



# **Takneek 17 Lecture**

## **Electronics Club IITK**

## Electromania Problem Statement Discussion

We are here to help you prepare and win Electromania.





## Before we start ...

1. We assume you do not have ANY prior knowledge in electronics.
2. If you do not understand anything or want something more, feel free to interrupt.
3. Try to answer the questions posed during the lecture.
4. Don't care about someone opinion on you (when asking questions/doubts or when answering to questions).
5. **Most important instruction : Do follow the above four points.**

# Lecture Flow



# 1

## Problem Statement

“ A journey of Thousand Miles begins with a single step “



## Electromania

1. Most participated event from Electronics Club mainly for Y17 guys to show their skills in good circuit designing, logic designing and practical implementation.
2. Basic idea is to create a prototype of a device which can count number of people present in room.
3. It would provide you with the knowledge of basic electronics such as IR led's, transistors and many other IC's.
4. [Electromania Problem Statement](#)

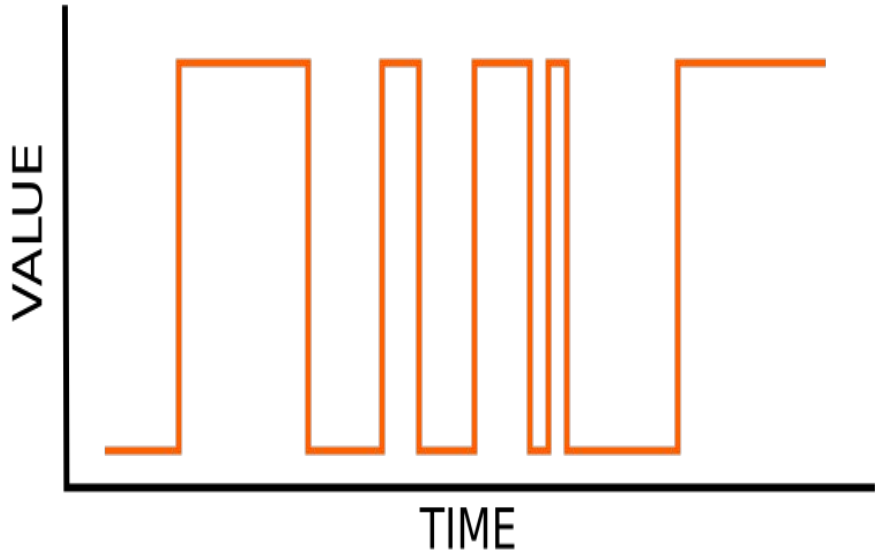
# 2

## Some Basics (Theory)

“ A journey of Thousand Miles begins with a single step “



## Digital Signals



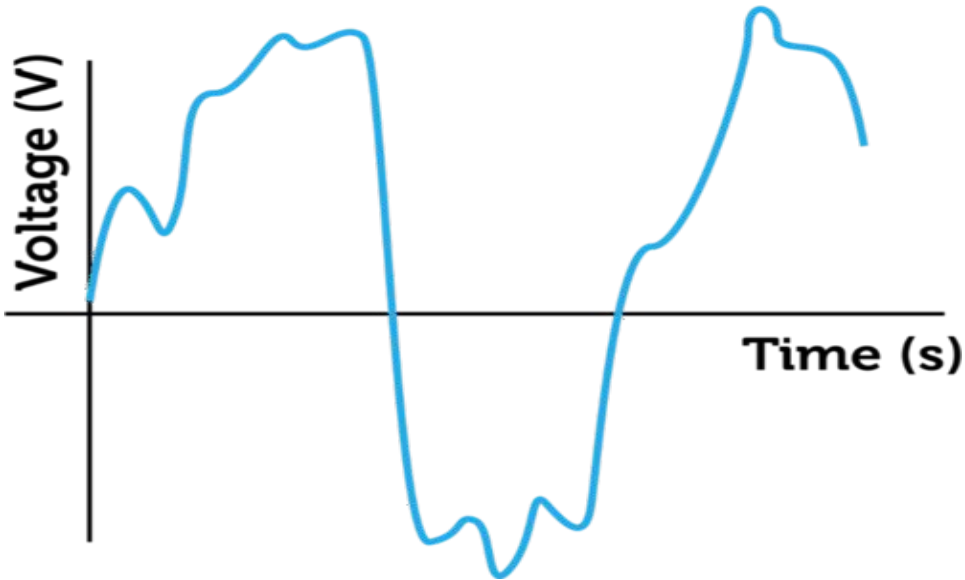
- Values are discrete.
- At any given point of time the possibilities are that voltage is either 5V or 0V.
- Intermediate values are not allowed.
- We denote 5V by the number “1” and 0V by the number “0”.





## Analog Signals

### Analog signals



- Values are continuous.
- At any given point of time, the voltage can take any value.



## Binary to Decimal

<b>128</b>	<b>64</b>	<b>32</b>	<b>16</b>	<b>8</b>	<b>4</b>	<b>2</b>	<b>1</b>							
<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>1</b>							
<hr/>														
<b>128</b>	<b>+</b>	<b>0</b>	<b>+</b>	<b>0</b>	<b>+</b>	<b>16</b>	<b>+</b>	<b>8</b>	<b>+</b>	<b>0</b>	<b>+</b>	<b>2</b>	<b>+</b>	<b>1</b>
<b>= 155</b>														



## Decimal to Binary

Find the Binary equivalent for Decimal 35

<i>Divisor</i>	2	35	1	<i>Remainder</i>
	2	18	0	
	2	9	1	
	2	4	0	
	2	2	0	
	2	1	1	
		0		
	<i>Quotient</i>		<i>MSD</i>	

↑ *LSD*

*MSD - most significant digit*

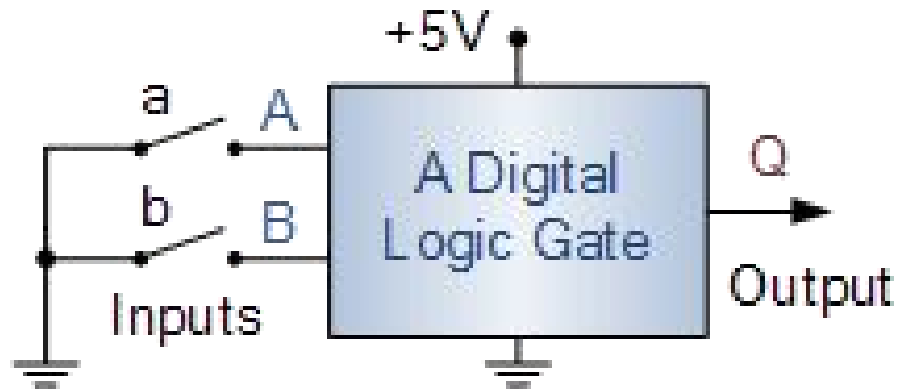
*LSD - least significant digit*

*Therefore, the binary equivalent for 35 is*

**100101**

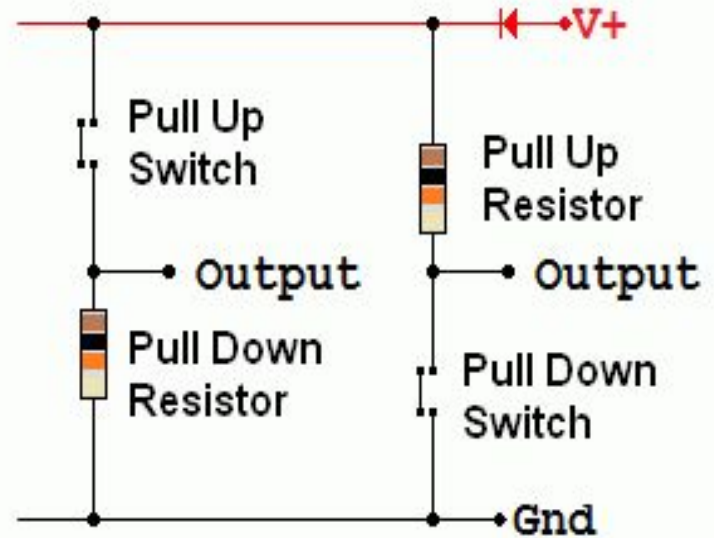
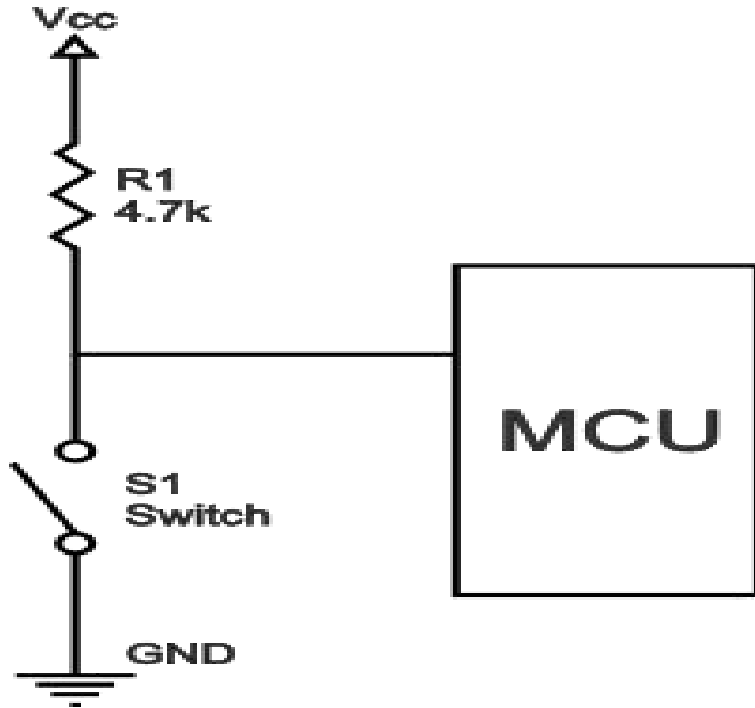


