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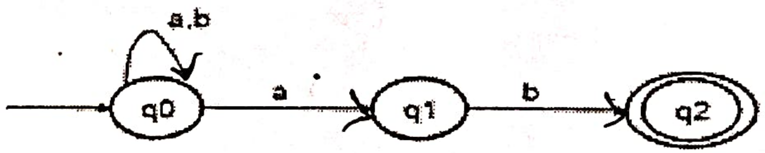
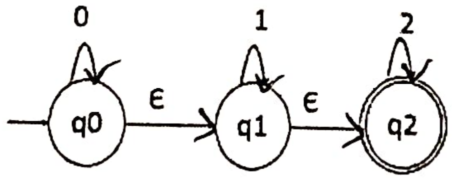
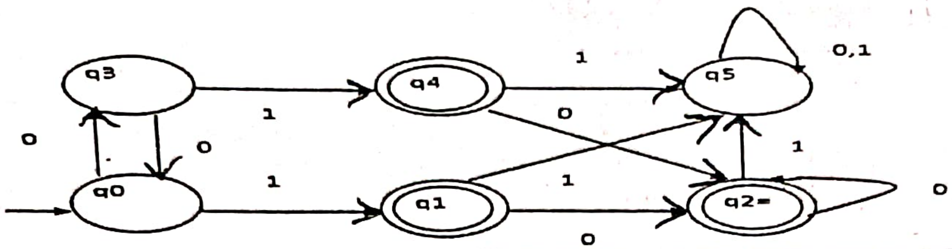
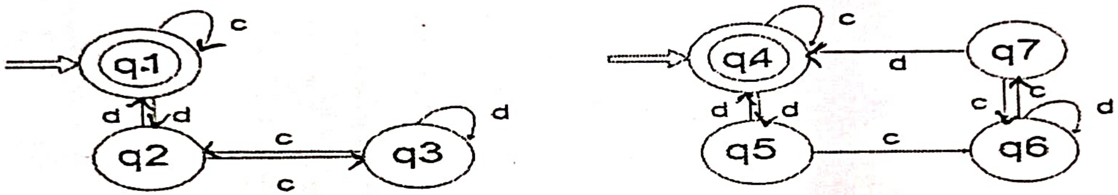
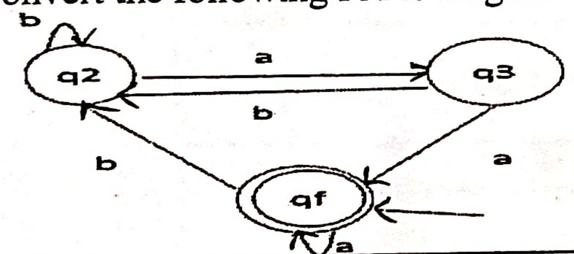
CMRIT
CMR INSTITUTE OF TECHNOLOGY, BENGALURU.
ACCREDITED WITH A+ GRADE BY NAAC

Internal Assessment Test 1 – Sept. 2025

Subject/Code: Theory of Computation/ BCS503				
Date: 29/09/2025	Duration: 90 mins	Max. Marks: 50	Semester: 05	Branch: AI&DS (CSDS)

Sl.	Answer any FIVE FULL Questions	Marks	CO	RBT
1	a. Construct DFA equivalent to the NFA given below: 	6	CO1	L3
	b. Define the following terms with examples: i) Alphabet ii) String iii) Language iv) Concatenation of Languages v) Power of an Alphabet	4	CO1	L1
2	a. Differentiate between DFA, NFA and NFA with epsilon.	4	CO1	L1
	b. i) Design DFA to accept binary numbers divisible by 5. ii) Construct deterministic finite automata to accept strings over $\Sigma = \{0,1\}$ that doesn't contain three consecutive zeros.	6	CO1	L3
3	a. Construct FA for the given Regular Expression $(a+b)^*(bb+a)(aa+bb)^*$.	5	CO2	L3
	b. Convert the following NFA-ε to NFA 	5	CO1	L3

