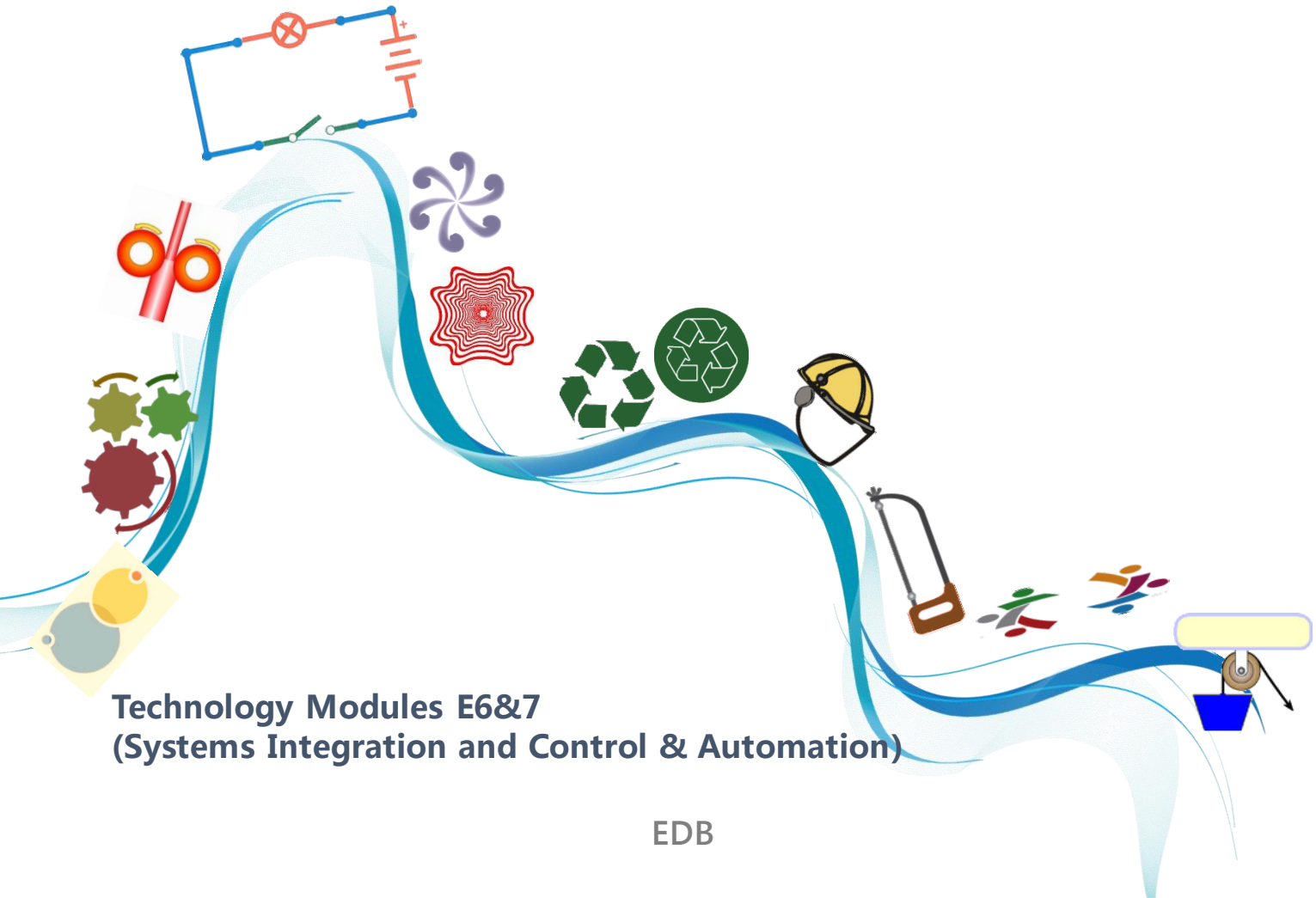
Enriched Technology Education KLA Curriculum

S1 Teaching Material

9

System & Modern Products



Technology Modules E6&7
(Systems Integration and Control & Automation)

EDB

Preface

To support the implementation of the Enriched Technology Education Key Learning Area Curriculum (Enriched Curriculum) at junior secondary level, the Technology Education Section of Curriculum Development Institute, Education Bureau, has developed a set of learning and teaching resource materials covering technological subjects learning element modules for teachers' reference and use.

The purpose of providing this set of teaching resource materials is to enable teachers to adopt the related technological subjects learning element modules under the Enriched Curriculum for students to acquire thorough understanding and mastery of the three key aspects in Technology Education Key Learning Area, viz. the technological understanding, technological capability and technological awareness, using a flexible approach with reference to the suggested learning progress.

