AIL210/CSL240
Course Name: Advanced Microprocessors and Microcontroller

Unit1: Introduction

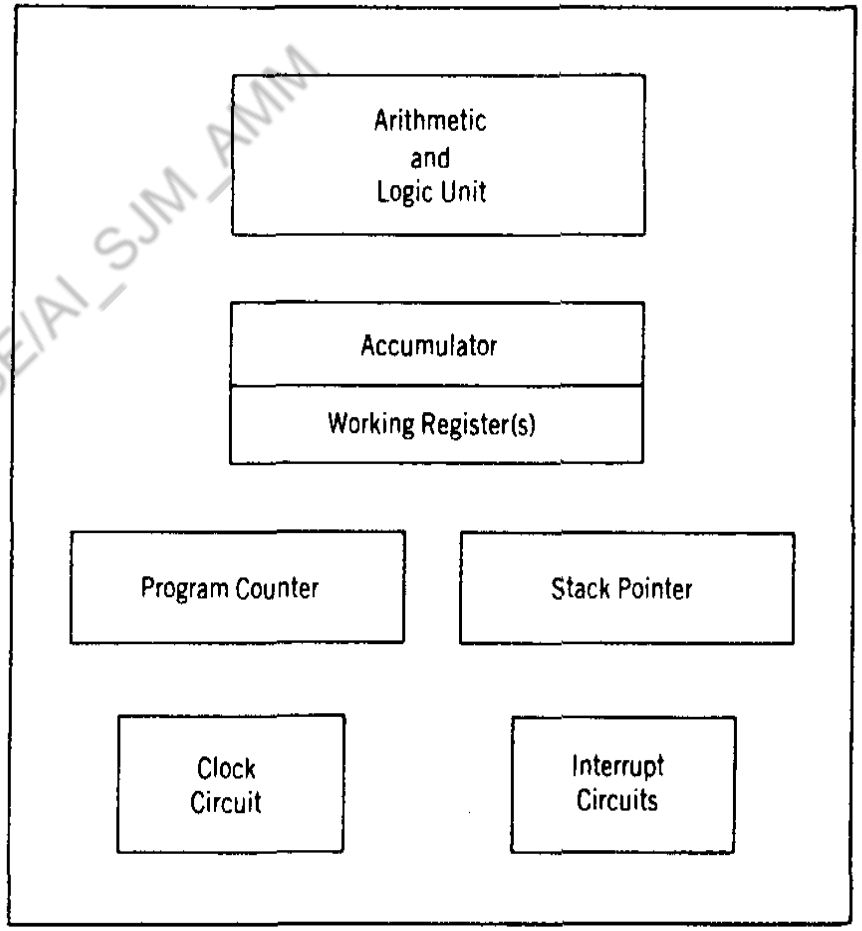
Introduction to Microprocessor

- Microprocessor is a controlling unit of a micro-computer, fabricated on a small chip capable of performing ALU (Arithmetic Logical Unit) operations and communicating with the other devices connected to it.

- Microprocessor consists of an ALU, register array, and a control unit
  - ALU performs arithmetical and logical operations on the data received from the memory or an input device.
  - Register array consists of registers identified by letters like B, C, D, E, H, L and accumulator.
  - The control unit controls the flow of data and instructions within the computer.

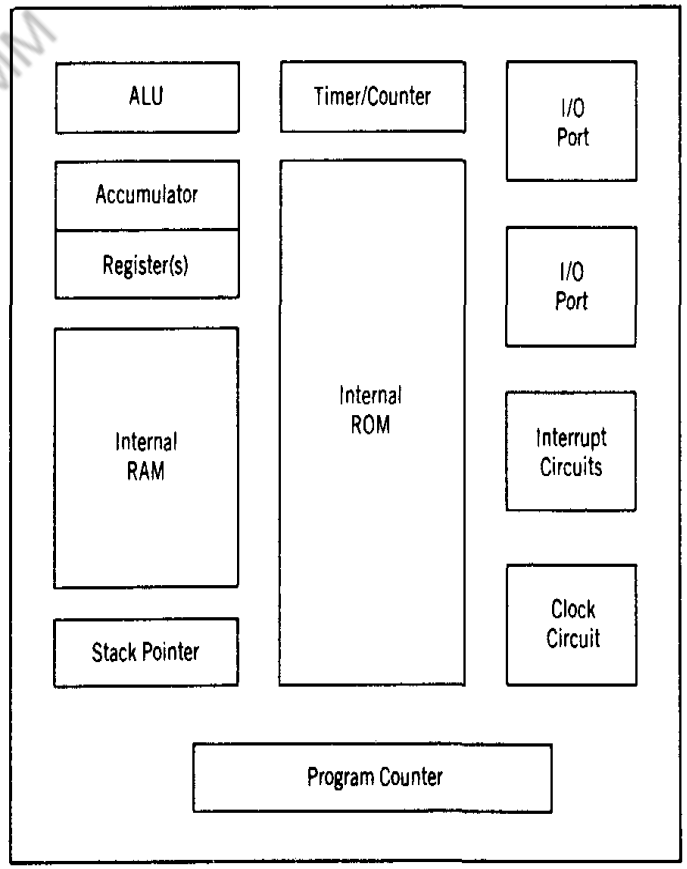
Microprocessor

- Figure show block diagram of a microprocessor CPU, which contains ALU, PC, SP, working registers , clock circuit and interrupt circuit.
- To make complete Microcomputer, one must add memory (ROM and RAM), memory decoders , an oscillator and IO devices .
- The Key term in describing design of microprocessor is “General purpose”
- The primary use of microprocessor is the fetch data, Perform computation on data and store result in memory or display for human use.
- The program used by CPU are stored in memory and loaded into RAM as user directs.

