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الإمـارات العـربيـة المتحدة
وزارة التـربيـــة والتعليـــم

CDI Revision Notes

Term 1 (2017 – 2018)

Grade 11 General

Unit 1 – Materials and Unit 2 – Fundamentals of Electronics

STUDENT INSTRUCTIONS –

- Student must attempt **all** questions.
- For this examination, you must have:
  - (a) An ink pen – blue.
  - (b) A pencil.
  - (c) A ruler.
  - (d) A calculator (if required).
- Electronic devices are not allowed.

Examination Specifications		
Domain	Marks	Time
Section 1 - 5 Multiple Choice Questions	5 Marks	3 - 4 minutes
Section 2 - 5 True or False Statements	5 Marks	3 - 4 minutes
Section 3 - 2 Short answer Questions 2 Diagram Questions 1 Matching Task	10 Marks (2 x 5) 20 Marks (2 x 10) 10 Marks	8 - 10 minutes 10 – 12 minutes 3 – 5 minutes
	Total – 50 Marks	Total – 35 minutes (5 minutes reading)

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الإمـــارات العـربيـة المتحدة
وزارة التربيـــة والتعليـــم

UNIT 1 - MATERIALS
SECTION 3 – METALS AND TREATMENTS

Word	Meaning
Ferrous metal	These are the metals that contain some iron.
Non – ferrous metal	These are the metals that do not contain iron.

Ferrous	Non-Ferrous
	
• Contain Iron • Magnetic • Examples: cast iron, mild steel, stainless steel	• Do not contain iron • Non magnetic • Examples: aluminium, copper, lead, zinc, gold and silver

Examples of ferrous metals:

IMAGE	NAME	COMPOSITION	PROPERTIES	USES
	Cast Iron	Iron + 3.5% carbon	Smooth skin with soft core, strong when compressed, self-lubricating, cannot be bent or forged.	Vices, lathe beds, garden bench ends, car brake drums, cooking pans etc.
	Mild Steel	Iron + 0.15 - 0.35% carbon	Ductile, malleable & tough, high tensile strength, poor resistance to corrosion, easily welded.	Car bodies, washing machine bodies, nuts & bolts, screws, nails, girders, etc.
	High Carbon Steel (tool steel)	Iron + 0.8 - 1.5% carbon	Very hard, rather brittle, difficult to cut, poor resistance to corrosion.	Tool blades e.g. saws, chisels, screwdrivers, punches, knives, files, etc.
	High Speed Steel	Iron + tungsten chromium vanadium	Very hard, heat resistant, remains hard when red	Drills, lathe cutting tools, milling cutters, power hacksaw blades etc.
	Stainless Steel	Iron + chromium nickel magnesium	Tough and hard, corrosion resistant, wears well, difficult to cut, bend and file	Cutlery, sinks, teapots, dishes, saucepans etc.

United Arab Emirates
Ministry of Education

الإمـارات العـربيـة المتحدة
وزارة التـربيـــة والتعليـــم

IMAGE	NAME	COMPOSITION	PROPERTIES	USES
	Aluminium	pure metal	Good strength/ weight ratio, malleable and ductile, difficult to weld, non-toxic, resists corrosion. Conducts heat and electricity well. Polishes well.	Kitchen foil, saucepans, drinks cans, etc.
	Duralumin	Aluminium + manganese magnesium	Stronger than pure Aluminium, nearly as strong as mild steel but only one third the weight.	Greenhouses, window frames, aircraft bodies, etc.
	Copper	pure metal	Tough, ductile and malleable. Conducts heat and electricity well. Corrosion resistant, solders well. Polishes well.	Electrical wire, central heating pipes, circuit boards, saucepan bases
	Brass	Copper + zinc	Quite hard, rigid, solders easily. Good conductor of heat and electricity. Polishes well.	Water taps, lamps, boat fittings, ornaments, door knockers.

	Bronze	Copper + tin	Tough, strong, wears very well, good corrosion resistance.	Coins, wheel bearings, statues, boat fittings
	Tin	pure metal	Weak and soft, malleable and ductile, excellent corrosion resistance, low melting point.	Solder (with lead), coating over mild steel (tin can).
	Lead	pure metal	Soft, malleable, very heavy, corrosion resistant, low melting point, casts well, conducts electricity well.	Roof coverings, solder (with tin), car battery plates.

United Arab Emirates
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الإمـــارات العـربيـة المتحدة
وزارة التـربيـــة والتعليـــم

SECTION 4 – PLASTICS AND COMPOSITES

Word	Meaning
Thermosetting plastics	Plastics that **cannot be reshaped** by heating but can withstand higher temperatures.
Thermoplastics	Plastics that can be **reshaped** by heating
Composite	A material that is made by combining two or more materials. They do not bind or merge together.

