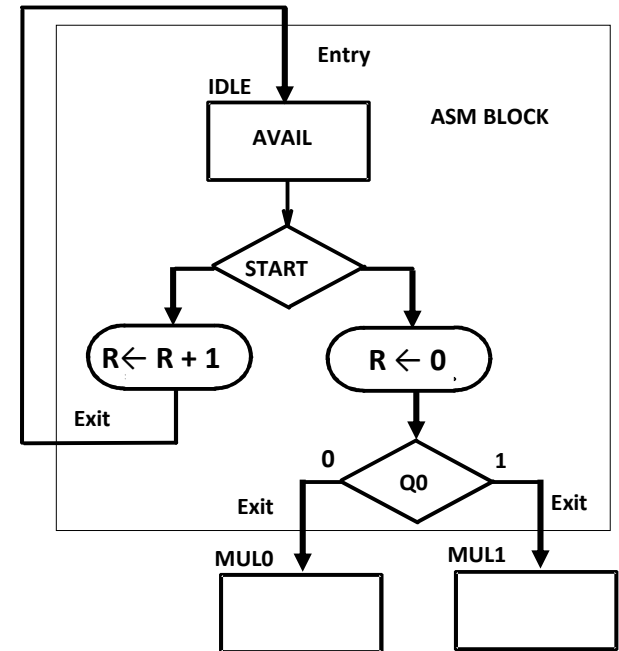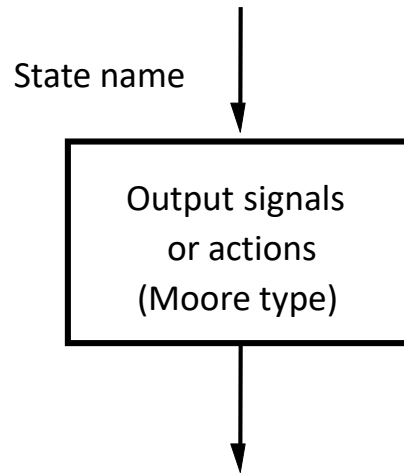# Algorithmic State Machine (ASM) Charts

Algorithmic State Machines
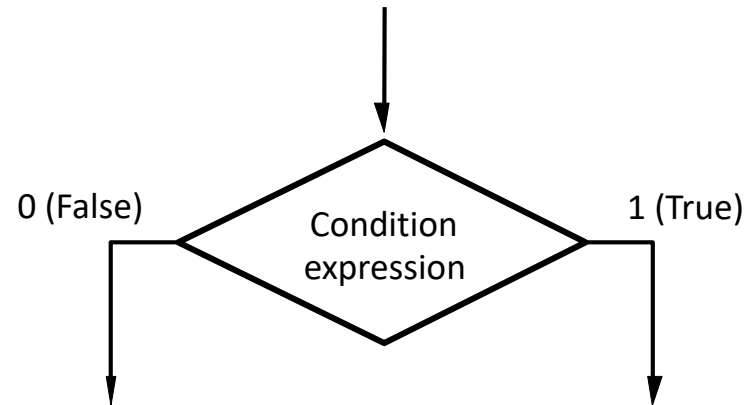
- A flowchart is a way of showing <u>actions</u> and <u>control flow</u> in an algorithm.

- An Algorithmic State Machine (<u>ASM</u>) is simply a flowchart-like way to specify <u>state diagrams for sequential logic</u>

