given FA generates the language having strings of _________

- ► ODD length
- ► EVEN length
- ► Equal number of a’s and b’s
- ► None of these

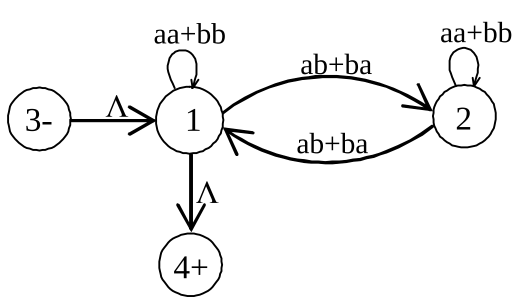
Question No: 5 (Marks: 1) - Please choose one



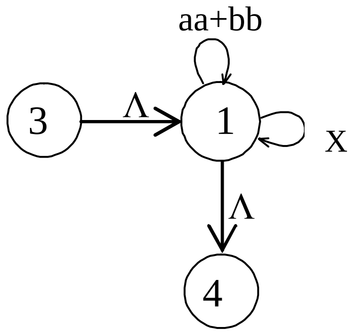
Above given GTG accepts the language in which strings

- ► Contains double a or double b
- ► Contains both a and double b
- ► Depends on the alphabet
- ► None of these

Question No: 6 (Marks: 1) - Please choose one



If above given TG is drawn like



Then what will be written in place of X.

► (ab+ba)(aa+bb)(ba+ab)

► (ab+ba)(aa+bb)(ab+ba)

► (ab+ba)(aa+bb)*(ab+ba)

► (ab+ba)(aa+bb)(ab+ba)*

Question No: 7 (Marks: 1) - Please choose one

FA3 expresses r1r2. Then initial state of FA3 will consist of

► Initial state of FA2

► Initial state of FA1

► Initial states of both FA1 & FA2

► Depends on FA's

Question No: 8 (Marks: 1) - Please choose one

FA3 expresses r1r2. Then there will be at least one final state of FA3 that consist of final state of FA1 and initial state of FA2.

► True

► False

► Depends on language

► None of these

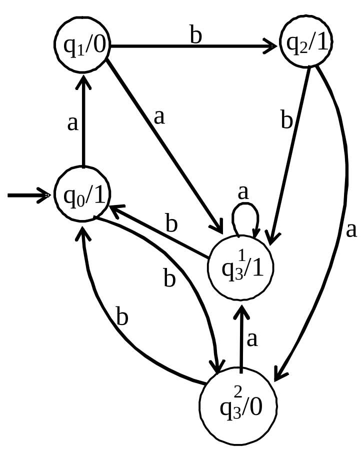
Question No: 9 (Marks: 1) - Please choose one

Two machines are said to be equivalent if they print the same output string when the different input string is run on them

- ► True
- ► False
- ► Depends on language
- ► May be or may not be

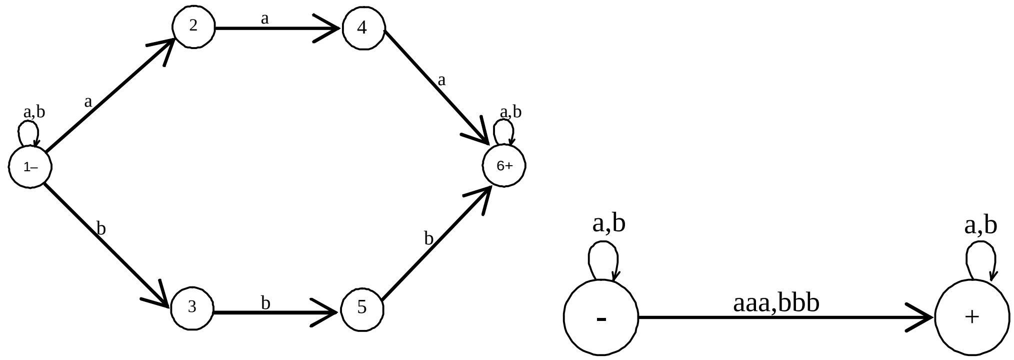
Question No: 10 (Marks: 1) - Please choose one

Running the string abbabbba on this Moore machine. The outputs will be________



- ► 101111010
- ► 01111010
- ► 01011110
- ► 01010101

Question No: 11 (Marks: 1) - Please choose one



Above given TG's are _______________.

► None of these

► Equivalent

► Non-equivalent

► TG's are not valid

Question No: 12 (Marks: 1) - Please choose one

TG can have more than one initial state.

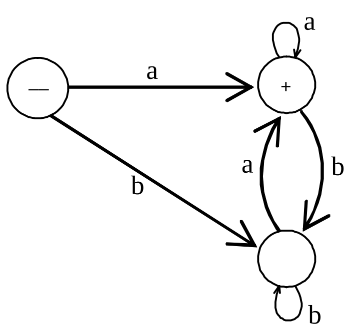
► True

► False

► Depends on alphabets

► None of these

Question No: 13 (Marks: 1) - Please choose one



Above given FA accepts null string.

► True

► False

► FA is not valid

► None of these

Question No: 14 (Marks: 1) - Please choose one

If in an NFA, ∧ is allowed to be a label of an edge then that NFA is called _________.

► Will not remain NFA

► NFA with ∧

► NFA with null string

► Either "NFA with null string" OR "NFA with ∧"

Question No: 15 (Marks: 1) - Please choose one

One FA has n states and m letters in the alphabet. Then FA will have _____ number of transitions in the diagram.

► (n)+(m)

► (m)(n) OR (n)(m)

► None of the given options

► (m)-(n)

Question No: 16 (Marks: 1) - Please choose one

(a+b)*a(a+b)*b(a+b)* is the RE of language defined over S={a,b} having at least one a and one b

► True

► False

► Such a language does not exist

► None of the given options

Question No: 17 (Marks: 1)

Is the following statement trure?
A regular language can not be infinite.

Question No: 18 (Marks: 1)

Can you say that for a certain string there may be more than one paths in a TG?

Question No: 19 (Marks: 2)

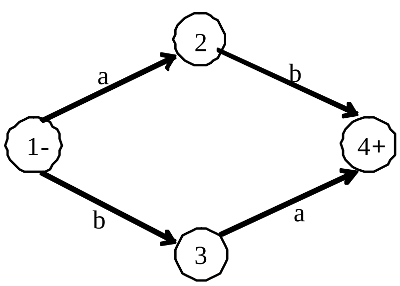
If a language can be accepted by an FA then it can be accepted by a TG as well.
What are the other two statements of kleenes's theorem?

Question No: 20 (Marks: 3)

Describe the method of NFA corresponding to Concatenation of FAs.

Question No: 21 (Marks: 5)

Draw FA corresponding to following NFA?



Question No: 22 (Marks: 10)

Let L be any language. Let us define the transpose of L to be the language of exactly those words that are the words in L spelled backward. If w ∈ L then reverse (w) ∈ L. for example, if L = {a, abb, bbaab, bbbaa}Then Transpose (L) = {a, bba, baabb, aabbb, Prove that if there is an FA that accepts L, then there is a TG that accepts the transpose of L.

MIDTERM EXAMINATION
Spring 2009
CS402- Theory of Automata (Session - 2)

Question No: 1 (Marks: 1) - Please choose one

If an alphabet has n number of letter, then number of strings of length m will be

► n+m

► (n)(m)

► m^n

► n^m

Question No: 2 (Marks: 1) - Please choose one

Languages generated by kleene star are always _______________.

► Finite

► Infinite

► Sometimes finite & sometimes infinite

► None of the these

Question No: 3 (Marks: 1) - Please choose one

1*(1 + Λ) = 1* this statement is

► True

► False

► Sometimes true & sometimes false

► None of these

Question No: 4 (Marks: 1) - Please choose one

a*b* = (ab)* this expression is ___________

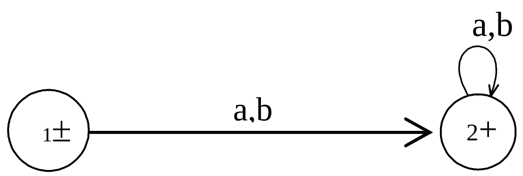
► True

► False

► Can't be assumed

► None of these

Question No: 5 (Marks: 1) - Please choose one



Above given FA can be expressed as ________

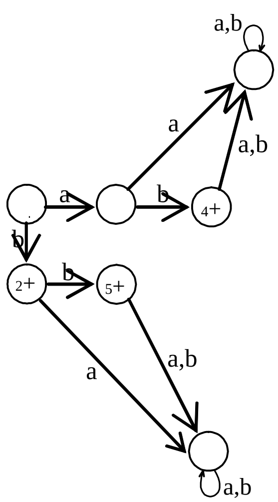
► (a + b)*

► a* + b*

► (ab + ba)*

► None of these

Question No: 6 (Marks: 1) - Please choose one



Above given FA accepts _____________ language.

- ► Finite
- ► Infinite
- ► Depends on alphabet
- ► None of these

Question No: 7 (Marks: 1) - Please choose one

If a language is expressed through TG, then that language will have its RE.

- ► True
- ► False
- ► Depends on language
- ► None of these

Question No: 8 (Marks: 1) - Please choose one

In TG there may exist more than one path for certain string.

- ► True
- ► False
- ► Depends on the language
- ► None of these

Question No: 9 (Marks: 1) - Please choose one

In TG there may exist no paths for certain string.

- ► True
- ► False
- ► Depends on the language

► None of these

Question No: 10 (Marks: 1) - Please choose one

GTG can have ________________ final state.

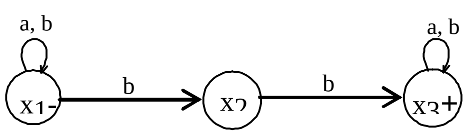
► 0

► 1

► More than 1

► All of the given

Question No: 11 (Marks: 1) - Please choose one



Above given diagram is an NFA. If we convert it into an FA using transition table, then new FA will be consisted on _______________ number of states.

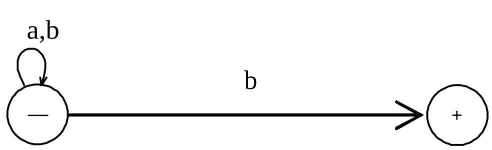
► 6

► 5

► 4

► 3

Question No: 12 (Marks: 1) - Please choose one



Above given TG accepts the language in which all strings

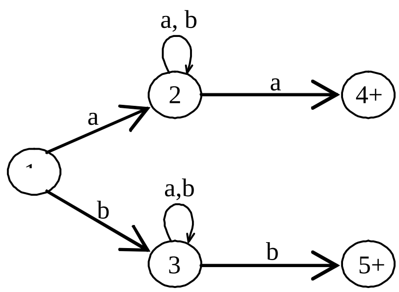
► Ends in b

► Begins with b

► Ends and begins with b

► None of the given

Question No: 13 (Marks: 1) - Please choose one



Above given TG has ______________ RE.

► a(a + b)*b + b(a + b)*a

► b(b + a)*a + b(a + b)*a

► None of these

► a(a + b)*a + b(a + b)*b

Question No: 14 (Marks: 1) - Please choose one

Every FA should be ___________

► Deterministic

► Non- Deterministic

► Deterministic & Non- Deterministic

► None of these

Question No: 15 (Marks: 1) - Please choose one

If in an NFA, $\wedge$ is allowed to be a label of an edge then that NFA is called _________.

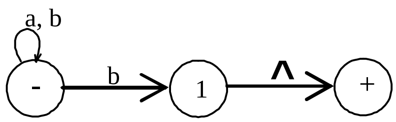
► Will not remain NFA

► NFA with ^

► NFA with null string

► Either "NFA with null string" OR "NFA with ^"

Question No: 16 (Marks: 1) - Please choose one



Above given structure is a _______________

► FA

► NFA

► NFA - ^

► None of the given options

Question No: 17 (Marks: 1)

In transition diagram of an FA, how can we represent initail and final states?

Question No: 18 (Marks: 1)

How can we say that two REs are equal?

Question No: 19 (Marks: 2)

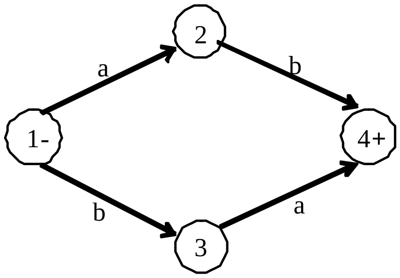
Can you accept the following statement? Or there is a condition to accept it?
For every Mealy machine there is a Moore machine that is equivalent to it.

Question No: 20 (Marks: 3)

Let S be all string of a's and b's with odd length. What is S*?

Question No: 21 (Marks: 5)

Draw FA corresponding to following NFA?



