



CS402 – Theory of Automata
Solved Subjective
From Midterm Papers

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PSMD01

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CS402 – Theory of Automata

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 q_0, q_1, q_2, \dots where q_0 is the initial state.

An alphabet of letters $\Sigma = \{a, b, c, \dots\}$ from which the input strings are formed.

An alphabet $\Gamma = \{x, y, z, \dots\}$ 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 to 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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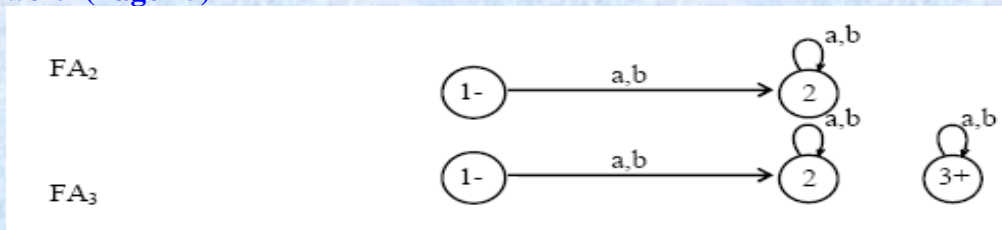
Can we accept the string going from final to initial state?

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

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

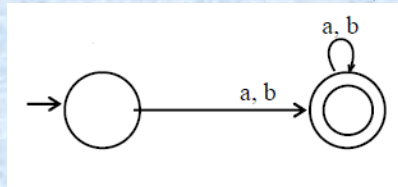
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1. Can we represent start and final state with + and - sign and is there any other way to represent it??

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:-

$bb(a+b)^*bb$

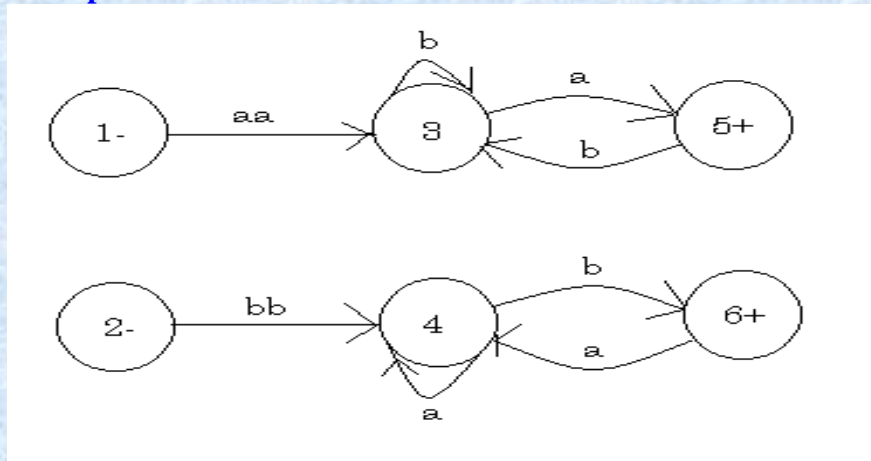
4. For proving Kleen's theorem part-II:

"If there are more than one transition edges between two states then we can reduce all these transition edges with a single transition edge"

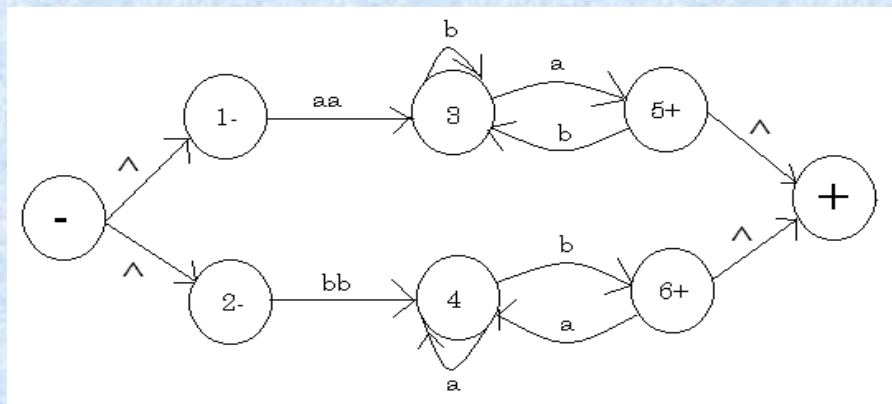
Explain this statement with the help of an example. (Marks 5)