- While flowcharts typically do not specify "time", an ASM explicitly specifies a <u>sequence of actions</u> and their <u>timing relationships</u>.
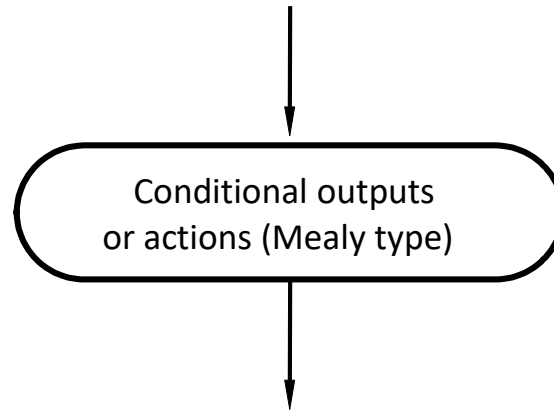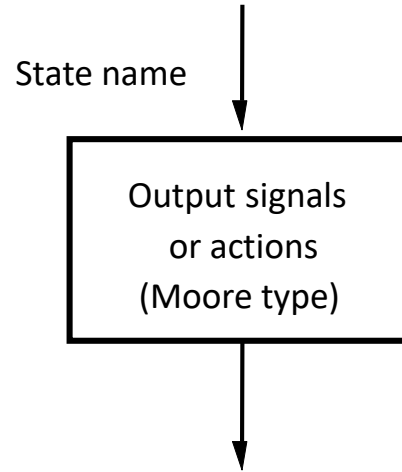
Elements used in ASM charts

State name

Output signals
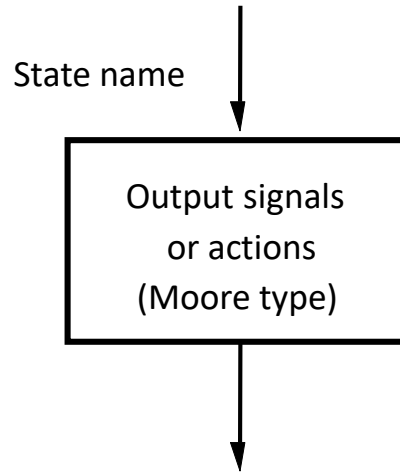or actions
(Moore type)

(a) State box

0 (False)   Condition
expression   1 (True)

(b) Decision box

Conditional outputs
or actions (Mealy type)

(c) Conditional output box

State Box

State name

Output signals
or actions
(Moore type)

State Box

State name

```
        |
        v
+-----------------+
|  Output signals |
|    or actions   |
|   (Moore type)  |
+-----------------+
        |
        v
```
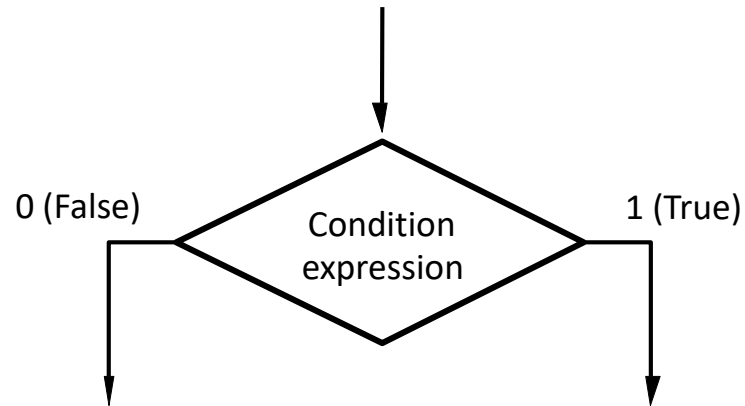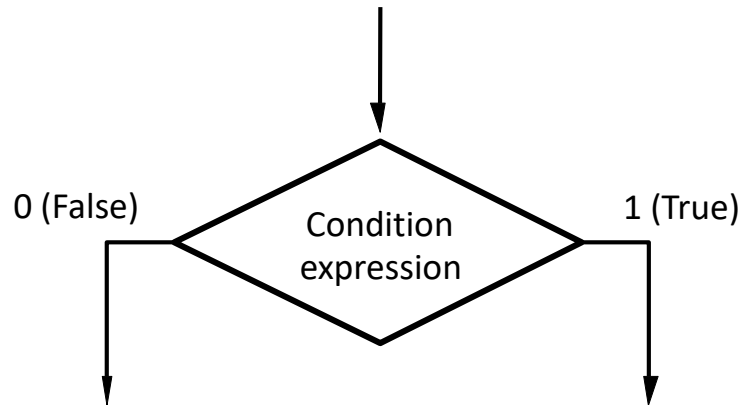
- **Indicated with a rectangle**
- **Equivalent to a node in the State diagram**
- **The name of the state is written outside the box**
- **Moore-type outputs are written inside the box**
- **Only the output that must be set to 1 is written (by default, if an output is not listed it is set to 0)**
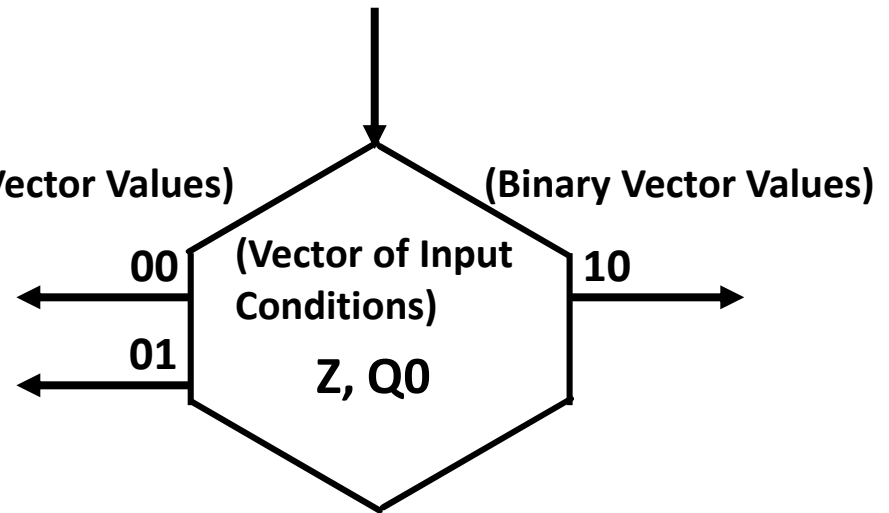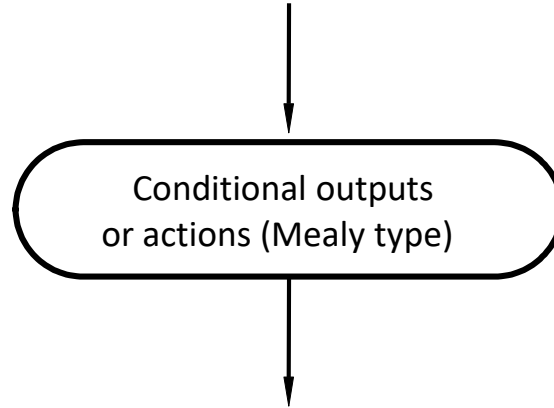
Decision Box

