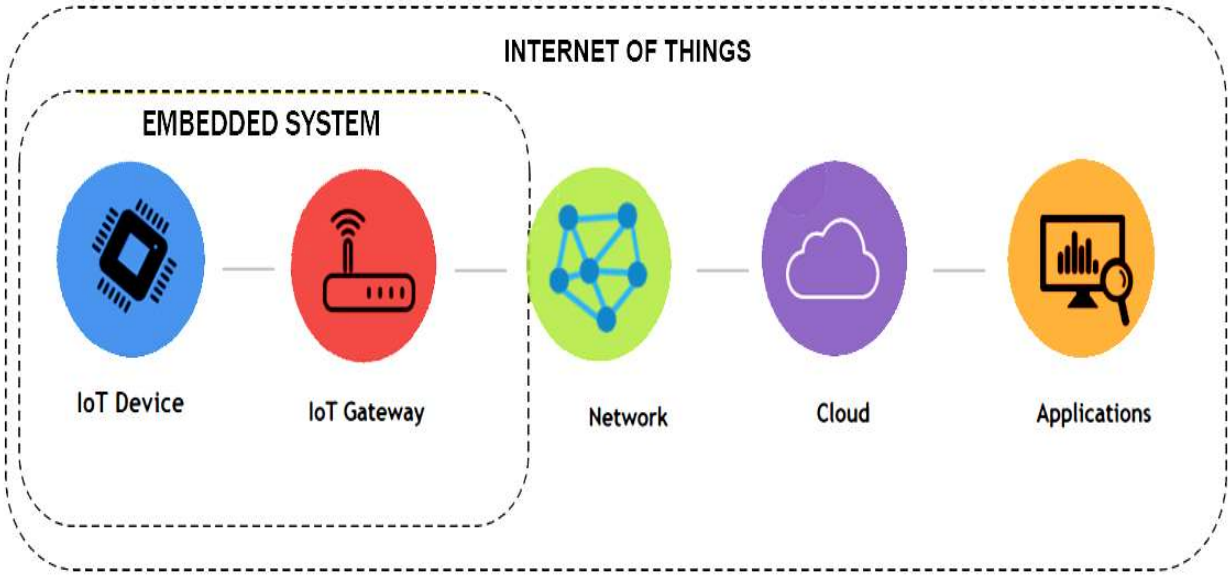
IOT UNIT 2 merged - notes for the mentioned subject

INTERNET OF THINGS

Lecture Notes

Unit-II

Embedded Devices in IOT



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Unit – II
EMBEDDED DEVICES

JNTUA SYLLABUS

Unit - II: **Embedded Devices**

Electronics, Embedded Computing Basics, Arduino, Raspberry Pi, Mobile phones and tablets, Plug Computing: Always-on Internet of Things

CONTENTS

EMBEDDED DEVICES IN IOT

2.1 EMBEDDED SYSTEM

- Embedded system is a combination of hardware (microcontroller or microprocessor) and software which together form a component of a large machine.
- This is a computer system – a combination of a computer processor, computer memory, and input/output peripheral devices that has a **"dedicated function"** within a larger mechanical or electronic system.
- For example, a fire alarm is an embedded system, which sense only smoke.
- When a computer becomes a part of another large system or when a computer becomes one of the components of a system, we call it as Embedded Computer or Embedded System.
- Laptops, Desktops, Servers are not embedded computers , they are referred as standalone systems.

Examples of Embedded Devices (Computer fixed inside)

- ✓ Automobiles
- ✓ Washing machine
- ✓ Dish washer
- ✓ Microwave oven
- ✓ Smart watches, Smart phones
- ✓ Robots
- ✓ Drones
- ✓ Smart TVs
- ✓ Refrigerator, Air Conditioners
- ✓ Manufacturing equipment
- ✓ Tele communication equipment
- ✓ Digital camera
- ✓ Video game consoles
- ✓ MP3 players, DVD players
- ✓ Wireless Routers
- ✓ Photocopiers (Xerox machines)
- ✓ GPS Receivers etc.,

Key components of an embedded system

1. **Hardware** – Embedded hardware suppliers(Arduino, Raspberry Pi, Broadcom) provides the needed hardware boards within build networking technologies. Hardware consists of processors, system application specific circuits,timers and memory.
2. **Software** – Software must do a specific task in a series. It should keep in view of three constraints. They are availability of system memory, availability of processor speed, power dissipation. Software engineers with embedded system knowledge will develop the code.
3. **Time operating system** – It organizes the system and provides a technique to run the system as per schedule.

2.2 ELECTRONICS

- It is the branch of the Physics and Technology concerned with the design of circuits using transistors and microchips and with the behavior and movement of electrons in a semiconductor, conductor, vacuum or gas.
- Electronics is mainly about Circuits or devices using transistors, microchips and other components.
- Electronics deals with electrical circuits that involve active electrical components such as integrated circuits, transistors, diodes, vacuum tubes, and sensors and associated passive electrical components and interconnection technologies.
- When it comes to thinking about the electronics in IOT, it's useful to split them into two main categories:
    - **Sensors**
    - **Actuators**
- Within both categories, the electronic components can talk to the computer in a number of ways.
- The Sensors & Actuators works mainly with digital I/O, which has only two states:
    - a button can either be pressed or not;
    - or an LED can be on or off.
- These states are usually connected via General-Purpose Input/ Output **(GPIO)** pins and map a digital 0 in the processor to 0 volts in the circuit and the digital 1 to a set voltage, usually the voltage that the processor is using to run (commonly 5V or 3.3V).
- Computers are purely digital devices; we need a way to translate between the analogue voltages in the real world and the digital of the computer.
- An Analogue-to-Digital converter (ADC) measures varying voltages.
- Microcontrollers often have a number of these converters built in. They will convert the voltage level between 0V and a predefined maximum into a number, depending on the accuracy of the ADC.
- The flipside of an ADC is a DAC, or Digital-to-Analogue converter.

