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AMRUTA INSTITUTE OF ENGINEERING & MANAGEMENT SCIENCES
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REPORT ON SKILL ENHANCEMENT LAB
INTERNET OF THINGS (IOT) LAB

PREFACE

This IOT lab is intended to teach the design and analysis of IOT systems. To introduce the terminology, technology and its applications of IOT. To introduce the Raspberry PI platform, that is widely used in IoT applications. To introduce the implementation of web-based services on IoT devices. The manual contains the exercise programs and their solution for easy & quick understanding of the students. We hope that this practical manual will be helpful for students of CSE,ECE,ISE branches for understanding the subject from the point of view of applied aspects

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ABOUT THE DEPARTMENT

Vision:

Empowering the students by giving exposure on current technologies, multiple research and innovation for developing dependable technologies and socially responsible engineers in the field of Electronics and Communication Engineering.

Mission:

1. Providing strong conceptual based teaching learning methodology to achieve excellent skill sets in design and develop.

2. Impart knowledge in emerging areas through Industry interactions, technical talks and seminars.

3. Motivating graduates to become entrepreneurs.

4. By imbibing human values and ethics to make them socially responsible professionals.

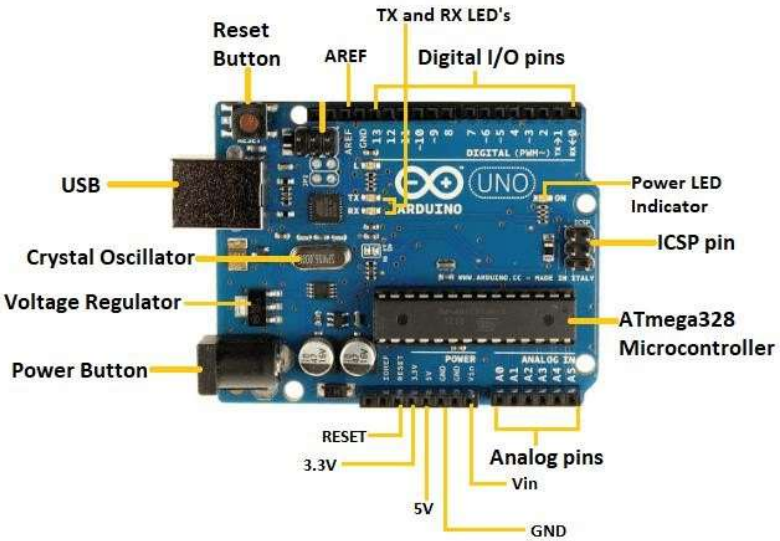
LIST OF EXPERIMENTS

Sl No	List of Experiments
	Introduction to Arduino board & Sensors
	Part-A
1	Turning LED On/Off using Arduino
2	Turning Multiple LED On/Off using Arduino
3	Interfacing Switch (push button)-LED using Arduino
4	Ultrasonic Sensor using Arduino
5	Ultrasonic Sensor-LED Interface using Arduino
6	DC motor for Fan control using IR sensor using Arduino
7	Door Sensor using Arduino
8	Touch Sensor using Arduino
	Part-B
9	LCD Display using Arduino
10	Moisture Sensor using Arduino
11	Flame Sensor using Arduino
12	LDR Sensor using Arduino
13	Humidity Sensor using Arduino
14	Smoke sensor using Arduino
15	Water level sensor using Arduino

Year	Course Name	No. of participants
2023-2024	Internet of Things (IOT) lab	63 (ISE) + 50 (ECE+CE+ME)

Arduino

Arduino is an open-source electronics platform based on easy-to-use hardware and software. 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. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), basedon Processing.



Arduino Uno Board

The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Arduino also simplifies the process of working with microcontrollers.

Power USB

Arduino board can be powered by using the USB cable from your computer. All you need to do isconnect the USB cable to the USB connection

Power button

Arduino boards can be powered directly from the AC mains power supply by connecting it to the Jackof Power button.

Voltage Regulator

The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used by the processor and other elements.

Crystal Oscillator

The crystal oscillator helps Arduino in dealing with time issues. How does Arduino calculate t ime? Theanswer is, by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHz.