Thermoplastics	Thermosetting Plastics
Heated and can be reshaped.	Do not reshape with heat.
Plastics become soft at a temperature lower than 100.	Withstand higher heat than thermoplastics.
Plastic bottles.	Saucepan handles, electric socket.

Glass Reinforced Plastic (GRP)
• Known better as fiberglass • Composite made from combining glass fibers and polyester resin • Tough, rigid and lightweight • Boat hulls, car body shells and canoes

Carbon Fiber Reinforced Plastic (CFRP)
• Most expensive composite. • Best strength to weight ratio of any construction material • It is made from high tensile strength carbon fibers which are woven together and then incased in a plastic resin. • Resistant to stretching, rigid material, light in weight • Can withstand high temperatures • Formula One cars, racing bikes and helicopter blades

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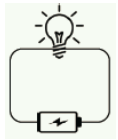
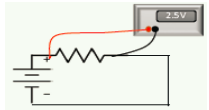
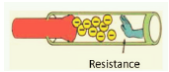
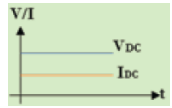
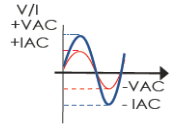
Ministry of Education

الإمـــارات العـربيـة المتحدة
وزارة التـربيـــة والتعليـــم

UNIT 2 – FUNDAMENTAL OF ELECTRONICS
SECTION 1 – ELECTRICAL CIRCUITS

Word	Meaning	Image
Electrical Circuit	A closed path for electrons to move through electrical components, connected by a conductive wire.	
Schematic Diagram	A graphical representation of an electrical circuit that uses symbols.	
Voltage	The charge difference between two points.	
Current	The rate at which electric charge flows through a certain point .	
Resistance	A material's tendency to resist (oppose) the flow of charge (current) .	
DC	An electric current that flows in one direction and has a constant voltage level; used in devices that use batteries or USB cables for power	
AC	An electric current that periodically changes its direction; the voltage level also reverses with the current; used to deliver power to houses, office buildings, etc.	
Battery	An electrical DC power source	

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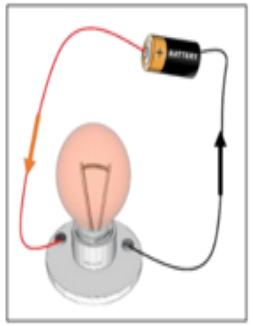
INTRODUCTION

We use electricity in our daily lives to power our electric devices. **For example** –

- Cars get electric power from batteries.
- Computers, televisions, air conditioners, cell phone chargers & electric wall sockets.

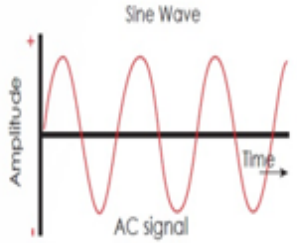
Electric current is the flow of electric charge carried by electrons. Electrons are very small particles within atoms. They carry electric energy and flow through defined paths known as **electric circuits**.

Electronics is described as the science of dealing with electricity. **For example** - An electronic appliance has more functions than a simple electrical device. An electronic kettle could maybe send an SMS to your phone, telling you that your water is ready. A simple electric kettle **ONLY** boils water.

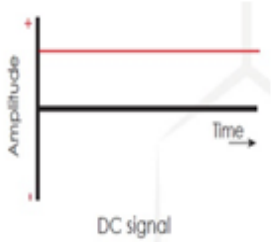


Electric Circuit : Group of electric components connected by conductors for current flow.