## Floating Voltages and Remedies





## Pull-up and Pull-down



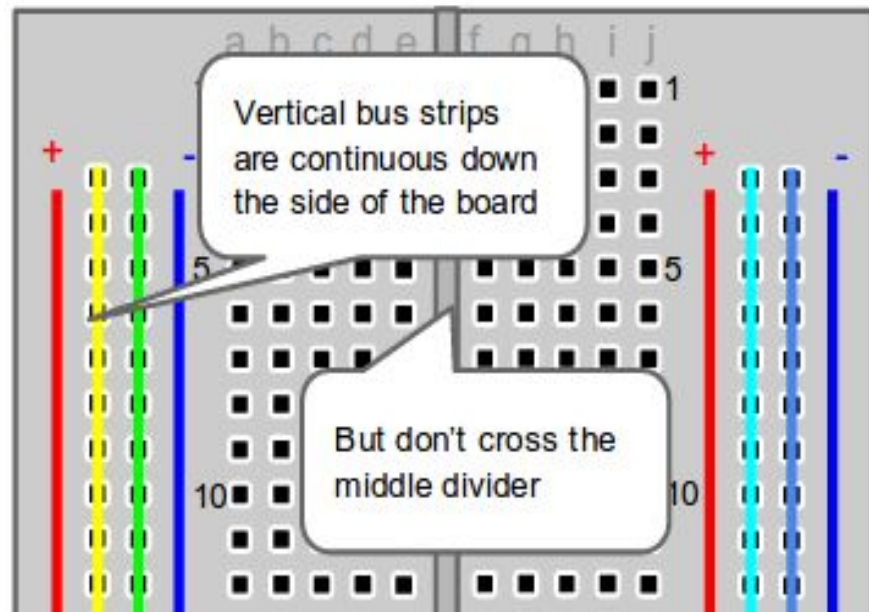
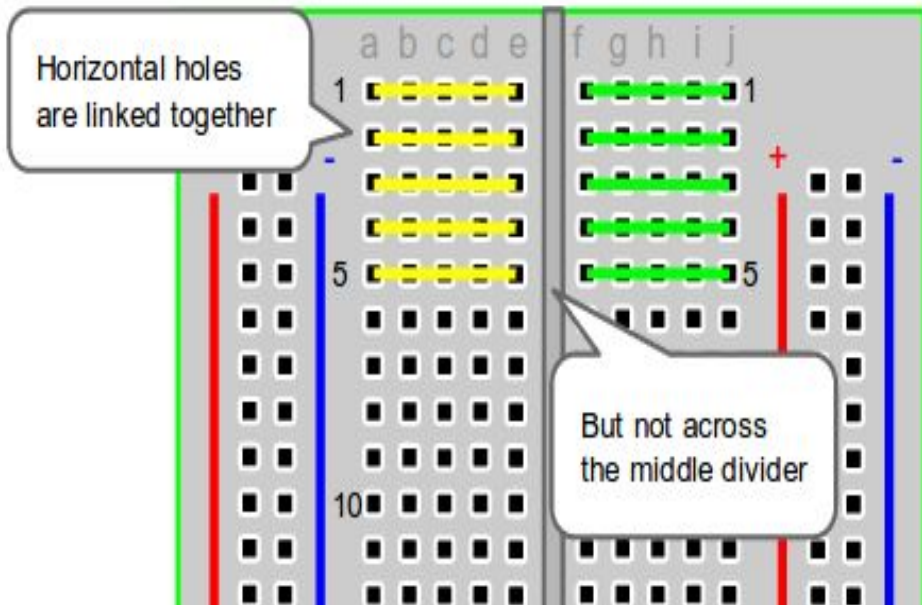
# 3

## Some Basics (Practical)

“ A journey of Thousand Miles begins  
with a single step “

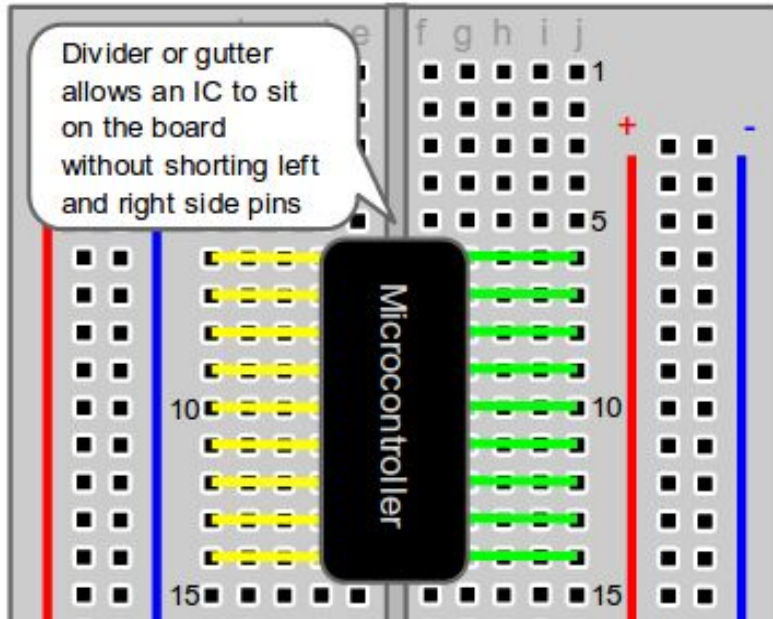


## Breadboard (BB)





## Breadboarding

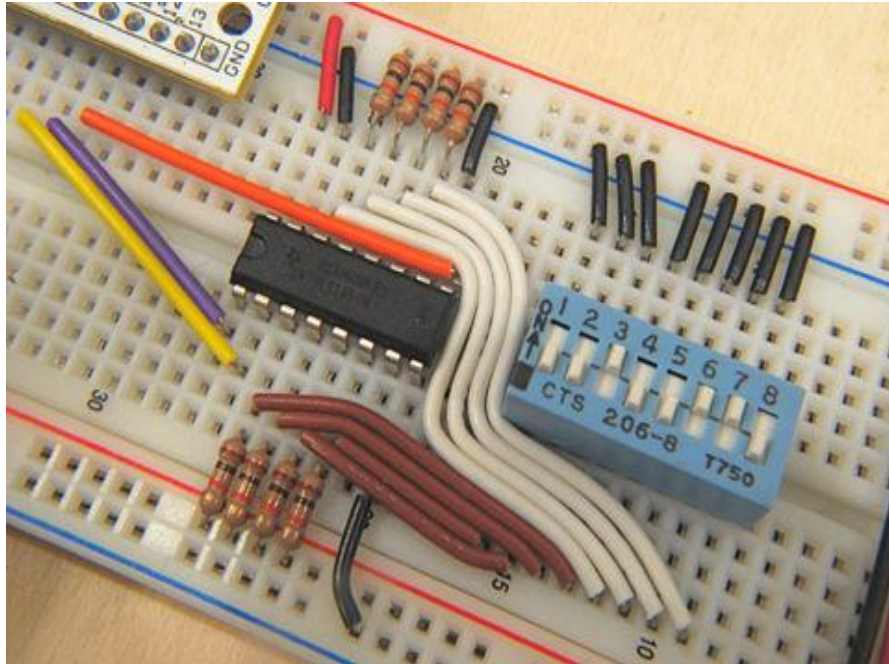


- Vertical long lines are generally used as power supply rails.
- ICs are placed as shown in the figure to avoid shorting.





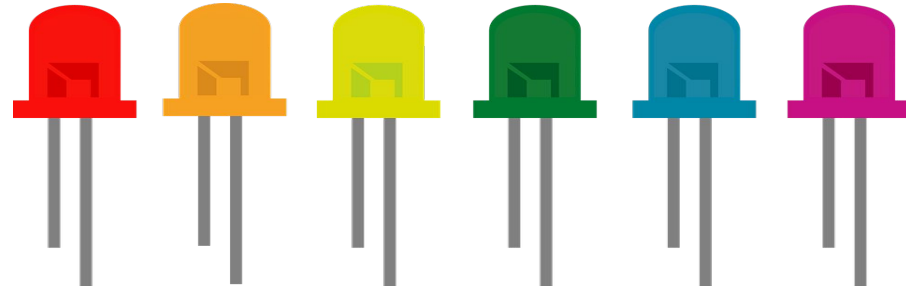
## Good practices



- Always use red and black coloured wires respectively when connecting to 5V supply and 0V (ground).
- Dangling wires is a bad breadboarding practice.
- The picture on the left is example of a good breadboarding.
- Why do we need a Breadboard and what are it's uses ?