Arduino Reset

You can reset your Arduino board, i.e., start your program from the beginning. You can reset the UNO board in two ways. First, by using the reset button on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET

AREF

AREF stands for Analog Reference. It is sometimes, used to set an external reference voltage(between 0 and 5 Volts) as the upper limit for the analog input pins.

TX and RX LEDs

On your board, you will find two labels: TX (transmit) and RX (receive). They appear in two places on the Arduino UNO board. First, at the digital pins 0 and 1, to indicate the pins responsible for serial communication. Second, the TX and RX led. The TX led flashes with different speed while sending the serial data. The speed of flashing depends on the baud rate used by the board. RX flashes during the receiving process.

Digital I/O

The Arduino UNO board has 14 digital I/O pins (of which 6 provide PWM (Pulse Width Modulation) output. These pins can be configured to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relays, etc. The pins labeled “~” can be usedto generate PWM.

Power LED indicator

This LED should light up when you plug your Arduino into a power source to indicate that your board is powered up correctly. If this light does not turn on, then there is something wrong with the connection.

ICSP pin

Mostly, ICSP is a tiny programming header for the Arduino consisting of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (Serial Peripheral Interface), which could be consideredas an "expansion" of the output. Actually, you are slaving the output device to the master of the SPIbus.

Analog pins

The Arduino UNO board has six analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.

Pins (3.3, 5, GND, Vin)

- 3.3V (6) − Supply 3.3 output volt
- 5V (7) − Supply 5 output volt
- Most of the components used with Arduino board works fine with 3.3 volt and 5 volt.
- GND (8) (Ground) − There are several GND pins on the Arduino, any of which can be used toground your circuit.
- Vin (9) − This pin also can be used to power the Arduino board from an external power source,like AC mains power supply.

Main microcontroller

Each Arduino board has its own microcontroller. You can assume it as the brain of your board. The main IC (integrated circuit) on the Arduino is slightly different from board to board. The microcontrollers are usually of the ATMEL Company. You must know what IC your board has before loading up a new program from the Arduino IDE.

It offers some advantages over other systems:

- **Inexpensive**
- **Cross-platform**
- **Simple, clear programming environment**
- **Open source and extensible software**
- **Open source and extensible hardware**

Arduino UNO board is used in the following applications.

- Weighing Machines.
- Traffic Light Count Down Timer.
- Parking Lot Counter.
- Embedded systems.
- Home Automation.
- Industrial Automation.
- Medical Instrument.
- Emergency Light for Railways.

After learning about the main parts of the Arduino UNO board, we are ready to learn how to set up theArduino IDE. Once we learn this, we will be ready to upload our program on the Arduino board.

In this section, we will learn in easy steps, how to set up the Arduino IDE on our computer and preparethe board to receive the program via USB cable.

Step 1 − First you must have your Arduino board and a USB cable. In case you use Arduino

UNO, Nano,Arduino Mega 2560, or Diecimila, you will need a standard USB cable (A plug to B plug), the kind youwould connect to a USB printer as shown in the following image.

Step 2 − Download Arduino IDE Software.

You can get different versions of Arduino IDE from the Download page on the Arduino Official website.You must select your software, which is compatible with your operating system (Windows, IOS, or Linux). After your file download is complete, unzip the file.

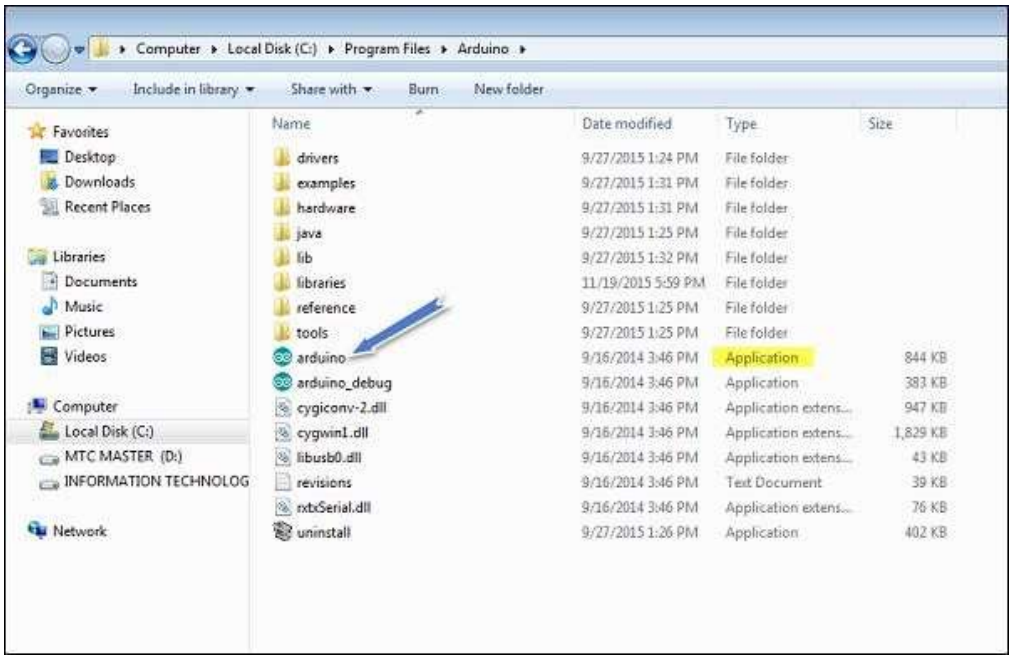
Step 3 − Power up your board.