2.3 SENSORS

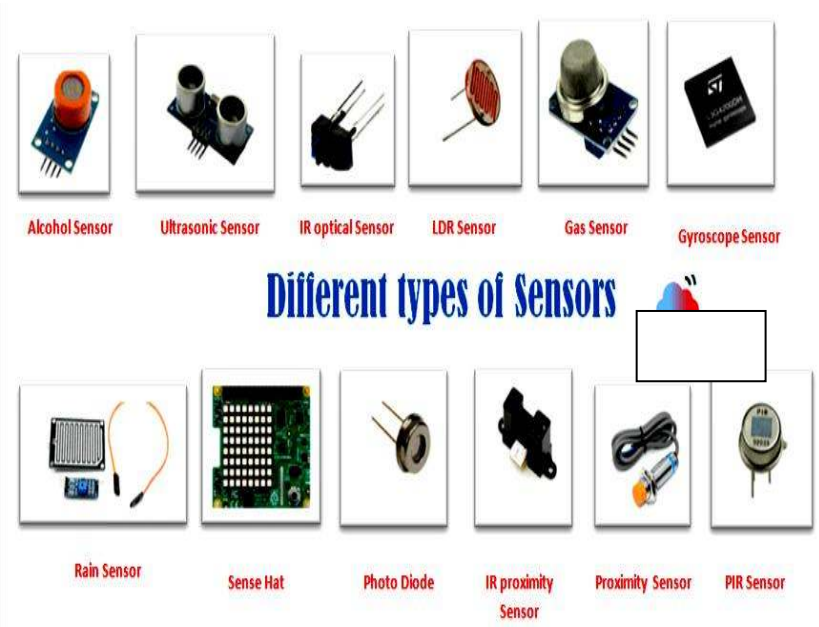
Sensors are the ways of getting information *into our device ,* finding out things about our surroundings.

- Push buttons and switches are the simplest sensors , which allow some user input.
- Sensing the environment is another easy option.
- Microphones monitor audio and sounds
- Light Dependent Resistors (LDR) allows measurement of ambient light levels.
- Temperature sensors measure the condition of cold or hot in the environment.

- Few sensors will measure humidity, moisture levels etc.,

List of Sensors

- ✓ Rain sensor
- ✓ Alcohol sensor
- ✓ Ultrasonic sensor
- ✓ IR optical sensor
- ✓ LDR sensor
- ✓ Gas/ smoke sensor
- ✓ Gyroscope sensor
- ✓ Heat sensor
- ✓ Photo diode
- ✓ Proximity sensor
- ✓ PIR (Passive Infra Red) Sensor
- ✓ Color sensor
- ✓ Accelerometer
- ✓ Potentiometer
- ✓ Thermistor



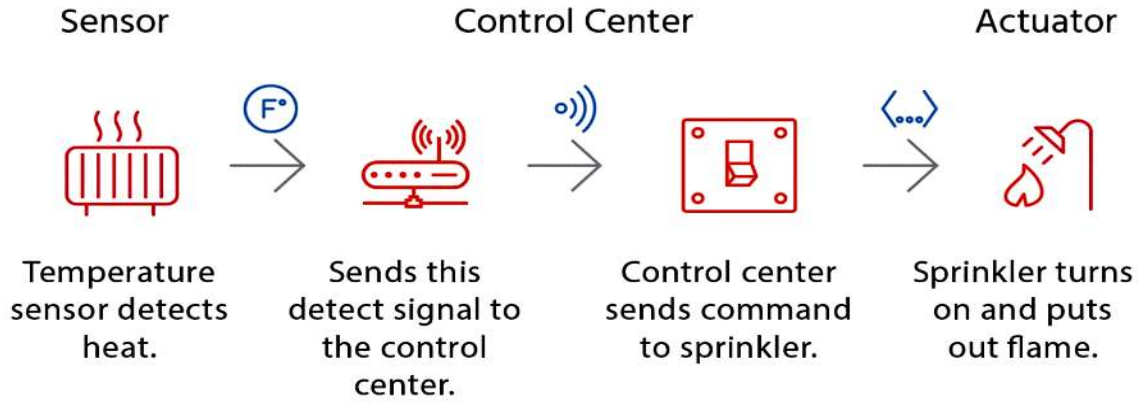
2.4 ACTUATORS

Actuators are the *outputs for the device—the motors, lights ,* and so on, which let our device do something to the outside world.

