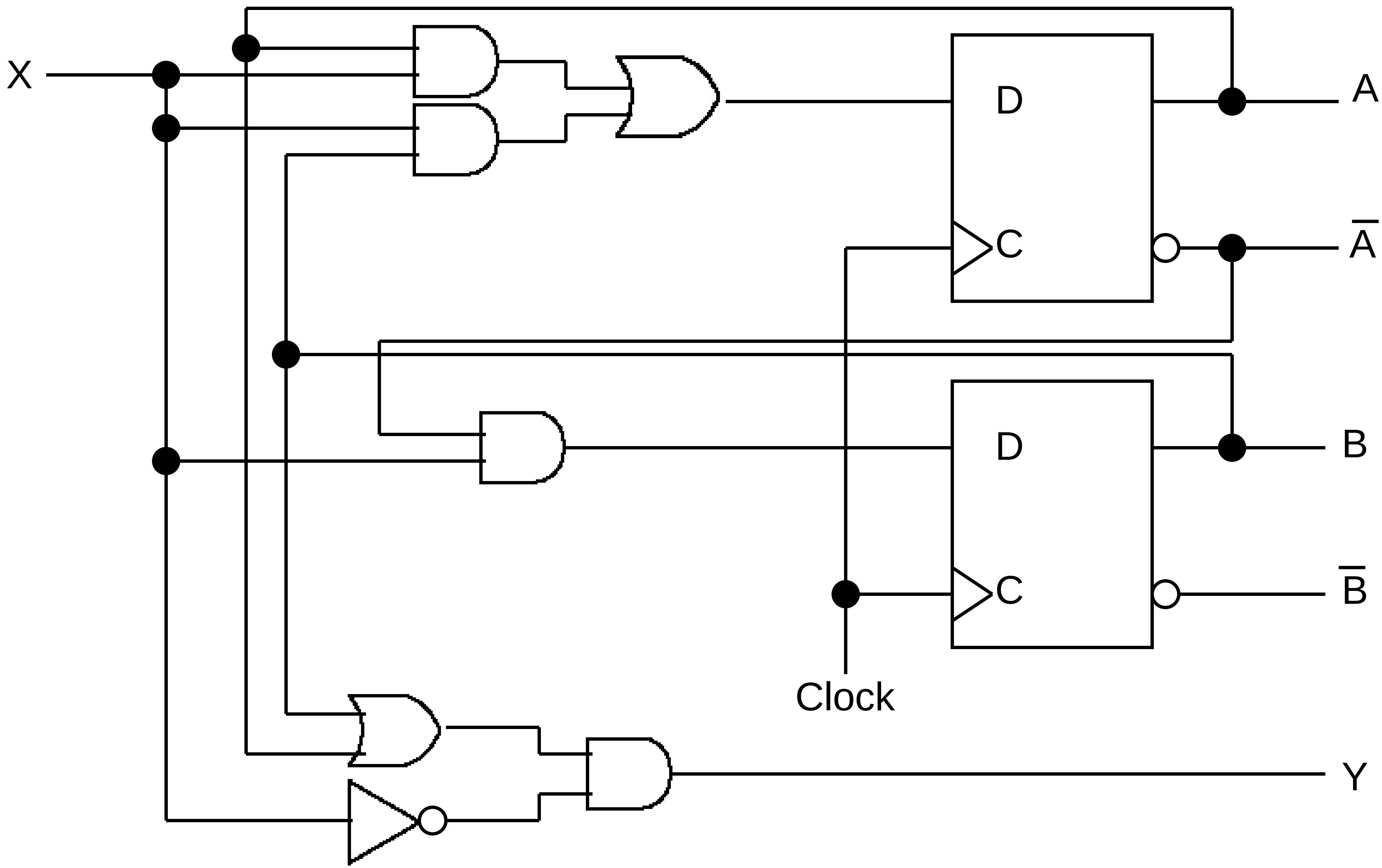
Analysis and Designing of Sequential Circuit