The Arduino Uno, Mega, Duemilanove and Arduino Nano automatically draw power from either, the USB connection to the computer or an external power supply. If you are using an Arduino Diecimila, you have to make sure that the board is configured to draw power from the USB connection. The power sourceis selected with a jumper, a small piece of plastic that fits onto two of the three pins between the USB andpower jacks. Check that it is on the two pins closest to the USB port.

Connect the Arduino board to your computer using the USB cable. The green power LED (labeled PWR)should glow.

Step 4 − Launch Arduino IDE.

After your Arduino IDE software is downloaded, you need to unzip the folder. Inside the folder, you canfind the application icon with an infinity label (application.exe). Double-click the icon to start the IDE.



Step 5 − Open your first project.

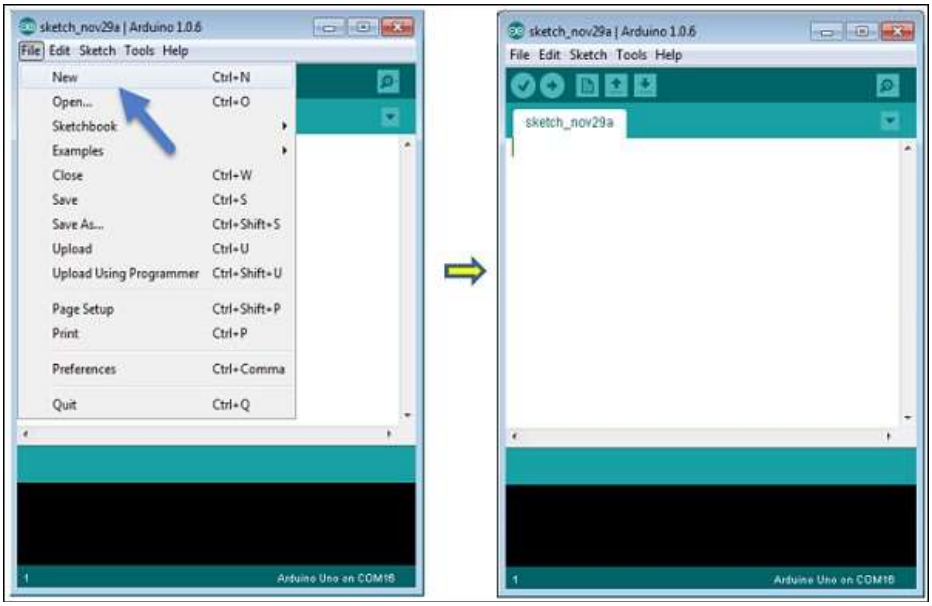
Once the software starts, you have two options −