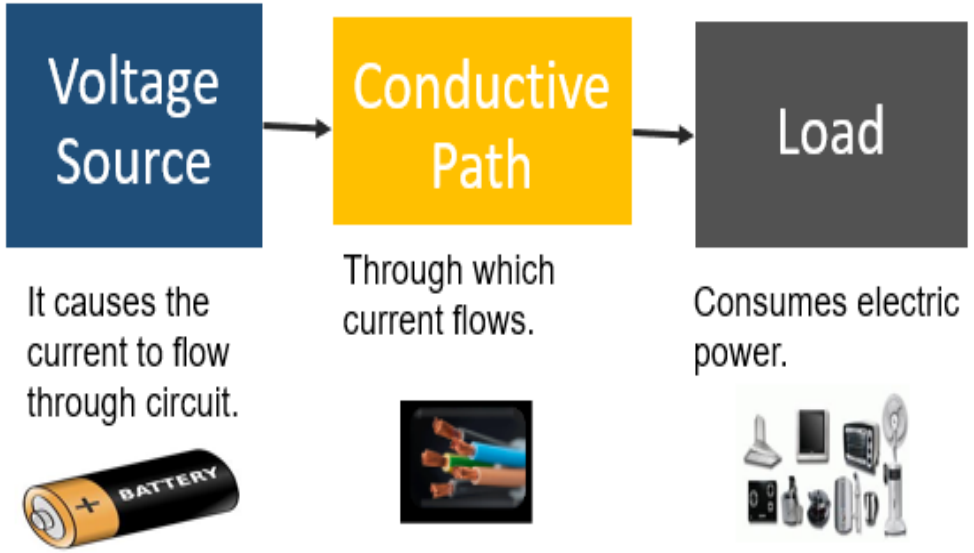
Types of Voltage Source



Alternating Current : Wall Socket



Direct Current : Battery

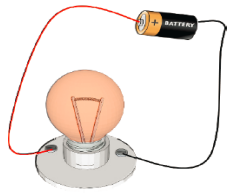


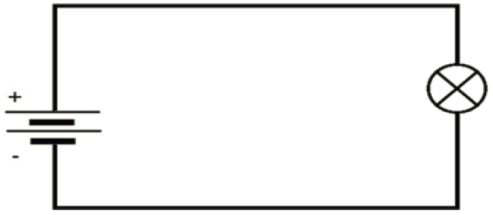
United Arab Emirates
Ministry of Education

الإمـــارات العـربيـة المتحدة
وزارة التـربيـــة والتعليـــم

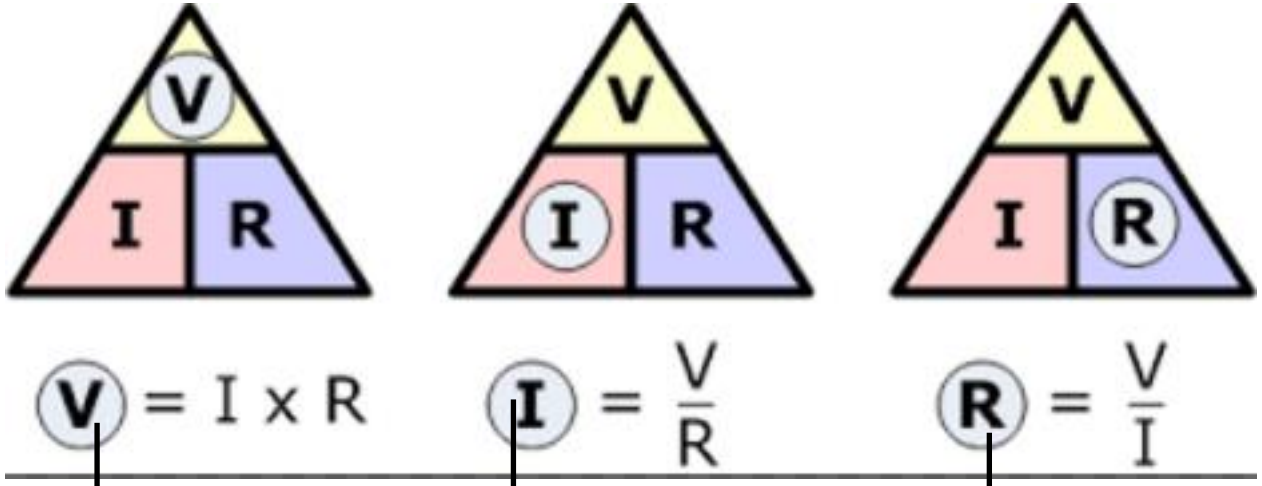
ELECTRICAL SCHEMATIC

An electrical wire	
A connected wire	Connected
A disconnected wire	Not connected
A battery	+ - or + -
A light lamp or load	
Motor	M

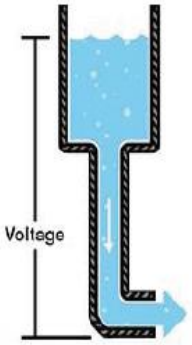


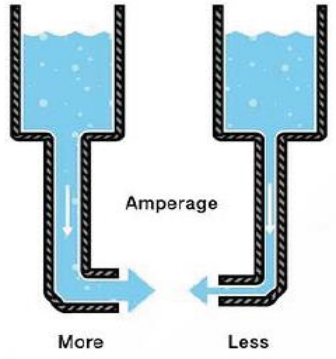


Ohm's Law

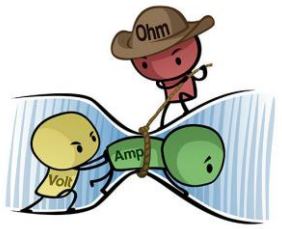


- **Voltage** is the difference in charge between two points.
- Measured in Volts(V).





- **Current** is the rate at which charge is flowing.
- Measured in Amperes(A).



- **Resistance** is a material's tendency to resist the flow of charge (current).
- Measured in Ohms(Ω).

United Arab Emirates
Ministry of Education

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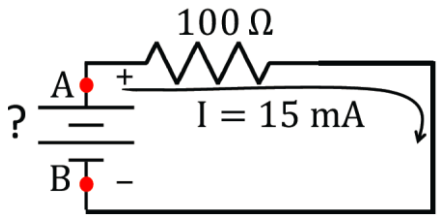
Problem 1:

Using Ohm's Law, what is the **voltage difference** between point A and B if the **current** flowing through the resistor is **15 mA,** and the **resistance** is **100 Ω**?



Solution:

V = I × R = 0.015 A × 100 Ω =1.5 V

Problem 2:

If the resistor in the previous example is replaced with another resistor, that has double the resistance, how much current would be flowing in the circuit using the same 1.5V battery as a voltage supply?

Solution:

V = 1.5 V,
R = 2 × 100Ω = 200 Ω
V = I × R ⟶ I = V / R = 1.5 V / 200 Ω = 0.0075 A = 7.5 mA

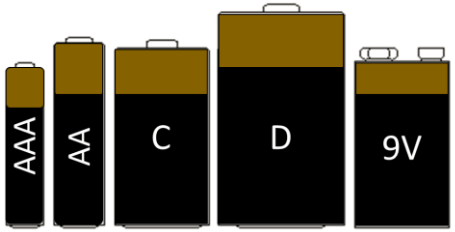
Problem 3:

Compare the value of the new current with the value of the initial current. Justify your answer.

Solution:

The new current is half the initial current (7.5 is half of 15). When the resistance was doubled, the current flowing became less (half the original current). This is because current is INVERSELY proportional to the resistance.

BATTERIES



- A battery is a common DC power supply.
- A battery is made up of two plates. One plate is positively charged (+), the other plate is negatively charged (-).
- The plates are surrounded by a chemical solution called electrolyte.
- The electrical energy of a battery is made by converting the chemical energy of the battery. This happens when a chemical reaction between the plates and the electrolyte produces a voltage difference between the two plates.
- This makes the electrons flow and generates an electric current.
- The figure below shows some commonly used batteries that are available at the market. Each type has a different voltage.

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Ministry of Education

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وزارة التـربيـــة والتعليـــم

SIGNAL - For receiving and sending information

1. Analog Signals

- This signal has infinite number of values.
- Stored in continuous form between minimum and maximum value.

Examples

- Brightness of sun
- Room temperature
- Speaker
- Mixing colors
- Old radio
- Old photograph

2. Digital Signals

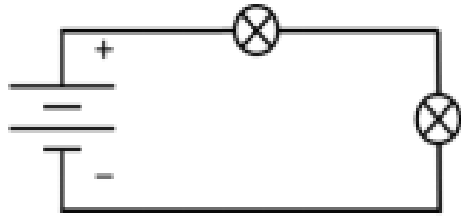
- These signals have a finite set of possible values(0V or 5V).
- Stored in coded form (0,1) (min., max.)

Examples

- Light switch in class room.
- Power button of phone.
- Game controller buttons
- Calculator screen
- Digital camera
- Digital music player

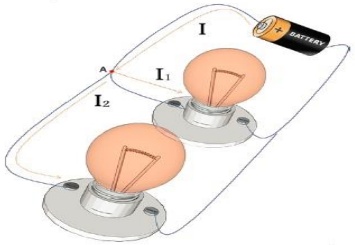
SERIES CIRCUITS

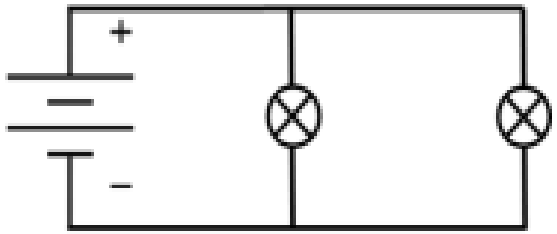
- Electric current flows in **ONE** defined path in series circuits.
- The current must flow through the wires, all the way through both light bulbs and back to the battery.



PARALLEL CIRCUITS

- In parallel circuits, electric current has more than one path.
- The components are connected to the same common points, this allows the current to be distributed over the paths.





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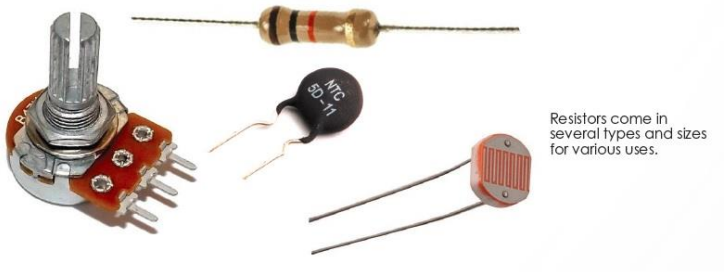
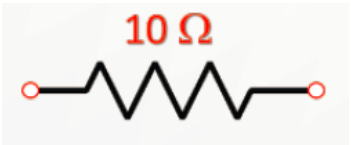
الإمـــارات العـربيـة المتحدة
وزارة التـربيـــة والتعليـــم

