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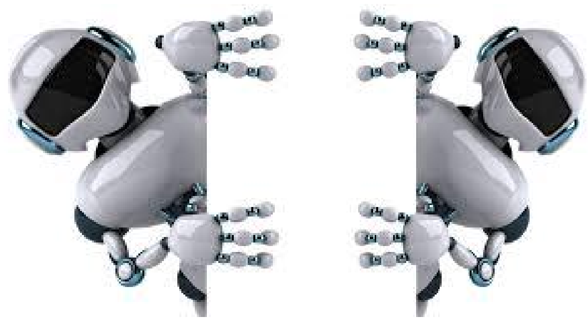
Robo – Electronics Lab



Course Content Overview

To Understand Electricity, Introduction to Resistors, Capacitors, Diodes, Bipolar Junction Transistors and other Electronics Components.
Use of Electronics Components in Designing Electronics Circuit and Sensors
Electro- Magnetic Theory, Designing and Working of Electric Relay
Application of integrated Circuits(IC's) in making electronics projects
Introduction to Types of Motors, Designing and Working of Motors , Use of DC Geared Motors and Servo Motors
Electronics Projects 1. Alternate Switching of LEDs using Relay 2. Burglar Alarm 3. Relay as an Oscillator 4. Touch Activated Switch Using a Transistor 5. Automatic Night Lamp 6. Transistor as a Blinker (LED Flasher) 7. Alternate Blinking of LEDs using Transistor 8. Transistor as an Amplifier and a Switch 9. Water Level Indicator 10. Flash an LED using 555 Timer 11. Music Instrument using 555 Timer 12. Clap Switch 555 Timer (Glowing of LED by Clapping)

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Understanding Electricity

Electricity is basically the movement of electrons in the conductor and for these movement electrons need energy and this energy is obtained from batteries and cell.

Batteries help electrons to move across a conducting wire by providing them energy. Batteries behave in the same way as the water pump that installed in our house; we know that the function of a water pump is to lift water from ground to the roof top where the tank is placed. In the same way batteries works they transfer electrons from one point to the other.

Electricity is of two types:

I. Direct Current (DC) - Battery or cells are the Direct Current source which gives us constant electricity supply.
Direct current has various applications in our everyday life like the wrist watch; TV remote, Mobile phone battery etc. all are installed with a cell/battery which are the sources of direct current.

II. Alternating Current (AC) - The electricity which is supplied in our household is the source of Alternating Current which usually has high voltage and high current supply for operating various electrical appliances in our house such as T.V, refrigerator, air-conditioner etc. This high voltage is generating in electric power station which is supplied to our house via long transmission wires.

Note: It is dangerous to handle alternating current (AC) as it gives high electric shock.

Long Transmission Wires

Electricity Generation Power Plant

Electric Current

We know that electricity is the flow of electrons across a wire and to measure the amount of electrons flow through a wire in a given time we need to calculate electric current. Thus,

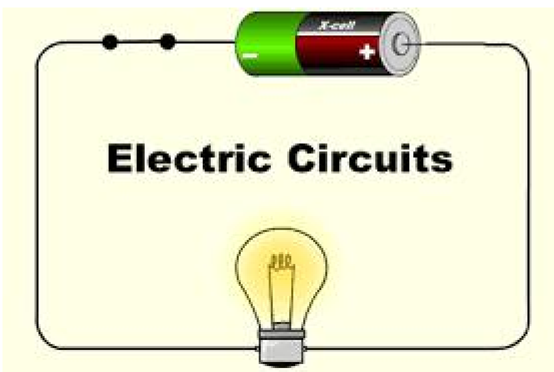
Electric Current can be defined as the flow of electrons in a given time; it is denoted by **I**, its SI unit is **Ampere (A)**

I = Q/T, where **'Q'** is total charge, and **'T'** is time, and to calculate the total charge across the conducting wire, we use a formula **Q = ne**. Electric current can be measured with the device called Ammeter.

Potential Difference

We know electrons need energy to move from one point to another in a wire, and to get this energy we connect the wire across the battery in a circuit as shown below. Here, the positive (+) terminal is at the higher energy level of 'V' volts whereas the negative (-) terminal is at the lower energy level of '0' volts, and because of this difference of energy, electrons tends to move in a conducting wire,

Thus, with the difference of voltage (V – 0) volts = V volts, the electrons flows in a wire from one point to another.



The mathematical formula to calculate potential difference is given by **V = W / Q**, where **W** is the work done on the charge **Q** to move it from one point to another across the wire.

As we can see when electrons are moving across the bulb, it starts glowing. Thus, we can say that motions of electrons are responsible for the glowing of bulb.

As we know that we all have different food requirement like child has a different food requirement then adult, in the same way different appliance in our home like TV, Fridge, Air conditioner, Laptop, Mobile phone charger etc. needs different amount of electricity for their proper working but there is only single wire that comes in our home which bring electricity from the electric tower. So, how do these appliances take different amount of electricity for their proper functioning?

The important electrical component comes into picture is **Resistors** that can be used to control the amount of electricity that flows in different electrical appliances.

Resistors

Resistors are the wires which have a high resistance value i.e. they obstruct the flow of electrons through them, such wires are made up of materials such as tungsten, nichrome, manganin, constantan etc. which reduce or limits the flow of current (electrons).

We use Resistors in our house in heating appliances such as electric heater, electric toaster etc. These electrical appliances are installed with high resistance wires made up of nichrome, the property of nichrome is to obstruct the flow of current through it and thus converts electric energy into heat.

Electric bulb we use in our house are fitted with filament which is made up of high resistance wire tungsten, the work of filament is to obstruct the flow of electric current through it and convert it into heat and light.

Resistance of Resistors is measured in ohms (Ω).

Now a days resistors are widely use in electronic circuits to run computers, mobile phones etc.

Commercially produced resistors are of two major types: **Wire bound resistors and Carbon resistors**.

Wire bound resistors are made by winding the wires of an alloy such as manganese, constantan and nichrome etc. These resistances are typically in the range of a fraction of an ohm to a few hundred ohms.

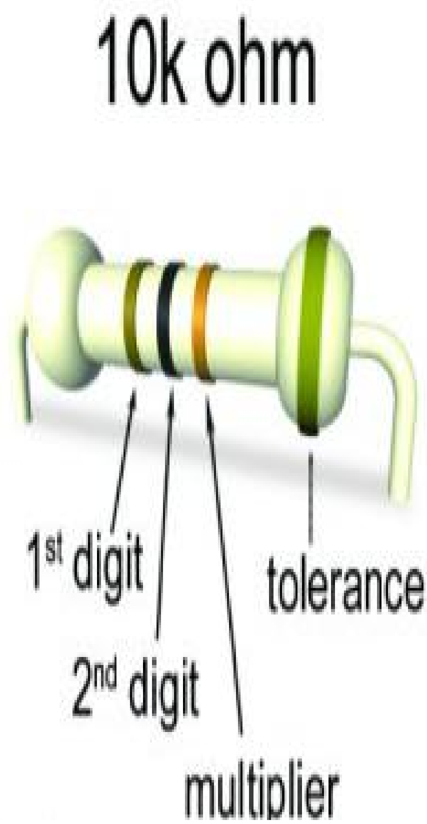
Resistors in the higher range are made mostly from carbon. Carbon resistors are compact, inexpensive and thus find extensive use in electronic circuits. Carbon resistors are small in size and hence their values are given using a colour code.

Decoding the colour band of carbon resistors

The carbon resistors have a set of co-axial coloured rings on them whose significance are listed in below table. The first two bands from the end indicate the first two significant figures of the resistance in ohms. The third band indicates the decimal multiplier and the last band stands for tolerance or possible variation in percentage about the indicated values. Sometimes, this last band is absent and that indicates a tolerance of 20%.

For example, if the four colours are orange, blue, yellow and gold, the resistance value can be calculated from the below table is 36×10^4 Ω with a tolerance of 5% ().

Color	Color Name	1st digit 1st stripe	2nd digit 2nd stripe	Multiplier 3rd stripe	Tolerance 4th stripe
	Black	0	0	x1	-
	Brown	1	1	x10	1%
	Red	2	2	x100	2%
	Orange	3	3	x1,000	3%
	Yellow	4	4	x10,000	4%
	Green	5	5	x100,000	-
	Blue	6	6	x1,000,000	-
	Violet	7	7	-	-
	Grey	8	8	-	-
	White	9	9	-	-
	Gold	-	-	x0,1	5%
	Silver	-	-	x0,01	10%



Combination of Resistors - Series and Parallel Combination

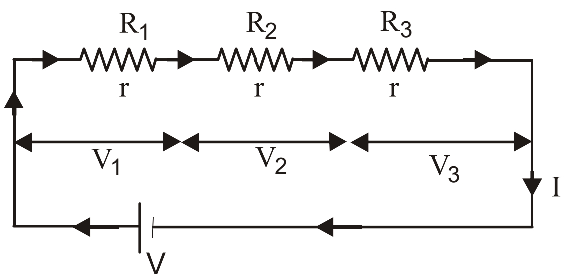
We can increase or decrease the value of resistance by connecting them in series or parallel combination respectively.

Series Combination of Resistances

A number of resistances are said to be connected in series if these joined end to end and the same current flows through each resistance.
The total resistance in series combination is the algebraic sum of the individual resistances.

$R_S = R_1 + R_2 + R_3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + R_n$

In series combination of resistors – current (I) across each resistor remains same whereas potential difference (V) divides.



Here R_1, R_2, R_3 = 3 resistors connected in series combination.

V = Potential difference between end points.
V_1, V_2, V_3 = Potential differences across R_1, R_2, R_3 respectively.
I = Current flowing through the combination (same through each resistor in series combination).

Thus, $V = V_1 + V_2 + V_3$

According to Ohm's law $V = I R$.

$IR_s = IR_1 + IR_2 + IR_3$

Where R_S be the resultant resistant of combination, so

$R_s = R_1 + R_2 + R_3$

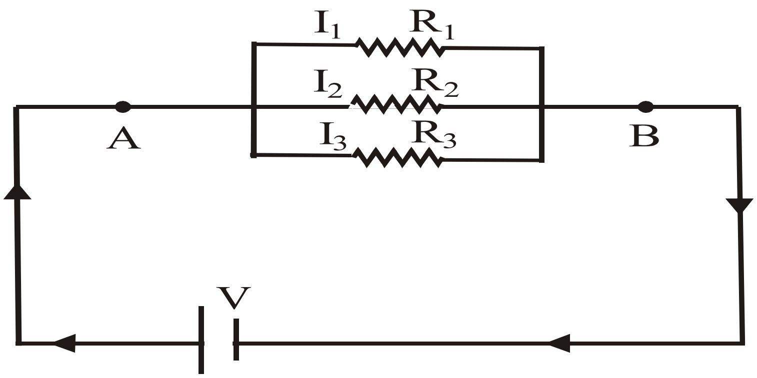
Thus, we can say when resistors are connected in series connection; total resistance is equal to the sum of all resistances.

Resistances in Parallel Combination

A number of resistors are said to be connected in parallel if one end of each resistor is connected to one point and the other ends is connected to other point so that the potential difference across each resistor is same and is equal to applied potential difference between two points.
In parallel combination of resistors, total resistance of the combination is sum of the reciprocals of the individual resistance.

$$\boxed{\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

In parallel combination of resistors – potential difference (V) across each resistor remains same whereas current (I) divides.



Here R_1, R_2, R_3 = 3 resistors connected in parallel combination.