- Create a new project.
- Open an existing

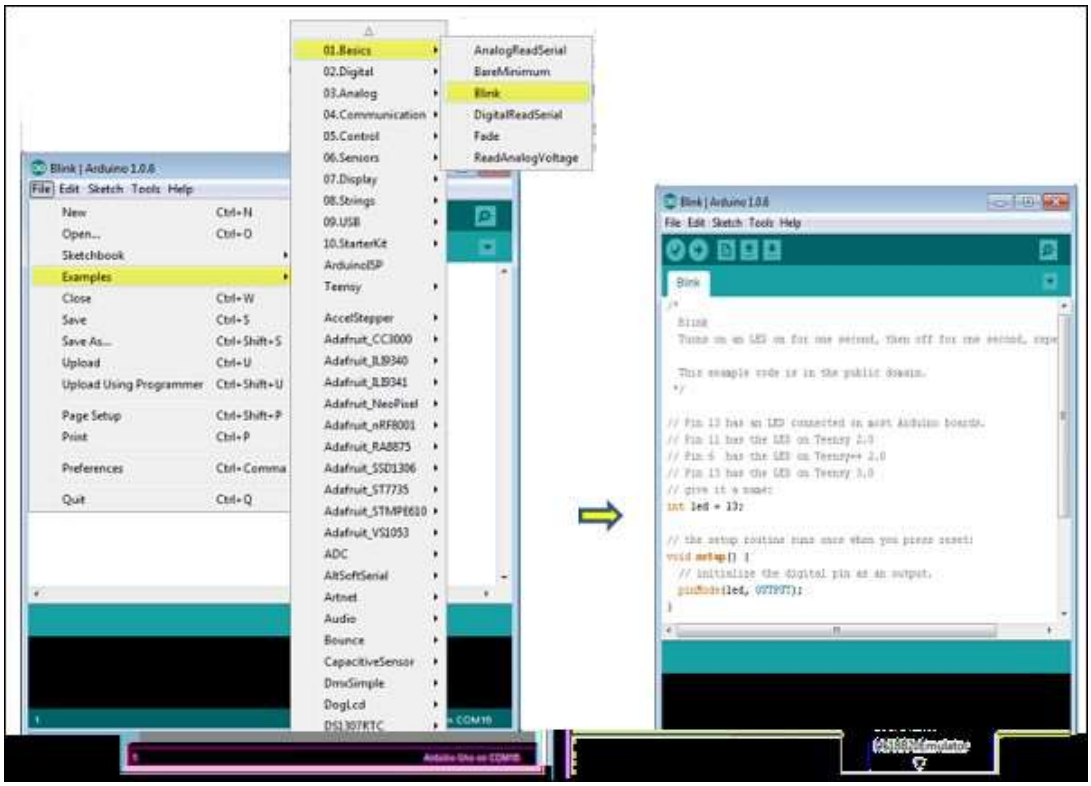
project example. To create a

new project, select File →

New.



To open an existing project example, select File → Example → Basics → Blink.