SECTION 2 – RESISTORS

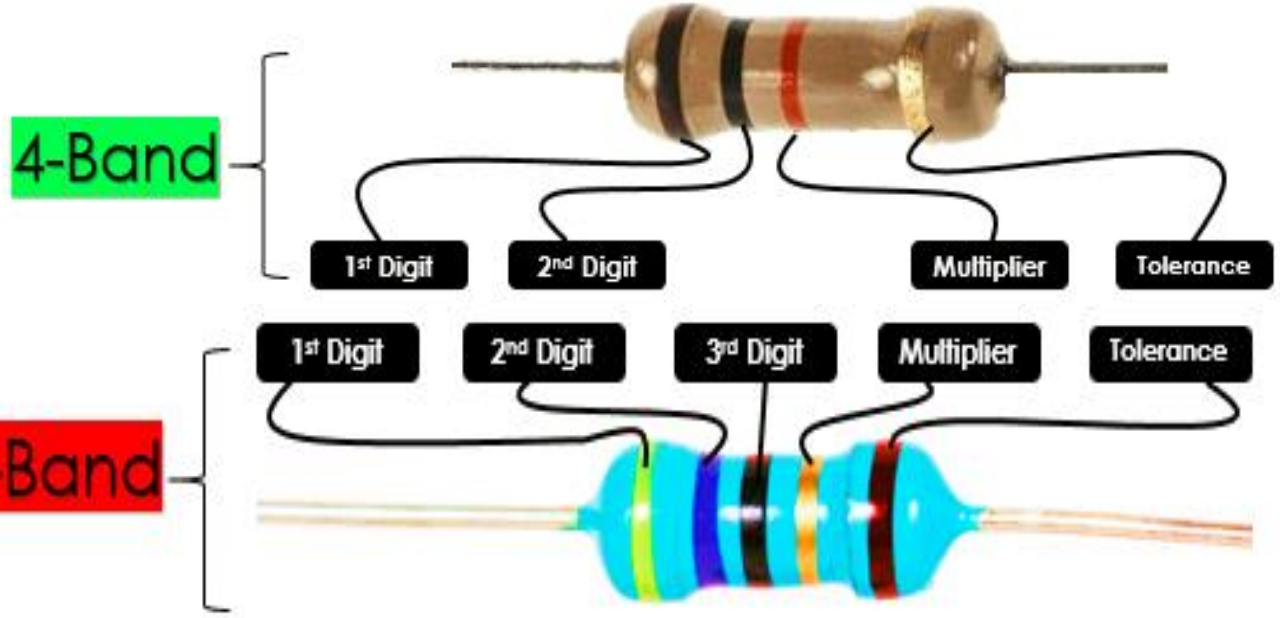
Word	Meaning	Image
Resistor	An electronic component that resists the flow of current in an electric circuit.	
Colour Code Table	A table used to find out the resistance value of the colour coded resistor.	



- Resistors are also used to divide voltages.
- The schematic symbol is shown below –



Types of Resistors



Tolerance is the maximum electrical or mechanical variations plus or minus in the specifications tolerated without affecting the operations of the device.

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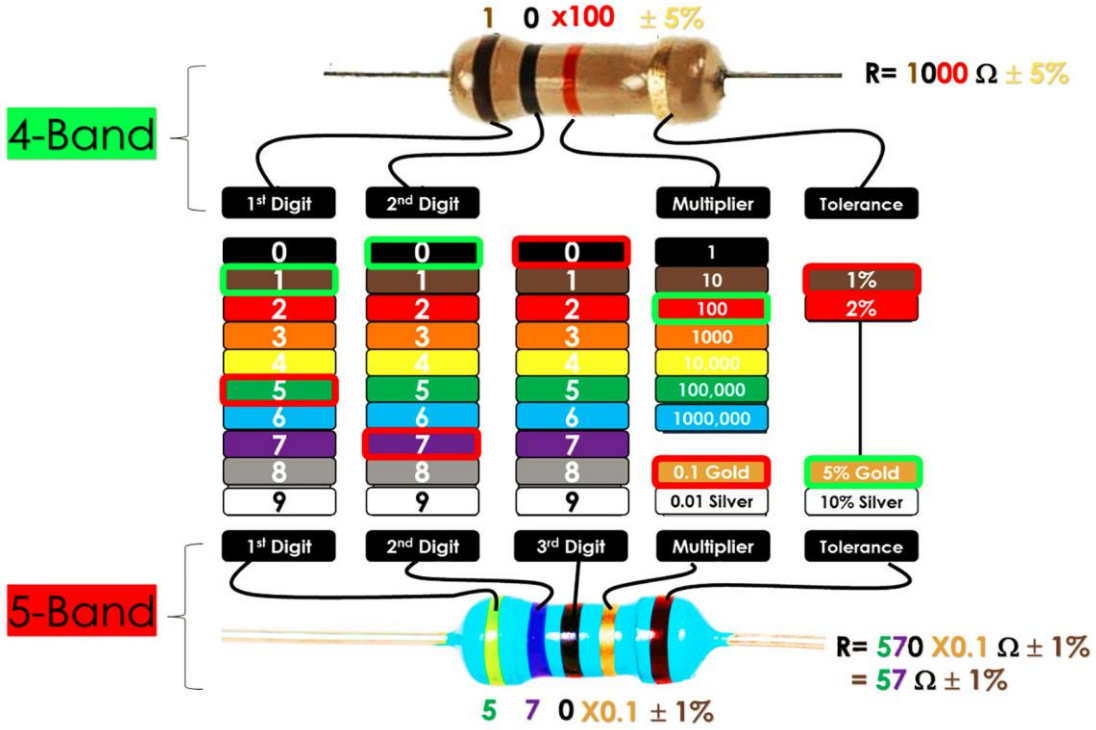
The resistance of a resistor