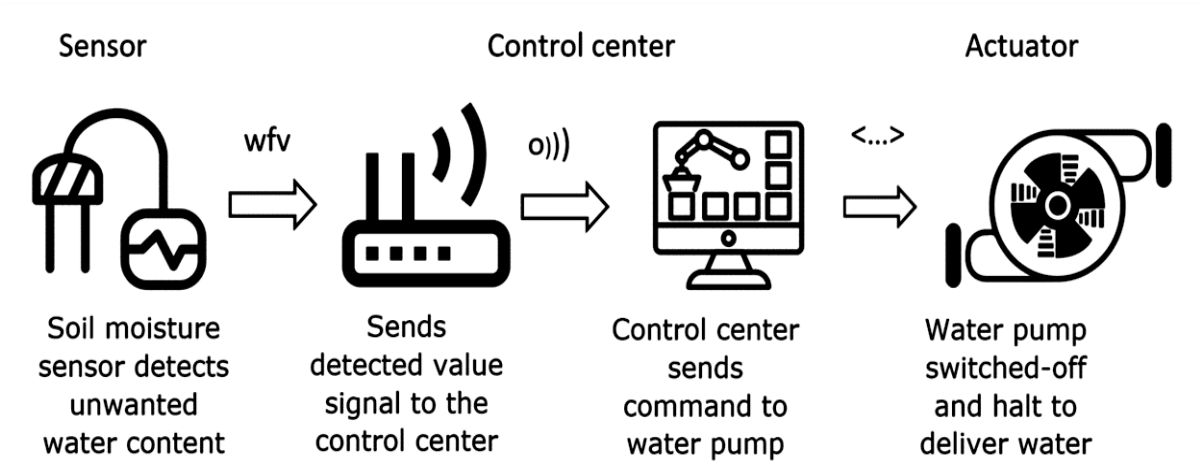
- One of the simplest and most useful actuator is light. It is easy to create electronically and gives an output.
- Light Emitting Diode (LED) generally comes in red, green, white and other colors.
- More complicated visual outputs are also available such as LCD(Liquid Crystal Display) screens to display text or simple graphics.
- We can connect the output to the speakers to create sounds.
- More complicated actuator outputs are motors.
  - ✓ Stepper motor can be moved in step wise.
  - ✓ Usually a fixed number of steps will perform a full rotation.
  - ✓ DC motors simply move at a given speed.
  - ✓ Both types of motor can be one directional or move in both directions.

Sensor to Actuator Flow

Example1. Smoke sensor sensing the heat and Actuator (Sprinkler) spraying the water to put off the fire.

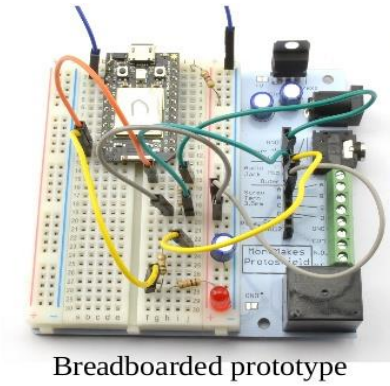


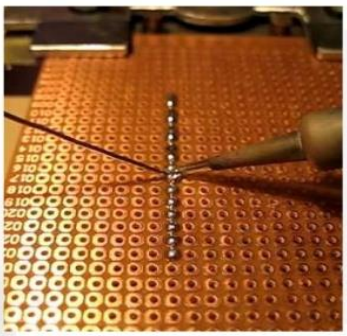
Example2. Water level senor in soil sensing the excess moisture content and Actuator (Pump) is stopping the supply of water.

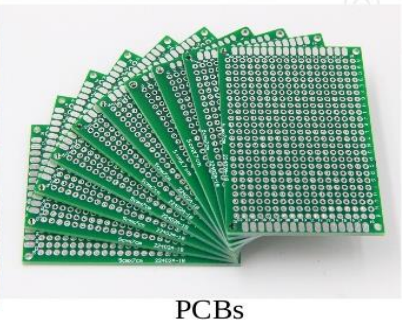


2.5 SCALING UP THE ELECTRONICS

- Electronics perspective point of view, the starting point for prototyping is usually a "breadboard".
- Breadboard – A simple way to take circuits and electronics projects to the next level. There are two types of breadboards namely: solderable breadboard and solder less breadboard.
- It's common to solder the components on to some protoboard, which may be sufficient to make the circuit more permanent.
- Moving beyond the protoboard (stripboard) the next level is PCB(Printed Circuit Board).It involves learning how to use a new piece of software and understanding some new terminology.


