






ANALOG ELECTRONICS WORKSHOP

IEEE SUTD



AGENDA

- Learn basics of analogue electronics
 - Build some cool circuits
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ANALOGUE ELECTRONICS

- Most basic electronic components
 - Resistors
 - Capacitors
 - Inductors
 - Semiconductor devices
 - LEDs
 - Diodes
 - Transistors

ANALOGUE ELECTRONICS – WHY?

- Complement you Arduino/ RPi projects
- Cheaper components
 - A lot of projects you do with your Arduino can also be implemented with discrete circuits
- Bad ass. Shows your prowess.

RESISTORS

- Ideal resistors follow ohms law
 - $V = I \times R$
- Resists the flow of current
- Units: Ω (ohms)
- Symbol: R



The standard resistor color code table:

Color	Digit 1	Digit 2	Digit 3*	Multiplier	Tolerance	Temp. Coef.	Fail Rate
Black	0	0	0	$\times 10^0$			
Brown	1	1	1	$\times 10^1$	$\pm 1\%$ (F)	100 ppm/K	1%
Red	2	2	2	$\times 10^2$	$\pm 2\%$ (G)	50 ppm/K	0.1%
Orange	3	3	3	$\times 10^3$		15 ppm/K	0.01%
Yellow	4	4	4	$\times 10^4$		25 ppm/K	0.001%
Green	5	5	5	$\times 10^5$	$\pm 0.5\%$ (D)		
Blue	6	6	6	$\times 10^6$	$\pm 0.25\%$ (C)		
Violet	7	7	7	$\times 10^7$	$\pm 0.1\%$ (B)		
Gray	8	8	8	$\times 10^8$	$\pm 0.05\%$ (A)		
White	9	9	9	$\times 10^9$			
Gold				$\times 0.1$	$\pm 5\%$ (J)		
Silver				$\times 0.01$	$\pm 10\%$ (K)		
None					$\pm 20\%$ (M)		

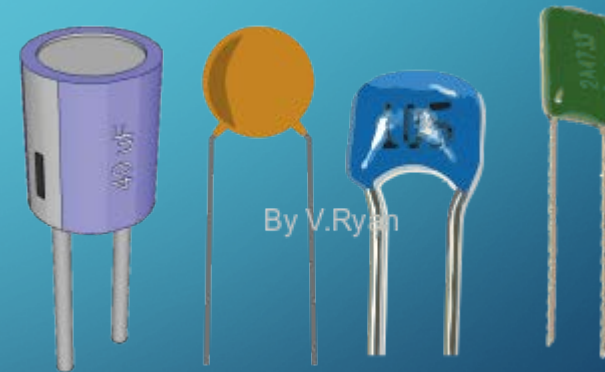
* 3rd digit - only for 5-band resistors

CAPACITOR

- Charge on a capacitor is given by its capacitance and the voltage across it

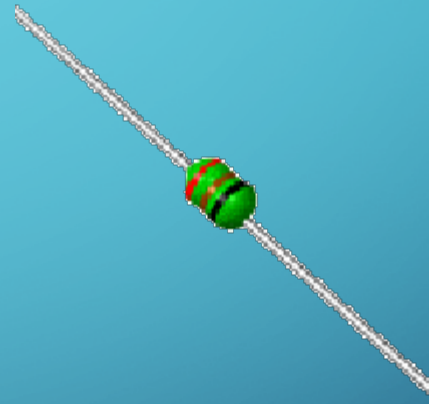
- $Q = C \times V \quad \gg \quad I = C \times \frac{dV}{dt}$

