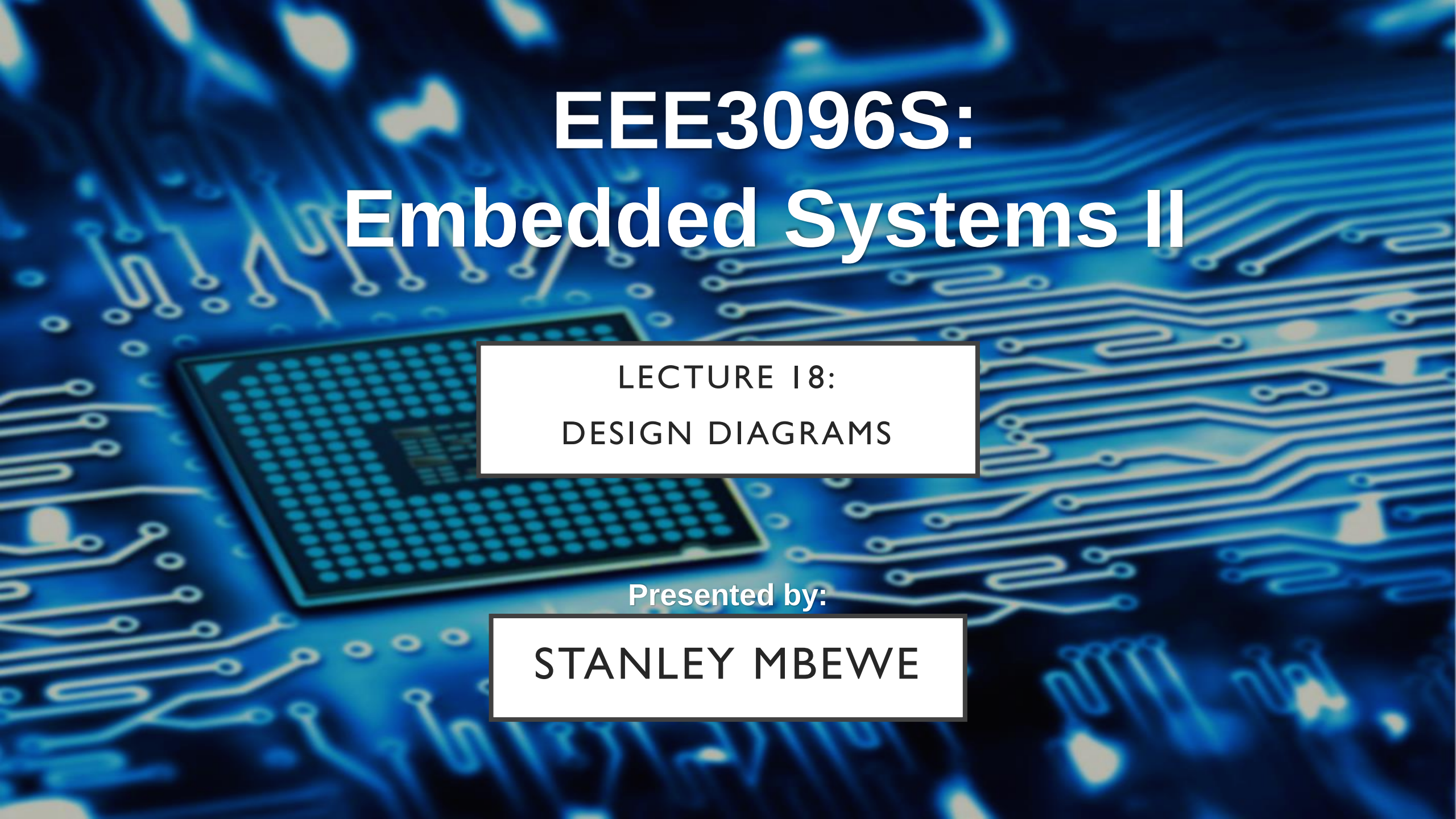


EEE3096S: Embedded Systems II

LECTURE 18: DESIGN DIAGRAMS

Presented by:

STANLEY MBEWE

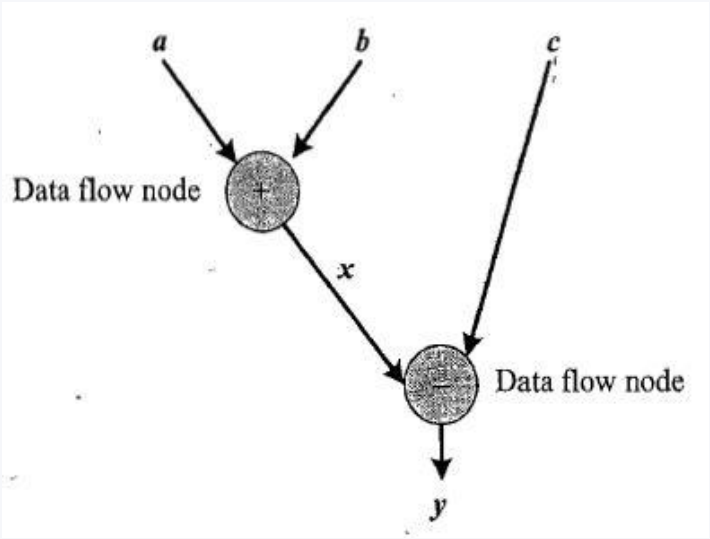
COMPUTATIONAL MODELS IN EMBEDDED DESIGN

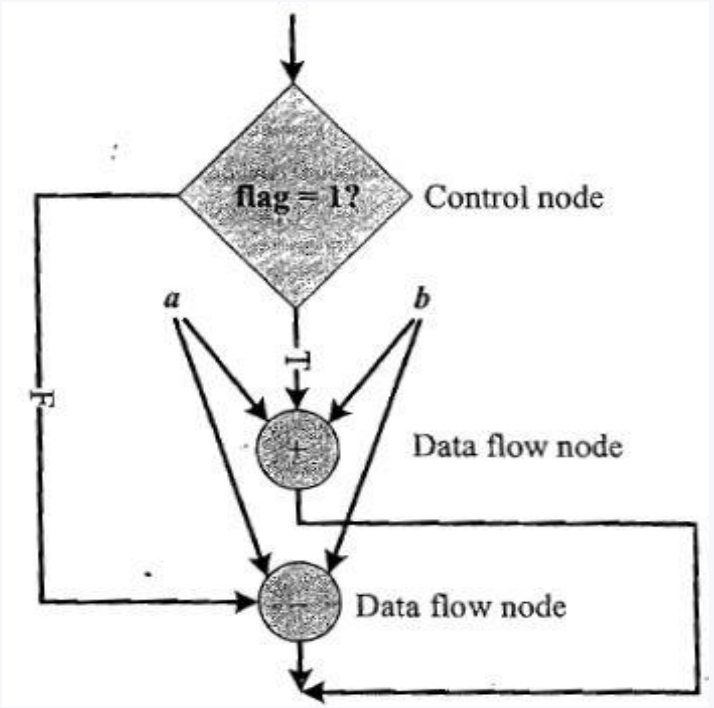
The following computational models are commonly used in embedded system design

- **Data Flow Graph (DFG) model**
- **State Machine model**
- Concurrent Process model
- **Sequential Program model (Flow charts)**
- Object Oriented model

DATA FLOW GRAPH/DIAGRAM (DFG) MODEL

- DFG model translates the data processing requirement into a data flow graph
- The model emphasizes on the data and operations on the data which transforms the input data to output data
- In a DFG model, a data path is a data flow path from input to output
- The Contol (CDFG) model is used for modelling applications involving conditional program execution.
  - Contains data flow nodes and decision nodes.
  - control node is represented by a ‘diamond’ block





STATE MACHINE MODEL

- Used for modelling reactive or event-driven embedded systems whose processing behavior are dependent on state transitions
- Embedded systems used in control and industrial applications are typical examples for event driven systems