Breadboarded prototype


Soldered prototype

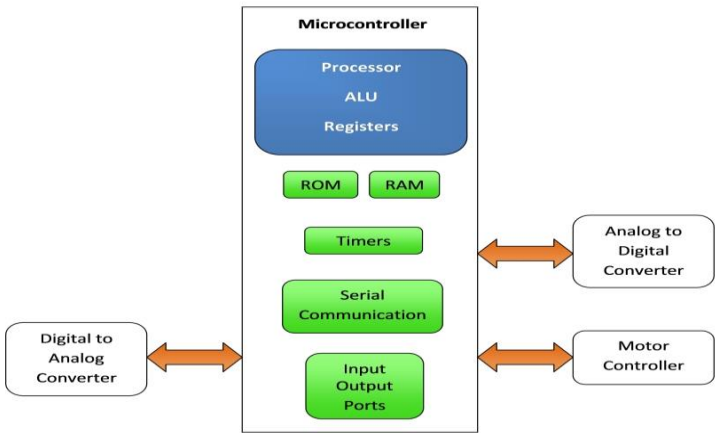

PCBs

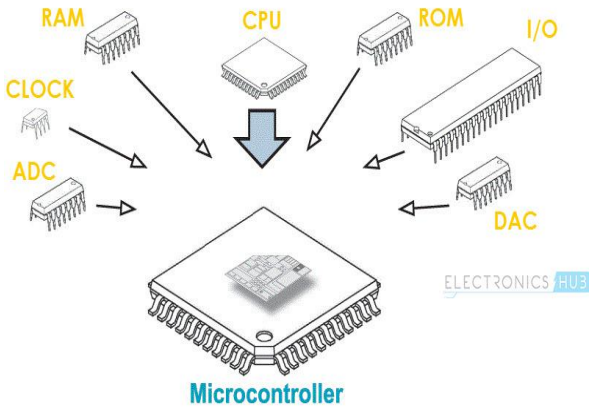
2.6 EMBEDDED COMPUTING BASICS

- ✓ Microcontrollers
- ✓ Microprocessors
- ✓ System on Chip (SoC)
- ✓ Choosing the platform

2.6.1 Microcontrollers

- Microcontrollers are small computers integrated into a single Silicon chip.
- They contain
  - CPU
  - RAM
  - ROM(EEPROM -Electrically Erasable Programmable Read Only Memory)
  - Memory for storing the program
  - I/O peripherals
  - ADC (Analog to Digital Converter)
  - DAC (Digital Analog Converter)
  - Peripherals such as clocks, timers, etc
- Microcontrollers are self sufficient and are used for specific tasks.
- Microcontrollers are embedded inside devices to control the actions and features of a product. Hence, they can also be referred to as embedded controllers.
- Microcontrollers can take inputs from the device they controlling and retain control by sending the device signals to different parts of the device.
- These microcontrollers are the engines of countless sensors and automated factory machinery.





Applications of Microcontrollers

- ✓ Washing Machine
- ✓ Microwave Ovens
- ✓ Vacuum cleaner
- ✓ Cell Phone
- ✓ Watch, Calculator
- ✓ Video game consoles
- ✓ TV Remote, Toys
- ✓ Cameras,
- ✓ Robots
- ✓ Oscilloscopes
- ✓ Multi-meter
- ✓ ECG Machine
- ✓ Cell Phones
- ✓ Telephone Sets.
- ✓ Fax, Printers etc.
- ✓ Mp3 Player, DVD player etc.
- ✓ Speedometer in Automobile etc.

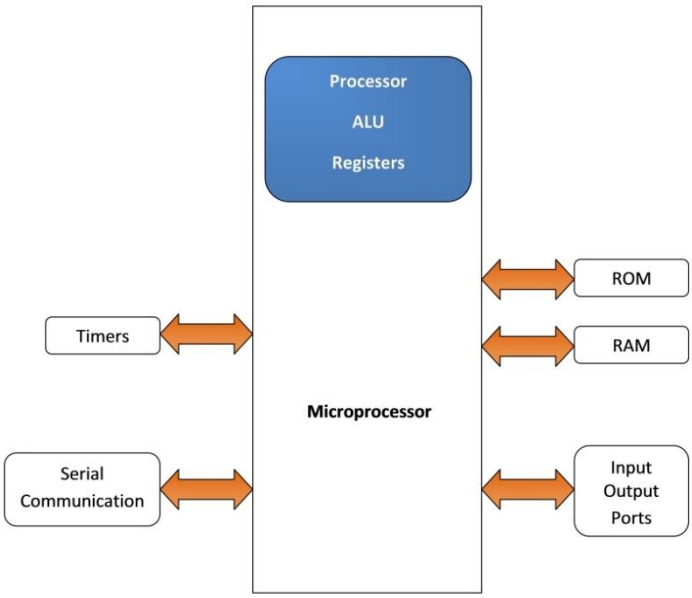
2.6.2 Microprocessor

- ➢ Microprocessor is a multipurpose programmable integrated device that has computing and decision making capability similar to CPU of the computer.
- ➢ It simply consists of the processor, the ALU (Arithmetic Logic Unit), the Instruction Decoder and a few registers which are used to store data for mathematical and logical operations.
- ➢ The ROM/RAM in which the program is to be stored, the I/O pins, timers etc all have to be added to the microprocessor separately using discrete devices.
- ➢ It is also known as CPU, the brain of all computers, electronic devices and many household devices

- It reads binary instructions from a storage device memory and accepts binary data as input and processes the instructions for execution.
- 32 bit microprocessor – Intel Pentium, Pentium II,III,IV, Intel dual core
- 64 bit microprocessor – Intel core 2.Intel core i3,i5,i7 ,i9

Parts of Microprocessor

- Arithmetic Logic Unit (ALU)
- Control Unit.
- I/O Units.
- Registers.
- Cache.



