Microcontroller

A short intro using Arduino Platform

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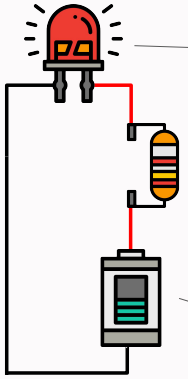
Microcontroller

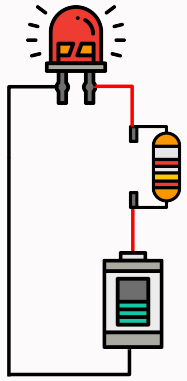
noun.
a person or thing that directs
or regulates something.

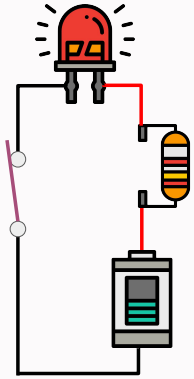


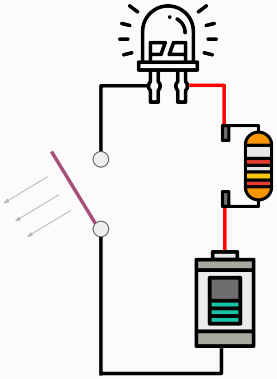
Light-Emitting Diode (LED)
Convert from Electrical Power into Light

Resistor
Control the amount of Power

Battery
Source of Power



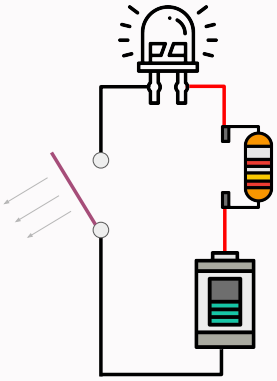




	Switch Logic	Circuit State	LED State
Open	0 - False	Open	0 - OFF
Closed	1 - True	Closed	1 - ON

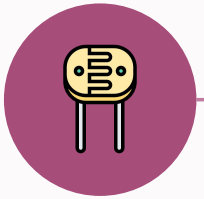
How to do it Automatically?

"Power ON when Dark"



Sensor

Detect physical state
and convert to logical voltage.



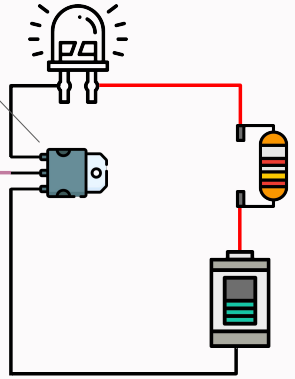
LOGIC

Logic **0**
0 Volts

Logic **1**
5 Volts

Transistor

As a Digital Switch

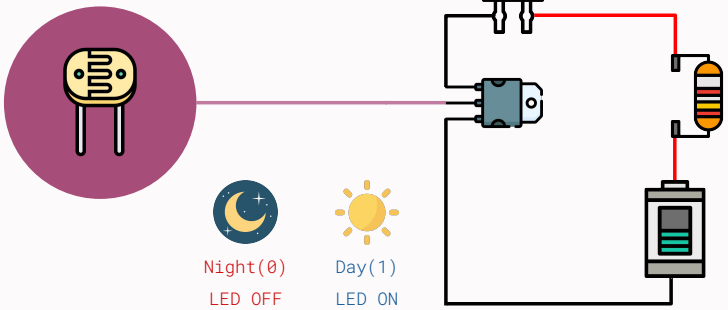


LOGIC

Logic **0** = 0 Volts = **OFF**

Logic **1** = 5 Volts = **ON**

** The logic level varies with the transistor used.*

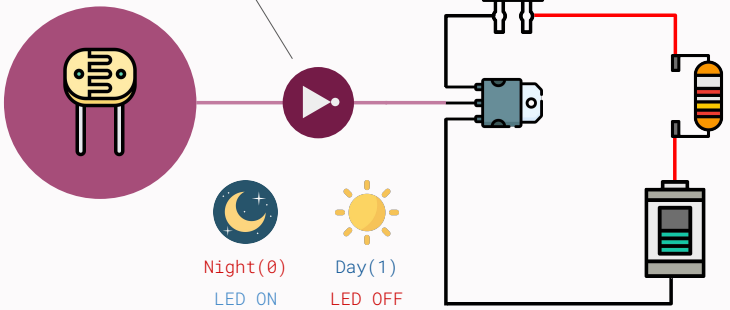


Night(0)
LED OFF

Day(1)
LED ON

NOT Gate

Flip the logic



Night(0)
LED ON

Day(1)
LED OFF

Source:
How to make Automatic Night Light Sensor Project
https://www.circuits-diy.com/how-to-make-automatic-night-light-sensor-project/

