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Internal Assessment Test 1 – Sept. 2017

Sub:	**Automata Theory and Computability**				Sub Code:	15CS54	Branch:	CSE, ISE	
Date:	20-09-2017	Duration:	90 min's	Max Marks: 50	Sem / Sec:	V Sem: CSE(A,B,C), ISE(B)		OBE	

Answer any FIVE FULL Questions

		MARKS	CO	RBT
1 (a)	Define the following terms : (i) Alphabet (ii) Language (iii) Concatenation of Languages (iv) Kleene closure of alphabet	[08]	CO1	L1
(b)	Which of the following sets are alphabet, and/or languages? A = { 0, 1}, B = { 0, 11} Give also explanation for your decision	[02]	CO1	L3
2 (a)	Define DFSM. And its language.	[05]	CO3	L1
(b)	Design a DFSM that accepts L = { w: w has at most three a s, and any number of b's}	[05]	CO3	L3
3 (a)	Obtain an NFSM to accept strings of a's and b's ending with aa or bb	[04]	CO3	L3
(b)	Construct equivalent DFSM for the above NFSM	[06]	CO2	L3
4 (a)	Give a formal definition of Moore Machine.	[05]	CO3	L1
(b)	Give a Mealy machine that outputs 1 if w has odd length, and 0 if w has even length. w is a string of the alphabet {a, b}	[05]	CO2	L3
5 (a)	Give a regular expression for the C programming variables that can be formed over the alphabet $\sum$ = {a, b, 9}. The regular expression shall represent all variables whose length is 4. Some examples of C programming variables over $\sum$ are abb9, abaa, baab	[06]	CO3	L3

	MARKS	CO	RBT
5 (b) Give an FSM for the regular expression (01+1)1*	[04]	CO3	L3
6 (a) Define equivalent states of DFSM.	[03]	CO4	L1
(b) Minimize the DFSM given by the following state transition table	[08]	CO2	L3

δ	0	1
->A	B	C
B	C	E
*C	D	C
D	C	E
*E	B	E

7 (a) Give a regular expression for L = {w∈ {0,1}* : w has even no of 1s and odd no of 0s}	[05]	CO3	L3
(b) Produce equivalent DFSM for an NFSM given by the following transition diagram, where X is start state, Z is final state.	[05]	CO3	L3

δ	∈	a	b
->X	{Z}	{Y}	{X,Z}
Y	{}	{X}	{}
*Z	{X,Y}	{Z}	{X}

20/09/2017

IAT-1
Automata Theory & Computability

1. a

Alphabet: A finite set of symbols. Example $\Sigma = \{a, b\}$ 2m

Language: - A set of strings over an alphabet -2m

or

- Given Σ, a language L is a subset of Σ^*

Example: For $\Sigma = \{a, b\}$, - 2m

Concatanation of two languages.

Let L_1 and L_2 be languages of Σ. Then the concatanation of L_1 and L_2, denoted as $L_1 L_2 = \{xy \mid x \in L_1, y \in L_2\}$

or

$L_1 L_2 = \{w \mid w = x.y$, where $x \in L_1$ and $y \in L_2\}$

Ex. $L_1 = \{aa, bb\}$, $L_2 = \{c, d\}$, $L_1 L_2 = \{aac, aad, bbc, bbd\}$

Kleene closure of alphabet Σ: (Kleene closure of Σ is denoted as Σ^*) -2m

$$\Sigma^* = \epsilon \cup \Sigma \cup \Sigma^2 \cup \Sigma^3 \cup \ldots \Sigma^i \cup \ldots$$
$$= \bigcup_{i \geq 0} \Sigma^i$$

Ex. $\Sigma = \{a\}$, $\Sigma^* = \{w \mid w$ is a string of a's$\}$

1. b

- $A = \{0, 1\}$ is an alphabet with symbols 0 and 1 1/2m

$A = \{0, 1\}$ is a language with strings 0, and 1 over an alphabet $\Sigma = \{0, 1\}$ 1/2m

- $B = \{0, 11\}$ is a language over $\Sigma = \{0, 1\}$ 1

2. a.