To analyze sequential circuits

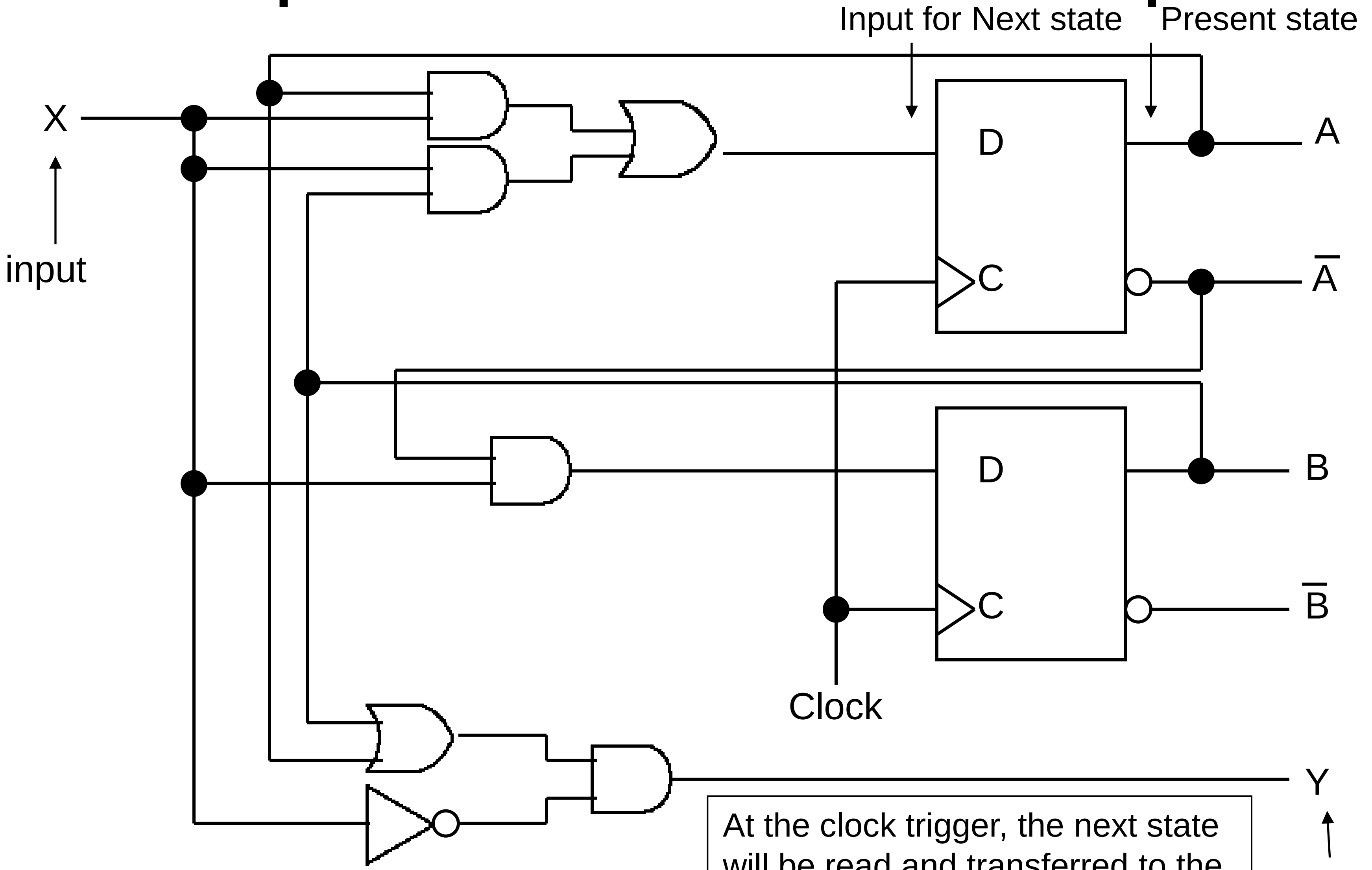
- Find Boolean expressions for the outputs of the circuit and the flip-flop inputs.
- Use these expressions to fill in the output and flip-flop input columns in the state table.
- Finally, use the characteristic equation or characteristic table of the flip-flop to fill in the next state columns.

- The result of sequential circuit analysis is a state table or a state diagram describing the circuit.

Sequential Circuit Description



Sequential Circuit Description



At the clock trigger, the next state will be read and transferred to the present state

