100+ Sensors & Modules

To Use With Arduino

PIR

Arduino

DHT11

MQ3
Sensor

Signal
VCC
GND
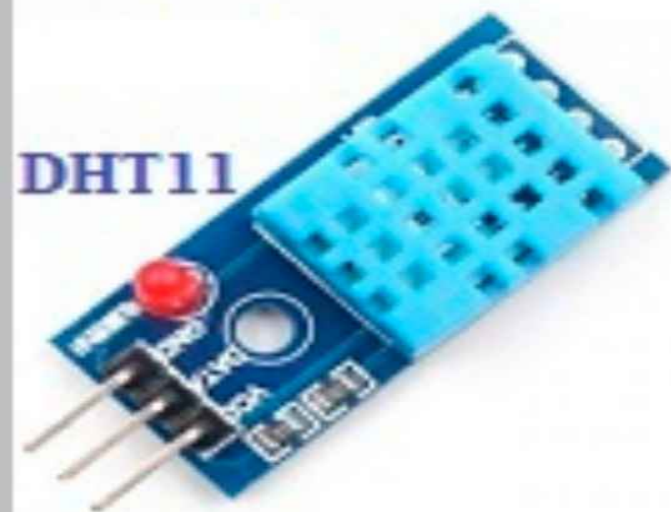
Vijay Verma

100+ Sensors
& Modules
To Use With Arduino

In this book, complete information about important electronics components is given. which we use with Arduino. Most of the sensors and modules details are given in this book. All the sensors and modules we use with the Arduino. which all students should know about.

Author

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(I have been working on Arduino based projects for 5 years)

Dedicate

This book is for all students, because it contains the most important electronics components details. Which all students should know about, because students continue to need these components. If any

student keeps experimenting at home or at school, then it is very important to know about these components. So that they can do their work easily.

NOTE- And those who want to do shows in school and college exhibition by creating student projects, So they too should know about all these electronics Sensors and modules so that they can make their project easily.

Introduction

In this book, complete information about important electronics Sensors is given. which we use with Arduino. Most of the sensors and modules details are given in this book. All the sensors and modules we use with the Arduino. All the components are given in this book. Along with his image his basic details are also given, By which any student can easily understand about the components.

Part-1
All Modules

Arduino UNO-

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6

Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino Uno comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.
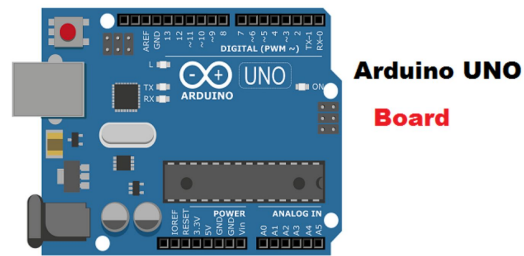
Arduino UNO
Board

Arduino Nano-

Arduino Nano is a small, compatible, flexible and breadboard friendly Microcontroller board, developed by **Arduino**.cc in Italy, based on ATmega328p (**Arduino Nano** V3. x) / Atmega168 (**Arduino Nano** V3. x). ... **Arduino Nano** Pinout

contains 14 digital pins, 8 analog Pins, 2 Reset Pins & 6 Power Pins.
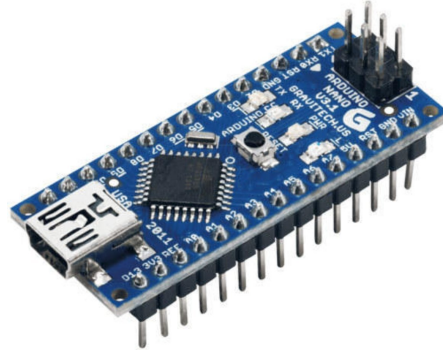
a. What is Arduino Nano used for?

Arduino Nano is one type of microcontroller board, and it is designed by **Arduino**.cc. It can be built with a microcontroller like Atmega328. This microcontroller is also **used** in **Arduino** UNO. It is a small size board and also flexible with a wide variety of applications.

Arduino Mega 2560-

The **Arduino Mega** 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.
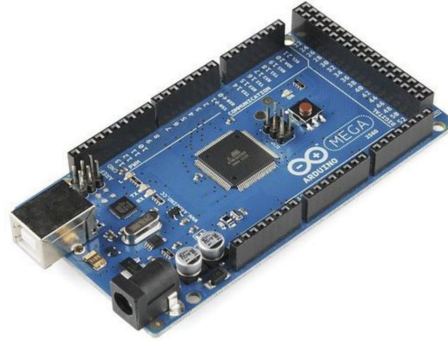
a. What is the use of Arduino Mega 2560?

The **Arduino MEGA 2560** is designed for projects that require more I/O lines, more sketch memory and more RAM. With 54 digital I/O pins, 16 analog inputs and a larger space for your sketch it is the recommended board for 3D printers and robotics projects.

NodeMCU ESP8266-

NodeMCU is an open source firmware for which open source prototyping board designs are available. ... The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for **ESP8266**. It **uses** many open source projects, such as lua-cjson and SPIFFS.

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.

NodeMCU is an open source IoT platform.It includes firmware which runs on the **ESP8266** Wi-Fi SoC from Espressif Systems, and hardware, which **is** based on the ESP-12 module. ... The firmware uses the Lua scripting language.

The VIN **pin** not directly connected to the USB's **5V** supply (at least on the LoLin v3 board). ... It is always on, and always **5V** (or whatever your USB port happens to provide - 4.75v - 5.25v). You must never ever connect VIN to a power source and connect the USB socket.

4*4 Keypad-

The **4*4** matrix **keypad** usually is used as input in a project. It has 16 keys in total, which means the same input values. The SunFouner **4*4** Matrix **Keypad** Module is a matrix non- encoded **keypad** consisting of 16 keys in parallel.

a. How does a 4x4 keypad work?

How it **Works**. This **4x4** matrix **keypad** has 16 built-in pushbutton contacts connected to row and column lines. A microcontroller can scan these lines for a button-pressed state. In the **keypad** library, the Propeller sets all the column lines to input, and all the row lines to input.

b. What is the function of keypad?

The keypad is a section on most computer keyboards and allows an individual to quickly input **numeric** values into a computer. For **example**, the keypad is often used for anyone who deals with numbers frequently or has to perform calculations with a software calculator.

OLED Display Module-

Wiring **OLED display** module to **Arduino** Uno
Start by connecting VCC pin to the 5V output on the **Arduino** and connect GND to ground. ... On the **Arduino** boards with the R3 layout, the SDA (data line) and SCL (clock line) are on the pin headers close to the AREF pin. They are also known as A5 (SCL) and A4 (SDA).
Display Technology: OLED (Organic LED)

MCU Interface: I2C / SPI

Operating Voltage: 3.3V – 5V
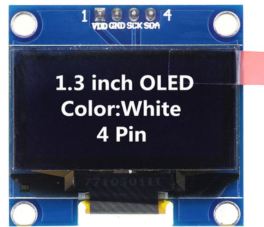
a. How does OLED display work?

   OLEDs work in a similar way to conventional diodes and LEDs, but instead of using layers of n-type and p-type semiconductors, they use organic molecules to produce their electrons and holes. A simple **OLED** is made up of six different layers. On the top and bottom there are layers of protective glass or plastic.

RFID Car Reader

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 is a technology similar in theory to bar codes. However, the RFID tag does not have to be scanned directly, nor does it require line-of-sight to a reader. The RFID tag it must be within the range of an RFID reader, which ranges from 3 to 300 feet, in order to be read. RFID technology allows several items to be quickly scanned and enables fast identification of a particular product, even when it is surrounded by several other items.

RFID tags have not replaced bar codes because of their cost and the need to individually identify every item.

a. What is RFID card reader?

Radio-frequency identification (**RFID**) uses electromagnetic fields to automatically identify and track tags attached to objects. ... 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**.

b. How do RFID card readers work?

RFID methods utilize radio waves to accomplish this. ... **RFID** tags contain an integrated circuit and an antenna, which are used to transmit data to the **RFID reader** (also called an interrogator). The **reader** then converts the radio waves to a more usable form of data.

Laser Module-

This 100mW **laser module** emits a small intense focused beam of visible red light. The **module** can

be used with an **Arduino** and photo resistor **module** to perform basic remote signaling. ... You should never look directly in to its beam or point the **laser** at another person.
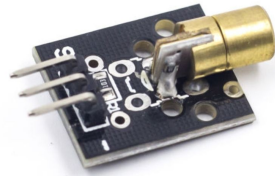
a. What is a laser module?

In the **laser** display industry the term "**laser module**" stands for a device that emits a single static **laser** beam of single or multiple wavelengths - or colours if we talk about the visible spectrum of light.

b. What is the function of laser?

Laser, a device that stimulates atoms or molecules to emit light at particular wavelengths and amplifies that light, typically producing a very narrow beam of radiation. The emission generally covers an extremely limited range of visible, infrared, or ultraviolet wavelengths.