Decision Box

- **Indicated with a diamond shape**
- **Used for a condition expression that must be tested**
- **The exit path is chosen based on the outcome of the test**
- **The condition is on one or more inputs to the FSM**
- **Shortcut notation: w means "is w equal to 1?"**

Vector Decision Box

- A hexagon with:
  - One Input Path (entry point).
  - A vector of input conditions, placed in the center of the box, that is tested.
  - Up to 2^n output paths. The path taken has a binary vector value that matches the vector input condition

(Binary Vector Values) **(Binary Vector Values)**

00 **(Vector of Input Conditions)** **10**

01 **Z, Q0**

Conditional Output Box

```
        │
        ▼
   ╭──────────────────╮
   │ Conditional outputs │
   │ or actions (Mealy type) │
   ╰──────────────────╯
        │
        ▼
```

- **Indicated with an oval shape**
- **Used for a Mealy-type output signals**
- **The outputs depend on the state variables and inputs**
- **The condition that determines when such outputs are generated is placed in a separate decision box**
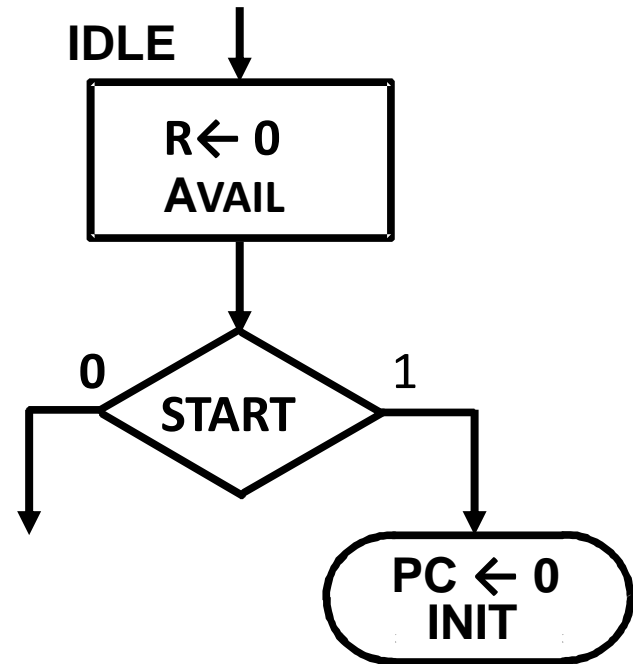
Conditional Output Box

