2020-21 Onwards (MR-20)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	B.Tech. IV Semester		
Code: A6903	Internet of Things Fundamentals Lab	L	T	P
Credits: 1.5		-	-	3

List of Programs:

1. Introduction to various sensors and various actuators & its Application (Students have to prepare Report for the same). Perform Experiment using Arduino Uno to measure the distance of any object using Ultrasonic Sensor.
   a) PIR Motion Sensor.
   b) Rain Drop Sensor.
   c) Moisture Sensor.
   d) Temperature Sensor.
   e) Touch Sensor.
   f) Infrared Sensor.
   g) Servo Moto.
   h) RFID Sensor.
   i) Bluetooth Module.
   j) Wi-Fi Module.

1. A)

The Sensors are devices that respond to a physical stimulus heat, light, sound, pressure, magnetism, motion, etc, and convert that into an electrical signal. They perform an input function. The Devices which perform an output function are generally called Actuators and are used to control. Both sensors and actuators are collectively known as Transducers. Transducers are devices used to convert energy of one kind into energy of another kind.

a) PIR Motion Sensor:

A motion detector is an electronic device which is used to detect the physical movement (motion) in a given area and it transforms motion into an electrical signals. It detects motion of any object or motion of human beings.

b) Rain Drop Sensor:

Raindrop sensor is basically a board on which nickel is coated in the form of lines. It works on the principal of resistance. Rain Sensor module allows to measure moisture via analog output pins and it provides a digital output when a threshold of moisture exceeds.

c) Moisture Sensor:

The Soil Moisture Sensor measures soil moisture grace to the changes in electrical conductivity of the earth (soil resistance increases with drought). The electrical resistance is measured between the two electrodes of the sensor. A comparator activates a digital output when an adjustable threshold is exceeded.

d) Temperature Sensor:

A device used to measure amount of heat energy that allows to detect a physical change in temperature from a particular source and converts the data for a device or user, is known as a Temperature Sensor.

e) Touch Sensor:

A touch sensor is a type of device that captures and records physical touch or embrace on a device and/or object. It enables a device or object to detect touch or near proximity, typically by a human user or operator. A touch sensor is an electronic sensor used in detecting and recording physical touch. Also known as tactile sensors, it's a small,

simple, low-cost sensor made to replace old mechanical switches we seen in the past.

f) Infrared Sensor:

An infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment. A sensor which measures the physical quantity of light rays and converts it into electrical signals which can be easily readable by user or an electronic instrument/device is called optical sensor as well.

g) Servo Motor:

A servomotor (or servo motor) is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. The main reason behind using a servo is that it provides angular precision, i.e. it will only rotate as much we want and then stop and wait for the next signal to take further action. The servo motor is unlike a standard electric motor which starts turning as when we apply power to it, and the rotation continues until we switch off the power. Servo motor applications are also commonly seen in remote-controlled toy cars for controlling the direction of motion, and it is also very widely used as the motor which moves the tray of a CD or DVD player.

h) RFID Sensor:

A radio frequency identification reader (RFID reader) is a device used to gather information from an RFID tag, which is used to track individual objects. Radio waves are used to transfer data from the tag to a reader. RFID tags are a type of tracking system that uses radio frequency to search, identify, track, and communicate with items and people. Essentially, RFID tags are smart labels that can store a range of information from serial numbers, to a short description, and even pages of data. An RFID system consists of a tiny radio transponder, a radio receiver and transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader.

i) Bluetooth Module:

Bluetooth module which is designed for wireless comunication. This module can be used in a master or slave configuration. It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard and many more consumer applications. It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions. It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data over air. It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

j) WiFi Module:

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all WiFi networking functions from another application processor. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime.

k) Gas & Smoke Sensors:

Gas sensors are specifically used to monitor changes of air quality and detect the presence of various gases. A smoke sensor is a device that senses smoke (airborne particulates & gases) and its level.

l) Level Sensor:

A sensor which is used determining the level or amount of fluids, liquids or other substances that flow in an open or closed system is called Level Sensor.

m) Accelerometer Sensors:

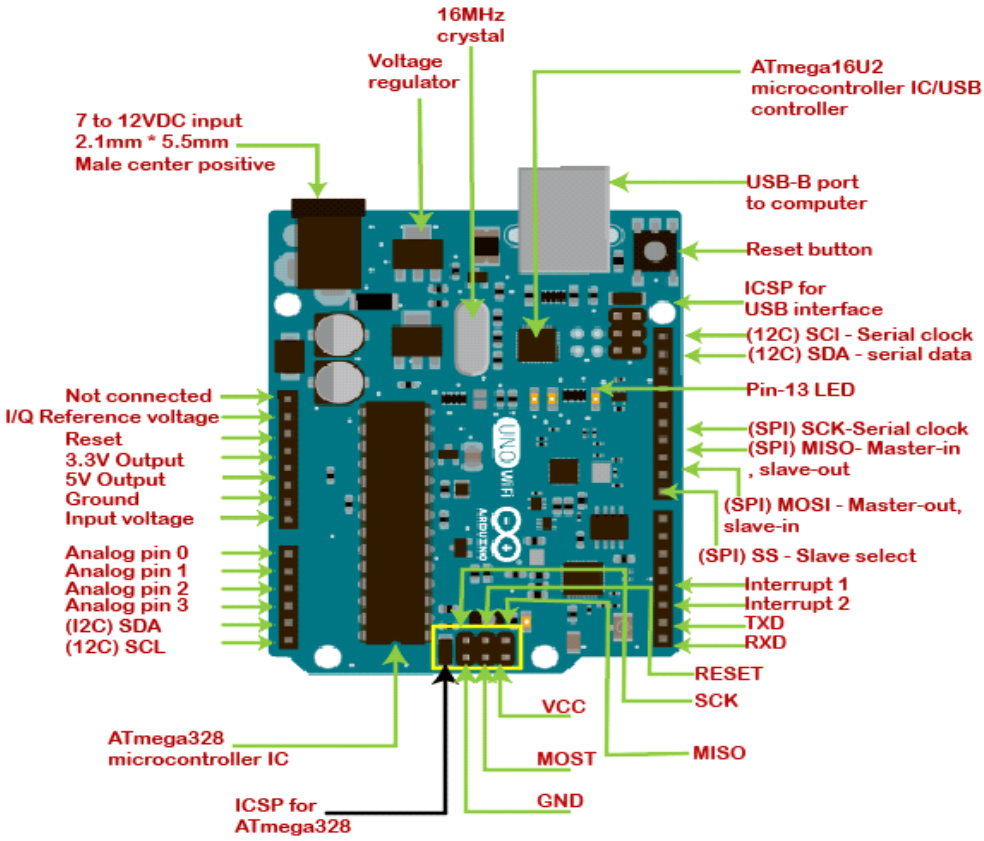
Accelerometer is a transducer that is used to measure the physical or measurable acceleration experienced by an object due to inertial forces and converts the mechanical motion into an electrical output.

2. Demonstrate Arduino and its pins.

Arduino is a platform that makes it easy for you to build projects using electronics. Arduino can also help you easily build IoT projects in two ways: Using traditional Arduino boards and attaching communication breakout modules (like Bluetooth, WiFi, LoRA, GSM, etc) to them. Arduino is a micro controller that can be connected to one or more sensors and help you capture the data or information and then pass it on to processor.

Features of Aurdino:

- Open source based electronic programmable board(micro controller) and software(IDE).
- Accepts analog and digital signals as input and gives desired output.
- No extra hardware required to load a program into the controller board



Arduino UNO:

Feature	Value
Clock speed	16MHz
Operating Voltage	5V
Digital I/O	14
Analog Input	6
PWM	6
UART	1
interface	USB via ATMega16U2

Arduino IDE:

Arduino IDE is an open source that is used to program the arduino controller board. It is based on variations of the C and C++ programming language. It can be downloaded from

arduino's official website and installed into PC.

Download and install the Arduino software (Arduino IDE 1.8.5).

Go to the Arduino website and click the download link to go to the download page. After downloading, locate the downloaded file on the computer and extract the folder from the downloaded file. Copy the folder to a suitable place such as your desktop.