Answer:- (Page 25)

Example:



First of all single initial and single final states are required as given below:



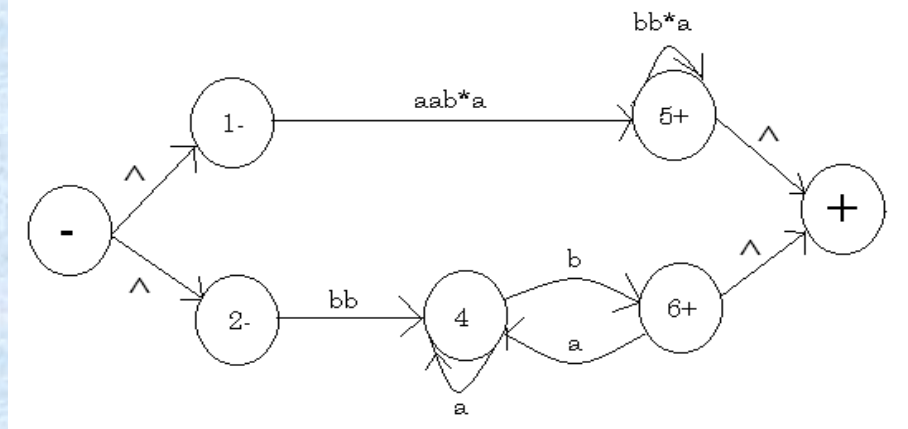
زندگی میں کامیابی کا یہی راز ہے کہ پریشانیوں سے پریشان مت بنو

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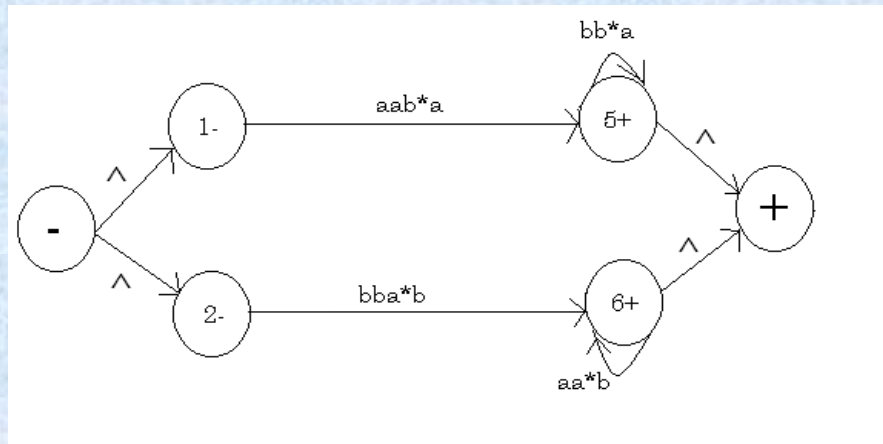
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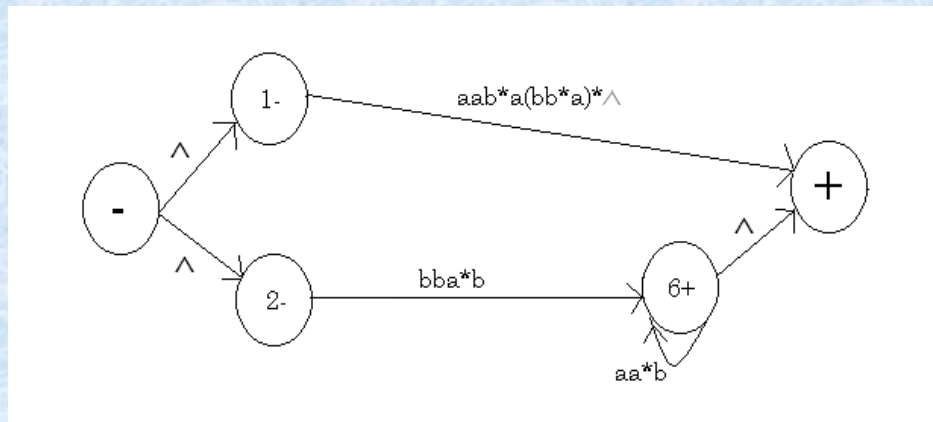
After eliminating state 3 the TG will look like:



Now eliminate state 4



Eliminate state 5



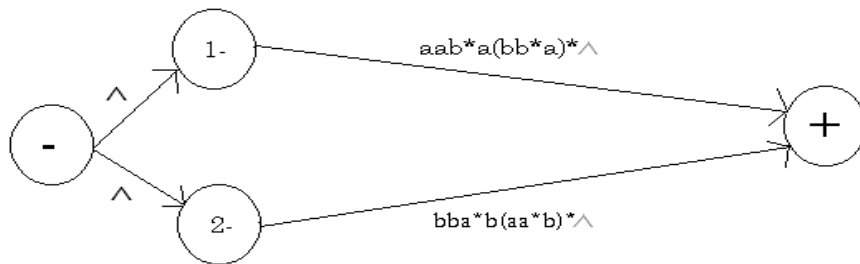
دنیا کی سب سے بڑی فتح نفس پر قابو رکھنا ہے

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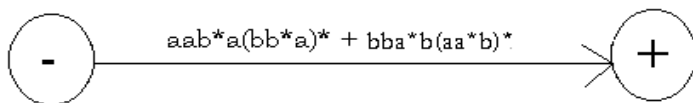
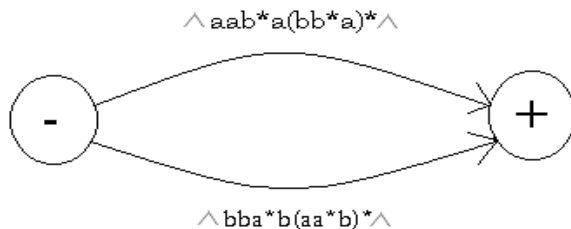
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Now eliminate state 6



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

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.

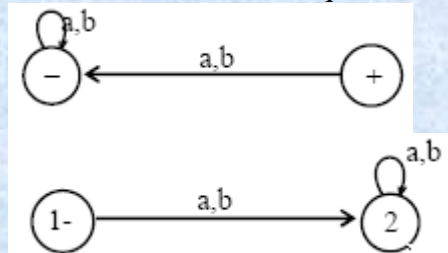
Explain Equivalent? (3 marks)

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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CS402 – Theory of Automata

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)

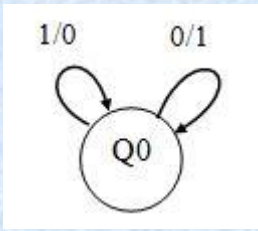
Answer:- Rep

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Write at least one similarity and one difference between DFA & NFA

Answer:- Rep

a. What is Σ and Γ for this machine



Answer:- (Page 58)

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

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

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 تمہیں سے بڑھ کر کوئی اچھا مشورہ نہیں دے سکتا

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 it is 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

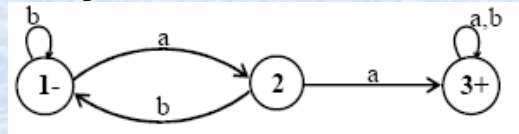
جو شخص ناکامیوں سے ڈر کر بھاگتا ہے کامیابی اس سے ڈر کر بھاگتی ہے

NFA corresponding to the Closure of an FA 5 marks

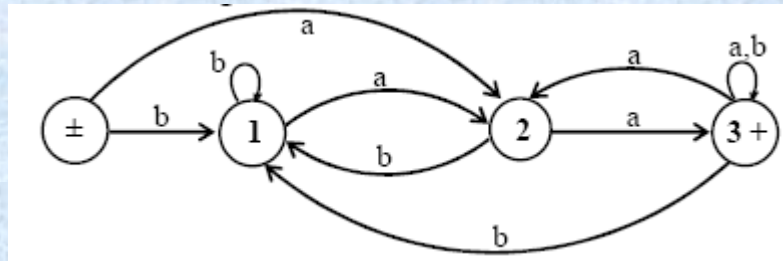
Answer: Page 50 and 52

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:-



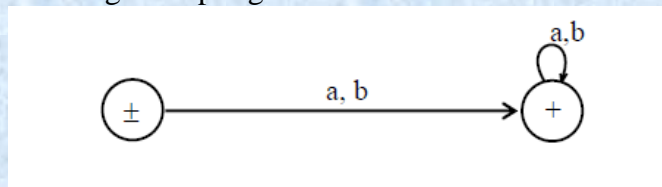
It may be observed that the FA* accepts only the additional string which is the Null string. Considering the state 1 to be final as well, will allow the unwanted strings be accepted as well. Hence the required NFA is constructed introducing the new initial state, shown below.