For the 4-band resistor, the tolerance is ±5%. This means that the real resistance of this resistor will not be exactly 1000 Ω. It might be +5% more or -5% less than 1000 Ω. So how much is 5% of 1000 Ω?

Tolerance = ±5 % of 1000 Ω

5% of 1000 Ω = $\frac{5}{100}$×1000 Ω= 50 Ω

∴ Tolerance= ± (5 % of 1000) = ±50 Ω

∴ R=1000 Ω ± 50 Ω

∴R is between (1000-50) Ω and (1000+50) Ω

∴ R is between (950) Ω and (1050) Ω

We call this a 'range'. So, the range of the resistance is {950 Ω to 1050 Ω}.

For the 5-band resistor, the tolerance is ±1%. This means that the real resistance of this resistor will not be exactly 57 Ω. It might be +1% more or -1% less than 57 Ω. So how much is 1% of 57 Ω?

Tolerance = ±1 % of 57 Ω

1% of 57 Ω = $\frac{1}{100}$× 57 Ω= 0.57 Ω

∴ Tolerance= ± (1 % of 57) = ±0.57 Ω

∴ R= 57 Ω ± 0.57 Ω

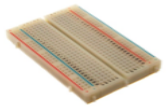
∴R is between (57 – 0.57) Ω and (57 – 0.57) Ω

∴ R is between (56.43) Ω and (57.57) Ω

We call this a 'range'. So, the range of the resistance is {56.43 Ω to 56.43 Ω}.

	Colour 1	Colour 2	Colour 3	Colour 4	
4-Band	1st Digit	2nd Digit	Multiplier	Tolerance	
	1	0	100	5%	
	R= Digit1 Digit 2 x Multiplier ± Tolerance R = 10 x 100 ± 5% = 1000 Ω ± 5% = 1kΩ ± 5%				
5-Band	Colour 1	Colour 2	Colour 3	Colour 4	Colour 5
	1st Digit	2nd Digit	3rd Digit	Multiplier	Tolerance
	5	7	0	0.1	1%
	R= Digit1 Digit 2 Digit 3 x Multiplier ± Tolerance R = 570 x 0.1 ± 1% = 57 Ω ± 1%				

SECTION 3 – ELECTRONIC CALCULATIONS

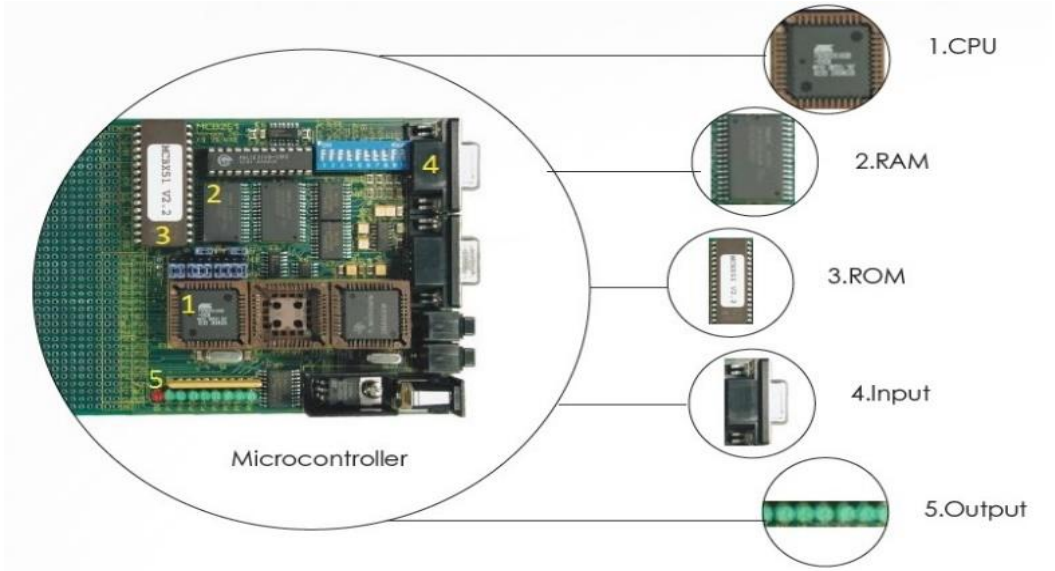
Word	Meaning	Image
Breadboard	An electronic base used for building prototypes for electric circuits.	
Multimeter	An electronic device used for measuring different electrical values.	