Question No: 22 (Marks: 10)

Give the recursive deflations for the following languages over the alphabet {a, b}:

(i) The language EVENSTRING of all words of even length.

(ii) The language ODDSTRING of all words of odd length.

MIDTERM EXAMINATION
Spring 2009
CS402- Theory of Automata (Session - 3)

Question No: 1 (Marks: 1) - Please choose one

Length of null string is

► Always not equal to 0

► Always equal to 0

► It has variable length

► All are true

Question No: 2 (Marks: 1) - Please choose one

If an alphabet has n number of letter, then number of strings of length m will be

► n+m

► (n)(m)

► m^n

► n^m

Question No: 3 (Marks: 1) - Please choose one

Languages generated by kleene star are always ______________.

► Finite

► Infinite

► Sometimes finite & sometimes infinite

► None of the these

Question No: 4 (Marks: 1) - Please choose one

"Every finite language can be expressed by FA". This statement is __________.

► True

► False

► Depends on language

► None of these

Question No: 5 (Marks: 1) - Please choose one

In FA, if one enters in a specific state but there is no way to leave it, then that specific state is called

► Dead States

► Waste Baskets

► Davey John Lockers

► All of these

Question No: 6 (Marks: 1) - Please choose one

In TG there may exist no paths for certain string.

► True

► False

► Depends on the language

► None of these

Question No: 7 (Marks: 1) - Please choose one

In GTG's there may exist no path for a certain string.

► True

► False

► Depends on alphabet

► None of these

Question No: 8 (Marks: 1) - Please choose one

In drawing FA3 (which is equal to FA1 + FA2), a state will be declared final if

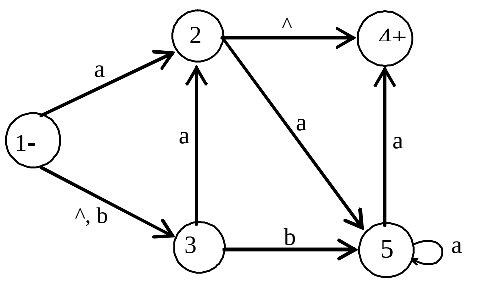
► States of both FA's are final

► At least one state is final

► Depends on language

► None of the given

Question No: 9 (Marks: 1) - Please choose one



Above given structure is an ________.

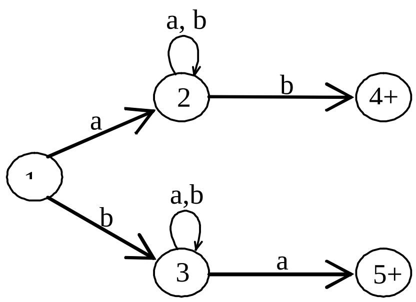
► FA

► NFA

► NFA -^

► TG

Question No: 10 (Marks: 1) - Please choose one



Above given TG represents the language____

► Begins and ends with same letters

► Begins and ends with different letters

► Begins with a

► None of these

Question No: 11 (Marks: 1) - Please choose one

In TG, there may be a transition for null string.

► True

► False

► Can't show transition for string

► None of these

Question No: 12 (Marks: 1) - Please choose one

The _______ machine helps in building a machine that can perform the addition of binary numbers.

► Incrementing

► Complementing

► Decrementing

► None of the given

Question No: 13 (Marks: 1) - Please choose one

GTG can have _____________ initial state.

► Zero

► One

► More than One

► One OR more than One

Question No: 14 (Marks: 1) - Please choose one

One FA has n states and m letters in the alphabet. Then FA will have _____ number of transitions in the diagram.

► (n)+(m)

► (m)(n) OR (n)(m)

► None of the given options

► (m)-(n)

Question No: 15 (Marks: 1) - Please choose one

If L1 and L2 are expressed by regular expressions r1 and r2, respectively then the language expressed by r1 + r2 will be _________

► Regular

► Ir-regular

► Can't be decided

► Another Language which is not listed here

Question No: 16 (Marks: 1) - Please choose one

Which statement is true?

- ► All words are strings
- ► All strings are words
- ► Both are always same
- ► None of these

Question No: 17 (Marks: 1)

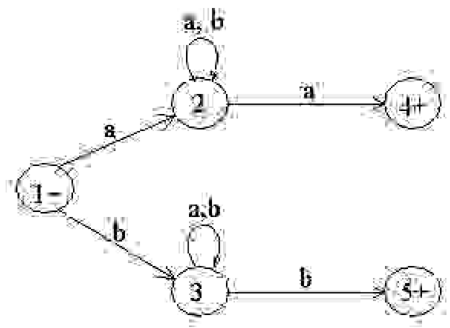
In transition diagram of an FA, how can we represent initail and final states?

Question No: 18 (Marks: 1)

What the Kleene’s Theorem Part I says?

Question No: 19 (Marks: 2)

Describe the language for the following TG



Question No: 20 (Marks: 3)

Show that there are exactly 5832 different finite automat with three states x, y, z over the alphabet {a, b}, where x is always the start state.

Question No: 21 (Marks: 5)

For proving Kleen's theorm part-II:
"If there are more than one transition edges between two states then we can reduce all these transition edges with a single transition edge"

Explain this statement with the help of an example.

Question No: 22 (Marks: 10)

i) Let S = {ab, bb} and let T = {ab, bb, bbbb} Show that $S^* = T^*$
ii) Let S = {ab, bb} and let T = {ab, bb, bbb} Show that $S^* \neq T^*$
iii) What principle does this illustrate?

MIDTERM EXAMINATION
Spring 2009
CS402- Theory of Automata (Session - 3)

Question No: 1 (Marks: 1) - Please choose one

Alphabet S = {a,bc,cc} has _______ number of letters.

► One

► Two

► Three

► Four

Question No: 2 (Marks: 1) - Please choose one

One language can be represented by more than one RE" this statement is____

► False

► True

► Can't be assumed

► None of these

Question No: 3 (Marks: 1) - Please choose one

(a + b)*b is RE for the language defined over S={a,b} having words not ending in a

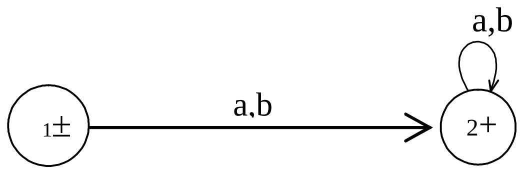
► True

► False

► Such a language is not regular

► None of these

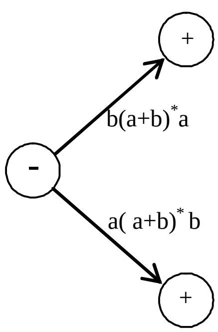
Question No: 4 (Marks: 1) - Please choose one



Above given FA accepts ___________ strings defined over S={a , b}

- ► All
- ► Some
- ► All but not null
- ► None of these

Question No: 5 (Marks: 1) - Please choose one



Above given GTG accepts the language in which strings

- ► Begins and ends with different letters
- ► Begins and ends with same letters
- ► Have length greater than 1
- ► None of these

Question No: 6 (Marks: 1) - Please choose one

According to 3rd part of the Kleene's theorem, If a language can be accepted by an RE then it can be accepted by a _________ as well

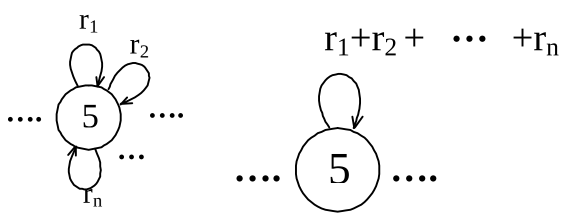
► TG

► FA

► TG and FA

► None of these

Question No: 7 (Marks: 1) - Please choose one



Above given GTG's are _______________

► Equivalent

► Non-equivalent

► Non-valid

► None of the given

Question No: 8 (Marks: 1) - Please choose one

If FA1 accepts no string and FA2 accepts many strings, then FA1 + FA2 will be equal to

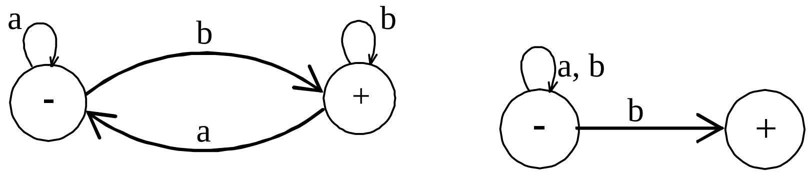
► FA1

► FA2

► May be both

► None of the given

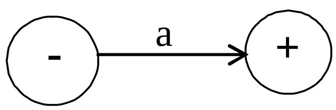
Question No: 9 (Marks: 1) - Please choose one



Above given NFA and FA generate same language.

- ► True
- ► False
- ► FA & NFA can’t be equivalent
- ► None of these

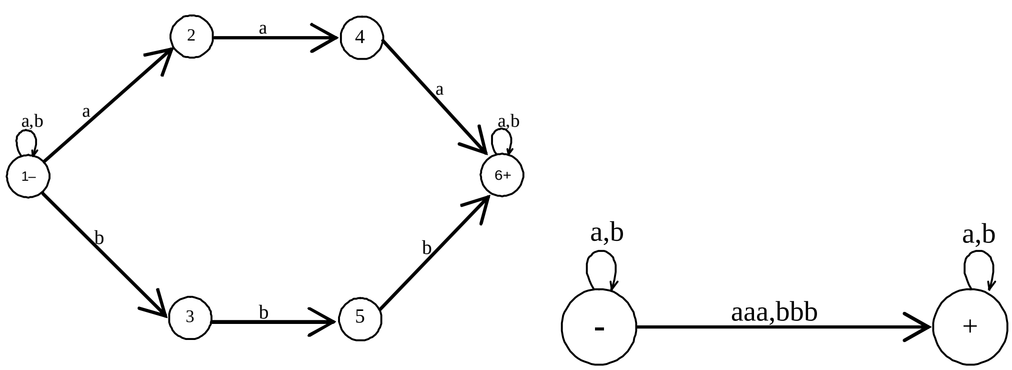
Question No: 10 (Marks: 1) - Please choose one



Above given structure is a ______________

- ► FA
- ► TG
- ► NFA
- ► FA and NFA

Question No: 11 (Marks: 1) - Please choose one



Above given TG’s are ______________.

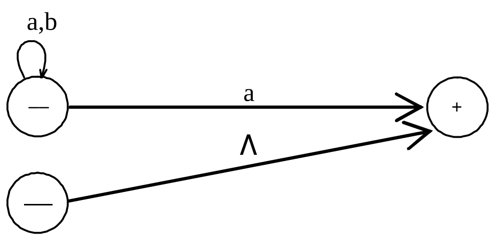
► Equivalent

► Non-equivalent

► TG's are not valid

► None of these

Question No: 12 (Marks: 1) - Please choose one



Above given TG has the _______________ RE.

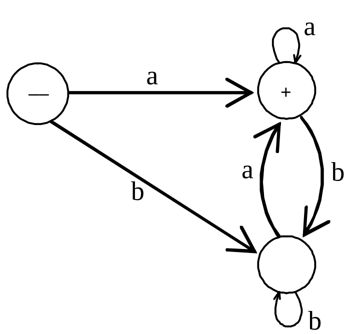
► (a + b)*a

► Λ + (a + b)*a

► None of these

► Λ + (a + b)*a*

Question No: 13 (Marks: 1) - Please choose one



Above given FA has __________ RE.

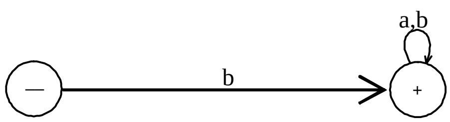
► (a + b)*a

► a(a + b)*

► ((a + b)*a)*

► (a + b)*a & ((a + b)*a)*

Question No: 14   (Marks: 1) - Please choose one



Above given TG accepts the _____________ string.

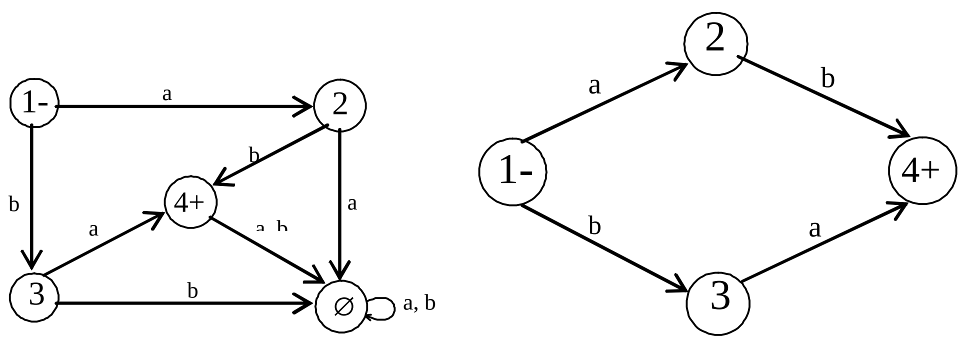
► bb

► baba

► bbba

► all of the given options

Question No: 15   (Marks: 1) - Please choose one



Above given FA and NFA are equivalent. This statement is ______________.