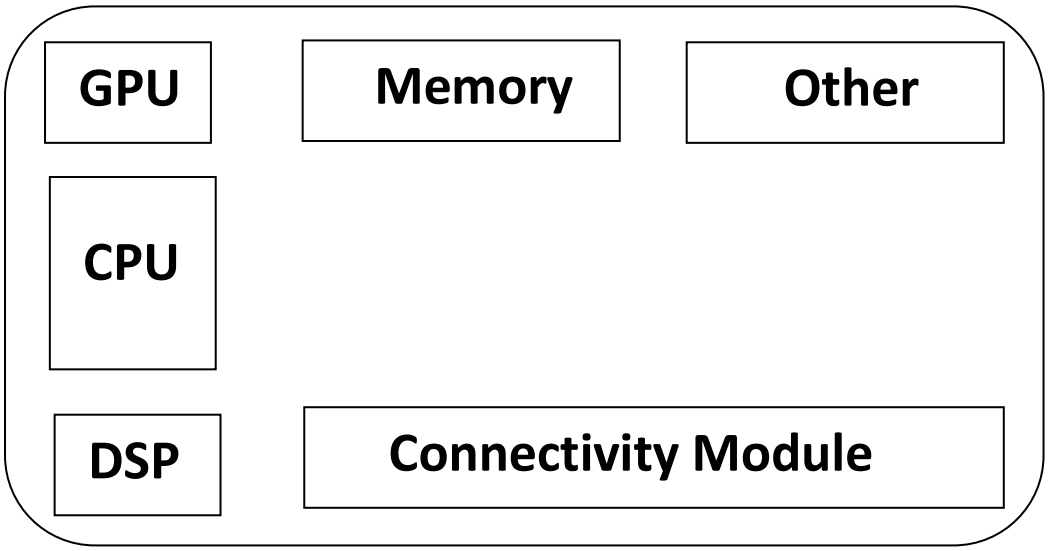
Applications of Microprocessor

- ✓ Desktop, Laptop
- ✓ Mobile phones, Tablets
- ✓ Mobile accessories
- ✓ Remote controls
- ✓ Telephone industry
- ✓ Satellite communication
- ✓ Traffic light control
- ✓ Medical instruments
- ✓ Speed control of motors
- ✓ Industrial automation
- ✓ Car -Ignition system, emission control system, Anti lock Braking System (ABS), Dashboard display, Infotainment (Information+ Entertainment) system, Door, Sunroof modules

2.6.3 System on Chip (SoC)

- A System on Chip is an integrated circuit that integrates all the components of a computer or electronic system in a single chip.
    - **SoC = Chip + Software + Integration**
- SoC is widely used in smart phones. Operating system in the smart phone is optimized for this SoC.
- Like the microcontrollers these SoCs combine a processor and a number of peripherals onto a single chip with more capabilities.
- SoC lies between low end microcontroller and a full end PC.
- The processors generally ranges from few hundred MHz to GHz
- RAM is measured in MB or GB instead of KB.
- Storage of SoC modules includes SD(Secure Digital) cards.
- SoC requires an operating systems like Android OS, Windows, iOS etc.,
- SoC performs more number of tasks with less power consumption (compared to laptop)

Inside the System on Chip (SoC)



- ✓ **CPU** – Central Processing Unit
- ✓ **GPU** – Graphical Processing Unit
- ✓ **DSP** – Digital Signal Processor (Audio processing, Video Processing , Display)
- ✓ **Memory Element** – ROM & RAM
- ✓ **Connectivity Module** – 4G LTE modems, Wi-Fi, Bluetooth, GPS, FM radio, USB
- ✓ **Other Modules** – Camera, location, security, sensors etc.,

2.6.4 Choosing the Platform

While selecting any platform for IOT mainly depends on **cost, performance and capabilities.** In addition to these factors, the following factors should be considered.

1. **Processor speed -** The processor speed or clock speed & Millions of Instructions Per Sec (MIPS) should be high.
2. **RAM –** Working memory for the system should be more.
3. **USB -** The hardware platforms should have USB provision in the board, so that we can connect to the computer.
4. **Power Consumption –** The hardware/microcontroller/microprocessor should consume less power.
5. **Networking -** Strong networking is always required while executing the projects. Wired Ethernet is the simplest one for the users but it requires a physical cable. Wireless networks avoid physical cable but sometimes network signals may not be strong.
6. **Interfacing with Sensors and other circuitry –** There should be a strong interface with the sensors and actuators. Sensors gather data from the environment and actuators like LEDs, motors, screens provides output.
7. **Physical size –** Now-a-days ,majority of the microcontrollers, microprocessors, System on Chip (SOC) , memory cards are being manufactured at a very small size making the system very compact.

2.7 ARDUINO

- Arduino is an open source platform used for building electronics projects.
- It is a small microcontroller board with a USB plug.
- The Arduino is a microcontroller development platform.
- It is easy to use hardware and software.
- Based on a simple I/O board and a development environment, that implements the processing/ writing a language.
- Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online**.**
- Arduino can be used to develop stand alone interactive objects or can be connected to software of IDE (Integrated Development Environment) that runs on the computer to write and upload computer code to the physical board.
- It is intended for students, artists, designers, hobbyists and anyone who thinks with technology.
- Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, smart phone & smart TV.
- It is programmed in Arduino Programming Language (APL) similar to c/C++.
- Its programming is very easy compared to other microcontroller packages.
- Arduino is the winner of "world best interaction award 2012" sponsored by Google.

Components of Arduino Uno Board

The major components of Arduino UNO board are as follows:

1. USB connector
2. Power port
3. 2.1mm center-positive plug
4. Microcontroller
5. Analog input pins
6. Digital pins
7. Reset switch
8. Crystal oscillator
9. USB interface chip
10. TX RX LEDs

1. **USB connector -** This is a printer USB port used to load a program from the Arduino IDE onto the Arduino board. The board can also be powered through this port.
2. **Power port** - The Arduino board can be powered through an AC-to-DC adapter or a battery. The power source can be connected by plugging in a 2.1mm center-positive plug into the power jack of the board.
3. **2.1mm center-positive plug** - The Arduino UNO board operates at a voltage of 5 volts, but it can withstand a maximum voltage of 20 volts. If the board is supplied with a higher voltage, there is a voltage regulator that protects the board from burning out.
4. **Microcontroller (Atmega328P)**- This rectangular chip is considered as the brain of the Arduino board chip with 28 pins. The UNO board has Atmega328P by Atmel (a major microcontroller manufacturer). Atmega328P has the following components in it:
   - **Flash memory** of 32KB. The program loaded from Arduino IDE is stored here.
   - **RAM** of 2KB. This is a runtime memory.

