



HAB621 Instrumentation and Measurement in Biomechanics



Serdar Arıtan

serdar.aritan@hacettepe.edu.tr

Hacettepe Üniversitesi

www.hacettepe.edu.tr

Spor Bilimleri Fakültesi

www.sbt.hacettepe.edu.tr

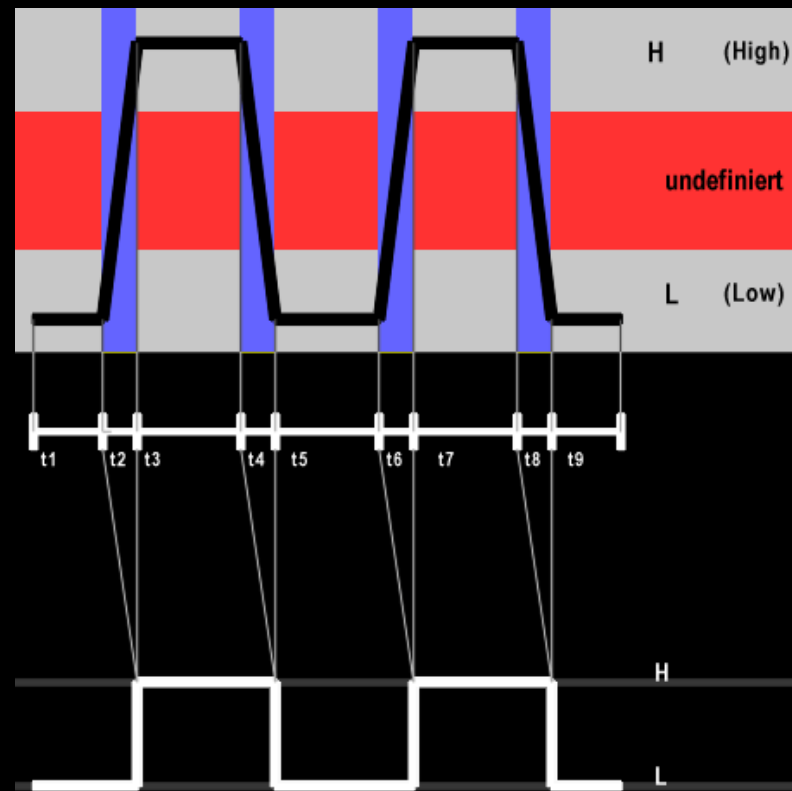
