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Final Assignment

Course Code : CSE-3227

Course Title : Theory Of Computation

DEPARTMENT OF CSE LU 50th BATCH

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SUBMITTED TO:

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Ans to the question no: 1 (a)

Theory of Computation:

The theory of computation is the branch that deals with what Problems Can be Solved on a model of Computation, using an algorithm, how efficiently they can be solved or to what degree (e.g., approximate solutions versus precise ones).

Branches of Theory of Computation:

The field is divided into three major branches:

i) Automata Theory

ii) Computability theory

iii) Computational Complexity theory

Ans to the question no: 1 (b)

Set: A set is a group of objects represented as a unit. {7, 21, 57}

Sequence: A sequence is a list objects in some order. Ascending, descending order etc. {3, 12, 15}

Tuples: Finite Sequences are called tuples. A sequence with K elements is called K-tuple. {7, 5, 19} is a 3 tuple. {7, 21} is 2 tuple, called pair

Proof: A Proof is convincing logical argument that a statement is true.

Theorem: Theorem is mathmatical statement Proved true.

Discuss 3 methods of Proof:

i) Proof by Construction

ii) Proof by Contradiction

iii) Proof by Induction

i) proof by Construction:

Many theorems state that a particular type of object exists. One way to Prove such a theorem is by demonstrating how to construct the object. The technique is called proof by Construction.

Theorem: If a and b are consecutive integers, the sum of a+b must be an odd number.

Proof: we first assume that our theorem is true. we then can say that since a and b are consecutive integers, b is equal to a+1. In that case, a + b can rewritten as a + a + 1 or 2a + 1. Therefore we can say that a+b = 2k + 1. we Know that any number multiplied by an even number must be even. We also Know that if we add 1 to any even number must be even. We also Know that if we add 1 to any even number, it becomes odd. Given these, we can say: a+b = 2k + 1 shows that a+b is odd.

ii) Proof by Contradiction:

In one common form of argument for proving a theorem, we assume that the theorem is false and then show that this assumption leads to an obviously false consequences, called a contradiction.

Theorem: If n^2 is even, then n is even.

Proof: Lets assume that n^2 is even but n is odd. we're assuming that the theorem is false. As we showed in the previous section, an odd number can be characterised by $n = 2K + 1$

iii) Proof by Induction:

It is more advanced method of Proving things

This method is used to show that all elements in an infinite set have a certain Property

- $1 + 2 + 3 + ---- + n = n(n+1)/2$ --- (1)

- Step 1: For $n = 1$,

$L.H.S = n = 1$

$R.H.S = n(n+1)/2 = 1$

- Step 2: For $n = m$,

$1 + 2 + 3 + ---- + m = m(m+1)/2$ --- (2)

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Ans to the question no: 1 (c)

FSM: A finite State Machine is a model of Computation; a conceptual tool to design systems. It processes a sequence of inputs that changes the state of the System.

Symbol: Symbol is nothing but Character

Example: a, b, c, 0, 1, +, −, % ---- etc

String: A string is a finite set sequence of symbols chosen from some alphabets. (sequence of symbols)

Language: Finite set of non empty strings are called Language (set of strings)

Cardinality: It means number of elements in a set

DFA: DFA stands for Deterministic Finite Automata.

5 tuples from the given DFA:

$Q = S_0, S_1, S_2$

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

$q_0 = S_0$

$F = S_0$

$\delta = Q \times \Sigma \rightarrow Q$

Ans to the Question no: 1 (d)

Regular language: Every finite set represents a regular language.

Example: All strings of length = 2 over $\{a, b\}^*$ i.e. $L = \{aa, ab, ba, bb\}$ is regular.

- Memory of finite state machines is very limited
- It can not store or count strings.