The content of this learning and teaching resources was compiled with project approach. It gives students a purposeful and meaningful learning context through a series of diversified activities such as design projects, case studies, technological exploration and simulation experiments, and thus arouses their interest in technology and devotion in learning, as well as nurtures their ability in problem-solving, realisation, innovation and spirit of entrepreneurship.

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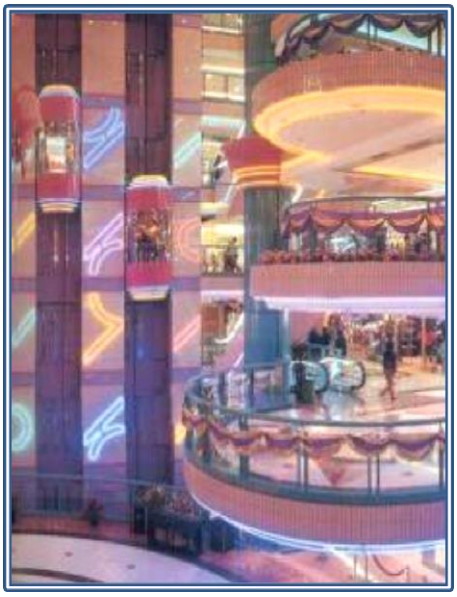
Relevant Knowledge

System Integration and Control & Automation

1. System integration

A system can be quite simple such as the light control system which requires only one single switch. However, with the continual development of technology, many systems have become increasingly complicated and include many different components. Take the lift as an example, it has to use a variety of components that co-ordinate properly with each other before it can take passengers to the different floors safely and quickly.



(a) Sightseeing lifts in the shopping mall

(b) The lift in the hospital

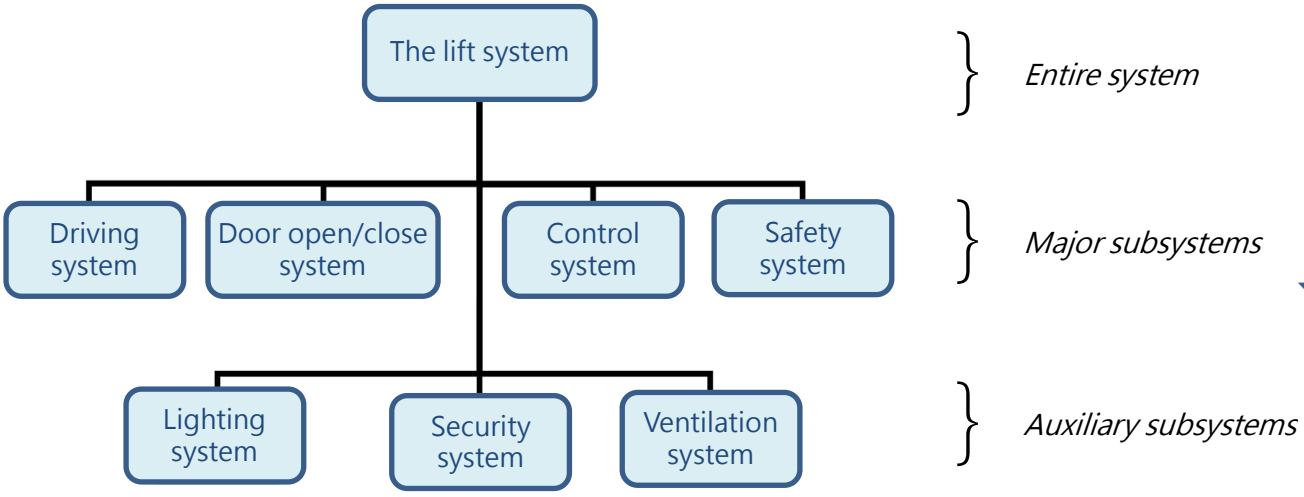
A system may include a large number of smaller parts called subsystems. For example, the lift system includes subsystems such as the driving system, door open/close system, control system, safety system, lighting system, ventilation system, and security system, etc.

(a) Control system

(b) Driving system

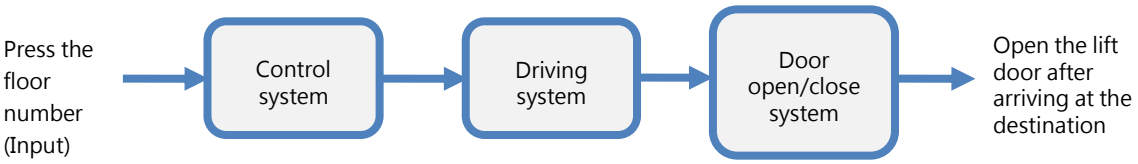
Relevant Knowledge

The multiple subsystems in a lift



In fact each subsystem can be regarded as a stand-alone system, and includes the three independent input, processing and output components. There are connections between the subsystems such that the output of a subsystem may be the input of another subsystem.

