جامـــــعة المـــــستـقبـل
AL MUSTAQBAL UNIVERSITY

قســـم الامـــــن الـــــــسيبرانـــــــي

DEPARTMENT OF CYBER SECURITY

SUBJECT: COMPUTATION THEORY
CLASS: 3rd

LECTURER: MSC :MUNTATHER AL-MUSSAWEE

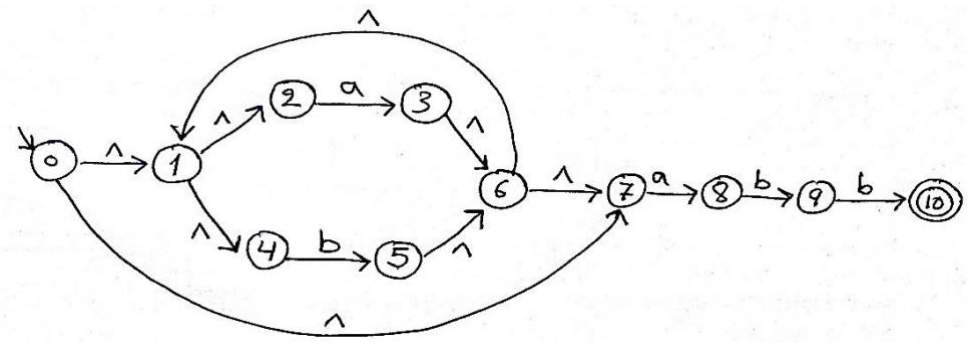
LECTURE: (4)

EQUIVALENCE OF NFA AND DFA

Convert Nondeterministic Finite Automaton(NFA)

to Deterministic Finite Automaton(DFA)

Example: Convert the following NFA to its equivalent DFA:



A= {0, 1, 2, 4, 7}

T(A, a) = {1, 2, 3, 4, 6, 7, 8} = B

T(A, b)= {1, 2, 4, 5, 6, 7} = C

T(B, a) = {1, 2, 3, 4, 6, 7, 8} = B

T(B, b) = {1, 2, 4, 5, 6, 7, 9} = D

T(C, a) = {1, 2, 3, 4, 6, 7, 8} = B

T(C, b) = {1, 2, 4, 5, 6, 7} = C

T(D, a) = {1, 2, 3, 4, 6, 7, 8} = B

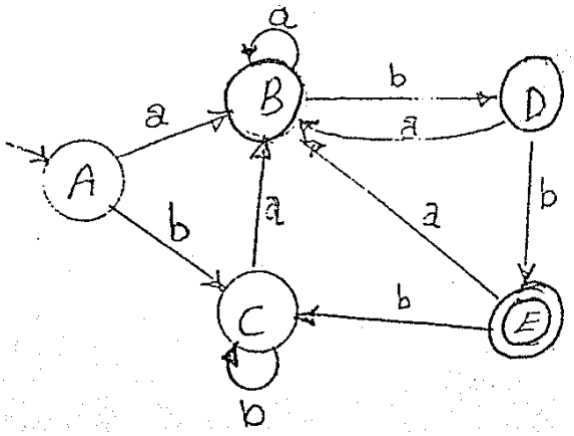
T(D, b) = {1, 2, 4, 5, 6, 7, 10} = (**E**)

T(E, a) = {1, 2, 3, 4, 6, 7, 8} = B

T(E, b) = {1, 2, 4, 5, 6, 7} = C

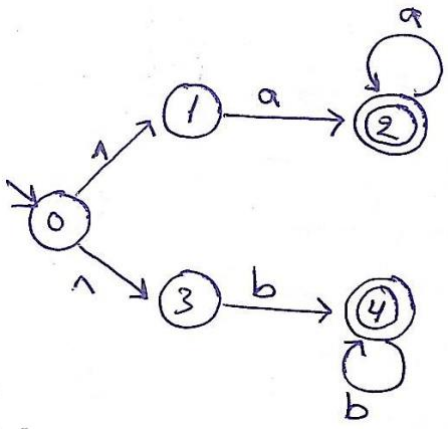
Transition Table

	a	B
A	B	C
B	B	D
C	B	C
D	B	E
E	B	C



DFA Transition Graph

Homework: Convert the following NFA to its equivalent DFA:



Finite State Machines with Output (Moore and Mealy Machines)

Moore Machines

A Moore machine is a collection of five things:

- A finite set of states q0, q1, q2, … where q0 is designated as the start state.
- An alphabet of letters for forming the input string

$$\sum = \{a, b, c, ...\}.$$

- An alphabet of possible output characters

$$\Gamma = \{x, y, z, ...\}.$$

- A transition table that shows for *each* state and *each* input letter what state is reached next.
- An output table that shows what character from Γ is printed by each state that is entered.