4	a. Minimize the following DFA.  	6	CO2	L3
	b. Explain the applications of regular expressions with examples.	4	CO2	L2
5	a. Check the equality of the following FA's  	5	CO2	L3
	b. State and prove that regular languages are closed under union, intersection, and complement.	5	CO2	L2
6	Convert the following FA to Regular expression  	5	CO2	L3
	b. Design NFA to accept strings over $\Sigma = \{0,1\}$ that contain 1100 as substring.	5	CO1	L2

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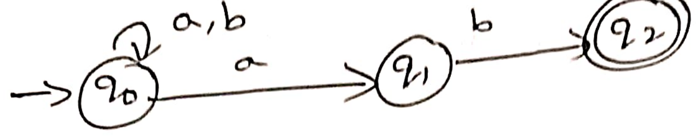
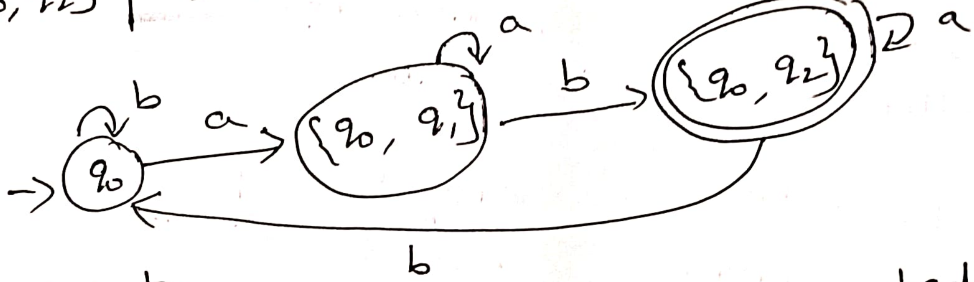
TOC- BCS503

IAT-1

1. a) NFA to DFA



$\delta \mid \Sigma$	a	b
$\rightarrow q_0$	$\{q_0, q_1\}$	q_0
$\{q_0, q_1\}$	$\{q_0, q_1\}$	$\{q_0, q_2\}$
$\{q_0, q_2\}$	$\{q_0, q_1\}$	$\{q_0\}$



1. b) **Alphabet:**

Is a finite set of symbols. Denoted by Σ

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

String: Sequence of symbols over an Σ.

Ex: $\Sigma = \{a,b\}$ then 'a', 'ab' are strings 'abba',

Language: set of strings over an Σ

$L = \{a, b, ab, ba, \ldots\}$ over $\Sigma = \{a,b\}$

concatenation

Let L_1 & L_2 are 2 Languages then

$L_1 \cdot L_2 = \{xy \mid x \in L_1 \text{ and } y \in L_2\}$

Power of an Alphabet

$\Sigma^0 = \{\epsilon\}$

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

$\Sigma^2 = \{10, 11, 01, 00\}$

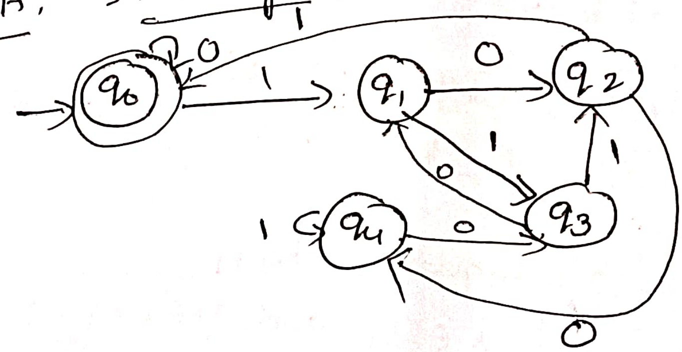
$\Sigma^* = \{\epsilon, 0, 1, 10, 11, 01, \ldots\}$

(2) a)