- An oval with:
  - One input path from a decision box or decision boxes.
  - One output path
  - Register transfers or outputs that occur only if the conditional path to the box is taken.

- Transfers and outputs in a state box are <u>Moore type</u> - dependent only on state

- Transfers and outputs in a conditional output box are <u>Mealy type</u> - dependent on both state and inputs

From Decision Box(es)

↓

(Register transfers or outputs)
**R ← 0**
RUN

↓
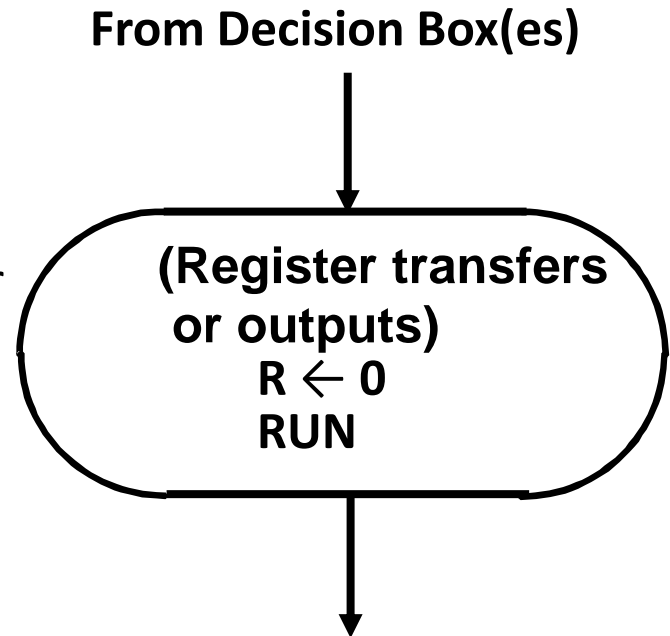
Connecting Boxes Together

- By connecting boxes together, we begin to see the power of expression.