V = Potential difference between end points.
I_1, I_2, I_3 = Current across R_1, R_2, R_3 respectively.
V = Potential difference across each resistor.

$$I = I_1 + I_2 + I_3$$

According to Ohm's law

$$\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

Let R_p be the equivalent resistance.

$$V\left(\frac{1}{R_P}\right) = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\boxed{\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

Capacitors

Capacitors are the charge storing devices. When an electric current flows through them with a potential difference of V volts, then they stores some amount of charge.

How much charge a capacitor is currently storing depends on the potential difference (voltage) between its plates.

Q α V or Q= CV, where C is called capacitance of the capacitor. A capacitor's capacitance tells you how much charge it can store.

This relationship between charge, capacitance, and voltage can be given by

$$Q = CV \text{ or } C = Q/V$$

Charge (Q) stored in a capacitor is the product of its capacitance (C) and the voltage (V) applied to it.

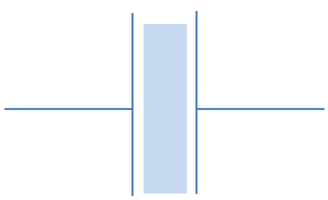
The SI unit of capacitance is 1 farad (1coulomb/ volt).

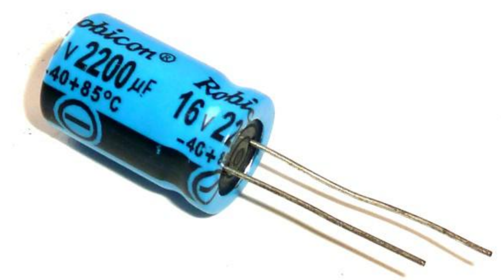
Relation $C = Q/V$, shows that for large C, V is small for a given Q. This means a capacitor with large capacitance can hold large amount of charge Q at relatively small value of V.

Capacitance is independent of Q or V, it depends only on the geometrical configuration (shape, size and separation) of the system of two conductors ($C = \varepsilon A/d$), the relation shows that C depends only on the geometry of the system.

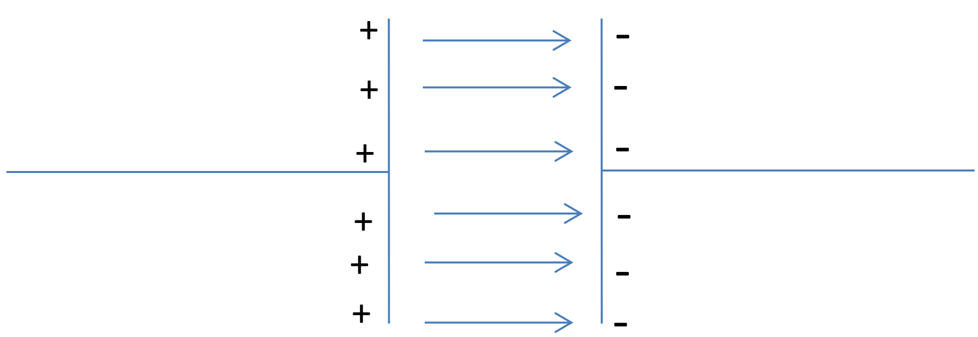
It has been observed that the capacitance of the capacitor can be increased by inserting some dielectric medium having dielectric constant K, the modified formula of capacitance is $C = K\varepsilon A/d$

Capacitors are made by arranging two conducting plates parallel to each other separated by an insulating material as shown below.





When current flows into a capacitor, the charges gets accumulate on the plates of the capacitor because they can't cross the insulating dielectric. Electrons which are negatively charged are accumulating into one of the plates, and it becomes overall negatively charged and the other plate becomes positively charged due to electrostatic induction.



Direction of Electric Field

The stationary charges on these plates create an electric field, which influence electric potential energy and voltage. When charges group together on a capacitor like this, the capacitor is storing electric energy just as a battery might store chemical energy.

Energy stored in a capacitor

In transferring positive charge from one conductor to another in a case of parallel plate capacitor, work will be done externally, which is given by

$W = Q^2 / 2C = (1/2)(CV^2) = 1/2\,(QV)$

Since electrostatic force is conservative, this work is stored in the form of potential energy of the system, when the capacitor discharges, this stored up energy is released.

Charging and Discharging of a capacitor

When positive and negative charges accumulate on the capacitor plates, the capacitor becomes **charged**. A capacitor can retain its electric field because the positive and negative charges on each of the plates attract each other but never meet each other.

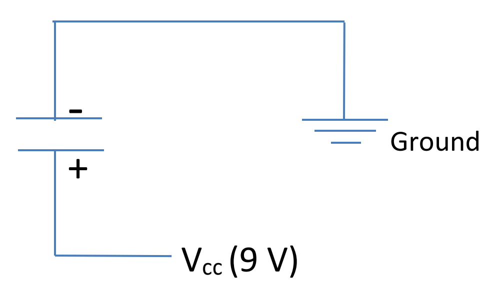
At some point the capacitor plates will be so full of charges that they just can't accept any more. There are enough negative charges on one plate that they can repel any others charge that try to join them. Thus all capacitors have maximum capacity to store charge on them called **capacitance of a capacitor**.

If a path in the circuit is created, which allows the charges to find another path to each other, they'll leave the capacitor, and it will **discharge**.

For example, in the circuit below, a battery can be used to induce an electric potential across the capacitor. This will cause equal but opposite charges to build up on each of the plates, until they're so full they repel any more current from flowing.

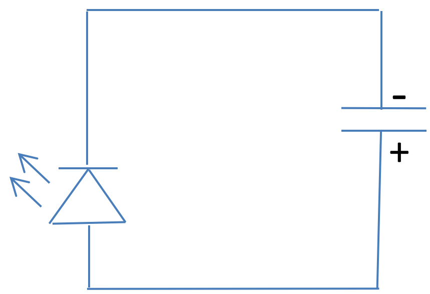
<u>Charging of Capacitor</u>

Connect the positive leg of capacitor to V_{cc} (9 V) and the negative leg to the ground, this arrangement will store charge in the capacitor.



Discharging of Capacitor

Now, an LED placed in series with the capacitor could provide a path for the current, and the energy stored in the capacitor could be used to briefly illuminate the LED.



The above activity shows that capacitor store charge and can discharge when it gets a short path.

Combination of Capacitors

Capacitors in series: The left plate of first capacitor and the right plate of second capacitor are connected to two terminals of the battery and have charges +Q and -Q, respectively. It then follow that the right plate of the first capacitor has charge –Q and the left plate of second capacitor has charge + Q. If this was not so, the net charge on both capacitors would not be zero. Thus, in the series combination, charges on the two plates (+ - Q) are the same on each capacitor.

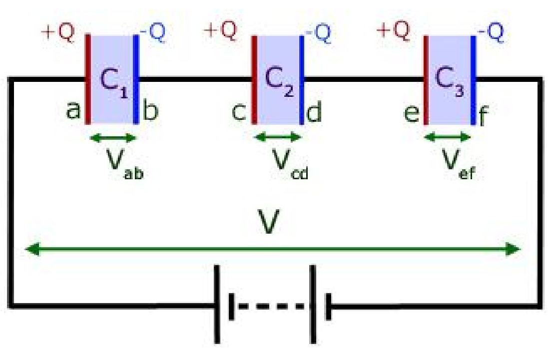
The total potential drop V across the combination is the sum of the potential drops V_1 and V_2 across capacitors C_1 and C_2, respectively.

$$V = V_1 + V_2 = Q/C_1 + Q/C_2$$

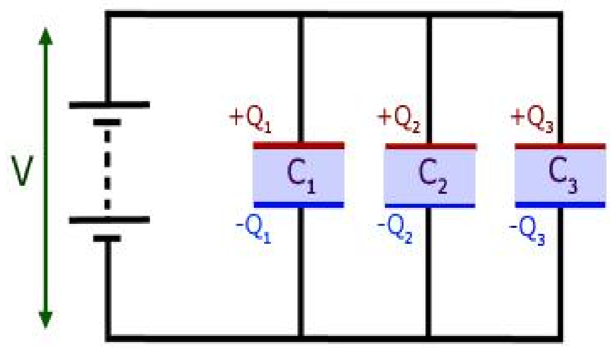
$$V/Q = 1/C_1 + 1/C_2$$

The effective capacitance of the capacitors is given by

$$1/C = 1/C_1 + 1/C_2$$



Capacitors in parallel: In this case, the same potential difference is applied across both the capacitors. But the plate charges Q_1 and Q_2 are not necessarily the same:



Capacitor Application: Signal Filtering

Capacitors have a unique response to signals of varying frequencies. They can block out low-frequency or DC signal-components while allowing higher frequencies to pass right through.

Capacitor provides capacitative reactance (resistance) to DC as direct current has zero frequency ($\upsilon = 0$).

According to relation, $X_c = 1/\omega C = 1/2\pi\upsilon C = 1/0 =$ infinity.

Where X_c = capacitative reactance and υ = frequency

Thus, capacitor provides infinite resistance to DC. Hence capacitors are used for filtering purpose.

Filtering signals can be useful in all sorts of signal processing applications. Radio receivers might use a capacitor (among other components) to tune out undesired frequencies.

Diodes

A semiconductor diode is basically a p-n junction with metallic contacts provided at the ends for the application of an external voltage.

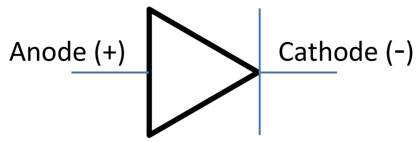
The key function of a diode is to control the direction of current-flow. Current passing through a diode can only go in one direction, called the forward direction. Current trying to flow the reverse direction is blocked. They're like the one-way valve of electrons.

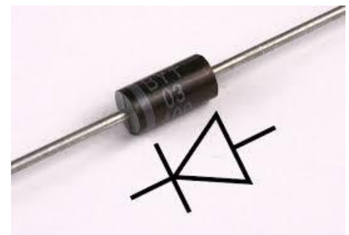
If the voltage across a diode is negative, no current can flow, and the diode looks like an open circuit. In such a situation, the diode is said to be off or **reverse biased**.

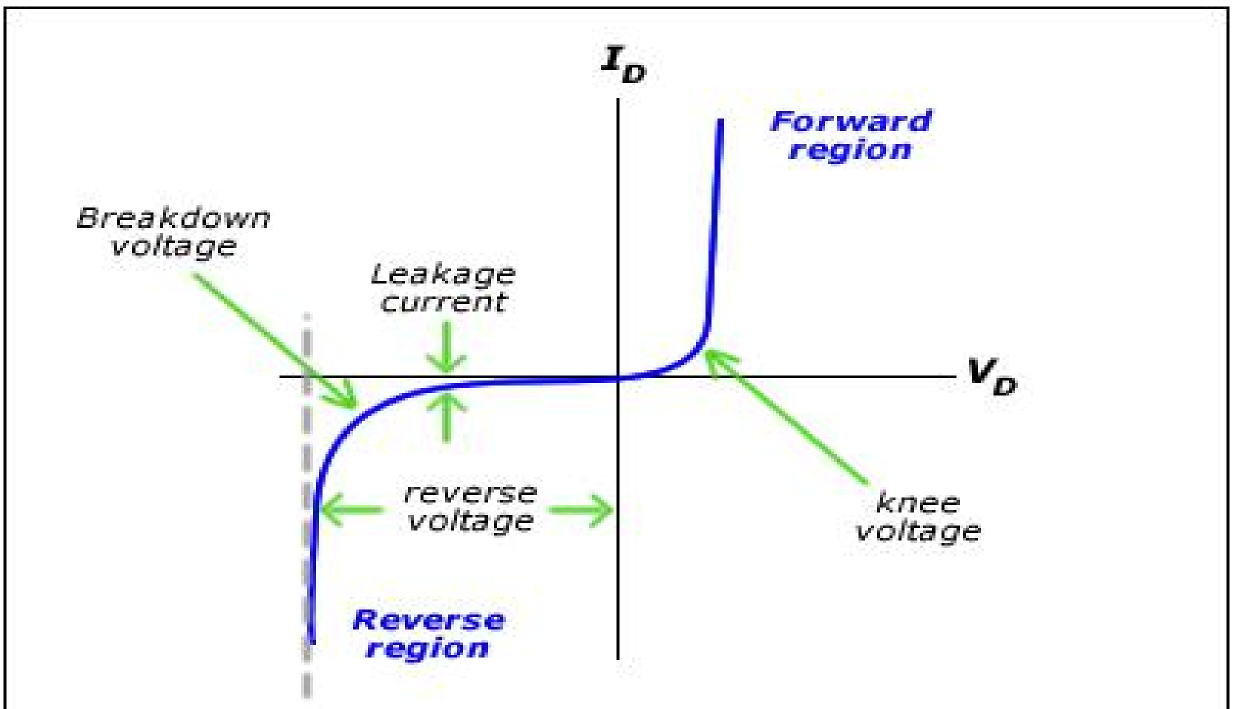
As long as the voltage across the diode isn't negative, it'll "turn on" and conduct current. When a diode is conducting current it's **forward biased**.