- Stores energy in an electric field
- Units: F (Farads)
- Symbol: C



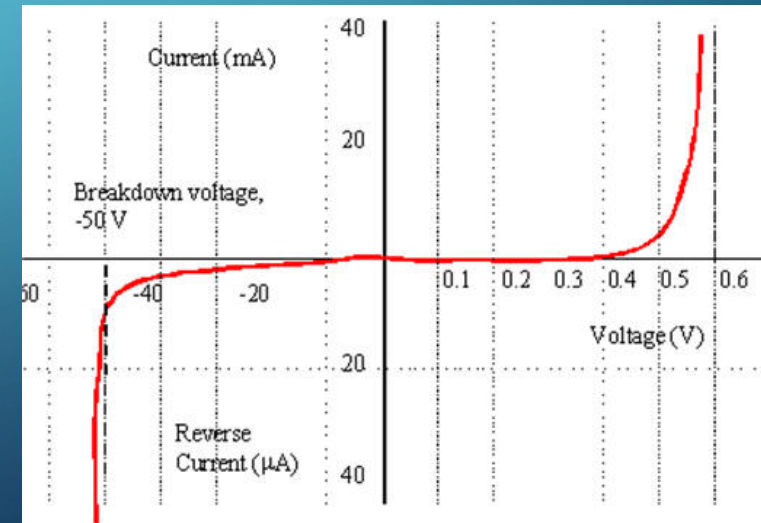
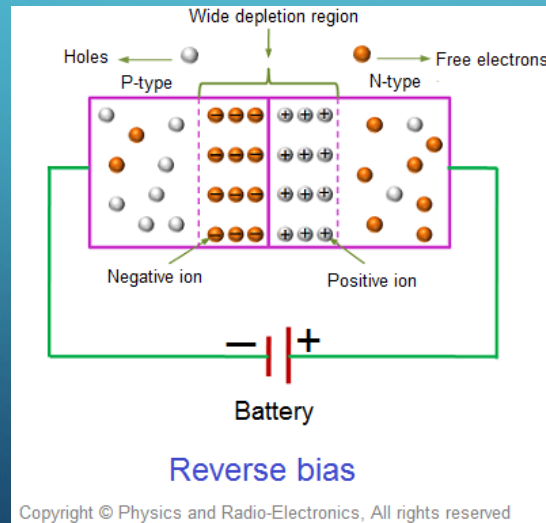
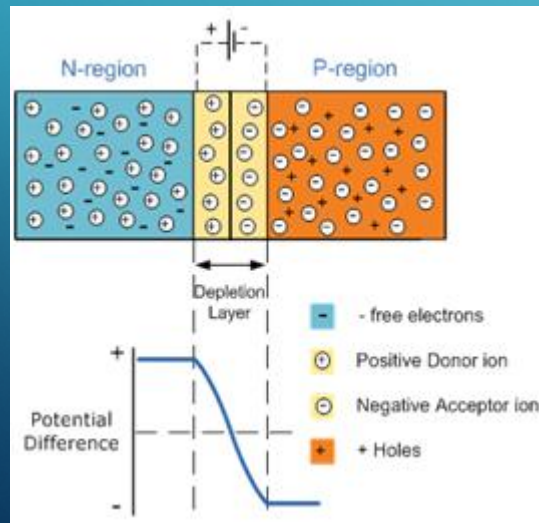
INDUCTOR

- $V = L \times \frac{dI}{dt}$
- Stores energy in a magnetic field
- Units: H (Henry)



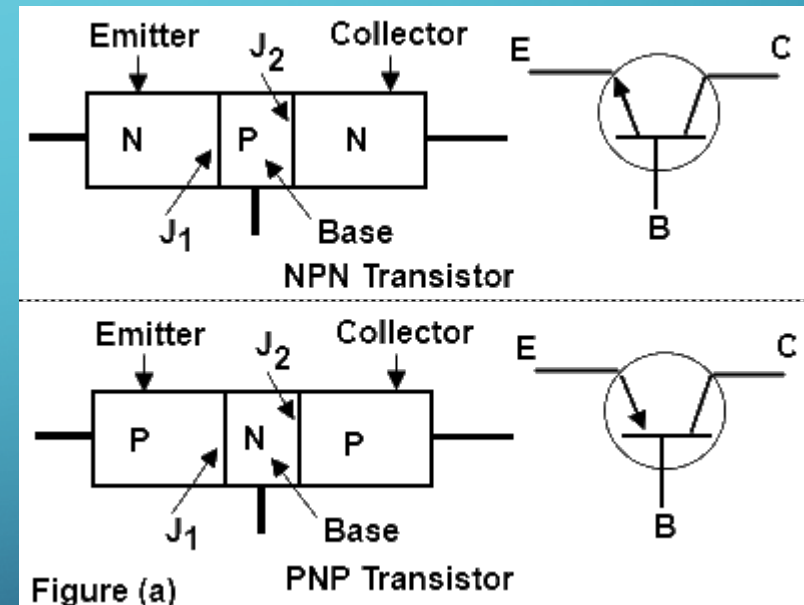
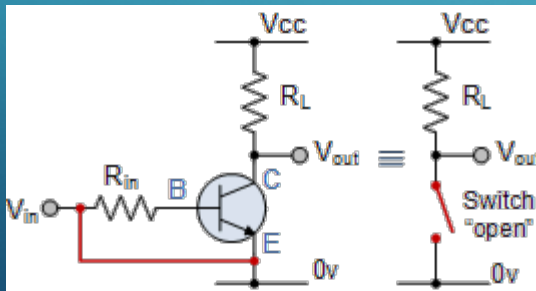
DIODES

- Semiconductor device formed from a N and P doped semiconductor joined together.
- Allow current to flow in one direction only.



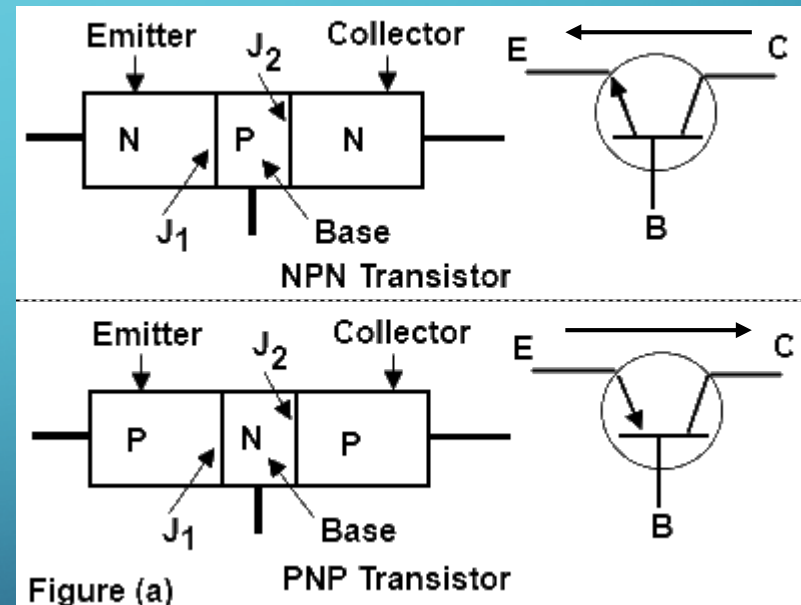
TRANSISTORS – BJTs

- Formed from NPN junctions or PNP junctions. (Bipolar junction transistor)
- Electronic switch
- Can also be used as an amplifier



TRANSISTORS

- As a switch
- NPN:
 - If V_{be} is $> 0.7V$
 - Transistor turns on
- PNP
 - If V_{eb} is $> 0.7V$
 - Transistor turns on



SCHEMATIC SYMBOLS



Diode



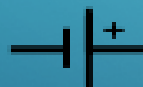
Capacitor



Inductor



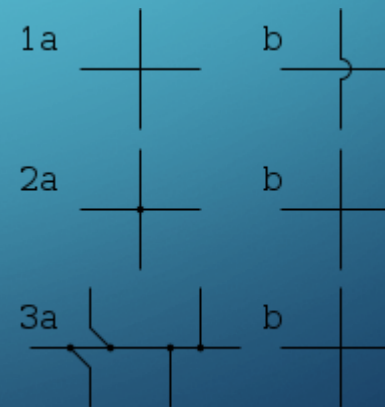
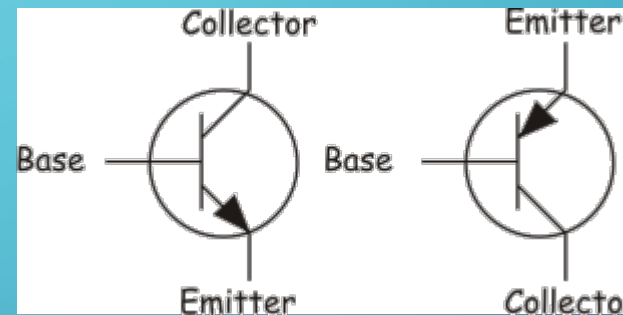
Resistor