Take the lift system as an example, the output of the control system will affect the driving and the door open/close systems.

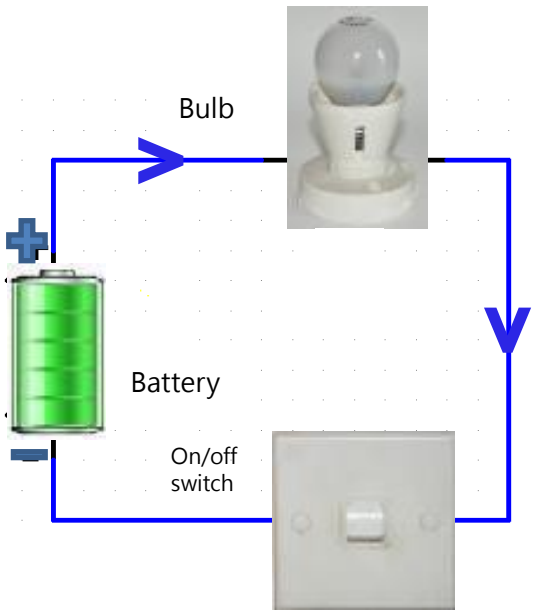


Therefore, when we analyse a complicated control system, we can break down its different parts into simpler subsystems to simplify the understanding of the entire system operation. In addition, with the use of the subsystem concept, it is easier for us to understand the operation principles of the entire system's different parts or components, and the inter-relationships among them. Bulb

2. Basic electrical & electronic systems

As mentioned in teaching material 6, control systems such as electrical, electro-magnetic, electronic, computing, radio frequency, communications, signal processing, etc. all have very close relationships. For example:

A traditional electric fan can be transformed from an electrical system to an electronic system by adding an infrared remote control. When coupled with the temperature sensor, microcomputer controlled wind swinging, speed and time control, etc. it may even become a computer control system.



Relevant Knowledge

Let us refer to them as electronic systems in below:

1. Basic electrical system

The above diagram illustrates a simple circuit which consists of three parts:

1. A source that can provide electric charges or voltages, such as the battery.
2. A path that allows the flow of electrical charges such as a copper wire and a switch.
3. An object with electric resistance, or simply called an object that works with electricity, such as a light bulb.

2. Electronic system

The above simple circuit is in fact a simple but complete system already. Same as any other systems it also includes the three main parts:

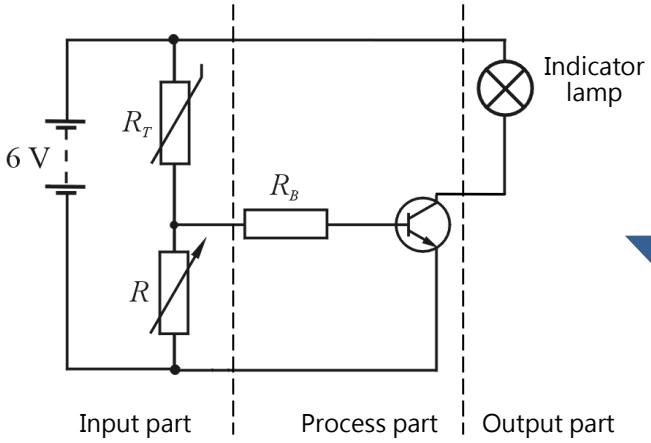
The input, process and output in electronics or electrical systems are usually:

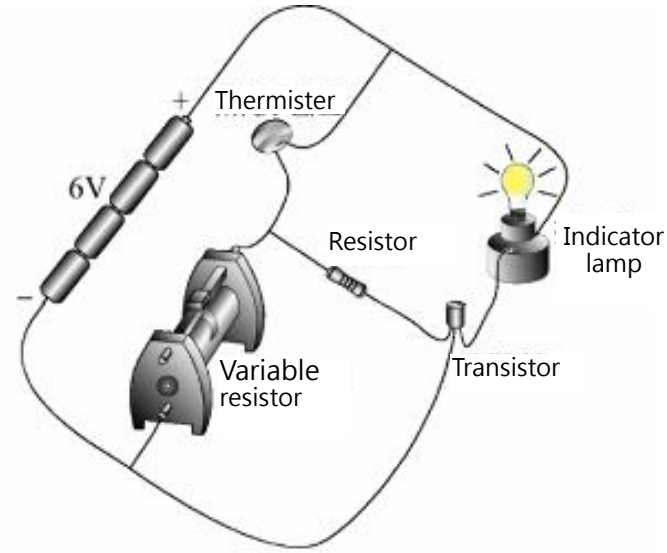
Input - Electrical energy and / or electronic signals.