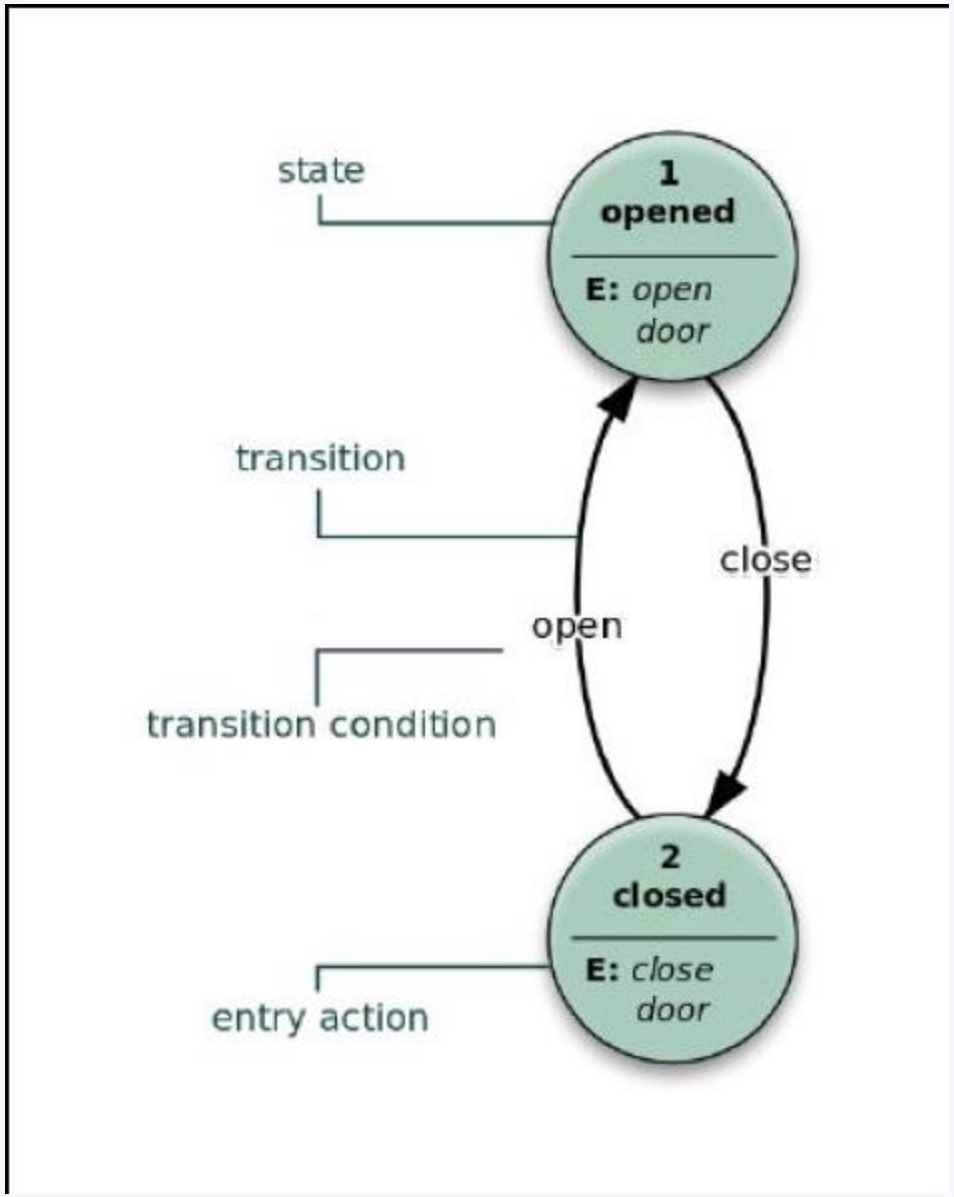
STATE MACHINE MODEL

- The model describes the system behavior with *states, events, actions* and *transitions.*
  - ***State*** is a representation of a current situation
  - An ***event*** is an input to the state
  - ***Transition*** is the movement from one state to another
  - ***Action*** is an activity to be performed by the state machine

- A Finite State Machine (FSM) model is one in which the number of states are finite (known)

Eg: A door

- 2 states: Opened, Closed
- Inputs: action



STATE MACHINE MODEL

Exercise

- Consider an embedded system for driver/passenger seat belt warning system in an automotive. Design the system using the FSM model.
- The system requirements are captured as:

1. When the vehicle ignition is turned on and the seat belt is not fastened within 10 seconds of ignition ON, the system generates an alarm signal for 5 seconds
2. The alarm is turned off when the alarm time (5 seconds) expires, or when the driver/passenger fastens the belt or if the ignition is turned off, which ever happens first.

STATE MACHINE MODEL

Solution

- *States*: alarm off, waiting, alarm on
- *Events*: ignition key on, ignition key off, timer expire, alarm time expire and seat belt on.

Draw the State Machine Model!