It is a two terminal device. The positive terminal of a diode is called the **anode**, and the negative terminal is called the **cathode**. Current can flow from the anode end to the cathode, but not the other direction.

Diode Symbol







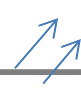
Diode curve

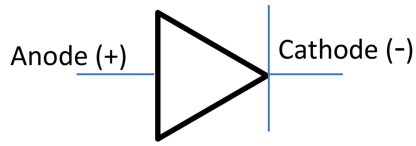
Light-Emitting Diodes (LEDs)

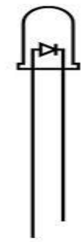
The flashiest member of the diode family is the light-emitting diode (LED). These diodes will light up when a positive voltage is applied.

It is a heavily doped p-n junction which under forward bias emits spontaneous radiation. The diode is encapsulated with a transparent cover so that emitted light can come out.

Light Emitting Diode Symbol







Usually the longer leg of LED is positive and the smaller leg is negative.

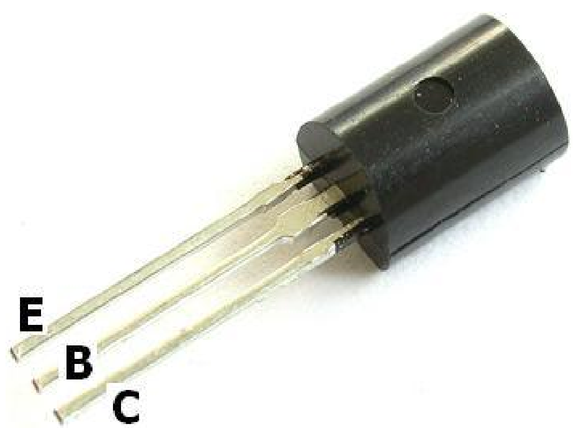
Like normal diodes, LEDs only allow current through one direction. LEDs can emit red, yellow, orange, green and blue light are commercially available.

Bipolar Junction Transistor (BJT)

Transistor is a very important electronic component. It has three doped regions forming p-n junction between them. There are two types of transistors.

(i) N-P-N transistor: Here two segments of n-type semiconductor (emitter and collector) are separated by a segment of p-type semiconductor (base).

(ii) P-N-P transistor: Here two segments of p-type semiconductor (emitter and collector) are separated by a segment of n-type semiconductor (base).

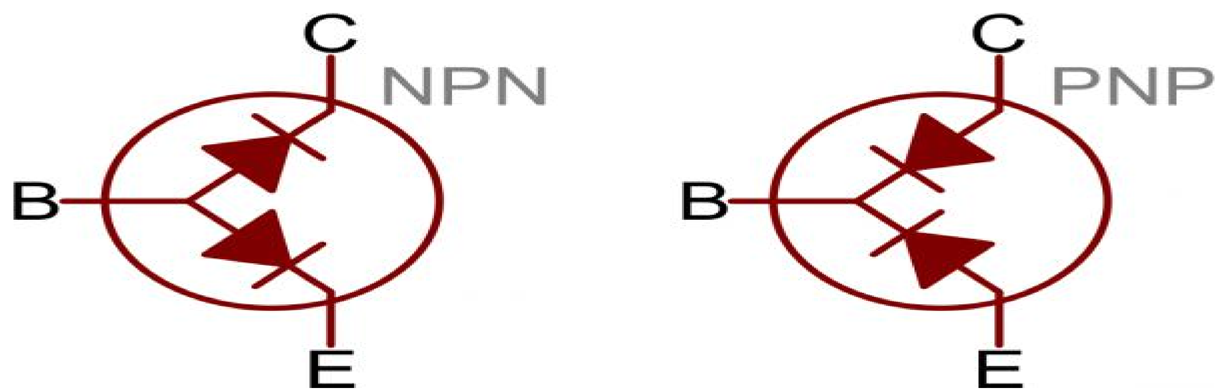


All the three segments of transistors have different thickness and their doping levels are also different.

(i) Emitter: This is the segment on one side of the transistor. It is of moderate size and heavily doped. It supplies a large number of majority carriers for the current flow through the transistor.
(ii) Base: This is the central segment. It is very thin and lightly doped.

(iii) Collector: This segment collects a major portion of the majority carriers supplied by the emitter. The collector side is moderately doped and larger in size as compared to the emitter.

The transistor is kind of like an electron valve. The base pin is like a handle you might adjust to allow more or less electrons to flow from emitter to collector.



The diode connecting base to emitter is the important one here; it matches the direction of the arrow on the schematic symbol, and shows you which way current is intended to flow through the transistor.

Identification of NPN or PNP Transistor

<u>Transistor Structure and Operation</u>

Transistors are built by stacking three different layers of semiconductor material together. Some of those layers have extra electrons added to them (a process called "doping"), and others have electrons removed (doped with "holes" – the absence of electrons). A semiconductor material with extra electrons is called an **n-type** (n for negative because electrons have a negative charge) and a material with electrons removed is called a **p-type** (for positive).

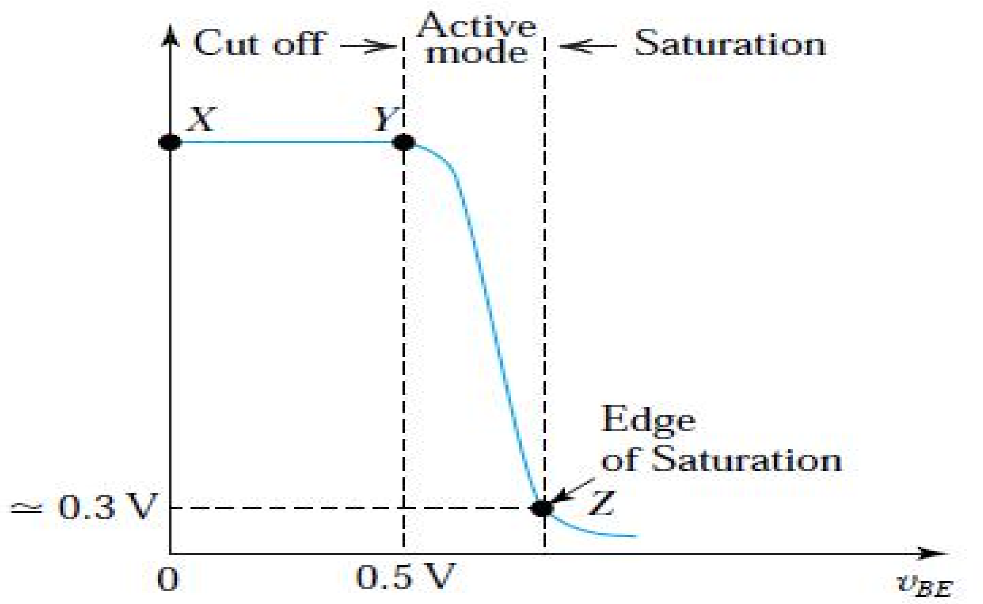
We can see that electrons can easily flow from **n** regions to **p** regions, as long as they have a little force (voltage) to push them. But flowing from a p region to an n region is really hard (requires a lot of voltage). But the special thing about a transistor is the fact that electrons can easily flow from the p-type base to the n-type collector as long as the base-emitter junction is forward biased (meaning the base is at a higher voltage than the emitter).

The NPN transistor is designed to pass electrons from the emitter to the collector. The emitter "emits" electrons into the base, which controls the number of electrons the emitter emits. Most of the electrons emitted are "collected" by the collector, which sends them along to the next part of the circuit.

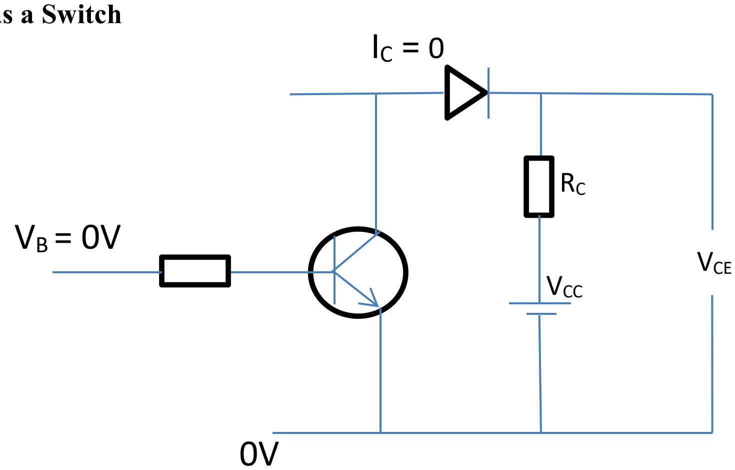
A PNP works in opposite sense. The base still controls current flow, but that current flows in the opposite direction – from emitter to collector. Instead of electrons, the emitter emits "holes" (a conceptual absence of electrons) which are collected by the collector.

Modes of Operation of Transistors

- **Saturation** – The transistor acts like a **short circuit**. Current freely flows from collector to emitter.
- **Cut-off** – The transistor acts like an **open circuit**. No current flows from collector to emitter.
- **Active** – The current from collector to emitter is **proportional** to the current flowing into the base.



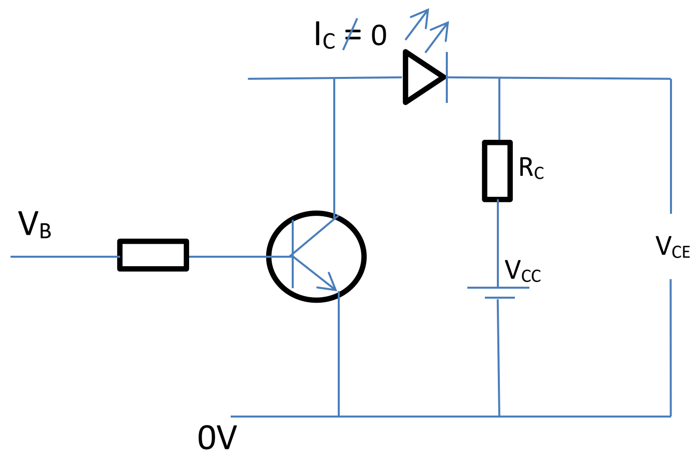
Transistor as a Switch



$V_{CE} = V_{CC} - I_C R_L$ (using Kirchhoff's voltage law)

Here emitter is already grounded (0 V) if base is also at 0 V then emitter and base are at the same potential difference, I_C = 0, thus $V_{CC} = V_{CE}$

Thus transistor is considered as in **off** state.