EGBI 101
Basic Engineering Skills in Biomedical Engineering

Time

Knowledge

Money

Land & Space

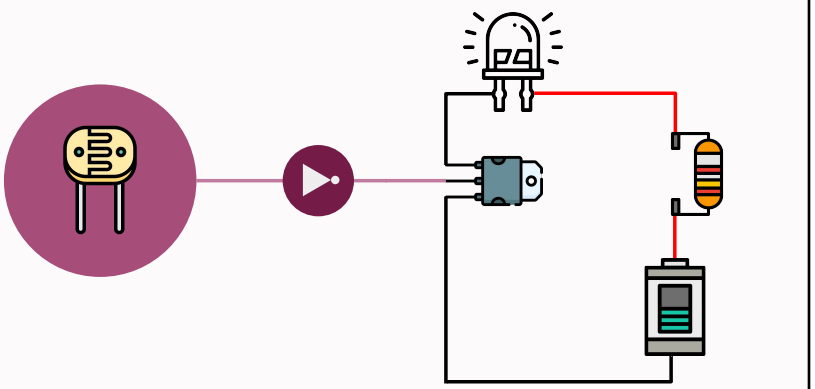
“EXPENSIVE”

Human Resources

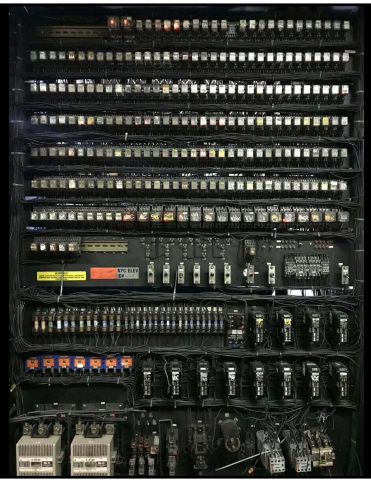
Technology

Equipments

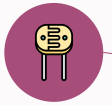
EGBI 101
Basic Engineering Skills in Biomedical Engineering



EGBI 101
Basic Engineering Skills in Biomedical Engineering



General Purpose Controller Unit



IN_A
IN_B
IN_C
IN_D
IN_E
IN_F

```
IF IN_A is 1:
    OUT_A is 0
ELSE:
    OUT_A is 1
```

** This is not the actual PLC code.*

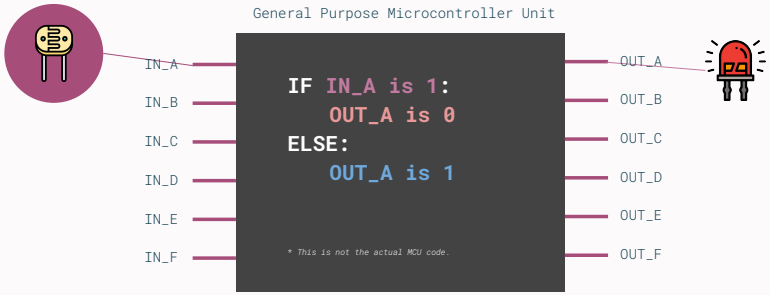
OUT_A
OUT_B
OUT_C
OUT_D
OUT_E
OUT_F

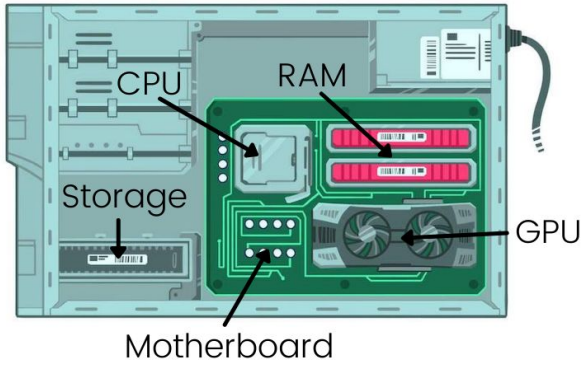
Programmable Logic Controller (PLC)