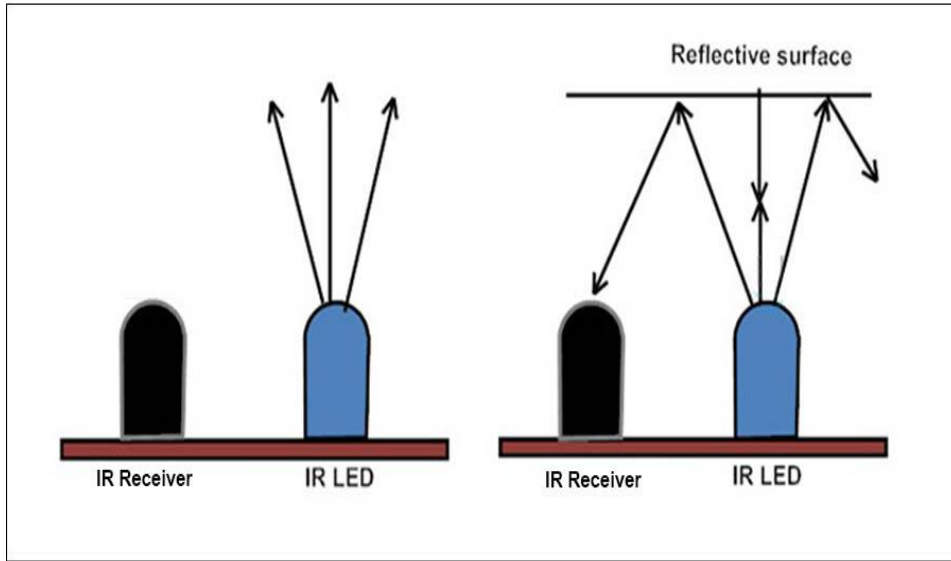


## LEDs



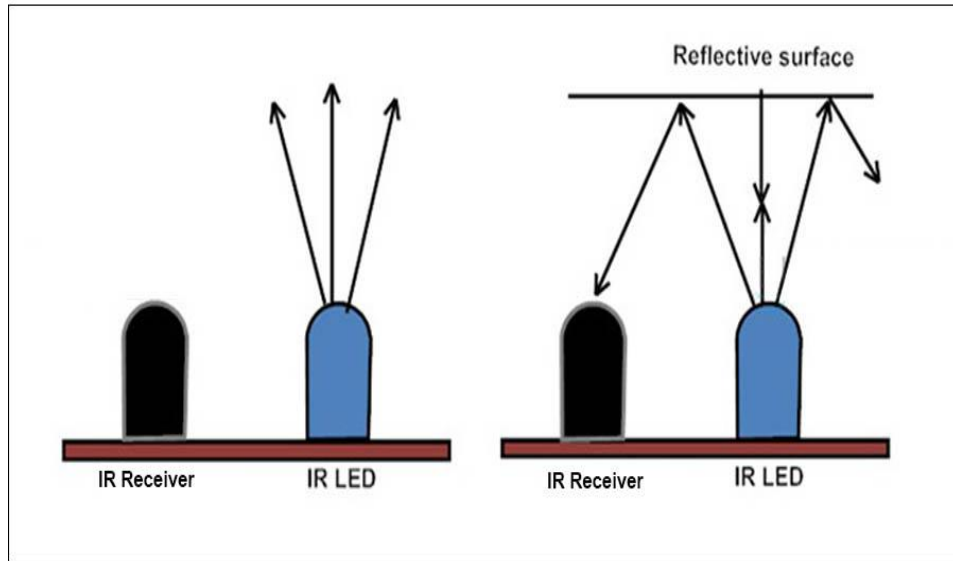
- LEDs are special kind of diode that emit light when forward biased.
- Different kind of LEDs emit light of various colors.
- For LED to light, longer side must be at higher potential, and shorter one at lower potential.
- **NOTE : Always use a resistance (~200 Ohms) in series with LED (Why ?).**
- At which end of the LED should the resistance be connected ?
- What are the uses of LEDs ?

## IR Transmitter & Receiver



- IR Transmitter (LED) when powered up emits IR rays (visible only when seen under a camera).
- A Photodiode (IR receiver) is a reverse biased pn junction in which reverse current increases when the junction is exposed to light.
- When the light gets reflected from some obstacle and reaches receiver, it produces some current which when passed through resistor creates a voltage.

## IR Transmitter & Receiver

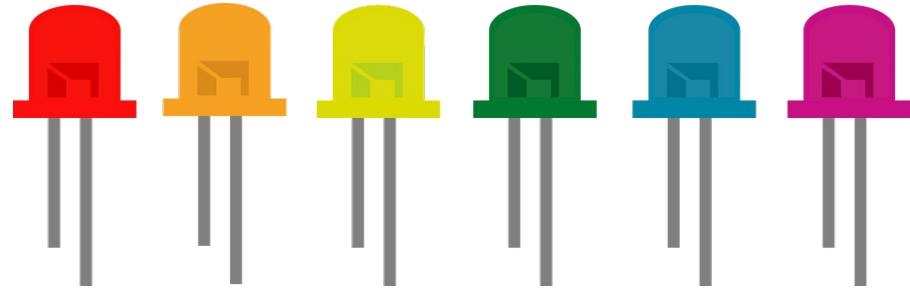


- With proper choice of resistances, a voltage of 0.7 Volts can be generated.
- But all the digital ICs work with 5V.
- Hence this 0.7V must be used as a switch/trigger to 5V.
- This will be explained later in BJT.

Debugging is like being the  
detective in a crime movie  
where you're also the  
murderer.



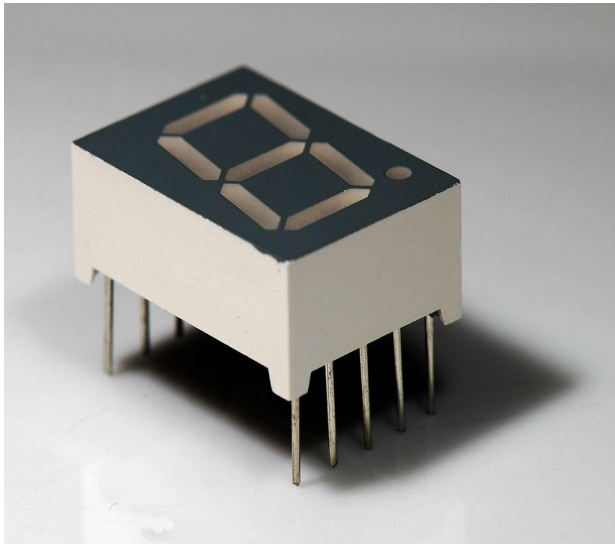
## Uses of LEDs



- **YES YOU GUESSED IT !!!**
- LEDs are mostly used in debugging besides other uses.
- Other uses include lighting (as in your rooms) and indication of some process (indicative LEDs as in your computer/laptop).
- Another interesting use of LEDs is cheap and bright displays (as in Indian railways).
- “ Without LEDs, Electronics is hard and boring ”



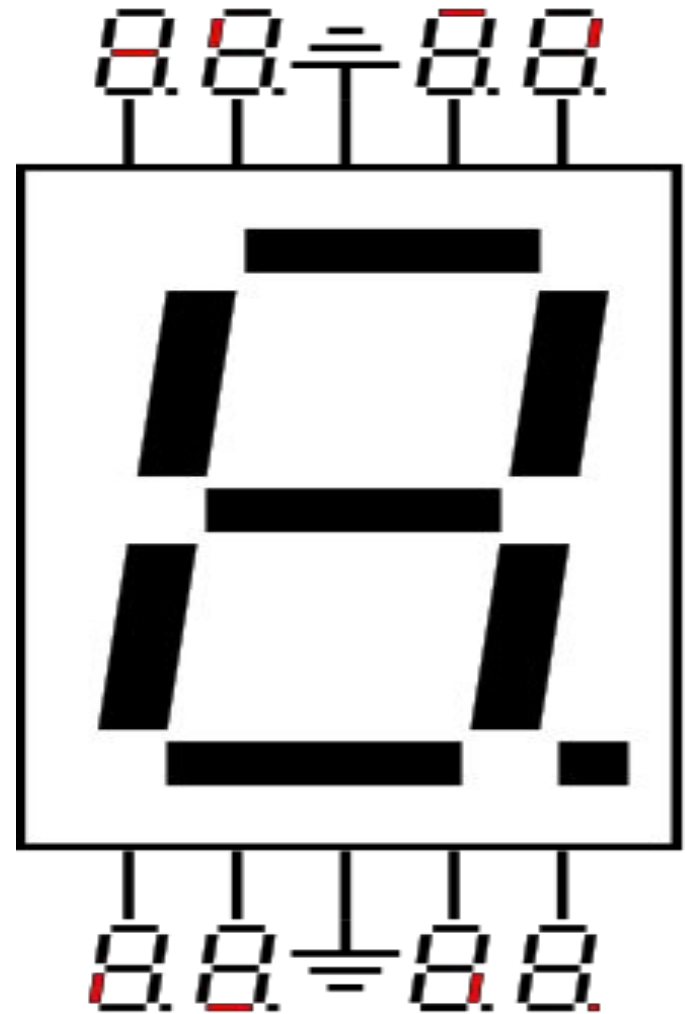
## Seven Segment Display



- Seven segment display most commonly used to display numbers (in calculators) is just a set of 7 LEDs.
- There are two types:
  - 1. All negative terminals of LEDs are connected together.
  - 2. All positive terminals are connected together.
- Mostly used in combination with 7447 IC (explained later).



## Common Cathode Type







## Power Supply



- Now comes the BAAP (I am not talking about Nokia), the power supply.
- The ICs we use operate at the 5V supply.
- It is difficult to find batteries of 5V.
- Hence we use phone chargers.
- There is (normally) 5V potential difference between inside and outside of the pin of chargers (old chargers).

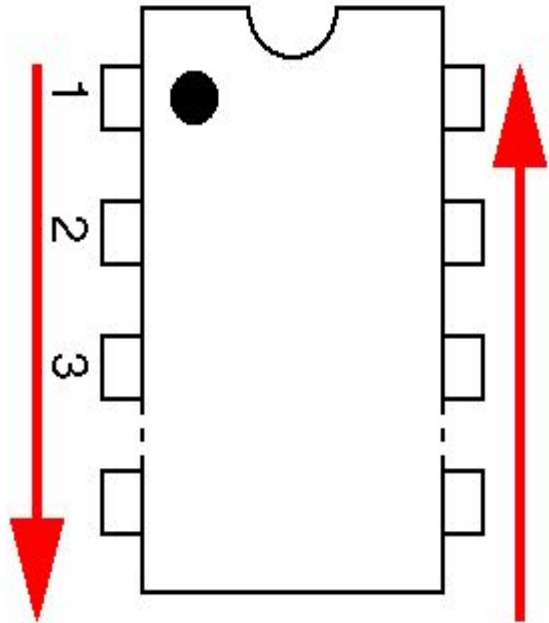
# 4

## Important ICs (Digital & Non Programmable)

“ A journey of Thousand Miles begins with a single step “



## Important points



- IC stands for Integrated Circuit.
- For easy understanding consider it as a large number of transistors compressed into small space which serves a particular “Purpose”.
- The “Purpose” is generally to take input from some set of pins and output the processed input on some other pins.
- Any IC follows the numbering of pins as shown in the figure.



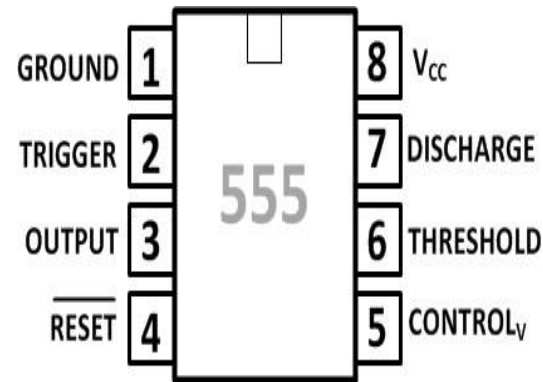
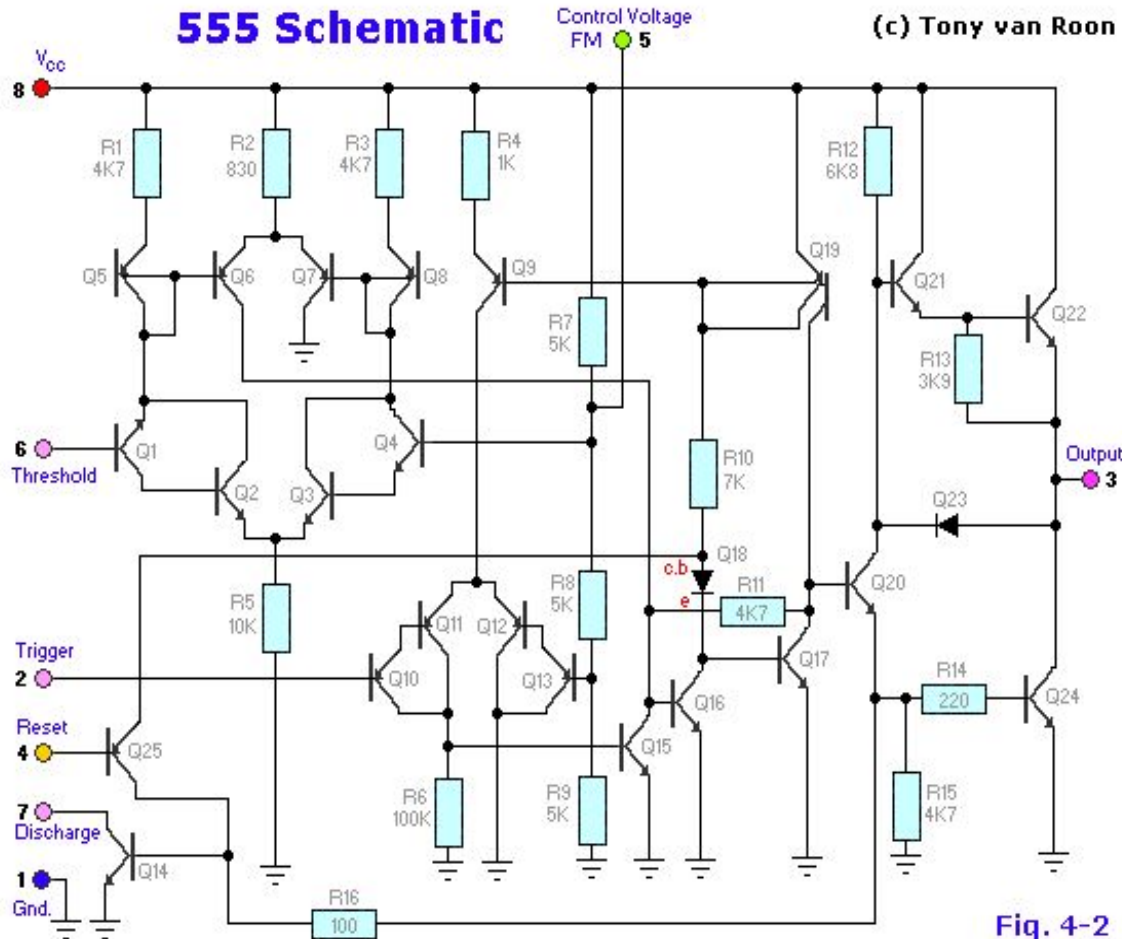
## WORD OF CAUTION

From this point onwards we will treat ICs as black boxes which gives some output for a given input.

NOTE: We will **NOT** go into internal construction of the device.

# 555 Schematic

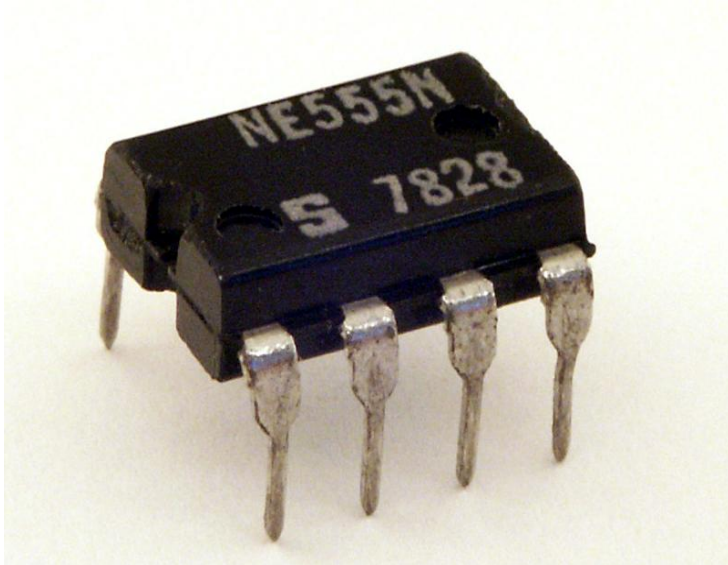
(c) Tony van Roon



drawing by Secret Engineer



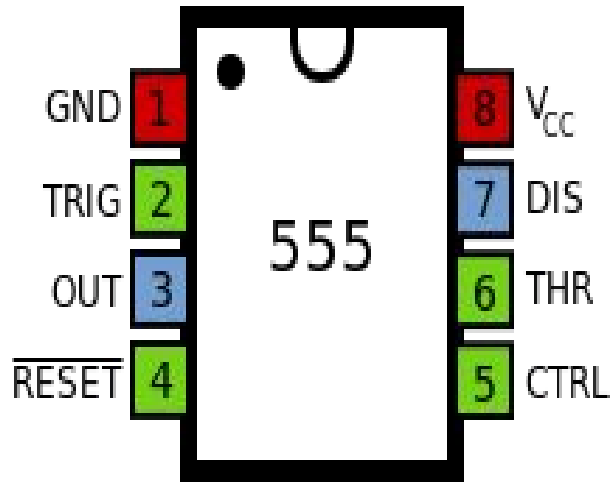
## 555 Timer



- 555 Timer is one of the most commonly used IC and is the heart of almost any real life appliance.
- Why is it called timer ?
- Because it is responsible for things to happen at given intervals, and synchronize various operations.
- There are three modes of operation of this IC viz
  - Astable
  - Monostable
  - Bi stable



## Pin Out



- The pin out diagram of 555 is shown in the figure.
- Pin number 5 is called control pin and by applying voltage here one can change timing characteristics of the IC.
- In most (all) cases this pin is not used and to avoid disturbance, it must be grounded via decoupling capacitor.
- To know more about the pins, please do visit wiki-page [https://en.wikipedia.org/wiki/555\\_timer\\_IC](https://en.wikipedia.org/wiki/555_timer_IC)



## 555 Timer - Astable

50% duty cycle



75% duty cycle



25% duty cycle

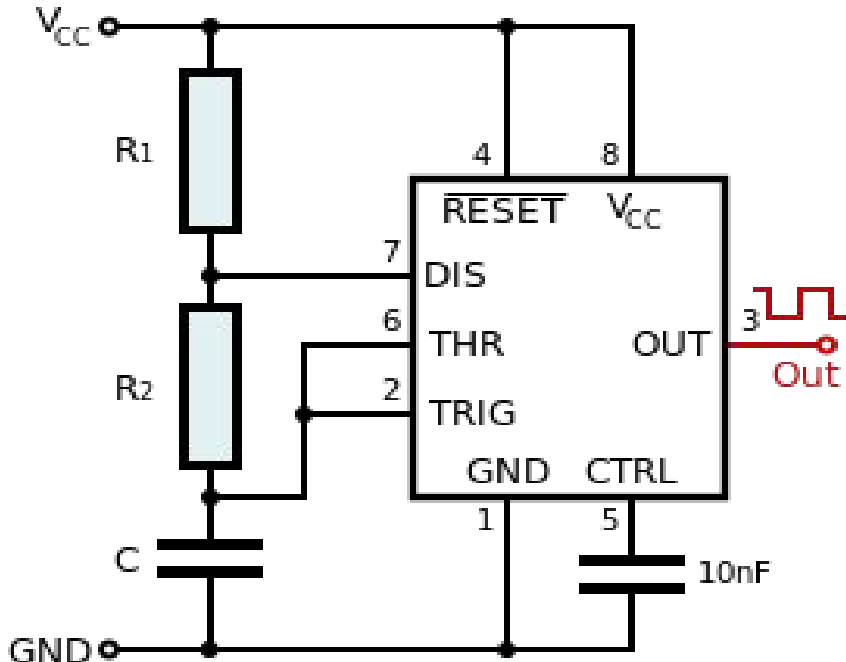


- In Astable mode, as the name suggests the output is not stable in either states i.e neither 0 nor 1.
- As a result it oscillates between 1 and 0 at a particular frequency determined some formulas given in next slide.
- **Duty Cycle** : Duty cycle of a pulse is defined as the percent of time High signal is present in the total duration of the pulse.
- You can also change duty cycle of the output pulse (Explained in next slide).