Biyomekanik Araştırma Grubu

www.biomech.hacettepe.edu.tr

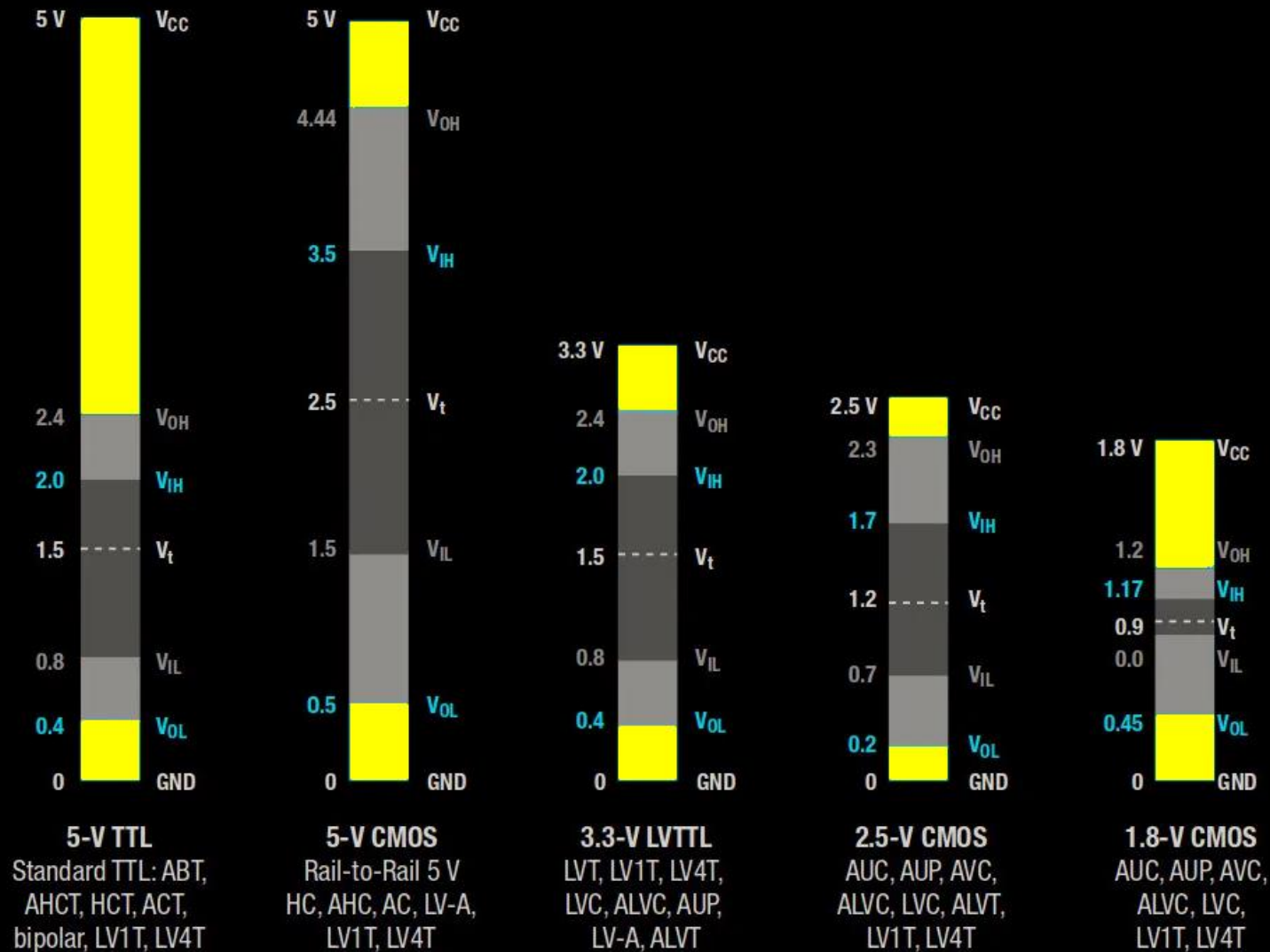
Çizim: De Motu Animalium G.Borelli (1680)



High vs Low

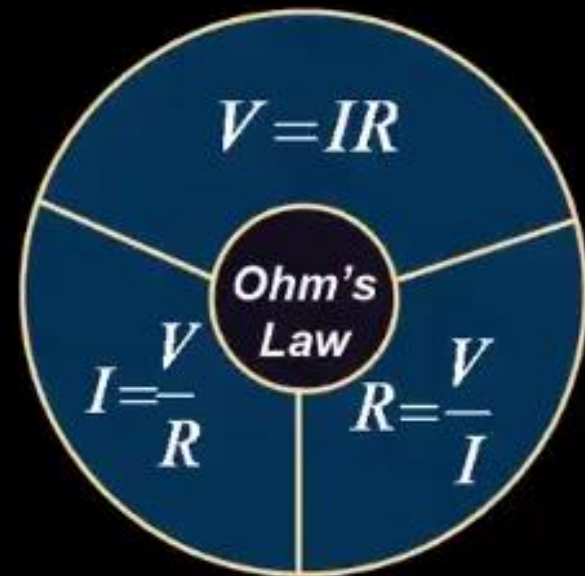
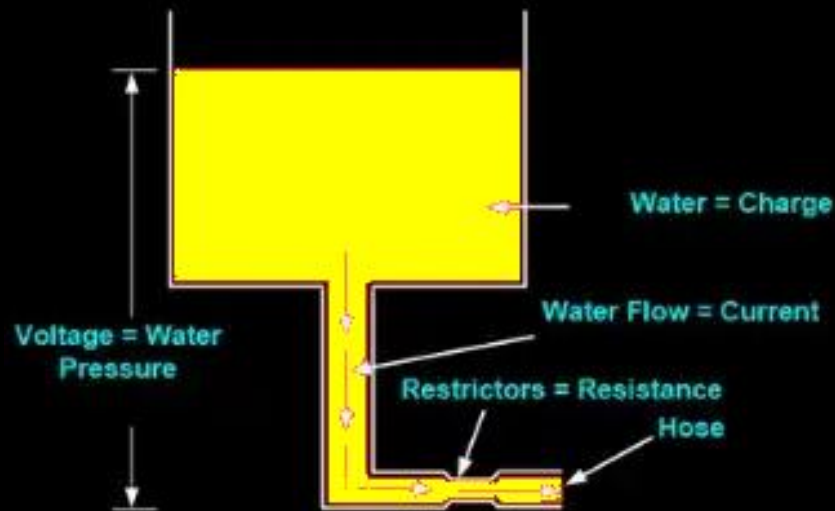