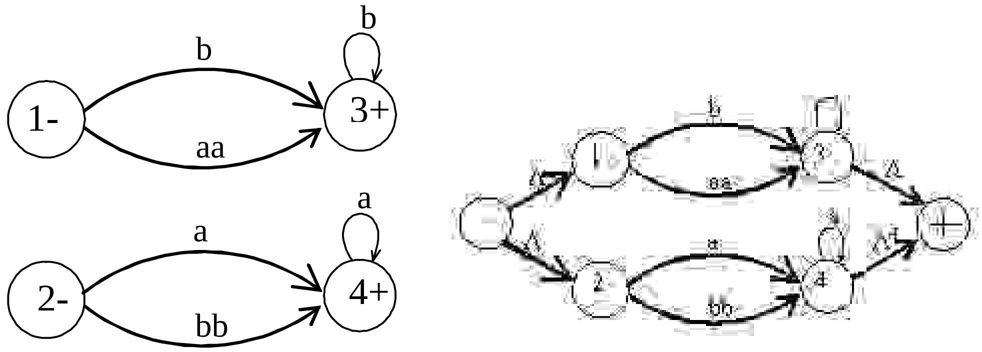
► True

► False

► FA & NFA can never be equivalent

► None of the given options

Question No: 16   (Marks: 1) - Please choose one



Above given two TG's are _______________.

► Equivalent

► None-equivalent

► Not valid

► None of the given

Question No: 17 (Marks: 1)

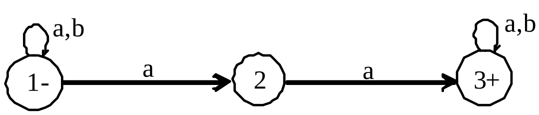
What is the difference between Regular Languages and Non Regular Languages?

Question No: 18 (Marks: 1)

What is meant by tokenizing a string?

Question No: 19 (Marks: 2)

Define the language for the following NFA also write the regular expression for the language?



Question No: 20 (Marks: 3)

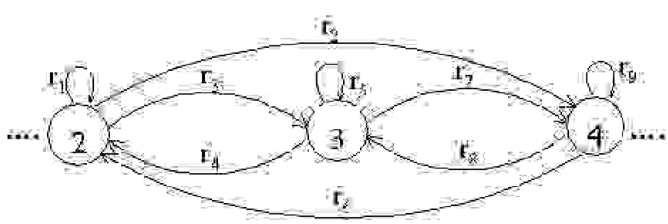
Describe the method of NFA corresponding to Concatenation of FAs.

Question No: 21 (Marks: 5)

(i) When asked to give a recursive definition for the language PALINDROM over the alphabet S = {a, b}, a student wrote:
Rule 1 a and b are in PALINDROM.
Rule 2 If x is in PALINDROM, then so are axa and bxb
Unfortunately all the words in the language defined above have an odd length and so it is not all of PALINDROM. Fix this problem.
(ii) Give a recursive definition for the language EVENPALINDROM of all palindromes of even length

Question No: 22 (Marks: 10)

What do you mean by "bypass and state elimination" Also reduce the following TG by eliminating state 3. (Draw reduced TG)



MIDTERM EXAMINATION
Spring 2009
CS402- Theory of Automata (Session - 3)

Question No: 1 (Marks: 1) - Please choose one

If r1 and r2 are regular expressions then which of the following is not regular expression.

► r1 = r2

► r1r2

► r1*

► r1 – r2

Question No: 2 (Marks: 1) - Please choose one

Which of the following is not a word of language EQUAL?

► aaabbb

► abbbabaa

► abababa

► bbbaaa

Question No: 3 (Marks: 1) - Please choose one

If S = {aa, bb}, then S* will not contain..

► aabbaa

► bbaabbbb

► aaabbb

► aabbbb

Question No: 4 (Marks: 1) - Please choose one

One language can be represented by more than one RE" this statement is____

- ► False
- ► True
- ► Can't be assumed
- ► None of these

Question No: 5 (Marks: 1) - Please choose one

"Every Infinite language is regular" this statement is

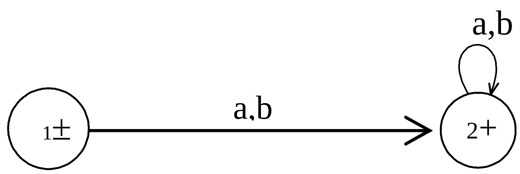
- ► True
- ► False
- ► Can't be supposed
- ► None of these

Question No: 6 (Marks: 1) - Please choose one

PALINDROME can be defined by more than one regular language

- ► True
- ► False
- ► By only one RE
- ► Some times By only one RE and Some times False

Question No: 7 (Marks: 1) - Please choose one



Above given FA can be expressed as ________

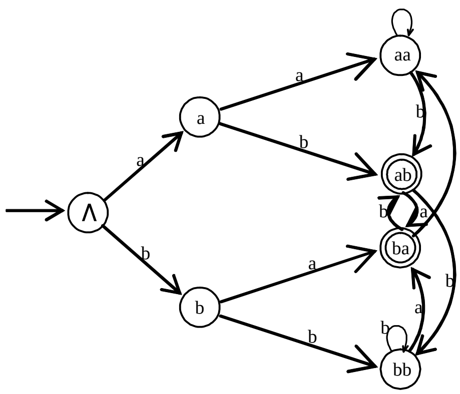
► (a + b)*

► a* + b*

► (ab + ba)*

► None of these

Question No: 8 (Marks: 1) - Please choose one



Above given FA is drawn using

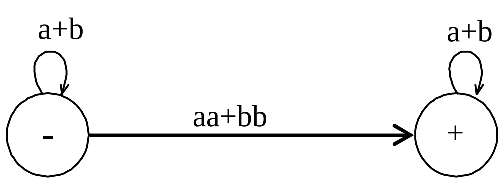
► Tree structure

► It is not an FA

► Graph structure

► None of these

Question No: 9 (Marks: 1) - Please choose one



Above given GTG accepts the language in which strings

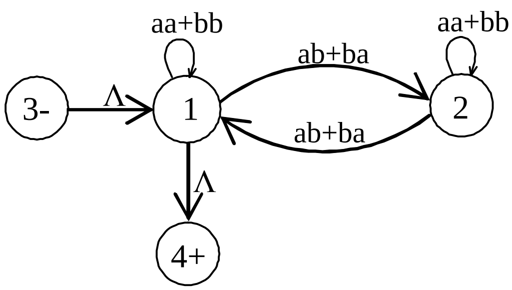
► Contains double a or double b

► Contains both a and double b

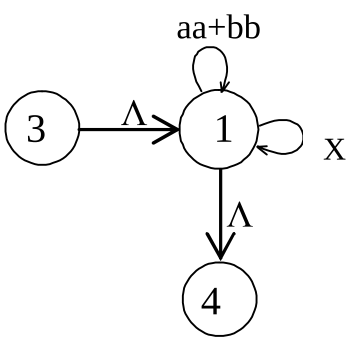
► Depends on the alphabet

► None of these

Question No: 10 (Marks: 1) - Please choose one



If above given TG is drawn like



Then what will be written in place of X.

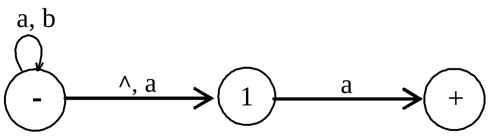
► (ab+ba)(aa+bb)(ba+ab)

► (ab+ba)(aa+bb)(ab+ba)

► (ab+ba)(aa+bb)*(ab+ba)

► (ab+ba)(aa+bb)(ab+ba)*

Question No: 11 (Marks: 1) - Please choose one



Above given NFA-^ accepts____

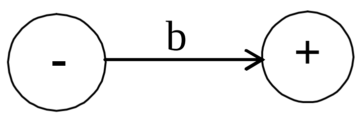
► bab

► a

► aba

► a & aba

Question No: 12 (Marks: 1) - Please choose one



Above given structure is a _________________.

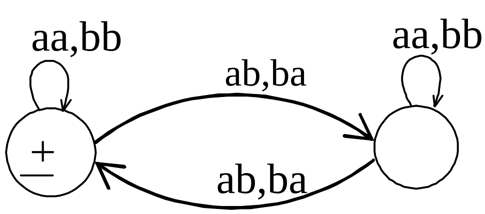
► FA

► TG

► FA & TG

► NFA

Question No: 13 (Marks: 1) - Please choose one



Above given TG has _____________ RE.

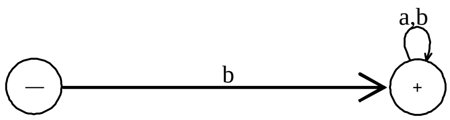
► (aa+aa+(ab+ab)(aa+ab)*(ab+ba))*

► (aa+bb+(ab+ba)(aa+bb)*(ab+ba))*

► (aa+bb+(ab+ba)(aa+bb)(ab+ba))*

► None of these

Question No: 14 (Marks: 1) - Please choose one



Above given TG has _______________ RE.

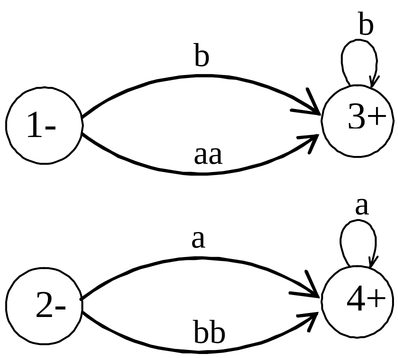
► b(a + b)*

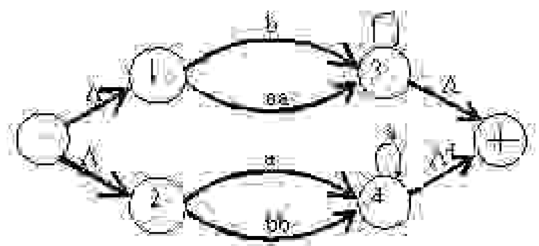
► b*(a + b)*

► b*(a + b)

► None of these

Question No: 15 (Marks: 1) - Please choose one





Above given two TG's are _______________.

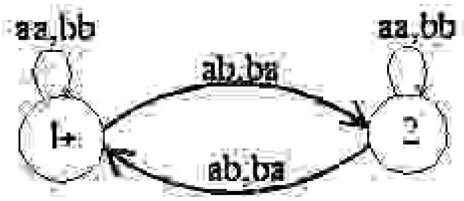
► Equivalent

► None-equivalent

► Not valid

► None of the given

Question No: 16 (Marks: 1) - Please choose one



Above given TG has ___________________________ RE.

- ► (aa+bb+(ab+ba)(aa+bb)(ab+ba))*
- ► (aa+bb+(ab+ba)(aa+bb)*(ab+ba))*
- ► (aa+ba+(bb+ba)(ab+bb)(ab+aa))*
- ► (ab+ba+(ab+ba)(aa+bb)(ab+ba))*

Question No: 17 (Marks: 1)

How can we say that two REs are equal?

Question No: 18 (Marks: 1)

What is meant by Kleene star closure of a language?

Question No: 19 (Marks: 2)

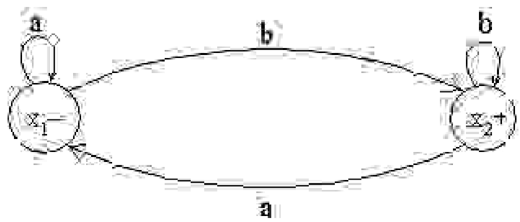
What the Pumping lemma II says about length(x) + length(y) must be:

Question No: 20 (Marks: 3)

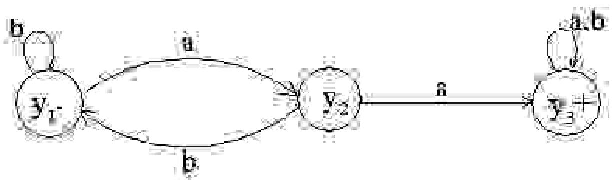
Consider the language S*, where S = {ab, ba}, Can any word in this language contain the substrings aaa or bbb? Why or why not?