## 555 Timer - Astable



- Frequency of output pulse is given by:

$$f = \frac{1}{\ln(2) \cdot C \cdot (R_1 + 2R_2)}$$

- High time is given by :

$$\text{high} = \ln(2) \cdot C \cdot (R_1 + R_2)$$

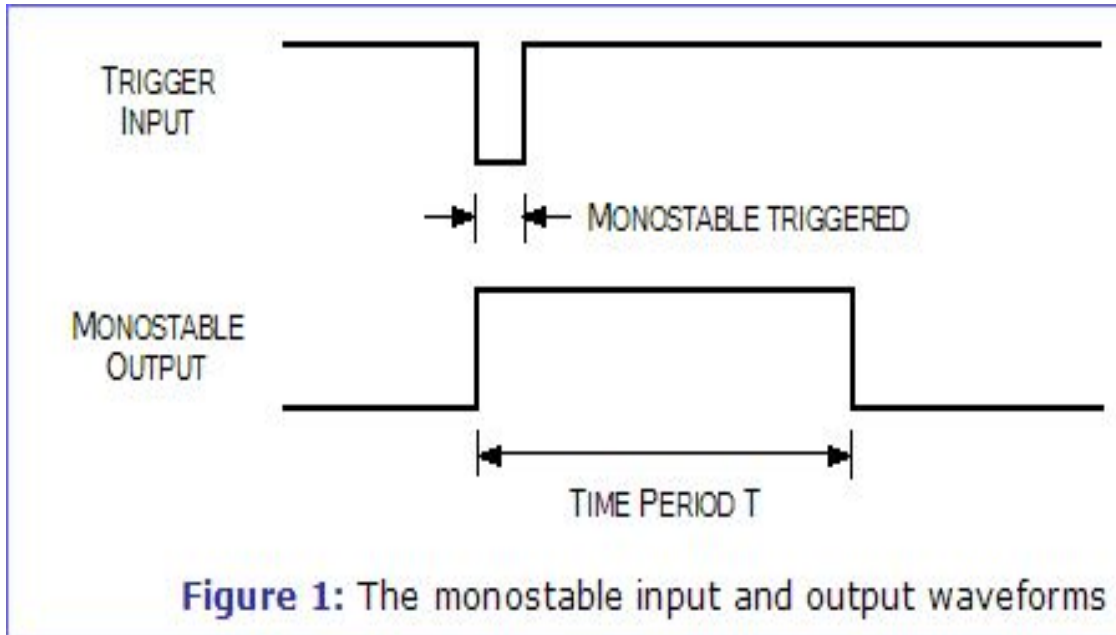
- Low time is given by :

$$\text{low} = \ln(2) \cdot C \cdot R_2$$

- Note : C is in Farads and R1 and R2 are in Ohms.



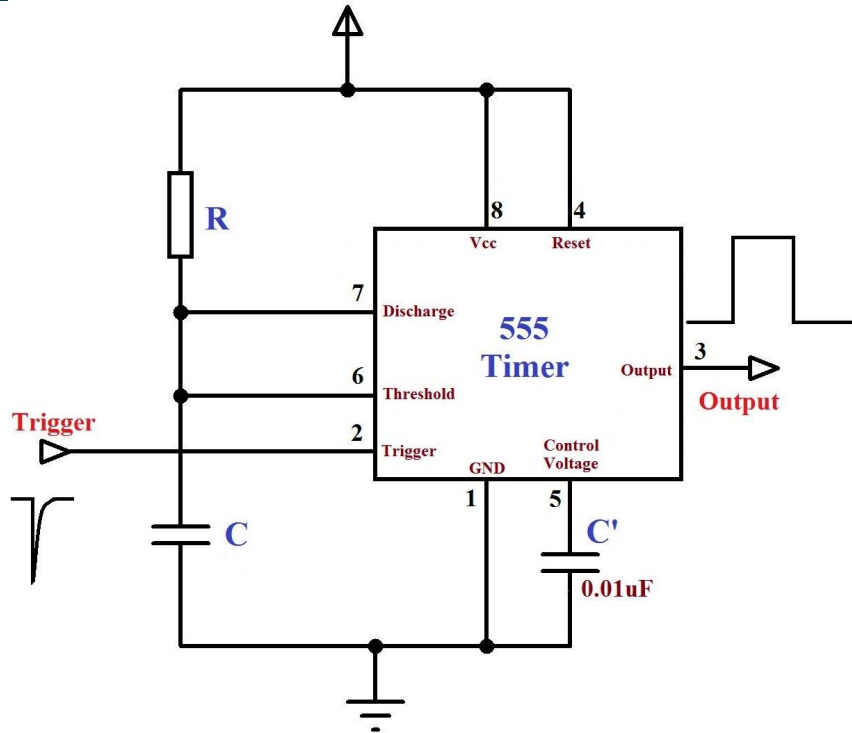
## 555 Timer - Monostable



- As the figure suggests, when you want to trigger a output, the input signal must go low.
- Pull up should be done for proper working.



## 555 Timer - Monostable

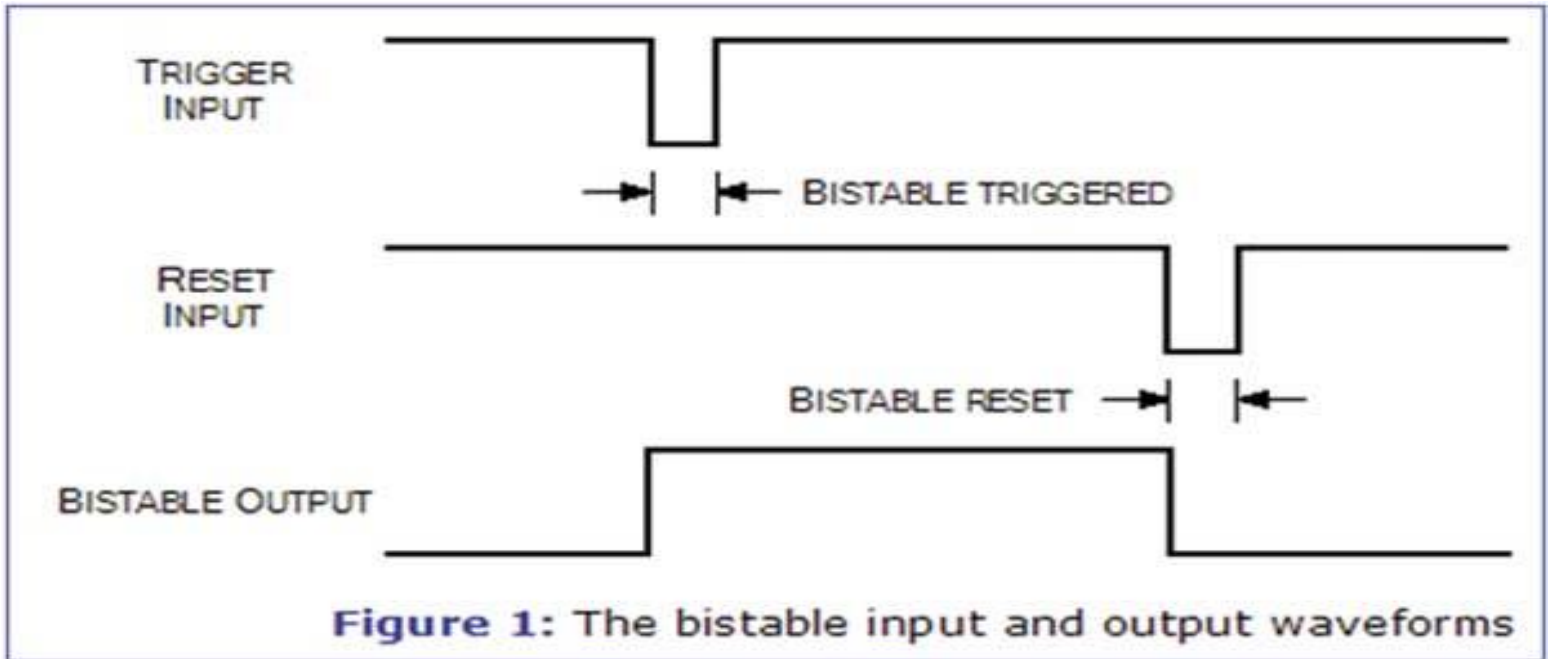


- Monostable as the name suggests is stable at only one state 0.
- Mono Stable Mode can be viewed as a one-shot pulse generator.
- The pulse trigger is generally a push button though it can be anything.
- Pulse width depends on the time, capacitor  $C$  takes to get charged to  $\frac{2}{3}$  of the supply voltage.