FINITE STATE MACHINES (FSM)

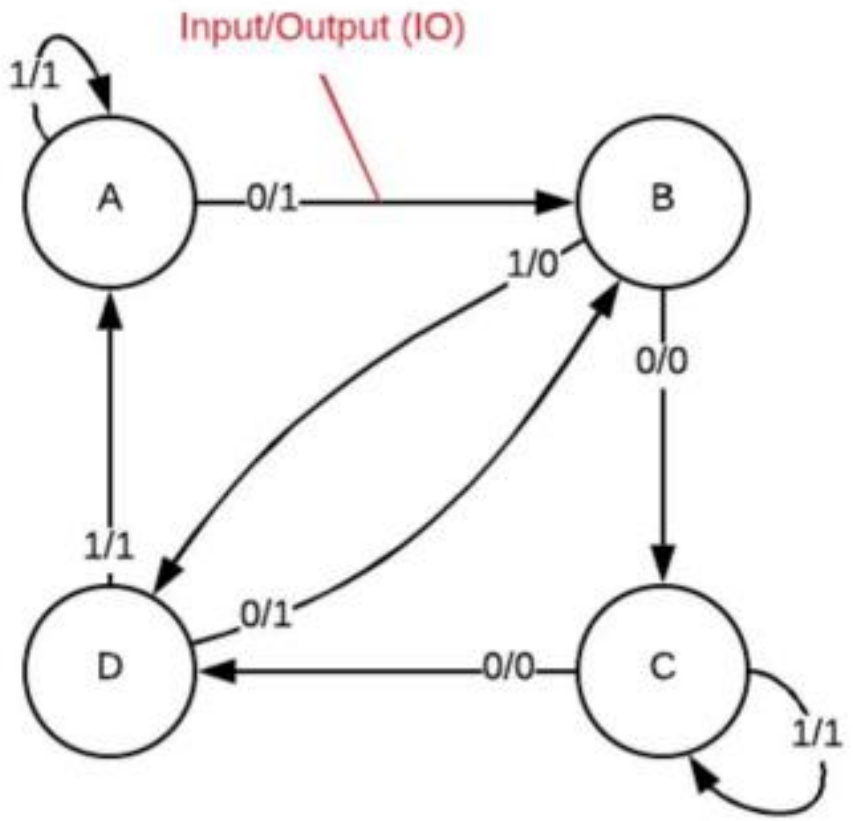
There are basically 2 common types of FSMs:

- Mealy FSM
  - Outputs depend on both current state and inputs
  - Asynchronous
  - Requires fewer states
- Moore FSM
  - Outputs depend on current states only
  - Synchronous
  - Requires more states

Mealy Finite State Machine

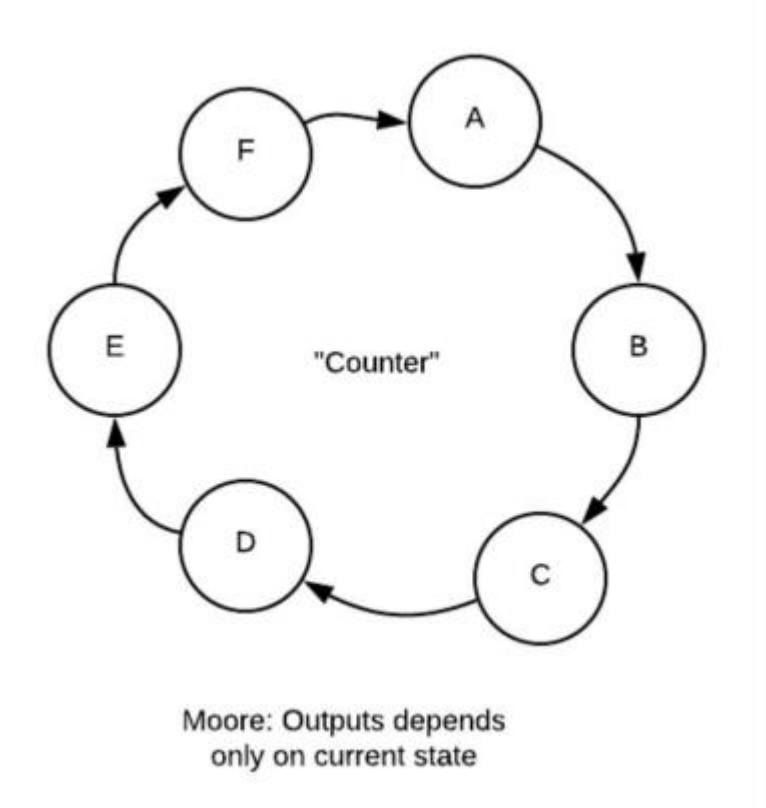
Current state	Input	Next State	Output
0 0 (A)	0	0 1 (B)	1
0 0 (A)	1	0 0 (A)	1
0 1 (B)	0	1 0 (C)	0
0 1 (B)	1	1 1 (D)	0
1 0 (C)	0	1 1 (D)	0
1 0 (C)	1	1 0 (C)	1
1 1 (D)	0	0 1 (B)	1
1 1 (D)	1	0 0 (A)	1