Not Regular language: So the languages which are not recognized by the finite state machines are called not regular languages. Those languages also required memory

Example : $a^n b^n$

Ans to the question no: 2 (a)

strings containing 0 0 1 (DFA)

Solution :

$L1 = \{001, 0011, 1001, 110011, ----\}$

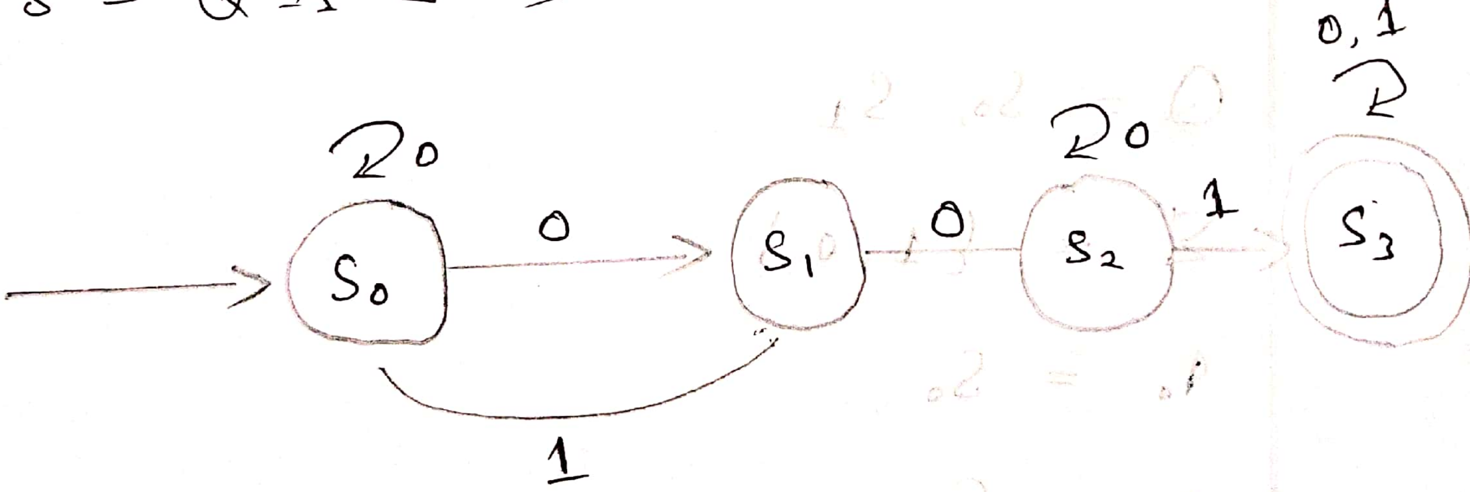
$Q = S_0, S_1, S_2, S_3$

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

$q_0 = A$;

$F = D$;

$\delta = Q \times \Sigma \rightarrow Q$;



States / Inputs	0	1
S_0	S_1	S_0
S_1	S_2	S_0
S_2	S_2	S_3
S_3	S_3	S_3

Ans to the question no: 2 (b)

Strings contains at least one 1 (DFA)

Solution:

$L_2 = \{1,\ 01,\ 100,\ 010,\ 00011 \text{----}\}$

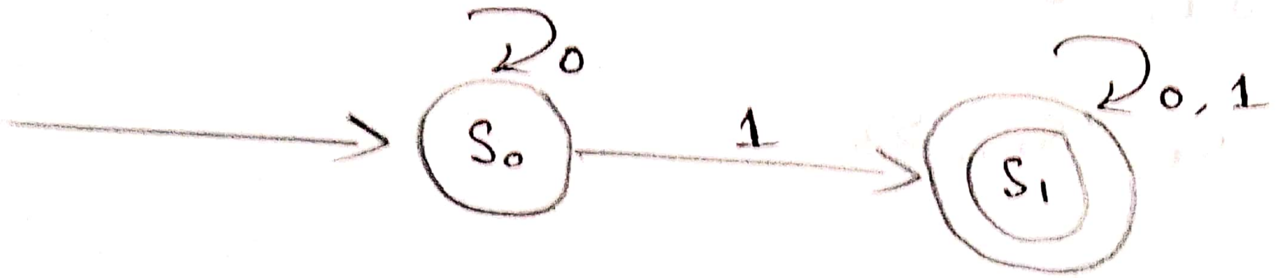
$Q = S_0, S_1$

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

$q_0 = S_0$

$F = S_1$

$\delta = Q \times \Sigma \rightarrow Q;$



States / Inputs	0	1
S_0	S_0	S_1
S_1	S_1	S_1

Ans to the question no : 2 (c)

Set of all strings contains 001 (NFA)

Solution:

$L3 = \{001, 0001, 1001, 01001 \ldots\}$

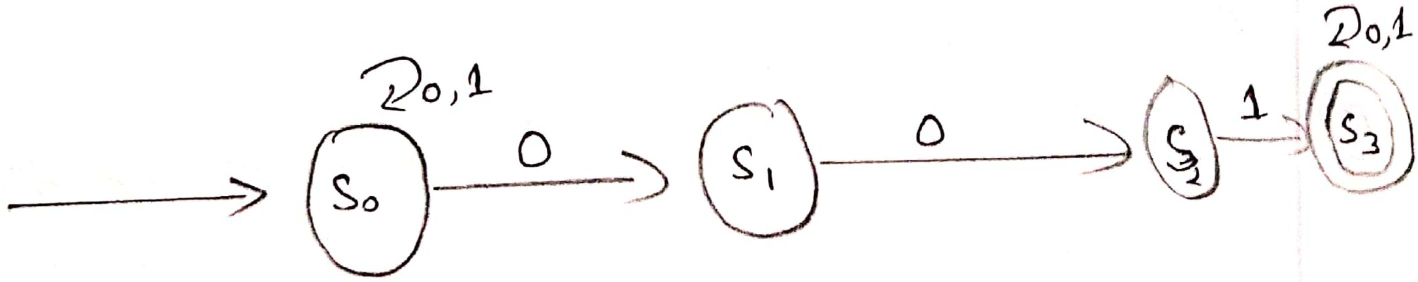
$Q = S_0, S_1, S_2, S_3$

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

$q_0 = S_0$

$F = S_3$

$\delta = Q \times \Sigma \rightarrow 2^Q$



States / Input	0	1
S_0	S_0, S_1	S_0
S_1	S_2	ε
S_2	ε	S_3
S_3	S_3	S_3

Ans to the question no: 2 (d)

Set of all strings over {0, 1} length 2,

Solution:

$L_4 = \{00, 01, 10, 11\}$

$Q = \{S_0, S_1, S_2\};$

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

$q_0 = S_0$

$F = S_2$

$\delta = Q \times \Sigma = 2^Q$

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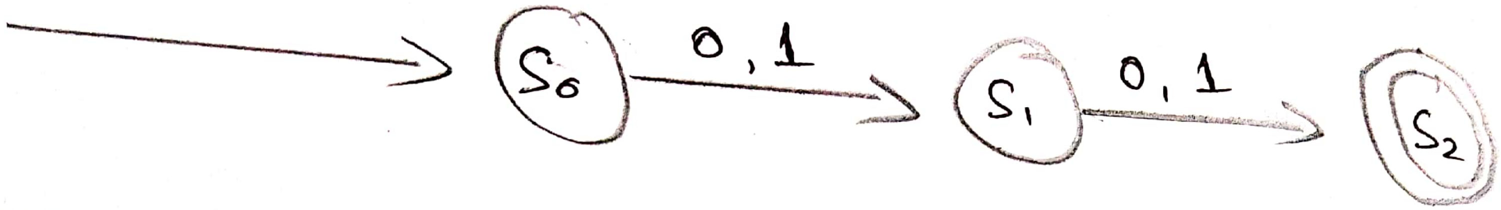


