11. 논리제어

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◆ **Introduction to logic control**

◆ **PLC (Programmable Logic Controller)**

◆ **Ladder logic**

Introduction to logic control (1)

◆ **Two types of control**

    – Motion control (CNC & Industrial robots)

    – Logic (discrete) control

◆ **What is discrete control?**

    – Deal with parameters that change at discrete moments

    – Discrete: Binary or 1/0 or True/False

    – Example

        ▪ Limit switch: contact/no contact

        ▪ Motor: on/off

        ▪ Valve: closed/open
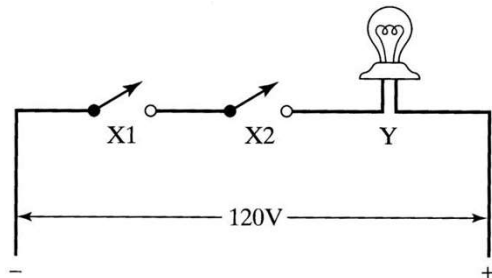
Introduction to logic control (2)

◆ **Two category of discrete control**

- Logic control: event-driven changes in the system

- Sequence control: time-driven changes in the system

◆ **Characteristics of logic control**

- No memory (does not consider any previous values of input)

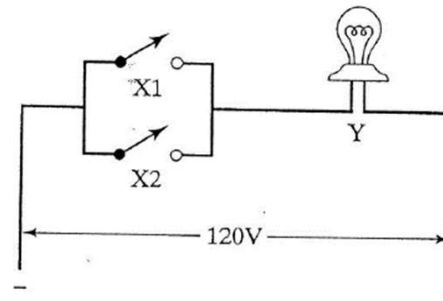- Time-independent

- Basic elements (logic gates): AND, OR, NOT
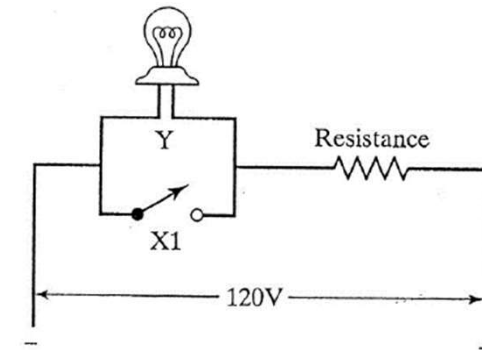
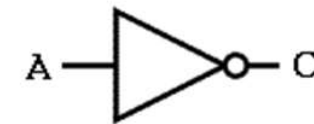# Logic gates: AND, OR, NOT

AND

Inputs		Output
A	**B**	**C**
0	0	0
0	1	0
1	0	0
1	1	1

OR

Inputs		Output
A	**B**	**C**
0	0	0
0	1	1
1	0	1
1	1	1

NOT

Input	Output
A	**C**
0	1
1	0

Logic gates: NAND, NOR, XOR

NAND
(AND + NOT)

A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

NOR
(OR + NOT)

A	B	F
0	0	1
0	1	0
1	0	0
1	1	0

XOR

A	B	F
0	0	0
0	1	1
1	0	1
1	1	0

Logic gates

◆ **Push button switch example**
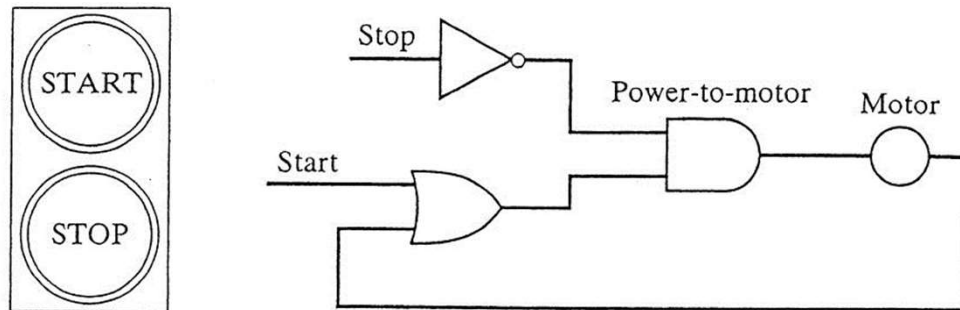
▪ Truth table

Start	Stop	Motor	Power-to-motor
0	0	0	0
0	1	0	0
1	0	0	1
1	1	0	0
0	0	1	1
0	1	1	0
1	0	1	1
1	1	1	0

PLC (Programmable Logic Controller) (1)

◆ **What is PLC?**

- – A microprocessor-based device to replace wiring and relay for logic control

- – Programming is easier than wiring!