If some voltage is applied at V_B then potential difference is created between V_B and V_E thus I_C becomes non-zero($I_C \neq 0$) and LED starts glowing.

Thus transistor is considered as in **on** state.

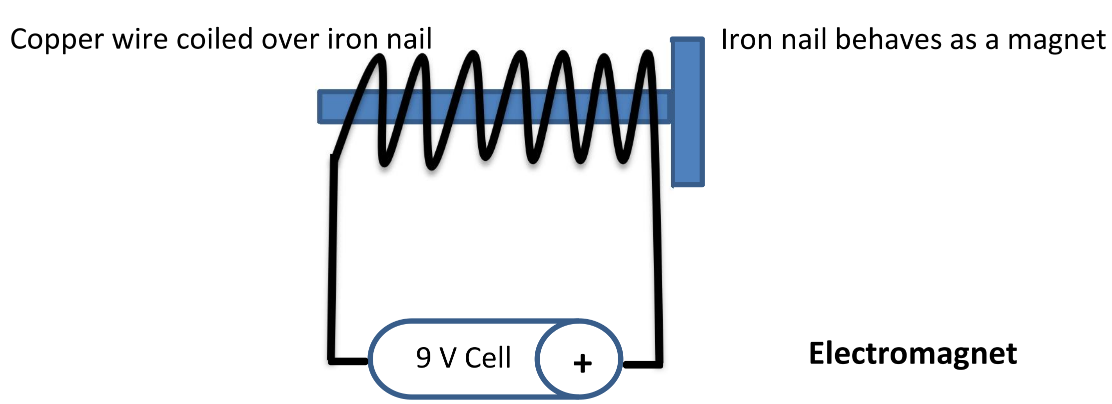
If I_C and R_L are so adjusted that value of V_{CE} is zero(0), then $V_{CC} = I_C R_L$ and $I_C = V_{CC} / R_L$ and I_C becomes saturate.

Electro-Magnetism

Electricity and magnetism are inter-related; we can produce magnetism with the electricity and vice-versa.

Production of Magnetism with Electricity

Oersted (a physics professor) was the first person who explains that when electric current flows through a conductor then wire behaves as a magnet (i.e. it produces magnetic effects)

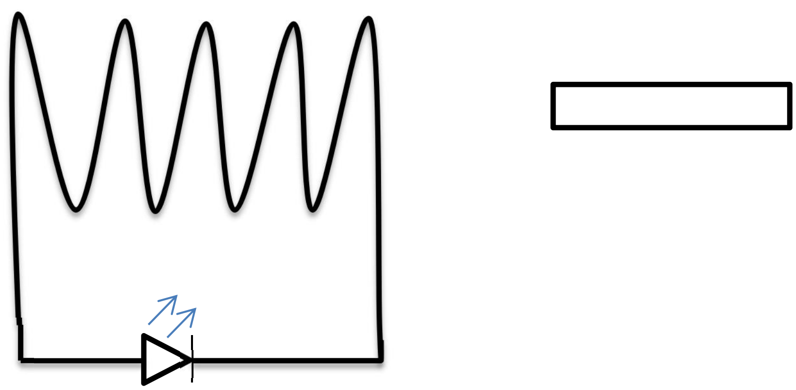


The above diagram shows a simple sketch of an electromagnet, here a copper wire is coiled over an iron nail and the ends of the wire are joined to the 9 V cell, on closing the key we find that iron nail behaves as a magnet, it starts attracting small pieces of iron.

This activity shows that we can produce magnetic effects with the help of electricity.

Production of Electricity from Magnetism (Electro Magnetic Induction)

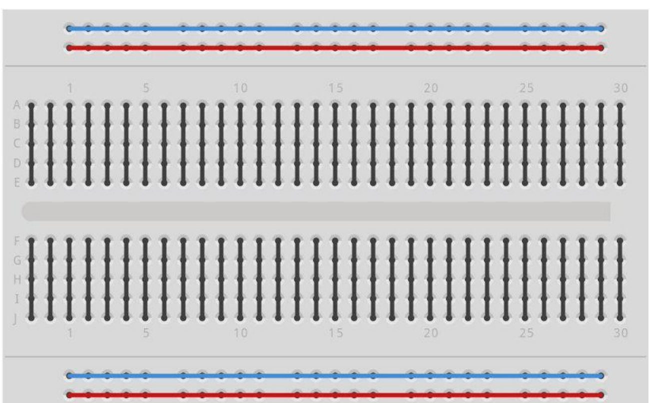
Michael Faraday explains that when a copper wire coil and a magnet are moving relative to one another then electricity is produced.

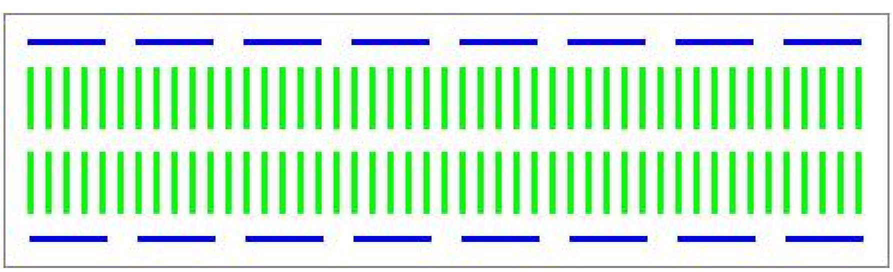


If we try to move magnet and copper coil relative to one another then we can find that LED starts glowing.