TTL vs CMOS

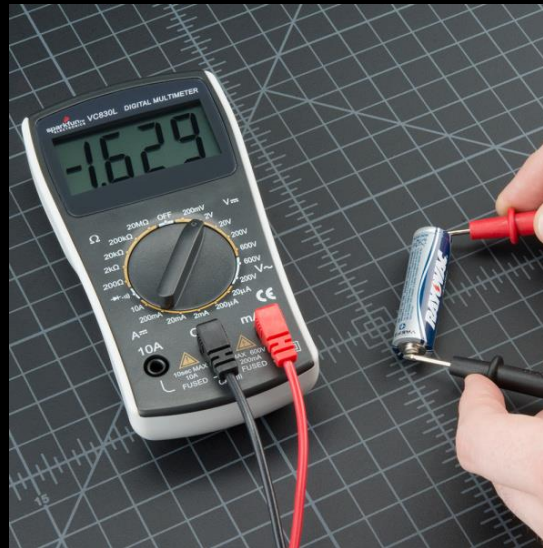
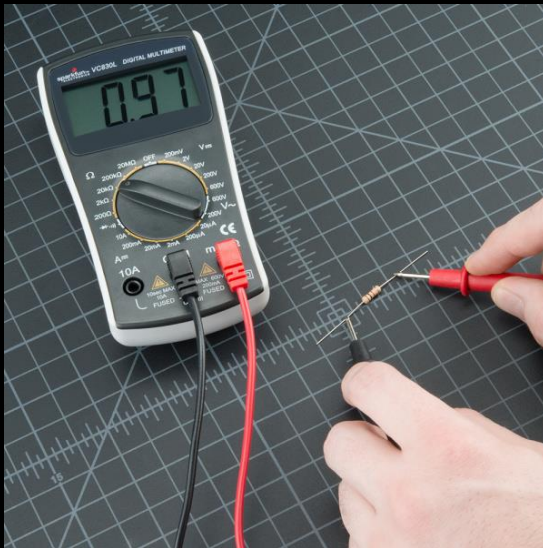


OHM's Law

What is Ohm's Law?