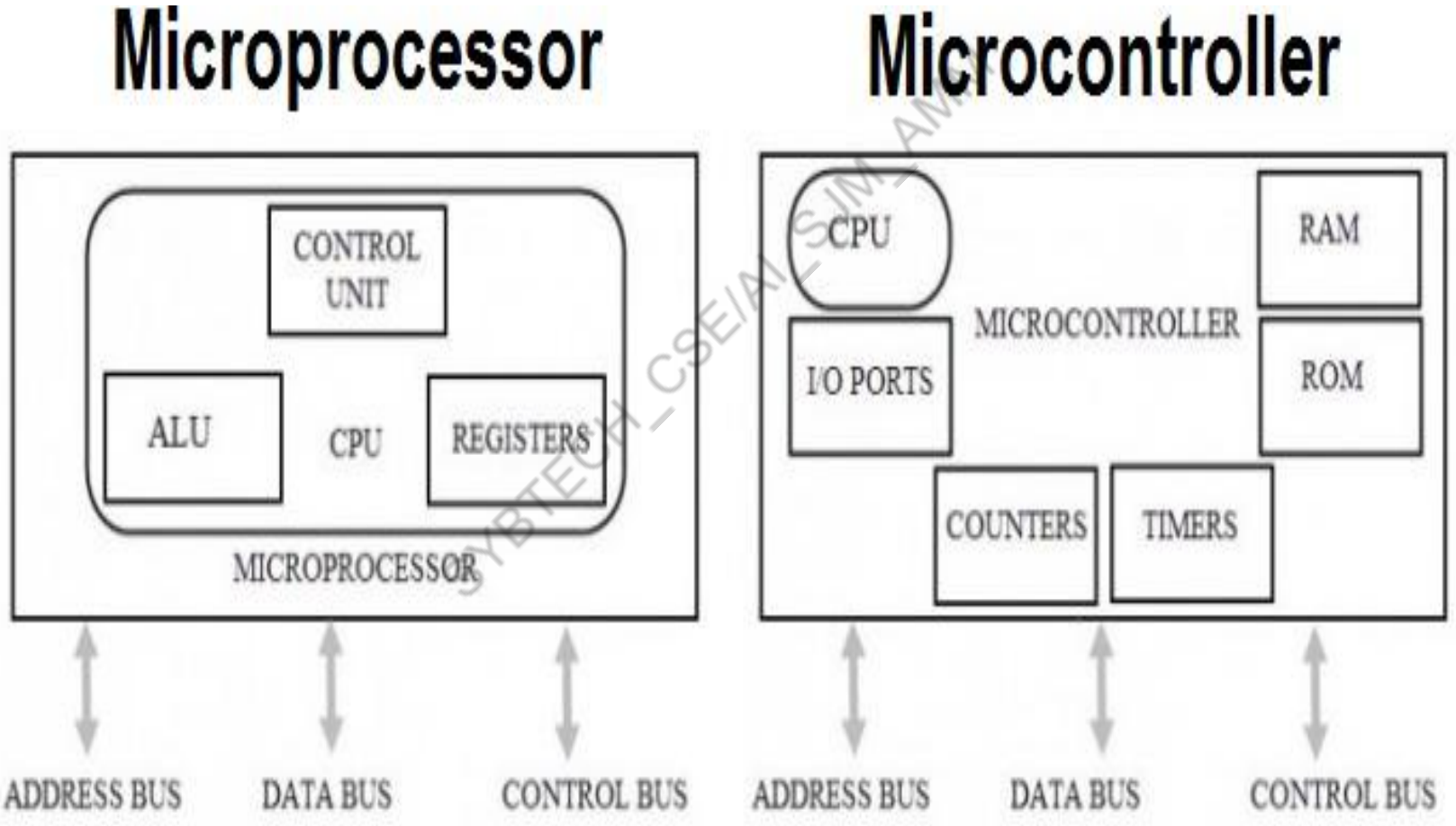


Microcontroller

- Figure shows block diagram of a typical microcontroller , which is a true computer on a chip.
- The design incorporates ALU,PC,SP and registers. It also added ROM ,RAM , IO, counters and clock circuits.
- The prime use of microcontroller is to control the operation of a machine using a fixed program that are stored in ROM and that does not change over the lifetime of the system.
- The microcontroller uses a limited set of instructions that are used move code and data from internal memory to the ALU
- Microcontroller pins are programmable- capable of having different functions depending upon the wishes of the programmer.
- The microcontroller is concerned with getting data from/to its pins.
- The microcontroller architecture and instruction set are optimized to handle data in bit and byte size.



