

**Systems and Introduction to Electronics**

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**THE SYSTEMS APPROACH**

###### Solving problems in technology can be made simpler if we use something called the SYSTEMS APPROACH. Most things can be analysed using this method.

###### For most things we want it to do something for us. – This is called the OUTPUT.

To get it to do this we need to put something in. – this is called the **INPUT.**

How this is done is called the **PROCESS.** We do not need to know how it is done so the process is usually put inside a ‘Black Box.’

Process

Input

Output

This block diagram is called the UNIVERSAL SYSTEM and can be applied to any system.

It might help you to understand the idea of a system if you think about some of the systems that are at work in your own body. For example: if you pick up a hot plate by mistake, you quickly put it down. Your fingers sense the heat and pass a signal to your brain, your brain processes (decides what to do) this signal and sends its own signal to the muscles in your arm, then your muscles pull your hands away from the plate.

When going to work in the morning a person can use a car to get there. He or she only needs to know how to drive and to put petrol into it. How it all works can be left to the mechanics in the garage.

Car

Petrol

Movement

###### Task 1

Copy and complete the block diagrams below by adding the correct inputs and outputs.

Doorbell

Windmill

Table lamp

CD player

TV

Hair dryer

###### Extension

Some of these systems can have more than 1 input or more than 1 output. Add anymore you can think of to your block diagrams.

Light sensor

Moisture Sensor

Solenoid

Bulb

NOR gate

Latch

Inverter (NOT gate)

AND gate

Relay

Motor

Push switch

Buzzer

**Output boards**

**Process boards**

NAND gate

OR gate

Transducer driver

Magnetic Switch

Temperature sensor

**Electronics Sub-Systems Boards**

In this unit you will use pre made electronics sub-systems circuit boards and computer simulation to design, build and test electronic circuits. Your teacher will demonstrate how these should be used.

When using the circuit boards there are a few key rules to remember:

 Electricity can harm people and circuits. Always make sure that the supply voltage is set to 6 volts.

 The boards should be carefully handled, used and put away as they are expensive to replace.

 Always connect the boards on a flat surface, line up the edge connectors, and push them gently together.

You will use a variety of input, process and output sub-systems:

**Input boards**

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Power

connection

Light sensor

Transducer driver

Bulb

Power

connection

Switch

Transducer driver

Buzzer

Make sure you understand what a transducer and a transducer driver are.

**Task 3: An Automatic Light**

 Build the circuit shown below.

Answering in sentences:

1. What happens when you cover the light sensor?

2. What happens when you adjust the sensitivity dial on the light sensor?

3. What are the main inputs and outputs to this system? Add them to your sub-system diagram.

4. What does the transducer driver do in this circuit?

NOTE: From now on the power connection will not be shown in sub-systems diagrams, but must still be used.

**Task 2**

1. Build and test this circuit using the E&L Boards

2. Build the circuit without the Transducer Driver. What happens without it? Answer in sentences

**The Inverter (NOT gate)**

***Invert***means ‘***upside down’*** or *‘****opposite****’*. The skater in the picture is inverted. That means he is upside down, definitely opposite to the way human beings normally are!

In electronics, an ***inverter***takes an input signal and gives out the opposite.

This means it turns an on into an off, or an off into an on. An inverter is

often called a ***NOT gate***, because if the ***input is on the output is not on***,

and if ***the input is off the output is not off***!

A better way of explaining this is to use a diagram,

or construct a ***truth table***:

![xmas-invert[1]]()

*On (logic 1)*

Off (logic 0)

*Off (logic 0)*

On (logic 1)

Inverter

![MCj02909300000[1]]()

Input A

Output Z

Truth tables are often used in many areas of engineering (electronics in

particular). Remember, 1 = on and 0 = off.

Truth table for an inverter.

Symbol for an inverter (you will need to use this later in the course)

|  |  |
| --- | --- |
| **Input A** | **Output Z** |
| 0 | 1 |
| 1 | 0 |

![MCj02909300000[1]]()![MCj02909300000[1]]()![MCj02909300000[1]]()![MCj02909300000[1]]()![MCj02909300000[1]]()

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Truth table for an inverter.

Symbol for an inverter (you will need to use this later in the course)

On (logic 1)

*Off (logic 0)*

Off (logic 0)

*On (logic 1)*

Inverter

**Task 3: The Inverter**

Build up the circuit.

Experiment with this simple circuit and once you are happy with how it works answer the following questions in sentences where appropriate.

Light Sensor

Inverter

Transducer driver

Bulb

1. Build the circuit without the inverter, then add the inverter back into the circuit. What effect does the inverter have to the circuit?

2. What are the main inputs and outputs to this system? Add them to your sub-systems diagram.

3. The inverter is sometimes called a NOT gate. Fully explain why this is.

![TSW-PLUS-5_small[1]]()![23365509[1]]()

voltage

Off

time

On

Positive edge

Negative edge

**The Latch**

Mechanical latches are used all the time on doors and gates. When the door is closed the latch holds the door in the closed position. The latch must be reset before the door can be opened.

Electronic latches work in a similar way. When the ***latch*** receives an*‘****on****’* signal it will switch on the output, and the latch is **set**. When the input signal is removed, ***the latch will stay on*** and so the output will stay on ***until the reset button is pressed***.

Think about a simple burglar alarm that is triggered when a burglar steps on a pressure pad. The output alarm must stay on even if the burglar steps off the pressure pad:

Pressure pad

Latch

Buzzer

Transducer driver

A push switch turns on an output when pressed, but switches off the output when not pressed.

A latch switch will turn on an output when pressed, and will stay on until it is reset.