Breadboard	Multimeter
• There are three main components – (1) Nodes – electronic components are connected to the nodes. (2) Power Rails – It is used to supply the board with power. Internally these nodes are connected vertically. (3) Terminal stripes – These are the horizontally connected nodes. • They are marked with letters (columns) and numbers (rows) to help build the circuit properly.	• It also checks the continuity in a circuit. • The different values measured are - current (Amps – AC & DC) - resistance (Ohms) - voltage (Volts – AC or DC) - diode testing, - capacitance (Farads), - transistor testing, etc. • It has two probes.

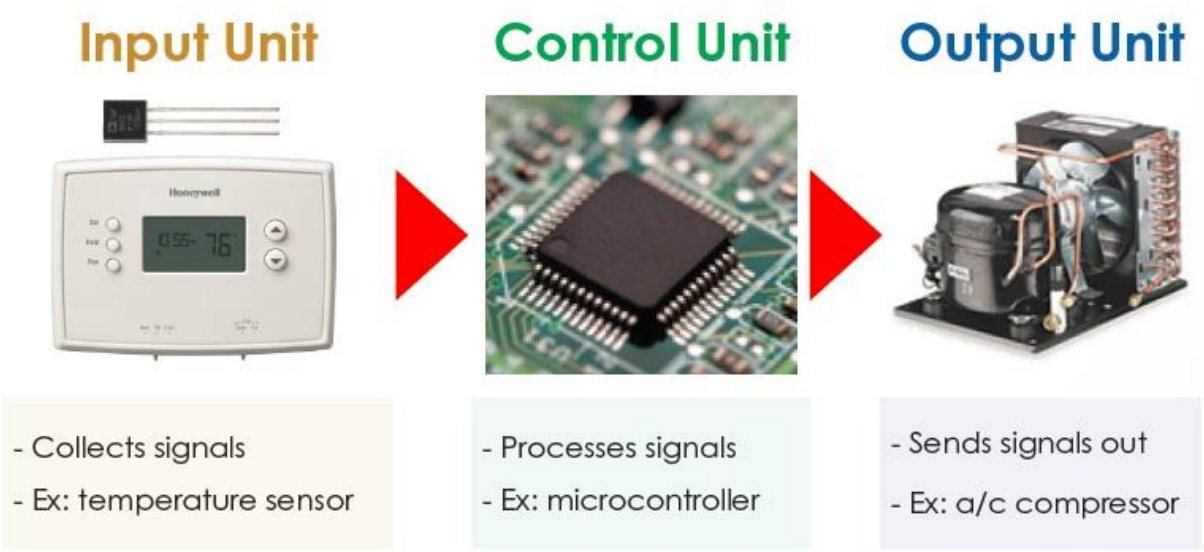
SECTION 4 – EMBEDDED SYSTEMS

Word	Meaning
Embedded system	A computer system that has a specific function within a larger system.
Microcontroller	A minicomputer that fits on a single chip and controls a system.
Processing	A series of actions / steps that lead to a certain result.
Input	The information or data entered into a system.
Output	The information or data produced by a system based on the input information.

- **Embedded systems** : It is a specialized computer system with a specific function within a larger mechanical or electrical system. Examples include an air conditioner in car; a seatbelt warning in a car, a garden watering system & a motion sensitive security system.
- An “embedded system” is known as an **input.** It is a device that contains a **computer unit or a microcontroller** that reads the changes in an environment. It then controls an **output** system to change the environment.
- **Controller** : It is an electronic chip that works as a computer to manage the operation of electronic devices. It controls certain machines. It can be programmed to read input and controlling output. It has 3 main parts.



A controller has four main parts: central processing unit, random access memory, read only memory and I/O ports. When all these parts are connected on a single chip, you have a microcontroller.



An embedded system has an input unit to collect data, a control unit to process the signal and an output unit to send signals out.