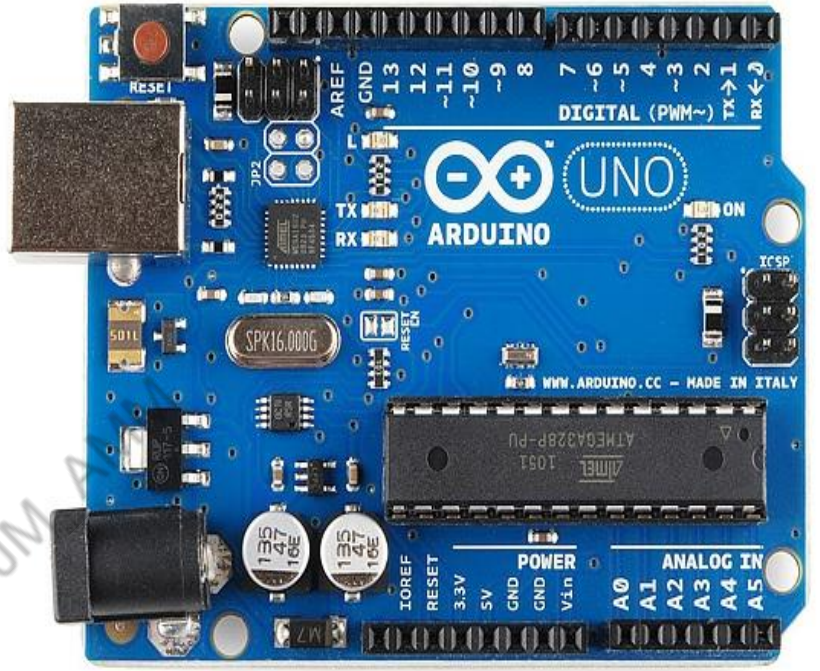
Comparison of Microprocessor and Microcontroller



Comparison of Microprocessor and Microcontroller

Microprocessor	Microcontroller
• Microprocessors are widely used in computer systems.	• Microcontroller is widely used in embedded systems.
• It has only CPU embedded into it.	• It has CPU, a fixed amount of ROM,RAM and other peripherals all embedded on it.
• All the components are externally connected so circuit becomes large and complex.	• All the components are internally connected so circuit becomes small and simple.
• It consumes more power than microcontroller.	• It consumes less power than microprocessor.
• Microprocessor has very less internal register storage so it has to rely on external storage.	• Microcontroller has many internal register storage.
• All memory operations result in high processing time.	• All register operations results in less processing time.
• Microprocessor used for General purpose applications.	• Microcontrollers used for Special (Single) purpose applications.
• Its designing and hardware cost is high.	• Its designing and hardware cost is low.
• Example of Microprocessor: 8085	• Example of Microcontroller: 8051 (8 Bit Microcontroller)

Arduino Uno: A Microcontroller



- A microcontroller board, contains on-board power supply , USB port to communicate with PC and ATmega328P microcontroller chip.
- Arduino is best know for its hardware but you also need software to program that hardware.
- Both hardware and the software are called “Arduino.”
- The combination enables you to create projects that sense and control physical world.
- The software is free, open source and cross-platform.

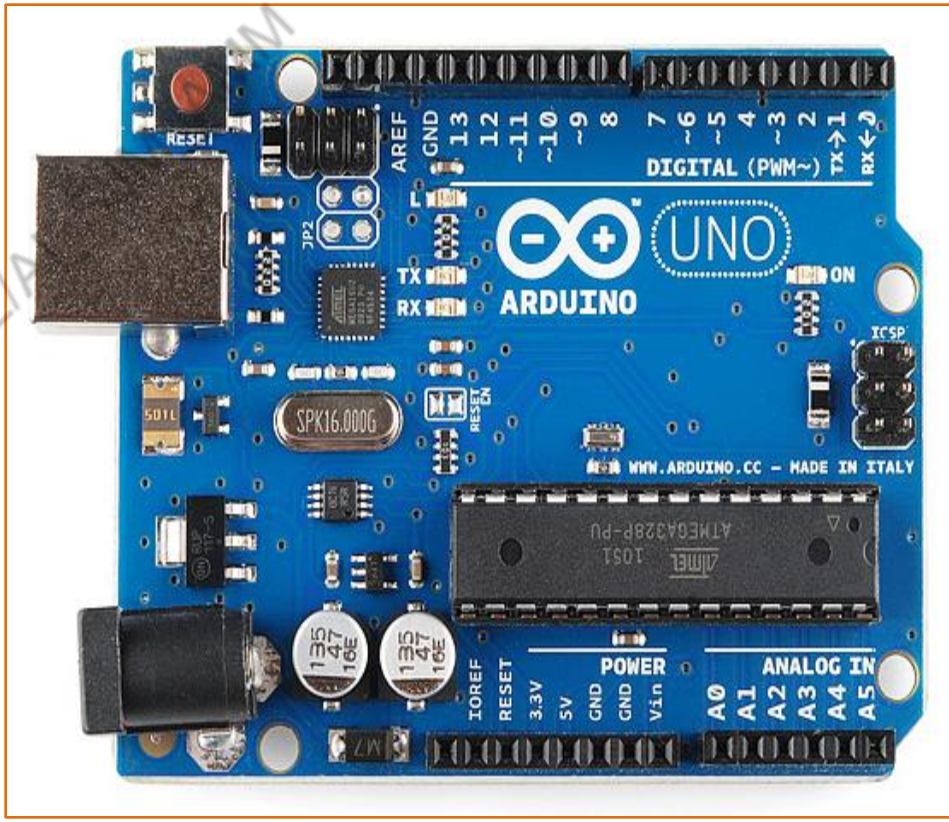
Ardiuno Uno

- Software programs called sketches are created on a computer using the Arduino integrated development environment. (IDE)
- The IDE enables you to write and edit code and convert this code into instructions that Arduino hardware understands.
- The IDE also transfers those instructions to the Arduino board (a process called uploading)