Process - Uses electronic components, integrated circuits and microprocessors for computing, measurement, memory, calculation, etc.

Output - Produces sound, transmits information, displays on the screen, etc.

3. Modularised electronic system





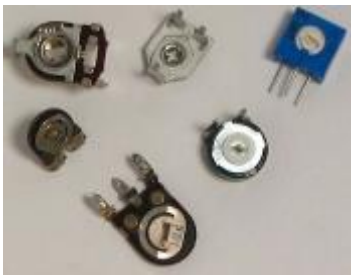
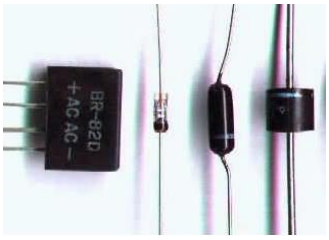
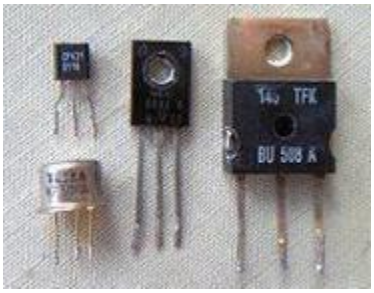
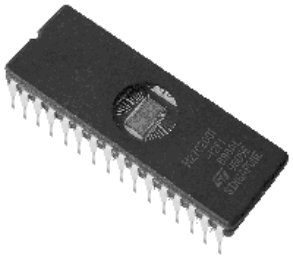
Pictures of physical objects are not commonly used in electronics

The study of electronics often uses electronics circuit diagram, the upper diagram is a typical example of the circuit for a sensor. There are many electronic symbols in the diagram so it is difficult to understand. As it composes of many subsystems, it is easier to use the modular form to learn, design, and analyse them.

Relevant Knowledge

(a) Modules

(b) Components commonly used in the circuit

Input part	Control part	Output part
 Variable resistors	 Diodes	 Buzzer
 Thermistors	 Transistors	 Electric motor (motor)
 Light dependent resistor	 Integrated circuit	 Light emitting diodes (LED)

Relevant Knowledge

4. Modularised electronic systems learning kit

There are many learning kits for modularised electronic systems; students can use them to study electronics and electrical systems.

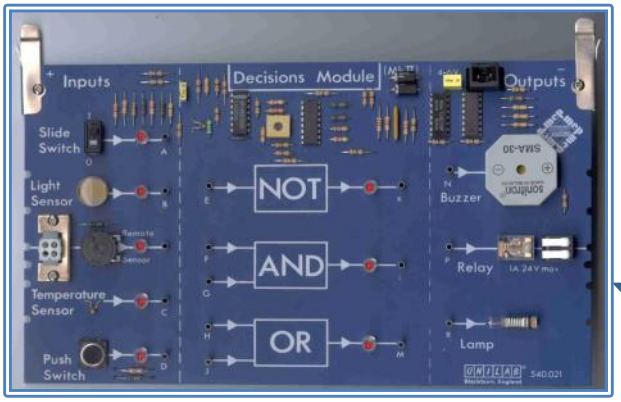
For example, the entry-level kits that can be bought from the Internet

(a)

Simple modular kits

(Example: http://item.taobao.com/item.htm?spm=a230r.1.14.23.4QgTeJ&id=16469936619)

(b) Advanced level kit



(c) Integrated advanced level kit

5. Micro-controller

Micro-controller is a type of programmable integrated circuit chip. The micro-controller can be programmed to perform different functions. It uses a set of instructions or sub-tasks to control the way it works, and allow users to write programs according to these instructions

a) Use of micro-controller

Actually micro-controller is a micro-computer mounted on a chip to perform some scheduled tasks, which can be found in a variety of electronic products used in our daily life. Some examples are illustrated as follows:

Examples of daily electronic products that use micro-controller

Relevant Knowledge

b) Similarities between micro-controller system and personal computer

Micro-controller is similar to a computer, then what's inside a computer?
All computers have several major parts:

- Central processing unit (CPU): can execute programs. When you use the personal computer to browse the Internet, the CPU is actually executing a program to allow the browser to display the particular page.
- Secondary memory (such as hard disk): contains the browser program and the preferred settings of the user.
- Main memory (such as RAM): can store the browser program which the computer is going to execute.
- Input and output devices: allow people to communicate with the outside world during program execution. In your computer, the keyboard and mouse are input devices whereas the monitor and printer are output devices.

The diagram on the right shows an exploded view of the modern PC, but what can be found in a digital camera may only be:

1. Screen (Small)
2. Motherboard (Small)
3. Microprocessor
4. Memory (Small capacity)

.