States / Input	0	1
S_0	S_1	S_1
S_1	S_2	S_2
S_2	ε	ε

Ans to the question no : 3 (a)

Set of all strings over {0, 1} that ends with 0

Ans: (NFA)

$L = \{10, 0, 000, 010, 001010, \ldots\}$

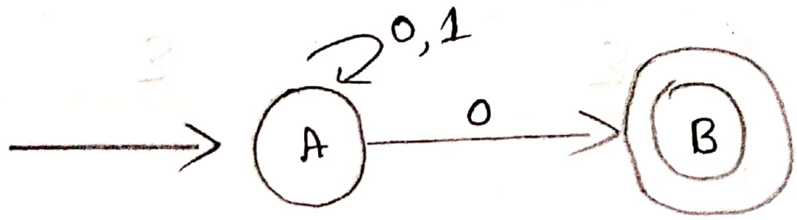
$Q = \{A, B\}$

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

$q_0 = A$

$F = B$

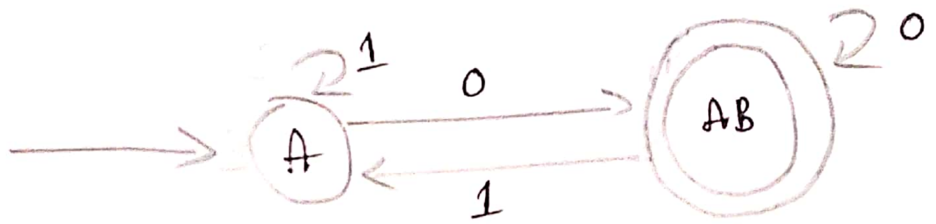
$\delta = Q \times \Sigma = 2^Q$



Input	0	1
A	A, B	A
B	ε	ε

Converted DFA table and diagram are:

Input / states	0	1
A	AB	A
AB	AB	A



Here,

$L = \{00, 0, 10, 1010, 010, 101110 \ldots\}$

$Q = \{A, AB\}$

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

$q_0 = A$

$F = AB$

$\delta = Q \times \Sigma \rightarrow Q$

Ans to the Question no : 3 (b)

From the diagram NFA table is :

Input / states	a	b
q_0	q_2, q_1	q_0, q_1
q_1	q_1	ε
q_2	ε	ε

The Converted DFA table is :

States / Input	a	b
q_0	$q_1 q_2$	$q_0 q_1$
$q_1 q_2$	q_1	D
$q_0 q_1$	$q_1 q_2$	$q_0 q_1$
q_1	q_1	D
D	D	D