	DFA	N.FA	NFA-ε
(1)	For each state i/p symbol there is exactly one transition	For each state & i/p symbol there can be zero or many transitions	Same as NFA, & allows ε-transitions
(2)	ε-moves not allowed	ε-moves not allowed	ε-moves allowed.
(3)	Easier to simulate, harder to design	Easy to design & harder to simulate	Easy to design.
(4)	String Acceptence is at unique path	string accepted atleast one path	string accepted atleast one path.
(5)	$Q \times \Sigma \to Q$	$Q \times \Sigma \to 2^Q$	$Q \times \Sigma \cup \{\epsilon\} \to 2^Q$

(2) (b) DFA, Divisibly by 5.

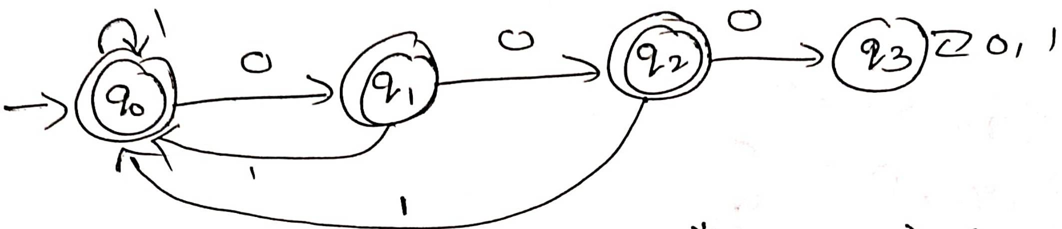
(i)



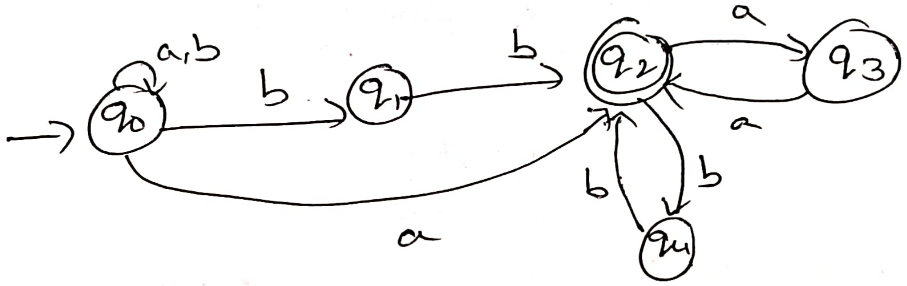
0000 - q0
0001 - q1
0010 - q2
0011 - q3
0100 - q4
0101 - q0
0110 - q1
0111 - q2
1000 - q3
1001 - q4
1010 - q0
1011 - q1
1100 - q2

(2) b) (ii) contains '000' as substring

does not contains '000' as substring.