DS3231 RTC Module/Clock Module-

The DS3231 is an **RTC** IC developed by Maxim Integrated. It is a low cost, extremely

accurate **RTC** IC with communication over I2C Interface. An interesting feature of DS3231 **RTC** IC is that it has integrated crystal oscillator and temperature sensor and hence you don't have to connect an external crystal.
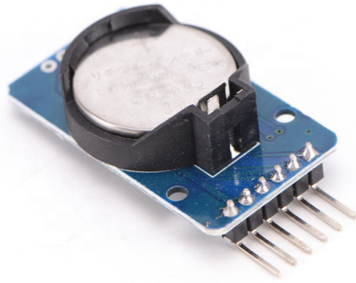
a. What is a clock module?
Introduction. The SparkFun Real Time **Clock Module** is a simple breakout board for the DS1307 real-time **clock** (**RTC**). It can accurately keep track of seconds, minutes, hours, days, months, and years for almost a decade, so your microcontroller doesn't have to.

b. How does RTC module work?
An **RTC** maintains its clock by counting the cycles of an oscillator – usually an external 32.768kHz crystal oscillator circuit, an internal capacitor based oscillator, or even an embedded quartz crystal. ... Some RTCs maintain the oscillator setting at the last known point before it went out of lock with the input.

7 Segment Display-

It has all the external circuit required to drive a 4 Digit **7 Segment** Display. ... This display connects

to an **Arduino** using 2 wires only! Using only 2 Digital Input/Output pins for communication, it allows you to use the other pins for your project.

a. What is the application of 7 segment display?
   Applications of Seven Segment Displays

   The **applications of seven segments** are mostly in digital calculators, electronic meters, digital clocks, odometers, digital clocks, clock radios, etc. Today most of the **7 segment applications** are using LCDs, because of low current consumption.

b. How does a 7 segment display work?
   The **7-segment displays** are really just **seven** LEDs lined up in a particular pattern. ... Each of the **seven** LEDs is called a **segment** because when illuminated the **segment** forms part of a numerical digit (both Decimal and Hex) to be displayed. An additional 8th LED is sometimes used for indication of a decimal point.

ESP32 CAM WiFI Module-

The ESP32 **CAM WiFi Module** Bluetooth with OV2640 **Camera Module** 2MP For Face

Recognition has a very competitive small-size **camera module** that can operate independently as a minimum system with a footprint of only 40 x 27 mm; a deep sleep current of up to 6mA and is widely used in various IoT applications.

a. What is ESP32 camera module?
Overview. The **ESP32-CAM** is a small size, low power consumption **camera module** based on **ESP32**. It comes with an OV2640 **camera** and provides onboard TF card slot. The **ESP32-CAM** can be widely used in intelligent IoT applications such as wireless video monitoring, WiFi image upload, QR identification, and so on.

b. How do I know if my ESP32 cam is working?
1) Go to Tools > Board and select AI-Thinker **ESP32-CAM**. 2) Go to Tools > Port and select the COM port the **ESP32** is connected to. 3) Then, click the upload button to upload the code. 4) When you start to **see** these dots on the debugging window as shown below, press the **ESP32-CAM** on-board RST button.

nRF24L01 Module-

nRF24L01 is a single chip radio transceiver for the world wide 2.4 - 2.5 GHz ISM band. The transceiver consists of a fully integrated frequency synthesizer, a power amplifier, a crystal oscillator, a demodulator, modulator and Enhanced ShockBurst™ protocol engine.


a. How do I know if nRF24L01 is working?

Open Serial **Monitor** on the IDE window for Mega2560, and you can see the received data printed every 500ms, that is, Rx = 85, 170, 17. It indicates both **NRF24L01** modules **work**.

Fingerprint Module-

These **modules** come with FLASH memory to store the **fingerprints** and work with any microcontroller or system with TTL serial. These **modules** can be added to security systems, door locks, time attendance systems, and much more.
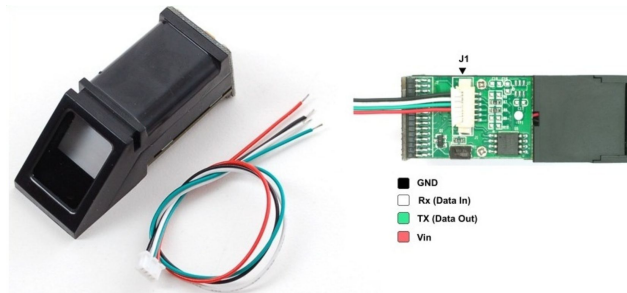
a. What is fingerprint sensor module?

Fingerprint sensor module is used as a way to verify identity. ... This module has a rich command set for operating functions such as to enroll/verify/identify fingerprints, read/write fingerprint template file, get fingerprint image and so on. It uses UART interface (3.3V level, TTL) to communicate with external devices.

b. What are fingerprint scanners used for?

A fingerprint scanner is a device used to identify a person by scanning their fingerprints. We have several ridges on our fingers. Additionally, every person has a unique pattern. Hence, a fingerprint scanner scans them to identify us.

GSM Module-

A **GSM**/GPRS **Module** is an IC or chip that connects to the **GSM** Network using a SIM (Subscriber Identity **Module**) and Radio Waves. The common radio frequencies in which a typical **GSM Module** operates are 850MHz, 900MHz, 1800MHz and 1900MHz.

a. What is GSM module?

A **GSM modem** or **GSM module** is a hardware device that uses **GSM** mobile telephone technology to provide a data link to a remote network. From the view of the mobile phone network, they are essentially identical to an ordinary mobile phone, including the need for a SIM to identify themselves to the network.

b. What is GSM module used for?

A **GSM** GPRS **Module** is **used** to enable communication between a microcontroller (or a microprocessor) and the **GSM** / GPSR Network. Here, **GSM** stands for Global System for Mobile Communication and GPRS stands for General Packet Radio Service.

GPS Module-

Global Positioning System (**GPS**) is a satellite-based system that uses satellites and ground stations to measure and compute its position on Earth. **GPS** is also known as Navigation System with Time and Ranging (NAVSTAR) **GPS**. **GPS receiver** needs to receive data from at least 4 satellites for accuracy purpose.

a. What is a GPS module?

GPS receivers use a constellation of satellites and ground stations to compute position and time almost anywhere on earth. ... With this information and some math, a ground based receiver or **GPS module** can calculate its position and time.

b. How do I know if my GPS module is working?
okey, boy, give you a very simple to **check if** your **GPS work**, do not need Arduino or any code. connect the **gps** to directly to your UART of computer, **if** your computor do not have a uart, just use a USB2UART convert, like the ch340 **module** orFt232 **module** , and then open the uart **monitor** .... the **gps module** will report.

L298N Motor Driver-

This L298N Motor Driver Module is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.
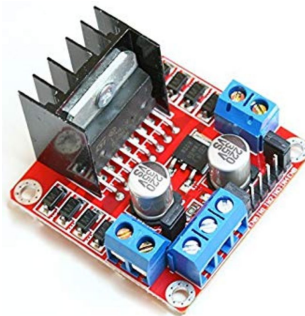
a. What is L298N motor driver?

This **L298N Motor Driver** Module is a high power **motor driver** module for **driving** DC

and **Stepper Motors**. This module consists of an **L298 motor driver** IC and a 78M05 5V regulator. **L298N** Module can control up to 4 DC **motors**, or 2 DC **motors** with directional and speed control.

b. What is the use of motor driver?

A **motor driver** is a small Current Amplifier whose **function** is to take a low-current control signal and then turn it into a higher-current signal that can drive a **motor**. The L293D is a typical **Motor Driver** which can drive 2 DC **motors** simultaneously.

L293D Motor Driver Module-

Widely used in robotics, **motor** driving applications and heavy project applications. This **l293d module** can drive 4 dc **motor** in one direction, or drive 2 dc **motor** in both direction. With terminal blocks for connecting **motors** and power supply and berg sticks for control signals from microcontroller.
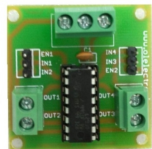
a. What is L293D motor driver?
   The **L293D** is a popular 16-Pin **Motor Driver** IC. As the name suggests it is mainly used to drive **motors**. A single **L293D** IC is capable of running two DC **motors** at the same time; also the

direction of these two **motors** can be controlled independently.

b. How does L293D motor driver work?
How **Motor Driver** Operates? The **L293D** IC receives signals from the microprocessor and transmits the relative signal to the **motors**. It has two voltage pins, one of which is used to draw current for the **working** of the **L293D** and the other is used to apply voltage to the **motors**.

BO Motor-

DC motor (BO) Battery Operation. Dc motor converts electrical energy into mechanical energy. Why DC gear motor used in robot Motor control circuit. DC MOTOR concept is where gears reduce the speed of the vehicle but increase its torque is known as gear reduction.

Motor Wheel-

This is 65mm Robot Wheel for BO Motor (Yellow). The wheel is made up of high-quality rubber which gives maximum traction while operating. The wheel is strong and sturdy as it features a nylon reinforced plastic rim.

__Motor 200RPM-__

200 RPM 12V DC geared motors widely use for robotics applications. Very easy to use and available in standard size. ... DC Geared motors with robust metal gearbox for heavy-duty applications, available in the wide RPM range and ideally suited for robotics and industrial applications.


__Motor Wheel-__

Relay-

A **relay** is an [electrically](#) operated [switch](#). It consists of a set of input terminals for a single or multiple control signals, and a set of operating [contact terminals](#). The switch may have any number of contacts in multiple [contact forms](#), such as make contacts, break contacts, or combinations thereof.

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance [telegraph](#) circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

The traditional form of a relay uses an [electromagnet](#) to close or open the contacts, but other operating principles have been invented, such as in [solid-state relays](#) which use [semiconductor](#) properties for control without relying on [moving parts](#). Relays with calibrated operating characteristics and sometimes multiple

operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called *protective relays*.

2Channel 5volt Relay Kit-

This is a 5V 4-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equiped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller.

4Channel 5volt Relay Kit-

This is a 5V 4-channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current. It is equiped with high-current relays that work under AC250V 10A or DC30V 10A. It has a standard interface that can be controlled directly by microcontroller.
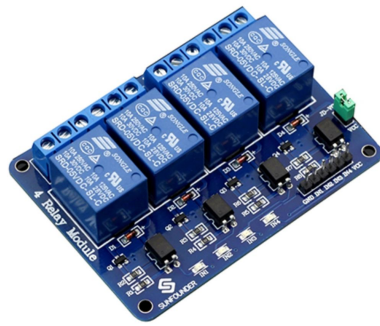
Bluetooth Module HC-05-

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup.
Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate)

3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

a. How does HC-05 Bluetooth module work?

HC-05 has red LED which indicates connection status, whether the **Bluetooth** is connected or not. Before connecting to **HC-05 module** this red LED blinks continuously in a periodic manner. When it gets connected to any other **Bluetooth** device, its blinking slows down to two seconds. This **module works** on 3.3 V.

b. What is the range of Bluetooth module HC-05?
10 meters

It uses the 2.45GHz frequency band. The transfer rate of the data can vary up to 1Mbps and is in **range** of 10 meters. The **HC-05 module** can be operated within 4-6V of power supply. It supports baud rate of 9600, 19200, 38400, 57600, etc.

Servo Motor-

A servomotor 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. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a [closed-loop control](#) system.

a. What is a servo motor How does it work?

The **servo motor** is a closed-loop mechanism that incorporates positional feedback in order to control the rotational or linear speed and position. The **motor** is controlled with an electric signal, either analog or digital, which determines the amount of movement which represents the final command position for the shaft.

b. What is the advantage of servo motor?

Servo motors achieve high **speed** at high torque values. Quiet at high speeds. Encoder utilization provides higher accuracy and resolution with closed-loop **control**.

LCD Display-

An LCD is an electronic display module that uses liquid crystal to produce a visible image. The 16×2 LCD display is a very basic module commonly used in DIYs and circuits. The 16×2 translates o a display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7 pixel matrix.
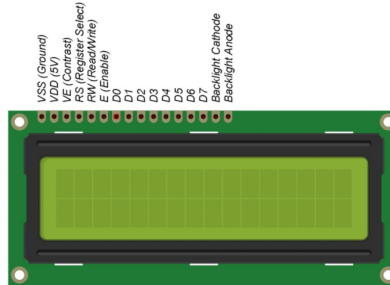
a. What does 16 mean in 16x2 LCD?
A **16x2 LCD means** it **can** display **16** characters per line and there **are** 2 such lines. In this **LCD** each character **is** displayed in 5x7 pixel matrix. The **16** x 2 intelligent alphanumeric dot matrix display **is** capable of displaying 224 different characters and symbols. This **LCD** has two registers, namely, Command and Data.

b. How do you use 16 <UNK> 2 LCD display?
16×2 Character LCD Pinout

- VCC is the power supply for the **LCD** which we connect the 5 volts pin on the Arduino.
- Vo (**LCD** Contrast) controls the contrast and brightness of the **LCD**. ...
- RS (Register Select) pin lets the Arduino tell the **LCD** whether it is sending commands or the data.

Breadboard-

A breadboard is a solderless device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connect the holes on the top of the board. The metal strips are laid out as shown below. Note that the top and bottom rows of holes

are connected horizontally and split in the middle while the remaining holes are connected vertically.
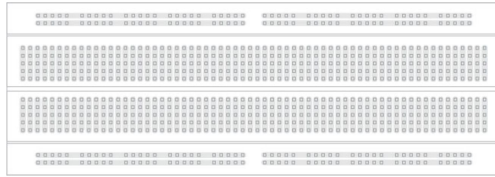
a. What is a breadboard and how does it work?
   A **breadboard** is a rectangular plastic board with a bunch of tiny holes in it. These holes let you easily insert electronic components to prototype (meaning to build and test an early version of) an electronic circuit, like this one with a battery, switch, resistor, and an LED (light-emitting diode).

b. What is breadboard explain?
   A thin plastic board used to hold electronic components (transistors, resistors, chips, etc.) ... Used to develop prototypes of electronic circuits, **breadboards** can be reused for future jobs. They can be used to create one-of-a-kind systems but rarely become commercial products. See printed circuit board.

Joystick Switch-

Joystick switches or **joysticks** are manually actuated control devices for installation in control and front panels as well as in portable control equipment. They are used wherever motion sequences analogous to the actuation direction are controlled by hand.

a. What is joystick switch?

A **joystick** is an input device consisting of a stick that pivots on a base and reports its angle or direction to the device it is controlling. ... **Joysticks** are often used to control video games, and usually have one or more push-buttons whose state can also be read by the computer.

b. How does a joystick work?

Basically, **joystick** detects the direction you are holding the stick in by use of an electronic switch. There is a printed circuit board inside the **joystick** base. The terminals can't complete the electric circuit when the **joystick** is in a neutral state (the stick is not pressing the contacts into the 'on' position).

Mini Solar Panel-

The electric field produced comprises almost constant voltage but current that varies with the amount of sunlight falling on the **cells**. A typical **mini solar panel** can generate between 0.06 and 4 watts of electric **power**.
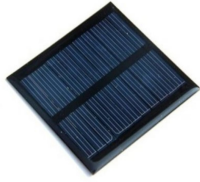
CNC Shield-

This **CNC shield** software is designed to control a **CNC** or a 3D printer. It comes with 4 sockets A4988 stepper driver. This board has Arduino pin connections and pins for engine and other peripherals.
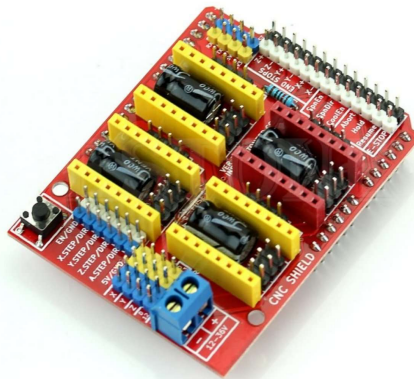
a. What is CNC shield?

The **CNC Shield** V3. 0 allows you to build a engraving machine, 3D printer, mini **CNC** and other similar devices using your Arduino. It is designed as a **shield** and can plug on top of an Arduino requiring no external connections and wiring.

b. What is shield used for?

Shields are **used to** intercept specific attacks, whether from close-ranged weaponry or projectiles such as arrows, by means of active blocks, as well

as to provide passive protection by closing one or more lines of engagement during combat.

CNC Driver A4988-

The A4988 is a complete Microstepping Motor **Driver** with built-in translator for easy operation. The **driver** has a maximum output capacity of 35 V and ± 2 A. It can operate bipolar **stepper** motors in full-, half-, quarter-, eighth-, and sixteenth-step modes.


a. What is A4988 driver?

The **A4988** is a microstepping **driver** for controlling bipolar stepper motors which has built-in translator for easy operation. This means that we can control the stepper motor with just 2 pins from our controller, or one for controlling the rotation direction and the other for controlling the steps.

b. How does A4988 work?

The **A4988** driver allows microstepping by allowing intermediate step locations. This **is** achieved by energizing the coils with intermediate current levels. For example, if you choose to drive NEMA 17 having 1.8° or 200 steps per revolution in quarter-step mode, the motor **will** give 800 microsteps per revolution.

CNC Driver DRV8825-

The **DRV8825** is a Motor **Driver** with two H-bridge **drivers** and a micro stepping indexer. The **driver** has a maximum output capacity of 45 V and ± 2.5 A. It can operate bipolar **stepper** motors in full, 1/2, 1/4, 1/8, 1/16 and 1/32-step modes. This **driver** module is generally used in Robotics, ATMs and Gaming Machines.
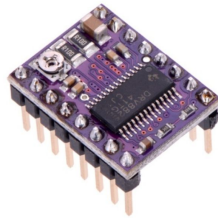

a. What is DRV8825?

The **DRV8825** is a stepper motor driver board that has on a DRV8825_chip that enables control of stepper motors through arduino type programming firmware and software. ... It is one of the two most popular add-on stepper motor driver boards, along with the 4988.

Stepper Motor-

Stepper motors are DC motors that move in discrete steps. They have multiple coils that are organized in groups called "phases". By energizing each phase in sequence, the motor will rotate, one step at a time. With a computer controlled stepping

you can achieve very precise positioning and/or speed control.
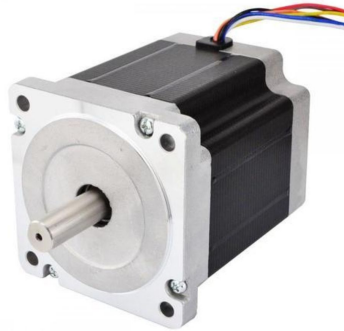
a. What is stepper motor and its working?