First Arduino program

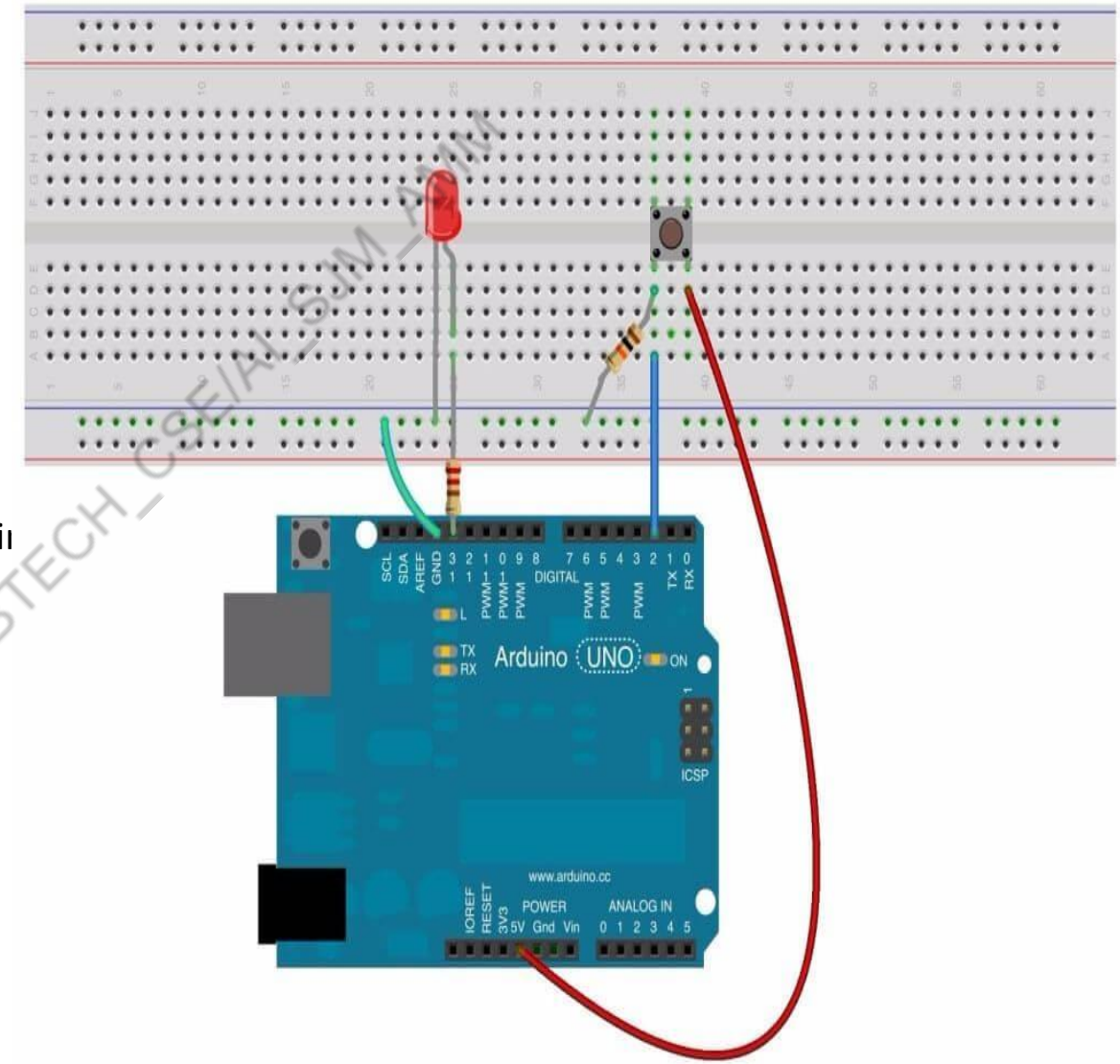
```
Blink LED
void setup()
{
pinMode(LED_BUILTIN, OUTPUT);
}


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

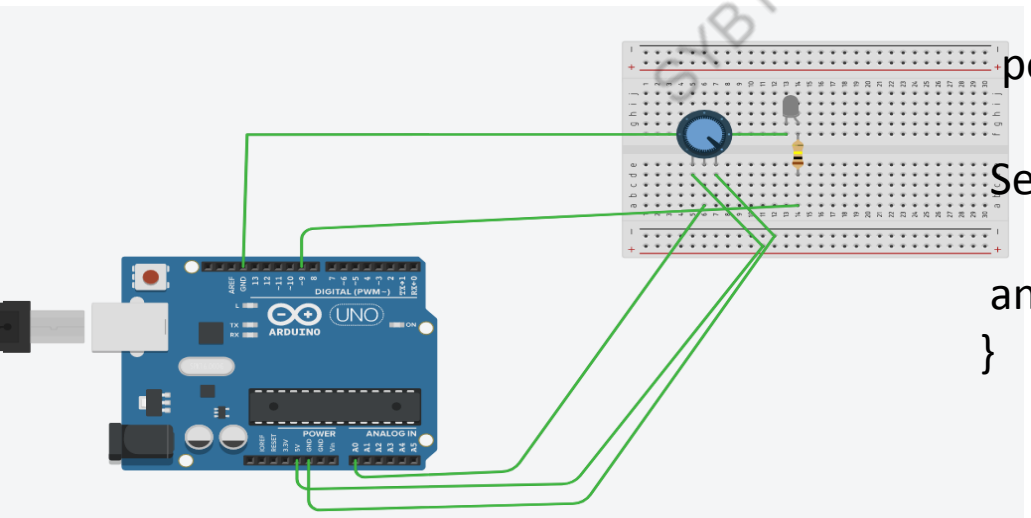


Arduino Program for Push Button