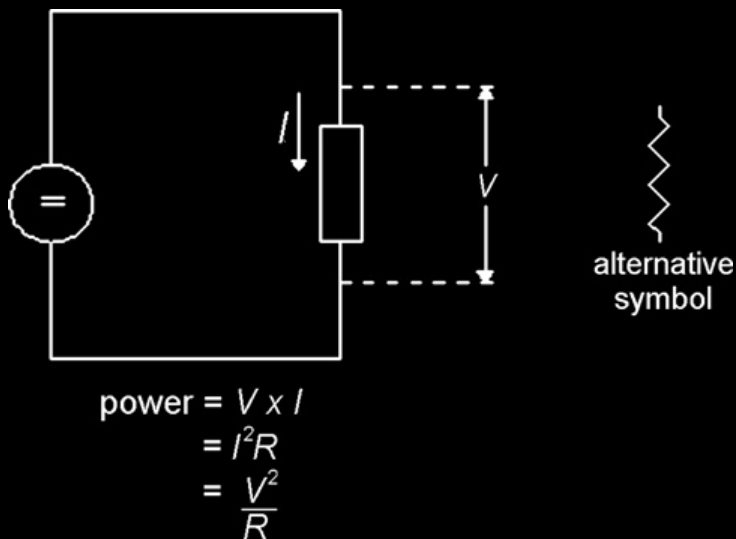


Experiment Hour for OHM's Law

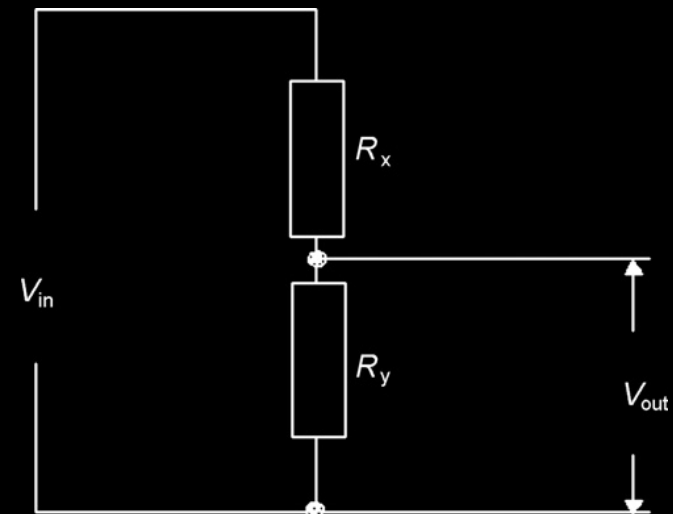


Resistors

Resistors are the most common of passive components. A resistor is used to **control current** or to convert a wave of current into a wave of voltage, using the $I = V/R$ or $V = RI$ relationship.



Power dissipated by a resistor. There are three versions of the formula, so that you can use Whichever is most suitable.



$$V_{out} = V_{in} \frac{R_y}{(R_y + R_x)}$$



TOLLERANCE

GOLD	±5%
SILVER	±10%



BLACK

0

0

x1Ω

BROWN

1

1

x10Ω

RED

2

2

x100Ω

ORANGE

3

3

x1.000Ω

YELLOW

4

4

x10.000Ω

GREEN

5

5

x100.000Ω

BLUE

6

6

x1.000.000Ω

VIOLET

7

7

GRAY

8

8

WHITE

9

9

$$K\Omega = x1.000\Omega$$

$$M\Omega = x1.000.000\Omega$$



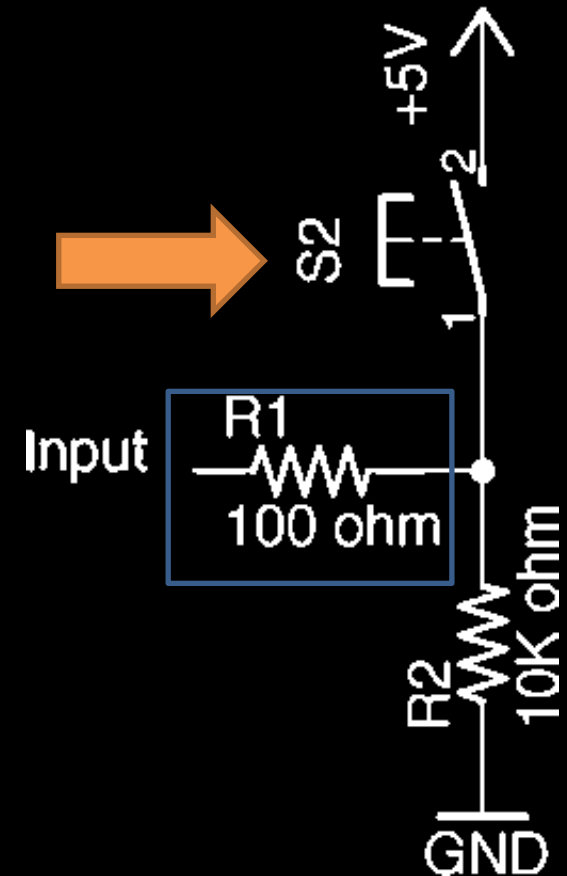
MULTIPLIER



With a voltage going through the switch and the switch open, no current can flow through it and no voltage can be measured at the output. When you close the switch, the current can flow through it and a voltage can be measured at the output. The open state can be thought of as a zero and the closed state as a 1 in a logic circuit.