A **stepper motor** is an electromechanical device it converts electrical power into mechanical power. ... **Stepper motors** are similar to switched reluctance **motors**. The **stepper motor** uses the theory of **operation** for magnets to make the **motor** shaft turn a precise distance when a pulse of electricity is provided.

b. What is a stepper motor used for?

The **stepper motor** is **used for** precise positioning with a **motor**, such as hard disk drives, robotics, antennas, telescopes, and some toys. **Stepper motors** cannot run at high speeds, but have a high holding torque.

Jumper wire-

A **jump wire** (also known as jumper wire, or jumper) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit,

internally or with other equipment or components, without soldering.

Part-2
All Sensors Details

PIR Sensor-

PIR sensors allow you to sense **motion**, almost always used to detect whether a human has moved in or out of the **sensors** range. They are small, inexpensive, low-power, easy to use and don't wear out. ... They are often referred to as **PIR**, "Passive Infrared", "Pyroelectric", or "IR **motion**" **sensors**

a. How does a PIR motion sensor work?

A passive infrared **sensor** (**PIR sensor**) is an electronic **sensor** that measures infrared (IR) light radiating from objects in its field of view. They are most often used in **PIR**-based **motion detectors**. ... They **work** entirely by detecting infrared radiation (radiant heat) emitted by or reflected from objects

b. What is the output of PIR sensor?

It has a built-in voltage regulator so it can be powered by any DC voltage from 4.5 to 12 volts, typically 5V is used. Other than this, there are a couple options you have with your **PIR**

IR Sensor-

 IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An **IR sensor** can measure the heat of an object as well as detects the motion. Usually, in the **infrared** spectrum, all the objects radiate some form of thermal radiation.

a. How does the IR sensor work?

Active **infrared sensors** both emit and detect **infrared** radiation. ... When an object comes close to the **sensor**, the **infrared** light from the LED reflects off of the object and is detected by the **receiver**. Active **IR sensors** act as

proximity **sensors**, and they are commonly used in obstacle detection systems (such as in robots).

b. What is the output of IR sensor?

IR detectors are digital out - either they detect 38KHz **IR** signal and **output** low (0V) or they do not detect any and **output** high (5V). Photocells act like resistors, the resistance changes depending on how much light they are exposed to.

Soil Moisture Sensor-

The **Soil Moisture Sensor** uses capacitance to measure the water content of **soil** (by measuring the dielectric permittivity of the **soil**, which is a function of the water content). Simply insert this rugged **sensor** into the **soil** to be tested, and the volumetric water content of the **soil** is reported in percent.
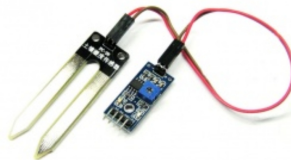
a. How does a soil moisture sensor work?

A small charge is placed on the electrodes and electrical resistance through the **sensor** is measured. As water is used by plants or as the **soil moisture** decreases, water is drawn from the **sensor** and resistance increases. Conversely, as **soil moisture** increases, resistance decreases.

b. What is the output of soil moisture sensor?

The **output** of the **soil moisture sensor** changes in the range of ADC value from 0 to 1023. This can be represented as **moisture** value in terms of percentage using formula given below. For zero **moisture**, we get maximum value of 10-bit ADC, i.e. 1023. This, in turn, gives 0% **moisture**

Fire Sensor-

A **sensor** which is most sensitive to a normal light is known as a **flame sensor**. That's why this **sensor** module is used in **flame** alarms. This **sensor** detects **flame** otherwise wavelength within the range of 760 nm – 1100 nm from the light source. ... The output of this **sensor** is an analog signal or digital signal.

a. How does a fire sensor work?

A **fire detector works** by detecting **smoke** and/or heat. These devices respond to the presence of **smoke** or extremely high temperatures that are present with a **fire**. However, other **sensors** are multi-function, and they will detect the presence of both **smoke** and high temperatures. ...

b. What are the specifications of a flame sensor?

The IR **flame sensor** is used to detect the presence of fire or other infrared source (**Flame** or a light source of a wavelength in the range of 760 nm to 1100 nm can be detected).

Ultrasonic Sensor-

An **ultrasonic sensor** is an electronic device that measures the distance of a target object by emitting **ultrasonic** sound waves, and converts the reflected sound into an electrical signal. **Ultrasonic** waves travel faster than the speed of audible sound (i.e. the sound that humans can hear).

a. How does the ultrasonic sensor work?

An **ultrasonic sensor** is an electronic device that measures the distance of a target object by emitting **ultrasonic** sound waves, and converts the reflected sound into an electrical signal. **Ultrasonic** waves travel faster than the speed of audible sound (i.e. the sound that humans can hear).

b. What is the output of ultrasonic sensor?

The **sensor** is small, easy to use in any robotics project and offers excellent non-contact range detection between 2 cm to 400 cm (that's about an inch to 13 feet) with an accuracy of 3mm. Since it operates on 5 volts, it can be hooked directly to an Arduino or any other 5V logic microcontrollers.

DHT11 Sensor-

The **DHT11** is a basic, ultra low-cost digital temperature and humidity **sensor**. It uses a capacitive humidity **sensor** and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). Its fairly simple to use, but requires careful timing to grab data.
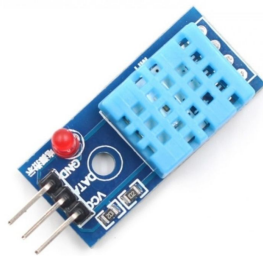
a. How does a DHT11 sensor work?

The **DHT11** calculates relative humidity by measuring the electrical resistance between two

electrodes. The humidity **sensing** component of the **DHT11** is a moisture holding substrate with the electrodes applied to the surface.

b. What is the output of DHT11 sensor?

DHT11 Specifications:

Operating Voltage: 3.5V to 5.5V. Operating current: 0.3mA (measuring) 60uA (standby) **Output**: Serial data. Temperature Range: 0°C to 50°C.

MQ135 Sensor-

Air quality **sensor** for detecting a wide range of **gases**, including NH3, NOx, alcohol, benzene, smoke and CO2. Ideal for use in office or factory. **MQ135 gas sensor** has high sensitivity to Ammonia, Sulfide and Benze steam, also sensitive to smoke and other harmful **gases**.

a. How does MQ135 sensor work?

An alcohol **sensor** detects the attentiveness of alcohol gas in the air and an analog voltage is an output reading. The **sensor** can activate at temperatures ranging from -10 to 50° C with a power supply is less than 150 Ma to 5V. The **sensing** range is from 0.04 mg/L to 4 mg/L, which is suitable for breathalyzers.

b. How do you calibrate a MQ 135 sensor?

While using the library-supported Arduino setup, **MQ-135** gas **sensor calibration** is done at first by finding the value of Ro in fresh air, and then using that value to find Rs through the formula: Rs = (Vcc/VRL-1)x RL, that means Rs = (5V/(sensorValue * (5.0/1023.0))-1)*RL.

MQ2 Sensor-

MQ2 gas sensor is **an electronic sensor used for sensing the concentration of gases in the air** such as LPG, propane, methane, hydrogen, alcohol, smoke and carbon monoxide. MQ2 gas sensor is also known as chemiresistor. It contains a sensing material whose resistance changes when it comes in contact with the gas.

a.　How does MQ2 gas sensor work?

What is MQ2 Gas Sensor? ... Using a simple voltage divider network, **concentrations of gas can be detected**. MQ2 Gas sensor works on 5V DC and draws around 800mW. It can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentrations anywhere from 200 to 10000ppm.

b.　What does MQ2 sensor detect?

The Grove - Gas Sensor(MQ2) module is useful for gas leakage detection (in home and industry). It can detect **combustible gas and smoke**. The output voltage from the Gas sensor increases when the concentration of gas. Sensitivity can be adjusted by rotating the potentiometer.

MQ3 Sensor-

It is a low cost semiconductor **sensor** which can detect the presence of alcohol gases at concentrations from 0.05 mg/L to 10 mg/L. The sensitive material used for this **sensor** is SnO2, whose conductivity is lower in clean air. It's conductivity increases as the concentration of alcohol gases increases.

a. How does MQ3 sensor works?

MQ-3 gas **sensor** has high sensity to Alcohol, and has good resistance to disturb of gasoline, smoke and vapor. This **sensor** provides an analog resistive output based on alcohol concentration. When the alcohol gas exist, the **sensor's** conductivity gets higher along with the gas concentration rising.

b. How do you calibrate a MQ-3 sensor?

Sensor Calibration Challenges

The poorly written **MQ-3** datasheet says to **calibrate** the **sensor** by exposing it to a known alcohol gas of 0.4mg/L. From there, you can determine gas alcohol content in terms of mg/L.