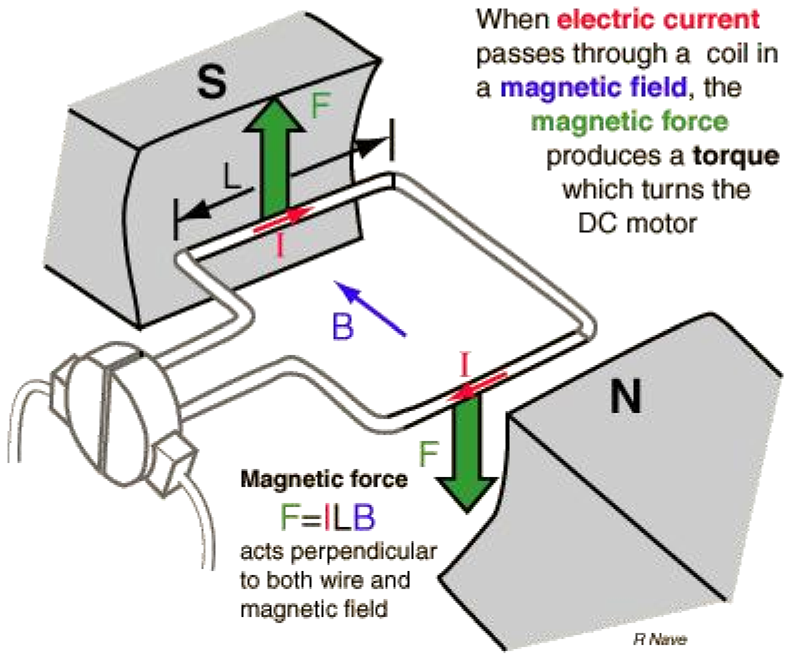
Electronic Components

1. Breadboard



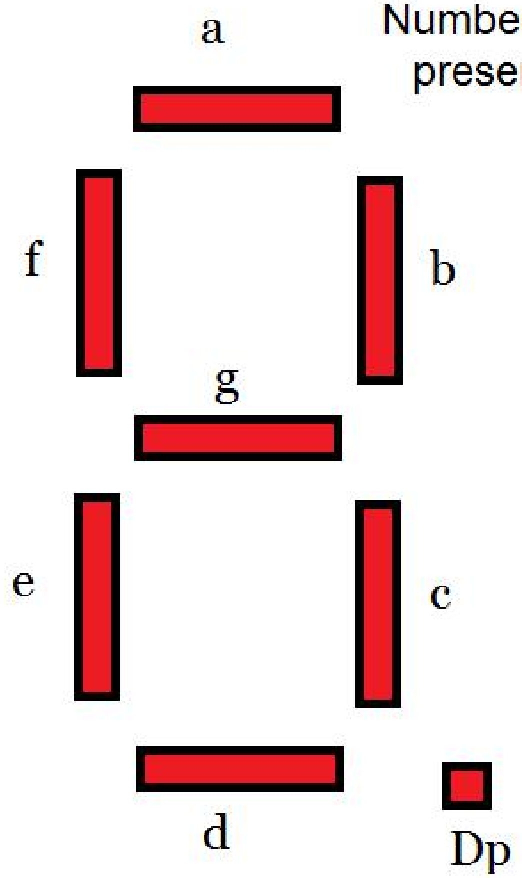


2. Electric Motor



3. Push Switch

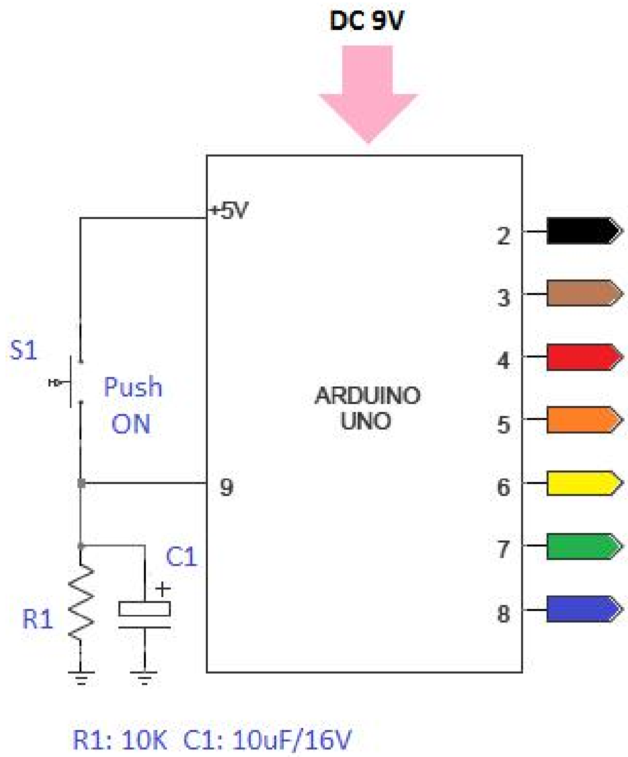
4. Seven Segment Display

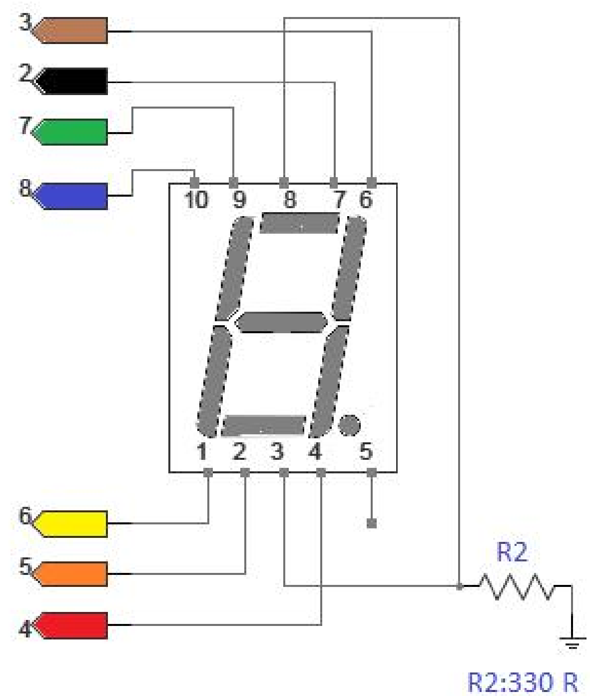


Numbers to present — Segments

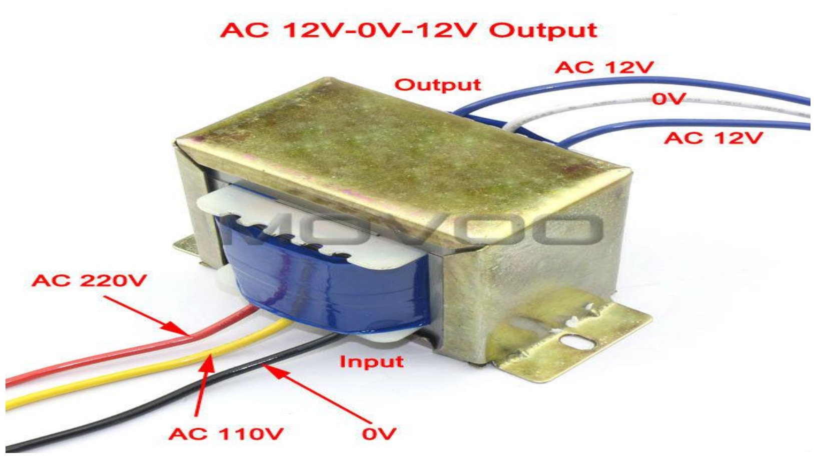
Numbers to present	g	f	e	d	c	b	a	Hex
0	0	1	1	1	1	1	1	3F
1	0	0	0	0	1	1	0	06
2	1	0	1	1	0	1	1	5B
3	1	0	0	1	1	1	1	4F
4	1	1	0	0	1	1	0	66
5	1	1	0	1	1	0	1	6D
6	1	1	1	1	1	0	1	7D
7	0	0	0	0	1	1	1	07
8	1	1	1	1	1	1	1	7F
9	1	1	0	0	1	1	1	67

0 : segment off
1 : segment on





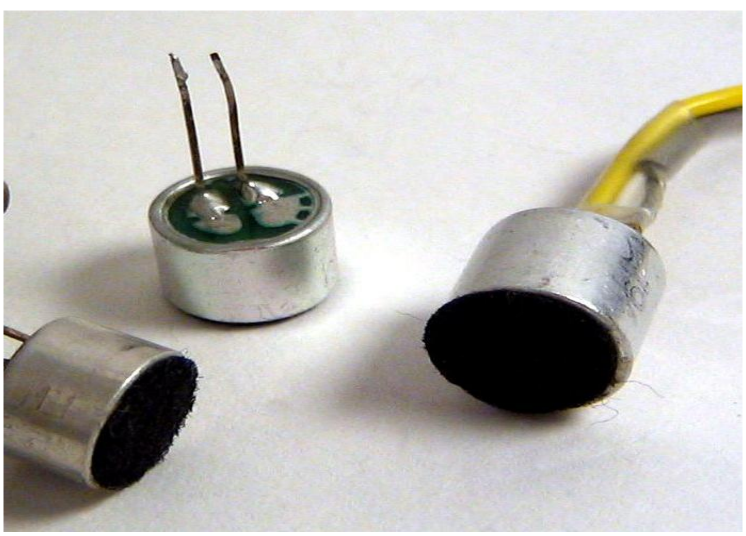
5. Transformer



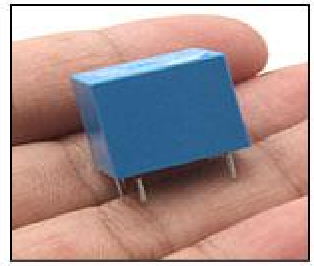
6. Bumper Switch

7. Electric Buzzer

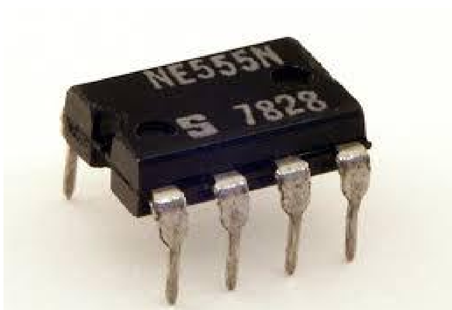
8. Electric Condenser Microphone

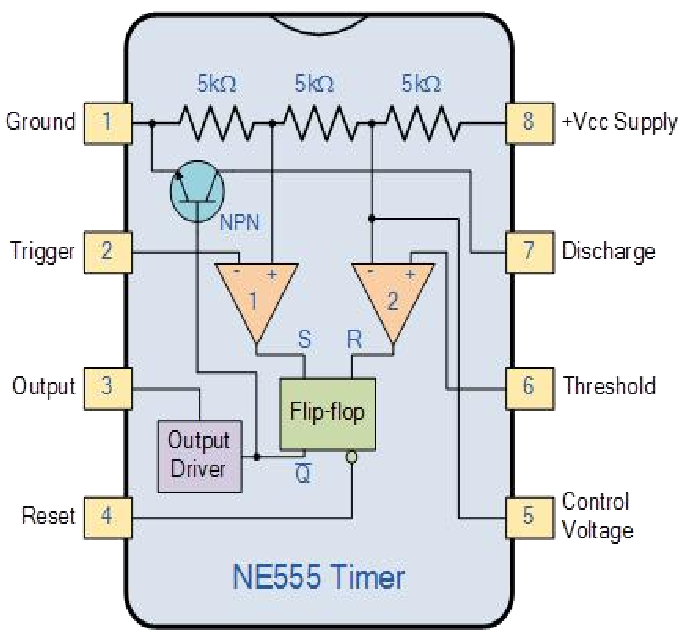


9. Relay

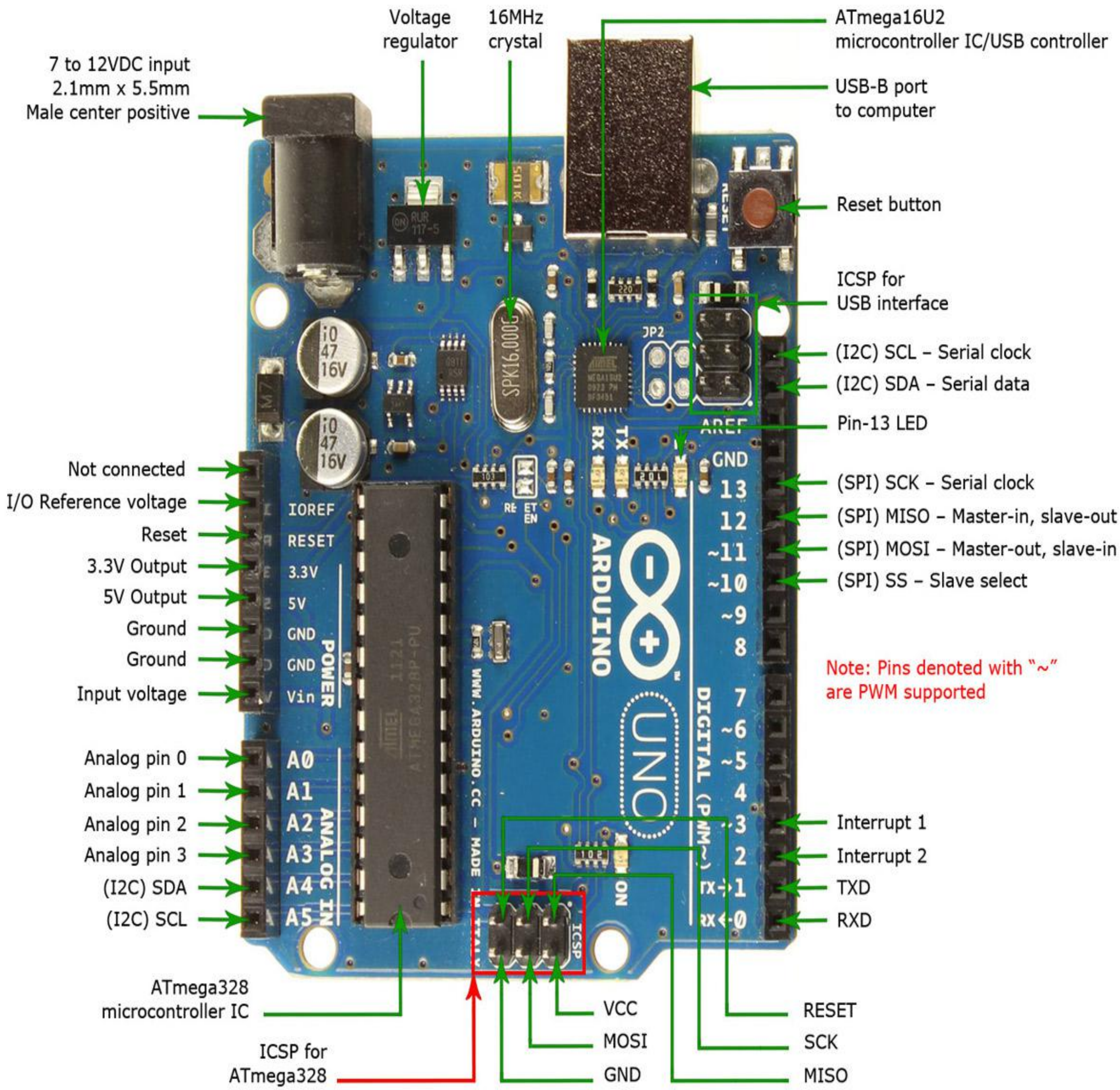


10. 555 Timer





Arduino Uno Programmable Board



It is a user friendly programmable board, on which we can design and feed programs in simple steps according to our needs and can make simple projects such as blinking of LEDs, controlling servo motors.

Arduino Uno Software

Arduino Uno Software can be download from the given link:

https://www.arduino.cc/en/Main/Software and then click on **Windows Installer** on the right hand side of the page to download the software.

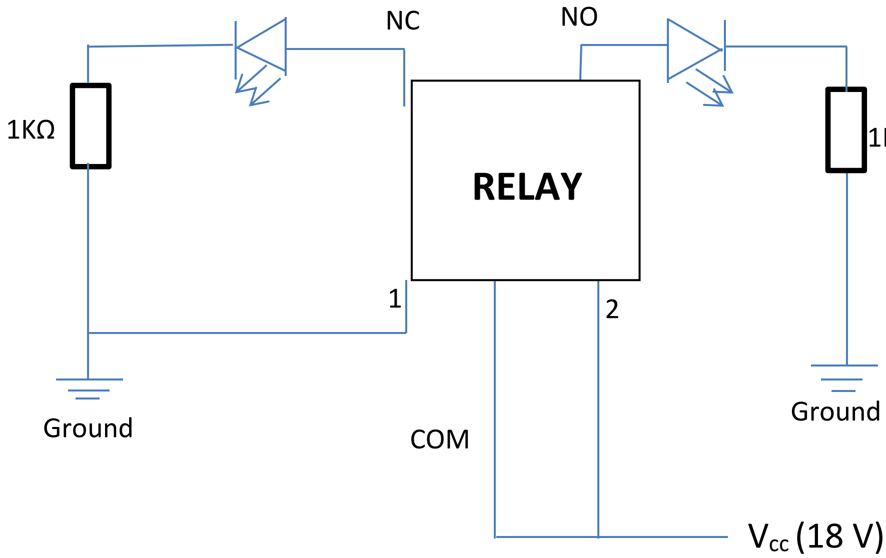
Electronics Projects

I. Alternating switching of LEDs using a Relay

Components Required

Relay, Two LEDs, Two 1 K resistors, Two 9 V batteries, Breadboard and some connecting wires.