Pull-Down Resistors

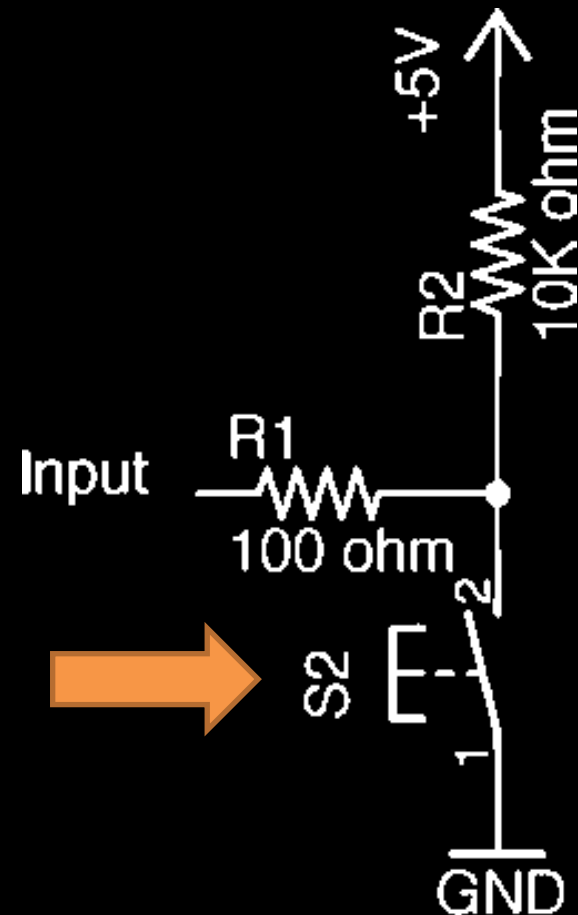
If the button is pressed, then the electricity takes the path of least resistance and moves between the five volts and the input pin, as there is a 100 ohm resistor on the input pin and a 10K ohm resistor on ground.





Pull-Up Resistors

The resistor now serves as a **pull-up** resistor. Now you can see that when the **button is not pressed**, the input pin is pulled towards the five volts and so will always be **high**. When the button is pressed, the path of least resistance is towards the ground and so the pin is pulled to ground or the low state. Without the resistor between five volts and ground it would be a short circuit which would damage your circuit or power supply.