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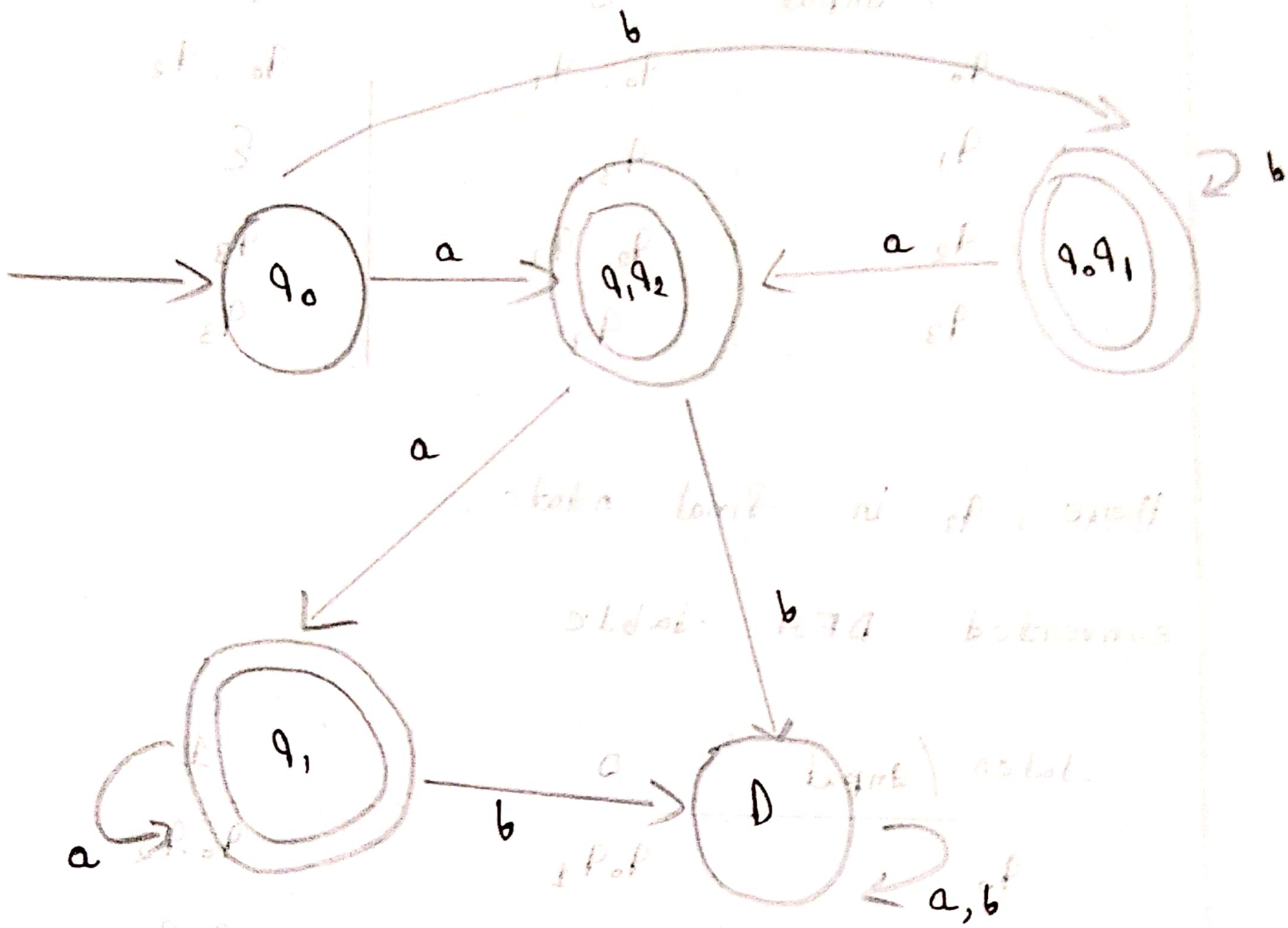


Here,

D is dead state

$q_1 q_2$, q_1 and $q_0 q_1$ are final state

q_0 initial state

Ans to the question no: 3 (c)

