DIGITAL DESIGN AND COMPUTER ORGANIZATION

Mealy and Moore Models of FSMs

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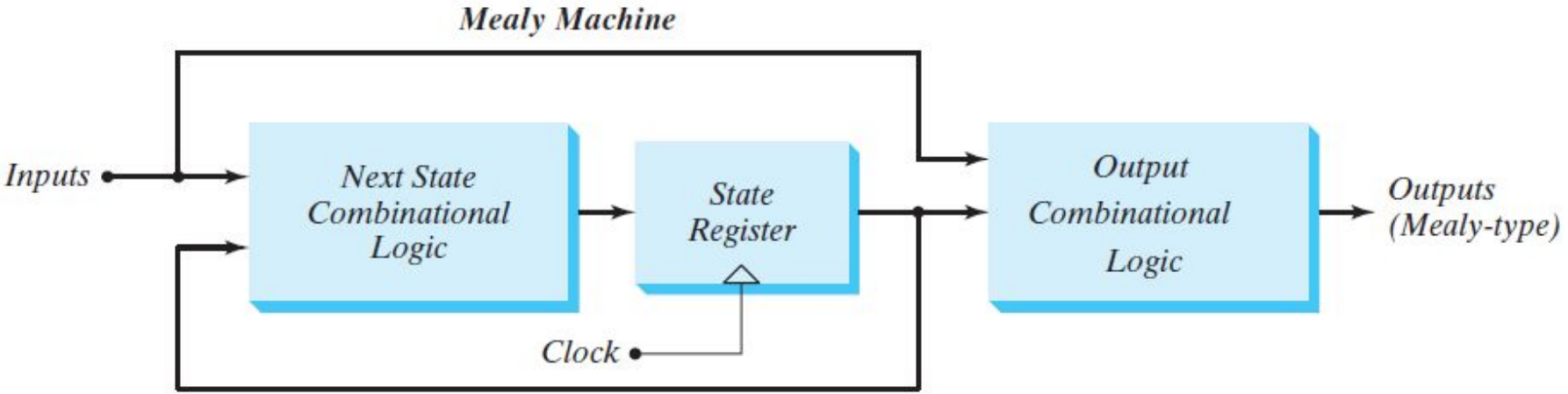
Department of Computer Science and Engineering

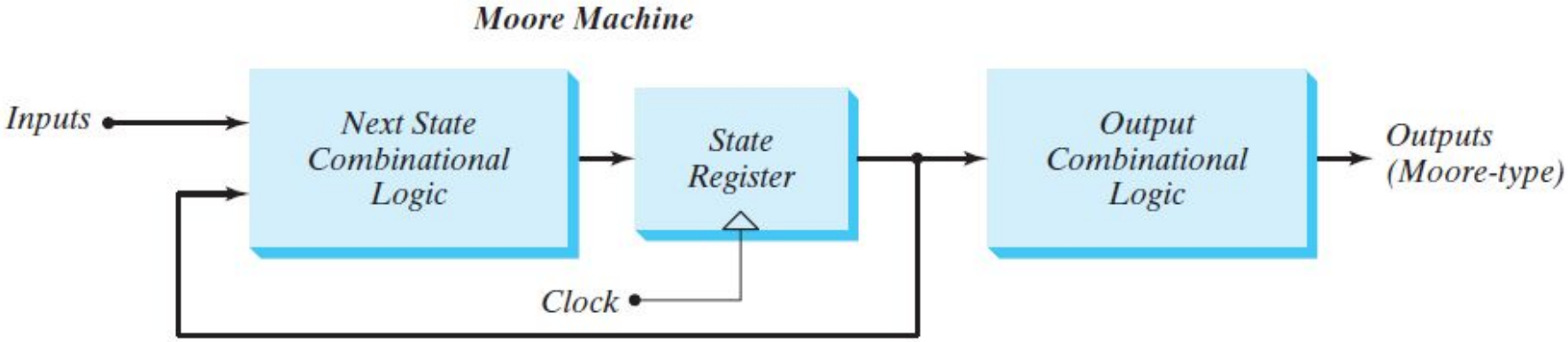
Introduction(T1-section 5.5)

- The most general model of a sequential circuit has inputs, outputs, and internal states.
- It is customary to distinguish between two models of sequential circuits: the Mealy model and the Moore model.
- They differ only in the way the output is generated.