```
const int buttonPin = 2;
const int ledPin =  13;
int buttonState = 0;
void setup()
{
  pinMode(ledPin, OUTPUT);
pinMode(buttonPin, INPUT);
}
void loop()
        {
   buttonState = digitalRead(buttonPi
  if (buttonState == HIGH)
{
digitalWrite(ledPin, HIGH);
}
else
{
digitalWrite(ledPin, LOW);
 }
        }
```



Concept of interfacing:
Example1: **Potentiometer**




```
const  int  LED = 9;
const int  POT = A0;

const int  potreading = 0;

void setup()
 {
   Serial.begin(9600);
  pinMode(LED,OUTPUT);
  pinMode(POT,INPUT);
}

void loop()
{
int potreading = analogRead(A0);

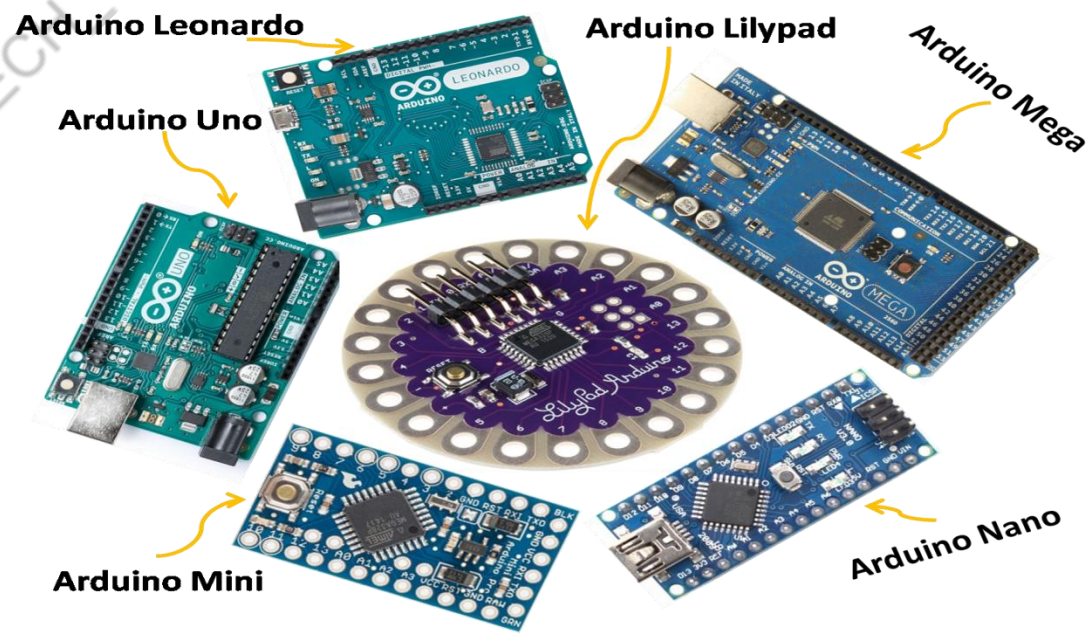
potreading = map(potreading,0,1023,0,255);

Serial.println(potreading);