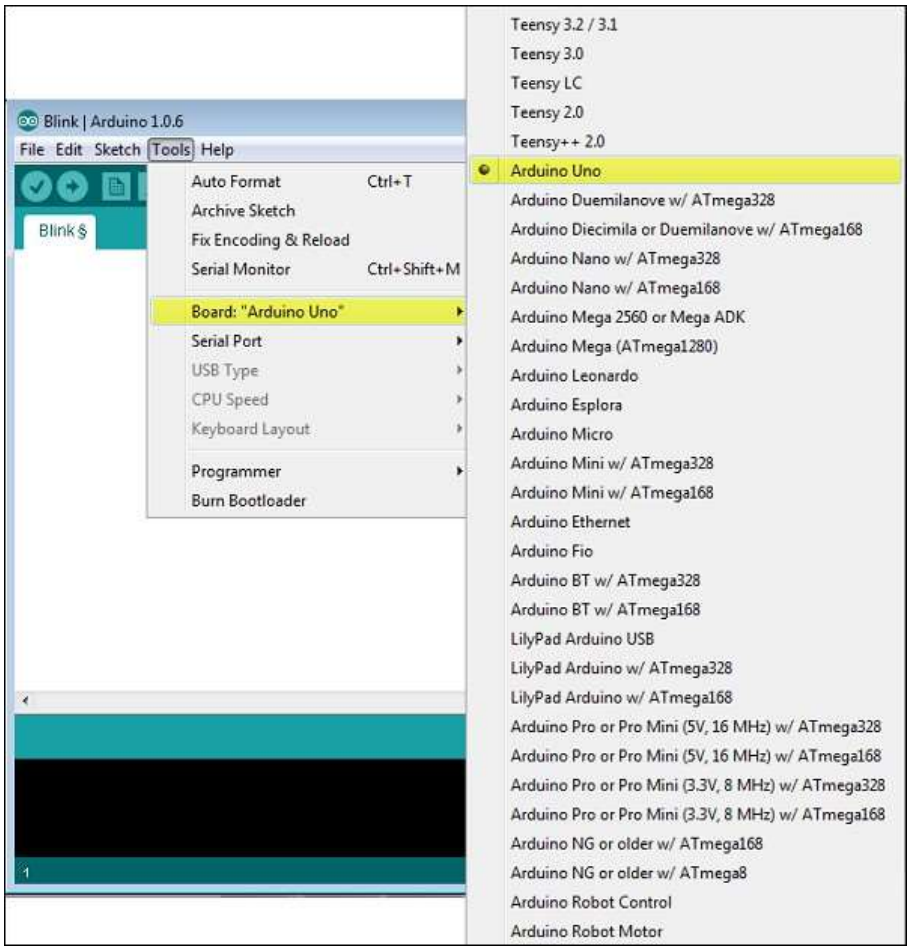


we are selecting just one of the examples with the name Blink. It turns the LED on and off with sometime delay. You can select any other example from the list.

Step 6 − Select your Arduino board.

To avoid any error while uploading your program to the board, you must select the correct Arduino boardname, which matches with the board connected to your computer.

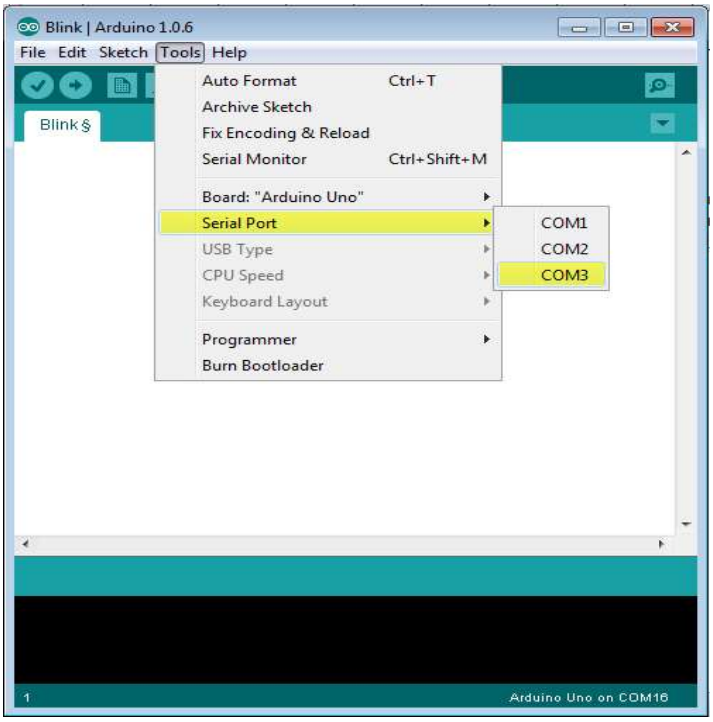
Go to Tools → Board and select your board.



Here, we have selected Arduino Uno board according to our tutorial, but you must select the name matching the board that you are using.

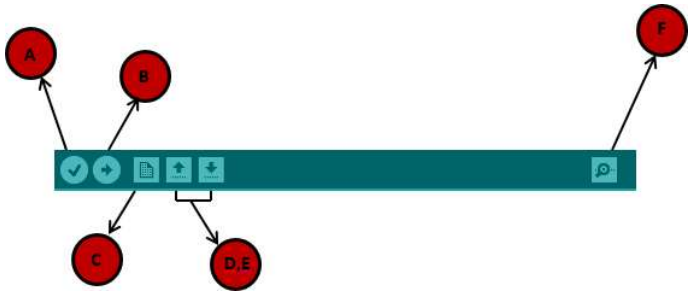
Step 7 − Select your serial port.

Select the serial device of the Arduino board. Go to Tools → Serial Port menu. This is likely to be COM3or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out, you can disconnect your Arduino board and re-open the menu, the entry that disappears should be of the Arduinoboard. Reconnect the board and select that serial port.



Step 8 − Upload the program to your board.

Before explaining how we can upload our program to the board, we must demonstrate the function ofeach symbol appearing in the Arduino IDE toolbar.