PIC 10F200
6 PIN SOT-23 PACKAGE
3 MM LENGHT
4 I/O PINS
4 MHZ INTERNAL OSCILATOR
0.375B PROGRAM MEMORY
OPERATING VOLTAGE 2 - 5.5 V
PRICE 0.3 DOLLARS

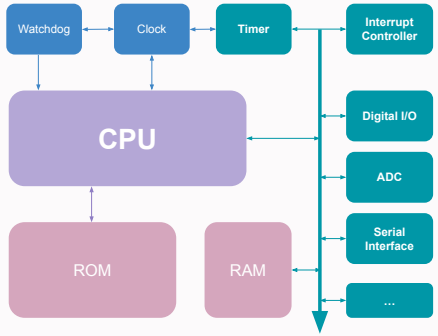
Source:
Smallest and cheapest microcontroller - tutorial (https://www.youtube.com/watch?v=300HMv6gOs8)

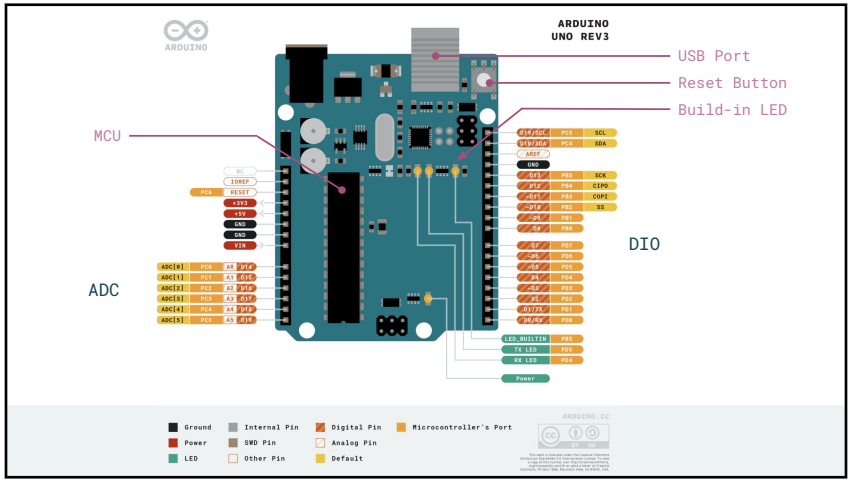
Which of the MCUs should we pick?



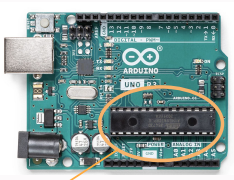


What's inside MCU?

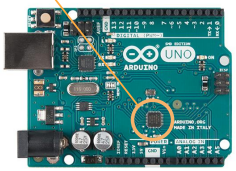




Arduino UNO



MCU : ATMEGA328p-pu



Tech specs

EGBI 101
Basic Engineering Skills in Biomedical Engineering

MICROCONTROLLER	ATmega328P
OPERATING VOLTAGE	5V
INPUT VOLTAGE (RECOMMENDED)	7-12V
INPUT VOLTAGE (LIMIT)	6-20V
DIGITAL I/O PINS	14 (of which 6 provide PWM output)
PWM DIGITAL I/O PINS	6
ANALOG INPUT PINS	6
DC CURRENT PER I/O PIN	20 mA
DC CURRENT FOR 3.3V PIN	50 mA
FLASH MEMORY	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
CLOCK SPEED	16 MHz
LED_BUILTIN	13
LENGTH	68.6 mm
WIDTH	53.4 mm
WEIGHT	25 g