MQ4 Sensor-

MQ4 Methane Gas **Sensor** detects the concentration of methane gas in the air and ouputs its reading as an analog voltage. The concentration **sensing** range of 300 ppm to 10,000 ppm is suitable for leak detection. ...
The **sensor** can operate at temperatures from -10 to 50°C and consumes less than 150 mA at 5 V.

a. What is MQ4 gas sensor?

MQ4 Methane **Gas Sensor** detects the concentration of methane **gas** in the air and ouputs its reading as an analog voltage. The concentration sensing range of 300 ppm to 10,000 ppm is suitable for leak **detection**. ... The **sensor** can operate at temperatures from -10 to 50°C and consumes less than 150 mA at 5V

b. How do you calibrate a MQ4 sensor?

Calibration. You would need to **calibrate** the **MQ**-4 gas **sensor** and generate an equation that converts the analog values to PPM. To **calibrate**, you need to use a sample of known concentration in ppm or a CO gas meter.

MQ5 Sensor-

The MQ5 Gas Sensor module is **useful for gas leakage detecting**. It can detect LPG, i-butane, methane, alcohol, Hydrogen, smoke and so on. The sensitivity can be adjusted using the on-board potentiometer, and you'd use this sensor by reading the analog pin to which it is connected.

a. What is an MQ5 gas sensor?

The Grove - Gas Sensor(MQ5) module is **useful for gas leakage detection** (in home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible.

b. How does MQ5 sensor work?

The working principle behind the MQ-5 gas sensor is as follows: **The sensor has a sensitive filament made of SnO2**. ... When a combustible gas such as LPG is introduced, the filament's conductivity rises, and the amount of change in it's conductance/resistance can be used to indicate the equivalent gas concentration.

MQ6 Sensor-

The MQ6 (LPG Gas Sensor) is **a simple-to-use liquefied petroleum gas (LPG) sensor**. It can be used in gas leakage detecting equipment in consumer and industry applications,this sensor is suitable for detecting LPG, iso-butane, propane, LNG. Avoid the noise of alcohol, cooking fumes and cigarette smoke.

a. How does MQ6 gas sensor work?

The MQ-6 can detect gas concentrations anywhere **from 200 to 10000ppm**. This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance. The drive circuit is very simple; all you need to do is power the heater coil with 5V, add a load resistance, and connect the output to an ADC.

MQ7 Sensor-

MQ7 is a **Carbon Monoxide (CO) sensor**, suitable for sensing Carbon Monoxide concentrations(PPM) in the air. MQ7 Gas sensor can measure CO concentrations ranging from 20 to 2000 ppm. ... The sensor could be used to detect different gases contains CO, it is with low cost and suitable for different application.

What is MQ-7?

The MQ7 is a **simple-to-use Carbon Monoxide (CO) sensor suitable for sensing CO concentrations in the air**. It can detect CO-gas concentrations anywhere from 20 to 2000ppm. The sensor's output is an analog resistance.

How does MQ7 gas sensor work?

Sensitive material of MQ-7 gas sensor is SnO2, which with lower conductivity in clean air. It **make detection by method of cycle high and low temperature**, and detect CO when low temperature (heated by 1.5V). ... When high temperature (heated by 5.0V), it cleans the other gases adsorbed under low temperature.

MQ8 Sensor-

MQ8 hydrogen gas sensor is **a Metal oxide semiconductor type sensor**. This sensor is used to detect Hydrogen gas within the air, detect gas leakage, and Hydrogen gas presence within the air. This sensor is very simple to use and detects hydrogen gas concentration in the range of 100-10000ppm anywhere.


a. What is mq8 sensor?

This is a simple-**to-use hydrogen gas sensor**, suitable for sensing hydrogen concentrations in the air. The MQ-8 can detect hydrogen gas concentrations anywhere from 100-10000ppm. This sensor has a high sensitivity and fast response time. The sensor's output is an analog resistance.

b. How is hydrogen gas detected?

Hydrogen gas detectors commonly use several mechanisms to determine the presence and concentration of hydrogen, including **gas chromatography**, mass spectrometry, catalytic bead, and thermal conductivity.

MQ9 Sensor-

Sensitive material of the **MQ9** gas **sensor** is SnO2, which with lower conductivity in clean air. It makes detection by the method of cycle high and low temperature, and detect CO when the low temperature (heated by 1.5V). ... When a high temperature (heated by 5.0V), it detects Methane, Propane, etc.
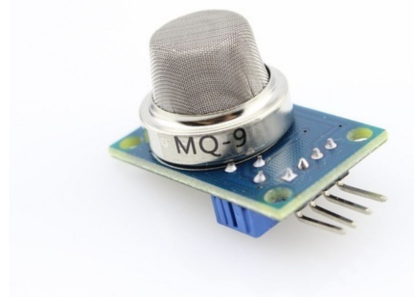
a. How does MQ-9 sensor work?

Sensitive material of **MQ-9** gas **sensor** is SnO2, which with lower conductivity in clean air. It make detection by method of cycle high and low temperature, and detect CO when low temperature (heated by 1.5V). ... When high temperature (heated by 5.0V), it cleans the other gases adsorbed under low temperature.

b. How do you calibrate a MQ9 sensor?

Calibration. You would need to **calibrate** the **MQ**-9 gas **sensor** and generate an equation that converts the analog values to PPM. To **calibrate**, you need to use a sample of known concentration in ppm or a CO gas meter.

Sound Sensor-

A **Sound Sensor** is a simple device that detects **sound**. It is simply put a Microphone with some processing circuit. Using a **Sound Sensor**, you can measure the intensity of **sound** from different sources like knocks, claps, loud voices, etc. The **Sound Sensor** used in this project is shown in the image below.

a. How does a sound sensor work?

Sound sensors work by detecting differences in air pressure and transforming them into electrical signals. ... **Sound** waves cause the diaphragm to vibrate, which vibrates the magnets and induces a current in the coil. The most common microphones used for music are dynamic, ribbon or condenser microphones.

b. How do you calibrate a sound sensor?

Now to calibrate the sensor, start clapping near the microphone and adjust the potentiometer until you see the Status LED on the module blink in response to your claps. That's it your sensor is now calibrated and ready for use.

Thermal Sensor-

The TMP36 **temperature sensor** is an easy way to measure **temperature** using an **Arduino**! The **sensor** can measure a fairly wide range of **temperature** (-50°C to 125°C), is fairly precise (0.1°C resolution), and is very low cost, making it a popular choice.

a. What is thermal sensor?

Temperature **sensors** are constructional elements for measuring temperature and employ the functional dependence of a certain physical property of the **sensor** material on temperature.

b. What is the use of thermal sensor?

Non-contact **temperature sensors** are usually infrared (IR) **sensors**. They remotely detect the IR energy emitted by an object and send a signal to a calibrated electronic circuit that determines the object's **temperature**. Among the contact **temperature sensors** are thermocouples and thermistors.

Photosensitive Sensor-

LDR **sensor** module is used to detect the intensity of light. It is associated with both analog output pin and digital output pin labelled as AO and DO respectively on the board. ... The **sensor** has a potentiometer knob that can be adjusted to change the sensitivity of LDR towards light.

a. What is a photosensitive sensor?

Light   **Sensors**. Light **Sensors** are **photoelectric** devices that convert light energy (photons) whether visible or infra-red light into an electrical (electrons) signal.

b. How do LDR sensors work?

The **working** principle of an **LDR** is photoconductivity, which is nothing but an optical phenomenon. When the light is absorbed by the material then the conductivity of the material enhances. When the light falls on the **LDR**, then the electrons in the valence band of the material are eager to the conduction band.

c. What are the types of LDR?

Light dependent resistors, LDRs or photoresistors fall into one of two types or categories: Intrinsic

photoresistors: Intrinsic photoresistors use un-doped **semiconductor** materials including silicon or germanium.

Vibration Sensor-

When no **vibration** is detected, **Vibration sensor** output is 0 (low voltage),otherwise its output is 1(high voltage) 。 If **Arduino** get 0 (no **vibration**) from **vibration sensor** it will turn on green LED and turn off Red LED. If **Arduino** get 1 from **vibration sensor**, it will turn on Red LED and turn off green LED.

a. What is vibration sensor?

The **vibration sensor** is also called a piezoelectric **sensor**. These **sensors** are flexible devices which are used for measuring various processes. This **sensor** uses the piezoelectric effects while measuring the changes within acceleration, pressure, temperature, force otherwise strain by changing to an electrical charge.

b. What are the three types of vibration?

Machinery Vibrations can again be categorised into three types, depending on the nature of the vibrations:

- Torsional **Vibration**.
- Axial or Longitudinal **Vibration**.
- Lateral **Vibration**.