DC voltage
source



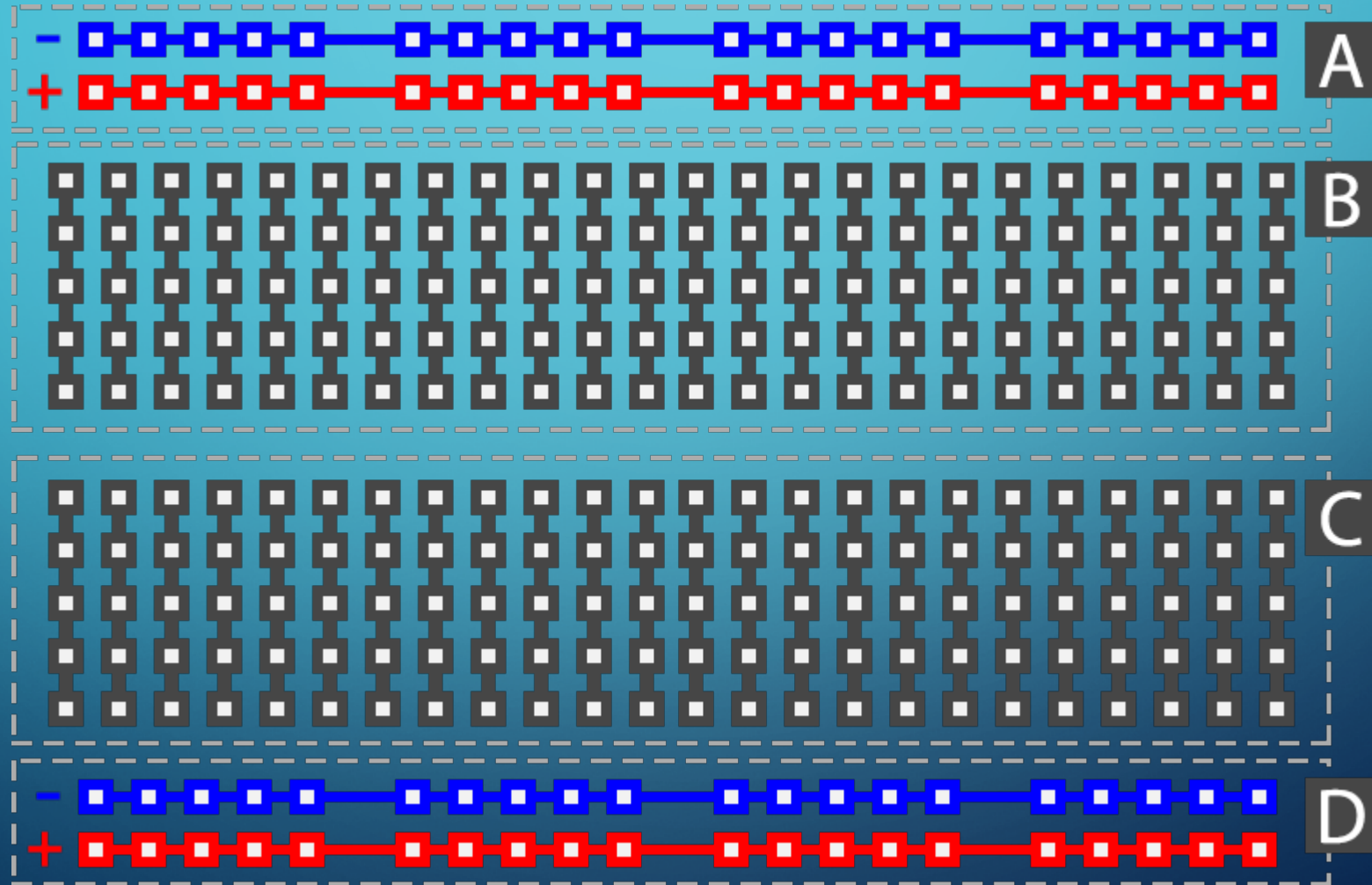
AC voltage
source



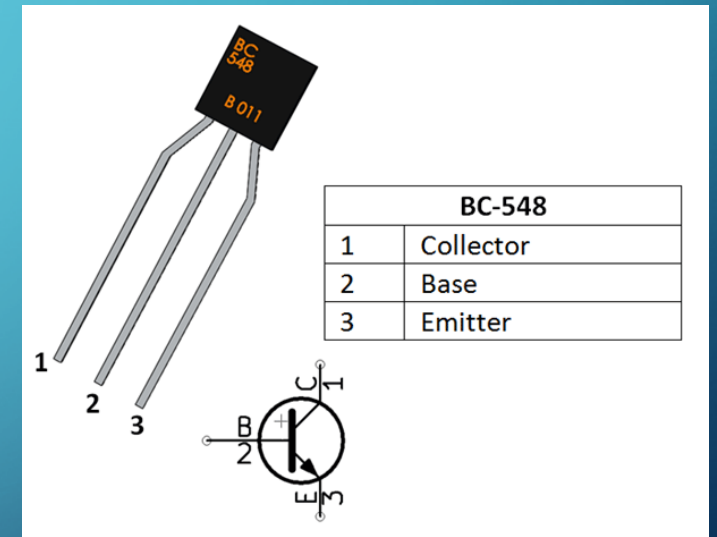
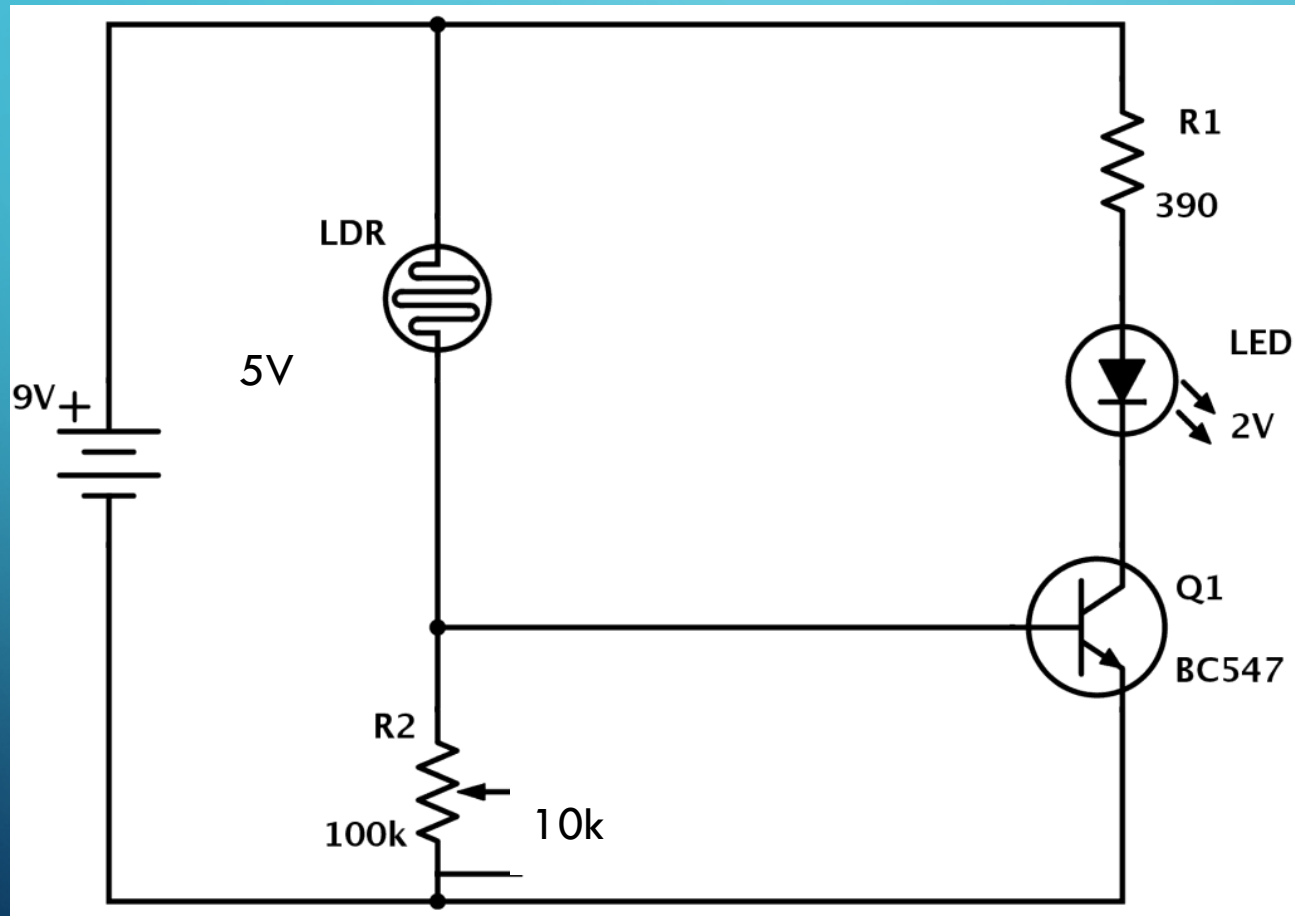
The background is a blue gradient. In the corners, there are white line-art illustrations of circuit boards or neural networks. These consist of straight lines of varying lengths and angles, ending in small circles, resembling electronic components or nodes in a network.