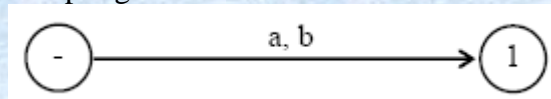
TGs: accepting all strings, accepting none, starting with b, not ending in b, containing aa, containing aa or bb..... 5 marks

Answer:- Page 19

all strings accepting none



accepting none



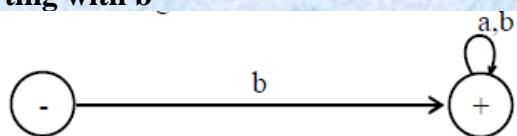
جو لوگوں کے سامنے فخر کرتا ہے وہ لوگوں کی نظروں سے گر جاتا ہے

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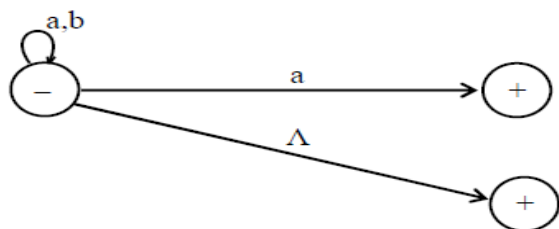
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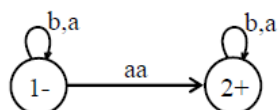
starting with b



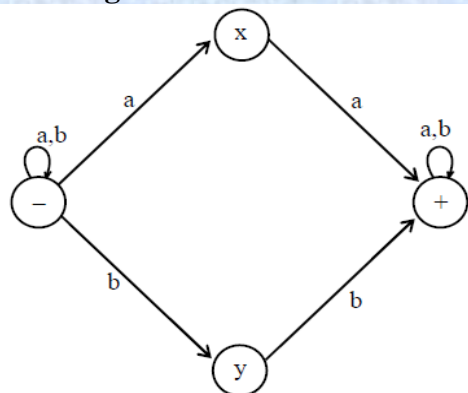
not ending in b



containing aa



containing aa or bb



عقل مند اپنے عیب خود دیکھتا ہے اور بیوقوفوں کے عیب دنیا دیکھتی ہے

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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

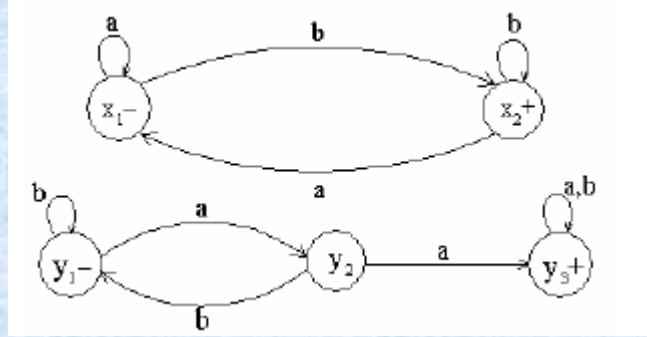
Explain mealy machine

Answer:- Rep

بد صورت چہرہ بد صورت دماغ سے بہتر ہے

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 true?

A regular language can not be infinite.

Answer:- (Page 11)

False because All finite languages are regular.

عقل مند 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)

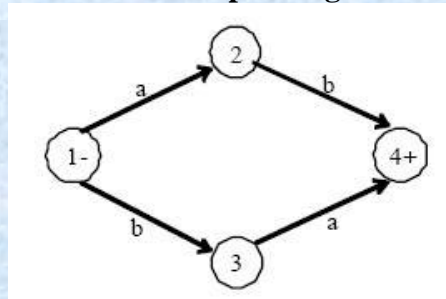
Describe the method of NFA corresponding to Concatenation of FAs.

Answer:- (Page 48)

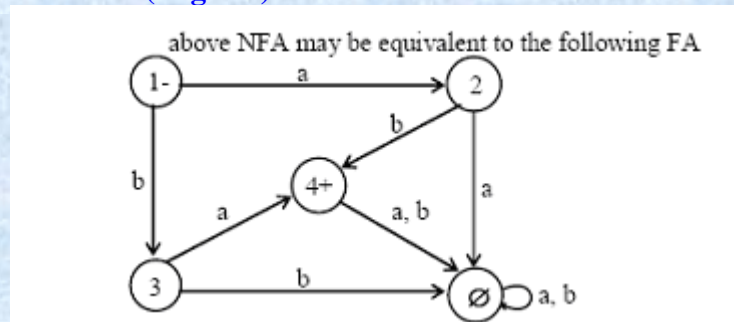
Introduce additional transitions for each letter connecting each final state of the first FA with the states of second FA that are connected with the initial state of second FA corresponding to each letter of the alphabet. Remove the +ve sign of each of final states of first FA and –ve sign of the initial 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 $w \in L$ then reverse (w) $\in L$. for example, if $L = \{a, abb, bbaab, bbbbaa\}$ 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 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.