- – Advantages of PLC

    - ▪ Smaller than relay logic network

    - ▪ Better reliability

    - ▪ Better connectivity to computer system

    - ▪ Variety of control functions

        - ✓ Timer, counter, …

PLC (Programmable Logic Controller) (1)

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PLC (Programmable Logic Controller) (2)

◆ **Components of PLC**

– Processor

– Memory

– I/O

– Programming device
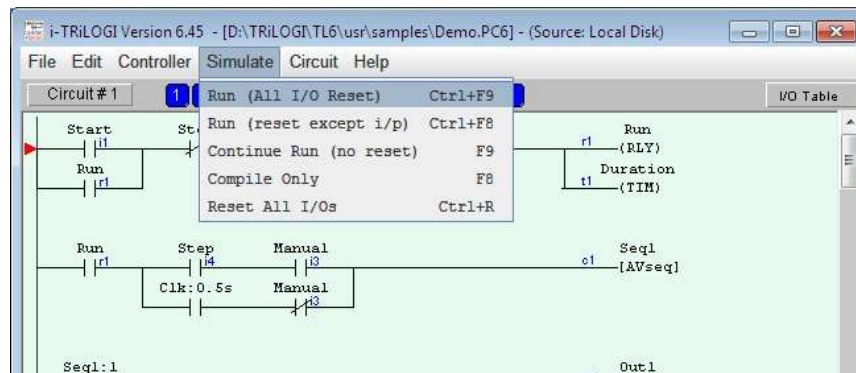
Screen for PLC programming

Commercial PLCs

PLC (Programmable Logic Controller) (3)

◆ **Standard logic programming languages (IEC 61131-3)**

- The third part (of 8) of the open international standard IEC 61131 for programmable logic controllers
  - Ladder diagram (LD), graphical
  - Function block diagram (FBD), graphical
  - Sequential function chart (SFC), graphical
  - Continuous Function Chart (CFC), graphical
  - Structured text (ST), textual
  - Instruction list (IL), textual

Ladder logic (1)

◆ **Ladder Logic Diagram**

– Programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware

– Used to develop software for programmable logic controller (PLC) used in industrial control applications

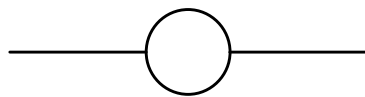▪ PLC: used to configure complex automation systems
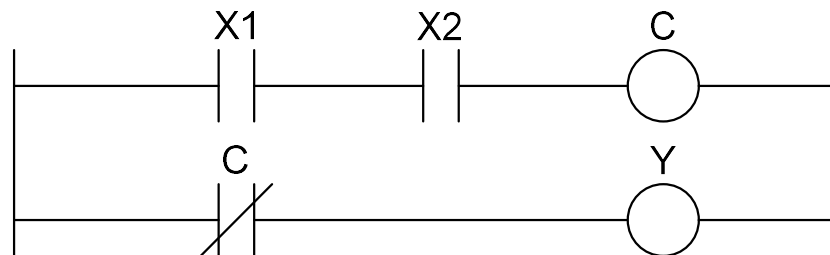
Ladder logic (2)

◆ **Symbol for ladder logic diagram**
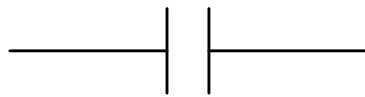
Normally open contacts
(switch, relay, other ON/OFF devices)
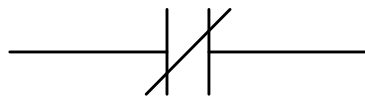
Normally closed contacts
(switch, relay, etc.)

Output loads
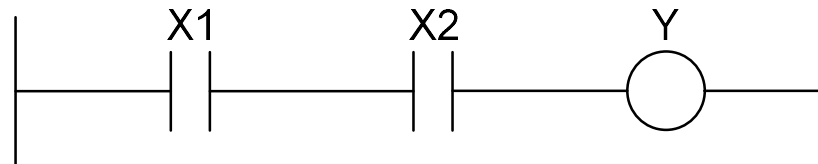(motor, lamp, solenoid, alarm, etc.)