(3) a) FA from R.E = $(a+b)^*(bb+a)(aa+bb)^*$



(3) (b) NFA-ϵ to NFA

ϵ-clos (q_0) = $\{q_0, q_1, q_2\}$

ϵ-clos (q_1) = $\{q_1, q_2\}$

ϵ-clos (q_2) = $\{q_2\}$

$\hat{\delta}(q_0, 0)$ = ϵ-clos$(\delta(\hat{\delta}(q_0, \epsilon), 0))$

= ϵ-clos$(\delta(\{q_0, q_1, q_2\}, 0))$

= ϵ-clos (q_0) = $\{q_0, q_1, q_2\}$

$\hat{\delta}(q_0, 1)$ = $\{q_1, q_2\}$

$\hat{\delta}(q_0, 2)$ = $\{q_2\}$

$\hat{\delta}(q_1, 0) = \text{E-cl}(\delta(\hat{\delta}(q_1, \epsilon), 0))$

$= \text{E-cl}(\delta(\{q_1, q_2\}, 0))$

$= \phi$

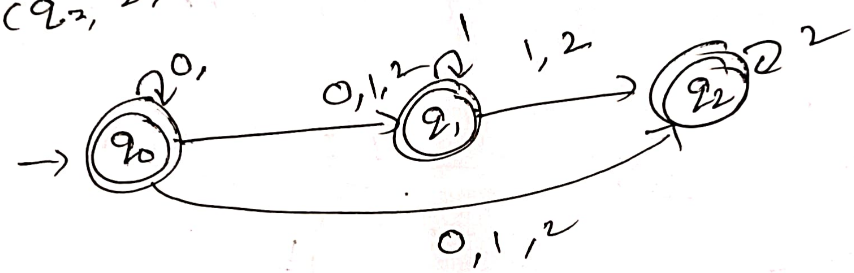
$\hat{\delta}(q_1, 1) = \{q_1, q_2\}$

$\hat{\delta}(q_1, 2) = \{q_2\}$

$\hat{\delta}(q_2, 0) = \phi$

$\hat{\delta}(q_2, 1) = \phi$

$\hat{\delta}(q_2, 2) = q_2.$



(4) (a) Minimize DFA

	q_0	$*q_1$	$*q_2$	q_3	$*q_4$	q_5
q_0	×					
$*q_1$	✓	×				
$*q_2$	✓		×			
q_3	·	✓	✓	×		
$*q_4$	✓			✓	×	
q_5	✓	✓	✓	✓	✓	×

(q_2, q_1)

$\delta(q_2, 0) = q_2 \qquad \delta(q_2, 1) = q_5$

$\delta(q_1, 0) = q_2 \qquad \delta(q_1, 1) = q_5$

(q_3, q_0)

$\delta(q_3, 0) = q_0 \qquad \delta(q_3, 1) = q_4$

$\delta(q_0, 0) = q_3 \qquad \delta(q_0, 1) = q_1$

(q_5, q_0)

$\delta(q_5, 0) = q_5 \qquad \left.\begin{array}{l}\delta(q_5, 1) = q_5 \\ \delta(q_0, 1) = q_1\end{array}\right\} \rightarrow \text{Mark.}$

$\delta(q_0, 0) = q_3$

(q_4, q_1)

$\delta(q_4, 0) = q_2 \qquad \delta(q_4, 1) = q_5$

$\delta(q_1, 0) = q_2 \qquad \delta(q_1, 1) = q_5$

(q_4, q_2)

$\delta(q_4, 0) = q_2 \qquad \delta(q_4, 1) = q_5$

$\delta(q_2, 0) = q_2 \qquad \delta(q_2, 1) = q_5$

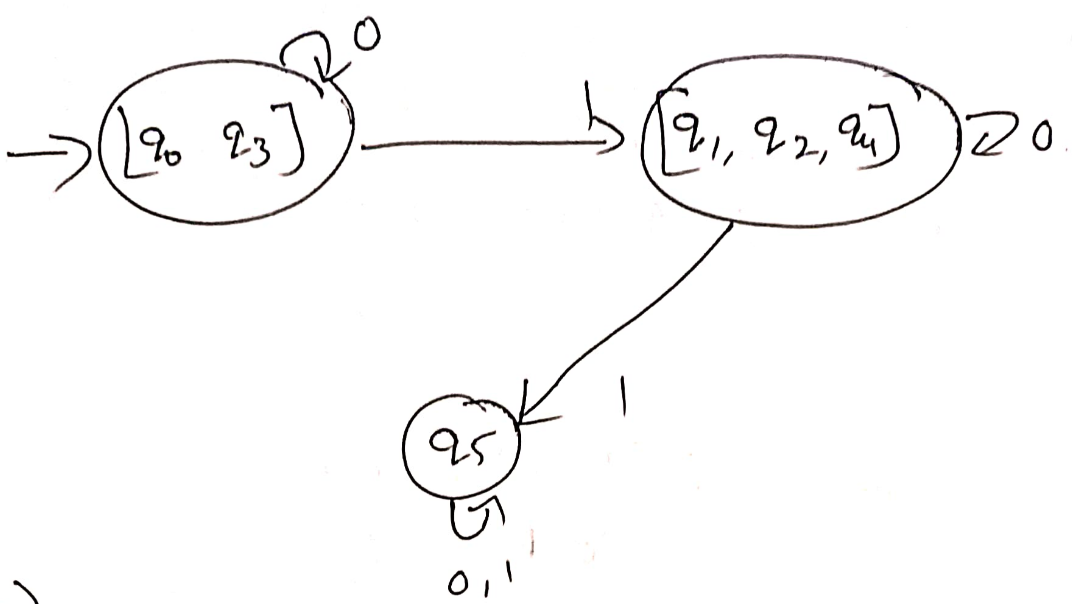
(q_5, q_3)

