Unit-3: Sensors and Hardware for IoT

- Sensors and Classifications of sensors,
- Actuators, Transducers,
- IoT sensor Development Boards and classifications,
- Basics of wireless networks,
- Wi-Fi libraries
- Introduction to node MCU, block diagram.

Questions to be discussed:

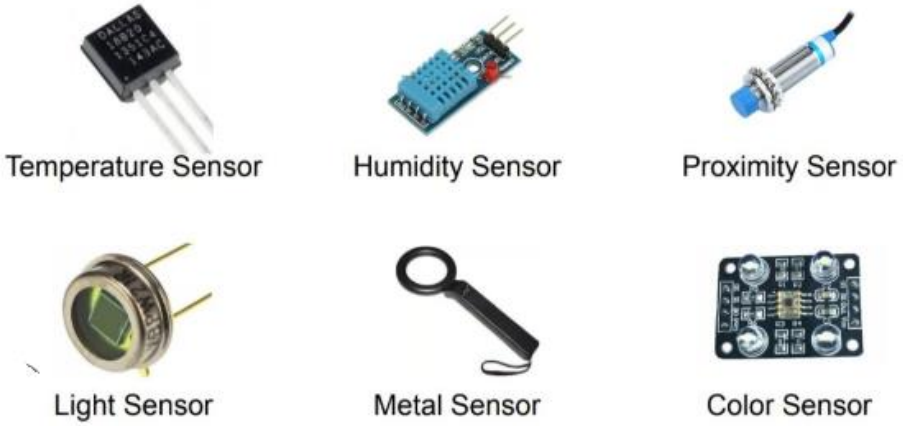
1. What do you mean by sensors? Explain different types of sensor in brief.
2. Differentiate between sensor and actuator?
3. What is sensor IOT development board? Discuss its type in brief.
4. Discuss about wireless network. What are advantages of wireless network?
5. Explain in brief about Node MCU. Also write the features of it.
6. Write short notes on:
   a. Actuators
   b. Transducer
   c. Wi-Fi Library

What are sensors?

- Sensors or transducers represent physical devices that convert one form of energy into another.
- Sensors are such devices which are used to convert physical quantities into the electrical signals for the purpose of monitoring and controlling.
- So sensor takes input from environment and converts into electrical form then controller the system.
- Sensor works as an input device.
- Sensors convert a physical device into an electrical impulse to take the desired action.
- Example: Thermocouple, photo cell, RTD, LVDT, strain gauge, Load cell etc.

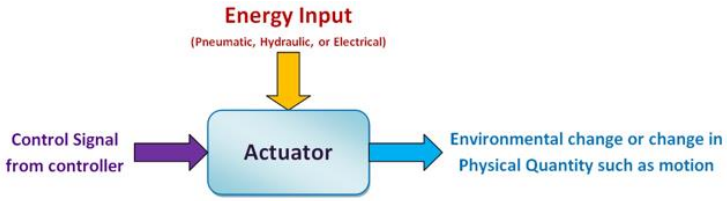
Types of Sensors:

1. **Temperature**: The temperate sensor records the amount of heat in a given setting.
2. **Moisture**: The moisture sensors record the amount of humidity.
3. **Light**: Light sensors record the ambient light. In your smartphone, when the brightness is adjusted according to the exposure to light.
4. **Motion**: Motion sensors are usually installed in security systems and help detect unauthorized activity.
5. **Proximity**: Motion sensors and proximity sensors can be kept in the same basket, as the majority of their functions are similar.
6. **Gyroscope**: These sensors are used to measure the velocity of a moving object.



What are Actuators?

- Actuators are such devices which deliver physical quantity (like force or motion) to the environment by converting source energy according to control signal received that can be in electrical form.
- They convert electrical impulses into physical actions or objects.
- In the light example, as the sensor is reading the brightness of the light by converting it into an electrical signal, an actuator takes action according to the desired setting.
- So here, it will decrease or increase the light brightness according to the set parameters.
- Actuator acts as output device.
- Examples: Electric motor actuator, heaters, electro-hydraulic actuator, magnetic actuator etc.



Difference between sensor and actuator:

Sensor	Actuator
Sensor converts physical quantities and characteristics into electrical signals.	Actuator converts electrical signals into physical action such as force and motion.
It acts as an input device in any control system.	It acts as an output device in a control system.
Sensor takes input from environment.	Actuator takes input from output signal.
Sensor gives output to input signal conditioning unit of system to convert into electrical form.	It gives output to environment and makes impact on load to control parameters.
It gives information to the system about environment condition to monitor and control.	It accepts command from system to deliver physical action.
Sensors are often used to measure pressure, temperature, fluid levels, vibration, speed etc.	Actuators are often used to operate control valves, dampers, guide vanes, and to move objects from one place to another, to move conveyor belts in robotic arms movement etc.
Examples: Thermocouple, photo cell, RTD, LVDT, strain gauge, Load cell, PH meter etc	Examples: motor actuator, servo motor, heaters, electro-hydraulic actuator, magnetic actuator etc

- ✓ RTD (Resistance Temperature Detector)
- ✓ LVDT is an acronym for Linear Variable Differential Transformer.