Set Up:

- Power the board by connecting it to a PC via USB cable
- Launch the Arduino IDE
- Set the board type and the port for the board
- Tools-->Board-->select your board
- Tools-->Port-->select your port

Arduino IDE Overview:

- Program coded in Arduino IDE is called a SKETCH
- To create a new sketch
- File-->New
- To open an existing sketch
- File-->open
- There are some basic ready-to-use sketches available in the EXAMPLES section
  File-->Examples-->select any program
- Verify: Checks the code for compilation errors
- Upload: Uploads the final code to the controller board
- New: Creates a new blank sketch with basic structure
- Open: Opens an existing sketch
- Save: Saves the current sketch
- Serial Monitor: Opens the serial console
  All the data printed to the console are displayed here

Sketch Structure:

A sketch can be divided into two parts:

Setup()

Loop()

The function setup() is the point where the code starts, just like the main() function in c and c++ . I/O variables, pin modes are initialized in the Setup() function. Loop() function, as the name suggests, iterates the specified task in the program.

3. Demonstrate NodeMCU and its working and its pins.

The NodeMCU ESP8266 development board comes with the ESP-12E module containing ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports RTOS and operates at 80MHz to 160 MHz adjustable clock frequency. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs. Its high processing power with in-built Wi-Fi / Bluetooth and Deep Sleep Operating features make it ideal for IoT projects. NodeMCU can be powered using Micro USB jack and VIN pin (External Supply Pin). It supports UART, SPI, and I2C interface. The NodeMCU Development Board can be easily programmed with Arduino IDE since it is easy to use. Programming NodeMCU with the Arduino IDE will hardly take 5-10 minutes. All you need is the Arduino IDE, a USB cable and the NodeMCU board itself.

NodeMCU ESP8266 Specifications & Features

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1

- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects
- Power: Micro-USB, 3.3V, GND, Vin

  Micro-USB: NodeMCU can be powered through the USB port

  3.3V: Regulated 3.3V can be supplied to this pin to power the board

  GND: Ground pins

  Vin: External Power Supply
- Control Pins: EN, RST

  The pin and the button resets the microcontroller
- Analog Pin:A0

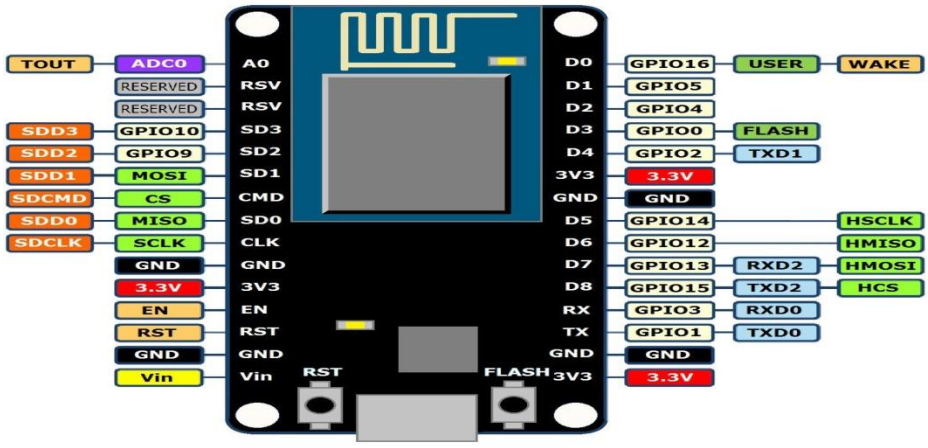
  Used to measure analog voltage in the range of 0-3.3V
- GPIO Pins: GPIO1 to GPIO16

  NodeMCU has 16 general purpose input-output pins on its board
- SPI Pins: SD1, CMD, SD0, CLK

  NodeMCU has four pins available for SPI communication
- UART Pins: TXD0, RXD0, TXD2, RXD2

  NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program
- I2C Pins:

  NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

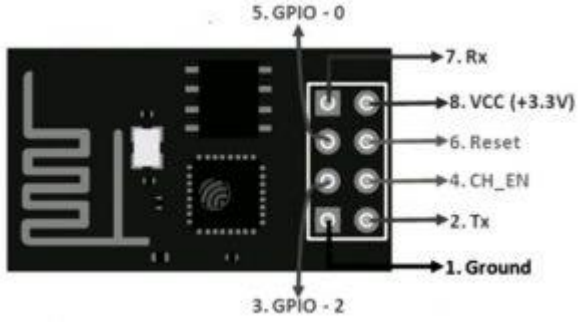


4. Getting Started with ESP8266 Wi-Fi SoC

In 2014, an ESP8266 Wi-Fi module was introduced and developed by third-party manufacturers like AI thinkers, which is mainly utilized for IoT-based embedded applications development. It is capable of handling various functions of the Wi-Fi network from another application processor. It is a SOC (System On-chip) integrated with a TCP/IP protocol stack, which can provide microcontroller access to any type of Wi-Fi network.

An ESP8266 Wi-Fi module is a SOC microchip mainly used for the development of end-point IoT

(Internet of things) applications. It is referred to as a standalone wireless transceiver, available at a very low price. It is used to enable the internet connection to various applications of embedded systems.
The ESP8266 Wi-Fi module is highly integrated with RF balun, power modules, RF transmitter and receiver, analog transmitter and receiver, amplifiers, filters, digital baseband, power modules, external circuitry, and other necessary components.
A set of AT commands are needed by the microcontroller to communicate with the ESP8266 Wi-Fi module. Hence it is developed with AT commands software to allow the Arduino Wi-Fi functionalities, and also allows loading various software to design the own application on the memory and processor of the module. The ESP8266 Wi-Fi module comes with a boot ROM of 64 KB, user data RAM of 80 KB, and instruction RAM of 32 KB. It can support 802.11 b/g/n Wi-Fi network at 2.4 GHz along with the features of I2C, SPI, I2C interfacing with DMA, and 10-bit ADC. Interfacing this module with the microcontroller can be done easily through a serial port. An external voltage converter is required only if the operating voltage exceeds 3.6 Volts. It is most widely used in robotics and IoT applications due to its low cost and compact size.
The ESP8266 Wi-Fi module pin configuration/pin diagram is shown in the figure below. The ESP8266-01 Wi-Fi module runs in two modes.



Flash Mode: When GPIO-0 and GPIO-1 pins are active high, then the module runs the program, which is uploaded into it.
UART Mode: When the GPIO-0 is active low and GPIO-1 is active high, then the module works in programming mode with the help of either serial communication or Arduino board.
The ESP8266 Wi-Fi module specifications or features are given below:
It is a powerful Wi-Fi module available in a compact size at a very low price.
It is based on the L106 RISC 32-bit microprocessor core and runs at 80 MHz
It requires only 3.3 Volts power supply
The current consumption is 100 m Amps
The maximum Input/Output (I/O) voltage is 3.6 Volts.
It consumes 100 mA current
The maximum Input/Output source current is 12 mA
The frequency of built-in low power 32-bit MCU is 80 MHz
The size of flash memory is 513 kb
It is used as either an access point or station or both
It supports less than 10 microAmps deep sleep
It supports serial communication to be compatible with several developmental platforms such as Arduino
It is programmed using either AT commands, Arduino IDE, or Lua script
It is a 2.4 GHz Wi-Fi module and supports WPA/WPA2, WEP authentication, and open networks.
It uses two serial communication protocols like I2C (Inter-Integrated Circuit) and SPI (Serial Peripheral Interface).
It provides 10- bit analog to digital conversion
The type of modulation is PWM (Pulse Width Modulation)
UART is enabled on dedicated pins and for only transmission; it can be enabled on GPIO2.
It is an IEEE 802.11 b/g/n Wi-Fi module with LNA, power amplifier, balun, integrated TR switch,

and matching networks.
GPIO pins – 17
Memory Size of instruction RAM – 32 KB
The memory size of instruction cache RAM – 32 KB
Size of User-data RAM- 80 KB
Size of ETS systems-data RAM – 16 KB