6. Power supply

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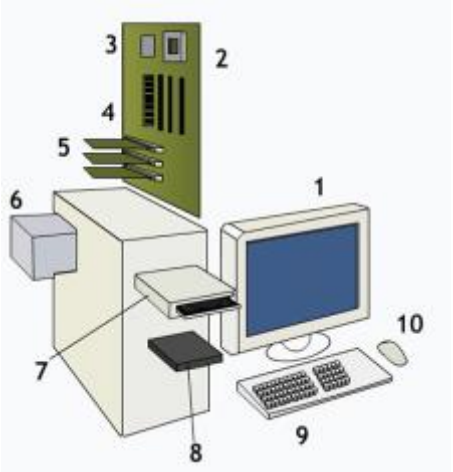


Computer components

1. Screen
2. Motherboard
3. CPU
4. Memory
5. Expansion card
6. Power supply
7. Optical drive
8. Hard disk
9. Keyboard
10. Mouse

10. Only has buttons with functions to move up and down, left and right

3. Automated modern products

Technological development has gone through several different stages. With the invention of the steam engine and various other machines, the first industrial revolution improved the efficiency of production, but at that time the control was still manual. With the emergence of microprocessor and new sensors, many manual control systems have been replaced by computer-controlled systems. Machines become more and more automated and less and less dependent on people, especially for tasks that require precise, monotonic and repetitive, high-risk and distance working, such as robotics, pollution monitoring systems, automation and remote sensing systems.

(a) Robots

"Robot" is officially defined by the Robot Institute of America as "a multifunctional control device designed to move materials, parts, tools or special devices, and to perform different tasks through various programming actions."

Different robots can be used for commercial purposes, usually being used for repetitive, highly accurate with less error actions such as the automobile production line. At all times, the robot requires a control program to control the speed, direction, acceleration, deceleration and distance of the movement.

"Industrial Robot" usually means a manipulator composing of multiple links and linear, rotary or prismatic style rod connection points. At one side the robot is fixed to the supporting base, on the other hand it is equipped with tools for being controlled to perform the tasks. Today, robots are becoming increasingly popular for entertainment and military purposes.

Relevant Knowledge

Industrial robot

Humanoid robot

Mechanical pet

Automatic vacuum cleaner

Relevant Knowledge

(b) Pollution monitoring

In the modern world, technology is progressing but pollution has also increased. We are being surrounded by all kinds of pollution. The environmental agencies collect different pollution data through automated monitoring system (such as, the density of various pollutants in the air) in order to propose targeted improvement measures.

Environmental Protection Department
http://www.epd-asg.gov.hk/cindex.html

(c) Remote sensing systems

Even incidents happened at extremely distanced locations can still affect us. Through remote sensing systems, the environment and natural disasters (landslides, earthquakes, tsunamis, flooding and typhoons, etc.) are being all-weather monitored; the data will automatically be recorded and sent to the users.

Earth station of the satellite remote sensor of the Chinese University of Hong Kong
http://www.iseis.cuhk.edu.hk/groundstation/index.htm

(d) Automation

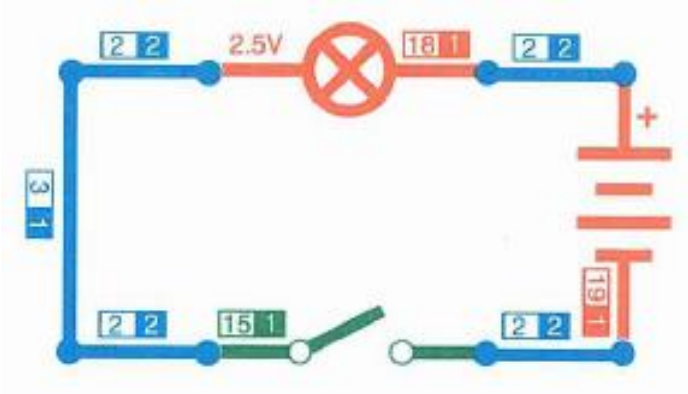
Besides industry and production, automation is also realised in various areas such as astronomy, medicine, military, security, construction, catering, etc. Most Hong Kong people have an octopus card, which developed from initially serving the auto-payment of fares of the five companies under its umbrella. Today it has become an electronic currency, electronic identification for gaining access to designated areas, and also other aspects of automation. The processes have been greatly simplified to make life more convenient and pleasurable.

Smart card
http://www.octopus.com.hk/octopus-for-businesses/business-applications/other-uses/tc/index.html

Lesson Exercises

1. Lighting systems in our daily life include:

Input	Press the switch to connect to the circuit	Press the switch to disconnect from the circuit
Process	Electric current passes through the light bulb via the circuit	Electric current cannot pass through the circuit
Output	The light is on	The light is off



Point out what input, process and output elements have been included in three application systems of our daily life.

