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National University of Computer and Emerging Sciences, Lahore Campus

National University of Compatibility			Course Code:	CS-3005
SU CONTRACTOR OF THE PROPERTY	Course Name:	Theory of Automata	Semester:	Fall 2023
	Degree Program:	BS (CS)	Total Marks:	30
	Exam Duration:	60 Minutes	Weight	17.5%
	Paper Date:	2-10-2023	Page(s):	7
	Section:	ALL	1 -9-1-7	
	Exam Type:	Midterm-I	C. Alami	
		1,000,000,000,000	Section	-

Student: Name:

Roll No ._ Answer in the space provided, showing complete working.

ROUGH SHEETS ARE NOT ALLOWED.

In case of confusion or ambiguity make a reasonable assumption.

Question 1: (10 points):

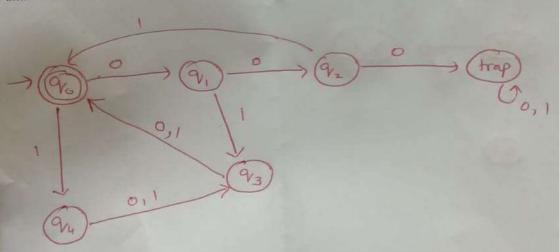
Instruction/Notes:

Design deterministic finite automata (DFA) of the following language:

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

 $L = \{x \mid x \in \Sigma^* \text{ and } |x| \text{ should be multiple of 3 and every three-length chunk of the string}$ contains at most two occurrences of 0}

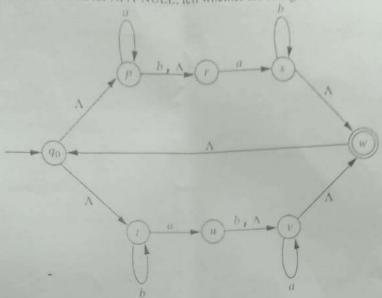
010 and 001100 are two of the accepting strings 0101 and 000010 are two of the rejecting strings



School of Computer Science

estion 2: (5 points):

sing the extended transition function for NFA-NULL, tell whether the string ab € L or not. Show full working



g* (90, ab)

& (av, na) = NU 8 (P, a) } -0

8 (90, N = 139,3 = 390, P, E, r)

grand = 1 7 U g (P, a) 7 |

8 (9,0b) = 1 3 8 (2, b) 8 16 3 P.Y. U.V. W. 90 t, 8, W3

=ハイギ, V, 七, s} = 3 r, v, w, q., p, t, s} Since WEA ab el.

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z 入うのしおろいちょうりならう = 13 P, U, 53 = 3 P, +, U, V, W, 90, P, b, r, S, w}

Consider a language L defined over the alphabet set Σ . Suppose D₁ is a deterministic finite automata (DFA) with 5 tuples (Q, Σ, q_0, A, T) where 5 tuples (Q,Σ, q₀, A, T) where

Q = finite set of states

 Σ = finite set of alphabets

q₀ = initial state

A= set of final states

T= set of transition functions.

Construct finite automata F1 ((DFA or NFA or NFA-NULL but clearly mention which FA you have developed)) for L^R where for LR where

 L^R = Reverse of L.

You have to define all the 5 tuples of F1 $(Q_1, \Sigma_1, p_0, A_1, T_1)$

$$\Sigma_1 = \{ \sum$$

Ti=1
$$T_1(P_0, \Lambda) \rightarrow A$$
 in P_1 invert all transition if $T(q, q) \rightarrow X$ in P_1 invert all transition then for FI
 $T_1(X, q) \rightarrow Y$

Hint:

Construct FA for LR and then fill the tuples.

If L accepts the string $x = x_0 x_1 \dots x_n \{ \text{ where } x_0 x_1 \dots x_n \in \Sigma \}$ then L^R will accept $y = x_n x_{n-1} \dots x_1 x_0$. For example

Example #1

le #1
L=
$$\{x \mid x \in \{a,b\}^* \text{ and } x = abbb\}$$

Then

$$L^R = \{x | x \in \{a,b\}^* \text{ and } x = bbba\}$$

Example #2

L=
$$\{x \mid x \in \{a,b\}^* \text{ and } x \text{ ends with ab}\}$$

Then $L^R = \{x \mid x \in \{a,b\}^* \text{ and } x \text{ starts with ba}\}$

estion 3 (5+2 +2+2+4 = 15 points): Short answers

Section:

Consider a language L defined over the alphabet set Σ . Suppose D₁ is a deterministic finite automata (DFA) with 5 tuples (Q,Σ, q₀, A, T) where

Q = finite set of states

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Construct finite automata F1 ((DFA or NFA or NFA-NULL but clearly mention which FA you have developed)) for LR where

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You have to define all the 5 tuples of F1 $(Q_1, \Sigma_1, p_0, A_1, T_1)$

QI={ QUPo

 $\Sigma_1 = \{$

po= Po

· A1= { %

TI= { T, (Po, A) -> A invest all transition

NFA - N. FA =

14 T(9,a) → 2 in D, Then for FI T, (R, a) > 8

Construct FA for LR and then fill the tuples. Hint:

Construct FA for E will accept $x = x_0 x_1 \dots x_n \{ \text{ where } x_0 x_1 \dots x_n \varepsilon \Sigma \}$ then L^R will accept $y = x_n x_{n-1} \dots x_1 x_0$.