-

Rain Sensor-

The **rain sensor** detects water that comes short circuiting the tape of the printed circuits. The **sensor** acts as a variable resistance that will change status : the resistance increases when the **sensor** is wet and the resistance is lower when the **sensor** is dry.

a. How do rain sensors work?
   The **rain sensor works** on the principle of total internal reflection. ... An infrared light beams at a 45-degree angle on a clear area of the windshield from the **sensor** inside the car. When it rains, the wet glass causes the light to scatter and lesser amount of light gets reflected back to the **sensor**.

b. What is raindrop sensor?
   Raindrop Sensor is a tool used for sensing rain. It consists of two modules, a rain board that detects the rain and a control module, which compares the analog value, and converts it to a digital value

c. What is the use of rain detector?
   Rain water detector will detect the rain and make an alert; rain water detector is used in the **irrigation** field, home automation, communication, automobiles etc. Here is the

simple and reliable circuit of rain water detector which can be constructed at low cost

TILT Sensor-

A **Tilt Sensor** switch is an electronic device that detects the orientation of an object and gives its output High or Low accordingly. Basically, it has a mercury ball inside it which moves and makes the circuit. So **tilt sensor** can turn on or off the circuit based on the orientation.

a. How does a tilt sensor work?

Tilt sensor produces an electrical signal which is proportional to the degree of **tilt** in multiple axes (Uniaxial & Biaxial). **Tilt sensors** measure the **tilting** position with its original reference. This **sensor** provides valuable information about both the vertical and horizontal **inclination tilt**.

b. How do you test a tilt sensor?

Testing your **sensor** is simple. Put your multimeter into continuity-**test** mode and touch the probes to the two leads. Then **tilt** to determine the angle at

which the switch opens and closes. When pointing down, the switch is Open Loop (no continuity).

Voltage Sensor-

The **Voltage Sensor** is a simple module that can used with **Arduino** (or any other microcontroller with input tolerance of 5V) to measure external **voltages** that are greater than its maximum acceptable value i.e. 5V in case of **Arduino**. Following is the image of the **Voltage Sensor** Module used in this project.

a. How does a voltage sensor work?

A **voltage sensor** is a **sensor** used to calculate and monitor the amount of **voltage** in an object. **Voltage sensors** can determine the AC **voltage** or DC **voltage** level. The input of this **sensor** is the **voltage**, whereas the output is the switches, analog **voltage** signal, a current signal, or an audible signal.

b. How do you measure voltage with a sensor?

Input and output **voltage** can be calculated **using**: Vin = Vout * (R2/(R1+R2)) Here R1 = 30K ohm and R2 = 7.5K ohm Vout = (analogvalue * 5 / 1024).

c. Can Arduino detect voltage?

It's relatively simple to use an **Arduino** to **measure voltages**. The **Arduino** has several analog input pins that connect to an analog-to-digital converter (ADC) inside the **Arduino**. The **Arduino** ADC is a ten-bit converter, meaning that the output value will range from 0 to 1023.

Water Flow Sensor-

Water Flow Sensor, as the name suggests, is a device to measure the **flow of water**. ... It has a plastic valve body with a rotor and a hall **sensor** circuit. It has three wires namely +5V (Red), GND (Black) and Output (Yellow). Since it works on +5V, it can be interfaced with any microcontroller like **Arduino**, for example.

a. What is a water flow sensor?

Water Flow Sensor. **Water flow sensors** are installed at the **water** source or pipes to measure the rate of **flow** of **water** and calculate the amount of **water** flowed through the pipe. Rate of **flow** of **water** is measured as liters per hour or cubic **meters**.

b. How do water flow sensors work?

The mechanical types of **water flow meters** work by measuring the speed of **water** flowing through the pipe that causes a piston or turbine to rotate. The volumetric **flow** rate of the **water** is proportional to the rotational speed of the blades.

c. What is the use of flow sensor?

Flow sensors are devices used for measuring the flow rate or quantity of a moving liquid or **gas** (22). New materials have been introduced into flow sensors to improve their performance.

Touch Sensor-

Touch sensor (also called **touch** button or **touch** switch) is widely used to control devices (e,g. touchable lamp). It has the same functionality as a button.
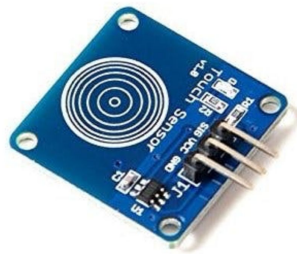
a. How does the touch sensor work?

Touch sensors work similar to a switch. When they are subjected to **touch**, pressure or force they get activated and acts as a closed switch. When the

pressure or contact is removed they act as an open switch. Capacitive **touch sensor** contains two parallel conductors with an insulator between them.

b. What is the application of touch sensor?

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.

Gyroscope Sensor-

The **gyroscope sensor** measures rotational velocity or rate of change of the angular position over time, along the X, Y and Z axis.
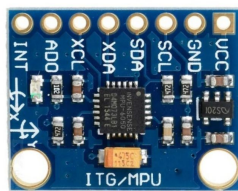
a. How does a gyroscope sensor work?

The motion of a pair of **sensing** arms produces a potential difference from which angular velocity is sensed. The angular velocity is converted to, and output as, an electrical signal. 4. The stationary part bends due to vertical drive arm vibration, producing a **sensing** motion in the **sensing** arms.

b. What does a gyroscope measure?

The **gyroscope** maintains its level of effectiveness by being able to **measure** the rate of rotation around a particular axis. When gauging the rate of rotation around the roll axis of an aircraft, it identifies an actual value until the object stabilizes out.

CO2 Sensor MH-Z16-

Infrared **CO2 sensor MH-Z16** Is a general-purpose, small **sensors**, the use of non-dispersive infrared (**NDIR**) Present in the principle of the air **CO2** Detect, with good selectivity, oxygen-dependent, long life, built-in temperature **sensor**, temperature compensation, with UART output, easy to use.

pH Sensor-

Analog **pH sensor** is designed to measure the **pH** value of a solution and show the acidity or alkalinity of the substance. It is commonly used in various applications such as agriculture, wastewater treatment, industries, environmental monitoring, etc.

a. What are pH sensors?

A **pH sensor** helps to measure the acidity or alkalinity of the water with a value between 0-14. When the **pH** value dips below seven, the water starts to become more acidic. ... Each type of **pH sensor** works differently to measure the quality of the water. The **pH** of water can help determine the quality of water.

b. How does a pH sensor work?

With the glass **electrode**, a glass membrane is fused on as a **pH sensor**. This membrane is filled with a buffer solution of known **pH** (typically **pH** = 7). ... The difference in H+ ions creates a potential that is read versus the stable potential of the reference **electrode**.

c. How is pH calculated?

   To **calculate** the **pH** of an aqueous solution you need to know the concentration of the hydronium ion in moles per liter (molarity). The **pH** is then **calculated** using the expression: **pH** = - log [H_3O^+]. ... Example: What is the pOH of a solution that has a hydroxide ion concentration of 4.82 x 10^{-5} M?

EC Sensor-

Plug and play conductivity **sensor** for **Arduino** is a convenient way to measure water salinity . Analog unit receives power from **Arduino's** 5v power supply and provides 0-5v output to any of it's analog inputs.

a. How does EC sensor work?

   The Vernier Conductivity **Probe** measures the ability of a solution to conduct an electric current between two electrodes. In solution, the current flows by ion transport. Therefore, an increasing concentration of ions in the solution will result in higher conductivity values. ... This current is converted into a voltage.

b. How is EC measured?
   EC is measured in units called Seimens per unit area (e.g. mS/cm, or miliSeimens per centimeter), and the higher the dissolved material in a water or soil sample, the higher the **EC** will be in that material.

c. What is EC value?
   EC stands for Electric Conductivity. Simply put, the **EC value** is the salt concentration in your substrate or in the nutrient solution. The salt concentration is a good indication of the available nutrients. This is why the **EC value** is important: it tells you if your plants are receiving the right amount of nutrients.

Water Pressure Sensor/ Liquid Pressure Sensor-

This is a **water pressure sensor** that adopts DFRobot Gravity 3-pin interface. It supports

standard 5V voltage input and 0.5~4.5V linear voltage output. It is compatible with multiple **Arduino** controllers. ... It will help you to diagnose whether there is **water**, how strong the **water pressure** is.

a. How does a water pressure sensor work?

Water pressure sensors are **transducers**, generating an electrical signal in proportion to the **pressure** they measure. ... This resistance is used to modify the output voltage of the **sensor**. Some **water pressure sensors** provide zero-based outputs, where zero **pressure** results in no output signal at all.

b. Where would a pressure sensor be used?

Pressure sensors are **used** for control and monitoring in thousands of everyday applications. **Pressure sensors** can also be **used** to indirectly measure other variables such as fluid/gas flow, speed, water level, and altitude.

Force Pressure Sensor-

Interfacing **Force** Sensitive Resistor to **Arduino**. An FSR(**Force** Sensitive Resistor) is a **sensor** that allows you to measure physical **pressure**, weight and squeezing. They are pretty much used in DIY electronics as they are available at low cost.
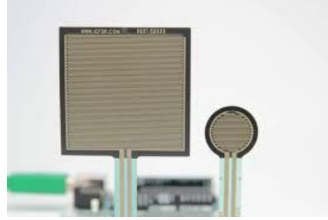
a. How does a force sensor work?

The **working** principle of a **force sensor** is that it responds to the applied **force**, as well as converts the value to a measurable quantity. ... These contain a conductive polymer film, which changes its resistance in a predictable way once **force** is applied on the surface.