DFSM $M = (Q, \Sigma, \delta, s, F)$

where Q = finite set of states — 2M

Σ = alphabet

$\delta : Q \times \Sigma \rightarrow Q$

$s \in Q$ s: start state

$F \subseteq Q$. F = set of final states

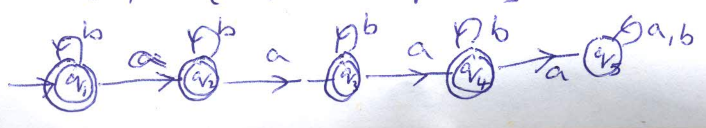
Extended δ ($\hat{\delta}$)

$$\boxed{\begin{aligned} &\hat{\delta}(q, \epsilon) = q \\ &\hat{\delta}(q, wa) = \delta(\hat{\delta}(q, w), a) \text{ for } a \in \Sigma \end{aligned}}$$ — 1m

- M accepts w if $\hat{\delta}(s, w) \in F$ — 1m

- $L(M) = \{w \mid M \text{ accepts } w\}$ — 1m

2. b



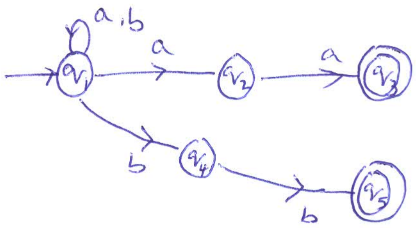
Start state 1
Final states 2
Error state 1

Tr diagram: 1

2a) DFSM $M = (\{q_1, q_2, q_3, q_4, q_5\}, \{a, b\}, \delta_M, q_1, \{q_1, q_2, q_3, q_4\})$ ✓ -1m

where δ is as given in transition diagram.

3a



3m

NFSM $M = (\{q_1, q_2, q_3, q_4, q_5\},$
$\{a, b\},$
$\delta_N,$
$q_1,$
$\{q_3, q_5\})$ 1m

δ_N is given by transition diagram.

δ_N	a	b
$\rightarrow q_1$	$\{q_1, q_2\}$	$\{q_1, q_4\}$
q_2	$\{q_3\}$	ϕ
q_3	ϕ	ϕ
q_4	ϕ	$\{q_5\}$
q_5	ϕ	ϕ

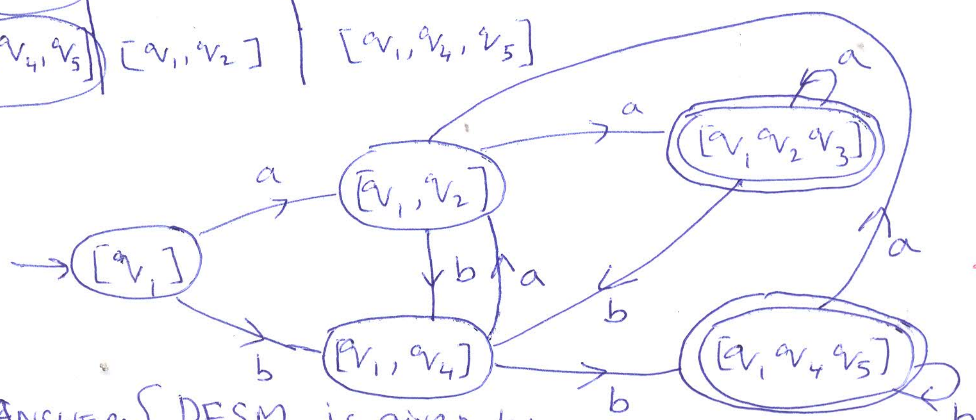
Table-1

3b CONVERSION NFSM M to DFSM N

Table-2

δ_D	a	b
$\rightarrow [q_1]$	$[q_1, q_2]$	$[q_1, q_4]$
$[q_1, q_2]$	$[q_1, q_2, q_3]$	$[q_1, q_4]$
$[q_1, q_4]$	$[q_1, q_2]$	$[q_1, q_4, q_5]$
$[q_1, q_2, q_3]$	$[q_1, q_2, q_3]$	$[q_1, q_4]$
$[q_1, q_4, q_5]$	$[q_1, q_2]$	$[q_1, q_4, q_5]$

3m



2m

ANSWER: { DFSM is given by the above transition diagram

DFSM $N = (\{[q_1], [q_1, q_2], [q_1, q_4], [q_1, q_2, q_3], [q_1, q_4, q_5]\},$ 1m
$\{a, b\},$
$\delta_D,$
$[q_1], \{[q_1, q_2, q_3], [q_1, q_4, q_5]\})$

where δ_D is as given in the transition table Table-2

4 (a)