A − Used to check if there is any compilation error. B − Used to upload a program to the Arduino board.C − Shortcut used to create a new sketch. D − Used to directly open one of the example sketch.E − Used to save your sketch.

F − Serial monitor used to receive serial data from the board and send the serial data to the board.

Now, simply click the "Upload" button in the environment. Wait a few seconds; you will see the RX and TX LEDs on the board, flashing. If the upload is successful, the message "Done uploading" will appear in the status bar.

Note − If you have an Arduino Mini, NG, or other board, you need to press the reset button physically on the board, immediately before clicking the upload button on the Arduino Software.

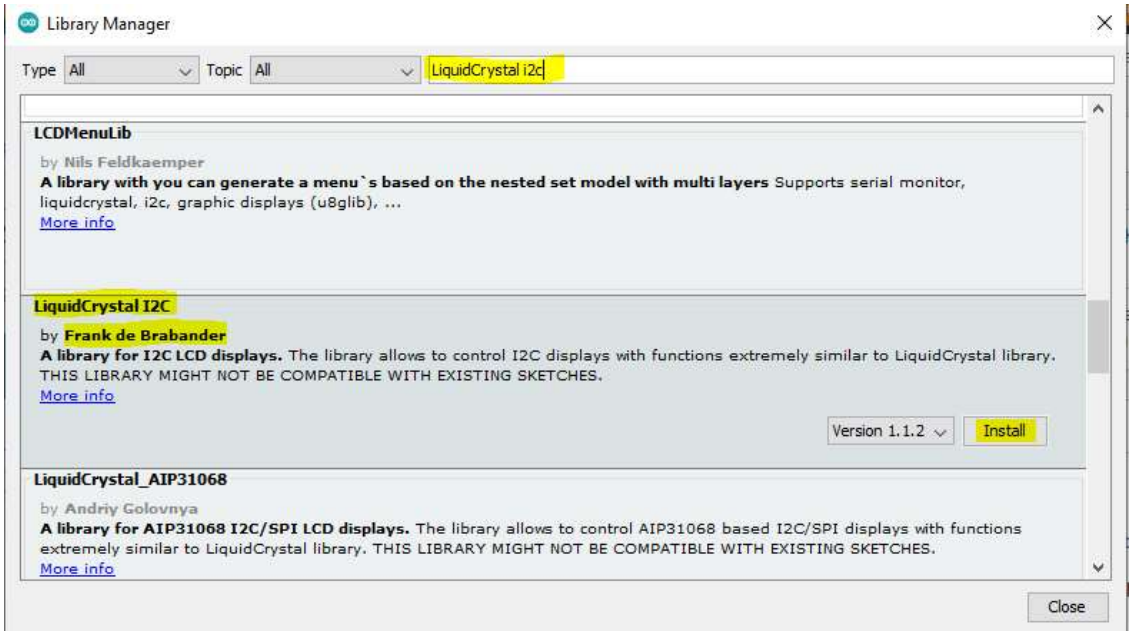
What are Libraries?

Libraries are a collection of code that makes it easy for you to connect to a sensor, display, module,etc. For example, the Liquid Crystal I2C library makes it easy to talk to character LCD displays.

There are thousands of libraries available for download directly through the Arduino IDE, and you canfind all of them listed at the Arduino Library Reference.

Installing Libraries

This library should be already downloaded to the Arduino IDE. Go to the Sketch menu >> Include Library >> Library Manager. In the top right text box, type in LiquidCrystal I2C then look for the LiquidCrystal I2C Library. Once you find the library click on it, select the latest version and hit install. Wait for the IDE to install the new library. Downloading may take time depending on your connection speed. Once it has finished, an *Installed* tag should appear.



Downloading may take time depending on your connection speed. Once it has finished, an *Installed* tagshould appear.

Sensors and Actuators

We live in a World of Sensors. You can find different types of Sensors in our homes, offices, cars etc. working to make our lives easier by turning on the lights by detecting our presence, adjusting the room temperature, detect smoke or fire, make us delicious coffee, open garage doors as soon as our car is nearthe door and many other tasks. All these and many other automation tasks are possible because of Sensors.

Sensors-A sensor is a device that measures physical input from its environment and converts it into data (electrical quantity) that can be interpreted by either a human or a machine.