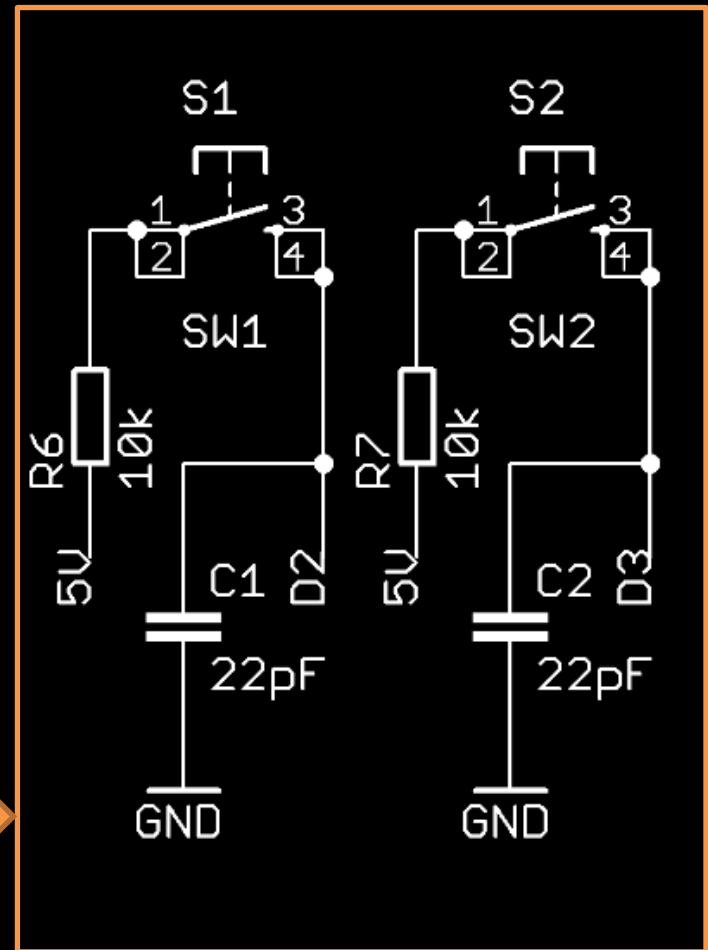
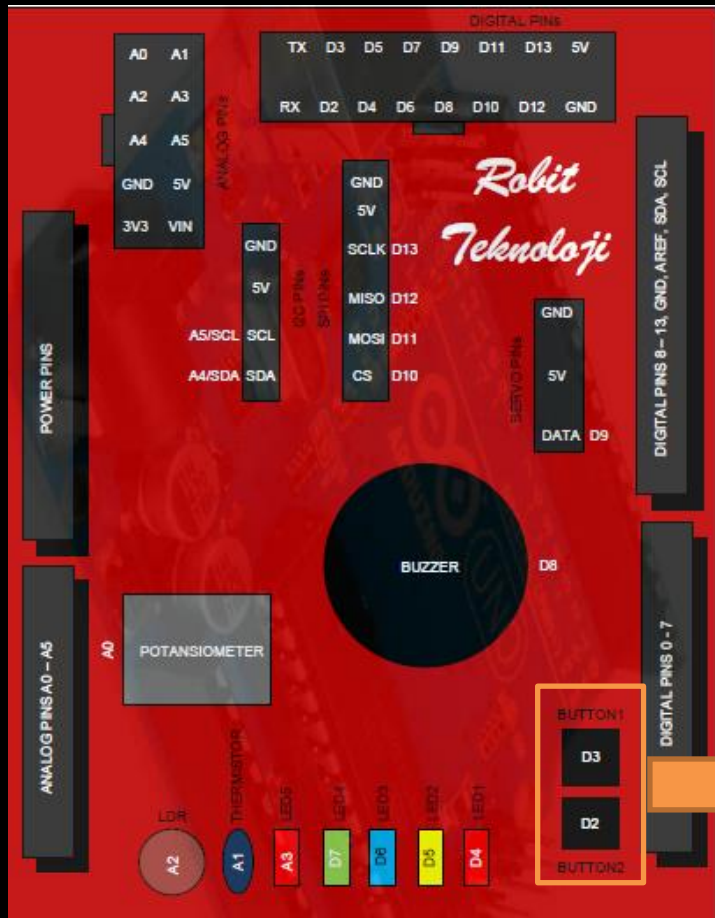