Input Equations

$$A_{next} = A_{present}X + B_{present}X$$

$$B_{next} = A'_{present}X$$

Next state in terms of input and present state

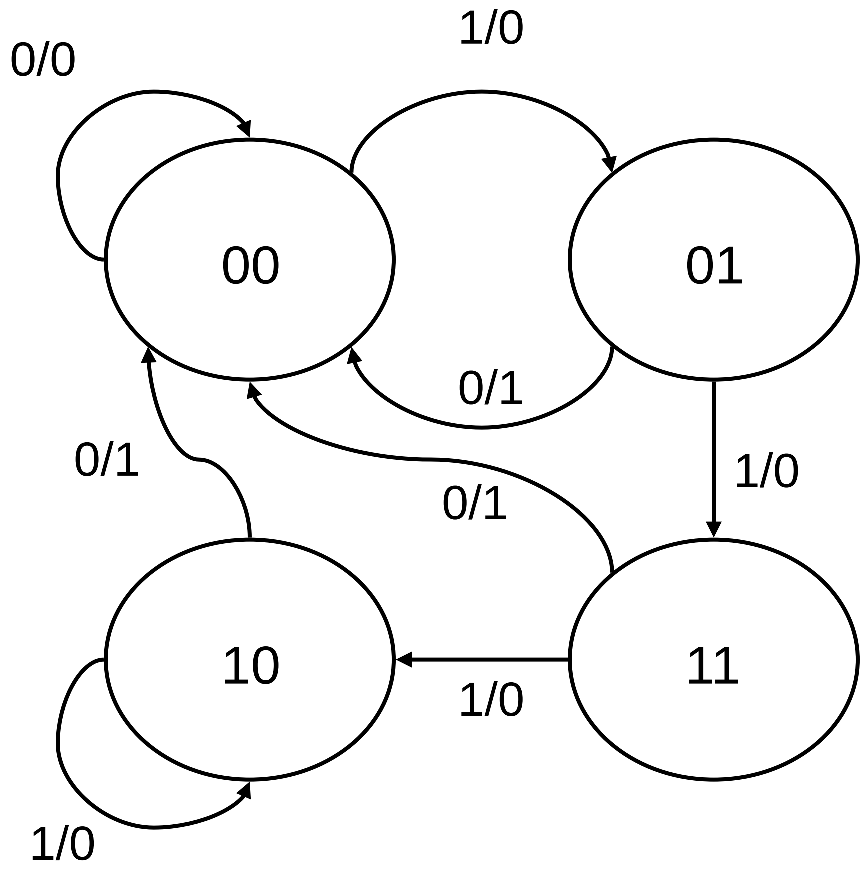
$$Y = (A_{present} + B_{present})X'$$

Output in terms of input and present state

State Table

Present State		Input	Next State		Output
A	B	X	A	B	Y
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	0	0	1
0	1	1	1	1	0
1	0	0	0	0	1
1	0	1	1	0	0
1	1	0	0	0	1
1	1	1	1	0	0

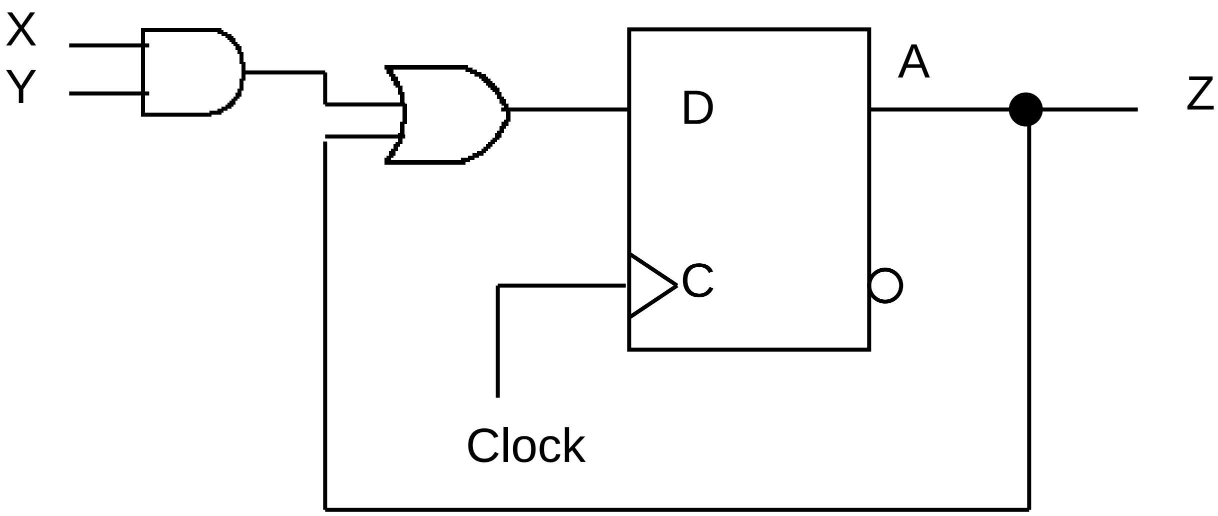
State Diagram



Mealy and Moore Models

- Preceding Example: Output depends on present state and input. This is called the Mealy Model
- Another kind of circuit: Output only depends on present state. This is called the Moore Model