State table



Mealy: Outputs depends on current state AND input

Moore Finite State Machine



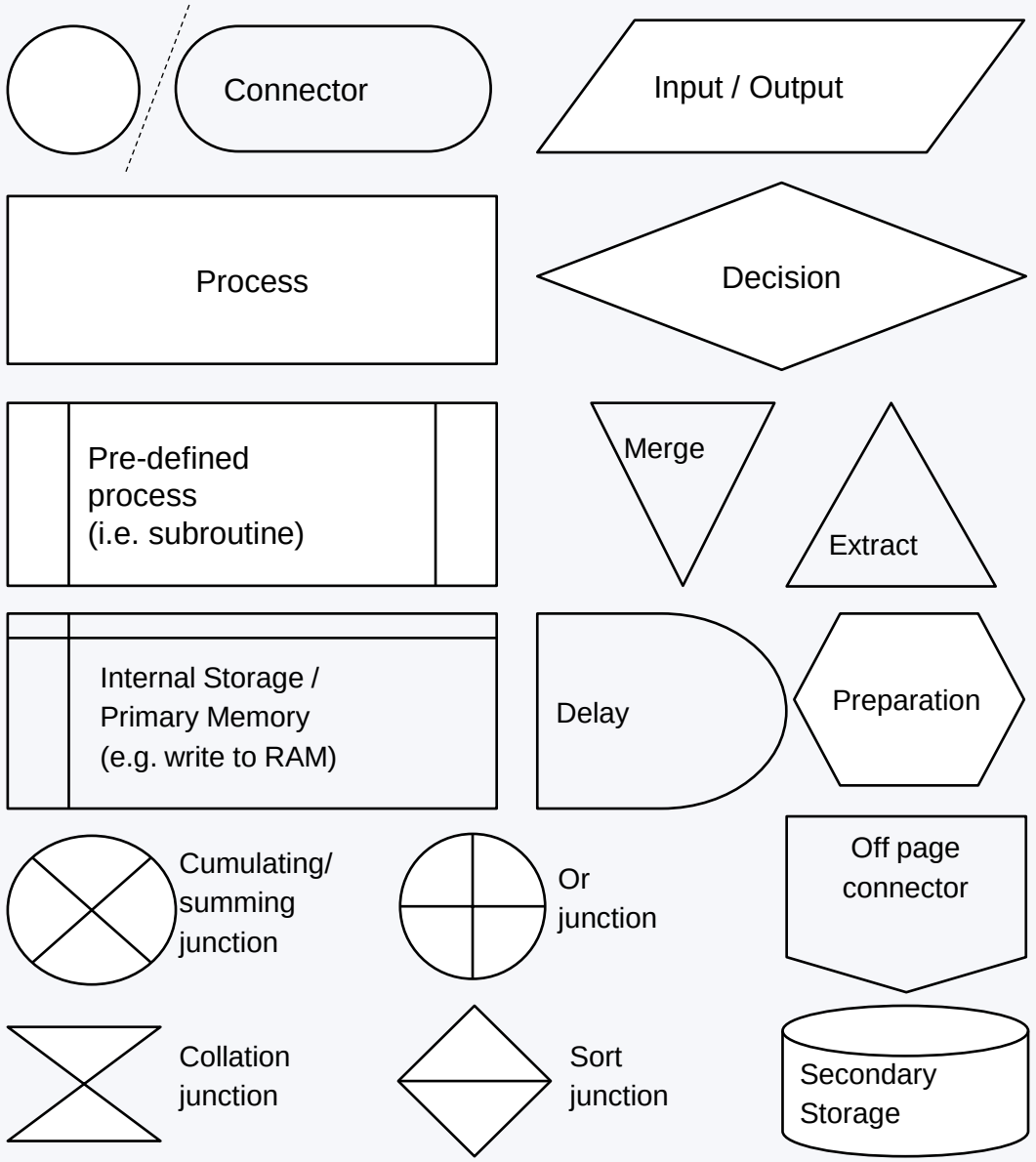
To remember difference: Moore is Less than Mealy (sounds ironic 😉).