BMP180 Pressure Sensor-

The BMP180 **barometric pressure sensor** is a great **sensor** that can be used to predict the weather, detect altitude, and measure vertical velocity. ... In this tutorial, I'm going to show you how to setup the BMP180 on an **Arduino**, so you can measure **barometric pressure**, and altitude from the ground or from sea level.
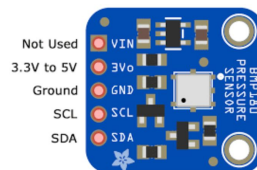
a. What is BMP180 pressure sensor?

BMP180 is one of **sensor** of BMP XXX series. They are all designed to measure Barometric **Pressure** or Atmospheric **pressure**. **BMP180** is a high precision **sensor** designed for consumer applications. Barometric **Pressure** is nothing but weight of air applied on everything.

b. How does a barometer sensor work?

How it **works**: Aneroid **barometer** consists of an aneroid cell inside. The aneroid cell expands/contracts when there are small changes to atmospheric pressure. This movement from the aneroid cell causes mechanical levers to amplify, resulting in display pointers to trigger and register as readings on the front display.

BMP280 Barometric Pressure Sensor-

BMP280 is **an absolute barometric pressure sensor especially designed for mobile applications**. The sensor module is housed in an extremely compact package. Its small dimensions and its low power consumption allow for the implementation in battery driven devices such as mobile phones, GPS modules or watches.

a. What is the BMP280?

The BMP280 is **an absolute barometric pressure sensor**, which is especially feasible for mobile applications. Its small dimensions and its low power consumption allow for the implementation in battery-powered devices such as mobile phones, GPS modules or watches.

b. How does the BMP280 work?

Grove - Barometer Sensor (BMP280) is a breakout board for Bosch BMP280 high-precision and low-power digital barometer. This module can be **used to measure temperature and atmospheric pressure accurately**. As the atmospheric pressure changes with altitude, it can also measure approximate altitude of a place.

c. How accurate is BMP280?

The BMP280 is perfectly suitable for applications like floor level detection since the sensors features excellent **relative accuracy of ±0.12 hPa**, which is equivalent to ±1 m difference in altitude, and an offset temperature coefficient (TCO) of only 1.5 Pa/K (equivalent to 12.6 cm/K).

BME280 Pressure Sensor-

The **BME280 sensor** module reads barometric **pressure**, temperature, and humidity. Because **pressure** changes with altitude, you can also estimate altitude. There are several versions of this **sensor** module. The **BME280 sensor** uses I2C or SPI communication protocol to exchange data with a microcontroller.

a. What is BME280 sensor?

The **BME280** is a humidity **sensor** especially developed for mobile applications and wearables where size and low power consumption are key design parameters. The unit combines high linearity and high accuracy **sensors** and is perfectly feasible for low current consumption, long-term stability and high EMC robustness.

b. How does a BME280 work?

The **BME280** sensor module reads barometric pressure, temperature, and humidity. Because pressure changes with altitude, you can also estimate altitude. There are several versions of this sensor module. The **BME280** sensor uses I2C or SPI communication protocol to exchange data with a microcontroller.

Color Sensor-

A **Color Sensor**, as the name suggests, is a device that senses or detects **colors**. A **color sensor** will use an external means of emitting light (like an array of white LEDs) and then analyse the reflected light from the object in order to determine its **color**.

a. How does the color sensor work?

A **color sensor** is a type of "photoelectric **sensor**" which emits light from a transmitter, and then detects the light reflected back from the detection object with a receiver.

b. What are the main parts of a color sensor?

A light source to illuminate the material surface, a surface whose **color** has to be detected and the receivers which can measure the reflected wavelengths. **Colour sensors** contain a white light emitter to illuminate the surface.

Pulse Sensor/ Heart Rate Sensor-

The **Pulse Sensor** is a plug-and-play **heart-rate sensor** for **Arduino**. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate live **heart-rate** data into their **projects**. Essence it is an integrated optical amplifying circuit and noise eliminating circuit **sensor**.

a. What is pulse rate sensor?

Pulse Sensor is a well-designed plug-and-play heart-**rate sensor** for Arduino. ... The **sensor** clips onto a fingertip or earlobe and plugs right into Arduino with some jumper cables. It also includes an open-source monitoring app that graphs your **pulse** in real time.

b. How does a pulse sensor work?

Pulse sensors use the photoelectric method. ... Transmission types measure **pulse** waves by emitting red or infrared light from the body surface and detecting the change in blood flow during heart beats as a change in the amount of light transmitted through the body.

Accelerometer-

Accelerometer is an electromechanical device that measures the force of acceleration due to gravity in g unit. It can be used in applications requiring tilt sensing. The ADXL335 measures acceleration

along X, Y and Z axes and gives analog voltage output proportional to the acceleration along these 3 axes.

a. What is the principle of accelerometer?

The basic underlying working **principle** of an **accelerometer** is such as a dumped mass on a spring. When acceleration is experienced by this device, the mass gets displaced till the spring can easily move the mass, with the same rate equal to the acceleration it sensed.

b. How does an accelerometer sensor work?

An **accelerometer** is a device that measures the vibration, or acceleration of motion of a structure. The force caused by vibration or a change in motion (acceleration) causes the mass to "squeeze" the piezoelectric material which produces an electrical charge that is proportional to the force exerted upon it.

Position Sensor-

Position Sensors. ... As their name implies, **Position Sensors** detect the **position** of something which means that they are referenced either to or from some fixed point or **position**. These types of **sensors** provide a "positional" feedback.

a. What is the principle of operation of potentiometric position sensor?

Potentiometric position sensor is **operated** based on the **principle** of resistive effect. A resistive track acts as a sensing element, and a wiper is attached to the body or part of the body whose displacement is to be measured. The wiper is also in contact with the track.

b. How do Arduino sensors work?

The Sharp proximity **sensor** can detect objects as close as 10 cm and as far away as 80 cm. It emits a pulse of infrared light and then detects the angle at which that light is reflected. The farther away an object is, the lower the output voltage. ... The **sensor's** output is connected to an **Arduino** analog input.

Water/ Liquid Level Sensor-

The water **level sensor** is super easy to use and only has 3 pins to connect. S (Signal) pin is an analog output that will be connected to one of the analog inputs on your **Arduino**. + (VCC) pin supplies power for the **sensor**. It is recommended to power the **sensor** with between 3.3V – 5V.
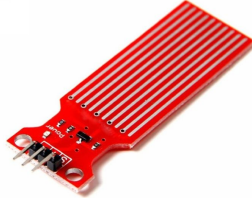
a. How does a water level sensor work?

Water level indicators work by using **sensor** probes to indicate **water** levels in a storage tank. These probes send information back to the control panel to trigger an alarm or **indicator**. As mentioned above, the control panel can be programmed to automatically turn on your pump to refill the **water** again.

b. What is the use of water level sensor?

Level sensors are used to detect the **level** of substances that can flow. Such substances include liquids, slurries, granular material and powders. **Level** measurements can be done inside containers or it can be the **level** of a river or lake.

Bio Sensor-

Well, a device similar to a Life Alert medical alarm system can be made as a portable **biosensor**. We decided to invest time in this **biosensor** because we think it is important that the people in are community, especially those at risk of falls, are safe.

a. What is bio sensor write working and application?

The simplest definition of a **Biosensor** is given here: A **Biosensor** is an analytical device that detects changes in **Biological** processes and converts them into an electrical signal. The term **Biological** process can be any **biological** element or material like enzymes, tissues, microorganisms, cells, acids, etc.

b. How does a biosensor work?

The term "**biosensor**" is short for "biological sensor." The device is made up of a transducer and a biological element that may be an enzyme, an antibody or a nucleic acid. The bioelement interacts with the analyte being tested and the biological response is converted into an electrical signal by the transducer.

Weight Sensor-

HX711 is a 24bit ADC, which amplifies and digitally converts the **Load cell** output. Then this amplified value is fed to the **Arduino**. Now **Arduino** calculates the output of HX711 and converts that into the **weight** values in grams and shows it on LCD. A push-button is used for calibrating the system.

a. How does a weight sensor work?

By definition, a **weight sensor** is a type of transducer, specifically a **weight** transducer. It converts an input mechanical force such as **load**, **weight**, tension, compression, or pressure into another physical variable, in this case, into an electrical output signal that can be measured, converted and standardized.

b. What is load cell working principle?

Load cell is a **sensor** or a transducer that converts a **load** or force acting on it into an electronic signal. Resistive **load cells work** on the **principle** of piezo-resistivity. ... When a **load**/force/stress is applied to the **sensor**, it changes its resistance.

Hall Effect Sensor-

The **Arduino Hall effect sensor** code can be used to detect a **magnet** and count the number of times it detects it. This is a very simple **Arduino** code that utilizes the interrupt pin 0 (digital pin 2) of the **Arduino**. Whenever the **Hall effect sensor** detects a **magnet**, it outputs a HIGH (5V) voltage to its Vout pin.

a. What is the principle of Hall effect?

The **principle of Hall Effect** states that when a current-carrying conductor or a semiconductor is introduced to a perpendicular magnetic field, a **voltage** can be measured at the right angle to the current path.

b. How does a Hall effect sensor work?