 analogWrite(LED,potreading);
}
```

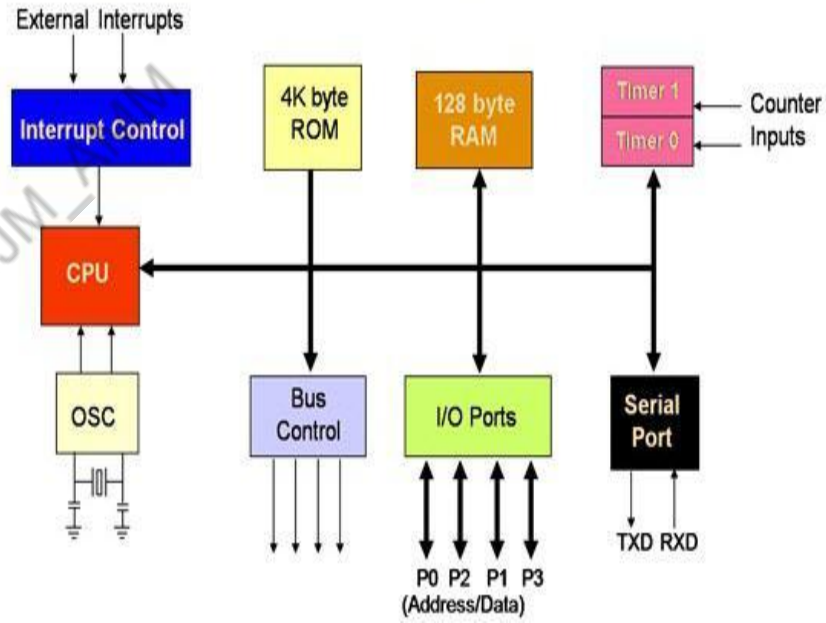
Ardiuno Uno : Hardware

- Arduino board is where the code you write is executed.
- The board can only control and respond to electricity, so specific components interact with the real world.
- These component can be sensors, which convert some aspect of the physical world to electricity so that the board can sense it.
- The most popular boards contain a USB connector that is used to provide power and connectivity for uploading your software onto the board.
- There are a variety of official boards that can use with Arduino software.
  - Arduino Nano
  - Arduino Micro
  - LilyPad Arduino Board
  - Arduino Mega (R3) Board
  - Arduino Leonardo



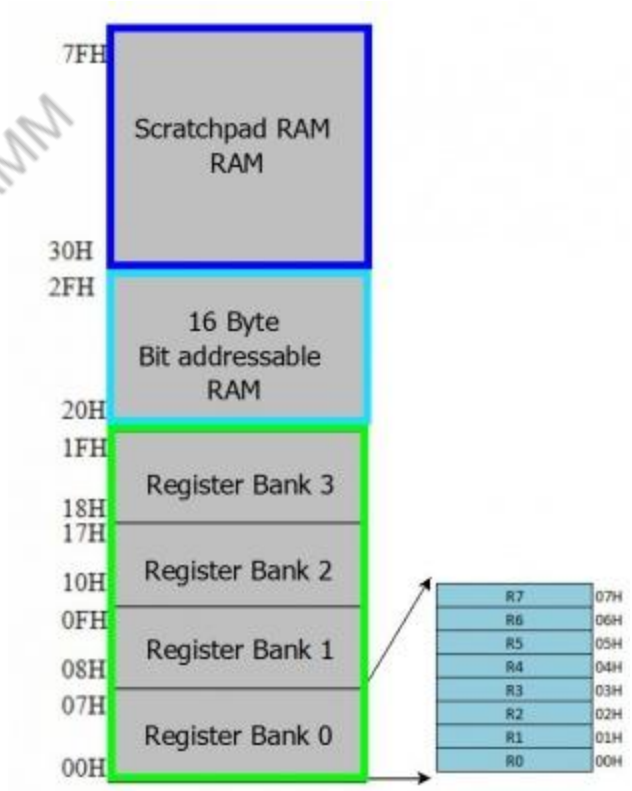
Features of Microcontroller

- 8 bit microcontroller (8 bit ALU)
- 4KB bytes on-chip program memory (ROM)
- 128 bytes on-chip data memory (RAM)
- 8-bit bidirectional data bus
- 16-bit unidirectional address bus. So maximum external Program/Data memory that can be interfaced = 64KB
- 2 Timers each of size 16 bit wide.
- Four 8-bit parallel ports(P0, P1, P2, P3)
- 16-bit program counter and data pointer
- 8051 may also have a number of special features such as UARTs, ADC etc.



Features of Microcontroller

- Four register banks so total 32 , 8 bit general purpose registers.
- It uses Harvard , RISC architecture. (Modern architecture)
- 40 pin DIP (Dual in line package)
- On chip oscillator of 12MHz.
- +5 v Dc supply.
- Total 5 interrupts ..2 hardware #INT0 and #INT1 and 3 software interrupts timer0, timer1 and serial port.
- On chip serial port with programmable baud rate.(Tx/Rx)



Types of the microcontroller

- Microcontroller types according to
  - Number of bits
  - memory architecture
  - memory/devices
  - instruction set.

Types of the microcontroller

- Microcontroller types according to
  - **Number of bits**
    - The bits in the microcontroller are 8-bits, 16-bits, and 32-bits microcontroller.
      - **8 bit Microcontroller** : the internal bus is 8-bit then the ALU performs the arithmetic and logic operations
      - Example : 8051 Microcontroller
      - **16-bit microcontroller** performs greater precision and performance as compared to the 8-bit. For example, 8-bit microcontrollers can only use 8 bits, resulting in a final range of 0×00 – 0xFF (0-255), Whereas 16-bit microcontrollers with their bit data width have a range of 0×0000 – 0xFFFF (0-65535).
      - **32-bit microcontroller** uses the 32-bit instructions to perform the arithmetic and logic operations.
      - These are used in automatically controlled devices including medical devices, engine control systems.
-

Types of the microcontroller

- Microcontroller types according to
  - **Memory architecture**
    - **Harvard Memory Architecture Microcontroller**:
      - A microcontroller unit has a dissimilar memory address space for the program and data memory, the microcontroller has Harvard memory architecture in the processor.
    - **Princeton Memory Architecture Microcontroller**:
      - a microcontroller has a common memory address for the program memory and data memory, the microcontroller has Princeton memory architecture in the processor.

Types of the microcontroller

- Microcontroller types according to
  - memory/devices
    - **Embedded Memory Microcontroller**:
      - An embedded system has a microcontroller unit that has all the functional blocks available on a chip is called an embedded microcontroller.
      - **Example:** 8051 having program & data memory, I/O ports, serial communication, counters and timers and interrupts on the chip is an embedded microcontroller.
    - **External Memory Microcontroller**:
      - An embedded system has a microcontroller unit that has not all the functional blocks available on a chip is called an external memory microcontroller.
      - Example: 8031 has no program memory on the chip is an external memory microcontroller.

Types of the microcontroller

- Microcontroller types according to
  - instruction set.
    - **CISC**: CISC is a Complex Instruction Set Computer. It allows the programmer to use one instruction in place of many simpler instructions.
    - CISC systems shorten execution time by reducing the number of instructions per program.
    - **RISC**: The RISC stands for Reduced Instruction set Computer, this type of instruction sets reduces the design of microprocessor for industry standards.
    - RISC systems shorten execution time by reducing the clock cycles per instruction.

CISC:	Mov AX, 4	**RISC**:		Mov AX, 0
	Mov BX, 2			Mov BX, 4
	MUL BX, AX			Mov CX, 2
			Begin	ADD AX, BX
			Loop	Begin

Concept of interfacing

- In many applications, the microcontroller is connected with some external devices called as interfacing devices for performing some specific tasks.
- Example:
  - consider security system with a user changeable password project, in which an interfacing device(keypad) is interfaced with microcontroller to enter the password.
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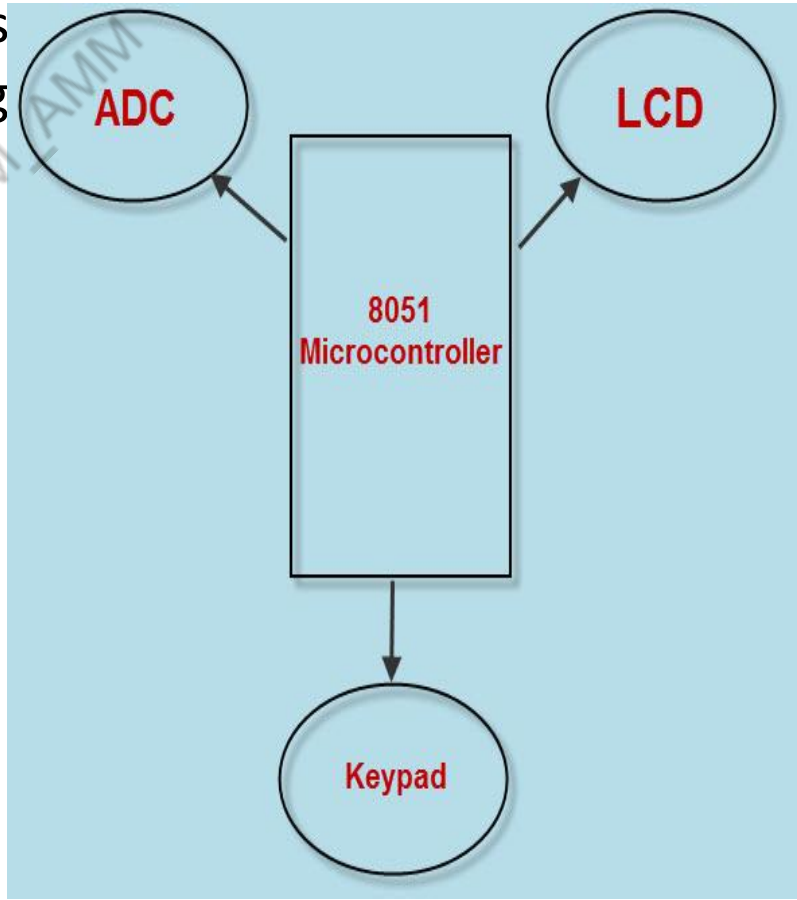
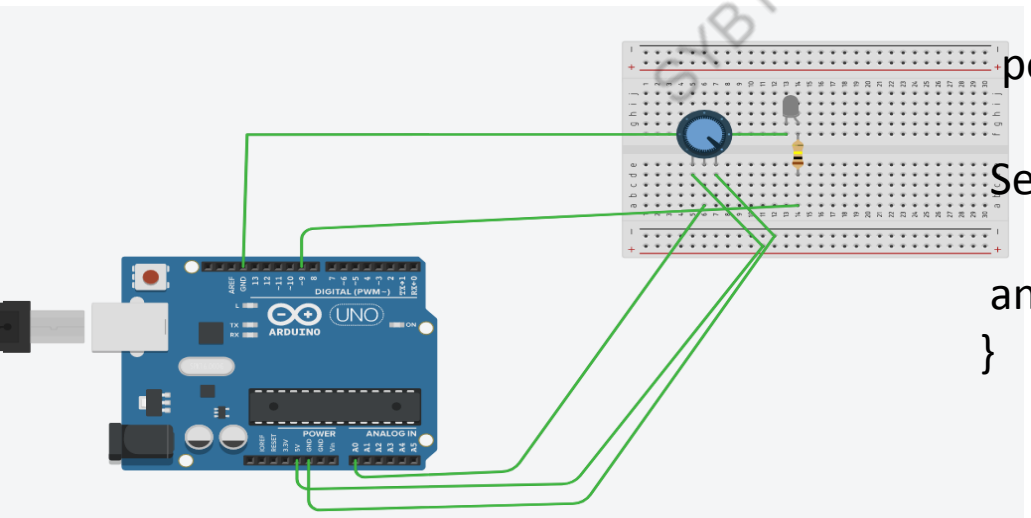


Concept of interfacing

- **Interfacing Devices**
  - Interfacing can be defined as transferring data between microcontrollers and interfacing peripherals such as sensors, keypads , ADC.
  - These devices that are interfacing with microcontroller are used for performing special tasks or functions.
  - Interfacing is a technique that has been developed and being used to solve many composite problems.
  - To facilitate multiple features with simple circuits, microcontroller is interfaced with devices such as ADC, keypad, LCD display.

Concept of interfacing:
Example1: **Potentiometer**

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const int  POT = A0;

const int  potreading = 0;

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 {
   Serial.begin(9600);
  pinMode(LED,OUTPUT);
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}

void loop()
{
int potreading = analogRead(A0);

potreading = map(potreading,0,1023,0,255);

Serial.println(potreading);

 analogWrite(LED,potreading);
}
```