Question No: 21 (Marks: 5)

Give the transition table of an FA3 corresponding to FA1+FA2, where FA1, FA2 are given below.
FA1



FA_2



Question No: 22 (Marks: 10)

What is meant by nondeterminism? Draw the TG for the following RE

$(aa)^{*}b(b^{*}+((aa)^{+}b)^{*})bb.$

MIDTERM EXAMINATION
Spring 2009
CS402- Theory of Automata (Session - 3)

Question No: 1 (Marks: 1) - Please choose one

S = {baa, ab}, then S* will not contain

► abbaab

► abab

► baabaa

► abbaa

Question No: 2 (Marks: 1) - Please choose one

1*(1 + Λ) = 1* this statement is

► True

► False

► Sometimes true & sometimes false

► None of these

Question No: 3 (Marks: 1) - Please choose one

One language can be represented by more than one RE" this statement is____

► False

► True

► Can't be assumed

► None of these

Question No: 4 (Marks: 1) - Please choose one

a(a+b)*a+b(a+b)*b is RE for the language defined over S={a,b} having words beginning and ending with same letters

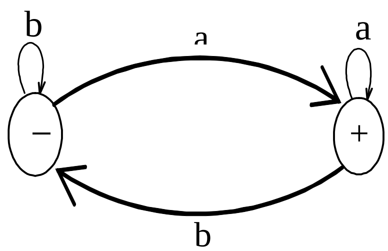
► True

► False

► Such a language is not regular

► None of these

Question No: 5 (Marks: 1) - Please choose one



Above given FA can be expressed by

► (a + b)*a

► (a + b)*b

► a (a + b)*

► b (a + b)*

Question No: 6 (Marks: 1) - Please choose one

If a language has RE, then that language can be expressed through TG.

► True

► False

► Depends on language

► None of these

Question No: 7 (Marks: 1) Please choose one

In TG there may exist no paths for certain string.

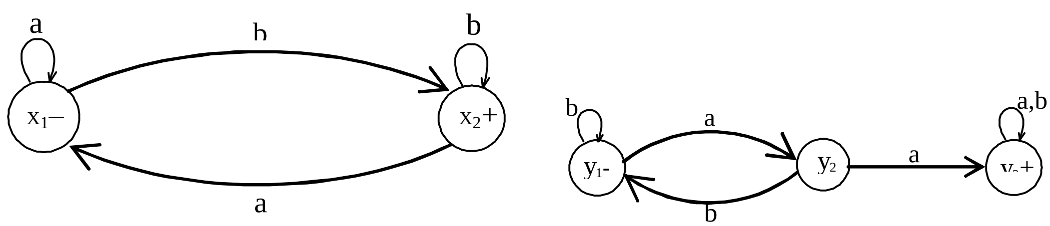
► True

► False

► Depends on the language

► None of these

Question No: 8 (Marks: 1) - Please choose one



FA3 will express r1r2. then F3 will have ____________________ number of states in its diagram.

► 8

► 7

► 6

► 5

Question No: 9 (Marks: 1) - Please choose one

FA1 corresponds to r*, then FA1 must accept _______________ string.

► Every

► Null

► Odd length

► Even length

Question No: 10 (Marks: 1) - Please choose one

In NFA, there may be more than one transition for certain letters and there may not be any transition for certain letters. This statement is ______________.

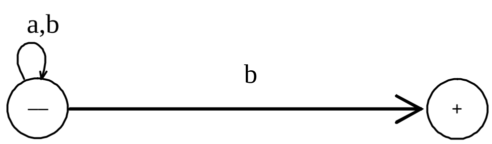
► False

► True

► Depends on language

► None of the given

Question No: 11 (Marks: 1) - Please choose one



Above given TG accepts the language in which all strings

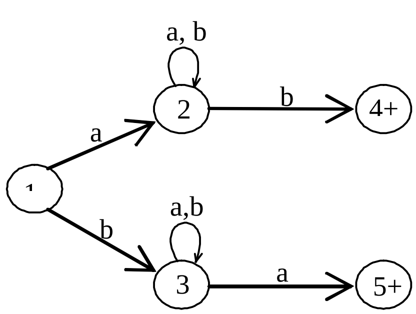
► Ends in b

► Begins with b

► Ends and begins with b

► None of the given

Question No: 12 (Marks: 1) - Please choose one



Above given TG represents the language____

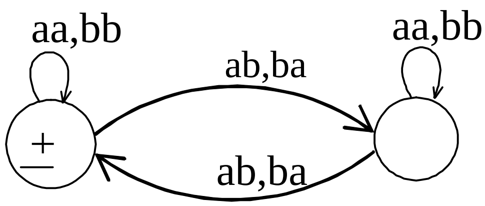
► Begins and ends with same letters

► Begins and ends with different letters

► Begins with a

► None of these

Question No: 13 (Marks: 1) - Please choose one



Above given TG represents the language i.e.

► EVEN-EVEN

► PALINDROME

► FACTORIAL

► None of these

Question No: 14 (Marks: 1) - Please choose one

FA1 and FA2 are two FA's representing two languages. Then FA3, which is sum of FA1 and FA2, will accept the strings which are

► Accepted by FA1 AND FA2

► Accepted by FA1 OR FA2

► Accepted by FA1 AND/OR FA2

► None of the given options

Question No: 15 (Marks: 1) - Please choose one

a (a + b)* is the RE of language defined over S = {a, b} having at least one a

► True

► False

► Such a language does not exist

► None of the given options

Question No: 16 (Marks: 1) - Please choose one

(a + b)* a is RE for the language defined over S={a,b} having words not ending in b

► True

► False

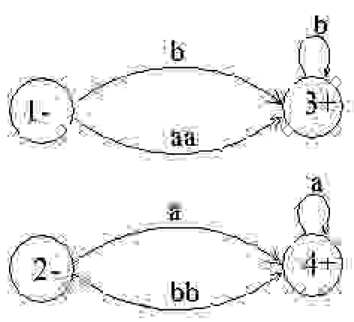
► Such a language is not regular

► None of the given options

Question No: 17 (Marks: 1)

What is meant by a "language" in automata?

Question No: 18 (Marks: 1)



For the above given TG draw an equivalent TG having only one final state.

Question No: 19 (Marks: 2)

Give the regular expression for EVEN-EVEN language?

Question No: 20 (Marks: 3)

Give an example of a set S such that S* only contains all possible string of a's and b's that has length divisible by 3

Question No: 21 (Marks: 5)

Construct a regular expression defining the following language over the alphabet S = {a, b}:
All words that contains at least one of the strings s_1, s_2, s_3 or s_4

Question No: 22 (Marks: 10)

What is meant by nondeterminism? Draw the TG for the following RE

$(aa)^{*}b(b^{*}+((aa)^{+}b)^{*})bb.$

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Question No: 1 (Marks: 1) - Please choose one

Σ={a,Aa,Abb}, then string aAaAbbAa has ________ length.

- ► One
- ► Two
- ► Three
- ► Four

Question No: 2 (Marks: 1) - Please choose one

Languages generated by kleene star are always _______________.

- ► Finite
- ► Infinite
- ► Sometimes finite & sometimes infinite
- ► None of the these

Question No: 3 (Marks: 1) - Please choose one

Let S = {aa, bb} be a set of strings then s* will have

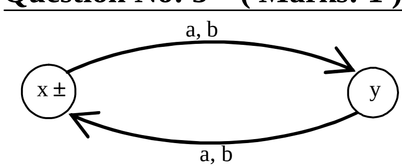
- ► Λ
- ► abba
- ► aabbbaa
- ► bbaab

Question No: 4 (Marks: 1) - Please choose one

If r1 = (aa + bb) and r2 = (a + b) then the language (aa + bb)* will be generated by

- ► (r1)(r2)
- ► (r1 + r2)
- ► (r2)*
- ► (r1)*

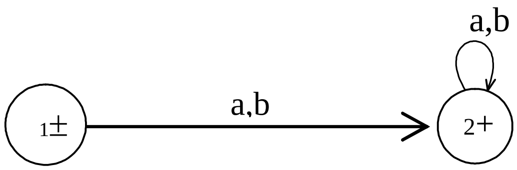
Question No: 5 (Marks: 1) - Please choose one



Above given FA can be represented by

- ► ((a+ b) (a + b))*
- ► (a + b)(a + b)*
- ► (a + b)(a + b)
- ► (a + b)*(a + b)*

Question No: 6 (Marks: 1) - Please choose one



Above given FA accepts ___________ strings defined over Σ={a , b}

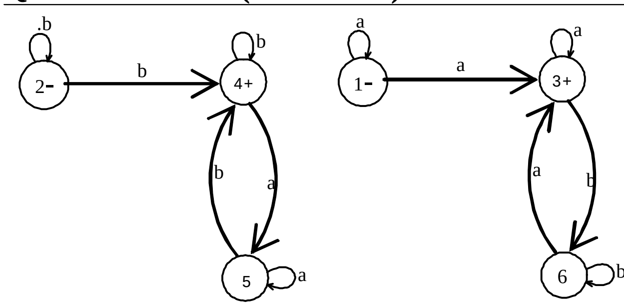
- ► All
- ► Some
- ► All but not null
- ► None of these

Question No: 7 (Marks: 1) - Please choose one

If a language can be expressed through FA, then it can also be expressed through TG.

- ► True
- ► False
- ► Depends on language
- ► None of the above

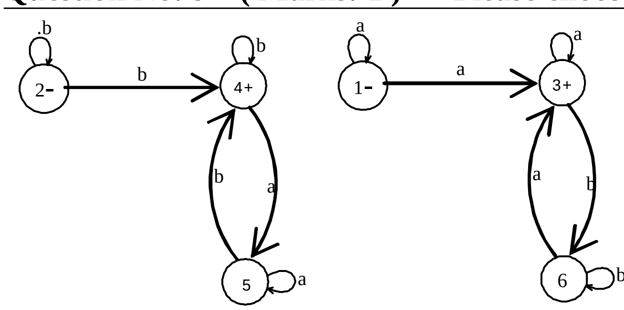
Question No: 8 (Marks: 1) - Please choose one



Above given TG has ____________________ RE.

- ► a+b+a(a + b)*a + b(a + b)*b
- ► a(a + b)*a + b(a + b)*b
- ► both are given
- ► none of the given

Question No: 9 (Marks: 1) - Please choose one



Above given FA accepts the language in which strings

- ► Begins with and ends in same letter

- ► Begins with and ends in different letter
- ► Has length more than 2
- ► None of the given

Question No: 10 (Marks: 1) - Please choose one

GTG can have _______________ final state.

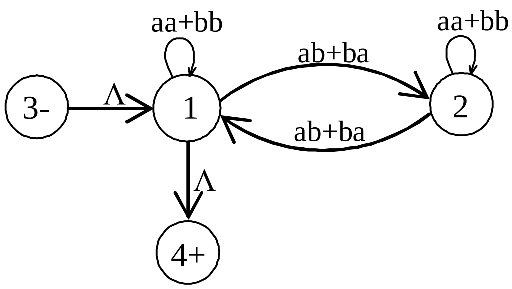
- ► 0
- ► 1
- ► More than 1
- ► All of the given

Question No: 11 (Marks: 1) - Please choose one

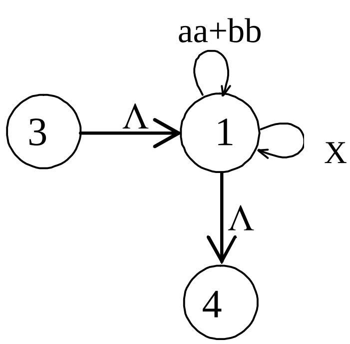
In GTG, if a state has more than one incoming transitions from a state. Then all those incoming transitions can be reduced to one transition using _____________ sign

- ► -
- ► +
- ► *
- ► None of the given

Question No: 12 (Marks: 1) - Please choose one



If above given TG is drawn like



Then what will be written in place of X.

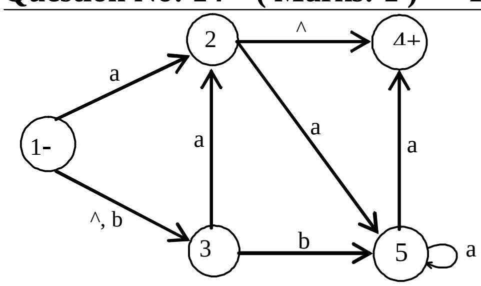
- ► (ab+ba)(aa+bb)(ba+ab)
- ► (ab+ba)(aa+bb)(ab+ba)
- ► (ab+ba)(aa+bb)*(ab+ba)
- ► (ab+ba)(aa+bb)(ab+ba)*

Question No: 13 (Marks: 1) - Please choose one

"One language can be expressed by more than one NFA". This statement is _______________.

- ► False
- ► True
- ► Depends on NFA
- ► None of the given

Question No: 14 (Marks: 1) - Please choose one



Above given structure is an _________.