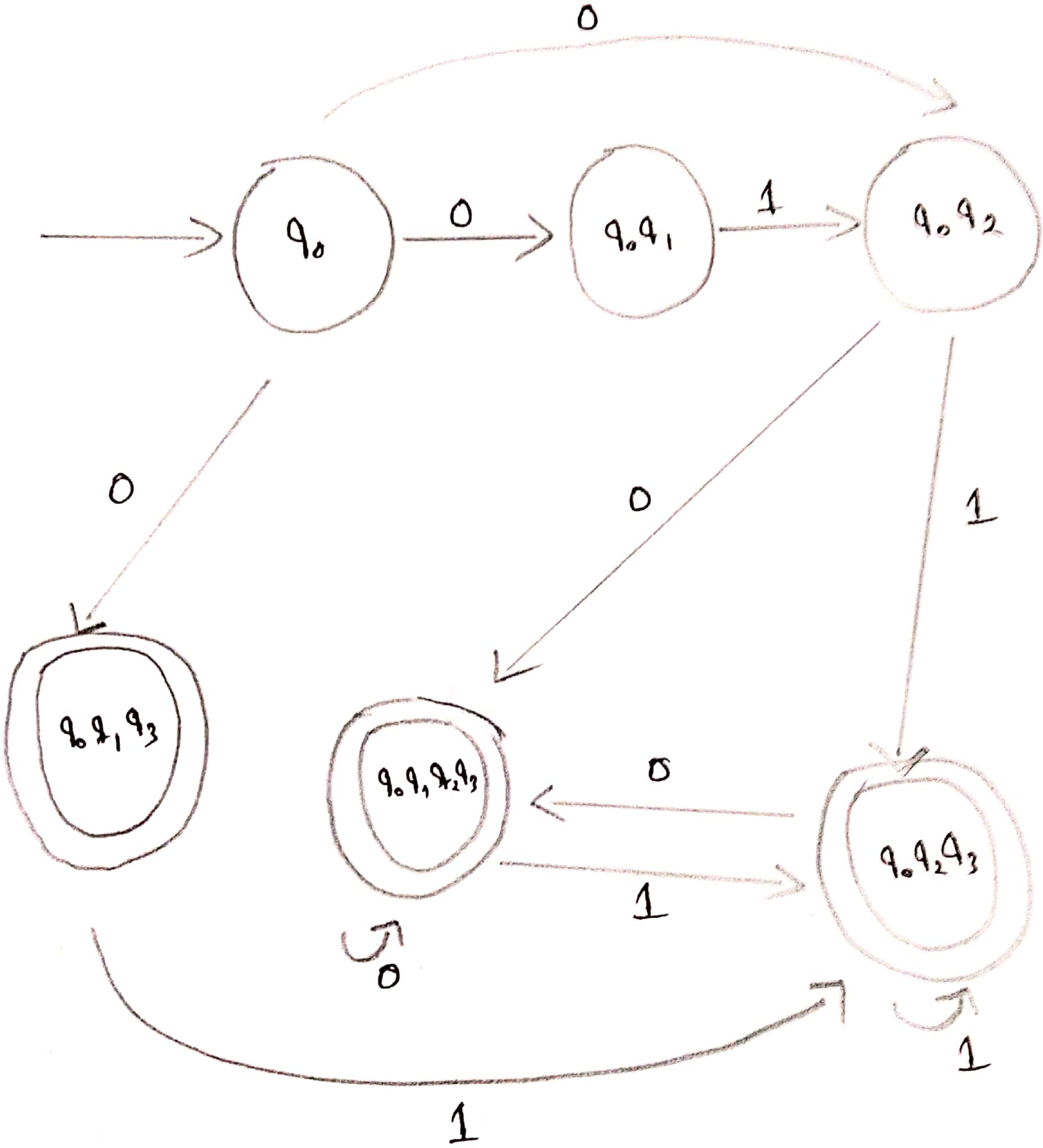
given NFA table

States / Input	0	1
q_0	q_0, q_1	q_0, q_2
q_1	q_3	ε
q_2	q_2, q_3	q_3
q_3	q_3	q_3

Here, q_3 is final state,

converted DFA table

States / Input	0	1
q_0	$q_0 q_1$	$q_0 q_2$
$q_0 q_1$	$q_0 q_1 q_3$	$q_0 q_2$
$q_0 q_2$	$q_0 q_1 q_2 q_3$	$q_0 q_2 q_3$
$q_0 q_1 q_3$	$q_0 q_1 q_3$	$q_0 q_2 q_3$
$q_0 q_1 q_2 q_3$	$q_0 q_1 q_2 q_3$	$q_0 q_2 q_3$
$q_0 q_2 q_3$	$q_0 q_1 q_2 q_3$	$q_0 q_2 q_3$



Here Final set of state $= \{q_0q_1q_3,\ q_0q_1q_2q_3,$
$q_0q_2q_3\}$

Initial state $= q_0$