UNDERSTANDING SCHEMATICS

BUILDING CIRCUITS ON A BREADBOARD



CIRCUIT #1 LIGHT SENSOR





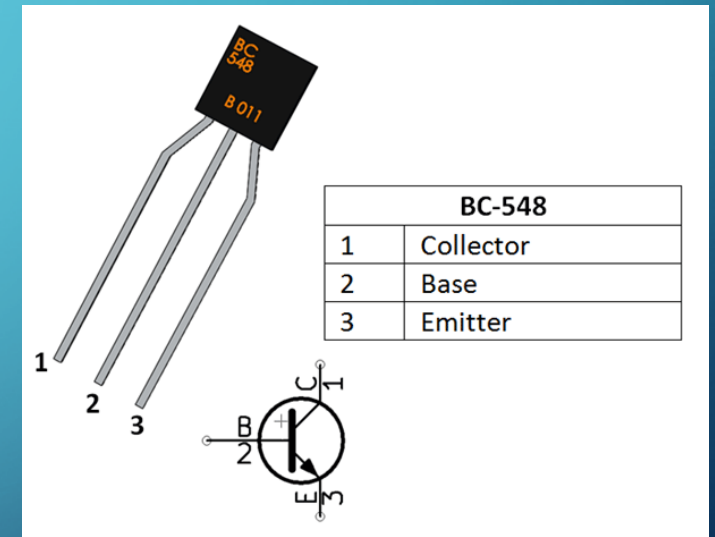
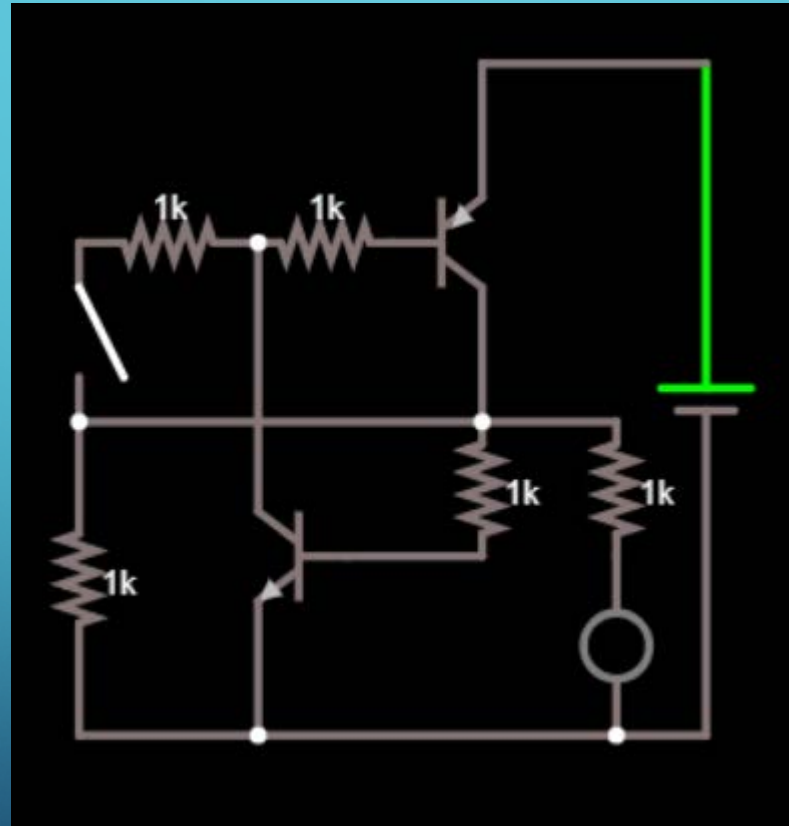
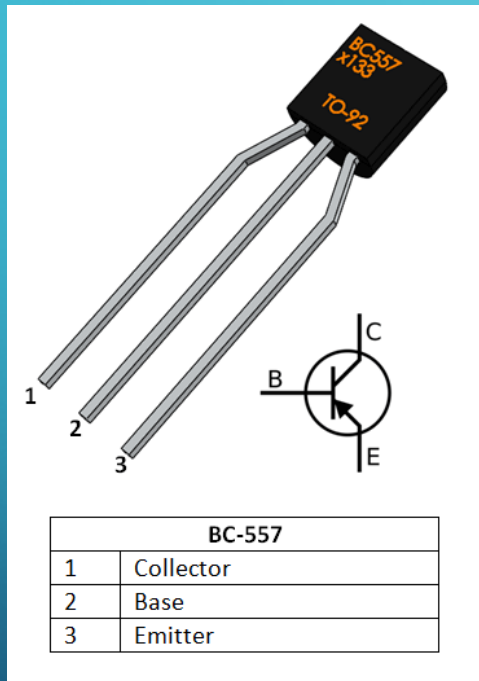
CIRCUIT #1 LIGHT SENSOR