TMR — Timer

CTR — Counter

Ladder logic (3)
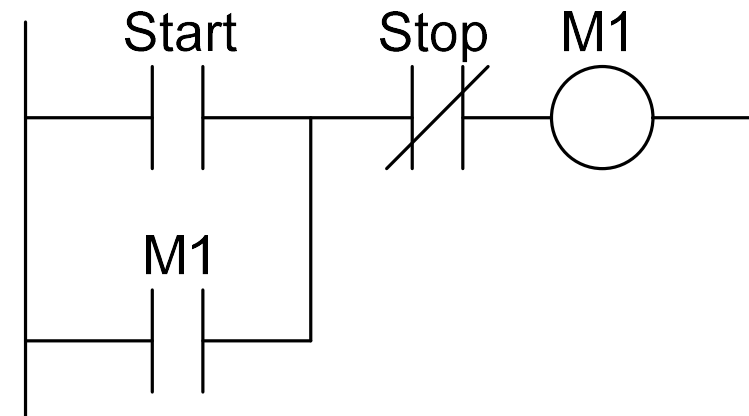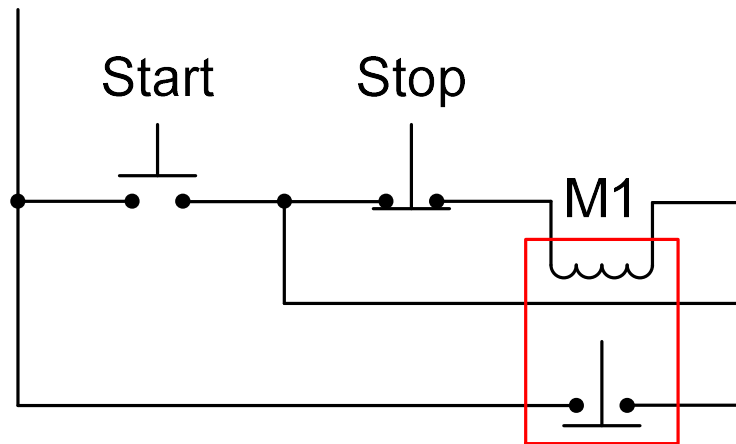
Ladder logic (4)
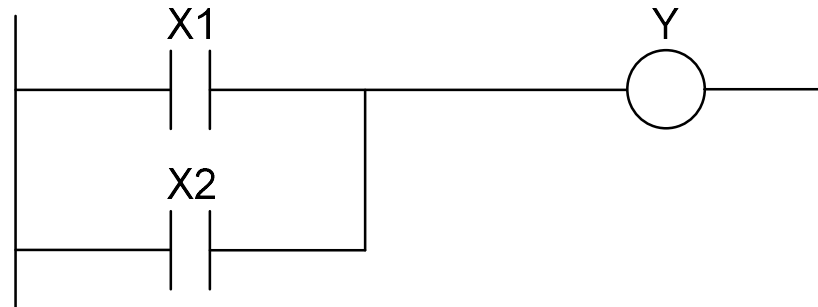
◆ **AND, OR, NOT in ladder logic**

