

# 3.1 Design of logic functions

Basic structure of combinational logic  
and sequential logic

# Combinational Logic and Sequential Logic

- **Combinational logic (組合せ回路)**
  - The output value is a pure function of the present input only.
  - The function can be described by **Boolean Expressions** or a **truth table**.
  - The circuit is implemented by a **wired logic** or a **LUT ( Look-up Table)**.
- **Sequential logic (順序回路)**
  - The output depends not only on the present value of its input signals but on the current state that is a result of the sequence of past input
  - The function can be described by a **state transition diagram** or a **characteristic table**.
  - The circuit is implemented by **a combinational logic and registers (\*)**.

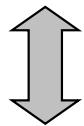
\* Register: A register is a logic circuit to storages the data for a clock cycle.

# Implementation of combinational logic

Boolean Expression  $\longleftrightarrow$

$$x = \overline{a \cdot b}$$

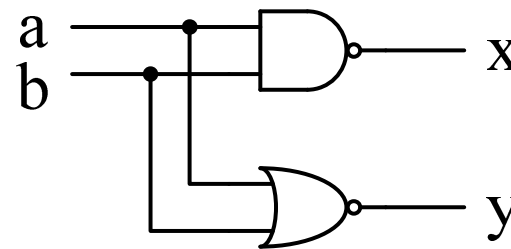
$$y = \overline{a + b}$$



Truth table

a	b	x	y
0	0	1	1
0	1	1	0
1	0	1	0
1	1	0	0

Wired logic



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LUT (Look-up Table)

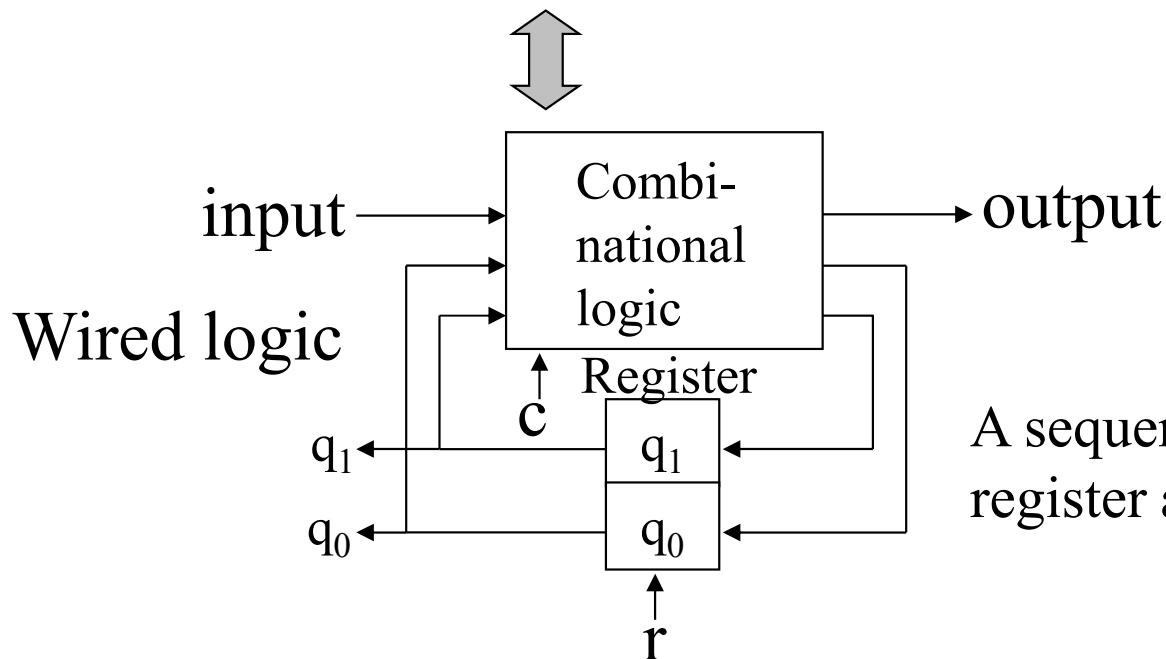
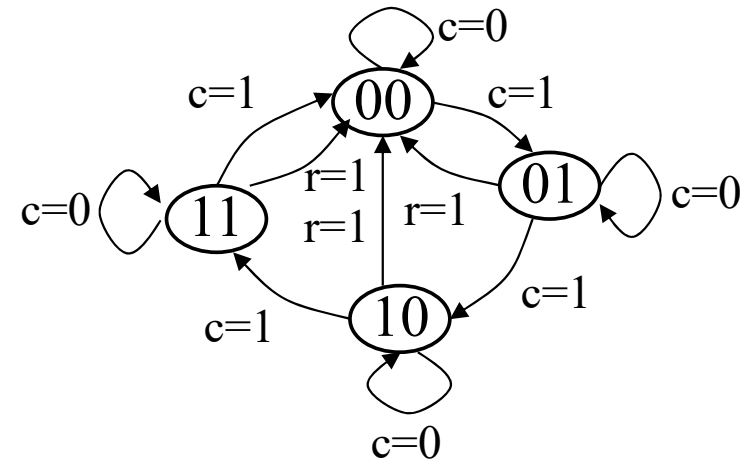
(ab) address	Memory									
00	1	1	DC	DC	DC	DC	DC	DC	DC	
01	1	0	DC	DC	DC	DC	DC	DC	DC	
10	1	0	DC	DC	DC	DC	DC	DC	DC	
11	0	0	DC	DC	DC	DC	DC	DC	DC	
	data (x	y)	Unused						3	

# Implementation of sequential logic

State transition table  
(状態遷移表)

r	c	$q_1q_0(n+1)$
0	0	$q_1q_0(n)$
0	1	$q_1q_0(n) + "01"$
1	0	0 0
1	1	0 0

State Transition Diagram  
(状態遷移図)



A sequential logic consists of a register and a combinational logic.