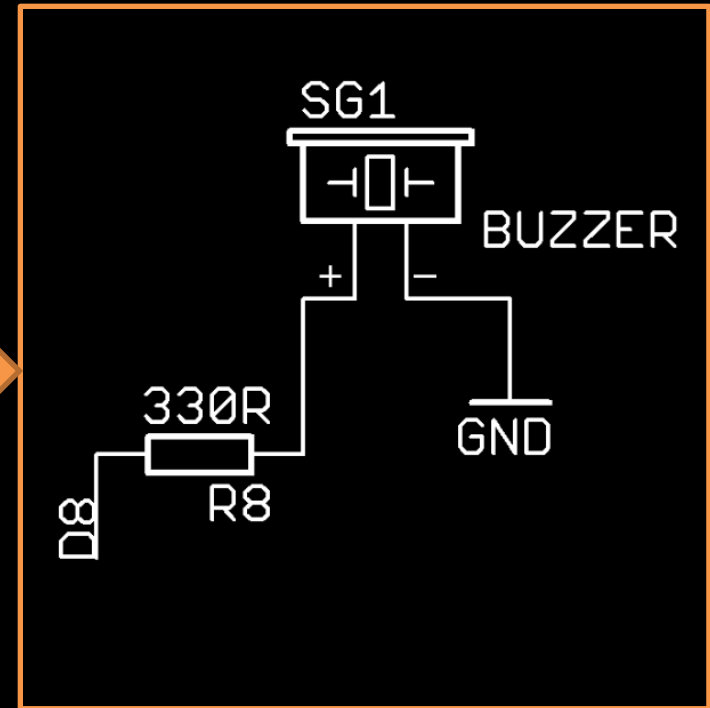
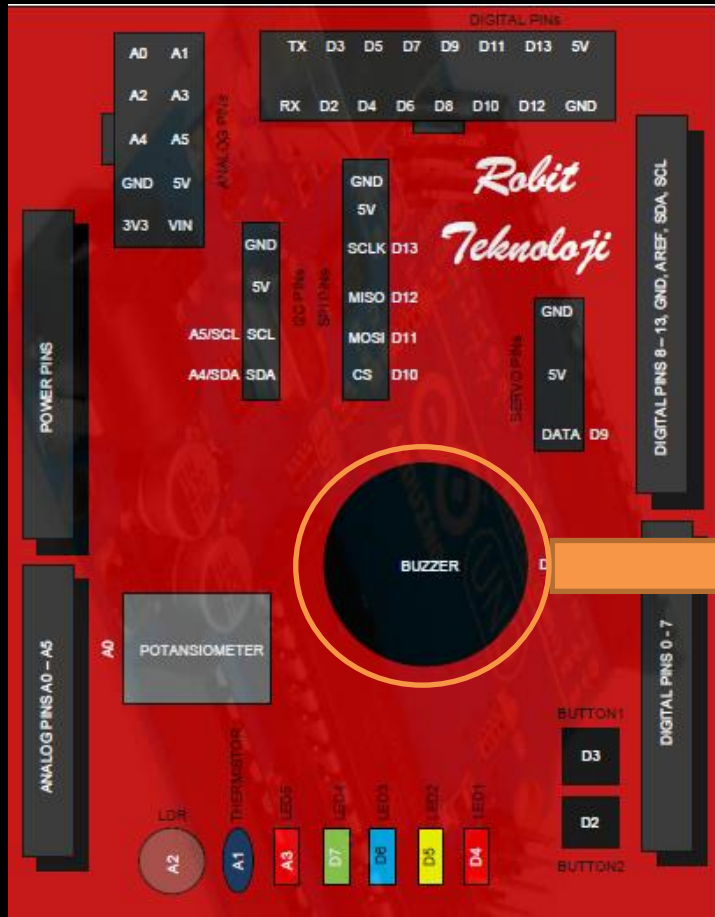
The Arduino's Internal Pull-Up Resistors

Conveniently, the Arduino happens to **have pull-up resistors** connected to the digital pins (the **analog pins** have **pull-up** resistors also). These have a value of **20K ohms** and need to be activated in software to use them. To activate an internal pull-up resistor on a pin, you first need to change the **pinMode** of the pin to an **INPUT** and then write a **HIGH** to that pin using a **digitalWrite** command. For example:

```
pinMode(pin, INPUT);  
digitalWrite(pin, HIGH);
```