A Moore machine is very similar to a Finite Automaton (FA), with a few key differences:

- It has no final states.
- It does not accept or reject input, instead, it generates output from input.
- Moore machines cannot have nondeterministic states.

Example:

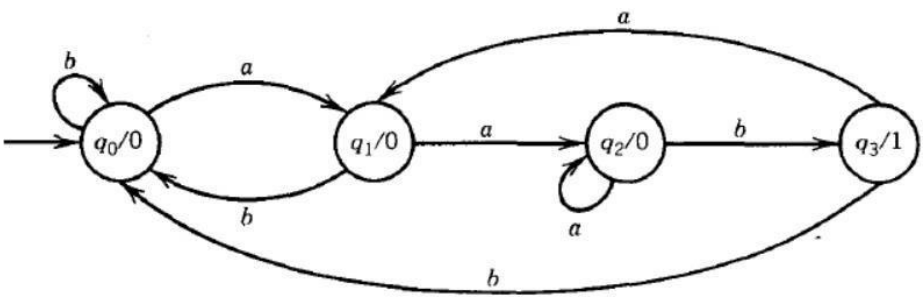
Input alphabet: $\sum = \{a, b\}$

Output alphabet: $\Gamma = \{0, 1\}$

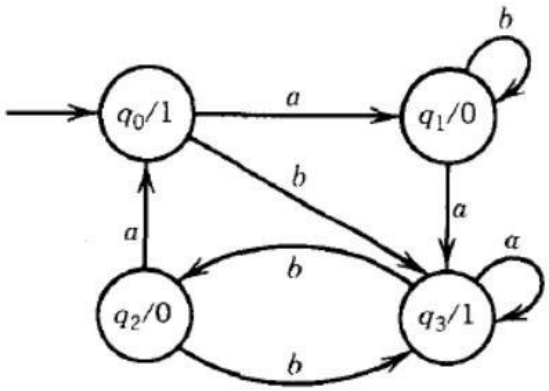
Names of states: q0, q1, q2, q3, (q0 = start state)

Input string: aaababbaabb

Input string		a	a	a	b	a	b	b	a	a	b	b
State	q0	q1	q2	q2	q3	q1	q0	q0	q1	q2	q3	q0
Output	0	0	0	0	1	0	0	0	0	0	1	0



Homework: Trace the operation of the following machine on the input string *abab.*



Mealy Machine

A Mealy machine is a collection of four things:

- A finite set of states q0, q1, q2, … where q0 is designated as the start state.
- An alphabet of letters for forming the input string

$$\sum = \{a, b, c, ...\}$$

- An alphabet of possible output characters

$$\Gamma = \{x, y, z, ...\}$$

- A pictorial representation with states represented by small circles and directed edges indicating transitions between states. Each edge is labeled with a compound symbol of the form ***i/o*** where ***i*** is an input letter and ***o*** is an output character. Every state must have exactly one outgoing edge for each possible input letter. The edge we travel is determined by the input letter ***i***; while traveling on the edge we must print the output character ***o***.

✍ Notice that in a Mealy machine the output string has the same number of characters as the input string has letters.

Example:

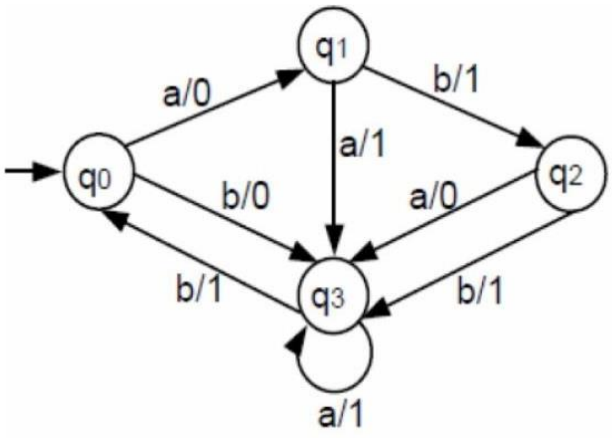
Input alphabet: ∑ = {a, b}

Output alphabet: Γ = {0, 1}

Names of states: q0, q1, q2, q3, (q0 = start state)

Input string: aaabb

Input string	a	a	a	b	b
Output	0	1	1	1	0



Homework: Trace the operation of the following machine on the input string *ababbbaba.*