- Can you ...
- 
- 
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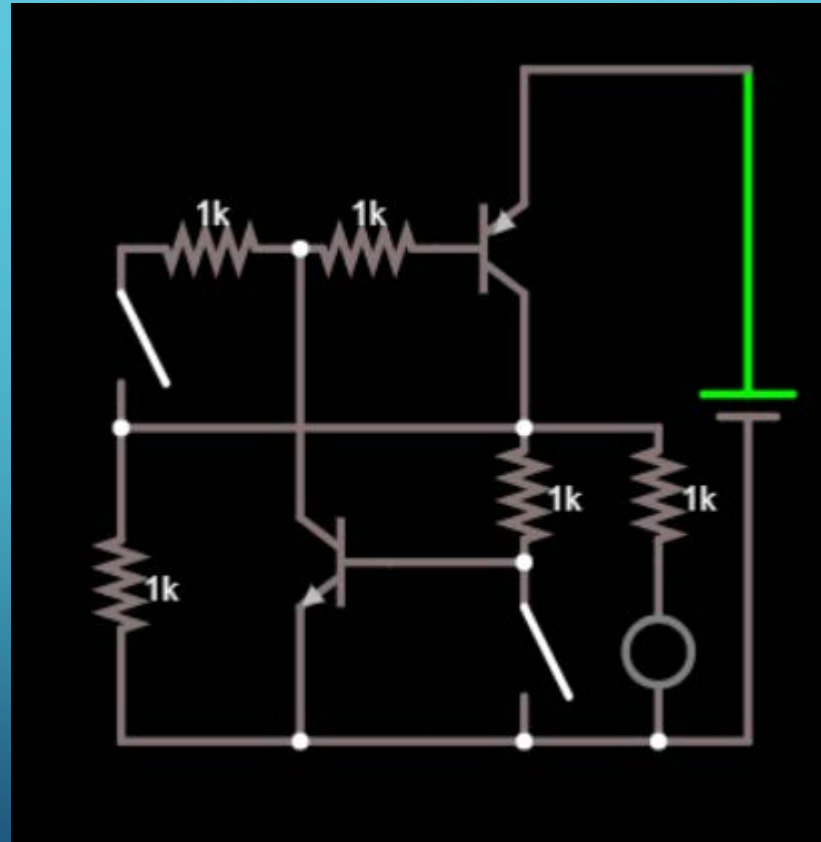
CIRCUIT #2 BURGLAR ALARM

- Input: Burglar crosses beam of IR light
 - Triggers circuit
- Output: Buzzer / LED turns on AND doesn't turn off even after crossing
 - Latch output