- What are the:
  - Inputs?
  - Outputs?
  - Conditional Outputs?
  - Transfers?
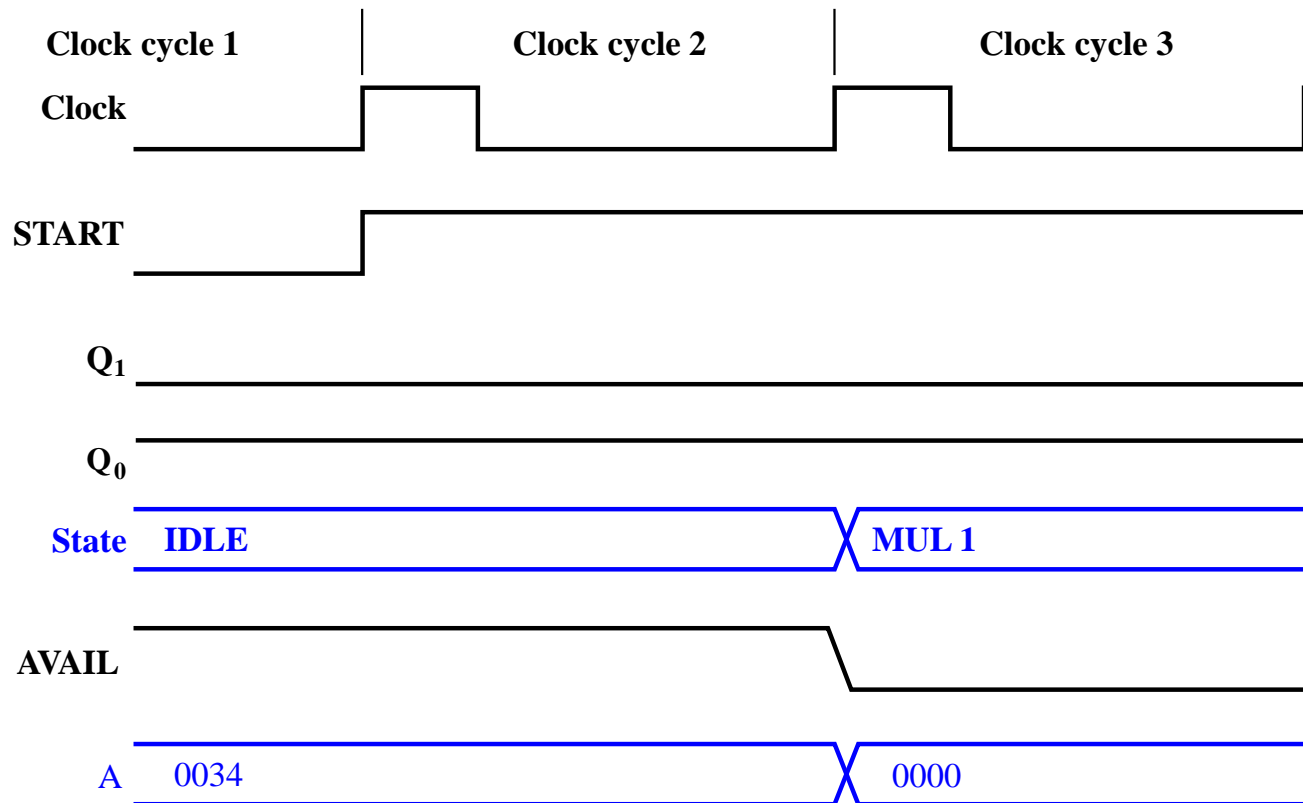 - Conditional Transfers?

ASM Blocks

- One state box along with all decision and conditional output boxes connected to it is called an ASM Block.