Using semiconductors (such as silicon), **Hall effect sensors work** by measuring the changing voltage when the device is placed in a magnetic field. In other words, once a **Hall effect sensor** detects that it is now in a magnetic field, it is able to sense the position of objects.

DHT22 Humidity Sensor-

The **DHT22** is a basic, low-cost digital temperature and humidity **sensor**. It uses a capacitive humidity **sensor** and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). ... Humidity: 0-100%, 2-5% accuracy. Temperature: -40 to 80°C, ±0.5°C accuracy.

a. How connect DHT22 to Arduino?

Wiring – **Connecting** DHT11 and **DHT22 to Arduino** UNO

Power the sensor with 5V and **connect** ground to ground. Finally, **connect** the Data pin to a digital pin #2. We also need to place a pull-up resistor of 10KΩ between VCC and data line to keep it HIGH for proper communication between sensor and MCU.

CMOS/ Image Sensor-

This is a low cost camera module, that can operate at a maximum of 30 fps and 640 x 480 ("VGA") resolutions, equivalent to 0.3 Megapixels. ... It provides full-frame, sub-sampled or windowed 8-bit images in various formats, controlled through the Serial Camera Control Bus (SCCB) interface.

a. How does a CMOS sensor work?

Complementary Metal Oxide Semiconductor (**CMOS**)

In a **CMOS sensor**, the charge from the photosensitive pixel is converted to a voltage at the pixel site and the signal is multiplexed by row and column to multiple on chip digital-to-analog converters (DACs). Inherent to its design, **CMOS** is a digital device.

b. What is CMOS sensor type?

A **CMOS sensor** is an electronic chip that converts photons to electrons for digital processing. **CMOS** (complementary metal oxide semiconductor) **sensors** are used to create images in digital cameras, digital video cameras and digital CCTV cameras.

Eye Blink Sensor-

This **Eye Blink sensor** senses the **eyeblink** using is infrared. The Variation Across the **eye** will vary as per **eye blink**. If the **eye** is closed, the output is high otherwise the output is low.
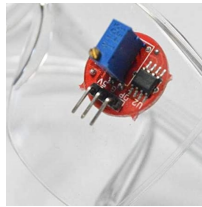
a. What is eye blink sensor?

The **eye-blink sensor** works by illuminating the **eye** and eyelid area with infrared light, then monitoring the changes in the reflected light using a phototransistor and differentiator circuit. ... Digital **Eye Blink** monitor for Vehicle Accident prevention & . Suitable for real time driving applications.

b. How does a blink sensor work?

The project involves preventing accidents due to drowsiness in vehicles by using **eye blink sensor**. The IR transmitter transmits infrared rays into

the **eyes**. The ray reflected from the **eye** is picked up by the receiver which is in a straight line to the transmitter.

DS3231 RTC Module/Clock Module-

The DS3231 is an **RTC** IC developed by Maxim Integrated. It is a low cost, extremely accurate **RTC** IC with communication over I2C Interface. An interesting feature of DS3231 **RTC** IC is that it has integrated crystal oscillator and temperature sensor and hence you don't have to connect an external crystal.
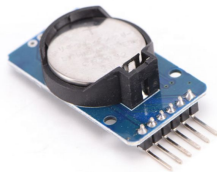
c. What is a clock module?
   Introduction. The SparkFun Real Time **Clock Module** is a simple breakout board for the DS1307 real-time **clock** (**RTC**). It can accurately keep track of seconds, minutes, hours, days, months, and years for almost a decade, so your microcontroller doesn't have to.

d. How does RTC module work?
   An **RTC** maintains its clock by counting the cycles of an oscillator – usually an external 32.768kHz crystal oscillator circuit, an internal capacitor based oscillator, or even an embedded quartz crystal. ...

Some RTCs maintain the oscillator setting at the last known point before it went out of lock with the input.

RFID Car Reader

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 is a technology similar in theory to bar codes. However, the RFID tag does not have to be scanned directly, nor does it require line-of-sight to a reader. The RFID tag it must be within the range of an RFID reader, which ranges from 3 to 300 feet, in order to be read. RFID technology allows several items to be quickly scanned and enables fast identification of a particular product, even when it is surrounded by several other items.

RFID tags have not replaced bar codes because of their cost and the need to individually identify every item.

c. What is RFID card reader?
Radio-frequency identification (**RFID**) uses electromagnetic fields to automatically identify and track tags attached to objects. ... 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**.

d. How do RFID card readers work?
RFID methods utilize radio waves to accomplish this. ... **RFID** tags contain an integrated circuit and an antenna, which are used to transmit data to the **RFID reader** (also called an interrogator). The **reader** then converts the radio waves to a more usable form of data.

ESP32 CAM WiFI Module-

The ESP32 **CAM WiFi Module** Bluetooth with OV2640 **Camera Module** 2MP For Face Recognization has a very competitive small-size **camera module** that can operate independently as a minimum system with a footprint of only 40 x 27 mm; a deep sleep current of up to 6mA and is widely used in various IoT applications.

c. What is ESP32 camera module?
Overview. The **ESP32-CAM** is a small size, low power consumption **camera module** based on **ESP32**. It comes with an OV2640 **camera** and

provides onboard TF card slot. The **ESP32-CAM** can be widely used in intelligent IoT applications such as wireless video monitoring, WiFi image upload, QR identification, and so on.

d. How do I know if my ESP32 cam is working?
1) Go to Tools > Board and select AI-Thinker **ESP32-CAM**. 2) Go to Tools > Port and select the COM port the **ESP32** is connected to. 3) Then, click the upload button to upload the code. 4) When you start to **see** these dots on the debugging window as shown below, press the **ESP32-CAM** on-board RST button.

Tracking sensors-

The Track Sensor Module contains an **IR Infrared reflection sensor** that can be used for line following and edge detection. This sensor is uses one TCRT5000 infrared reflection sensor to detect black lines drawn onto a white surface. Use a few of these modules to enable your robot to follow a line.


Analog Temperature Sensor-

What is an Analog Temperature Sensor?

An analog (or voltage output) temperature sensor provides a voltage level that is directly proportional to the measured temperature. In simple words, these **devices convert temperature to voltage**.

Microphone Sensor-

A microphone is a sensor or transducer **which converts sound to electric signals**. ... When the moving plate (diaphragm) vibrates in time with the sound wave, the distance between the plates and hence the capacitance is changed. The changes in capacitance can then be converted to an electrical signal.
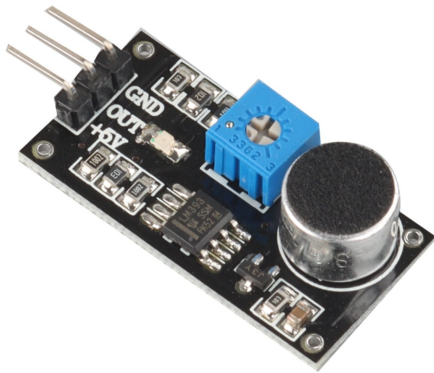
Magnetic Reed Switch sensor-

The sensor has three pins, from left to right on the sensor Digital Out (DO), Ground (GND) and input voltage (VCC). When the sensor reaches a specific level of magnetism detected it will output as LOW on the digital out pin.

Micro SD Card Reader-

Micro SD Card Reader Module has an **SPI interface** which is compatible with any sd card and it uses 5V or 3.3V power supply which is compatible with Arduino UNO/Mega.SD module has various applications such as data logger, audio, video, graphics.

KY-Knock Sensor-

The knock sensor, **detects the knocks and the taps**. It can work like a switch. The sensor output normally stays at High logic. The spring inside this sensor vibrates when knock or tap is detected and sends pulse or multiple high low pulses.

<u>LCD Display-</u>

An LCD is an electronic display module that uses liquid crystal to produce a visible image.

The 16×2 LCD display is a very basic module commonly used in DIYs and circuits. The 16×2 translates o a display 16 characters per line in 2 such lines. In this LCD each character is displayed in a 5×7 pixel matrix.
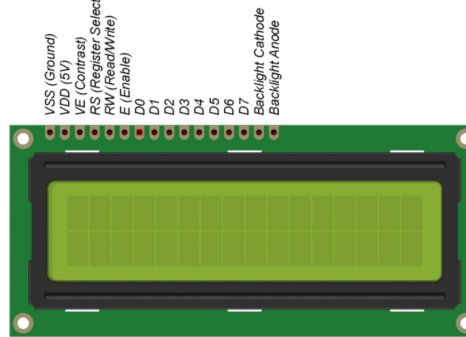
c. What does 16 mean in 16x2 LCD?
   A **16x2 LCD means** it **can** display **16** characters per line and there **are** 2 such lines. In this **LCD** each character **is** displayed in 5x7 pixel matrix. The **16** x 2 intelligent alphanumeric dot matrix display **is** capable of displaying 224 different characters and symbols. This **LCD** has two registers, namely, Command and Data.

d. How do you use 16 <UNK> 2 LCD display?
   16×2 Character LCD Pinout

- VCC is the power supply for the **LCD** which we connect the 5 volts pin on the Arduino.
- Vo (**LCD** Contrast) controls the contrast and brightness of the **LCD**. ...
- RS (Register Select) pin lets the Arduino tell the **LCD** whether it is sending commands or the data.