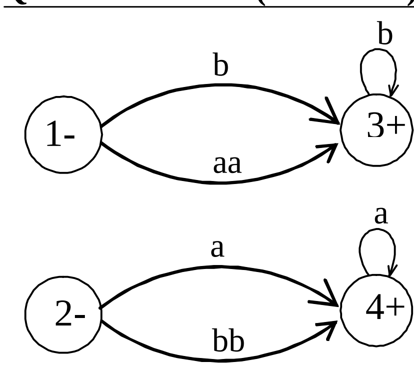
- ► FA
- ► NFA
- ► NFA -^
- ► TG

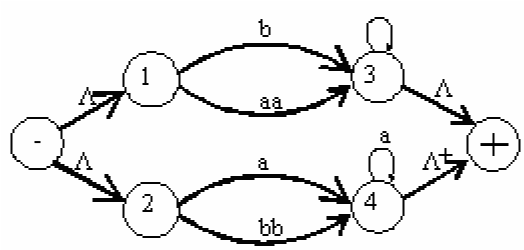
Question No: 15 (Marks: 1) - Please choose one

One FA has 3 states and 2 letters in the alphabet. Then FA will have ____________ number of transitions in the diagram

- ► 4
- ► 5
- ► 7
- ► 6

Question No: 16 (Marks: 1) - Please choose one





Above given two TG's are ________________.

- ► Equivalent

► None-equivalent
► Not valid
► None of the given

Question No: 1 (Marks: 1) - Please choose one

To access the element of two dimensional array we use,

► Single referencing

► Single dereferencing

► Double dereferencing

► Double referencing

Question No: 2 (Marks: 1) - Please choose one

setprecision is a parameter less manipulator.

► True

► False

Question No: 3 (Marks: 1) - Please choose one

Which of the following is NOT a preprocessor directive?

► #error

► #define

► #line

► #ndefine

Question No: 4 (Marks: 1) - Please choose one

We can use New keyword inside of Class Constructor.

► True

► False

Question No: 5 (Marks: 1) - Please choose one

It is possible to return an object from a function through **this** pointer.

► True

► False

Question No: 6 (Marks: 1) - Please choose one

We can change the artiy (Number of operands required) of an operator through operator overloading

► True

► False

Question No: 7 (Marks: 1) - Please choose one

new and **delete** operators cannot be overloaded.

► True

► False

Question No: 8 (Marks: 1) - Please choose one

The statement **cin.get ();** is used to,

► Read a string from keyboard

► Read a character from keyboard

► Read a string from file

► Read a character from file

Question No: 9 (Marks: 1) - Please choose one

When an array of object is created dynamically then there is no way to provide parameterized constructors for array of objects.

► True

► False

Question No: 10 (Marks: 1) - Please choose one

We can delete an array of objects without specifying [] brackets if a class is not doing dynamic memory allocation internally.

► True

► False

Question No: 11 (Marks: 1) - Please choose one

The insertion (<<) and extraction (>>) operators are unary operators.

► True

► False

Question No: 12 (Marks: 1) - Please choose one

What will be the correct syntax for the following function call?

float square (int &);

► square (int num);

► square (&num);

► square (num);

► square (*num);

Question No: 13 (Marks: 1) - Please choose one

What will be the output of the following code segment?

char *x = ”programming” ;
cout << *(x+2) << *(x+3) << *(x+5) << *(x+8) ;

► ogai

► ramg

► prgm

► rorm

Question No: 14 (Marks: 1) - Please choose one

When an operator function is define as member function then operand on the left side of operator must be an object.

► True

► False

Question No: 15 (Marks: 1) - Please choose one

Increment and decrement operators are ______.

► Binary operators

► Unary operators

► Logical operators

► Conditional operators

Question No: 16 (Marks: 1) - Please choose one

UNIX has been developed in ________ language.

► JAVA

► B

► C

► FORTRAN

Question No: 17 (Marks: 1) - Please choose one

Which of the following is used with bit manipulation?

► Signed integer

► Un-signed integer

► Signed double

► Un-signed double

Question No: 18 (Marks: 1) - Please choose one

We want to access array in random order which approach is better?

► Pointers

► Array index

► Both pointers and array index are better

► None of the given options.

Question No: 19 (Marks: 1) - Please choose one

Which of the following is the correct C++ syntax to allocate space dynamically for an array of 10 int?

► new int(10) ;

► new int[10] ;

► int new(10) ;

► int new[10];

Question No: 20 (Marks: 1) - Please choose one

Which of the following will be the correct function call for function prototype given below?
int func (int &);

► func(int num);

► func(&num);

► func(num);

► func(*num);

Question No: 21 (Marks: 1) - Please choose one

For non-member operator function, object on left side of the operator may be

► Object of operator class

► Object of different class

► Built-in data type

► All of the given options

Question No: 22 (Marks: 1) - Please choose one

Which of the following object(s) will call the member operator function within the statement given below?
obj1=obj2+obj3;

► Object obj1

► Object obj2

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Q. Point of Kleen Theory.
Answer:- (Page 25)
1. If a language can be accepted by an FA then it can be accepted by a TG as well.
2. If a language can be accepted by a TG then it can be expressed by an RE as well.
3. If a language can be expressed by a RE then it can be accepted by an FA as well.

Q. Difference and common between NFA & DFA
Answer:- (Page 25) Click here for detail
Difference
1-In FA Finite number of states, having one initial and some (maybe none) final states. While in NFA Finite many states with one initial and some final state.
2-In FA for each state and for each input letter there is a transition showing how to move from one state to another while in NFA there may be more than one transition for certain letters and there may not be any transition for certain letters.
3-In FA $\wedge$ is valid while in NFA $\wedge$ is not valid.

Common
Finite set of input letters,

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1) What is the function of mealy machine?
Answer:- (Page 60)
1's complementing and incrementing machines which are basically Mealy machines are very much helpful in computing.
The incrementing machine helps in building a machine that can perform the addition of binary numbers.

دنیا میں سب سے مشکل کام اپنی اصلاح اور سب سے آسان کام دوسروں پر نکتہ چینی کرنا ہے

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2) Write the first step to convert GTG to FA?
Answer:- (Page 26)
Step 1 If a TG has more than one start states, and then introduces a new start state connecting the new state to the old start states by the transitions labeled by Λ and make the old start states the non-start states.

3) Explain with example that how in GTG's we directly join the initial state with the final state?
Answer:- (Page 27)
Eliminate the middle state and connect the first state with the last by a single transition (include the possibility of circuit as well) labeled by the RE which is the concatenation of corresponding two REs in the existing sequence.

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Q#1
Check the given statements or correct or not if not then correct it.

1. String in regular language can not be infinite **True**
2. Concatenation of finite letters from alphabets called sigma **False**
3. There cannot be more than one FA,s for same language. **False**

Q#2.What is the difference between the strings and the words of a language?
Answer:- (Page 3)
Concatenation of finite number of letters from the alphabet is called a string. Words are strings belonging to some language.

Q#3. Is there any difference in PALINDROME and reverse of palindrome explain it?
Answer:- (Page 6)
PALINDROME is The language and words of PALINDROME are called reverse of palindromes

Q#6 explain Moor Machine?
Answer:- (Page 55)
A Moore machine consists of the following
A finite set of states q0, q1, q2, … where q0 is the initial state.
An alphabet of letters $\Sigma = \{a,b,c,\ldots\}$ from which the input strings are formed.
An alphabet $\Gamma=\{x,y,z,\ldots\}$ of output characters from which output strings are generated.
A transition table that shows for each state and each input letter what state is entered the next.
An output table that shows what character is printed by each state as it is entered.

خدا کے سوا کسی سے امید مت رکھو

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Q. What are the difference & similarities b/w FA & NFA?
Answer:- rep

Q.How can we show transition table of NFA to FA?
Answer:- (Page 45)
there may be more than one transition for a certain letter and there may not be any transition for certain letter, so starting from the initial state corresponding to the initial state of given NFA, the transition table along with new labels of states, of the corresponding FA, can be built introducing an empty state for a letter having no transition at certain state and a state corresponding to the combination of states, for a letter having more than one transitions.

Q.Is Kleen's star & Kleen's closure are different?
Answer:- (Page 7)
there is no difference between both

Q. What is the difference b/w Mealy & Moore machine?
Answer:- Click here for detail
Moore machines
Safer do use because outputs change at clock edge
May take additional logic to decode state into outputs
For Moore machine, output is valid after state transition. Output associated with stable present state

Mealy machines
Typically have fewer states
React faster to inputs. don't wait for clock
Asynchronous outputs can be dangerous
For Mealy machine, output is valid on occurrence of active clock edge. Output associated with transition from present state to next state. Output in Mealy machine occurs one clock period before output in equivalent Moore machine.

Q.Write a regular expression of length 6 which starts and end with the same double letters?

بری صحبت سے تنہائی بہتر ہے اور تنہائی سے نیک صحبت بہتر ہے

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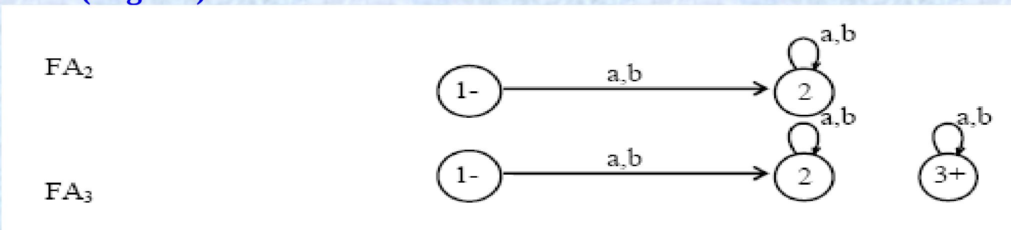
Can we accept the string going from final to initial state?
Answer:- (Page 15)
If any state starts from the final state it does not accept any string. Even it does not accept the null string, because there is no path starting from initial state and ending in final state.

If there is no initial state in FA then that FA does not accept any language Discuss two situations when an FA does not accept any string not even the null string?
Answer:- (Page 15)



In FA2, there is no final state and in FA3, there is a final state but FA3 is disconnected as the states 2 and 3 are disconnected.

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Read the given statement Yes/No justify your answer why? [3]

Is RE infinite?
Answer:- (Page 11)
No, All finite languages are regular.

An alphabet is concatenation of letters and is also called sigma?
Answer:- (Page 3)
No, Concatenation of finite number of letters from the alphabet is called a string.

اللہ کا خوف سب سے بڑی دانائی ہے

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All FA's are also NFA or not
Answer:- (Page 42)
FA can be considered to be an NFA as well , but the converse may not true.

Any other way to represent the final (+) and initial(-) states?........[2]
Answer:- (Page 13)
An arrow head can also be placed before that state and that the final state with double circle.

A regular language L has only ending with "01" are these belonged to?....[2]
Justify why
"1101" and "111011"
Answer:- (Page 53)
"1101" and "111011" are indistinguishable, for 1 belonging to Σ* s.t. both 1111 and 010011 don't belong to L i.e. for every z belonging to Σ*, either both 111z and 01001z belong to L, or both don't belong to L.

Explain Moore Machine……………………..…[5]
Answer:- Rep

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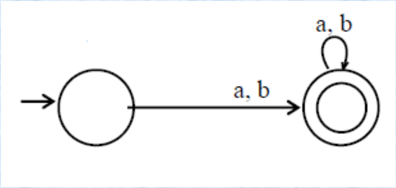
1. Can we represent start and final state with + and - sign and is there any other way to represent it??
Answer: Page 13
It may be noted that to indicate the initial state, an arrow head can also be placed before that state and that the final state with double circle,



2. The language can express in FA then why we need NFA. Justify your answer.
Answer:- Click here for detail
NFAs are interesting because we can express languages easier than FAs.
DFA can be understood as one machine. NFA can be understood as multiple little machines computing at the same time.

ایماندار کو غصہ دیر سے آتا ہے اور جلدی دور ہو جاتا ہے

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3. Makes a RE for a language does not have triple b or (bbb) at any place.