Circuit Diagram



We can understand the circuit diagram in the following steps:

a. Connect the NC and NO of the relay to the positive terminal of the two LEDs.

b. Connect the negative terminals of the LEDs to the ground via 1KΩ resistor.

c. Connect the terminal 1 of the relay to the ground and the 2 terminal to the V_{cc}.

d. Connect the COM of the relay to the V_{cc}.

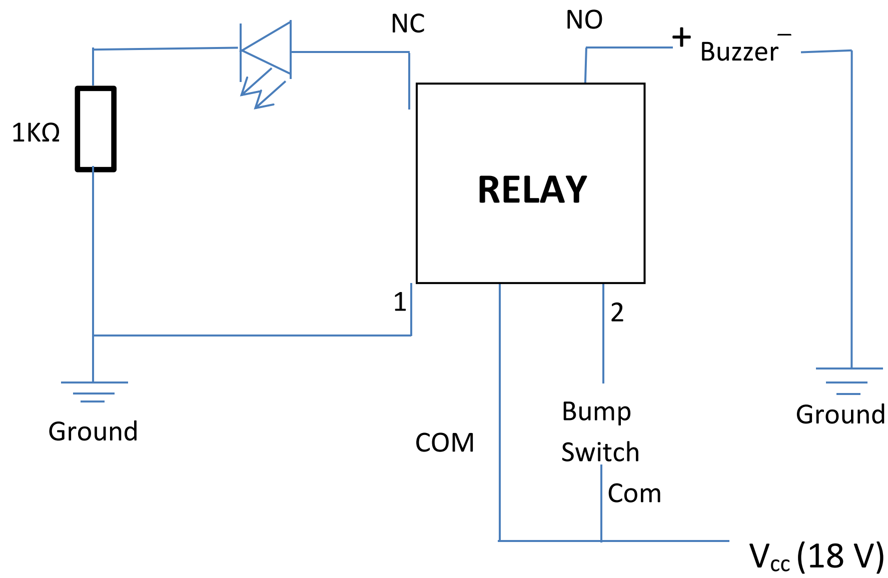
Notes, Observation and Conclusion

II. Burglar Alarm

Components Required

Relay, LED, One 1K resistors, Bump switch, Buzzer, Two 9 V batteries, Breadboard and some connecting wires.

Circuit Diagram



We can understand the circuit diagram in the following steps:

a. Connect the NC of the relay to the positive terminal of the LED and the negative terminal to the ground via 1KΩ resistor.
b. Connect the NO of the relay to the positive of the buzzer and negative end of buzzer to the ground.
c. Connect the COM of the relay to the V_{cc}.
d. Connect the terminal 2 of the relay to the V_{cc} via bump switch.

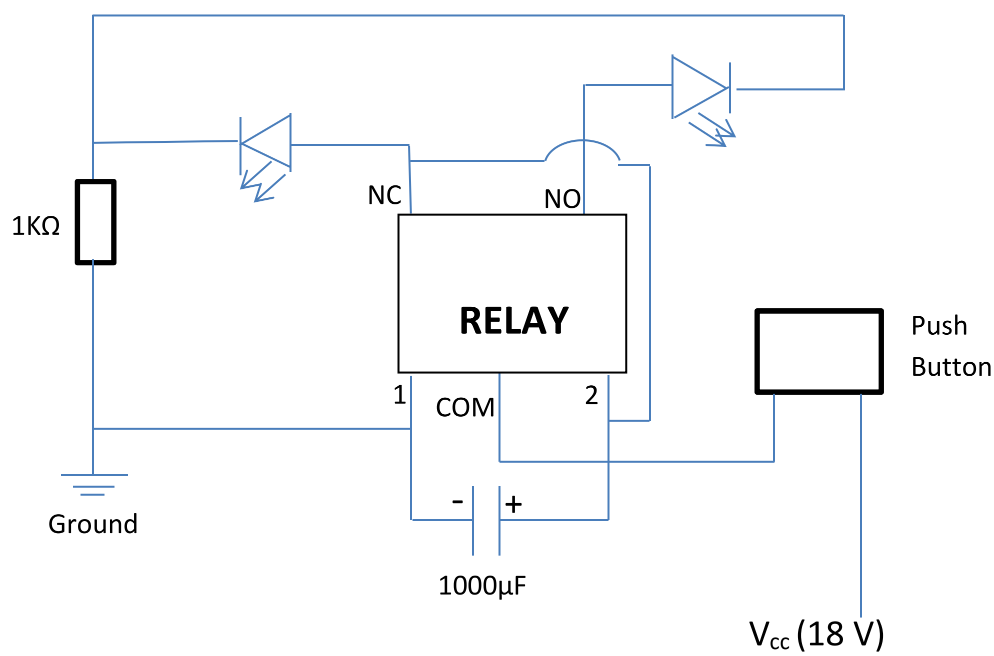
Notes, Observation and Conclusion

III. Relay as an Oscillator

Components Required

Relay, Push switch, Two LEDs, Two 1 K resistors, 1000 microfarad Capacitor, Two 9 V batteries, Breadboard and some connecting wires.

Circuit Diagram



We can understand the circuit diagram in the following steps:

a. Connect the NC and NO of the relay to the positive terminal of the LEDs.

b. Connect the negative terminal of both the LEDs to the ground via 1KΩ resistor.

c. Connect the COM of the relay to the push button and the other terminal of the push button to the V_{cc}.

d. Connect the terminal 2 of the relay to the NC and terminal 1 to the ground.

e. Connect the positive end of the 1000µF capacitor to terminal 2 and negative end to the the terminal 1 of the relay.

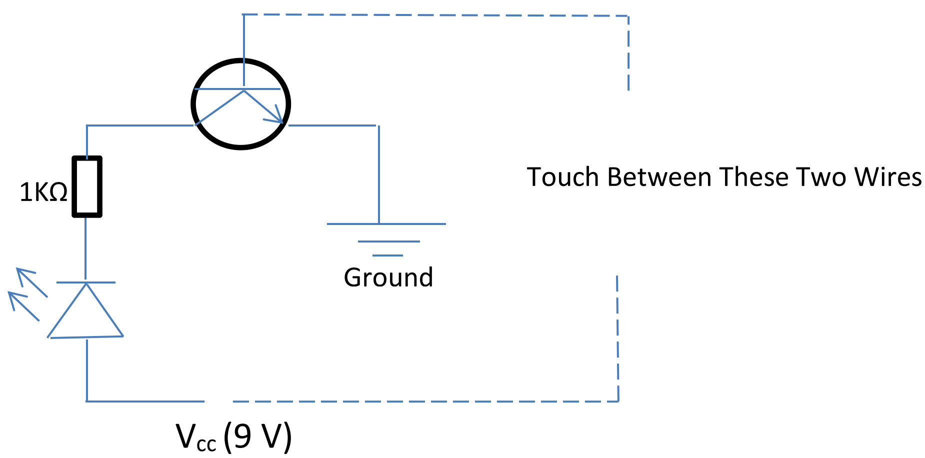
Notes, Observation and Conclusion

IV. **Touch Activated Switch using a Transistor**

Components Required

NPN transistor, 1 K resistor, LED, 9 V battery, breadboard and some connecting wires

Circuit Diagram



We can understand the circuit diagram in the following steps:

a. Connect the NPN transistor on the breadboard with emitter to be grounded.

b. Connect the collector of the transistor to the negative terminal of the LED via 1KΩ resistor.

c. Connect the positive terminal of the LED to V_{cc}.

d. Connect one end of the wire to the base of the transistor and the other end is left open.

e. Connect one end of the wire with V_{cc} and the other end is left open.

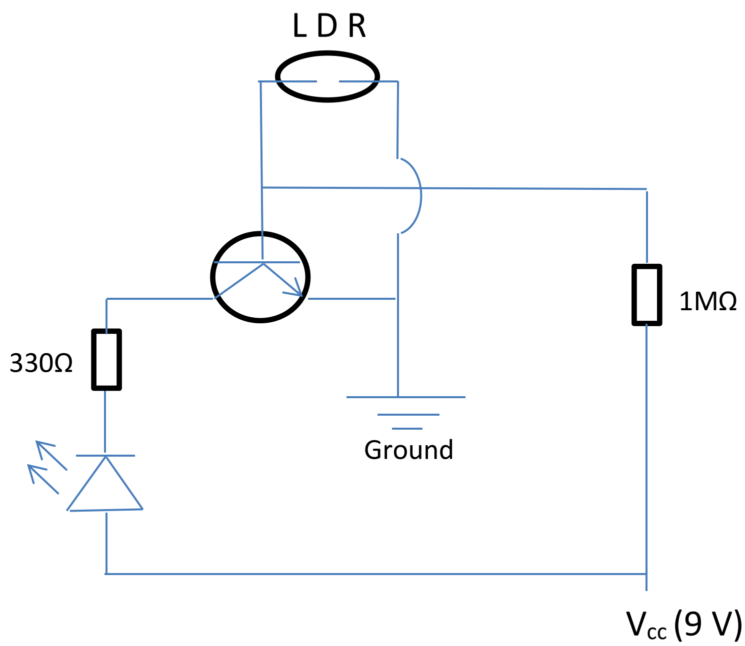
Notes, Observation and Conclusion

V. Automatic Night Lamp

Components Required

NPN transistor, LDR, 330 resistor, 1M resistor, LED, 9 V batteries, Breadboard and some connecting wires.

Circuit Diagram



We can understand the circuit diagram in the following steps:

a. Connect the base of the transistor to one terminal of the LDR and its other terminal to the ground.

b. Connect the base of the transistor to the V_{cc} via 1 MΩ resistor.

c. Connect the collector of the transistor to the negative end of the LED via 330Ω resistor and positive end of the LED to V_{cc}.

d. Connect the emitter of the transistor to the ground.

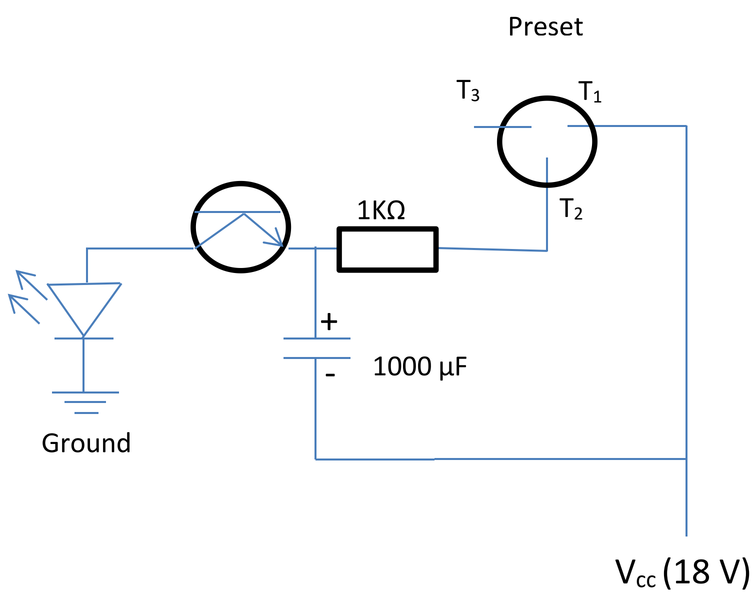
Notes, Observation and Conclusion

VI. **Transistor as Blinker(LED Flasher)**

Components Required

NPN transistor, 50 K preset, 1K resistor, 1000 microfarad capacitor, LED, Two 9 V batteries, Breadboard and some connecting wires.