$$t = \ln(3) \cdot RC \approx 1.1RC$$

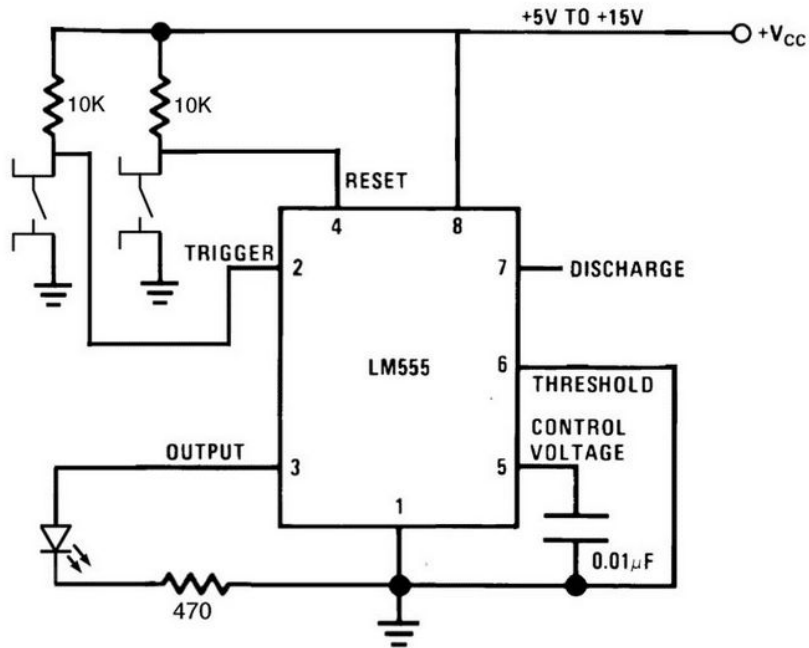


## 555 Timer - Bistable

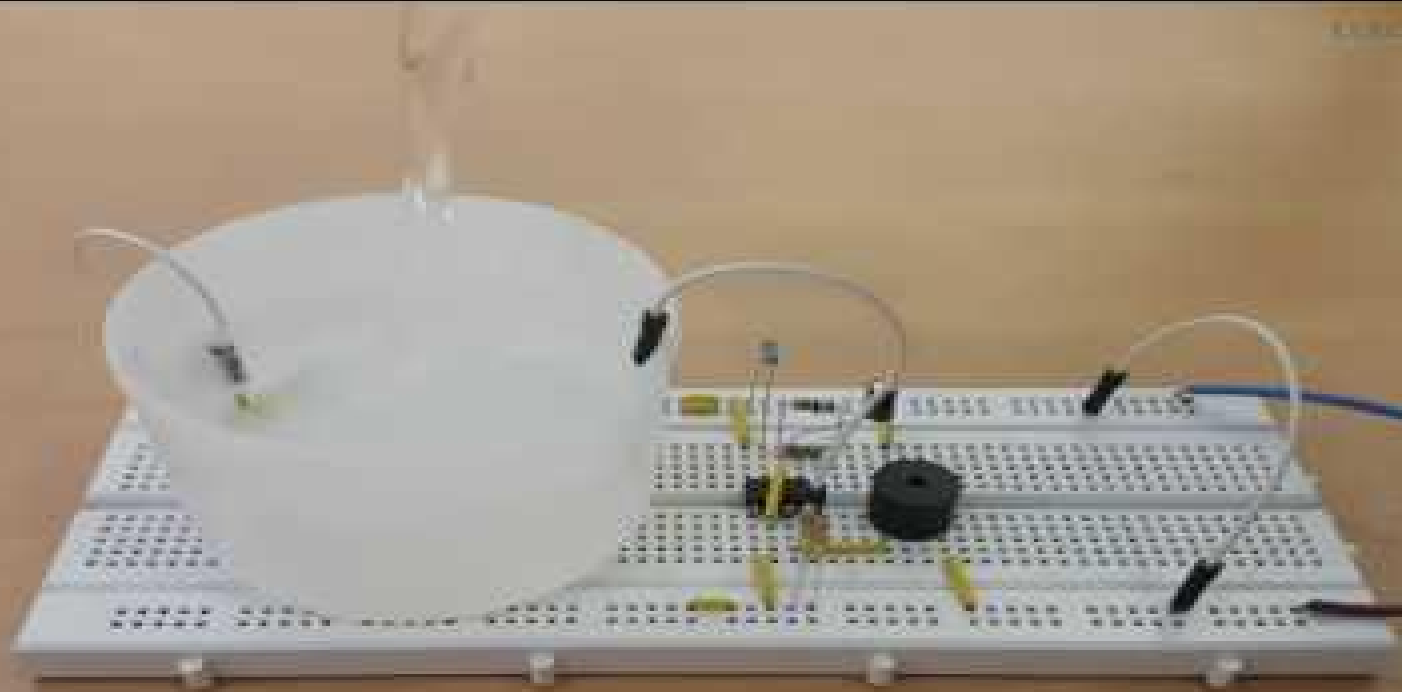




## 555 Timer - Bistable

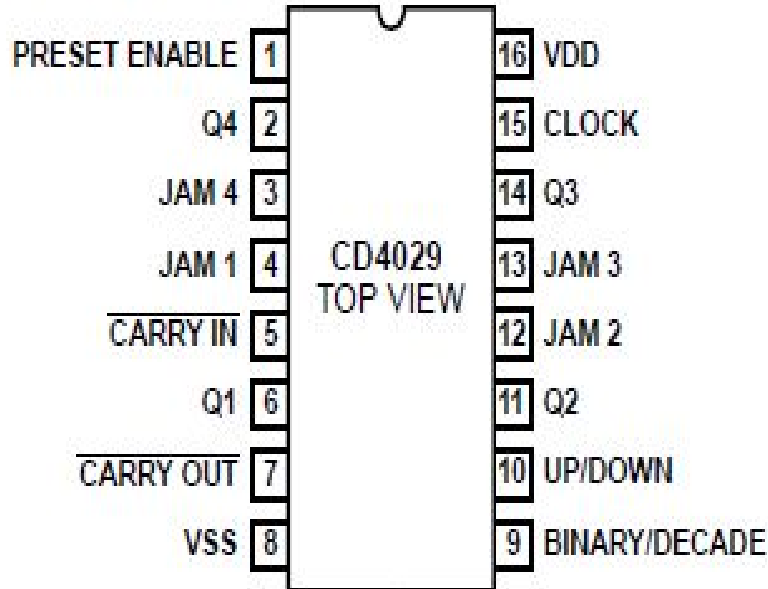


- Bistable as the name suggests is stable at both states i.e. 0 and 1.
- When Trigger pin is momentarily grounded, the output goes HIGH and stays there unlike monostable mode
- Reset pin as the name suggests, resets the output to GROUND.
- Construction of a simple water level alarm is shown in the next slide.





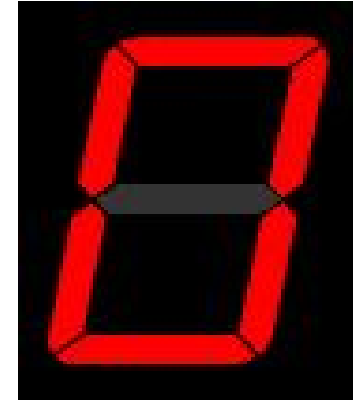
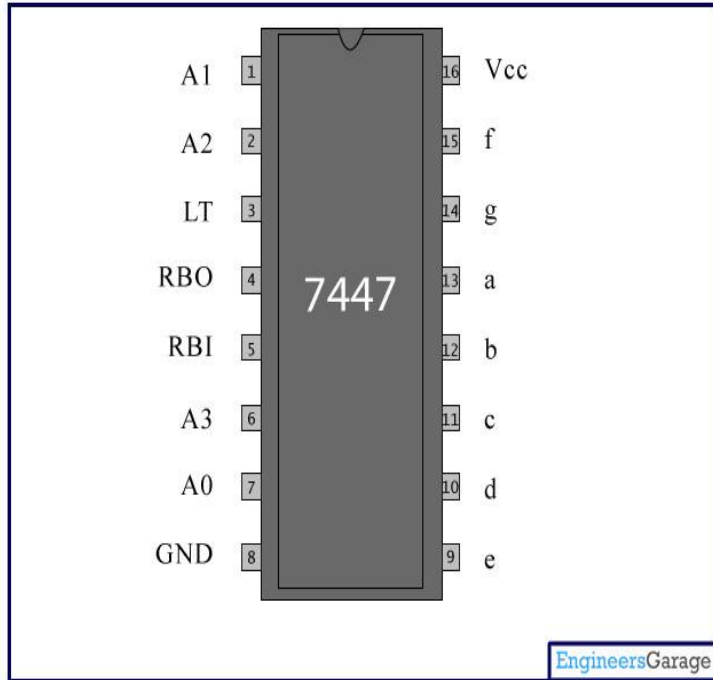
## 4029 Counter



- Counter as the name suggests this IC is a BCD decade up/down counter.
- What does it actually count ?
- It counts the number of ticks the 555 or any other IC sends to it.
- It outputs the result in binary of 4 digits (0 to 15 - 16 values).
- Pin 9 can be used to make it count till either 15 (binary) or 9 (decimal).
- After it reaches its full count, the Pin 7 is set to HIGH and output resets to zero.
- Pin 10 can be used to count up (0 to 9) or down (9 to 0).
- It is mostly used with 7447 Ic and a 7 segment display.



## 7447 & Seven segment display



- Consider it as a translator which translates the binary output of 4029 or any other IC to the language of 7 segment display.
- You might have seen this combination in many devices.



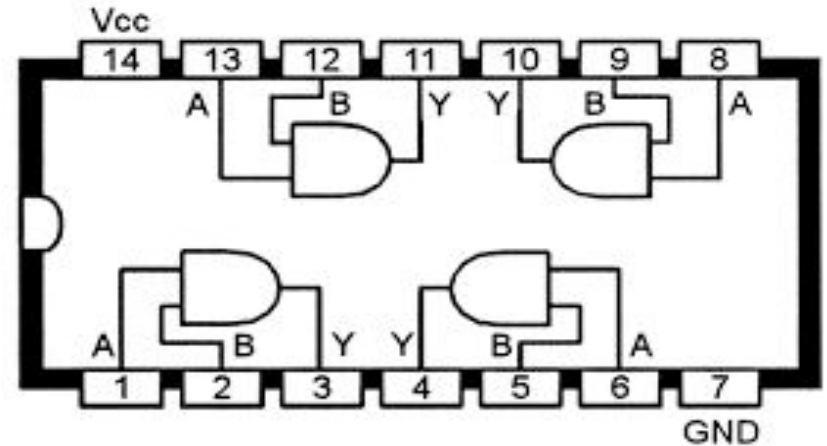
# Implementing Logic

A large, faint watermark of the number '11' is centered in the background of the slide. The background is composed of horizontal bands of color: a dark teal top band, a medium teal band containing the text and watermark, a light green band, and a pale lime green bottom band.



## AND Gate

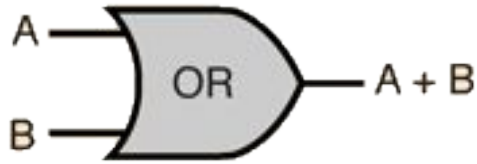
Input		Output
A	B	$Y=A.B$
0	0	0
0	1	0
1	0	0
1	1	1



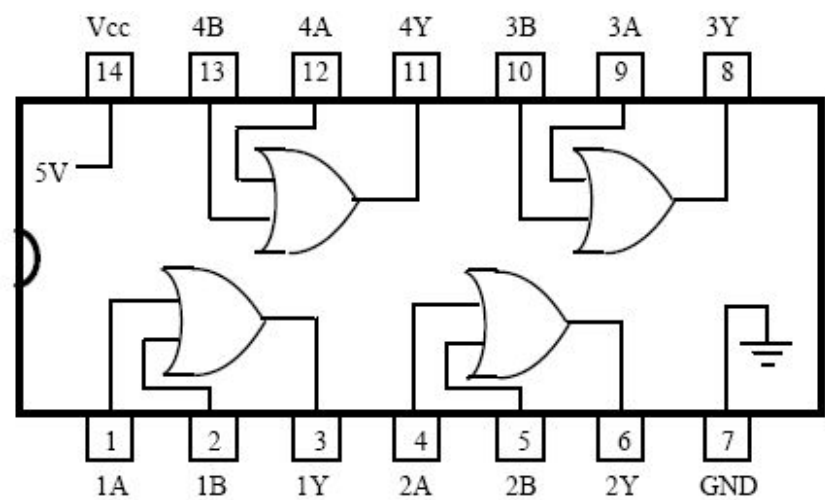
- A general IC has 4 two input AND gates as shown above
- The output of AND gate will be one only if both the inputs are one.
- In practical situation, you can use it if you want to take a particular action only if other two actions take place.