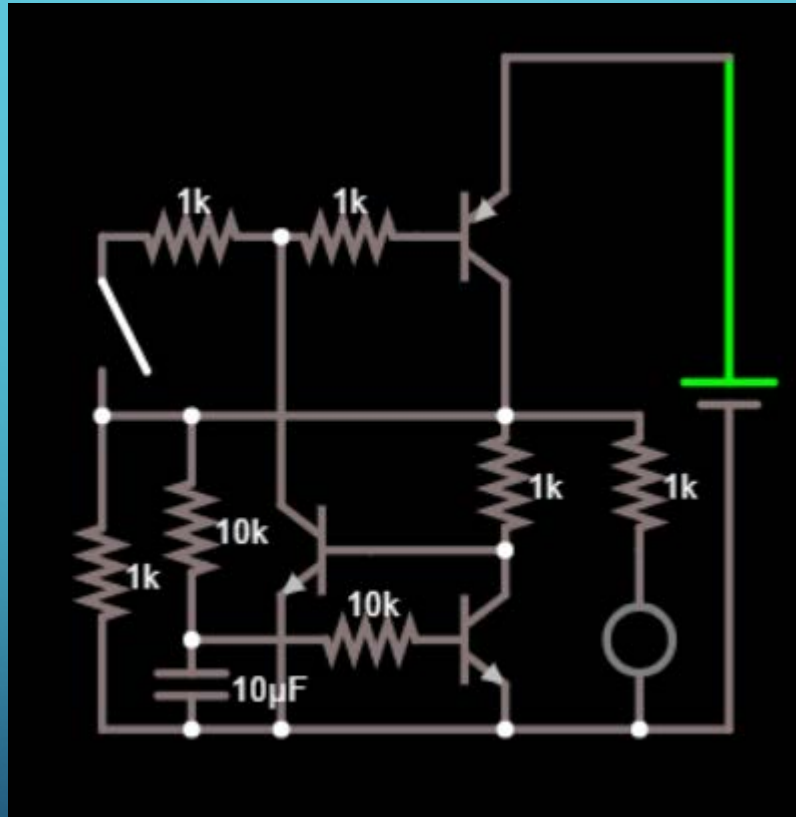
CIRCUIT #2 BURGLAR ALARM



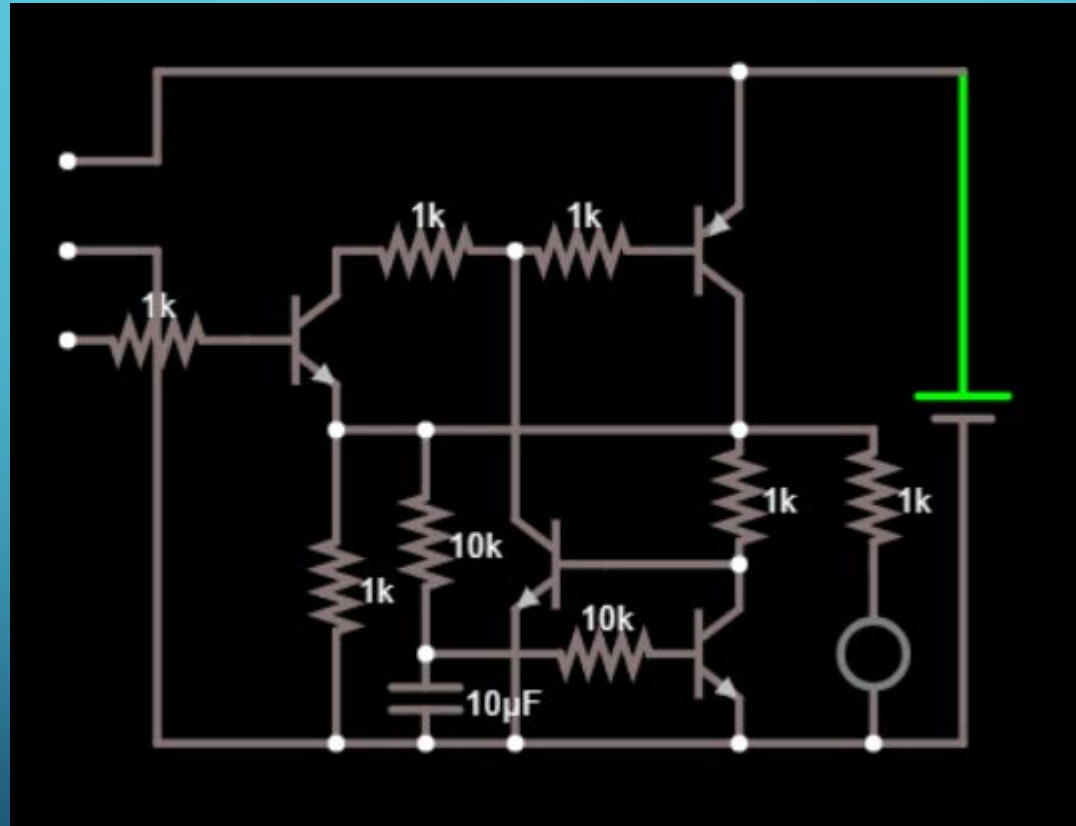
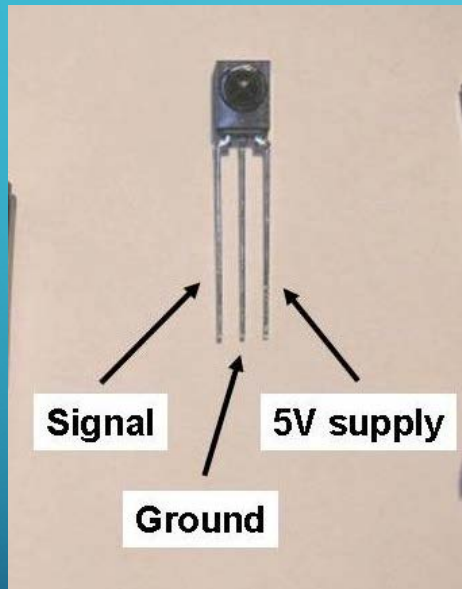
CIRCUIT #2 BURGLAR ALARM



CIRCUIT #2 BURGLAR ALARM



CIRCUIT #2 BURGLAR ALARM



The image features a blue gradient background with white circuit-like lines and circles in the corners. The text "THANK YOU" is centered in the upper left area.

THANK YOU