**Positive and Negative Edge Triggered Latches**

Look at the graph. When a circuit is off it has no voltage, and when it is on it has a positive voltage. The transition between off and on is called a ‘***positive edge****’* because the ***voltage is rising***. The transition between on and off is called a ‘***negative edge’*** because the ***voltage is falling***.

1. Add the main inputs and outputs to your sub-systems diagram.

2. What happens when you increase the light level to the light sensor?

3. What happens when you make the light sensor dark again? Is this what you expected to happen?

4. What does the reset button on the latch do?

5. Explain what the latch does in this circuit, and why it is called a ‘latch’.

6. Explain the difference between ‘positive edge’ and ‘negative edge’ triggered devices.

Light

sensor

Latch

Transducer driver

Bulb

**Task 4: The Latch Unit**

Build the circuit using circuit boards.

**Logic Gates**

There are 5 main logic gates: The NOT gate (which you have already used), the AND gate, OR gate, NAND gate and NOR gate. Their job is to take input signals, and decide what the output signal should be. They are used every day in many electronic devices.

Build the circuits and see how they work. Complete the Truth tables as you test them.

**The AND gate**

Switch

Switch

AND GATE

Transducer driver

Bulb

A

B

Z

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **Z** |
| 0011 | 0101 |   |

**Symbol for an AND gate** (you will learn more about electronic symbols later)

**Truth table for an AND gate**

Switch

**The OR gate**

Light

sensor

OR GATE

Transducer driver

Motor

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **Z** |
| 0011 | 0101 |   |

A

B

Z

**Symbol for an OR gate**

**Truth table for an OR gate**

Z

Switch

**The NAND gate**

Light

sensor

NAND GATE

Transducer driver

Bulb

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **Z** |
| 0011 | 0101 |   |

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **Z** |
| 0011 | 0101 |   |

![MCj02909300000[1]]()**Task 5**

Switch

Z

A

B

**Truth table for a NAND gate**

**Symbol for a NAND gate**

Light

sensor

NOR

GATE

Transducer driver

Buzzer

**Truth table for a NOR gate**

**The NOR gate**

**Symbol for a NOR gate**

Z

A

B

You should have discovered that a NAND gate is the same as an inverted AND gate. That’s how it gets its name: inverted AND = NOT AND = NAND. Likewise, a NOR gate is just like an inverted OR gate. Inverted OR = NOT OR = NOR.

Switch

Light

sensor

Magnetic Switch

AND GATE

OR GATE

Transducer Driver

Bulb

Build this circuit.

Test the circuit and complete the Truth Table for the system.

|  |  |  |  |
| --- | --- | --- | --- |
| Magnetic Switch | Light Sensor | Switch | Bulb |
| 0 | 0 | 0 |  |
| 0 | 0 | 1 |  |
| 0 | 1 | 0 |  |
| 0 | 1 | 1 |  |
| 1 | 0 | 0 |  |
| 1 | 0 | 1 |  |
| 1 | 1 | 0 |  |
| 1 | 1 | 1 |  |

**Incorporating a Motor**

The motor is used when converting electrical energy to kinetic energy. Another way of thinking about this is it is making a connection between an electrical circuit and a mechanical system.

**Your teacher will explain how to set up the connection between the relay and the motor**

Build and test this circuit.

Transducer driver

Switch

Relay

Motor

**Task 6**

Draw below the electrical connections between the relay and the motor

**Exercise 1**

![MCj03014840000[1]]()

 **Checkpoint: Garage Door**

 **Design, build and test a system that will automatically open a garage door when the owner flashes his headlights. The door must stay open until the car is safely in the garage and the owner presses a reset button to close the door.**

1. Draw a systems diagram for the task.
2. Design a circuit to meet the requirements of the task.
3. Build and test your circuit.
4. Does it work as you expected it to?
5. If you had to make any changes what were they?

**Exercise 2**

![MCj03014840000[1]]()

**Checkpoint : Burglar Alarm**

**Design, build and test a system that will automatically sound an alarm if a burglar enters a building and steps on a pressure pad underneath a window, or breaks an invisible light beam. The alarm should continue to sound until a reset button is pressed.**

1. Draw a systems diagram for the task.
2. Design a circuit to meet the requirements of the task.
3. Build and test your circuit.
4. Does it work as you expected it to?
5. If you had to make any changes what were they?

**Exercise 3**

![MCj03014840000[1]]()

**Checkpoint :Greenhouse Task**

**A flower grower can lose many young plants worth a great deal of money if the temperature in a greenhouse falls too low. The grower cannot have the heating on during the night just in case of low temperature because the fuel bills will be too high.**

**You therefore have to design a fan system that will switch on automatically in the night if the temperature falls too low.**

**You can use the motor to represent the fan**

1. Draw a systems diagram for the task.
2. Design a circuit to meet the requirements of the task.
3. Build and test your circuit.
4. Does it work as you expected it to?
5. If you had to make any changes what were they?

**Summary of your Knowledge and Understanding of this unit.**

|  |  |  |  |
| --- | --- | --- | --- |
|   |   |   | ***I can…*** |
|   |   |   | Draw a universal system diagram. |
|   |   |   | Identify inputs and outputs to a system. |
|   |   |   | Build circuits using a switch unit, light sensor, or temperature sensor. |
|   |   |   | Explain how a latch operates. |
|   |   |   | Build circuits using AND gates and OR gates. |
|   |   |   | Explain what an inverter does. |
|   |   |   | Describe how an inverter can make a light sensor into a dark sensor. |
|   |   |   | Complete truth tables for NOT, AND, and OR gates. |
|   |   |   | Complete truth tables for NAND and NOR gates. |
|  |  |  | Connect a Motor to a Relay Device |

**On a scale of 1 to 10 in which 1 is very poor and 10 is the best how do you think you performed.**

**Achievement**

**Effort**

**Behaviour**

**Completion of Unit Yes No Teachers Signature**: