# King Khalid University

***College of Computer Science***
***Department of Computer Engineering***


## LABORATORY ACTIVITY MANUAL

# 212CNE-4 Electronic Measurement & Instrumentation

**Student Information**

**Name:** ____________________________________________________________

**ID Number:** ______________________ **Serial Number:** ____ **Group Number:** __________

1444H 2nd Semester

Lab Instructor: Syed Jaffar Ali

# Syllabus and Course Outline

## Course Outline:

| Week No. | Experiment Number | Name of the experiment | Date | Marks Secured |
|---|---|---|---|---|
| 1 | Experiment 1 | Introduction to Electronics Measurement | 05/12/2022 | |
| 2 | Experiment 2 | Errors in Measurements | 12/12/2022 | |
| 3 | Experiment 3 | Measurement of Resistance Using Voltmeter & Ammeter | 19/12/2022 | |
| 4 | Experiment 4 | Measurement of Resistance Using Wheatstone's Bridge | 26/12/2022 | |
| 5 | Experiment 5 | Measurement of Capacitance Using Schering Bridge | 02/01/2023 | |
| 6 | Experiment 6 | Measurement of Inductance Using Maxwell Bridge | 09/01/2023 | |
| 7 | Experiment 7 | Introduction to Arduino and Sensors | 16/01/2023 | |
| 8 | Experiment 8 | Temperature & Humidity Sensor | 23/01/2023 | |
| 9 | Experiment 9 | MQ-2 Gas Sensor | 30/01/2023 | |
| | Experiment 10 | Sound Sensor | 30/01/2023 | |
| 10 | Experiment 11 | Photoresistor Sensor | 06/02/2023 | |
| | Experiment 12 | Touch Sensor | 06/02/2023 | |
| | Average of Lab Activity for 10 Marks: | | | |
| 10 | Mini Project – 10 Marks | | 06/02/2023 | |

## Grades:

- ✓ Lab Activity Manual / Report (with all Observations, Calculations & Readings) 10 marks
- ✓ Mini Project 10 marks

## Lab Policy:

- ✓ Attendance is Mandatory.
- ✓ Copies in labs will get a grade of ZERO.
- ✓ Lab reports are due at the beginning of the next lab session. LATE lab reports will have a 10% Penalty, for not submitting within one week of the due date.

# Academic Calendar Year 1444 H, Second Semester

# Computer Engineering Lab Rules and Policies

## GENERAL LABORATORY SAFETY POLICY

- The University of King Khalid University (KKU) is committed to providing a safe learning and working environment for its students, staff and faculty.
- The University of King Khalid University (KKU) and College of Computer Science require all students, visitors, staff and faculty to obey all Laboratory Safety Rules when present in all Computer Engineering laboratories at all times.

## GENERAL LABORATORY SAFETY RULES

- Food, drinks (water, coffee, tea,….), substances and related utensils shall not be brought into, stored or consumed in any laboratory.
- Smoking is prohibited in all laboratories at all times.
- Avoid all horseplay in the laboratory.
- Do not reboot, turn off, or move any workstation or PC.
- Do not load any software on any lab computer. Only lab operators and technical support personnel are authorized to carry out these tasks.
- Do not reconfigure the cabling/equipment without prior permission.
- Do not leave a workstation or a login unattended.
- Do not leave processes in the background without prior approval from the Systems Manager.
- Unauthorized users are not permitted in the computer labs. The departmental computer resources are to be used to support the instructional and research activities of the Computer Engineering (CE) Department. Abuse of these resources or conduct not in accord with University policy shall not be tolerated.
- Games may not be played on Computer lab systems or servers or cell phone,……. Etc.
- Footwear shall be serviceable, provide full coverage of the feet and have non-skid soles;
- All occupants shall be familiar with the locations and operation of safety and emergency equipment, including but not limited to, fire extinguishers, first aid kits, emergency eyewash stations and emergency showers, emergency power off system, fire alarm pull stations, emergency telephones, and emergency exits and egress plans.
- Learn and know what to do in an emergency.
- Unauthorized person(s) shall not be allowed in a laboratory for any reason.
- "Authorized" means having an official university business in the laboratory with the permission of the College of Engineering. Anyone under the age of eighteen must be under the immediate and direct supervision of a qualified authorized person at all times.
- Laboratories shall be secured when unoccupied.

- **Never open (remove cover) of any equipment in the laboratories. Never "jump," disable, bypass or otherwise disengage any safety device or feature of any equipment in the laboratories.**
- **All safety instructions, warnings, posted signs, verbal orders shall be complied with by all personnel.**
- **Report all problems and potential hazards in the Laboratories and Technical Support Unit (LTS U) room 13 /3/A -Computer Science Bldg-A.**
- **In case of emergency, dial 998.**

## Electrical Safety Guidelines

- **Be familiar with the electrical hazards associated with your workplace.**
- **You may enter the laboratory, only when authorized to do so and only during authorized hours of operation.**
- **Be as careful for the safety of others as for yourself. Think before you act. Be tidy and systematic.**
- **Remove metal bracelets, rings or watch straps when working in the laboratories.**
- **Food, drinks (water, coffee, tea,….), and other substances are strictly prohibited in the laboratory at all times. Avoid working with wet hands and clothing.**
- **Use extension cords (wires) only when necessary and only on a temporary basis.**
- **Request new outlets if your work requires equipment in an area without an outlet.**
- **Discard damaged cords(wires), cords that become hot, or cords with exposed wiring.**
- **Before equipment is energized ensure, (1) circuit connections and layout have been checked by a Teaching Assistant (TA) or Lecturer and all colleagues in your group give their assent.**
- **Know the correct handling, storage and disposal procedures for batteries, cells, capacitors, inductors and other high energy-storage devices.**
- **Experiments left unattended should be isolated from the power supplies. If for a special reason, it must be left on, a barrier and a warning notice are required.**
- **Equipment found to be faulty in any way should be reported to the LTSU immediately and taken out of service until inspected and declared safe.**
- **Voltages above 50V RMS AC and 120V DC are always dangerous. Extra precautions should be considered as voltage levels are increased.**
- **Never make any changes to circuits or mechanical layout without first isolating the circuit by switching off and removing connections to power supplies.**
- **Every lab is equipped with an Emergency Power Off System. This consists of a large switch on the wall labeled 'Emergency PowerOff' When this switch is depressed, electrical power to the lab will shut off, except for the lights. Only authorized personnel are permitted to reset power once the Emergency Power Off system has been engaged.**

# Electrical Emergency Response

**The following instructions provide guidelines for handling two types of electrical emergencies:**

1. **Electric Shock:**

   **When someone suffers a serious electrical shock, he or she may be knocked unconscious. If the victim is still in contact with the electrical current, immediately turn off the electrical power source. If you cannot disconnect the power source, depress the Emergency Power Off switch.**

   **IMPORTANT:**

   **Do not touch a victim that is still in contact with a live power source; you could be electrocuted. Have someone call for emergency medical assistance immediately. Administer first-aid, as appropriate.**

2. **Electrical Fire:**

   **If an electrical fire occurs, try to disconnect the electrical power source, if possible. If the fire is small and you are not in immediate danger; and you have been properly trained in fighting fires, use the correct type of fire extinguisher to extinguish the fire. When in doubt, push in the Emergency Power Off button.**

**DANGER: NEVER use water to extinguish an electrical fire.**

**The above general laboratory safety rules are designed to safeguard you and your co-workers, fellow students and colleagues and are a minimum requirement for individuals working in laboratories at The KKU. Specialized training and rules may apply depending type and scope of activities involved.**

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I have read and understand these rules and procedures, I agree to abide by these rules and procedures at all times while using these facilities, I understand that failure to follow these rules will result in disciplinary action may be taken.

Student Name: ---------------------------------------------------------------------- Student ID: --------------------

Lab #: - ------------------- Date: - ---------------------------- Signature: - ------------------------------------

# CONTENTS

# Experiment #1

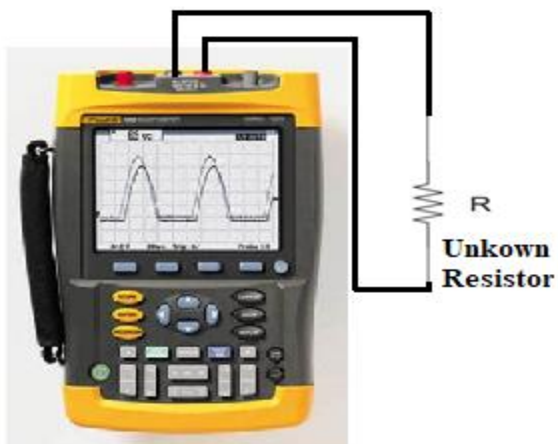
## Introduction to Electronics Measurement's