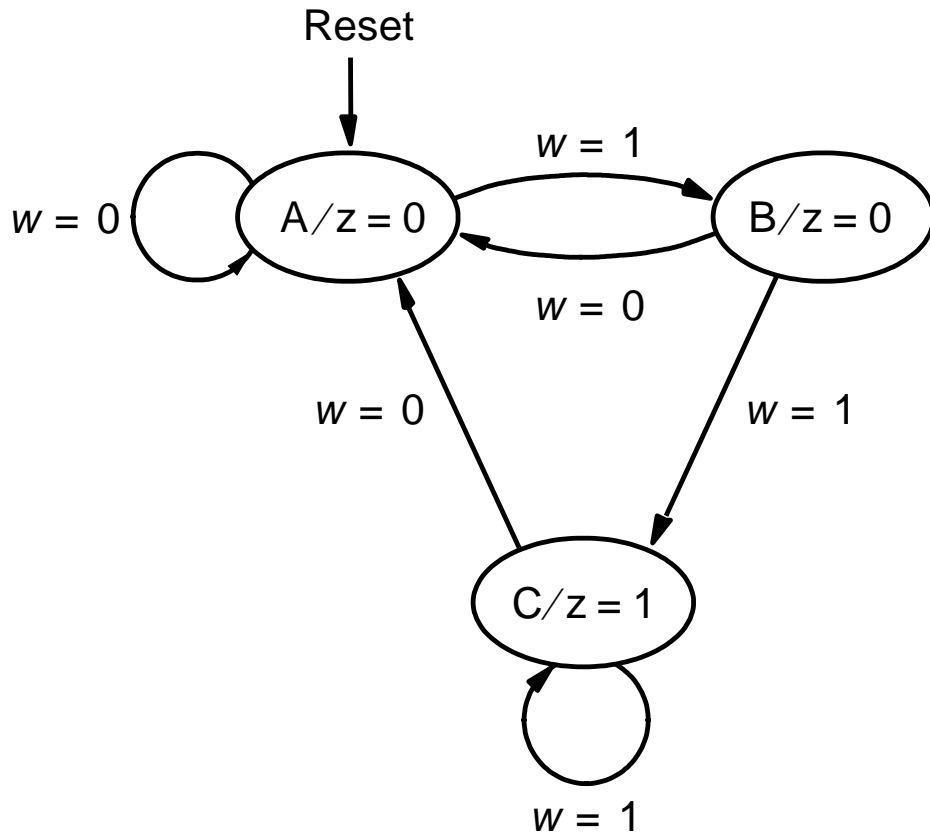- The ASM Block includes all items on the path from the current state to the same or other states.
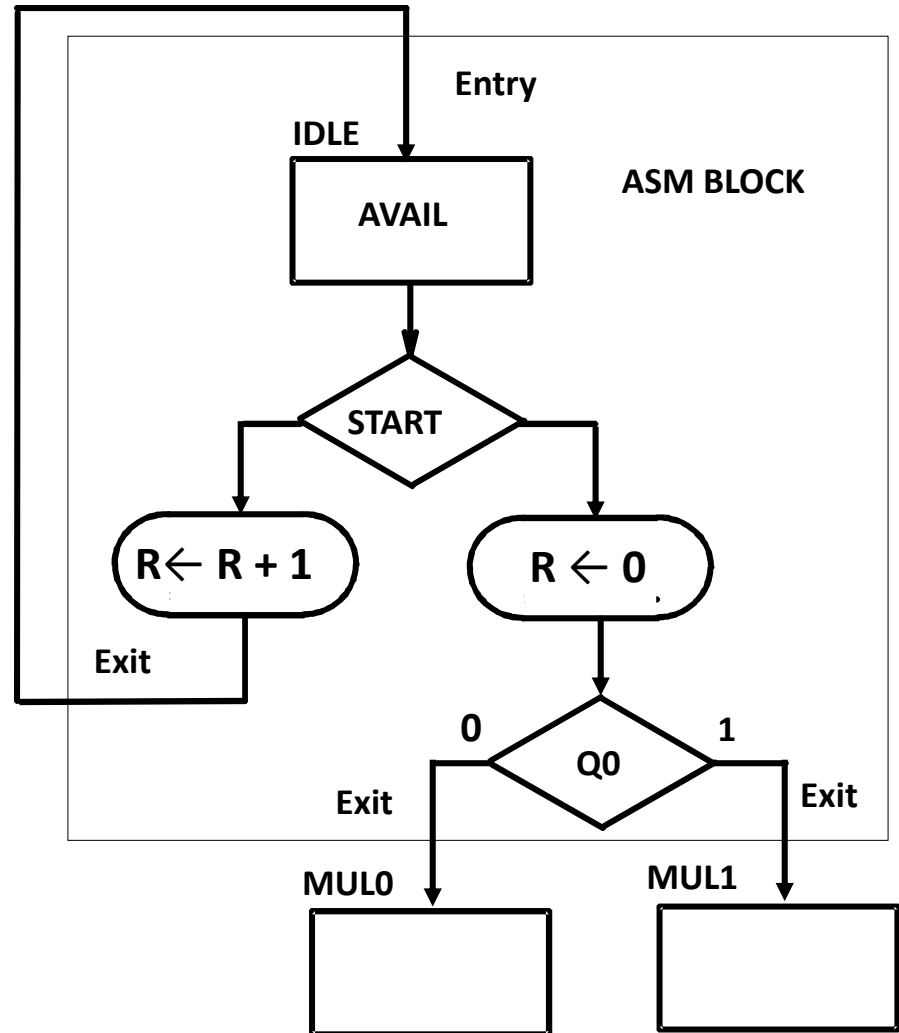
ASM Timing