Moore $M = (Q, \Sigma, O, S, D, s, F)$

where Q : finite set of states

Σ : input alphabet

O : output alphabet — 5m

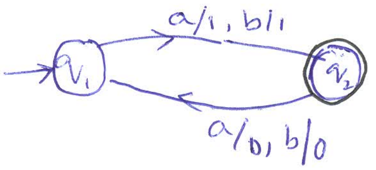
$\delta : Q \times \Sigma \to Q$

$S : D \to O^*$

$s \in Q$, s = start state

$F \subseteq Q$, F is set of final states

4(b)



— 5m

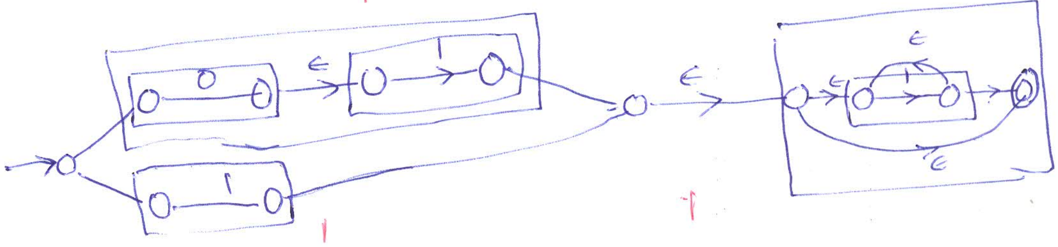
states – 3m

Transit – 2m

5(a) $(a+b)(a+b+9)(a+b+9)(a+b+9)$ — 06m

2m 4 terms: 2m, 2m

5(b)



6a DFSM $M = (Q, \Sigma, \delta, s, F)$ 03m

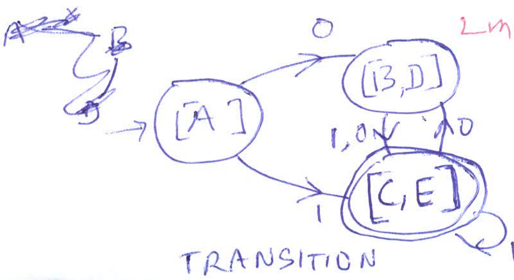
Equivalent states $q_1, q_2 \in Q$ are equivalent iff $\forall w \in \Sigma^*$, $\hat{\delta}(q_1, w)$ and $\hat{\delta}(q_2, w)$ are both in $Q - F$ or $\hat{\delta}(q_1, w)$ and $\hat{\delta}(q_2, w)$ are both in F.

6b MINIMIZATION OF DFSM

$\equiv^0$ [A, B, D], [C, E] 2m

$\equiv^1$ [A], [B, D], [C, E] 2m

$\equiv^2$ [A], [B, D], [C, E] 2m

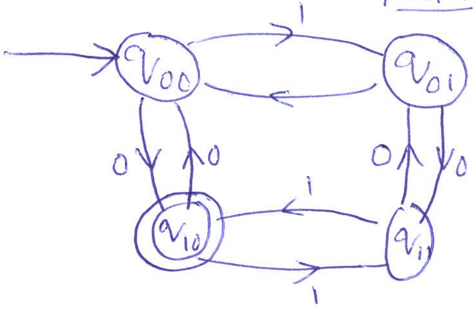


2m

TRANSITION DIAGRAM OF MINIMIZED DFSM

1 a) Construct DFSM for $L = \{w \in \{0,1\}^*;$ w has even no of 1's, and odd no of 0's $\}$

FIG-1



1m

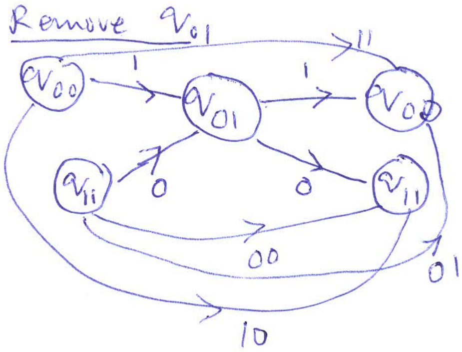
q_{00}: even no of 0's, even no of 1's

q_{01}: even no of 0's, odd no of 1's

q_{10}: odd no of 0's, even no of 1's

q_{11}: odd no of 0's, odd no of 1's

Remove q_{01}



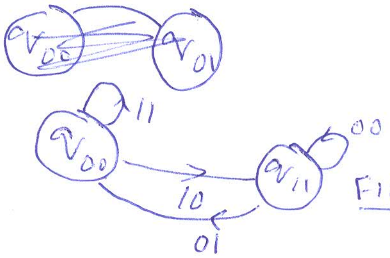


FIG-3 (after removing q_{01})