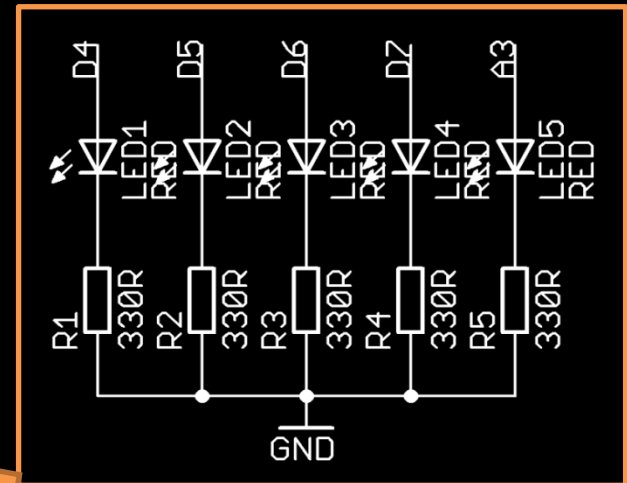
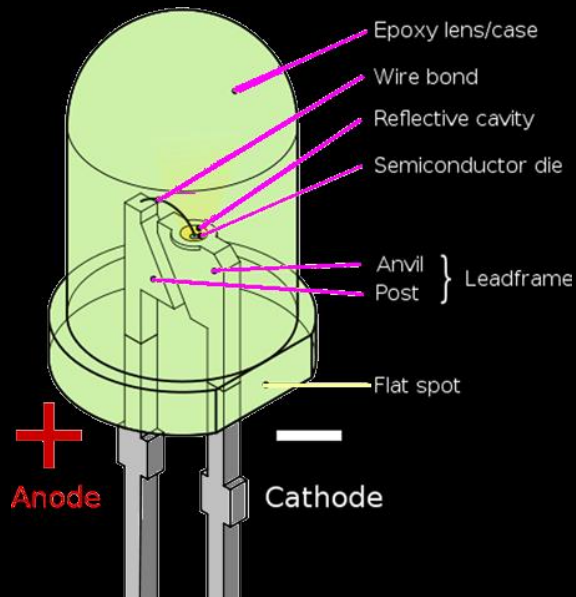
If you change the **pinMode** from **INPUT** to **OUTPUT** after activating the internal pull-up resistors, then the pin will remain in a **HIGH** state. This also works in reverse in that an output pin that was in a **HIGH** state that is subsequently switched to an **INPUT** mode will have its internal pull-up resistors enabled.







LED Chase Effect First, make sure your Arduino is powered off by unplugging it from the USB cable. Now take your breadboard, LEDs, resistors, and wires, and connect everything up as in picture.





Morse Coding

Morse CODE Signal Generator

Your classroom task is to renew old maritime communication with the help of modern technology by using the Arduino.





Morse Coding

International Morse Code

1. The length of a dot is one unit.
2. A dash is three units.
3. The space between parts of the same letter is one unit.
4. The space between letters is three units.
5. The space between words is seven units.

A • —
B — • • •
C — • — •
D — • •
E •
F • • — •
G — — •
H • • • •
I • •
J • — — —
K — • —
L • — • •
M — —
N — •
O — — —
P • — — •
Q — — • —
R • — •
S • • •
T —

U • • —
V • • • —
W • — —
X — • • —
Y — • — —
Z — — • •

1 • — — — —
2 • • — — —
3 • • • — —
4 • • • • —
5 • • • • •
6 — • • • •
7 — — • • •
8 — — — • •
9 — — — — •
0 — — — — —



Morse Coding

```
MORSECODE = {'A': '.-',      'B': '-...',    'C': '-.-.',  
              'D': '-..',     'E': '.',      'F': '..-.',  
              'G': '--.',     'H': '....',    'I': '..',  
              'J': '.---',    'K': '-.-',     'L': '-.-.',  
              'M': '--',      'N': '-.',      'O': '---',  
              'P': '.--.',    'Q': '--.-',    'R': '-.-.',  
              'S': '...',     'T': '-',       'U': '..-.',  
              'V': '...-',    'W': '-.-',     'X': '-.-.-',  
              'Y': '-.-.-',   'Z': '--..',    '0': '-----',  
              '1': '.----',   '2': '..---',   '3': '...--',  
              '4': '....-',   '5': '.....', '6': '-.....',  
              '7': '--...',   '8': '---..',   '9': '----.'  
            }
```

```
def main():  
  
    msg = input('MESSAGE: ')  
  
    for char in msg:  
        print (MORSECODE[char.upper()])  
  
if __name__ == "__main__":  
    main()
```