Block Diagrams



Block Diagrams

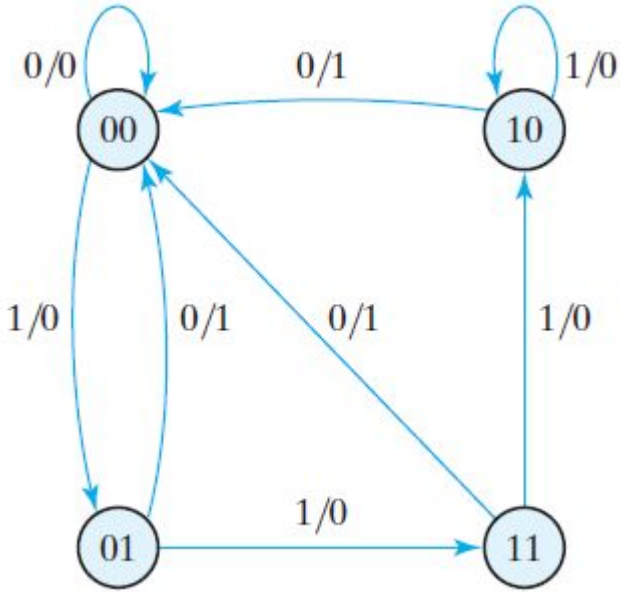


Introduction

- In the Mealy model, the output is a function of both the present state and the input.
- In the Moore model, the output is a function of only the present state.
- A circuit may have both types of outputs.
- The two models of a sequential circuit are commonly referred to as a **finite state machine,** abbreviated FSM.
- The Mealy model of a sequential circuit is referred to as a Mealy FSM or Mealy machine.
- The Moore model is referred to as a Moore FSM or Moore machine.

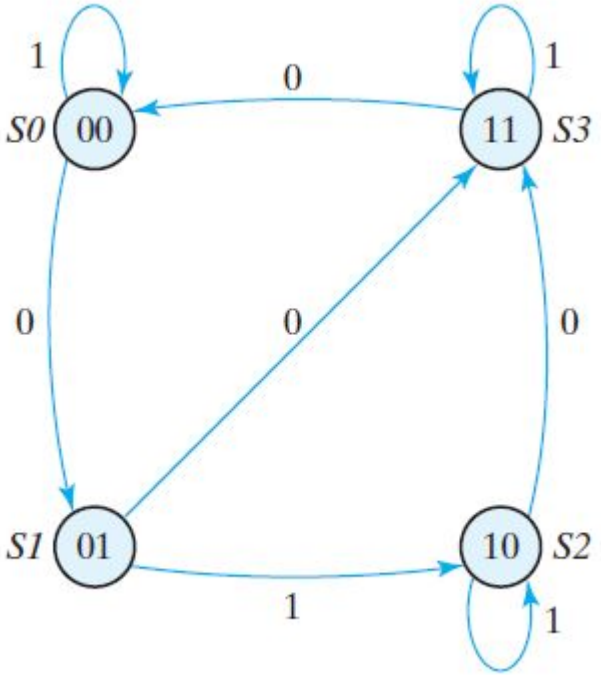
Mealy Machine

- Output y is a function of both input x and the present state of A and B .
- The corresponding state diagram shows both the input and output values, separated by a slash along the directed lines between the states.