- **CPU**: It controls everything that goes on within the device. It fetches the program instructions from flash memory and runs them with the help of RAM.
- **Electrica Erasable Programmable Read Only Memory (EEPROM)** of 1KB. This is a type of nonvolatile memory, and it keeps the data even after device restart and reset.

Atmega328P is pre-programmed with boot loader. This allows to directly upload a new Arduino program into the device, without using any external hardware programmer, making the Arduino UNO board easy to use.

5. **Analog input pins** - The Arduino UNO board has 6 analog input pins, labeled "Analog 0 to 5." These pins can read the signal from an analog sensor like a temperature sensor and convert it into a digital value so that the system understands. These pins just measure voltage and not the current because they have very high internal resistance. Hence, only a small amount of current flows through these pins.
6. **Digital pins** - These pins are labeled "Digital 0 to 13." These pins can be used as either input or output pins. When used as output, these pins act as a power supply source for the components connected to them.
   When used as input pins, they read the signals from the component connected to them. When digital pins are used as output pins, they supply 40 milliamps of current at 5 volts, which is more than enough to light an LED.
7. **Reset switch** - When this switch is clicked, it sends a logical pulse to the reset pin of the Microcontroller, and now runs the program again from the start. This can be very useful if the code doesn't repeat, and can be used to test multiple times.
8. **Crystal oscillator** - This is a quartz crystal oscillator which ticks 16 million times a second. On each tick, the microcontroller performs one operation, for example, addition, subtraction, etc.
9. **USB interface chip** - This is a signal translator. It converts signals in the USB level to a level that an Arduino UNO board understands.
10. **TX – RX indicator** - TX stands for transmit, and RX for receive. These are indicator LEDs which blink whenever the UNO board is transmitting or receiving data.

Arduino Boards/Types

1. Arduino Uno
2. Arduino Mega
3. Arduino BT
4. Arduino WiFi
5. Arduino Nano
6. Arduino Mini
7. Arduino YUN
8. Lilypad

- The standard Arduino has gone through a number of iterations – Arduino NG, Diecimila, Uno
- The Uno features an ATmega328 micro controller and a USB port to connect to the computer.
- Uno has 32 KB of storage, 2 KB RAM and 14 GPIO(General Purpose I/O) pins.
- Ardunio Mega 2560 provides 256 KB of storage, 8KB RAM, 3 more serial ports, and 54 GPIO Pins.
- The more recent Arduino Due has 32 bit ARM core micro controller. This is similar to Arduino Mega with 96KB RAM.
- The Arduino has 10-bit ADCs, which by default measure voltages between 0 & 5V
  - A voltage of 0 will give a reading of 0
  - 1V will give a reading of 205
  - 2.5V will give a reading of 512
  - 5V would read 1023 and so on

2.8 ARDUINO SOFTWARE/IDE (INTEGRATED DEVELOPMENT ENVIRONMENT)

- The Arduino is programmed in C/C++ language.
- The language is very simple and provides many concepts for simplicity of reading and writing powerful applications.
- Allows one click compiling, verification and burning of code on theArduino.
- Arduino IDE can be downloaded from www.arduino.cc
-

```
Arduino has two reserved functions:
 void setup()
 void loop()
There is no pop-up display window,hence void draw() is not special.
 Loop() can be considered to do the same thing as draw() for the arduino.
There are three types of variable in Arduino:
 char
 int
 long
Arduino has a few reserved constants,which donot need to be defined:
HIGH//5 volts
LOW//0 volts
INPUT//pin is input
OUTPUT//pin is output
Conditional statements are the same as in Processing.
Functions can be defined the same as in Processing
```

- The code needs to provide only two routines
  1. **setup():** This routine is run once when the board first boots.
     This is used to set the modes of I/O pins to input or output or to prepare a data structure which will be used throughout the program.
  2. **loop():** This routine is run repeatedly in a tight loop while the Arduino is switched on.
     We can check some input, do some calculation on it, and perhaps do some output in response.

Steps in Arduino Programming

- ✓ Open the IDE
- ✓ Write code and logic
- ✓ Click the verify/compile button to check your program for errors
- ✓ Attach the Arduino via USB to the PC
- ✓ Install drivers if first time
- ✓ Setup serial port being used
- ✓ Setup board which we need to program
- ✓ Click upload code to send code to Arduino.