Example 02 : Temperature sensor

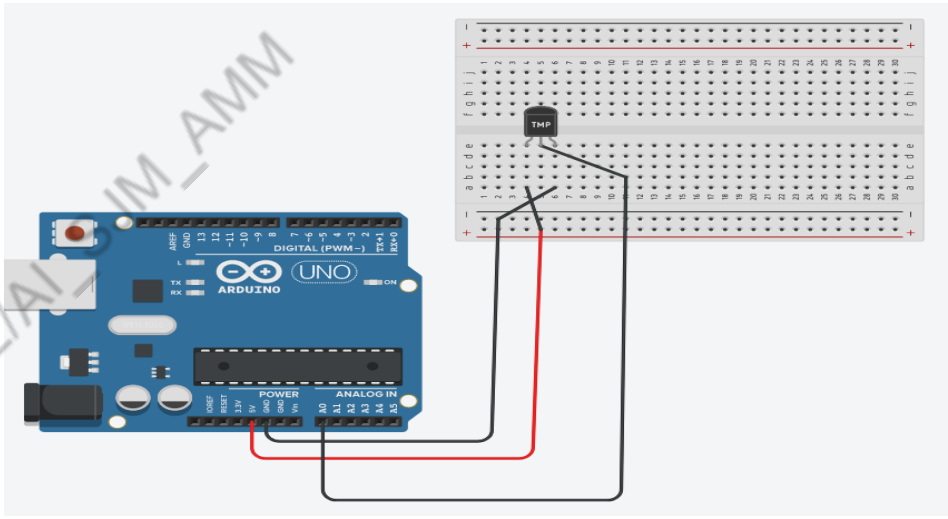
```
int sensorpin = A0;
void setup()
{
Serial.begin(9600);
}

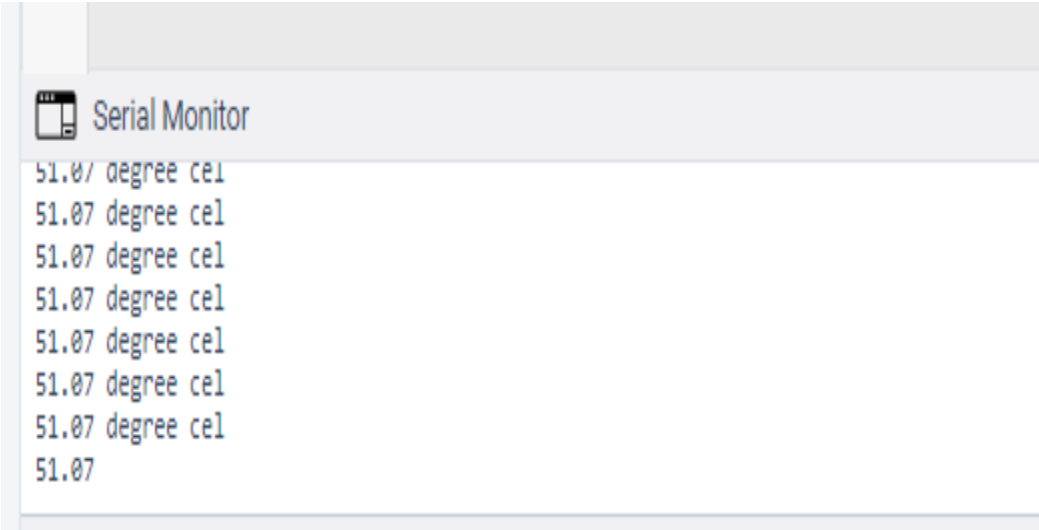
void loop()
{
float reading = analogRead(sensorpin);
  float tempC = reading/1024;
        tempC = tempC*5.0;
        tempC = tempC-0.5;
        tempC = tempC*100;



Serial.print(tempC);
  Serial.println(" degree cel");

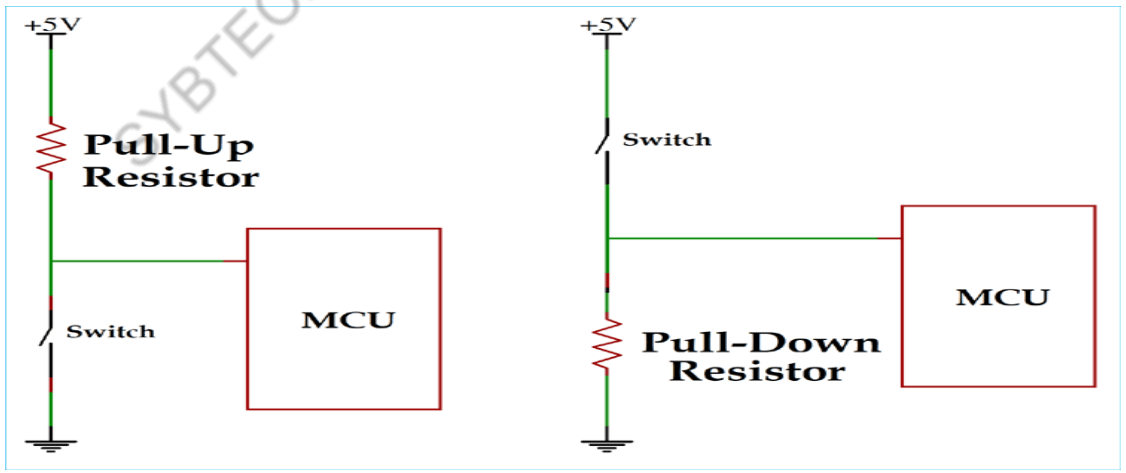
}
```





Pull up and Pull down register

- As digital circuit works in low current, connecting the logic pins directly to the supply voltage or the ground is not a good choice. As direct connection eventually increase current flow just like the short circuit and could damage the sensitive logic circuit which is not advisable.
- **To control the current flow, we need those pull-down or pull up resistors**.
- A pull-up resistor allow controlled current flow from supply voltage source to the digital input pins.
- A pull-down resistors could effectively control current flow from digital pins to the ground



Unit I Completed