Board		Arduino UNO	STM32-BluePill	PIC32MX795 Dev Board (USB 32-Bit Whacker)
MCU		ATmega328P	STM32F103C8T6	PIC32MX795F512L
CPU	Type	8 bits / AVR	32 bits / ARM Cortex-M3	32 bits / MIPS32 M4K Core
	Speed	20 MHz	72 MHz	80 MHz
MEM	Flash	32 KB	64 KB	512 KB
	SRAM	2 KB	20 KB	128 KB
	EEPROM	1 KB	N/A	N/A
COST (appox*)		28 USD 970 THB	9 USD 330 THB	147 USD 5040 THB

```
init:
    call serial_init
start:
    ldi r19, 0x0a ;push newline onto the stack
    push r19
    ldi r19, 0x3e ;print '>'
    call serial_transmit
loop:
    call serial_receive ;receive a character
    call serial_transmit ;print character
    cpi r19, 0x0a
    breq input_finished ;if it's a newline jump to input_finished
    push r19 ;otherwise push it to the stack
    rjmp loop
input_finished:
    pop r19 ;remove char from top of stack
    call serial_transmit ;transmit it
    cpi r19, 0x0a
    breq start ;if it's a newline, full string has been sent so go back to start
    rjmp input_finished
```



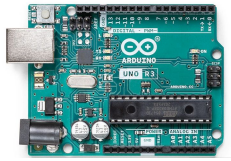
```
void setup()
{
  pinMode(LED,OUTPUT);
}

void loop()
{
  digitalWrite(LED,HIGH);
  delay(1000);
  digitalWrite(LED,LOW);
  delay(1000);
}
```

Arduino Platform

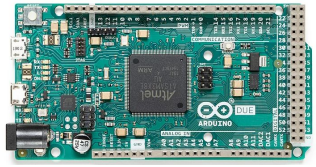
Arduino IDE

UNO

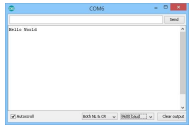


NANO

DUE



Code Editor & Compiler

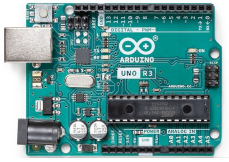


Serial Monitor

COM Port
(via USB Cable)

Upload Binary Code

Serial Monitor

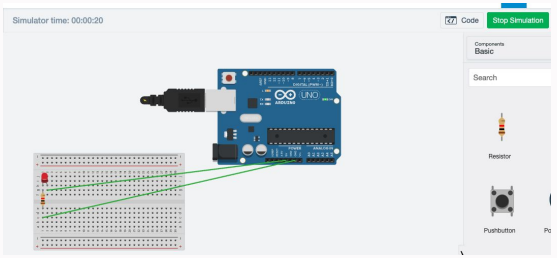


Let's try

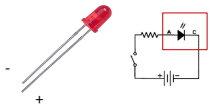
ONLINE LAB: Tinkercad.com

Tinkercad is a free-of-charge,
online 3D modeling program that runs in a web browser.

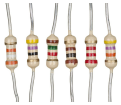
You can use Tinkercad to simulate the circuit
with Arduino board easily



ON-SITE LAB



Light-Emitting Diode

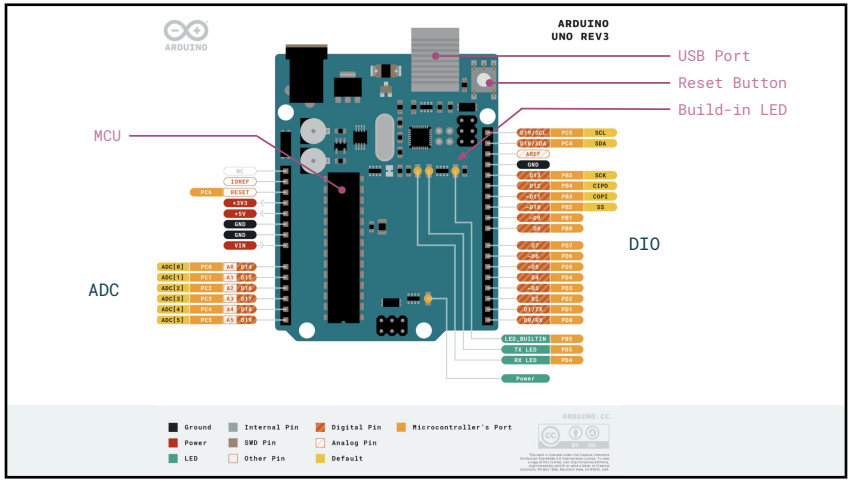


Resistor

Potentiometer
(Variable Resistor)