$\delta(q_5, 0) = q_5 \qquad \left.\begin{array}{l}\delta(q_5, 1) = q_5 \\ \delta(q_3, 1) = q_4\end{array}\right\} \text{Mark.}$

$\delta(q_3, 0) = q_0$

(q_5, q_4)

$\delta \backslash \Sigma$	0	1
$\rightarrow [q_0, q_3]$	$[q_0, q_3]$	$[q_1, q_2, q_4]$
$[q_1, q_2, q_4]$	$[q_1, q_2, q_4]$	q_5
q_3	$[q_0, q_3]$	$[q_1, q_2, q_4]$
q_5	q_5	q_5



4 b) **Applications of R.E :**

1. Regular expression in unix
2. Lexical Analysis
3. Finding pattern in Text

5 a). **check equality**

(v, v')	(v_c, v_c')	(v_d, v_d')
(q_1, q_4)	(q_1, q_4)	(q_2, q_5)
(q_2, q_5)	(q_3, q_6)	(q_1, q_4)
(q_3, q_6)	(q_2, q_7)	(q_3, q_6)
(q_2, q_7)	(q_3, q_6)	(q_1, q_4)

Both are equivalent.

5 b)

Closure under union

Let L & M are regular then we have

R.E $L = L(R)$ & $M = L(S)$

Then $L \cup M = L(R \cup S) = L(R+S)$ is a R.L

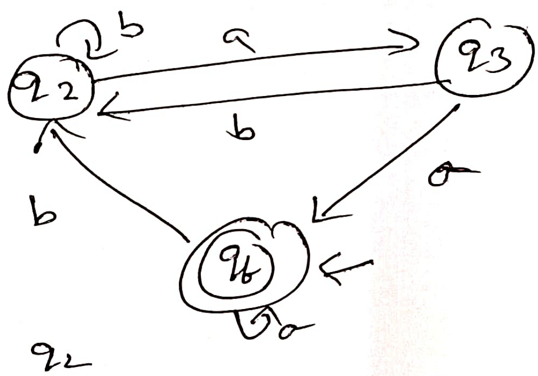
Closure under Complement:

If L is regular then $\bar{L} = \Sigma^* - L$ is also regular

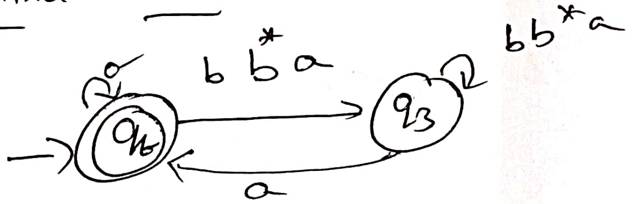
Closure under Intersection:

If L & M are RL, then $L \cap M$ is also R.L

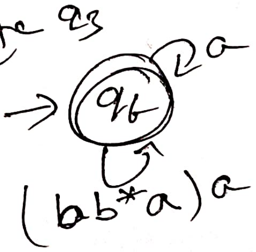
(6) a) FA to R.E



Eliminate q2



Eliminate q3



$= ((bab^*a)^*a)^* + a)^*$

6(b).