Example :Programming language—blinking a single LED

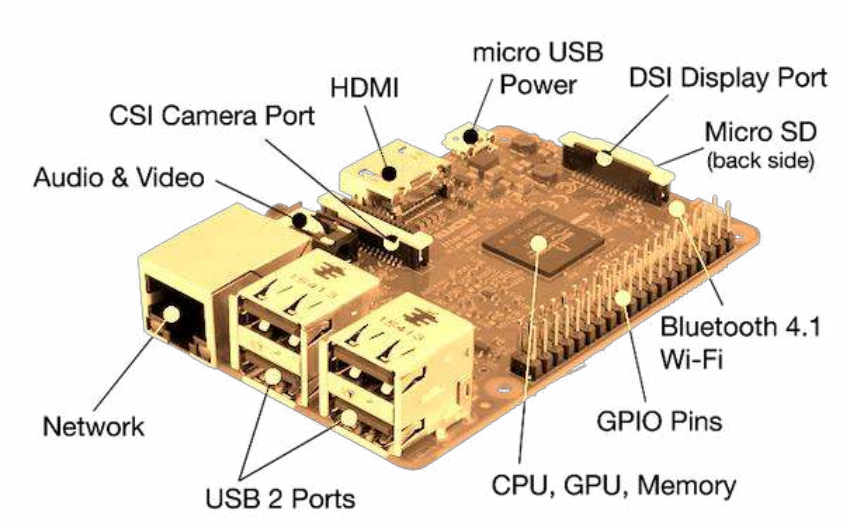
```
// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;
// the setup routine runs once when you press reset:
void setup() {
// initialize the digital pin as an output.
pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
digitalWrite(led, HIGH); // turn the LED on
delay(1000); // wait for a second
digitalWrite(led, LOW); // turn the LED off
delay(1000); // wait for a second
}
```

2.9 RASPBERRY Pi

- ➢ Raspberry Pi is a low cost credit card sized single board computer developed by Raspberry Pi foundation.
- ➢ It combined the power of a PC with the I/O strengths of a microcontroller.
- ➢ It runs on Linux platform with Python,Java, C++ programming languages
- ➢ The board features USB ports for keyboard and mouse, a HDMI port for display and Ethernet port for wired internet connectivity.
- ➢ It has on board WiFi and Bluetooth capabilities.
- ➢ "Raspbian" is the computer operating system used for Raspberry Pi and this OS can be downloaded from the website www.raspberrypi.org
- ➢ Several generations Raspberry Pi has been released. Presently Raspberry Pi 3 is being used widely.

Components of Raspberry Pi



The major components of Raspberry Pi board are as follows:

1. Processor
2. GPIO
3. DSI Display board
4. CSI Camera port
5. MicroSD slot
6. HDMI output port
7. USB ports
8. Ethernet Port
9. On board Bluetooth 4.1 WiFi
10. Micro USB power

1. **Processor –** It is equipped with a quad-core 64 bit Broadcom BCM2837 ARM SoC processor running at 1.2 GHz with 1 GB RAM
2. **GPIO –** GPIO stand for General Purpose Input/Output. These pins are a physical interface between the Raspberry Pi and the outside the World. These pins can be used to control LEDs, run motors etc., There are 40 GPIO pins on the board and they provide various functions.
3. **DSI Display board -** The DSI (Display Serial Interface) display port allows the Raspberry Pi to connect to a serial display similar to those used in tablets. Such display modules are available with touch controls and in common sizes such as 7 inches.
4. **CSI Camera port -** The CSI (Camera Serial Interface) camera port is a connector that allows the Raspberry Pi to connect to a Raspberry Pi camera module. Generic web cameras will not work as they commonly have only a USB connector.

5. **MicroSD slot -** This slot is used to house the microSD card that holds the Raspberry Pi operating system namely Raspbian. The microSD card does not come with the Pi. This SD card also holds all files, folders, documents, and pictures created by the user. It is essentially the hard drive of the computer.
6. **HDMI output port –** High Definition Multimedia Interface output port is compatible with HDMI port of most modern TVs and computer monitors.
7. **USB ports –** It has 4 USB (Universal Serial Bus) ports.These ports can be used to connect USB devices such as mouse, keyboard, network adapaters etc.,
8. **Ethernet port –** It has an Ethernet port connection for wired internet access.
9. **On board Bluetooth 4.1 WiFi –** It comes with on board wireless LAN i.e., WiFi and Bluetooth adapters.So there is often no need for the ethernet connector.
10. **Micro USB power -** Power to the Raspberry Pi can be provided using either a micro USB lead to the micro USB connector (recommended) or 5V can be directly fed into the 5V GPIO pin.

2.10 DIFFERENCES BETWEEN ARDUINO & RASPBERRY PI

S.No	Arduino	Raspberry Pi
1	It is a development board	It is a mini computer
2	It has 2KB RAM and runs at 16 MHz	It has 1GB to 8 GB RAM and runs at 1.5 GHz quad-core
3	It uses Arduino, C,C++languages	It use Python,Java languages
4	It has ATmega328P controller	It has Broadcom BCM2837 ARM SoC processor
5	It is a 8 bit system	It is a64 bit system
6	It has 6 analog pins	It does not have analog pins
7	It has 14 Digital I/O pins	It has 40 GPIO pins
8	It has one USB port	It has 4 USB ports
9	Does not have Camera port & HDMI port	CSI camera port & HDMI interface is available
10	It does not have Ethernet port for wired internet connection.	It has Ethernet port.
11	It has no on board Bluetooth /WiFi modules	It has on board Bluetooth/WiFi modules
12	It does not require operating system	It is based on Raspbian OS
13	It can provide onboard storage	It doesn't have on board storage but it provides an SD card port.
14	It consumes less power (50mA)	It consumes 700 mA power
15	It is a low cost hardware (Rs.1000/- to 1500/-)	Cost is higher than Arduino (Rs.3000/- to Rs 5000/-)
16	This board is used Embedded applications, Interfacing sensors & actuators, Building simple projects & circuits, Development of automation system etc.,	This board is used General PC/Educational projects, Machine learning/Computer vision. Gaming machines, Control a Robot, Learning to code etc.,