Answer:-

bb (a+b)* bb

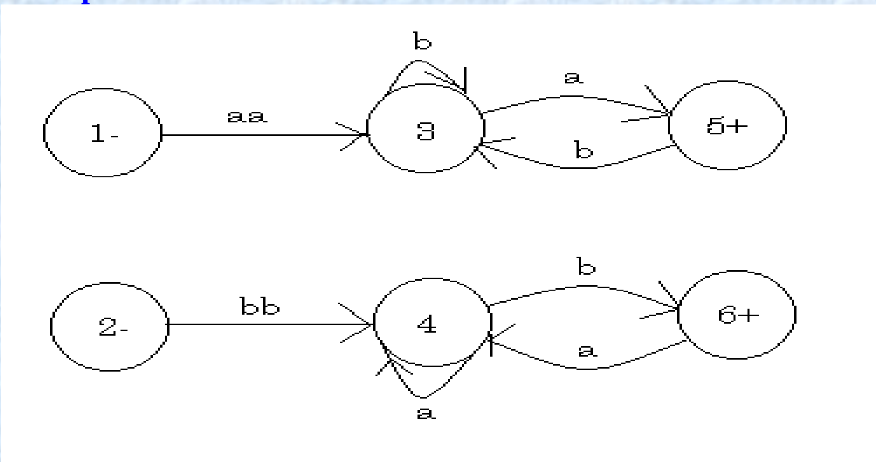
4.For proving Kleen's theorm part-II:

"If there are more than one transition edges between two states then we can reduce all these transition edges with a single transition edge"

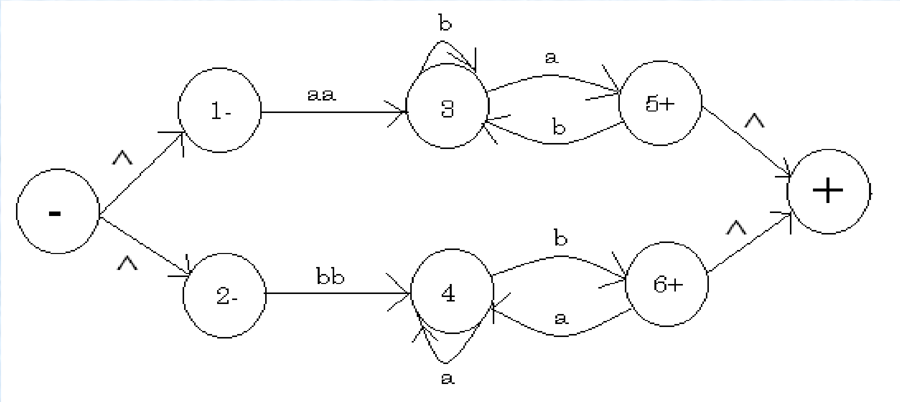
Explain this statement with the help of an example. (Marks 5)

Answer:-(Page 25)

Example:



First of all single initial and single final states are required as given below:



زندگی میں کامیابی کا یہی راز ہے کہ پریشانیوں سے پریشان مت بنو

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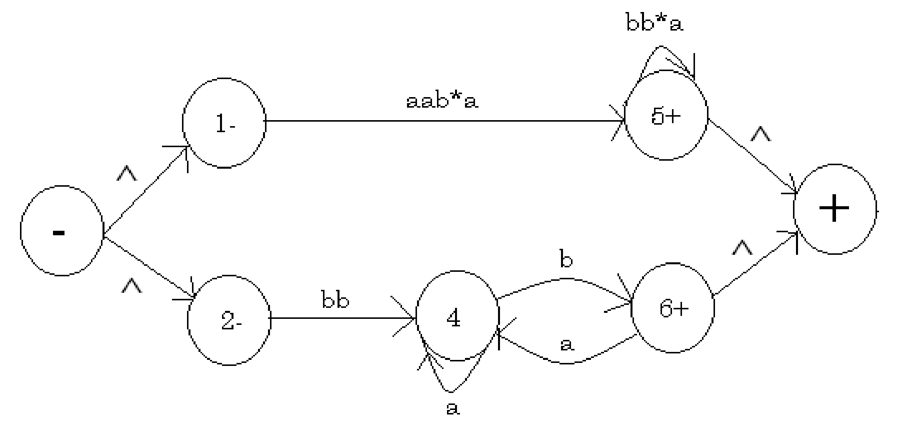
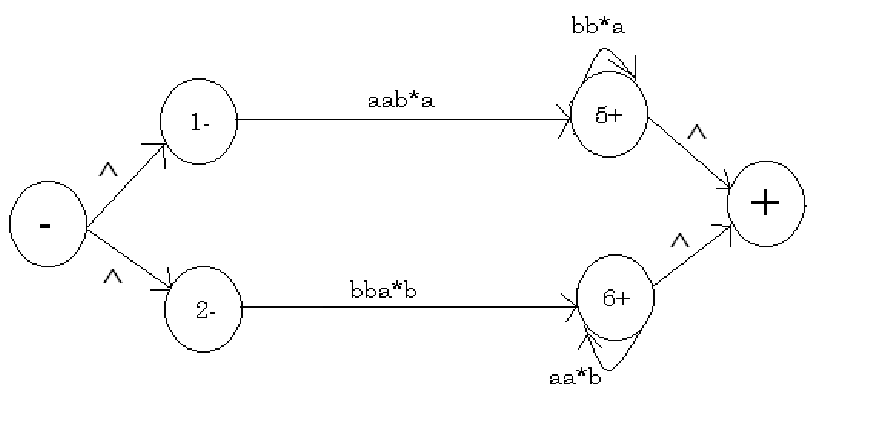
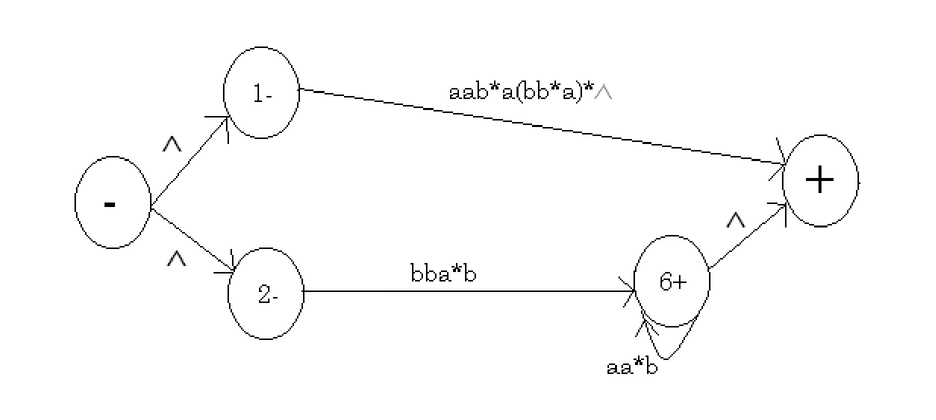
After eliminating state 3 the TG will look like:



Now eliminate state 4



Eliminate state 5



دنیا کی سب سے بڑی فتح نفس پر قابو رکھنا ہے

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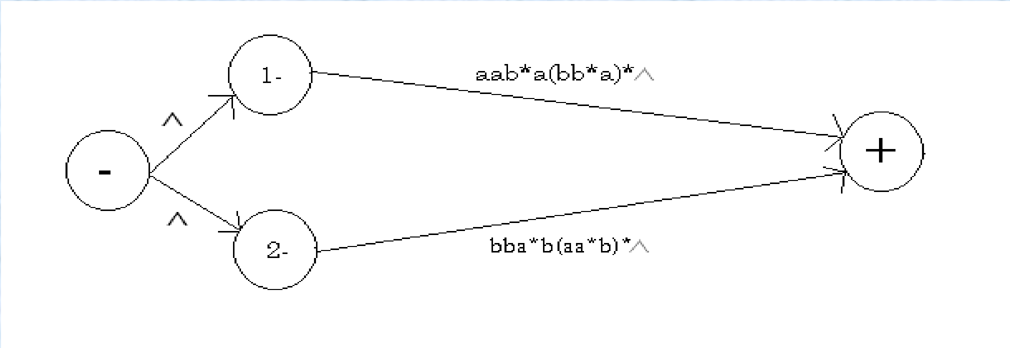
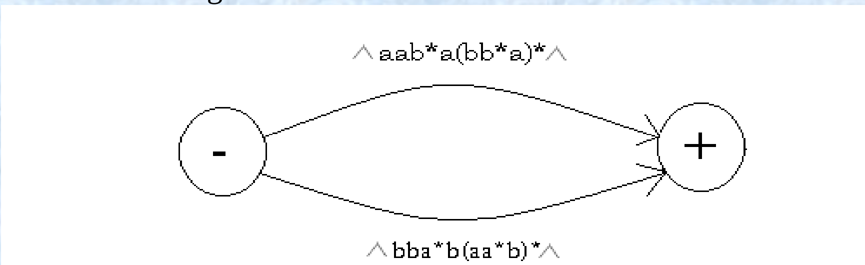
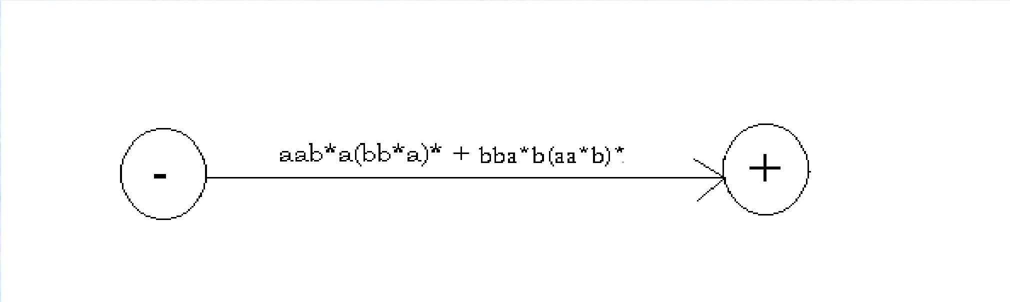
Now eliminate state 6



After eliminating states 1 and 2 the GTG will look like:





aab*a(bb*a)* + bba*b(aa*b)* is our required RE.

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What does an automaton mean? (2 marks)

Answer:- (Page 3)

it means "something that works automatically"

جھوٹ انسان اور ایمان دونوں کا دشمن ہے

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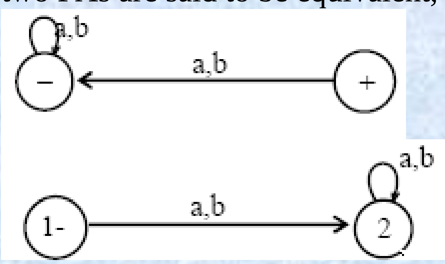
Explain Nondeterminism? (2 marks)
Answer: rep

Finite automata with output? (3 marks)
Answer:- (Page 55)
FA which generates an output string corresponding to each input String Such machines are called machines with output. There are two types of machines with output. Moore machine and Mealy machine.

Explain Equivalent? (3 marks)
Answer:- (Page 55)
Two regular expressions are said to be equivalent if they generate the same language.
r1 = (a + b)* (aa + bb) ,,, r2 = (a + b)*aa + (a + b)*bb ,,, r1 = r2

two FAs are said to be equivalent, if they accept the same language



Nondeterministic finite automaton (NFA) (5 marks)
Answer: rep

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If there are more than one edge between two states then we can replace them by one edge in a TG. Explain it with examples?
Answer:- rep

How can you say that two FAs are equivalent?
Answer:- (Page 15)
FAs are said to be equivalent, if they accept the same language.

عقل مند کہتا ہے میں کچھ نہیں جانتا جبکہ بے وقوف کہتا ہے کہ میں سب کچھ جانتا ہوں

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FA Doesn't accepts strings in which 3 conditions, Write all (3)

Answer:- (Page 15-16)

1. If there is no path starting from initial state and ending in final state.
2. If there is no final state
3. If it is disconnected with final state.

Define Mealy Machine(3)

Answer:- Rep

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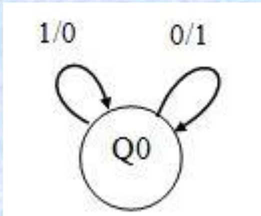
Write at least one similarity and one difference between DFA & NFA

Answer:- Rep

a. What is ∑ and Γ for this machine



Answer:- (Page 58)

∑={0,1}

Γ= {0,1}

b. What will be output of this machine if 110001101 is input

Answer:- 001110010

c. Describe the purpose of this machine

Answer:- REP

خود کو تمھیں سے بڑھ کر کوئی اچھا مشورہ نہیں دے سکتا

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By looking at transition diagram, how can we identify whether it is FA or TG
Answer: We can identify it by checking transition. If there are transition of every letter in every state then is it said to be as FA other we will consider it as TG.

Differentiate FA,TG & GTG
Answer:- (Page 25)
TGs and GTGs provide certain relaxations i.e. there may exist more than one path for a certain string or there may not be any path for a certain string, this property creates nondeterminism and it can also help in differentiating TGs or GTGs from FAs. Hence an FA is also called a Deterministic Finite Automaton (DFA). Also in GTG Directed edges connecting some pair of states labeled with regular expression.

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Different between word and strings? 2 marks
Answer: - (Page 3)
Words are strings belonging to some language while Concatenation of finite number of letters from the alphabet is called a string.

What is Transition? 2 marks
Answer:- (Page 11)
For each state and for each input letter showing how to move from one state to another.