	Audio system	( )	( )
Input			
Process			
Output			

2. Give 5 methods that can be used for input control in the circuit:

_____

_____

_____

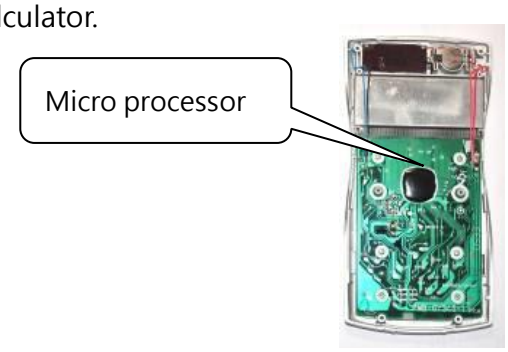
_____

_____

3. Form a group of three with your classmates to discuss on various products which control & automation can be applied.

4. State the subsystems that can possibly be contained in a home TV.

5. State the functions of the micro-controller in a calculator.



Calculator (Cover removed)

Lesson Exercises

6. Like many other electronic devices, when the cover is removed it will be discovered that the "NDS - Lite" portable game console composes of different types of components, including electronic parts, colour LCD display and amplifier, etc., as in the following diagram:

i. Why so many people are interested in such kind of game?

ii. State what electronic parts are there in the "NDS - Lite"?

iii. What is input control? Illustrate what input devices the "NDS - Lite" have?

iv. What is the output of the "NDS - Lite" game console?

Experiment on Modular Electronic System

I. Muted doorbell system

1. Situation

Chi Ming and Chun Kiu have a newborn baby. It has just fallen asleep but is waken up again when the doorbell rings. It is difficult for the baby to fall asleep again.

2. Outline

Design a door bell that will not wake up the baby.

3. Brief

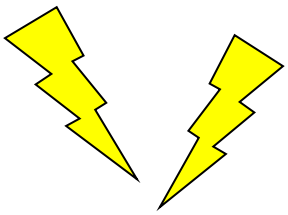
Can turn off the sound to let the baby sleep; but still let them know that there is visitor arriving at the door.

4. Exploration

Starts from a simple standard doorbell system:

***Input** device:*

The visitor presses the button to notify that someone is at the door.

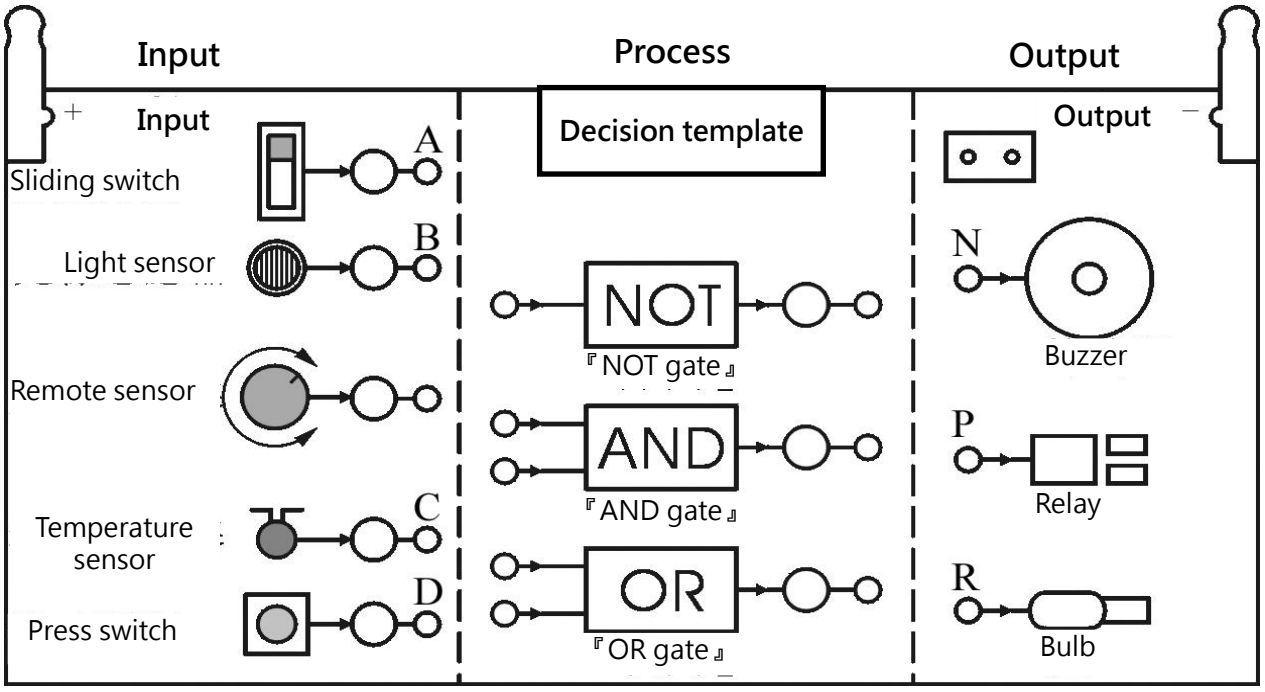


***Output** device:*

The bell rings to inform people inside the house that there is visitor at the door.