2.11 MOBILE PHONES & TABLETS

- A mobile phone, cellular phone, cell phone, or hand phone, sometimes shortened to simply mobile, cell or just phone, is a portable telephone that can make and receive calls over a radio frequency link while the user is moving within a telephone service area.
- A phone will have the access to a cellular radio system, so it can be used over a wide area, without a physical connection to a network.
- A tablet computer, commonly shortened to tablet, is a mobile device, typically with a mobile operating system and touch screen display processing circuitry, and a rechargeable battery in a single, thin and flat package.
- Tablets are almost like a computer but with lack of some input/output (I/O) abilities that others have.
- Modern tablets largely resemble modern smart phones, the only differences being that tablets are relatively larger than smart phones, with screens 7 inches (18 cm) or larger, measured diagonally.
- "Tablets are portable, while smart phones are pocketable "
- Mobile phones are also the most personal devices we use, while tablets are often shared with spouses, partners, or children."

2.12 SENSORS IN SMART PHONES

1. Accelerometer - It can detect Tilt or Orientation of the Phone. It can also detect Vibration and Acceleration. It helps to determine whether the phone is in portrait or landscape orientation. This sensor can also detect if the display of the phone is in upward or downward position. It also detects movement of the phone in any given direction.

2. Air Humidity Sensors – This sensor is not very popular at present but it will surely be used by most popular mobile phone brands in the near Future. This sensor can measure humidity in air. This data can be used in several useful ways.

3. Ambient Light Sensors – This Sensor detects the Light or Brightness to automatically adjust Brightness of the Display. It is used when we put on Phone in Auto Brightness Mode/ adaptive brightness display mode.

4. Barcode / QR Code Sensors – These Sensors can read Barcodes on Product Packaging and QR Codes. Most modern smart phone manufacturers install this Sensor.

5. Barometer - This sensor can measure Air Pressure that can be useful in several ways such as studying Weather and Altitude Change. Only High-End and Expensive Phones have these Sensors.

6. Fingerprint Sensors - The Fingerprint Sensor has become very common in most modern mobile phones. It is generally found at the back of the Smartphone and sometimes in the front bottom. Some manufacturers have also started to install it in-display itself. The Fingerprint sensor can read and stored biometric data of our fingers and can be used to unlock the phone thus replacing the use of any password or pattern.

7. GPS - Global Positioning System is also very common and popular is most modern phones. It helps to locate the location on Earth and helps in Navigation. Popular Services like Ola, Uber, Zomato and Swiggy use GPS Feature.

8. Gyroscope - The Gyroscope can detect orientation, rotation and direction of the phone very precisely. Many popular gaming apps use this feature of the gyroscope sensor.

9. Hall Sensor - The Hall sensor can detect magnetic field. This feature is used to Sleep and Wake the Phone when a Flip Cover is used.

10. Magnetometer - The Magnetometer is what acts as the compass in our Smartphone. This sensor detects magnetic field and can easily determine the direction of the North Pole. It can also detect metal. It is used in Maps, Compass, Navigation Apps and Metal detector apps.

11. Proximity Sensor - The proximity sensor can detect distance of the phone from our skin or any other object. This feature is used to disable the Touch screen when we receive a Phone Call and the phone is held near our Ear.

12. Thermometer - The thermometer in a Smartphone monitors temperature of the device and the battery. It is used to display the Temperature of the device and Environment. It is also used to shutdown the device in case of Overheating to prevent any damage

13. Touch screen Sensors - The Touch screen sensor is used to input data in the phone.

14. Pedometer Sensor- In some of the expensive phones, this sensor will be available. This is used for maintaining health and fitness. The user's walking motion will be detected and then analyzes the signal, calculates walking distance and calories burned and provides real time feedback to the user.

15. Heart rate sensor – Smart phones having in built health apps will have this sensors. This sensor measures the heart rate in BPM (Beats Per Minute), stress levels, oxygen level in the blood like pulse oximeter.

Question Bank

Unit II – Embedded Devices in IoT

2 Marks Questions

1. What is embedded system in IoT?
2. Are embedded computers found in IoT devices? Justify.
3. What is Raspberry Pi?
4. What is the role of Arduino in IoT projects?
5. List any two examples for embedded devices.
6. Define plug computing.
7. What is the difference between microcontroller and microprocessor
8. List the factors while selecting the platform for IoT.
9. Give the list of sensors in smart phone.
10. Draw the layout indicating sensor (smoke) to actuator(sprinkler) flow of a fire safety system in a building

10 Mark Questions

1. What is an Arduino and explain the architecture/components with neat sketch.
2. Write down the various features of Arduino.
3. Develop a simple application using Arduino.
4. Write about prototyping embedded devices.
5. Explain the functions of the components in Rasperrry Pi.
6. Illustrate the design issues for Raspberry Pi interfaces.
7. Construct the design of smart home with Raspberry Pi and other hardware devices with neat sketch.
8. Explain the procedure to build IoT with Raspberry Pi. What are the physical devices and end points?
9. Give the differences between Arduino & Raspberry Pi in detail.
10. Explain Microcontroller and Microprocessor and give the examples.