Different between Distinguishable strings and indistinguishable strings? 3 marks
Answer:- Page 53

Distinguishable strings and Indistinguishable strings

Two strings x and y, belonging to Σ^*, are said to be **distinguishable** w.r.t a language $L \subseteq \Sigma^*$ if there exists a string z belonging to Σ^* s.t. $xz \in L$ but $yz \notin L$ or $xz \notin L$ but $yz \in L$.
Two strings x and y, belonging to Σ^*, are said to be **indistinguishable** with respect to a language $L \subseteq \Sigma^*$ if for every string z belonging to Σ^*, either both xz or $yz \in L$ or both don't belong to L.

Explain Mealy machine? 3 marks
Answer:- Rep

جو شخص ناکامیوں سے ڈر کر بھاگتا ہے کامیابی اُس سے ڈر کر بھاگتی ہے

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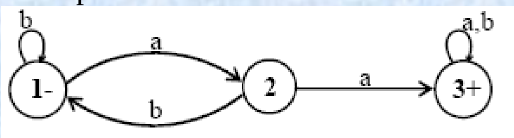
NFA corresponding to the Closure of an FA 5 marks

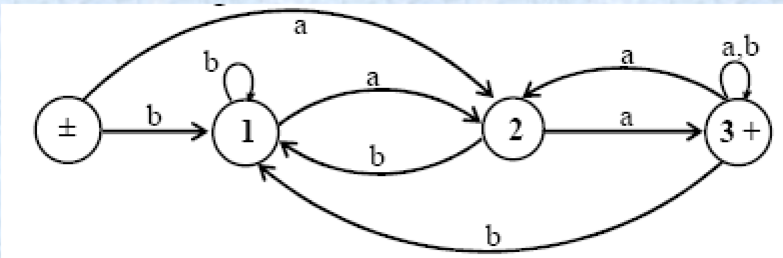
Answer: Page 50 and 52

Introduce an initial state which should be final as well (so that the Null string is accepted) and connect it with the states originally connected with the old start state with the same transitions as the old start state, then remove the –ve sign of old start state. Introduce new transitions, for each letter, at each of the final states (including new final state) with those connected with the old start state. This creates non-determinism and hence results in the required NFA.

Example:-



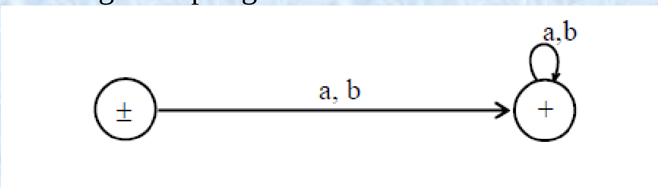
It may be observed that the FA* accepts only the additional string which is the Null string. Considering the state 1 to be final as well, will allow the unwanted strings be accepted as well. Hence the required NFA is constructed introducing the new initial state, shown below.



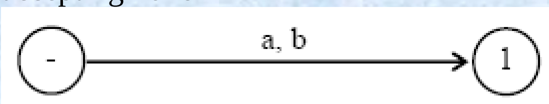
TGs: accepting all strings, accepting none, starting with b, not ending in b, containing aa, containing aa or bb…….. 5 marks

Answer:- Page 19

all strings accepting none

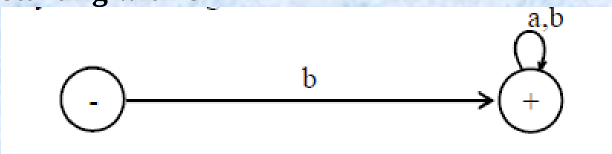


accepting none

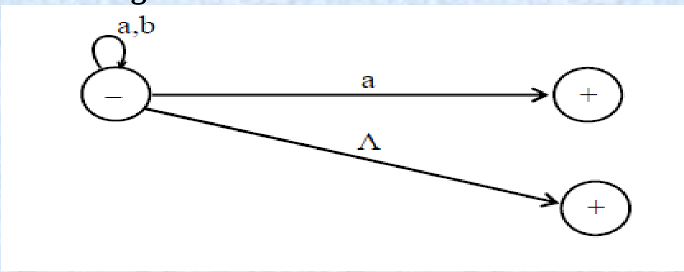


جو لوگوں کے سامنے فخر کرتا ہے وہ لوگوں کی نظروں سے گر جاتا ہے

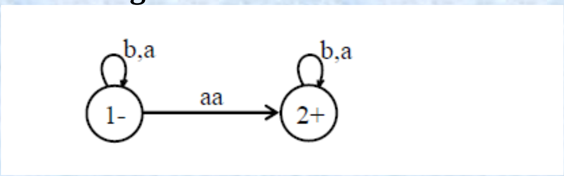
starting with b



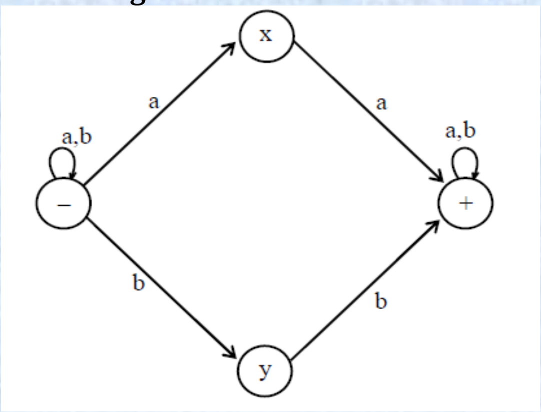
not ending in b



containing aa



containing aa or bb



عقل مند اپنے عیب خود دیکھتا ہے اور بیوقوفوں کے عیب دنیا دیکھتی ہے

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MIDTERM SPRING 2010
CS402 – Theory of Automata

Question No: 21 (Marks: 2) - Please choose one
The language can express in FA then why we need NFA. Justify your answer.
Answer:- rep

Question No: 22 (Marks: 2) - Please choose one
Names of four types of automata.
Answer:- Click here for detail
List of types of automata.
Nondeterministic/Deterministic Finite state machine (FSM)
Deterministic pushdown automaton (DPDA)
Pushdown automaton (PDA)
Linear bounded automaton (LBA)

Question No: 23 (Marks: 3) - Please choose one
Check the given statements or correct or not if not then correct it.
1. String in regular language can not be infinite **True**
2. Concatenation of finite letters from alphabets called sigma **False**
3. There cannot be more then on FA,s for same language. **False**

Answer:- Rep

Question No: 24 (Marks: 3) - Please choose one
How can we know, what language a certain RE represent
Answer:- (Page 25)
TGs and GTGs provide certain relaxations i.e. there may exist more than one path for a certain string or there may not be any path for a certain string, this property creates nondeterminism and it can also help in differentiating TGs or GTGs from FAs. Hence an FA is also called a Deterministic Finite Automaton (DFA).

Question No: 25 (Marks: 5) - Please choose one
Explain mealy machine
Answer:- Rep

بد صورت چہرہ بد صورت دماغ سے بہتر ہے

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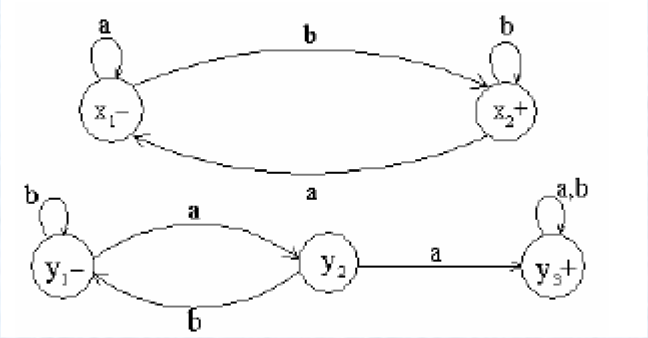
Question No: 26 (Marks: 5) - Please choose one

Give the transition table of an FA3 corresponding to FA1+FA2, where FA1, FA2 are given below.



Answer:- (Page 33)

Old States	New States after reading	
	a	b
$z_1 - \equiv (x_1, y_1)$	$(x_1, y_2) \equiv z_2$	$(x_2, y_1) \equiv z_3$
$z_2 \equiv (x_1, y_2)$	$(x_1, y_3) \equiv z_4$	$(x_2, y_1) \equiv z_3$
$z_3 + \equiv (x_2, y_1)$	$(x_1, y_2) \equiv z_2$	$(x_2, y_1) \equiv z_3$
$z_4 + \equiv (x_1, y_3)$	$(x_1, y_3) \equiv z_4$	$(x_2, y_3) \equiv z_5$
$z_5 + \equiv (x_2, y_3)$	$(x_1, y_3) \equiv z_4$	$(x_2, y_3) \equiv z_5$

MIDTERM EXAMINATION

Spring 2009

CS402- Theory of Automata (Session - 1)

Question No: 17 (Marks: 1)

Is the following statement trure?

A regular language can not be infinite.

Answer:- (Page 11)

False because All finite languages are regular.

عقلمند آدمی اس وقت تک نہیں بولتا جب تک خاموشی نہیں ہو جاتی

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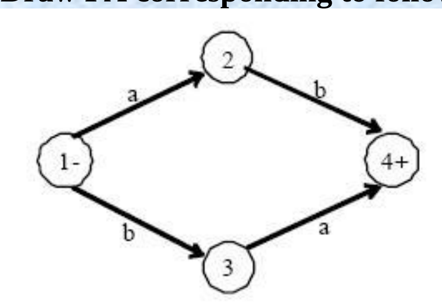
Question No: 18 (Marks: 1)
Can you say that for a certain string there may be more than one paths in a TG?
Answer:- (Page 25)
Yes, TGs and GTGs provide certain relaxations i.e. there may exist more than one path for a certain string.

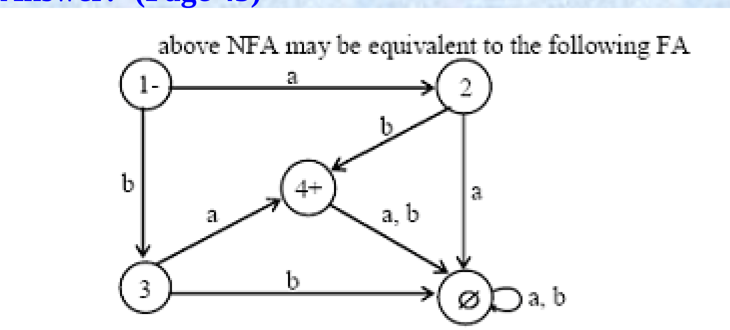
Question No: 19 (Marks: 2)
If a language can be accepted by an FA then it can be accepted by a TG as well.
What are the other two statements of kleenes's theorem?
Answer:- (Page 25)
If a language can be accepted by a TG then it can be expressed by an RE as well.
If a language can be expressed by a RE then it can be accepted by an FA as well.

Question No: 20 (Marks: 3)
Describe the method of NFA corresponding to Concatenation of FAs.
Answer:- (Page 48)
Introduce additional transitions for each letter connecting each final state of the first FA with the states of second FA that are connected with the initial state of second FA corresponding to each letter of the alphabet. Remove the +ve sign of each of final states of first FA and –ve sign of the initial state of second FA. It will create non-determinism at final states of first FA and hence NFA, thus obtained, will be the required NFA.

Question No: 21 (Marks: 5)
Draw FA corresponding to following NFA?



Answer:- (Page 43)



انسان دکھ نہیں دیتے بلکہ انسانوں سے وابستہ امیدیں دکھ دیتی ہیں

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Question No: 22 (Marks: 10)
Let L be any language. Let us define the transpose of L to be the language of exactly those words that are the words in L spelled backward. If w L then reverse (w) L. for example, if L = {a, abb, bbaab, bbbaa}Then Transpose (L) = {a, bba, baabb, aabbb, Prove that if there is an FA that accepts L, then there is a TG that accepts the transpose of L.

MIDTERM EXAMINATION
Spring 2009
CS402- Theory of Automata (Session - 3)

Question No: 17 (Marks: 1)
How can we say that two REs are equal?
Answer:- (Page 10)
Two regular expressions are said to be equivalent if they generate the same language.
If r1 and r2 are regular expressions then
(r1)
r1 r2
r1 + r2 and
r1*
are also regular expressions.

Question No: 18 (Marks: 1)
What is meant by Kleene star closure of a language?
Answer:- (Page 7)
Given Σ, then the Kleene Star Closure of the alphabet Σ, denoted by Σ*, is the collection of all strings defined over Σ, including Λ.It is to be noted that Kleene Star Closure can be defined over any set of strings.

Question No: 19 (Marks: 2)
What the Pumping lemma II says about length(x) + length(y) must be:
Answer:- From Lecture 26

Question No: 20 (Marks: 3)
Consider the language S*, where S = {ab, ba}, Can any word in this language contain the substrings aaa or bbb? Why or why not?
Answer:- Click here for detail
No words can contain aaa or bbb because every a and b is preceded / followed by a different letter, so one letter can never be surrounded on both sides by the same letter.a and b are the smallest words / strings not in S*.