USB Type B Cable

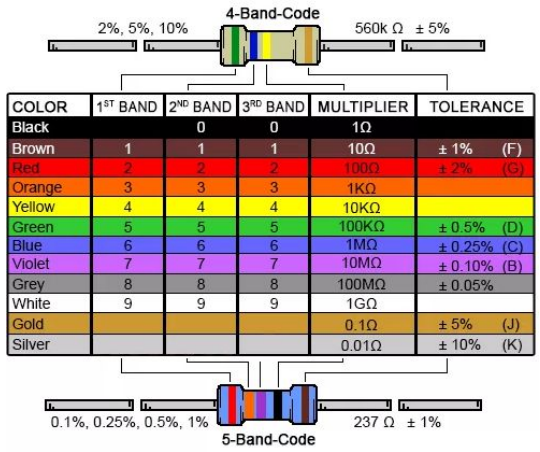
Arduino
UNO



LAB 01 :

Use 5V Pin to Power ON the LED

And try out with difference Resistor.



COLOR	1ST BAND	2ND BAND	3RD BAND	MULTIPLIER	TOLERANCE
Black		0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	± 0.5% (D)
Blue	6	6	6	1MΩ	± 0.25% (C)
Violet	7	7	7	10MΩ	± 0.10% (B)
Grey	8	8	8	100MΩ	± 0.05%
White	9	9	9	1GΩ	
Gold				0.1Ω	± 5% (J)
Silver				0.01Ω	± 10% (K)

Resistor Color Code Table

LAB 02 :

Use Digital Pin 5

to Power ON the LED (still)

LAB 03 :

Use Digital Pin 5

Blink the LED every 1 Seconds.

ON the LED for 0.5 Second,

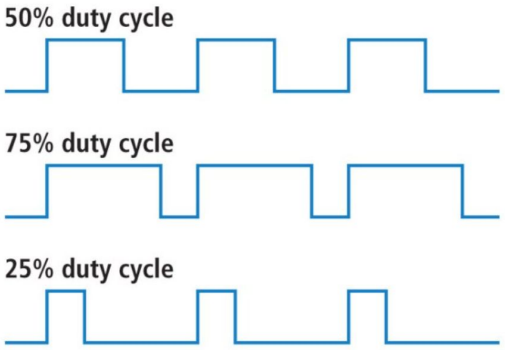
Then OFF for 0.5 Second,

and so on.

LAB 04 :

Use Digital Pin 5

and analogWrite() to dim the LED.



LAB 05 :

Say “Hello World!”

Using Serial.print()

Or Serial.println()

LAB 06 :

Using digitalRead()

Use Digital Pin 3

Read State of the pin (True,False)

And print out Using Serial.print()

LAB 07 :

Using analogRead()

Read voltage from potentiometer.

LAB 08 :

By using the Potentiometer,

Control the brightness of LED.

```
if AnalogRead() > 700 :
    LED ON @ 100%
else:
    LED OFF
```


LAB 09 :

By using the

Light Dependent Resistor (LDR),

Control the brightness of LED.

```
if DARK :
    LED ON @ 100%
else:
    LED OFF
```


BONUS A:

By using the potentiometer,

Control the brightness of LED.

```
if AnalogRead() > 700 :
    LED ON @ 100%
else if AnalogRead() <= 700 and >= 300 :
    LED ON @ 50%
else:
    LED OFF
```

BONUS B:

```
if Button is Pushed:
    LED ON @ 100%, No Blink
else if AnalogRead() > 700 :
    LED ON @ 20%, Blink at 1 Hz. (0.5s On, 0.5s OFF)
else if AnalogRead() <= 700 and >= 300 :
    LED ON @ 50%, Blink at 3 Hz
else:
    LED ON @ 100%, Blink at 5 Hz
```


BONUS C:

By using 2 LEDs,
Make it blink at different frequency.

One at 3 Hz,
and Another one at 7 Hz.

What's next?

- Another I/O
- Peripheral Modules
- Serial Communication
- Task Scheduler
- Memory Managements
- etc.

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