**AIM:** To understand the Equipment's and the Tools which is going to be used during the experiments and how to measure resistance value of Resitors Manually and with Equipments

**EQUIPMENTS REQUIRED:**

| Item | Quantity |
|---|---|
| Bread Board | **1** |
| Basic Electronics components | **1** |
| Resistors | **2** |
| Fluke Scope Meter | **1** |

**DIAGRAM:**



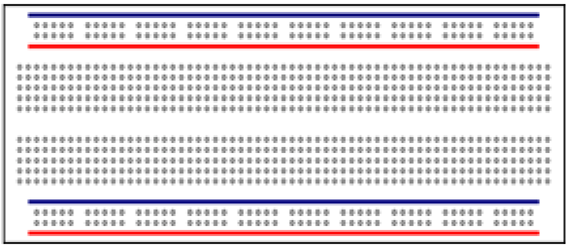

Fluke Scope Meter

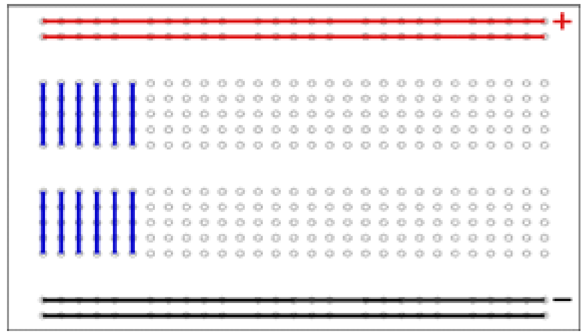
**BREIF THEORY:**

### The Breadboard:

A breadboard is used to build and test circuits quickly before finalizing any circuit design. The breadboard has many holes into which circuit components like ICs and resistors can be inserted.

Prototyping is the process of testing out an idea by creating a preliminary model from which other forms are developed or copied, and it is one of the most common uses for breadboards





So why do we call this electronic “circuit builder” a breadboard? Many years ago, when electronics were big and bulky, people would grab their mom’s breadboard, a few nails or thumbtacks, and start connecting wires onto the board to give themselves a platform on which to build their circuits.

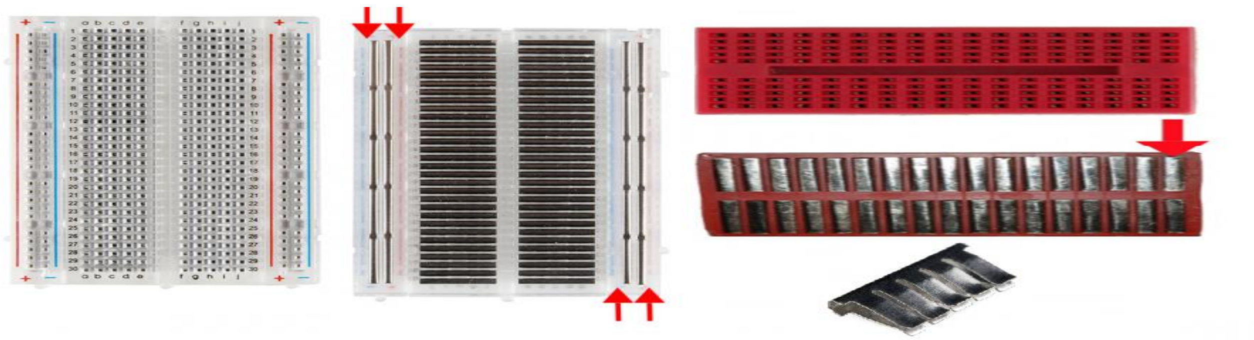
In the 1970s the solderless breadboard (also known as Plugboard, a Terminal Array Board) became available. Because the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. For this reason, solderless breadboards are also popular with students and in technological education.

Disadvantage of breadboard when compared to more permanent circuit connection methods, modern breadboards have high parasitic capacitance, relatively high resistance, and less reliable connections, which are subject to jostle and physical degradation.

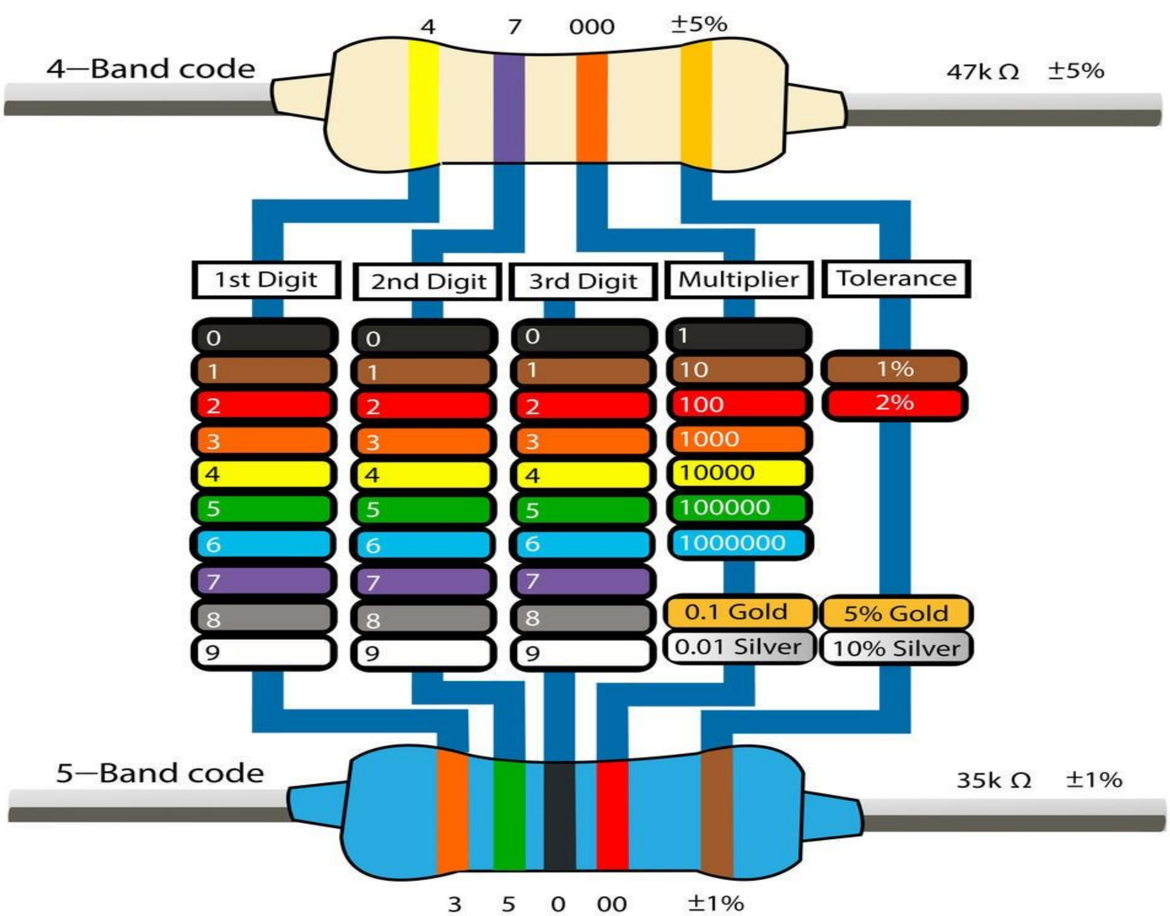
Breadboards connect pin to pin by metal strips inside the breadboard. The layout of a typical Breadboard is made up from two types of areas, called strips. Strips consist of interconnected electrical terminals.

The breadboard consists of two terminal strips and two bus strips (often broken in the center). Each bus strip has two rows of contacts. Each of the two rows of contacts are a node. That is, each contact along a row on a bus strip is connected together (inside the breadboard). Bus strips are used primarily for power supply connections but are also used for any node requiring a large number of connections. Each terminal strip has 60 columns and 5 rows of contacts on each side of the center gap. Each column of 5 contacts is a node.

Jump wires (also called jumper wires) for breadboard are with tiny plugs attached to the wire ends. Jump wire material usually be a 22-26 AWG (American Wire Gauge) (i.e. 0.33 mm2) solid copper, tin-plated wire.



**Resistor:** is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits, resistors are used to limit current flow, to adjust signal levels.



## PROCEDURE:

- Calculate the Value of Resistance for given Resistors manually from above shown method and note down in observation table
- Connect the resistance to Fluke Scope meter with crocodile clamp probes
- Switch on the Fluke Scope meter.
- Press Button named Meter and use arrow buttons to select Ohms.
- Note Down the resistance reading in observation table.
- Do the calculation to find Accuracy in observation table.

## OBSERVATIONS:

**Resistance Measurement:**

| Resistor With Color Codes | Color Code Value C | Fluke Scope Meter F | \|C – F\| | Accuracy (\|C-F\|/C)*100 |
|---|---|---|---|---|
| R1 = | | | | |
| R2 = | | | | |
| R3 = | | | | |

**Notes:**

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**Student Name:** ____________________________

**Student ID:**______________________ **EXP No.:** _____

**Instructor Signature:** ____________

**Date:** / /

# Experiment #2

## Errors in Measurements

**AIM:** To understand the measurement error caused by the Ohmmeter, voltmeter or the ammeter devices

**EQUIPMENTS REQUIRED:**

| Item | Quantity |
|---|---|
| Bread Board | **1** |
| LED | **1** |
| Resistors | **1** |
| AC/DC Power Supply | **1** |
| Fluke Scope Meter | **1** |
| Jump / Connecting Wires | **Few** |

**THEORY:**

In order to understand the concept of errors in measurement, we should know the two terms that defines the errors and these two terms are written below:

**True Value:** It is not possible to determine the true of quantity by experiment means. True value may be defined as average value of an infinite number of measured values when average deviation due to various contributing factor will approach to zero.

**Measured Value:** It may be defined as the approximated value of true value. It can be found out by taking means of several measured readings during an experiment, by applying suitable approximations on physical conditions**.**

**Absolute Error:** The absolute Error ( e ) is the magnitude of the difference between the True value and the Measure value.

**e = | True value – Measure value |**

**Relative Error:** The relative error ( er ) is the absolute error divided by the magnitude of the true value. The percent error is the relative error expressed in terms of per 100**.**

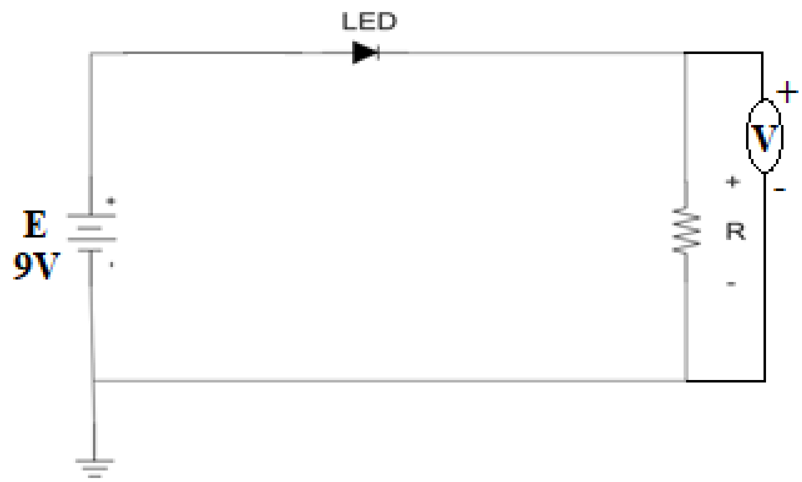
**er = Absolute error / True value**

**er = | True value – Measure value |/ True value**

**The percentage relative error is expressed as:**

**%er = (| True value – Measure value |/ True value) x 100**

## CIRCUIT DIAGRAM:




## PROCEDURE:

1. Measure the Resistance for given Resistor five times using Fluke Scope meter with one minute gap for every reading.
2. Calculate and fill the table with True Value, Absolute Error and Percentage Error.
3. Connect the Circuit as shown above and measure the voltage across the resitor five times using fluke scope meter with one minute gap for every reading.
4. Calculate and fill the table with True Value, Absolute Error and Percentage Error.