5. Test the design

The following exercise will use the **Input → Process → Output** functional template similar to the diagram below

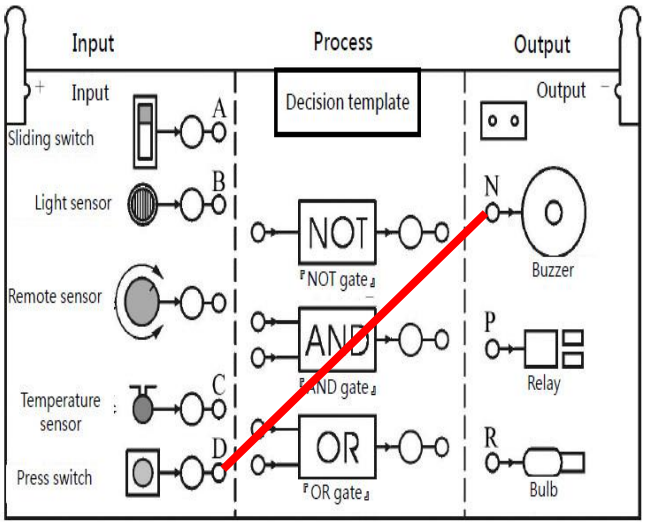


(a) Simple testing

(i) Connect to the power supply.

(ii) Press the "Press button" and you will find the red indicator light at the side rings. This means that it sends a signal to indicate that the "Press button" has been connected.

(iii) The signal has to be sent to the output device in order to complete the system. As in the right diagram, use a wire to connect the "Press button" and the buzzer together.



(iv) A standard doorbell system is now completed; press the "Press button" to test whether it can function properly.

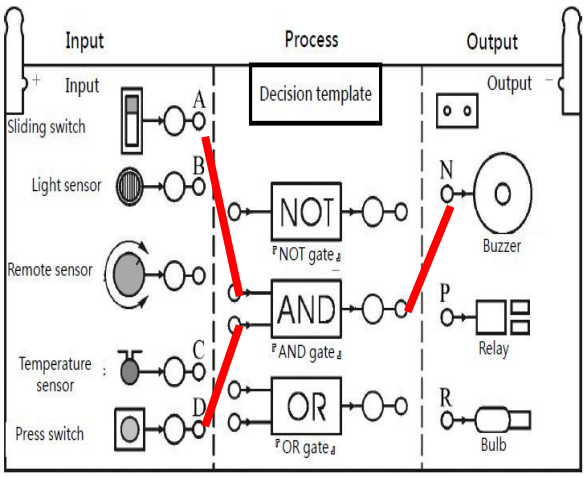
(v) Information is sent from the system's input device to the output device, and information is converted to signal.
That is: Press the button → Transmit information to the buzzer → The buzzer sounds —Visitor is at the door

(vi) The system (from the button to the buzzer) also concurrently conveys another piece of information, when the button is not pressed, the buzzer will not sound — no visitor at the door.

(b) Testing for improved input

(i) Now you have to improve the doorbell system such that it will not wake up the baby.

(ii) This system and the standard one have the same output device, but there are two input devices:
Input device 1: Transmit message to notify that there is visitor at the door.
Input device 2: Transmit message that the baby has fallen asleep, therefore the buzzer will not sound.



(iii) A "Sliding switch" can achieve the effect of input device 2.

(iv) Push the sliding switch from one side to the other side and you will find the indicator light turns on; now connect to the system as shown in the above diagram.

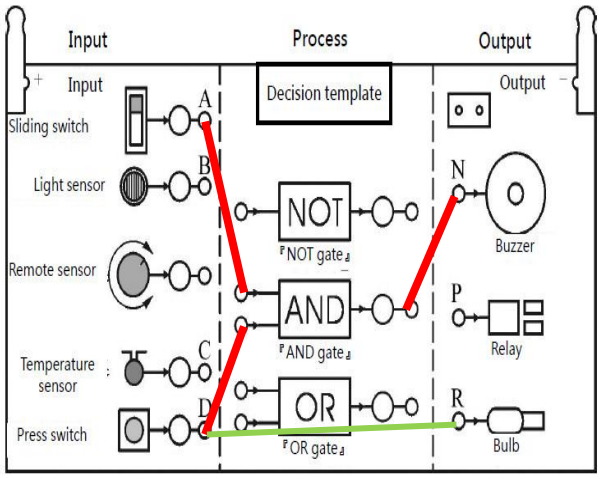
(v) Test whether the system allows Chi Ming and Chun Kiu to turn off the buzzer at any time.