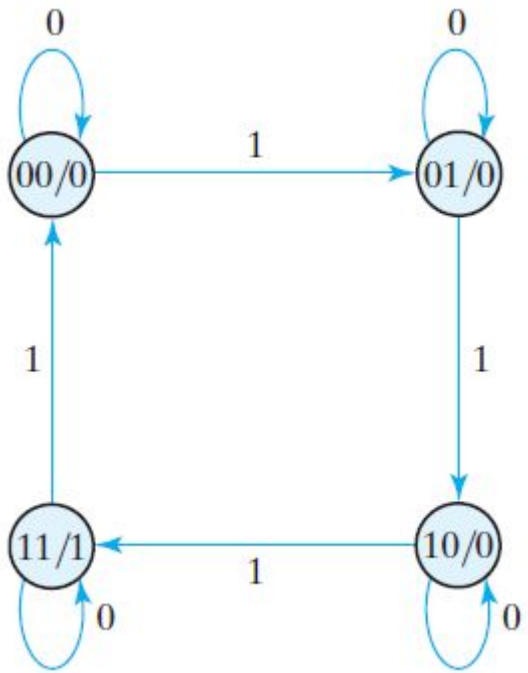
Moore Machine

- Here, the output is a function of the present state only.
- The corresponding state diagram has only inputs marked along the directed lines.
- The outputs are the flip-flop states marked inside the circles.



Moore Machine

- The output depends only on flip-flop values, and that makes it a function of the present state only.
- The input value in the state diagram is labeled along the directed line, but the output value is indicated inside the circle together with the present state.



Points to Remember

- **In a Moore model, the outputs of the sequential circuit are synchronized with the clock, because they depend only on flip-flop outputs that are synchronized with the clock.** In a Mealy model, the outputs may change if the inputs change during the clock cycle.
- In order to synchronize a Mealy-type circuit, the inputs of the sequential circuit must be synchronized with the clock and the outputs must be sampled immediately before the clock edge.
- The inputs are changed at the inactive edge of the clock to ensure that the inputs to the flip-flops stabilize before the active edge of the clock occurs.
- **Thus, the output of the Mealy machine is the value that is present immediately before the active edge of the clock.**

Applications

Mealy Model

Vending Machine with Coin Detection

- **How it works:** As soon as the correct coin is inserted (input) while the machine is in the “waiting” state, it immediately unlocks the product selection buttons (output).
- **Why Mealy:** Output depends on both **current state** (“waiting”) and **instant input** (coin detected) → faster interaction.

Applications

Moore Model

- **Example: Washing Machine Cycle**
- **How it works:** Once the washer enters the “spin” state, it spins for a fixed duration regardless of what buttons are pressed during that time.
- **Why Moore:** Output (motor spinning) depends only on **current state**, ensuring stability and avoiding mid-cycle changes

Moore:

- Needs separate states for “output=0” and “output=1.”
- More states.

- **Mealy:**
  - Can stay in one state and just make the output depend on x.
  - Fewer states.

MCQ

Consider a Mealy machine and a Moore machine implemented for the same problem. Which of the following is true?

A) Moore machine always has fewer states.

B) Mealy machine may have fewer states.

C) Both have the same number of states always.

D) Moore machine always produces output one clock earlier than Mealy.

MCQ

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B) Mealy machine may have fewer states.

C) Both have the same number of states always.

D) Moore machine always produces output one clock earlier than Mealy.

Answer: B — Mealy can have fewer states due to immediate output change.

MCQ

In a Mealy machine, the output depends on:
A) Present state only
B) Present state and next state
C) Present state and input
D) Input only

The main difference between a Moore and a Mealy machine is that:
A) Moore’s output depends only on input.
B) Mealy’s output depends only on state.
C) Moore’s output depends only on state, while Mealy’s output depends on state and input.
D) Mealy’s output is always faster than Moore’s output, regardless of design.

MCQ

In a Mealy machine, the output depends on:

A) Present state only

B) Present state and next state

C) Present state and input

D) Input only

Answer: C — Present state and input.

The main difference between a Moore and a Mealy machine is that:

A) Moore's output depends only on input.

B) Mealy's output depends only on state.

C) Moore's output depends only on state, while Mealy's output depends on state and input.

D) Mealy's output is always faster than Moore's output, regardless of design.

Answer: C — Moore → State only; Mealy → State + Input

THANK YOU

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