For example

Example #1

 $L = \{x \mid x \in \{a,b\}^* \text{ and } x = abbb\}$

 $L^R = \{x \mid x \in \{a,b\}^* \text{ and } x = bbba\}$

Example #2

 $L = \{x | x \in \{a,b\}^* \text{ and } x \text{ ends with ab}\}$

hen

 $L^R = \{x \mid x \in \{a,b\}^* \text{ and } x \text{ starts with ba}\}$

Roll Number: PART B True/ False with justification (no marks without justification) Every DFA is also a NFA-NULL Irue In NFA-NULL branshorn function in defined as Q x 18 UN of DFA: Q x & of DFA is Q x		Section:
True IN NFA-NULL brancher function in defined as 0×10^{14} IN NFA-NULL brancher function in defined as 0×10^{14} DFA: $0 \times 2 \rightarrow 0$ decreased to be a not necessary to be a Null transition for every state. PART C Language is regular if it has FA and R.E. PART D Give regular expression for the following language. L= (x x \(\epsilon (a,b)^*\) and x starts with ab and ends with ba) Ans: \(\text{ab} \text{ (at b)}^*\) ba + aba PART E NFA for the Language L is given below. a) Write regular expression for the language accepted by this FA? [Hint: No need to apply state elimination method] a (a bb) ab + a (a bb) a ab b) Enumerate the language L' (complement of L) [at least 10 elements in increasing order of length] 3 \(\text{A}, \text{b}, \text{ba}, \text{ab}, \text{aba}, \text{aba}	PADTR	The state of the s
PART D Give regular expression for the following language. L= {x x e{a,b}* and x starts with ab and ends with ba} Ans: ab (a+b) ba + aba PART E NFA for the Language L is given below. a) Write regular expression for the language accepted by this FA? [Hint: No need to apply state elimination method] a (a bb) ab + a (a bb) a a b b a b b) Enumerate the language L' (complement of L) [at least 10 elements in increasing order of length] a b (a+b) a b b a b a b b a b b a b b a b b a b a b b a b b a b a b b a b b a b b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b b a b a b a b a b b a b a b a b a b a b a b b a b		art is also a NEA MIIII
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PART D Give regular expression for the following language. L= {x x \(\epsilon\) and x starts with ab and ends with ba} Ans: ab (a+b) ba + aba PART E NFA for the Language L is given below. a) Write regular expression for the language accepted by this FA? [Hint: No need to apply state elimination method] a (a+b) ab + a (a+b) a a b b) Enumerate the language L' (complement of L) [at least 10 elements in increasing order of length] 3 A, b, ba, ab, bb, aab, abb, bab,	PART C Language is regular if it has	A and R.E
Ans: ab(a+b)ba + aba PART E NFA for the Language L is given below. a) Write regular expression for the language accepted by this FA? [Hint: No need to apply state elimination method] a (abb)ab + a (abb)ab + a (abb)ab + b Enumerate the language L' (complement of L) [at least 10 elements in increasing order of length] A b (a+b) A b A a a a a aba, abb, bab,	PART D	
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by this FA? [Hint: No need to apply state elimination method] a (a bb) ab + a (a bb) a a b a a b a a b b b b b b b b b	PART E	
b) Enumerate the language L' (complement of L) [at least 10 elements in increasing order of length] \[\begin{align*} \alpha \\ \begin{align*} \begin{align*} \begin{align*} \alpha \\ \begin{align*} align	by this FA? [Hint: No need to apmethod]	pply state elimination $\frac{a}{1}$ $\frac{a}{2}$ $\frac{a}{3}$
b) Enumerate the language L' (complement of L) [at least 10 elements in increasing order of length] 3, 10, ba, ab, bb, aaa 1 aba, abb, bab, abb, bab,	a (a bb) ab, +	a (at bb) a at b a 4 b
3 /2, b, ba, ab, bb, a'aa raba, abb, bab,		a (a+bb)* [ab*+
3 /2, b, ba, ab, bb, a'aa raba, abb, bab,	b) Enumerate the language L' (co	omplement of L) [at least 10 elements in increasing order of length]
- ab (a+b)" - aaa + a		3 n b ha ab bb,
-> b' (a+b)" -> aaat +a	= ab (a+b)	1, 1, 50, uo, aaa, aba, abb, bab,
- aaa' +a	-> b (a+b)"	