- Outputs appear while in the state
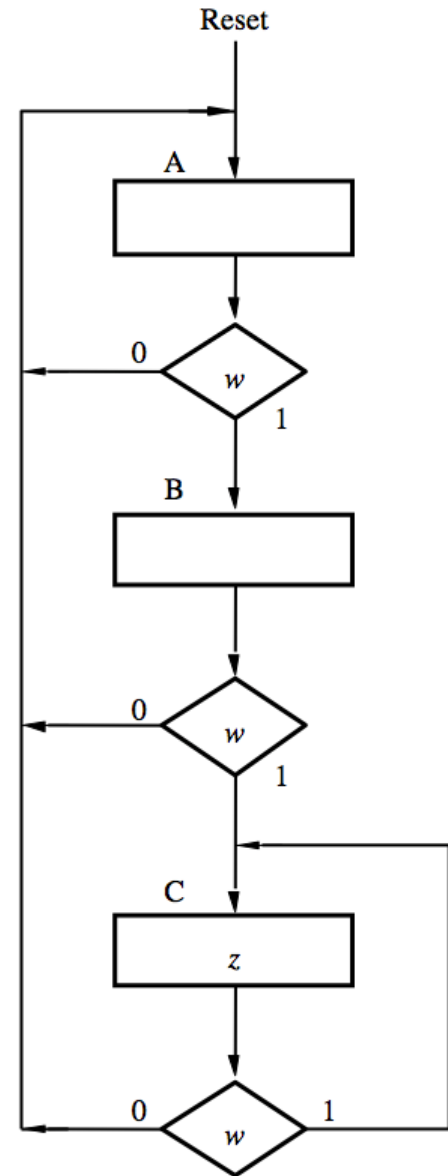- Register transfers occur at the clock while exiting the state - New values occur in the next state!
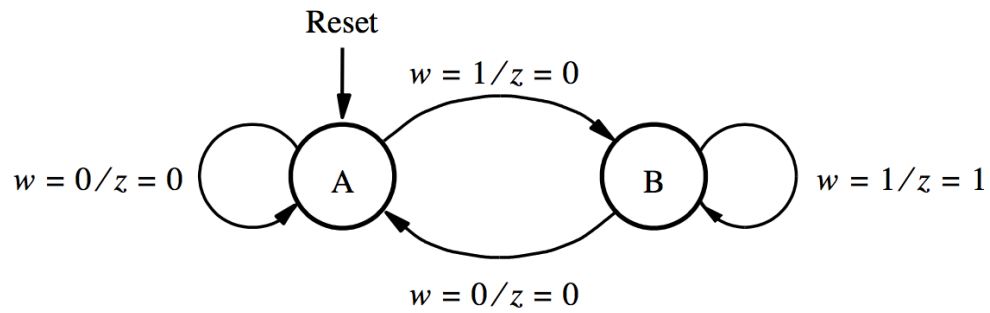
Some Examples