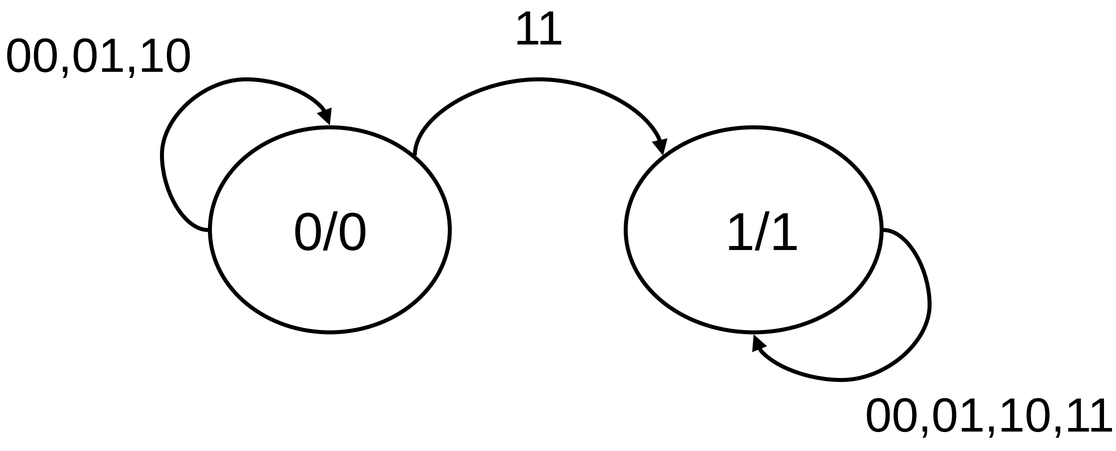
Example of Moore Model



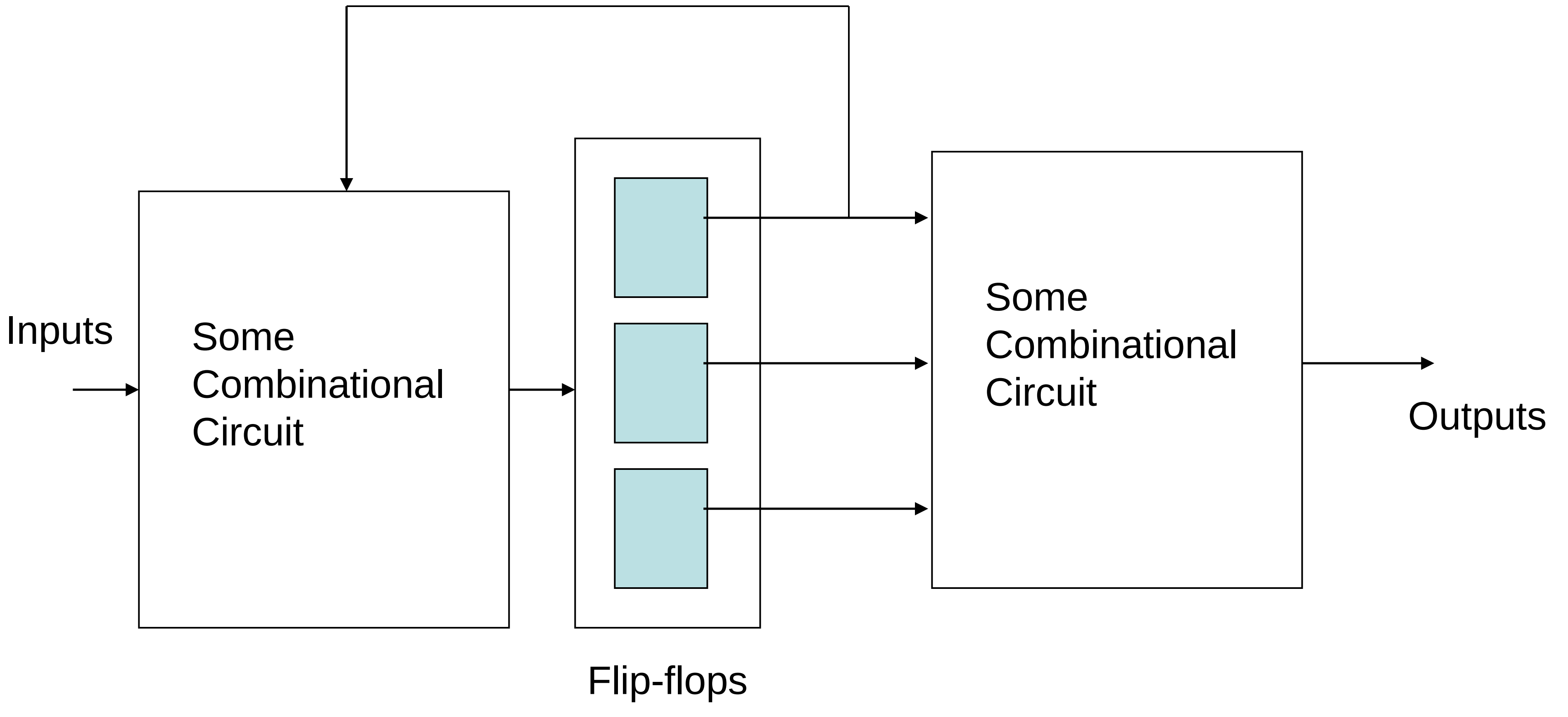
$A_{next} = A_{present} + XY$

$Z = A_{present}$