SEQUENTIAL PROGRAM MODEL (FLOW CHARTS)

- In this model, the functions or processing requirements are executed in sequence
- The program instructions are iterated and executed conditionally and the data gets transformed through a series of operations
  - Flow charts is another tool used for modelling sequential program flow

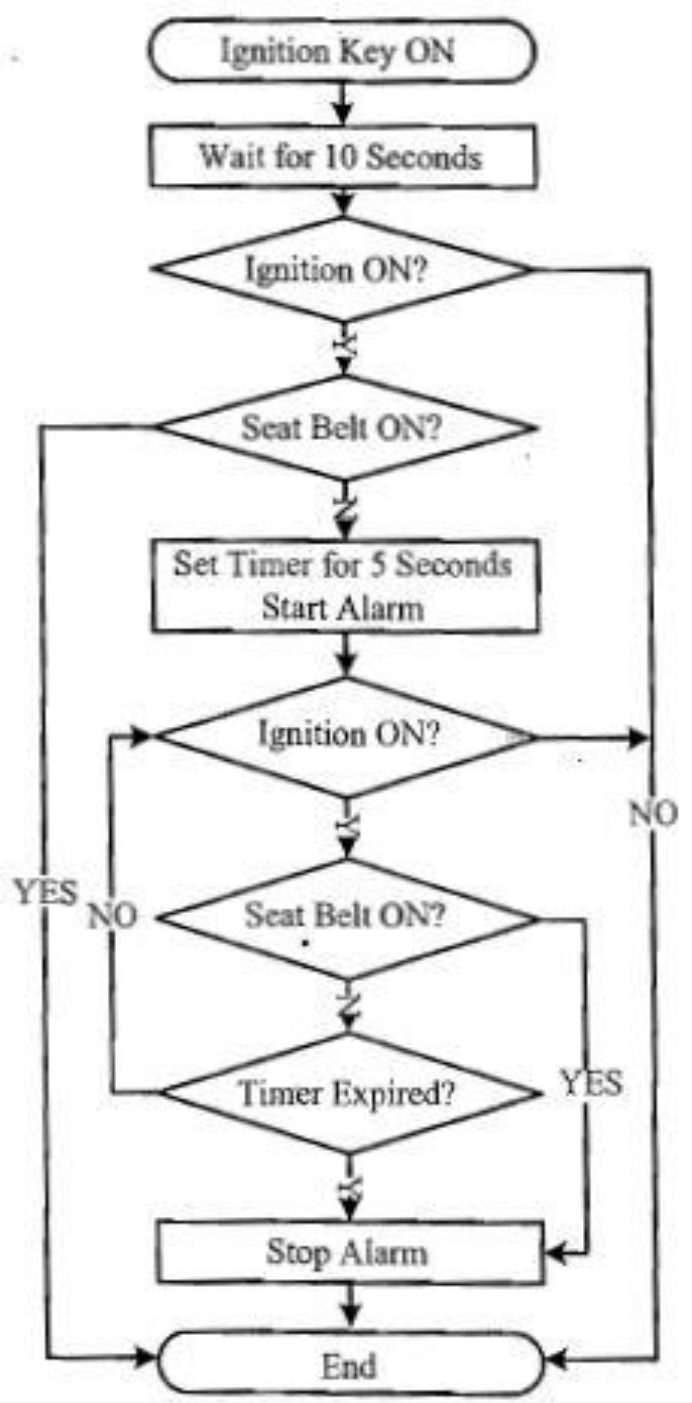
Flow Chart

Standard Symbols



SEQUENTIAL PROGRAM MODEL (FLOW CHARTS)

- Example: the seat belt warning system problem



Example flowchart from:
https://commons.wikimedia.org/wiki/File:Flowchart_connector_example.svg