## OR Gate



A	B	Out
0	0	0
0	1	1
1	0	1
1	1	1



- A general IC has 4 two input OR gates as shown above
- The output of OR gate will be zero only if both the inputs are zero.
- In practical situation, you can use it if you want to take a particular action if either of other two actions take place.



## NOT Gate

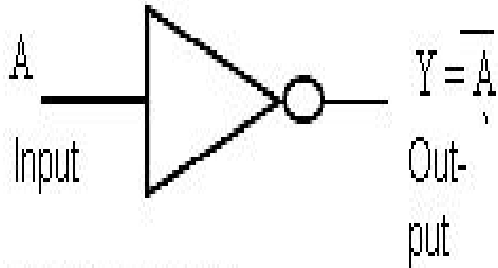
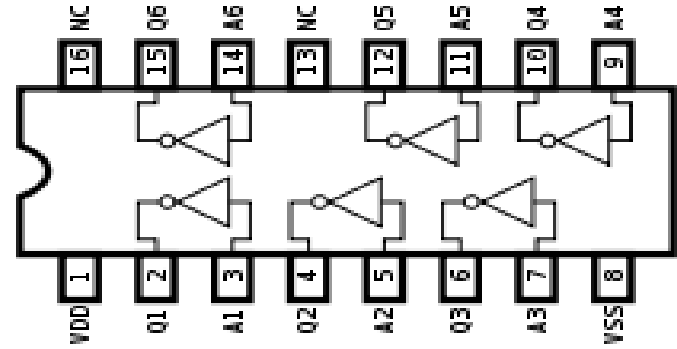


Fig 3.5 NOT Gate

Input	Output
A	$\overline{A}$
0	1
1	0

Table 3.3 : Truth Table for NOT Gate



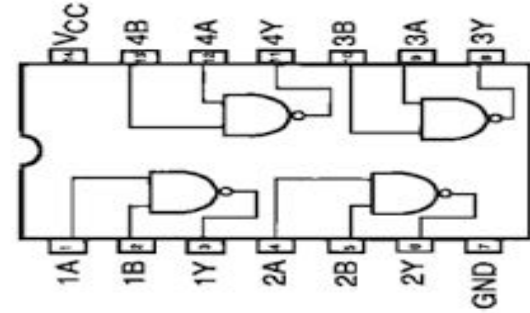
- A general IC has 6 NOT gates as shown above.
- The output of NOT gate will be a inverted input.
- In practical situation, it is used in combination with other logics.



## NAND Gate



A	B	Out
0	0	1
0	1	1
1	0	1
1	1	0

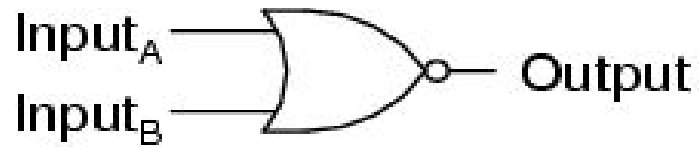


- A general IC has 4 two input NAND gates as shown above
- Equivalent to NOT of AND i.e. zero when both inputs are zero.



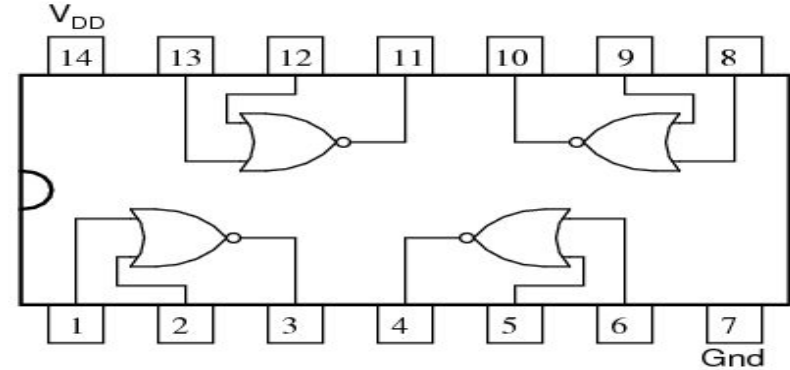
## NOR Gate

*NOR gate*



A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

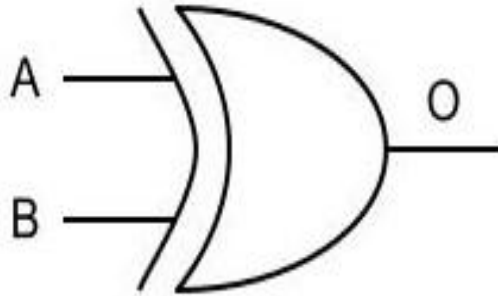
*"Pinout," or "connection" diagram for the 4001 quad NOR gate*



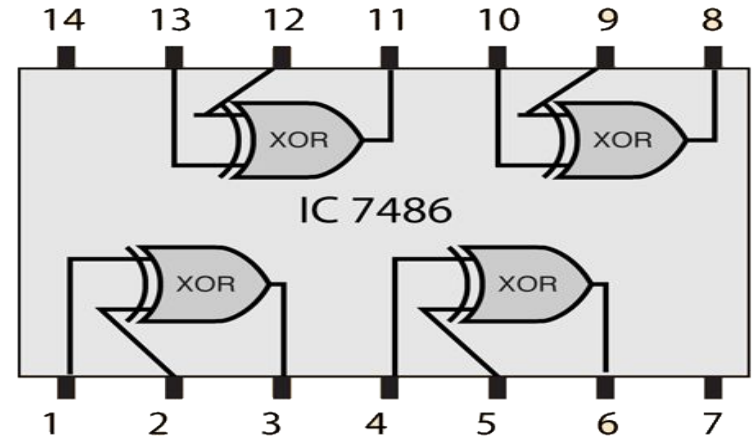
- A general IC has 4 two input NOR gates as shown above
- Equivalent to NOT of OR i.e. one only when both are zero.



## XOR Gate



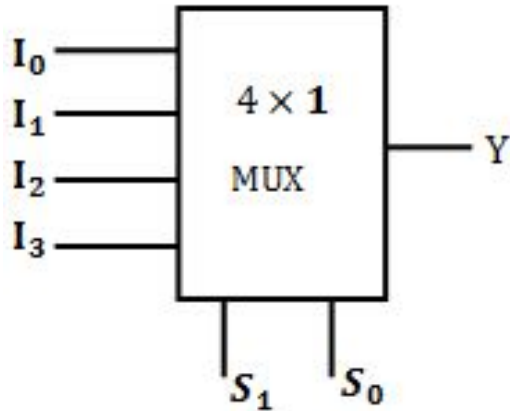
A	B	O
0	0	0
0	1	1
1	0	1
1	1	0



- A general IC has 4 two input XOR gates as shown above
- Also known as Exclusive OR.
- It gives one when odd number of Inputs are one



## Multiplexer & De-Multiplexer



Truth table

$S_1$	$S_0$	Y
0	0	$I_0$
0	1	$I_1$
1	0	$I_2$
1	1	$I_3$

### Multiplexer

- Multiple Input, One Output
- A single line is electrically connected to output.
- Selection of input line to be electrically sorted with output line is done via select lines.

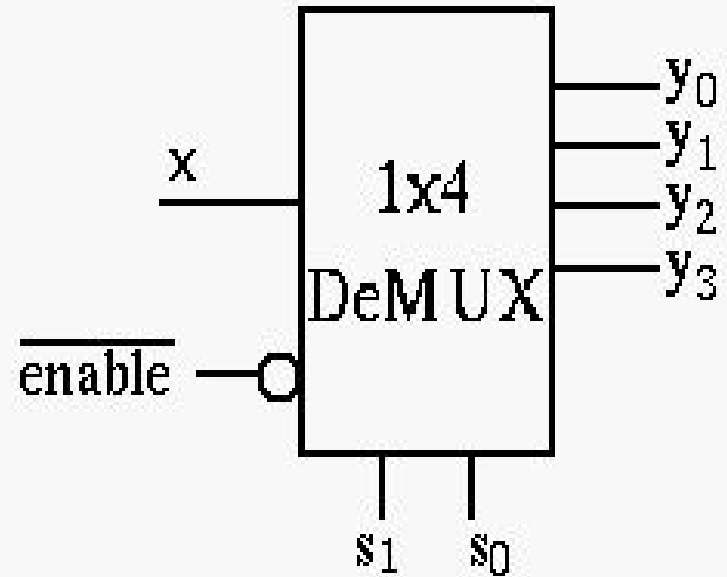
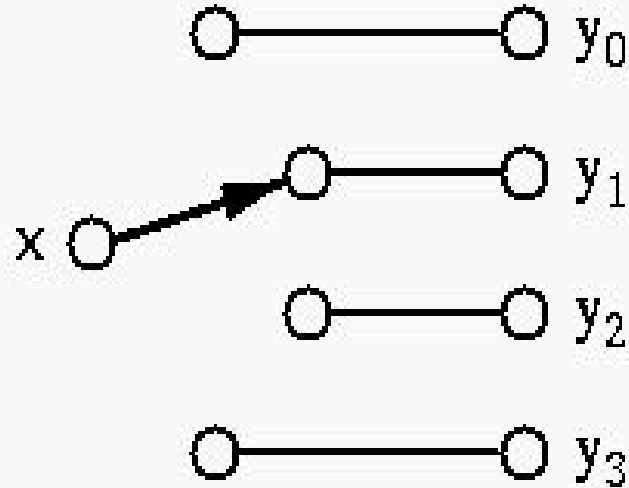
### De-Multiplexer

- One input, Multiple Output
- One of input is electrically connected to output.
- Selection of output line to be electrically sorted with input line is done via select lines.