X	Y	$A_{present}$	A_{next}
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

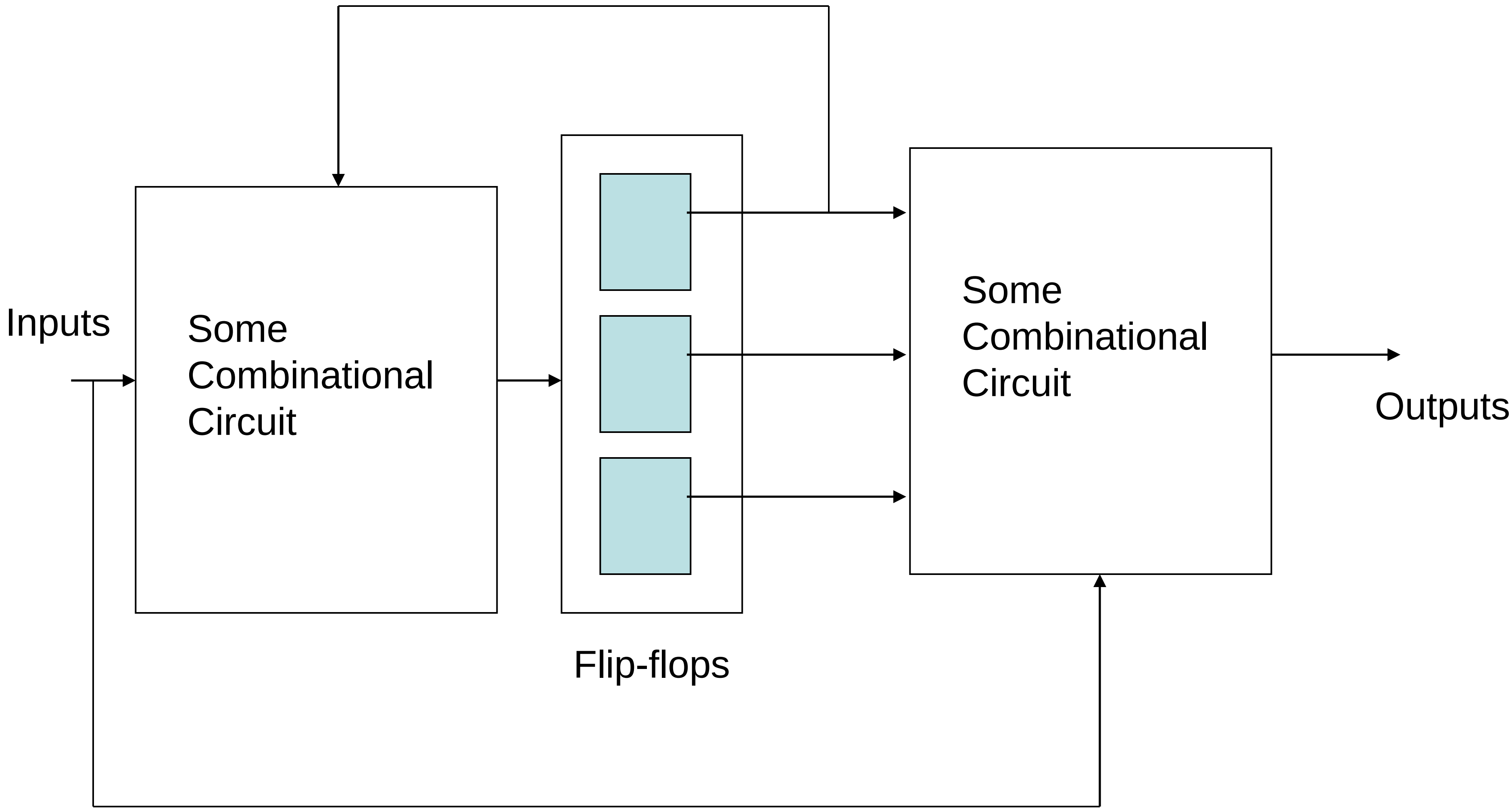


Moore Model