    – AND
- Y = X1 AND X2

    – OR
- Y = X1 OR X2

    – NOT
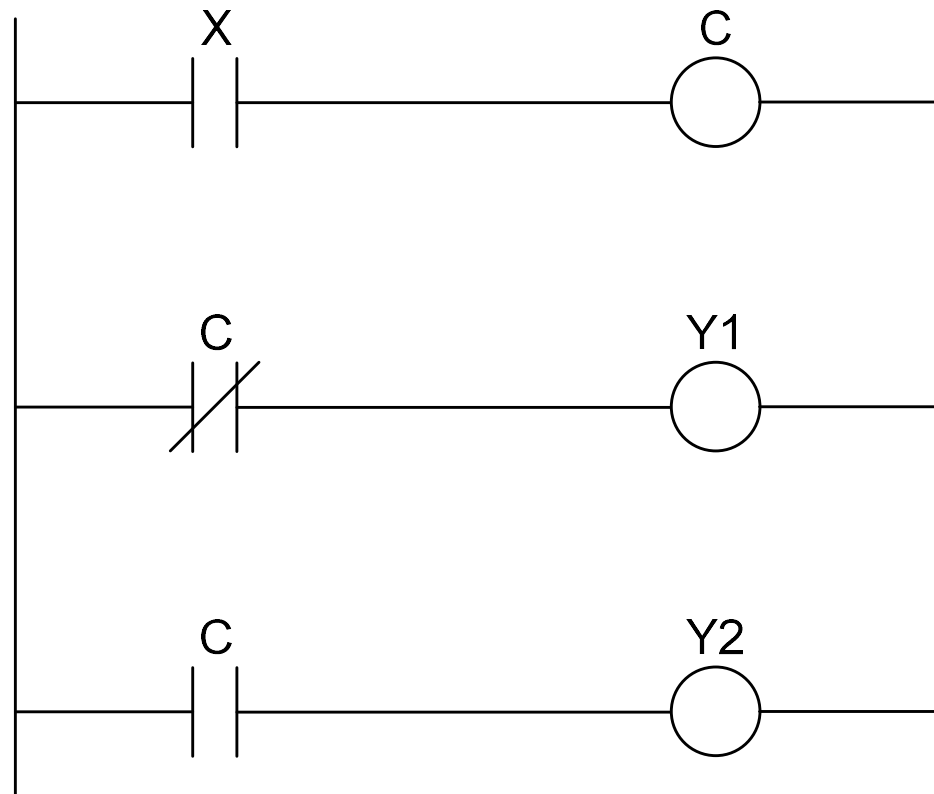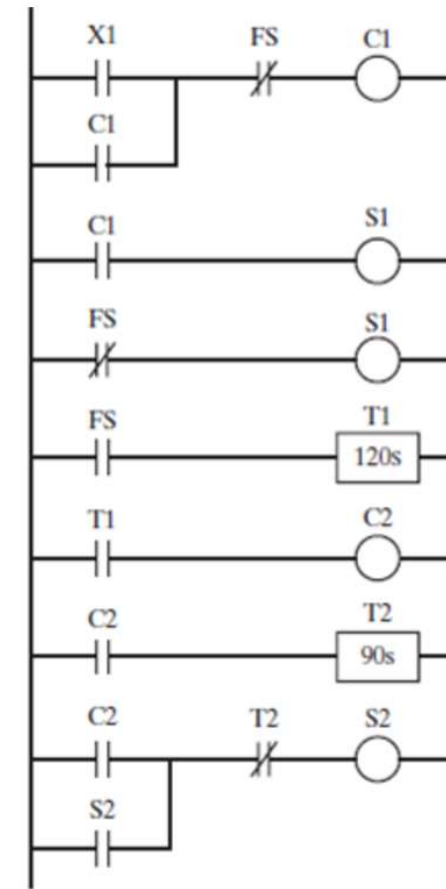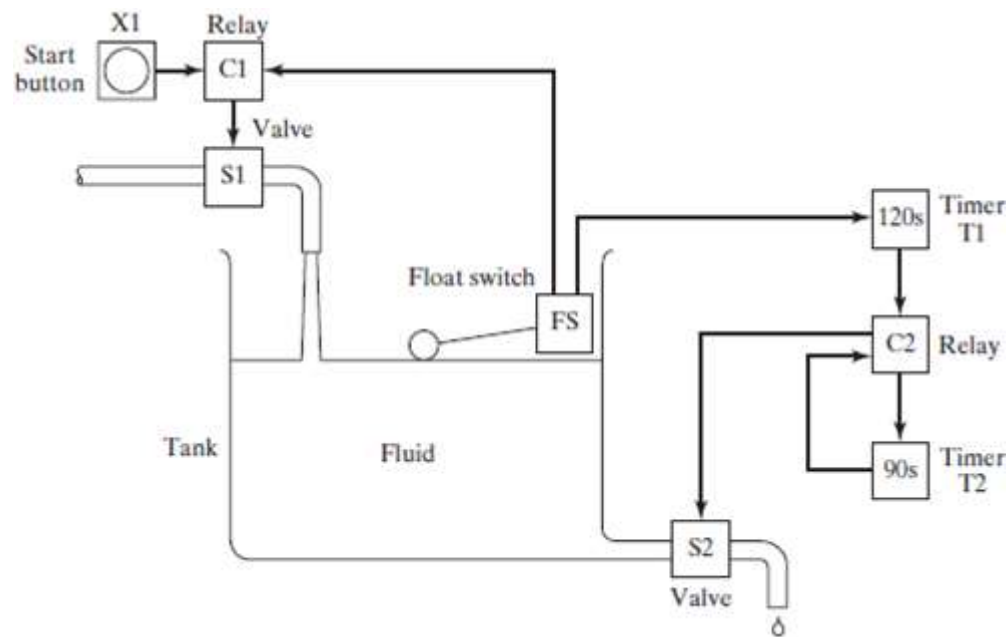- Y = NOT X1
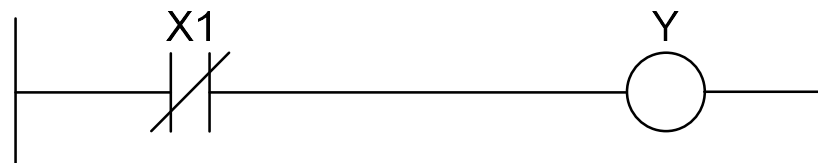
Ladder logic (5)

◆ **Control relay**

Ladder logic (6)

◆ **Fluid filling operation example**

Ladder logic (7)

◆ **Example 1**

– Draw ladder logic diagram to configure automatic capping system