Circuit Diagram



We can understand the circuit diagram in the following steps:

a. Connect two 9 V batteries in series such that total voltage available to the circuit is more than 12 V.
b. Connect collector of the transistor to the positive end of the Led and the negative terminal is to ground.
c. Connect emitter of the transistor to the positive end of the 1000µF capacitor and its negative end is to ground.
d. Connect the emitter of the transistor to the T_2 of the preset via 1KΩ resistor.
e. Connect the T_1 of the preset to V_{cc}.

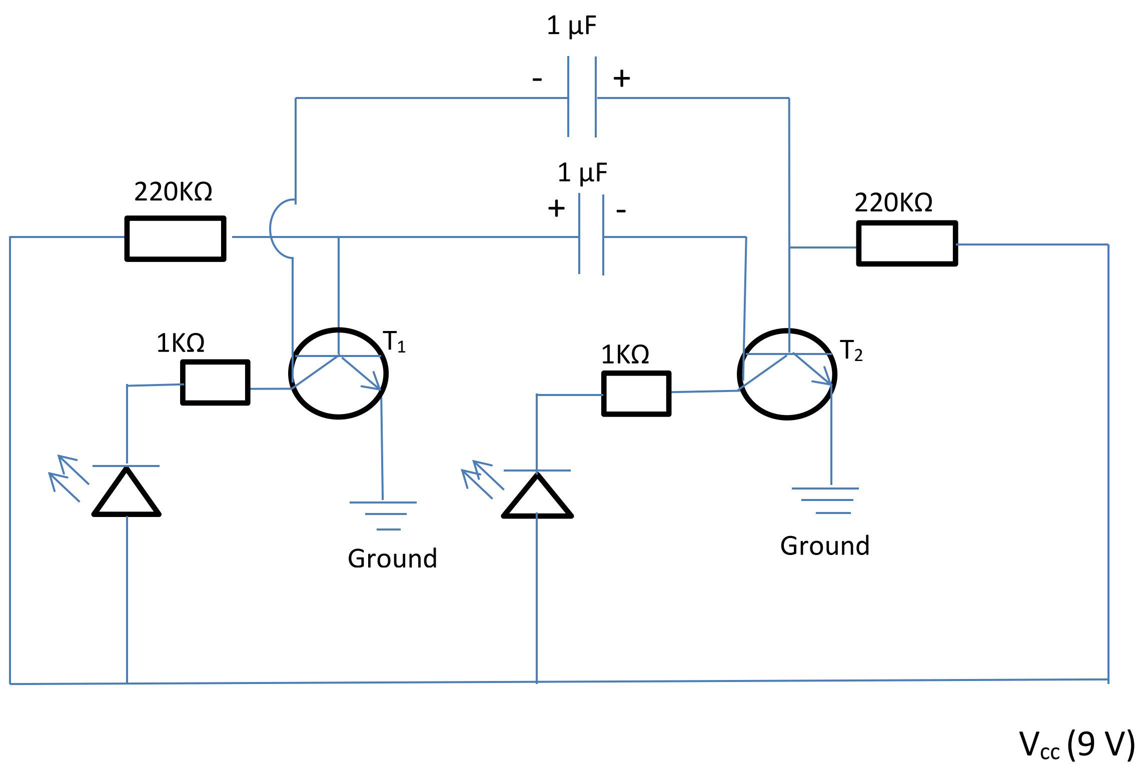
Notes, Observation and Conclusion

VII. Alternate Blinking of LEDs using Transistor

Components Required

Two NPN transistor, Two 1 microfarad capacitors, Two 220K resistors, Two 1K resistors, Two LEDs, 9 V batteries, Breadboard and some connecting wires.

Circuit Diagram



We can understand the circuit diagram in the following steps:

Here, we are using two transistors say T_1 and T_2, the emitter of both the transistors are grounded.

a. Connect the collector of both the transistors to the negative end of the LEDs via 1KΩ resistors.
b. Connect the positive ends of both the LEDs to V_{cc}.
c. Connect the collector of T_1 to the base of T_2 via 1µF capacitor with negative end connected to collector of T_1.
d. Connect the base of T_1 to the collector of T_2 via 1µF capacitor with positive end connected to base of T_1.
e. Connect the base of of both T_1 and T_2 to V_{cc} via 220KΩ resistor.

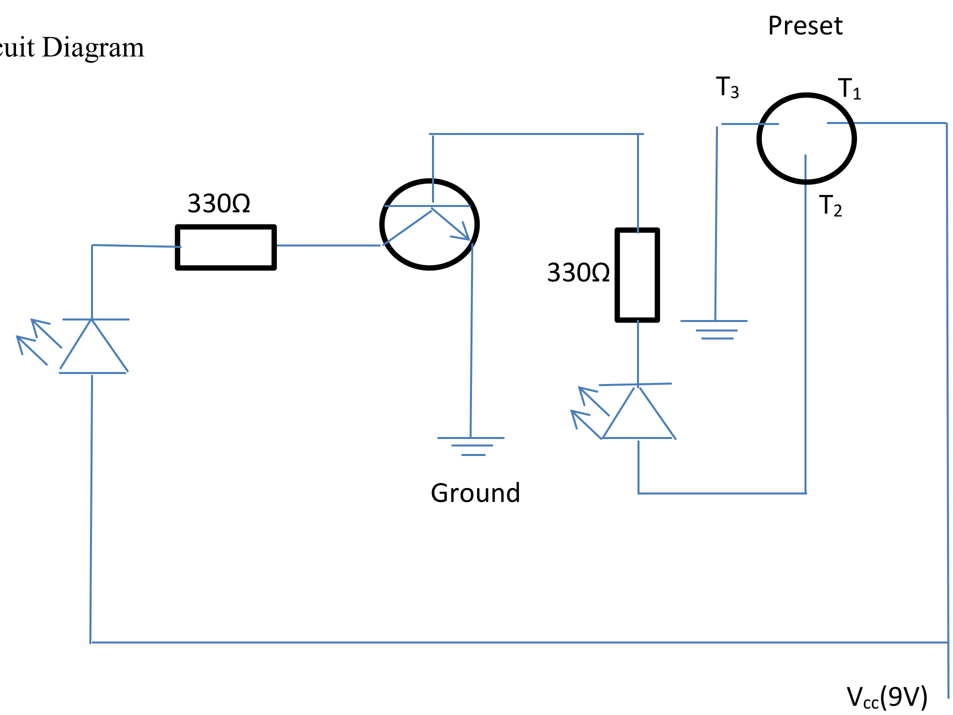
Notes, Observation and Conclusion

VIII. **Transistor as an Amplifier and a switch**

Components Required

NPN transistor, Two 330 resistor, Two LED, 10K preset, 9 V batteries, Breadboard and some connecting wires.

Circuit Diagram



We can understand the circuit diagram in the following steps:

a. Connect the emitter of the transistor to the ground.
b. Connect the collector of the transistor to the negative leg of the LED via 330Ω resistor.
c. Connect the positive leg of the LED to V_{cc}.
d. Connect the base of the transistor to the negative leg of the LED via 330Ω resistor.
e. Connect the positive end of the LED to the terminal 2 of the preset.
f. Connect the terminal 1 of the preset to V_{cc} and terminal 3 to the ground.

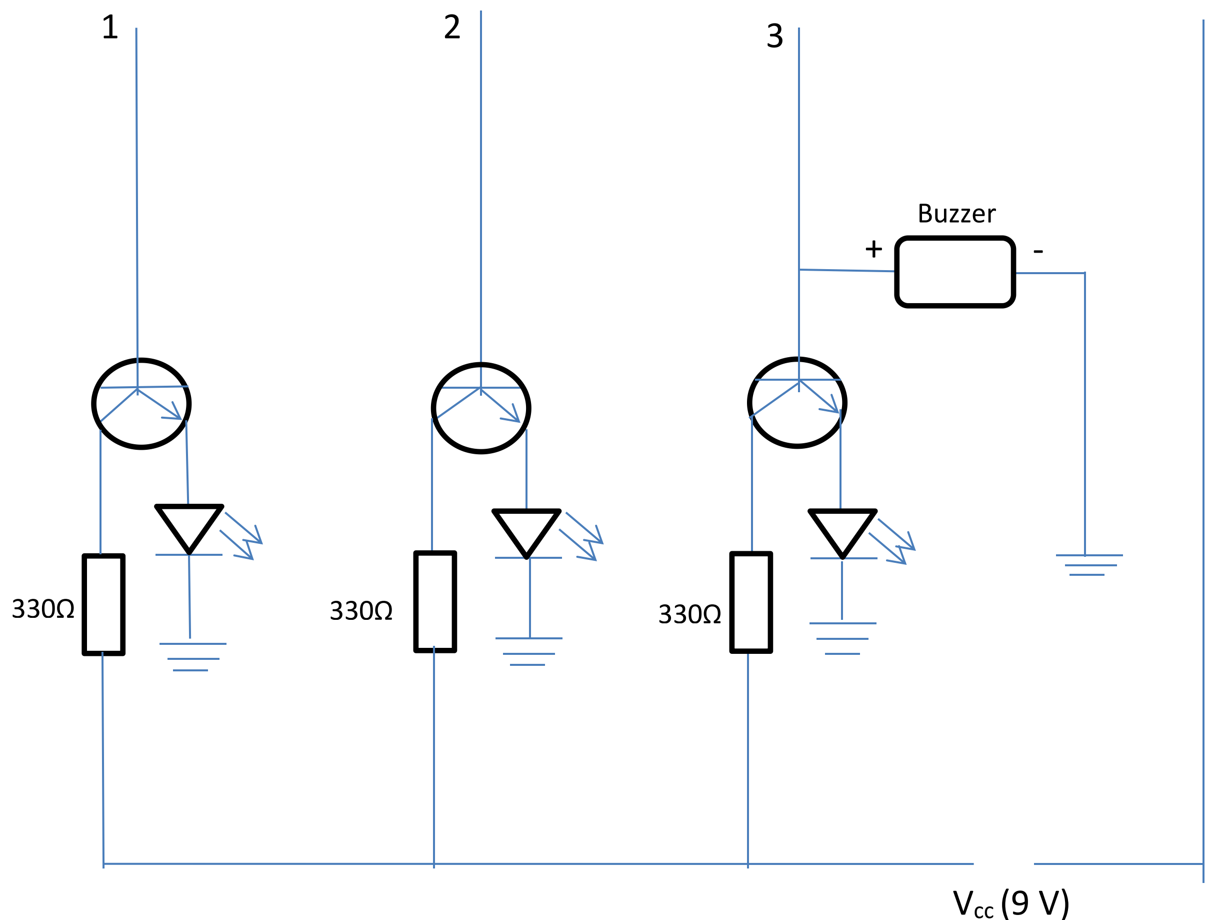
Notes, Observation and Conclusion

IX. Water Level Indicator

Components Required

Three NPN transistor, Three 330Ω resistor, Three different colour LEDs, Buzzer, Breadboard, 9 V battery and some connecting wires.

Circuit Diagram



We can understand the circuit diagram in the following steps:

a. Connect three NPN transistors on the breadboard.
b. Connect emitter of all three transistors with positive end of LEDs of different colour and the negative end of LEDs is to be grounded.
c. Connect the collector of all three transistors with V_{cc} via 330Ω resistor.
d. Connect the positive end of buzzer to the base of third transistor and the negative end to the ground.