(c) Testing for improved output

(i) The previous system is not perfect. When the buzzer is switched off, there is no way to know whether there is visitor at the door. A perfect system shall add another output device:
Output device 1: produce sound to attract attention.
Output device 2: can arouse attention even when silent.

(ii) "Light" can achieve the effect of output device 2.

(iii) As shown in the right diagram, add another wire to enable signal to be transmitted directly from the button to the light bulb.



(iv) The upper end of all the plugs on the wire is sockets, so it can be extended continuously.

(v) Test the system. Every time when the button is pressed, the light bulb will light up.

(vi) The buzzer will ring only when the sliding button is pushed to one side and the button is pressed simultaneously.

(vii) If your system cannot function properly, please check careful the connection method to ensure consistency with the above diagram.

6. Extended design

If the visitor presses the button only once while Chi Ming and Chun Kiu fail to pay attention to the light bulb, they will not know there is visitor at the door.

Is there any method to improve the design?

II. Thermal system in the farm

1. Situation

Chan Tai Ming is the owner of a farm, and keeping the incubator for chickens warm is very important to him.

2. Outline

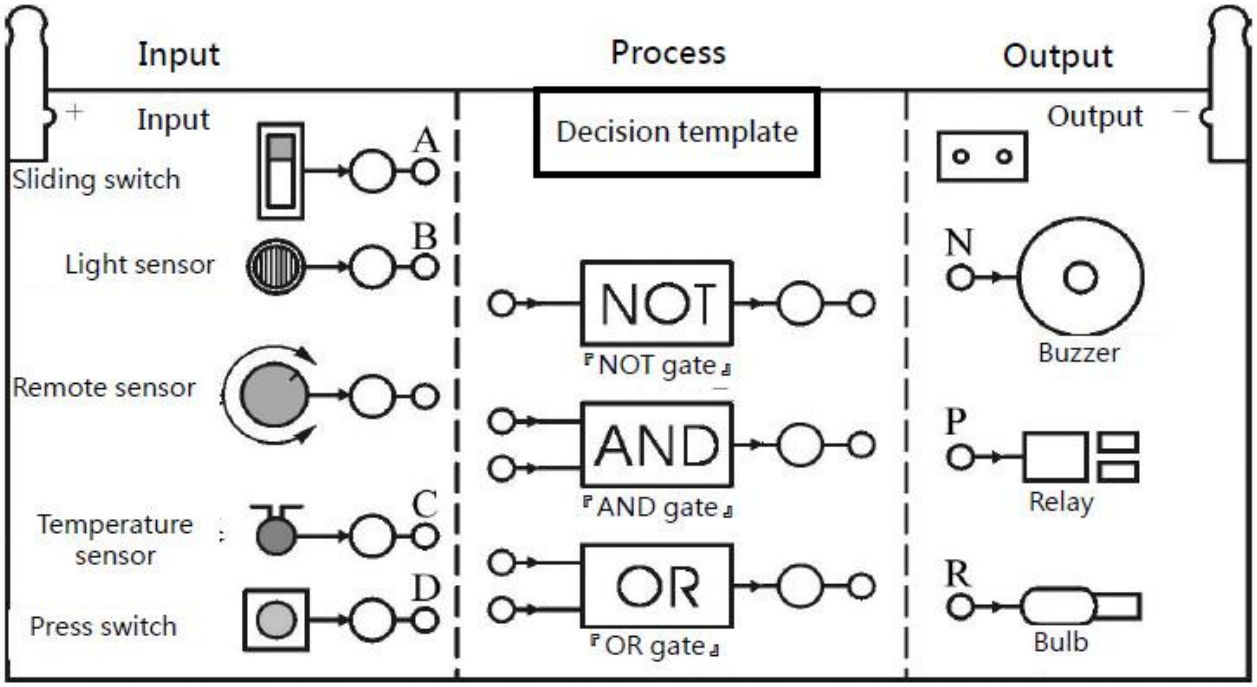
Design a temperature alarm to be used in the incubator.

3. Briefs

A device used to remind the farm owner when the temperature in the incubator is too low.

4. Exploration

Use the simulation solution scheme in the following connection template.



Challenging topic

III. Lights at night

1. Situation

Wan Sze lives alone; she feels nervous every time when someone knocks on the door, especially when the sky becomes dark in the evening.

2. Outline

Design a doorbell system that can adapt to the brightness of the environment.

3. Briefs

When somebody visits during the day time, pressing the bell will make the buzzer sound. During dim time and in the evening, the light outside the door will be lit together with the buzzer sounding.

4. Exploration

Use the simulation solution scheme in the following connection template.