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Ministry of Education

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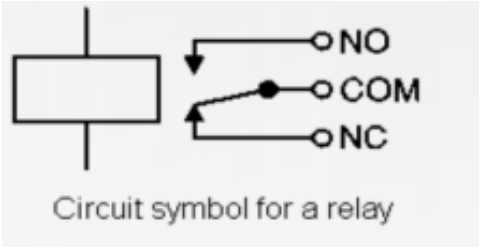
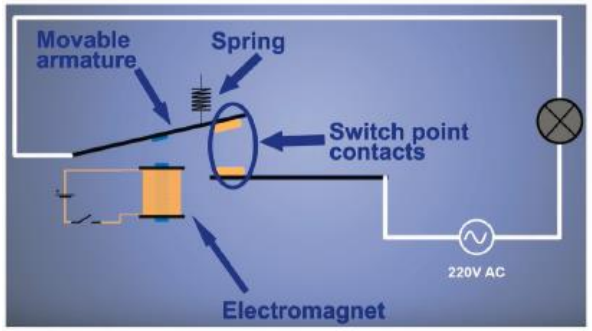
SECTION 5 – RELAY

Word	Meaning	Image
Relay	It is an electromagnetic switch that can be enabled by a small electrical signal and controls a much larger electrical current.	



Circuit symbol for a relay

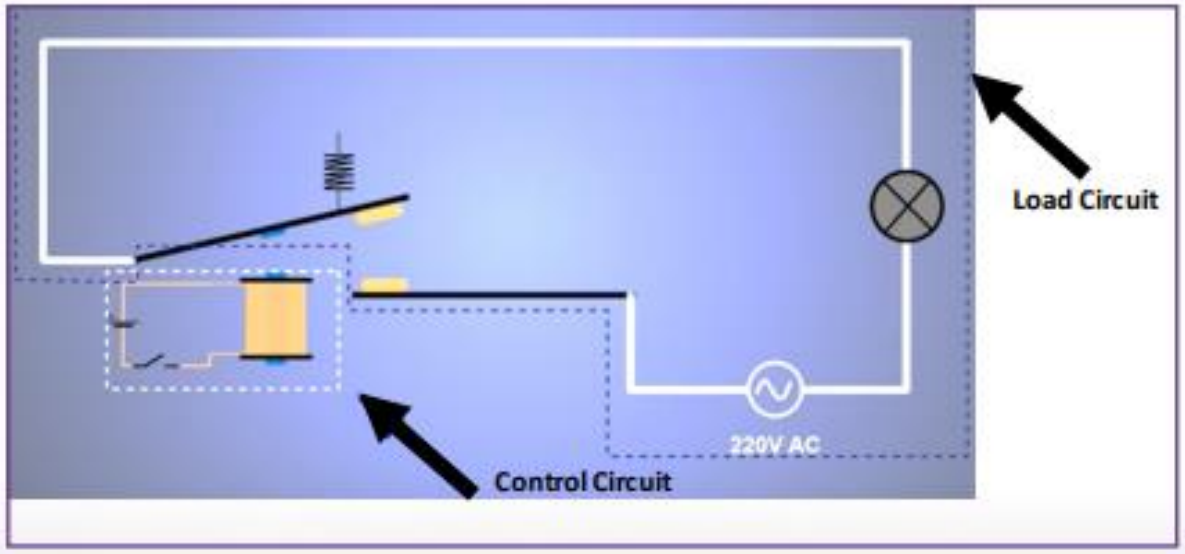


- There are 2 main circuits in a relay system -
  (a) Control Circuit
  (b) Load Circuit

- When power flows through the first circuit , it activates the electromagnet which generates a magnetic field. This magnetic field attracts the connector and activates the second circuit.

- Applications - fridges, washing machines, dishwashers and AC controls.

Control circuit and load circuit of a relay



Solid State Relays

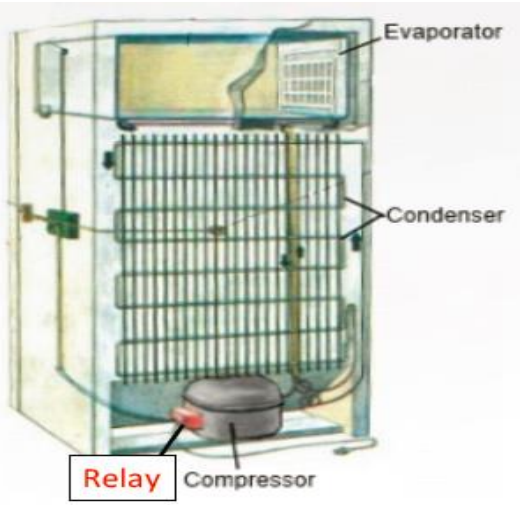
- Have **no coil, spring, or mechanical contact** switch.
- Much **faster** response time than electromagnetic relays.
- Made from **Semiconductor** materials.

Solid Stater Relays

Relay Applications

Car Indicator Light

Relays are used for powering car turning signal lights and many other devices. These are called “flashers”. It’s a type of relay with three terminals and the body works as the earth, in old Japanese cars like old Toyotas.



Fridge

Relays are commonly used in home appliances, like refrigerators for example, where there is an electronic control turning on a motor.