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 $\text{length}(x) + \text{length}(y)$ 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^* .

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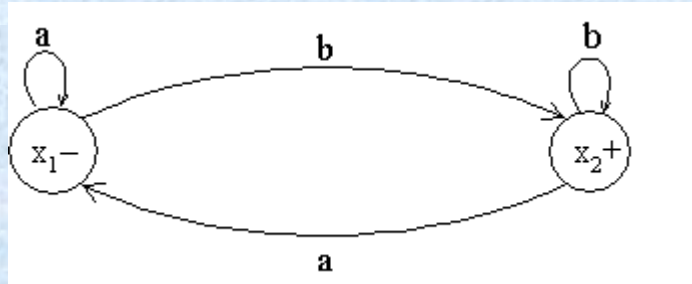
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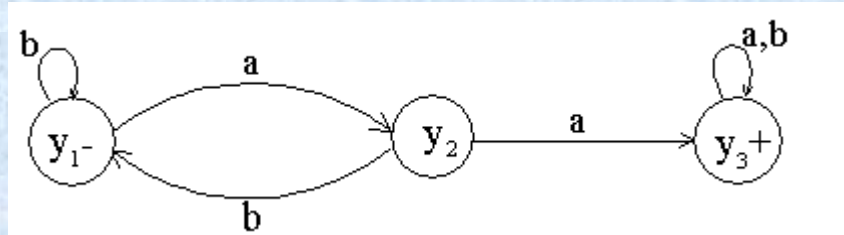
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Question No: 21 (Marks: 5)

Give the transition table of an FA3 corresponding to $FA1+FA2$, where $FA1$, $FA2$ are given below.



FA2



Answer:- Rep

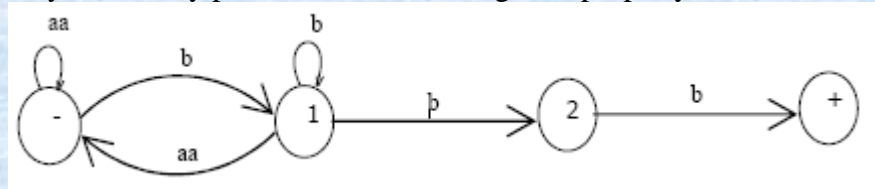
Question No: 22 (Marks: 10)

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)

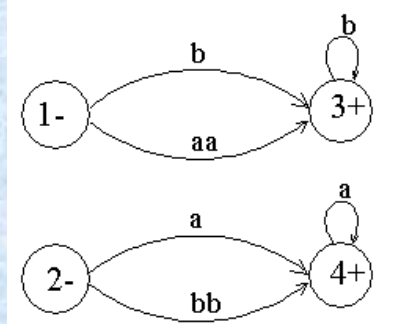
Question No: 17 (Marks: 1)

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.

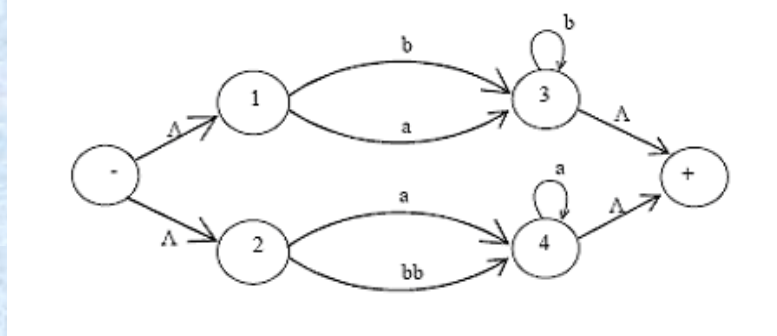
Question No: 18 (Marks: 1)



For the above given TG draw an equivalent TG having only one final state.