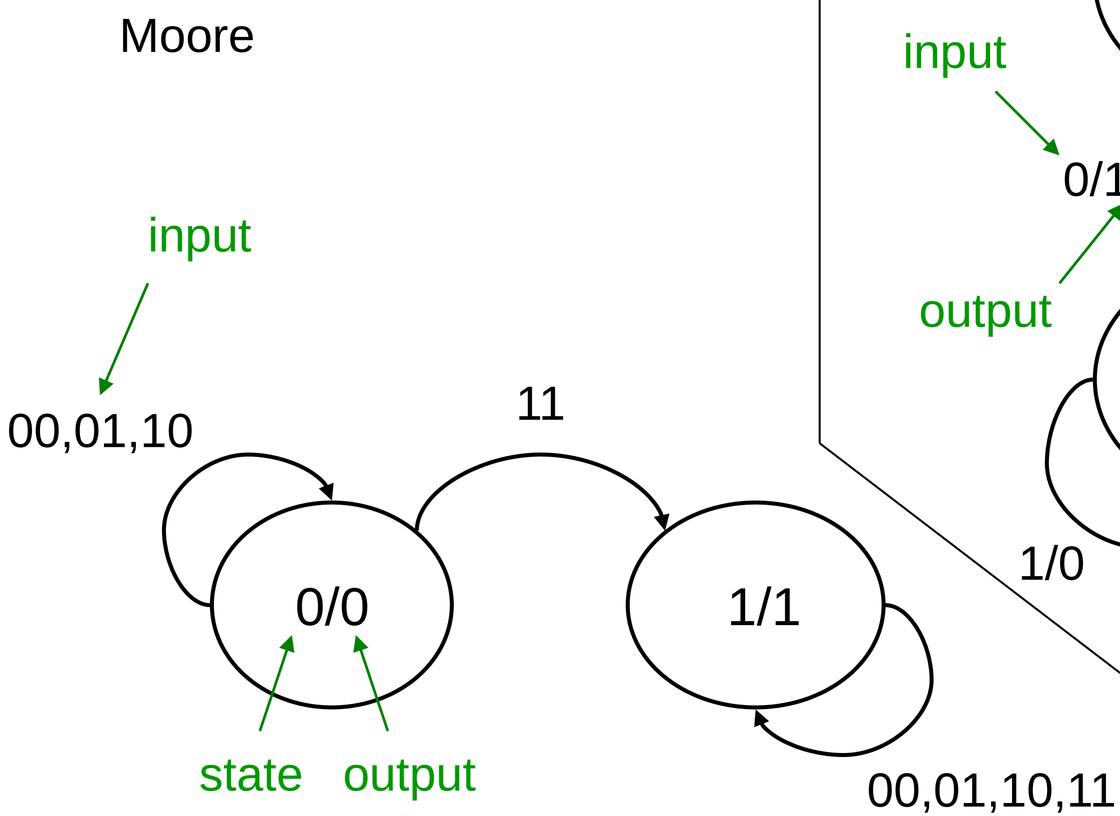


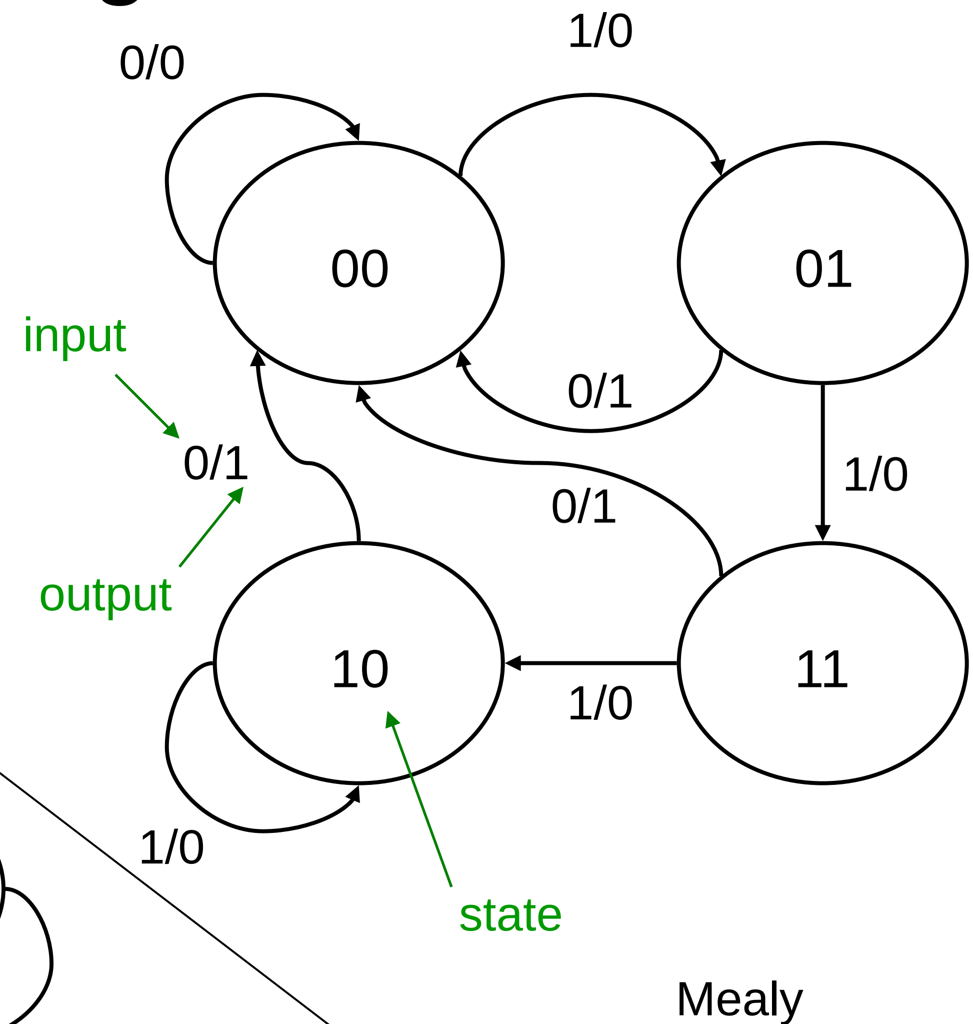
Inputs
Some Combinational Circuit
Flip-flops
Some Combinational Circuit
Outputs