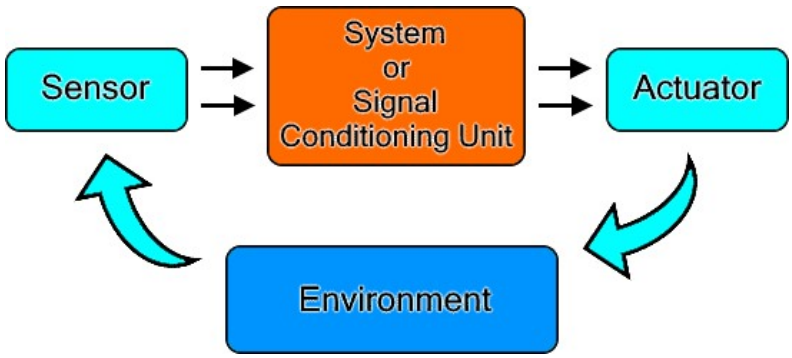


Fig:Sensors and actuators block diagram

Actuators-An actuator is a part of a device or machine that helps it to achieve physical movements by converting energy, often electrical, air, or hydraulic, into mechanical force. Actuators are present in almost every machine around us, from simple electronic access control systems, the vibrator on your mobile phone and household appliances to vehicles, industrial devices, and robots. Common examples of actuators include electric motors, stepper motors, jackscrews, electric muscular stimulators in robots, etc.

Classification of Sensors

In the first classification of the sensors, they are divided in to Active and Passive. Active Sensors are those which require an external excitation signal or a power signal. Passive Sensors, on the other hand, do not require any external power signal and directly generates output response.

The other type of classification is based on the means of detection used in the sensor. Some of the meansof detection are Electric, Biological, Chemical, and Radioactive etc.

The next classification is based on conversion phenomenon i.e., the input and the output. Some of the common conversion phenomena are Photoelectric, Thermoelectric, Electrochemical, Electromagnetic, Thermo-optic, etc.

The final classification of the sensors are Analog and Digital Sensors. Analog Sensors produce an analog output i.e., a continuous output signal (usually voltage but sometimes other quantities like Resistance etc.) with respect to the quantity being measured. Digital Sensors, in contrast to Analog Sensors, work with discrete or digital data. The data in digital sensors, which is used for conversion and transmission, is digital in nature.

Different Types of Sensors

The following is a list of different types of sensors that are commonly used in various applications. All these sensors are used for measuring one of the physical properties like Temperature, Resistance, Capacitance, Conduction, Heat Transfer etc.

1. Temperature Sensor
2. Proximity Sensor
3. Accelerometer
4. IR Sensor (Infrared Sensor)
5. Pressure Sensor
6. Light Sensor
7. Ultrasonic Sensor
8. Smoke, Gas and Alcohol Sensor
9. Touch Sensor

10. Humidity Sensor
11. Solar cell sensor
12. Metal detector sensor
13. Soil Moisture Sensor
14. Heartbeat Sensor
15. Microphone (Sound Sensor)
16. Tilt Sensor
17. Water Flow and Level Sensor
18. PIR (passive infrared)Sensor
19. Rain Sensor
20. Oil moisture Sensor
21. Real time clock Sensor
22. Vibration Sensor


Humidity Sensor
Flex Sensor
Touch Sensor
Solar Cell Light Sensor
Metal Dedector
Real Time Clock Sensor
Vibration Sensor
Thermistor (Temperature Sensor)
IR Sensor (Transmissive Type)
IR sensor
Ultrasonic sensor
Gyroscope Sensor
Accelerometer Sensor
Color Sensor
PIR Sensor
Gas Sensor
smoke sensor
LM35
Temperature Sensor
IR Receiver
LDR (Light Sensor)
Rain Sensor
Soil Moisture
Phototransistor
Water Flow Sensor
hearbeat sensor
Alcohol Sensor