FIG-2 = After removing q_{01} from FIG 1 and adding FIG-3 transitions

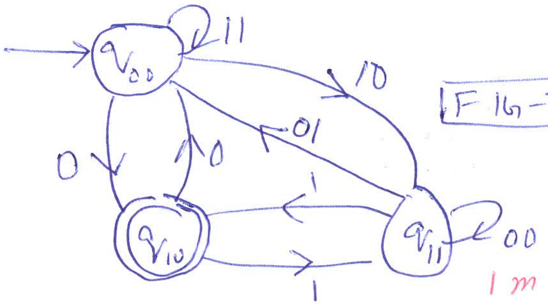
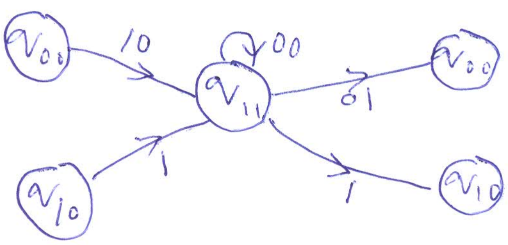


FIG-2

1m

Remove q_{11} from FIG-2



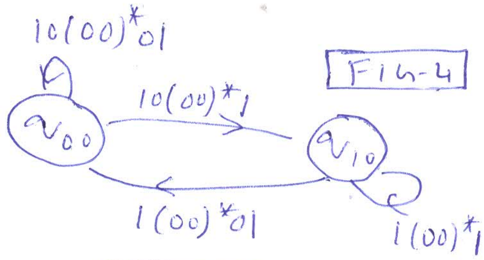


FIG-4

After dropping q_{11}

FIG-5 = After removing q_{11} from FIG-2 and Adding FIG-4 transitions

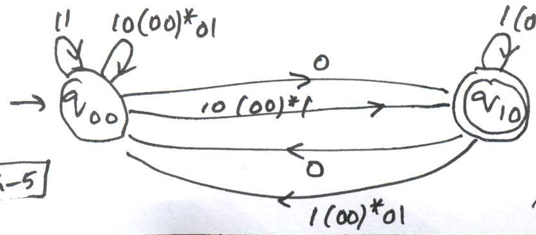
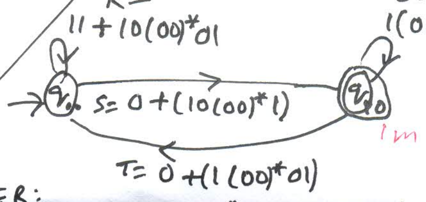


FIG-5

1m

FIG-6 Result of simplifying FIG-5



1m

ANSWER = $(R + SU^*T)^*SU^*$

ANSWER: $(11 + 10(00)^*01) + (0 + (10(00)^*1)(1(00)^*1)^*(0 + (1(00)^*01))^*$ $(0 + (10(00)^*1)(1(00)^*1)^*$

1m

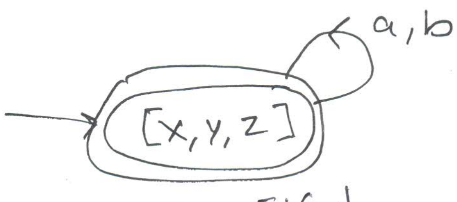
7.b

NFSM with δ:

δ	ϵ	a	b	ϵ-CLOSURE	
$\rightarrow$ X	{Z}	{Y}	{X,Z}	{X, Z, Y}	1m
Y	ϕ	{X}	ϕ	$\cancel{\phi}$ {Y}	1m
Z	{X,Y}	{Z}	{X}	{X, Y, Z}	1m

DFSM δ_D

	a	b	
[X, Y, Z]	[X,Y,Z]	[X,Y,Z]	1m



1m FIG-1

ANSWER: DFSM X = ({[X, Y, Z]}, {a, b}, δ, [X,Y,Z], {[X,Y,Z]})
where δ is as given in FIG-1