What is a transducer?

- A transducer is an electronic device that converts energy from one form to another for the purpose of measurement and control."
- The process of converting energy from one form to another is known as transduction.
- Examples: microphones, loudspeakers, thermometers, position and pressure sensors, and antenna.
- A photocells, LEDs, and even common light bulbs are transducers.
- Efficiency is an important consideration in any transducer.
- Transducer efficiency is defined as the ratio of the power output to the total power input.
- Mathematically, if P represents the total power input and Q represents the power output then the efficiency E, is given by:

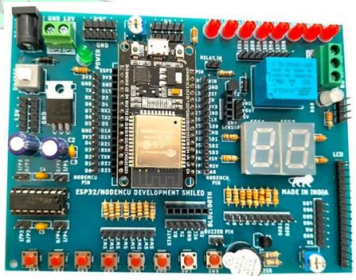
E = Q/P

What are IoT Development Boards?

- A development board is a printed circuit board with circuitry and hardware.
- An IoT development board includes:
  - A programming interface to program the microcontroller from a computer.
  - A power circuit used to provide stable DC power to the microcontroller.
  - Input components: buttons, switches, etc.
  - Output components such as LEDs.
  - Various I/O pins used for compatibility with sensors, motors, screens, and any other components.

Types of IoT Development Board:

1. Microcontroller
2. System-on-Chip
3. Single Board Computers (SBCs)



Microcontroller:

- Microcontroller based boards, usually built with CMOS processes.
- These are used in implants, office machines, power tools, and automotive control systems.

System-on-Chip(SoC):

- SoC boards have more system components integrated into the chip and memory.
- It has audio receivers, PCI, SATA, and USB communication abilities in addition to a microprocessor.
- They allow for higher processing speeds with less microchip power.

Single Board Computers (SBCs):

- It contains all the features of a computer on a single device, including I/O ports, microprocessors, and memory.
- SBCs are usually larger but are more capable and do not need to rely on expansion slots for additional peripheral capabilities.

Wireless Networks:

- Computer networks that are not connected by cables are called wireless networks.
- They generally use radio waves for communication between the network nodes.
- They allow devices to be connected to the network within the network coverage.

Types of Wireless Networks:

1. **Wireless LANs** – Connects two or more network devices using wireless distribution techniques.
2. **Wireless MANs** – Connects two or more wireless LANs spreading over a metropolitan area.
3. **Wireless WANs** – Connects large areas comprising LANs, MANs and personal networks.

Advantages of Wireless Networks:

- It provides clutter-free desks due to the absence of wires and cables.
- It increases the mobility of network devices connected to the system.
- Accessing network devices from any location within the network coverage.
- Installation and setup of wireless networks are easier.
- New devices can be easily connected to the existing setup.
- Wireless networks require no wires so, it reduces the setup costs.

Examples of wireless networks:

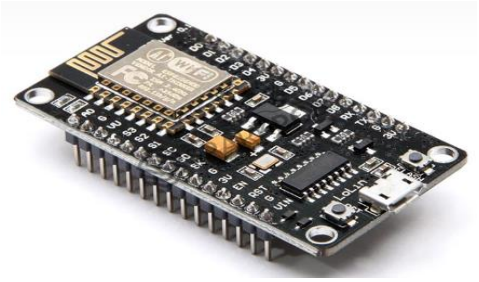
- Mobile phone networks
- Wireless sensor networks
- Satellite communication networks
- Terrestrial microwave networks

Wi-Fi library:

- It enabled boards can use the Wi-Fi library to connect to the internet.
- It can serve as either a server accepting incoming connections or a client making outgoing ones.
- The library supports WEP and WPA2 Personal encryption, but not WPA2 Enterprise.
- The Wi-Fi library is very similar to the Ethernet library, and many of the function calls are the same.

What is Node MCU?

- MCU stands for microcontroller unit.
- Node MCU is an open source IoT platform.
- Most people call **ESP8266** as a **WIFI module**, but it is actually a **microcontroller**.
- ESP8266 is the name of the microcontroller developed by Espressif Systems which is a company.
- This microcontroller has the ability to perform WIFI related activities hence it is widely used as a WIFI module.
- The Node MCU platform is a popular choice for creating IoT projects because of its low cost and the simplicity of its hardware.



What are the features of Node MCU?

- Node MCU has 128 KB RAM and 4MB of Flash memory to store data and programs.
- Its high processing power with in-built Wi-Fi/Bluetooth features make it ideal for IoT projects.
- It has better processor and memory:
- Node MCu comes with 80MHz clock speed and 4MB flash memory.
- Built-in TCP/IP Stack - IoT Ready:
- Node MCU has Wi-fi connection and can connect to internet via Wi-fi.
- It is best suited for IoT applications.

ESP8266 Functional Block Diagram