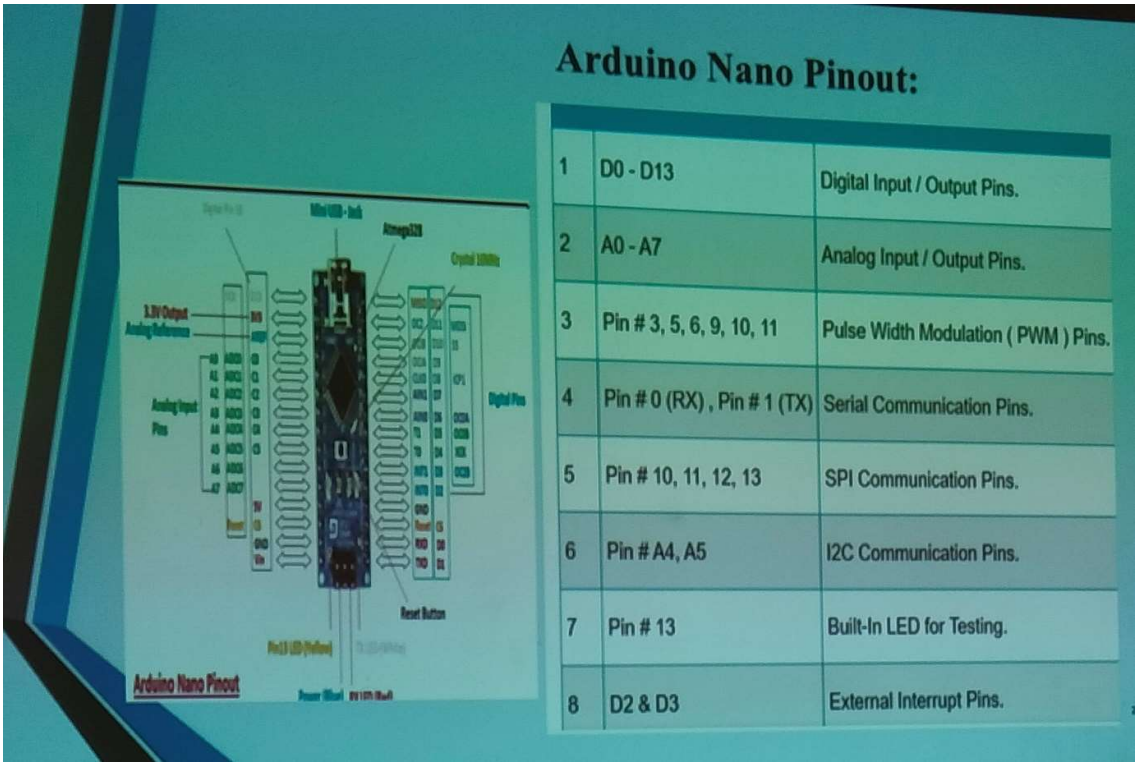
COURSE OUTCOMES:

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

No.	DESCRIPTION
CO1	Understand internet of Things and its hardware and software components
CO2	Interface I/O devices, sensors & communication modules
CO3	Remotely monitor data and control devices
CO4	Develop real life IoT based projects

GALLERY


Arduino Nano Pinout:
Arduino Nano Pinout
1 D0 - D13 Digital Input / Output Pins.
2 A0 - A7 Analog Input / Output Pins.
3 Pin # 3, 5, 6, 9, 10, 11 Pulse Width Modulation (PWM) Pins.
4 Pin # 0 (RX) , Pin # 1 (TX) Serial Communication Pins.
5 Pin # 10, 11, 12, 13 SPI Communication Pins.
6 Pin # A4, A5 I2C Communication Pins.
7 Pin # 13 Built-In LED for Testing.
8 D2 & D3 External Interrupt Pins.

IDEs, debuggers and tools for IoT programming

- **Eclipse IOT project (Kura)** - This is a **Java-based development framework for IoT applications.**
- **Arduino IDE** - This IDE includes support for the **C and C++ programming languages** for programmable microcontrollers. It's a complete package with many examples and pre-loaded libraries.
- **Raspbian** - This IDE comes with many packages and examples created specifically for the Raspberry Pi boards.
- **OpenSCADA** - This project is a part of Eclipse IOT Industry Working Group along with Eclipse SCADA (Supervisory Control and Data Acquisition). It provides several libraries, interface apps, and configuration tools.
- **PlatformIO** - This is a cross-platform IDE that supports over 400 embedded boards, and several development platforms and frameworks.
- **Macchina.io** - This is a toolkit for building embedded applications for IoT using **POCO C++ libraries and the V8 JavaScript engine**. The core is implemented in **C++. JavaScript is used for application development**. It enables dynamically extensible modular applications using the plug-in and services model similar to OSGi in Java.