Mealy Model


Inputs
Some
Combinational
Circuit
Flip-flops
Some
Combinational
Circuit
Outputs

Mealy and Moore Model State Diagrams



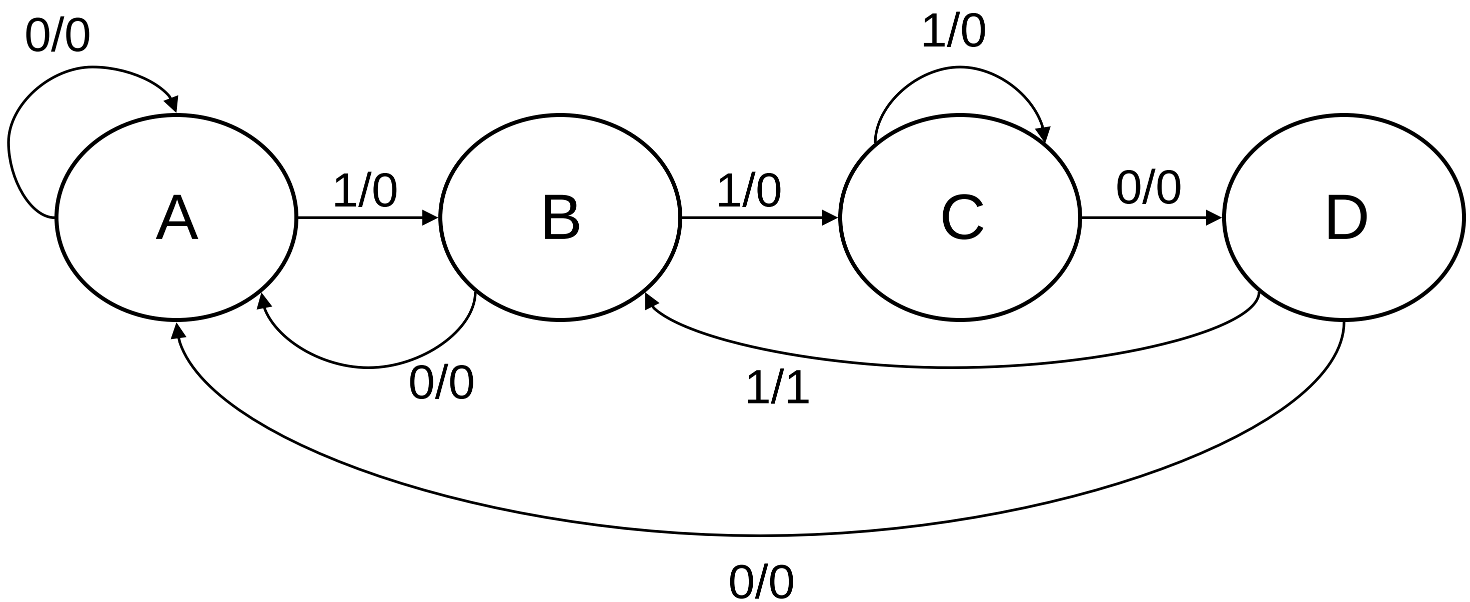


How to Design a Sequential Circuit

- 1. Specification
- 2. Formulation: Draw a state diagram
- 3. Assign state number for each state
- 4. Draw state table
- 5. Derive input equations
- 5. One D flip-flop for each state bit

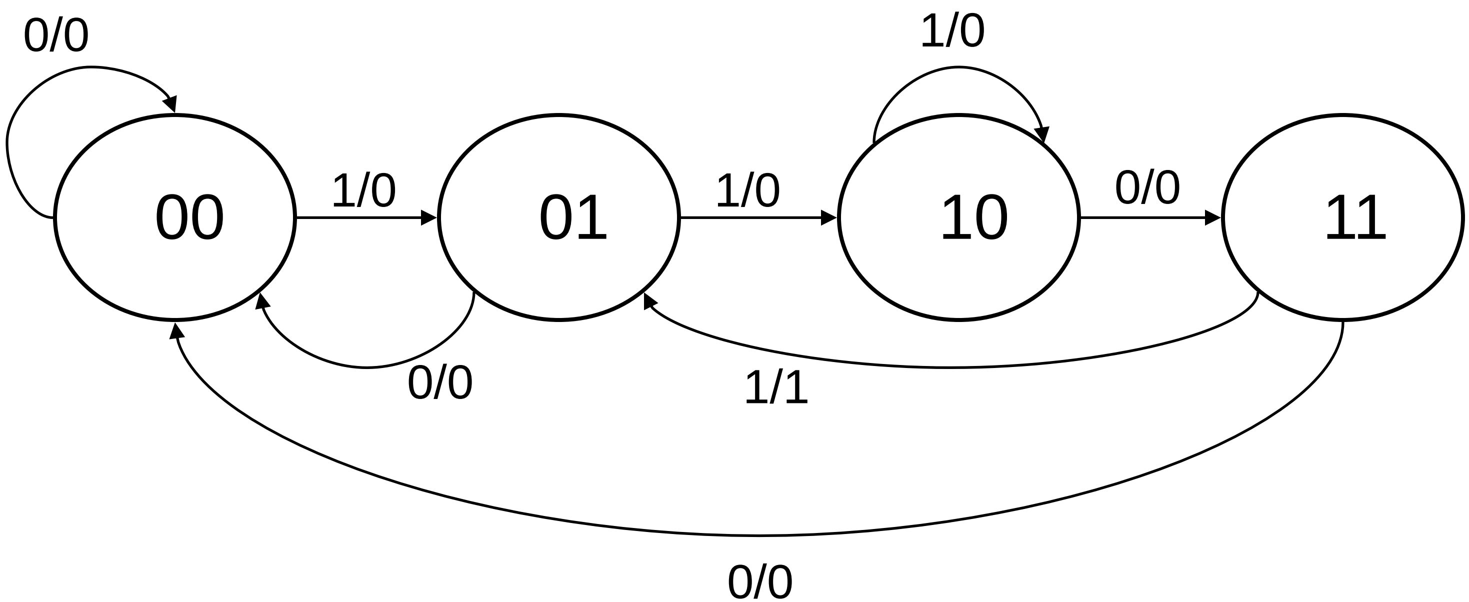
Example

- Design a sequential circuit to recognize the input sequence 1101.
- That is, output 1 if the sequence 1101 has been read, output 0 otherwise.



Assign States

- 4 states, so we need 2 bits



Draw State Table

Present State		Input	Next State		Output
A	B	X	A	B	Y
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	0	0	0
0	1	1	1	0	0
1	0	0	1	1	0
1	0	1	1	0	0
1	1	0	0	0	0
1	1	1	0	1	1

Derive Input Equations

A_{next} = A'BX + AB'

B_{next} = A'B'X + AB'X' + ABX

Y = ABX

Draw Circuit