Answer:- (Page 27)

The above TG can be converted to



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 $2 \times 2 \times 2 = 8$ 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 s_1, s_2, s_3 or s_4

Answer:- [Click here for detail](#)

$(a+b)^*(s_1+s_2+s_3+s_4)(a+b)^*$

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

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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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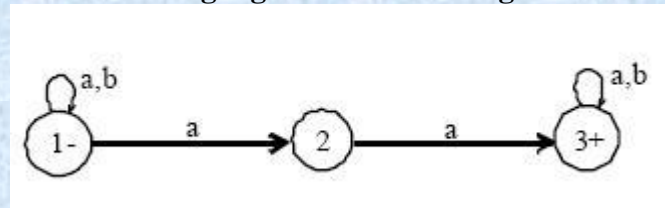
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Question No: 19 (Marks: 2)

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

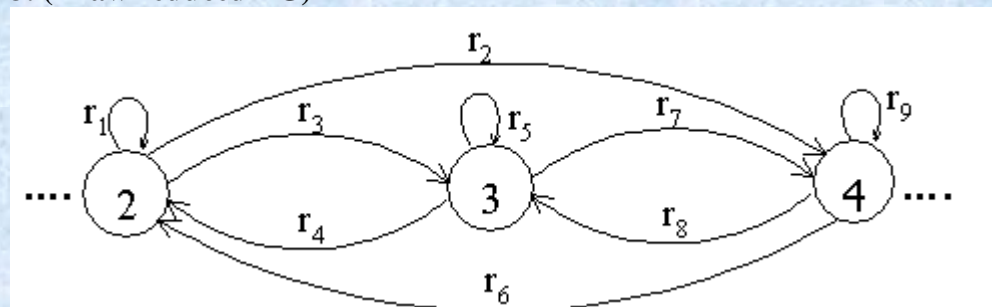
Rule 2 If x is in PALINDROM, then so are axa and bxb

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.

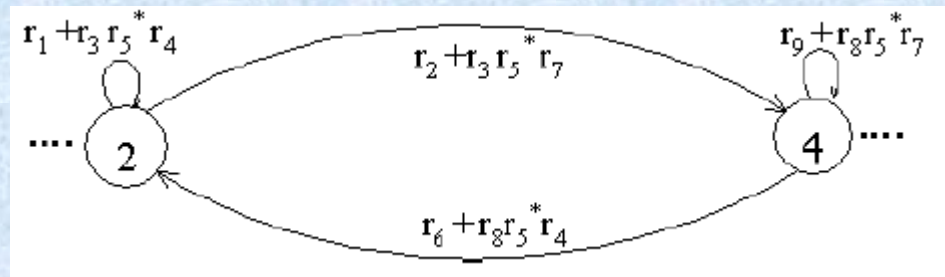
خاموشی غصے کا بہترین علاج ہے

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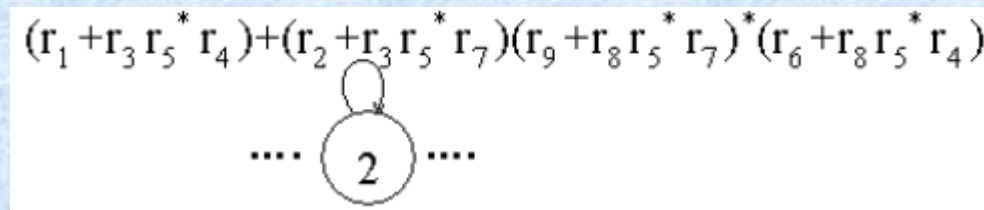
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To eliminate state 3 the above TG can be reduced to



To eliminate state 4 the above TG can be reduced to



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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

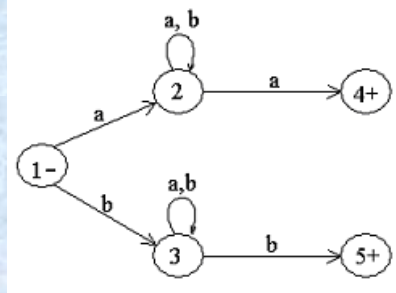
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Question No: 19 (Marks: 2)

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 automata 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 Kleene's theorem 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](#)

$S \subset T$, so $S^* \subset T^*$. $bbbb$ is the only word in T but not in S . However, $bb \in S$, so $bbbb \in S^*$ and $T^* \subset S^*$. Hence, $S^* = T^*$.

ii) Let $S = \{ab, bb\}$ and let $T = \{ab, bb, bbb\}$ Show that $S^* \neq T^*$

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 $S^* \neq T^*$.

But, S^* is a subset of T^* because both sets will contain all even factors of b .

iii) What principle does this illustrate?

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