بہترین تجربہ وہ ہے جس سے نصیحت حاصل ہو

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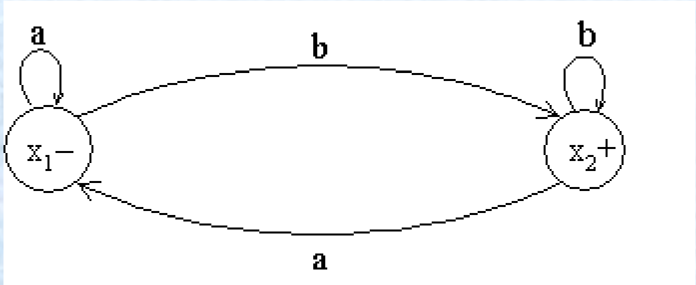
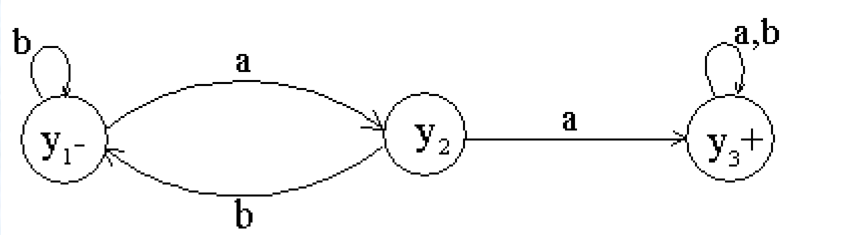
Question No: 21 (Marks: 5)
Give the transition table of an FA3 corresponding to FA1+FA2, where FA1, FA2 are given below.
FA1

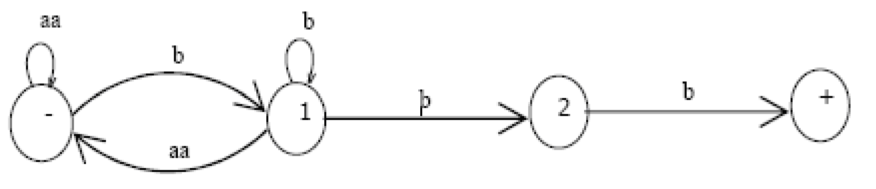


FA2



Answer:- Rep

Question No: 22 (Marks: 10)
What is meant by nondeterminism? Draw the TG for the following RE
(aa)*b(b*+((aa)+b)*) bb.
Answer:- (Page 25)
TGs and GTGs provide certain relaxations i.e. there may exist more than one path for a certain string or there may not be any path for a certain string, this property creates nondeterminism.



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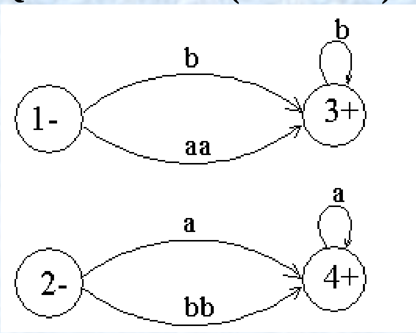
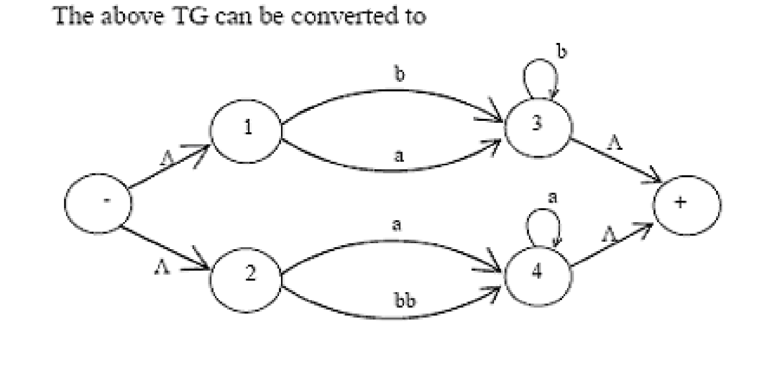
MIDTERM EXAMINATION
Spring 2009
CS402- Theory of Automata (Session - 3)

Question No: 17 (Marks: 1)
What is meant by a "language" in automata?
Answer:- Click here for detail
The set of all the words accepted by an automaton is called the language recognized by the automaton.

Question No: 18 (Marks: 1)



For the above given TG draw an equivalent TG having only one final state.
Answer:- (Page 27)



Question No: 19 (Marks: 2)
Give the regular expression for EVEN-EVEN language?
Answer:- (Page 10)
(aa+bb+(ab+ba)(aa+bb)*(ab+ba))*

تم اچھا کرو زمانہ تم کو برا سمجھے یہ اس سے بہتر ہے کہ تم برا کرو اور زمانہ تم کو اچھا سمجھے

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Question No: 20 (Marks: 3)
Give an example of a set S such that S* only contains all possible string of a's and b's that has length divisible by 3
Answer:- Click here for detail
If S contains all possible strings of a & b of length 3, then all the words in S* will have length divisible by 3 and will include any concatenation of a's and b's (because S did).
By the product rule, there are 2*2*2 = 8 possible words of length 3:
S = {aaa aab aba baa abb bba bab bbb}

Question No: 21 (Marks: 5)
Construct a regular expression defining the following language over the alphabet S = {a,b}:
All words that contains at least one of the strings s1, s2, s3 or s4
Answer:- Click here for detail
(a+b)*(s1+s2+s3+s4)(a+b)*

Question No: 22 (Marks: 10)
What is meant by nondeterminism? Draw the TG for the following RE
(aa)*b(b*+((aa)+b)*) bb.
Answer:- Rep

MIDTERM EXAMINATION
Spring 2009
CS402- Theory of Automata (Session - 3)

Question No: 17 (Marks: 1)
What is the difference between Regular Languages and Non Regular Languages?
Answer:- (Page 10 & 71)
The language generated by any regular expression is called a regular language while The language that cannot be expressed by any regular expression is called a Nonregular language

Question No: 18 (Marks: 1)
What is meant by tokenizing a string?
Answer:- (Page 4)
Tokenization is the process of breaking a string into letter belonging to Σ,

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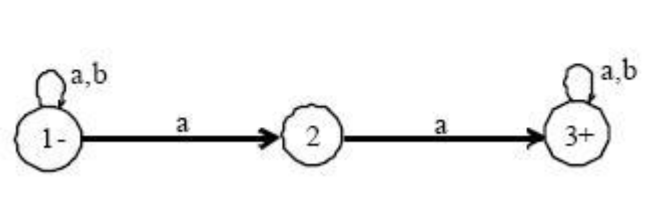
Question No: 19 (Marks: 2)

Define the language for the following NFA also write the regular expression for the language?



Answer:- (Page 40)

NFA accepts the language of strings, defined over Σ = {a, b}, containing aa.

(a+b)* aa (a+b)*

Question No: 20 (Marks: 3)

Describe the method of NFA corresponding to Concatenation of FAs.

Answer:- Rep

Question No: 21 (Marks: 5)

(i) When asked to give a recursive definition for the language PALINDROM over the alphabet S = {a, b}, a student wrote:

Rule 1 a and b are in PALINDROM.

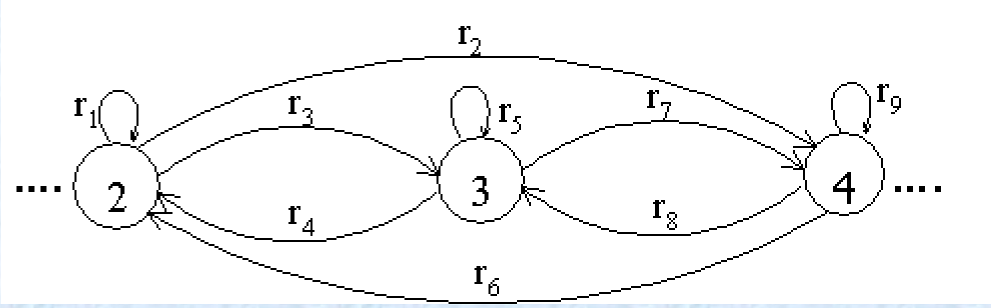
Rule 2 If x is in PALINDROM, then so are axa and bxb

Unfortunately all the words in the language defined above have an odd length and so it is not all of PALINDROM. Fix this problem.

(ii) Give a recursive definition for the language EVENPALINDROM of all palindromes of even length

Question No: 22 (Marks: 10)

What do you mean by "bypass and state elimination" Also reduce the following TG by eliminating state 3. (Draw reduced TG)



Answer: - (Page 28)

If three states in a TG, are connected in sequence then eliminate the middle state and connect the first state with the third by a single transition labeled by the RE which is the concatenation of corresponding two REs in the existing sequence.

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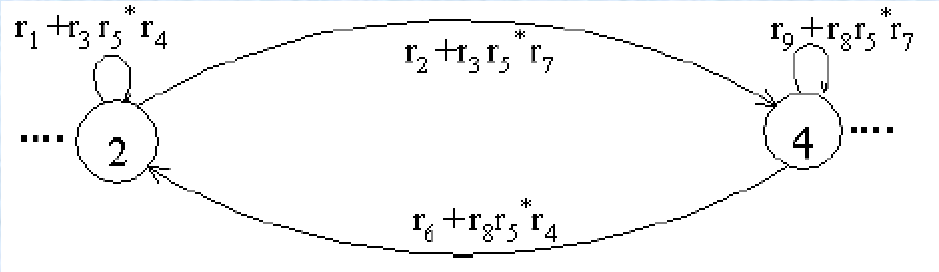
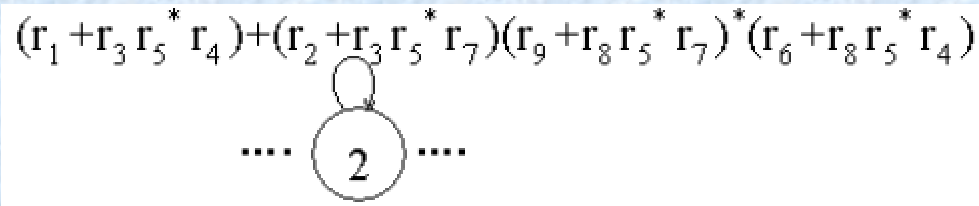
To eliminate state 3 the above TG can be reduced to



To eliminate state 4 the above TG can be reduced to



MIDTERM EXAMINATION

Spring 2009

CS402- Theory of Automata (Session - 3)

Question No: 17 (Marks: 1)
In transition diagram of an FA, how can we represent initail and final states?
Answer:-
we represent the inital state with minus sign (-) and final with plus sign (+)

Question No: 18 (Marks: 1)
What the Kleene's Theorem Part I says?
Answer:- (Page 25)
If a language can be accepted by an FA then it can be accepted by a TG as well.

جھوٹ رزق کو کھا جاتا ہے

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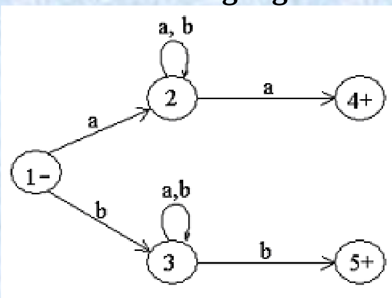
Question No: 19 (Marks: 2)
Describe the language for the following TG



Answer:-(Page 22)
Beginning and ending in same letters.
The language L may be expressed by RE a(a + b)*a + b(a + b)*b

Question No: 20 (Marks: 3)
Show that there are exactly 5832 different finite automat with three states x, y, z over the alphabet {a, b}, where x is always the start state.

Question No: 21 (Marks: 5)
For proving Kleen's theorm part-II:
"If there are more than one transition edges between two states then we can reduce all these transition edges with a single transition edge"
Explain this statement with the help of an example.
Answer:-Rep

Question No: 22 (Marks: 10)
i) Let S = {ab, bb} and let T = {ab, bb, bbbb} Show that S* = T*
Answer:- Click here for detail
S ⊂ T, so S* ⊂ T*. bbbb is the only word in T but not in S. However, bb 2 S, so bbbb 2 S* and T* ⊂ S*.
Hence, S* = T*.

ii) Let S = {ab, bb} and let T = {ab, bb, bbb} Show that S* not equal T*
Answer:- Click here for detail
S is a subset of T. Both sets contain ab.
In S b must be even length where in T b can be odd or even length and S* will contain only even words with b and T will contain words with both even and odd lengths of b. So S* isn't equal to T*.
But, S* is a subset of T* because both sets will contain all even factors of b.

iii) What principle does this illustrate?

افضل انسان وہ ہے جو اپنی اصلاح کی کوشش کرتا ہے

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