## De-Multiplexer

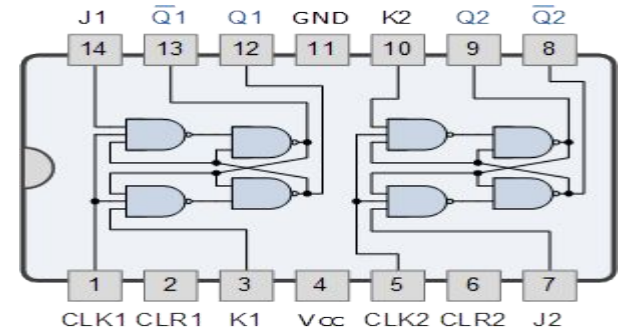




## Flip - Flop

### Truth Table

J	K	CLK	Q
0	0	↑	$Q_0$ (no change)
1	0	↑	1
0	1	↑	0
1	1	↑	$\bar{Q}_0$ (toggles)



- Flip - flops are mainly used in circuit as a 1 bit memory.
- Flip-flops are clock triggered and hence synchronised.

# 5

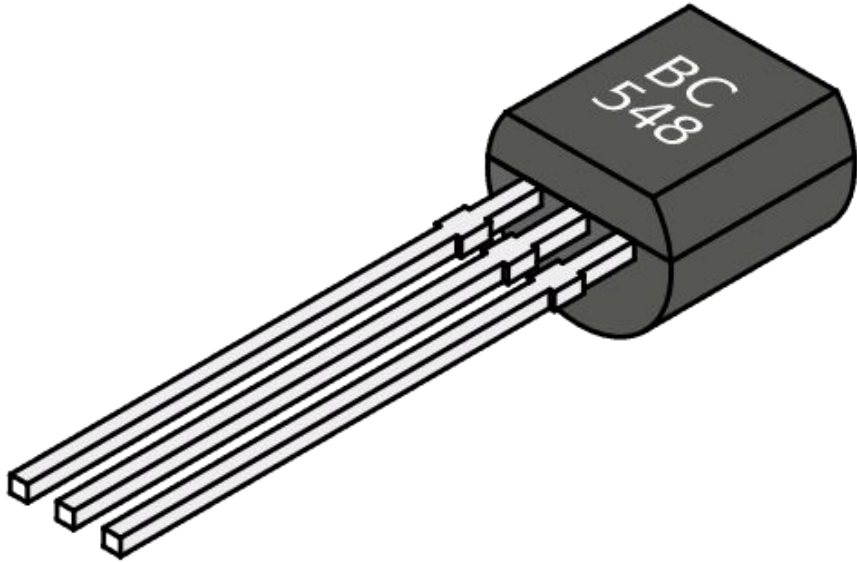
## Important Analog Devices

“ A journey of Thousand Miles begins with a single step “



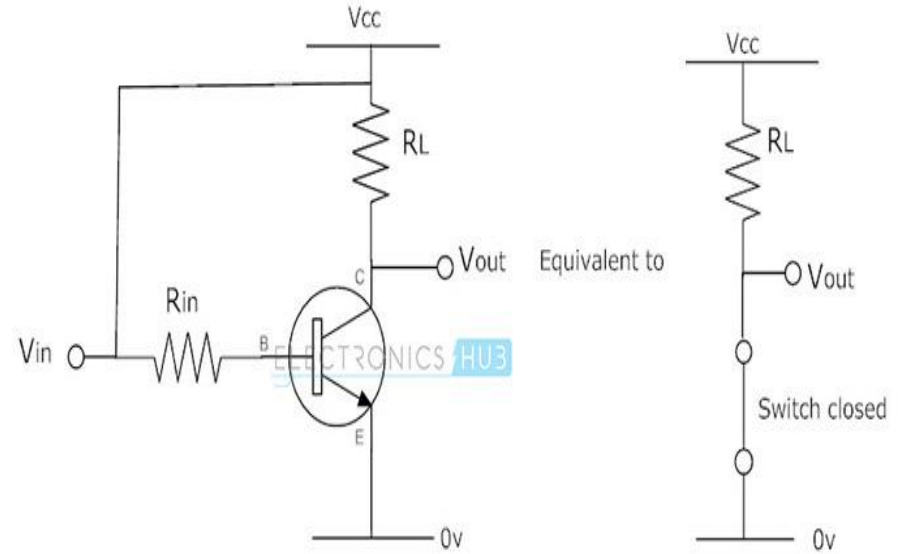
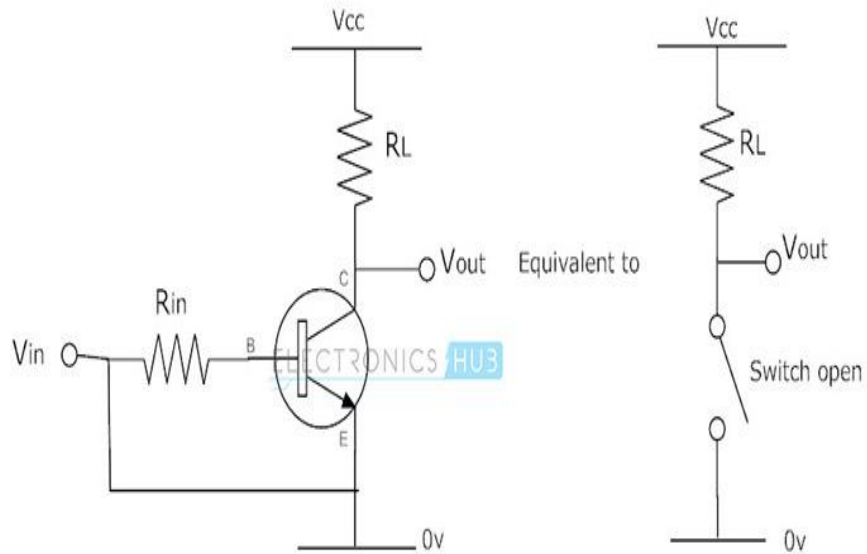
## Transistor

Transistor is the heart and soul of modern electronics

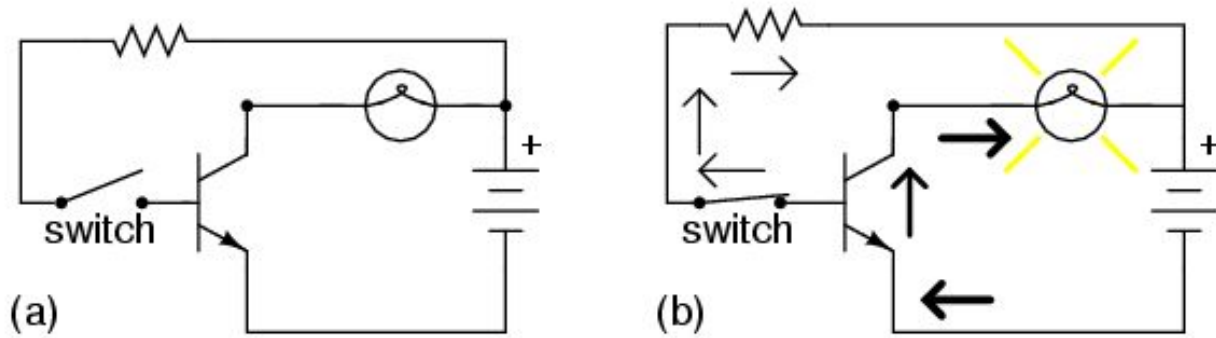


A **transistor** is a semiconductor device used to amplify or switch electronic signals.

# Transistor as Switch



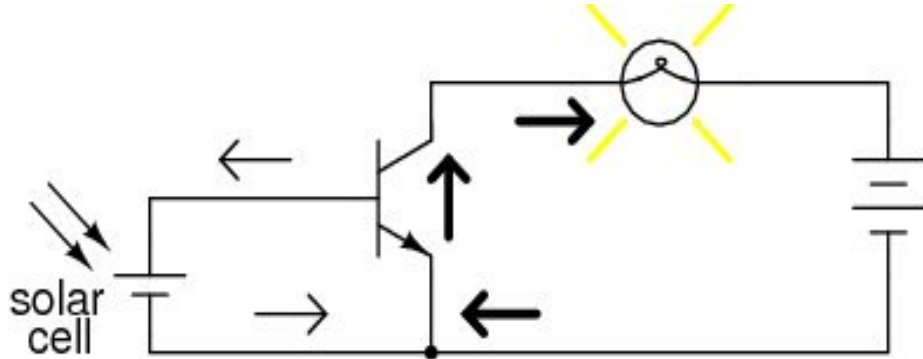
## Transistor as Switch



*Transistor: (a) cutoff, lamp off; (b) saturated, lamp on.*

**If we're still using a switch in the circuit, then what's the point of having a transistor as a switch.**

## Transistor as Switch



*Solar cell serves as light sensor.*

- As in the figure suppose a particular device gives 1V when in one state and 0V in other state. Now we cannot operate a LED in this range.
- Transistor comes to our rescue in the sense that it actually acts like an “electronic” switch.
- As shown in previous slide, when 1V is applied to the corresponding pin, the transistor glows the bulb by giving it 5V.

# 6

## **Rough Outline of Approach**

“ A journey of Thousand Miles begins  
with a single step “



Slides !!

On Electronics Club website

# Any questions?

You can always reach us at

[facebook.com/electronicclubiitk](https://www.facebook.com/electronicclubiitk) &  
[eclub.iitk@gmail.com](mailto:eclub.iitk@gmail.com)

Contacts available in E-Club website

<http://students.iitk.ac.in/eclub/index.html>

# THANKS

Contact us:

Hardik Maheshwari (Hall 12)

7309209153

Hemant Bollamreddi (Hall 3/110)

7388725462

Prince Saroj (Hall 5)