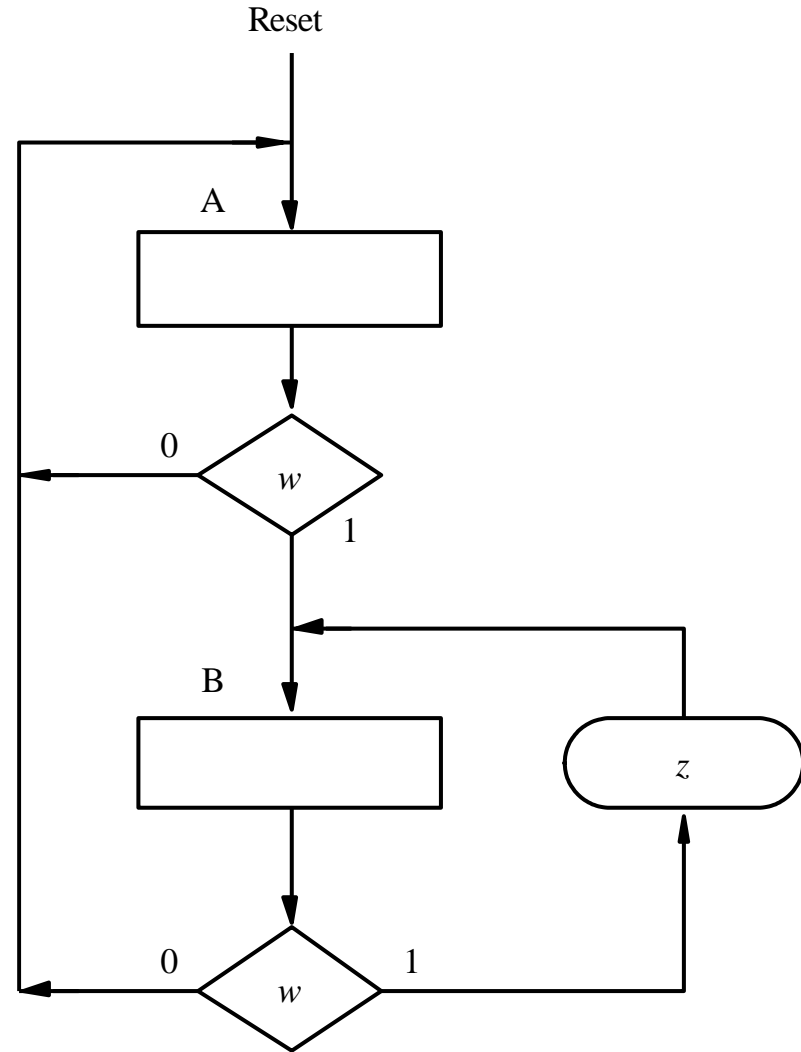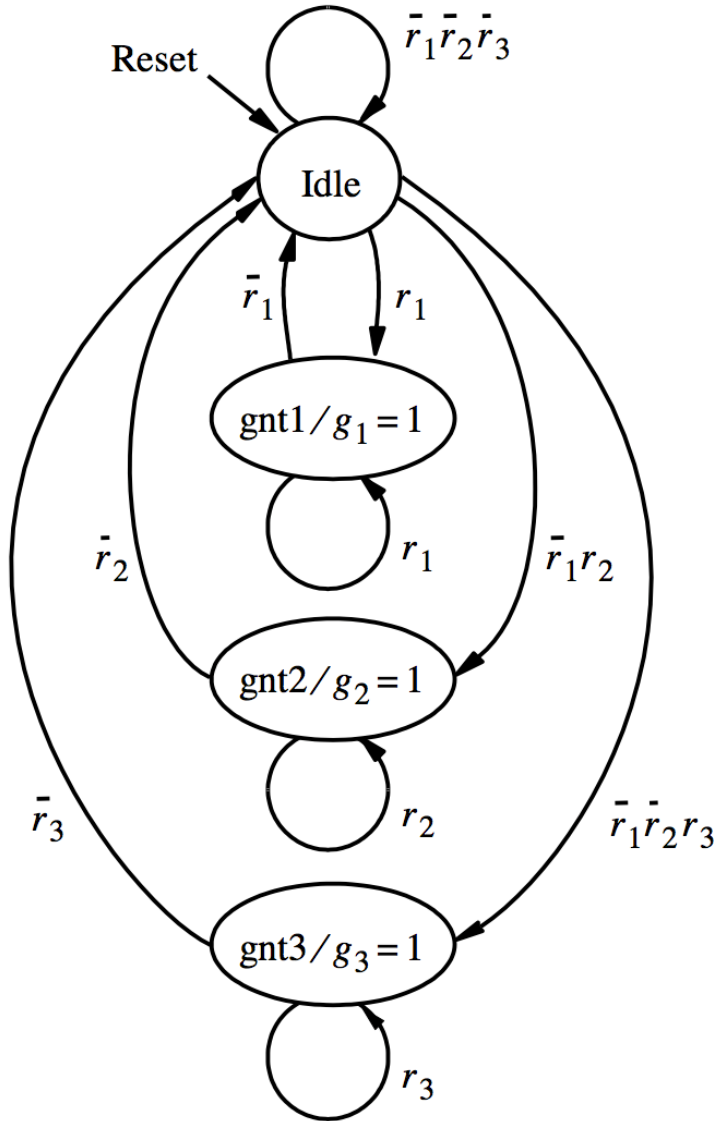# FSM

ASM chart

FSM

ASM chart

Reset

$w = 1/z = 0$

$w = 0/z = 0$

A

B

$w = 1/z = 1$

$w = 0/z = 0$

Reset

A

0

w

1

B

0

w

1

z

FSM

ASM chart