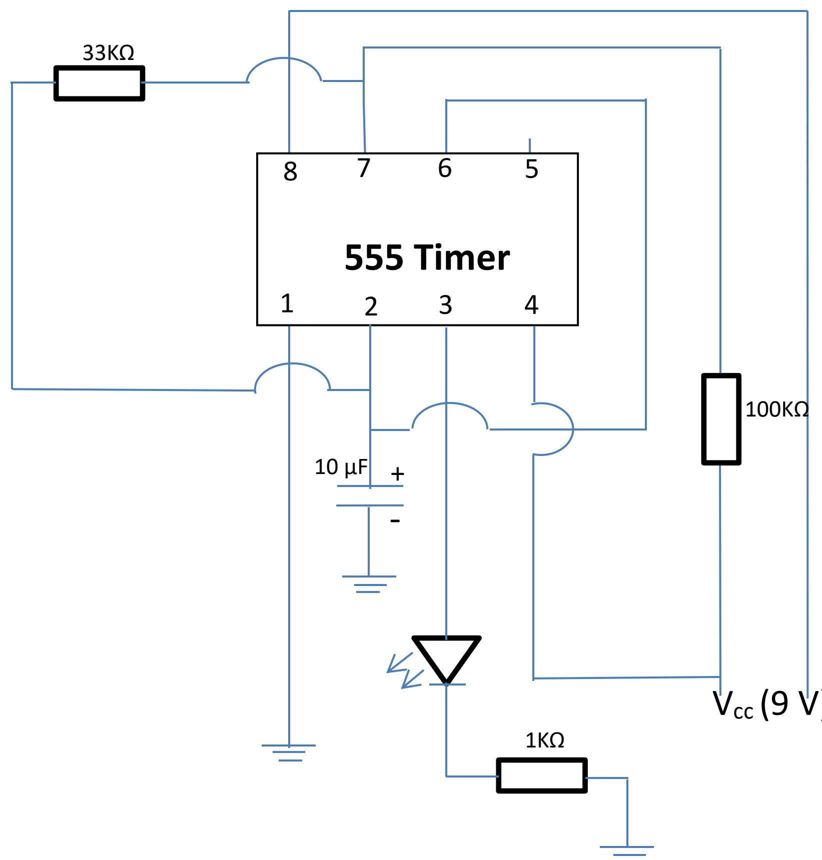
Notes, Observation and Conclusion

X. Flash an LED using 555 Timer

Components Required

555 timer, 10 microfarad capacitor, 1KΩ resistor, 100KΩ resistor, 33KΩ resistor, 220Ω resistor, LED, Breadboard, 9 V battery and some connecting wires.

Circuit Diagram



We can understand the circuit diagram in the following steps:

a. Insert NE555 timer on the breadboard

b. Connect pin 1 to the ground and pin 4 and pin 8 to V_{cc}

c. Connect positive terminal of capacitor to pin 2 and negative terminal to ground

d. Connect pin 2 to pin 7 via 43 KΩ

e. Connect pin 2 to pin 6

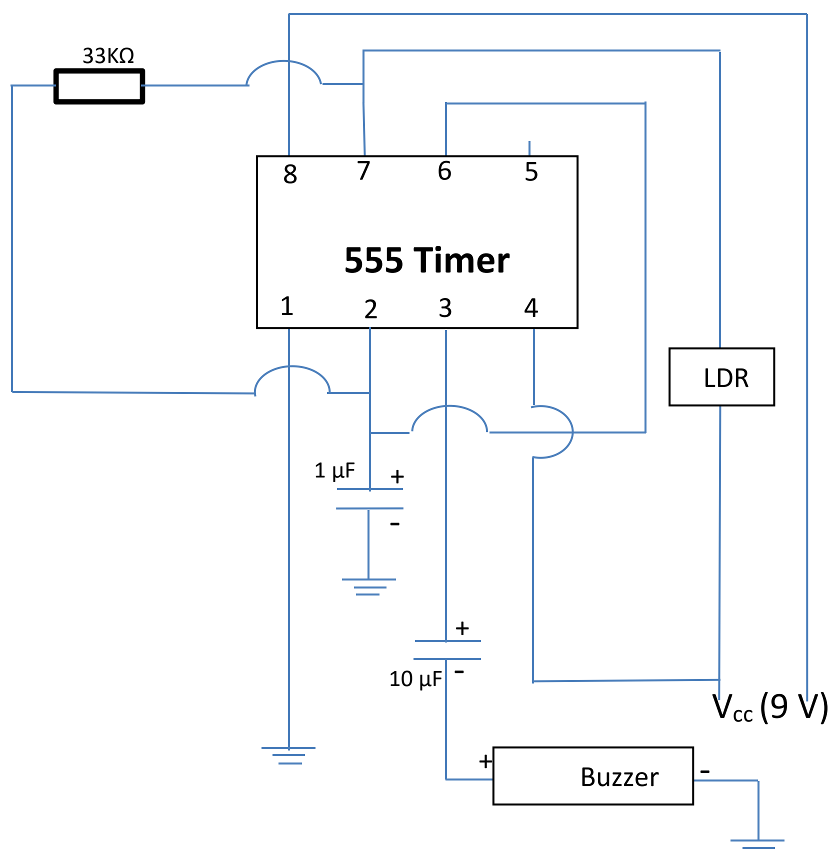
f. Connect positive terminal of LED to pin 3 and negative terminal to ground via 1KΩ

g. Connect pin 7 to V_{cc} via 90 KΩ

XI. Music Instrument using 555 Timer

Components Required

555 Timer, 10µF capacitor, 1µF capacitor, Buzzer, LDR, resistors , Breadboard, 9 V battery and some connecting wires.



We can understand the circuit diagram in the following steps:

a. Insert NE555 timer on the breadboard

b. Connect pin 1 to the ground and pin 4 and pin 8 to V_{cc}

c. Connect positive terminal of 1µF capacitor to pin 2 and negative terminal to ground

d. Connect pin 2 to pin 7 via 43 KΩ

e. Connect pin 2 to pin 6

f. Connect positive terminal of 10μF Capacitor to pin 3 and negative terminal to positive terminal to buzzer

g. Connect negative terminal of buzzer to ground

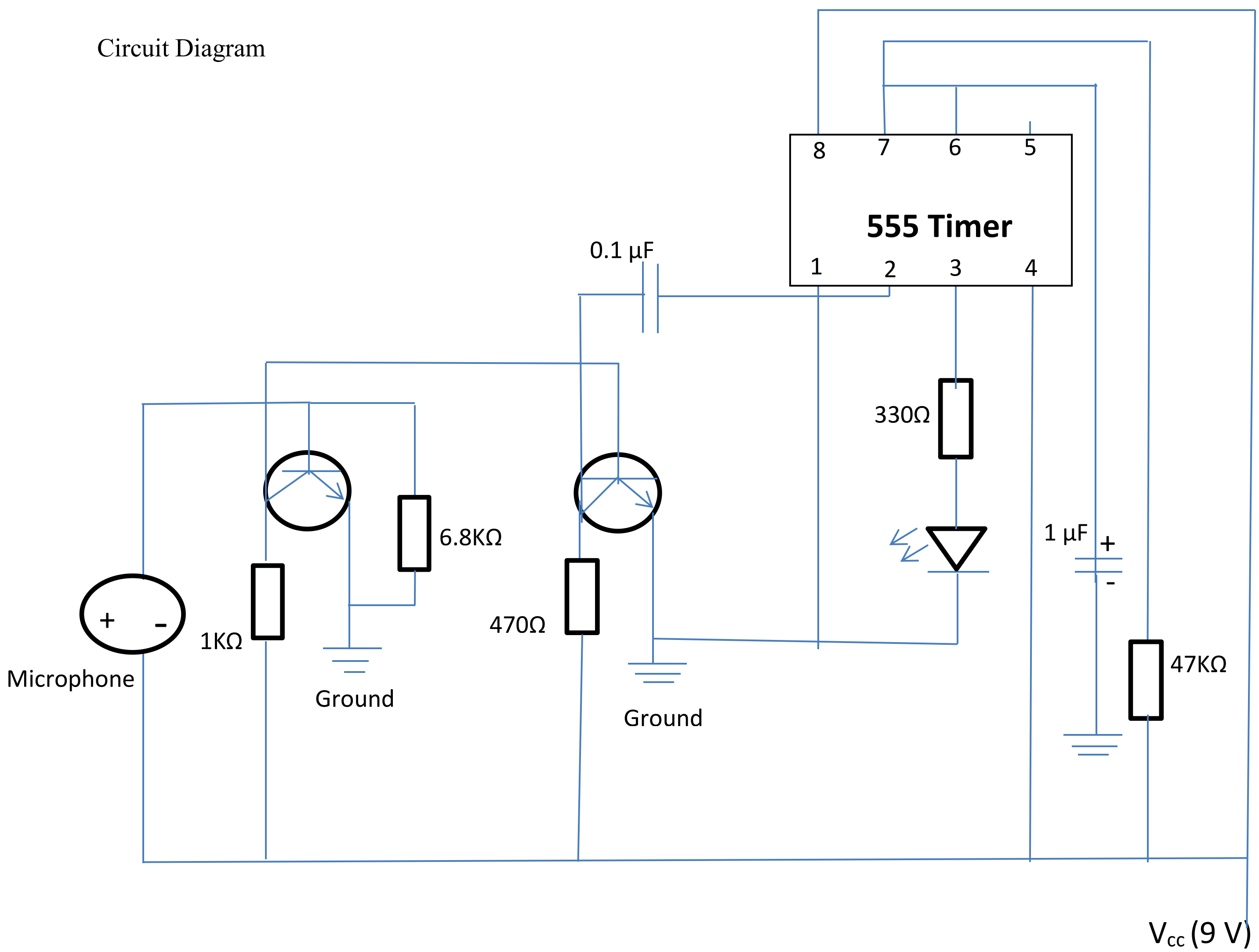
h. Connect pin 7 to V_{cc} via LDR

XII. **Clap Switch**

Components Required

Two NPN transistor, 555 timer, 100 microfarad capacitor, Electric condenser microphone, Two 0.1 microfarad capacitor, 1K resistor, 6.8K resistor or 4.7K resistor, 470 resistor, 47K resistor, 330 resistor, LED, Breadboard, 9 V battery and some connecting wires.

Circuit Diagram



We can understand the circuit diagram in the following steps:

a. Insert NE555 timer and two NPN transistors.

b. Connect the emitters of both the transistors to the ground.

c. Connect one leg of the 6.8K resistor to the base of the first transistor and second to the ground.

d. Connect one leg of the 1K resistor to the collector of the first transistor and second to the V_{cc}.

e. Connect the collector of the first transistor to the base of the second transistor.

f. Connect the one leg of the 470 resistor from the collector of the second transistor and the other leg to the V_{cc}.

g. Connect the first pin of the NE555 timer to the ground.

h. Connect pin 4 and 8 of the NE555 timer to the V_{cc}.

i. Connect pin 6 and pin 7 of NE555 timer together and connect 47K resistor from either of pin 6 or pin 7 to the V_{cc}.

j. Connect the positive leg of the 100 microfarad capacitor to pin 6 of the NE555 timer and the negative leg of the capacitor to the ground.

k. Connect the one leg of the 0.1 microfarad capacitor to pin 5 of the NE555 timer and the other leg to the ground.

l. Connect the one leg of the other 0.1 microfarad capacitor to pin 2 of the NE555 timer and the other leg to the collector of second transistor.

m. Connect the positive leg of the LED to pin 3 of the NE555 timer via 330 resistor and the negative leg of the LED to the ground.

n. Connect the positive leg of the electric condenser microphone to the V_{cc} and the negative leg to the base of the first transistor.

o. Connect the positive terminal of the 9 V battery to the V_{cc} and the negative terminal to the ground.

p. Notes, Observation and Conclusion