## OBSERVATION TABLE:

### Test1: Measure Errors for passive components

**Measure the Resistor values using Fluke Scope meter and fill the table below:**

| | R1 | R2 | R3 | R4 | R5 |
|---|---|---|---|---|---|
| Resistor Measured Values | | | | | |
| Absolute Error ( e ) | | | | | |
| Percentage Error ( %er ) | | | | | |

**True Value ( Average ) = (R1+R2+R3+R4+R5) / 5 = ………………………………..**

**Absolute Error ( e ) = | True Value – Measured Value|**

**Percentage Error ( %er) = ( | True Value – Measured Value| / True Value ) * 100**

### Test2: Measure Errors for active components

**Wire the circuit diagram and measure the voltage $V_R$ using Fluke Scope meter and fill the table below:**

| | $V_R$ 1 | $V_R$ 2 | $V_R$ 3 | $V_R$ 4 | $V_R$ 5 |
|---|---|---|---|---|---|
| **$V_R$ Measure Values** | | | | | |
| **Absolute Errors ( e )** | | | | | |
| **Percentage ( % er )** | | | | | |

**True Value ( Average ) = (VR1+VR2+VR3+VR4+VR4+VR5) / 5 = ……………………….**

**Absolute Error ( e ) = | True Value – Measured Value|**

**Percentage Error ( %er) = ( | True Value – Measured Value| / True Value ) * 100**

**<u>Notes:</u>**

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**Student Name:** ______________________

**Instructor Signature:** __________

**Student ID:**__________________ **EXP No.:** ____

**Date:** / /

# Experiment #3

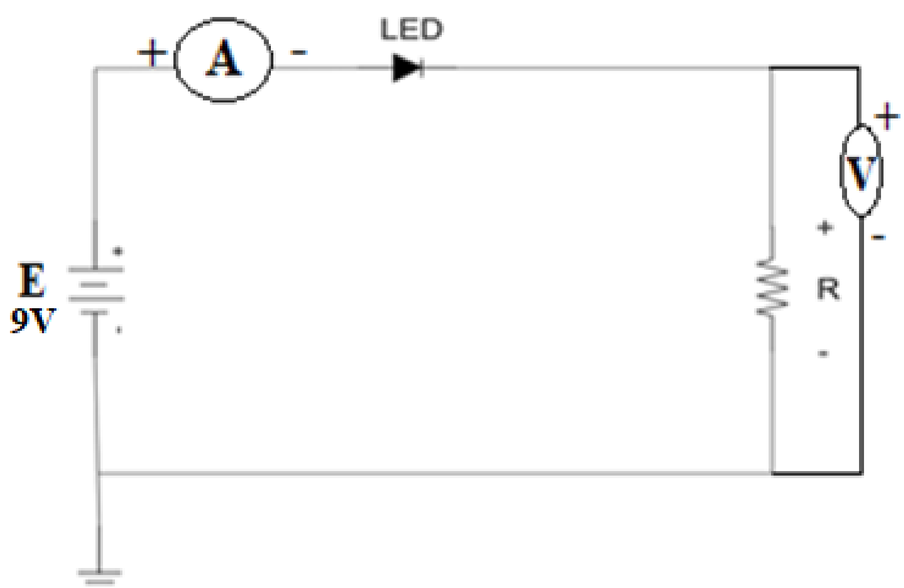
## Measurement of Resistance Using Voltmeter & Ammeter

**AIM:** To measure the unknown value of resistance using a Voltmeter and Ammeter.

**EQUIPMENTS REQUIRED:**

| Item | Quantity |
|---|---|
| Bread Board | **1** |
| LED | **1** |
| Resistors | **3** |
| Ammeter | **1** |
| AC/DC Power Supply | **1** |
| Fluke Scope Meter | **1** |
| Jump / Connecting Wires | **Few** |

**CIRCUIT DIAGRAM:**



## BRIEF THEORY:

### A resistor:

is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits, resistors are used to limit current flow, to adjust signal levels.

### ElectricCcurrent:

is a flow of electric charge. In electric circuits, this charge is often carried by moving electrons in a wire. It can also be carried by ions in an electrolyte, or by both ions and electrons such as in a plasma. The SI unit for measuring an electric current is the ampere, which is the flow of electric charge across a surface at the rate of one coulomb per second. Electric current is measured using a device called an ammeter.

### Voltage:

is the difference in electric potential energy between two points per unit electric charge. The voltage between two points is equal to the work done per unit of charge against a static electric field to move the charge between two points and is measured in units of volts (a joule per coulomb).

Voltage can be caused by static electric fields, by electric current through a magnetic field, by time- varying magnetic fields, or some combination of these three. A voltmeter can be used to measure the voltage (or potential difference) between two points in a system.

## PROCEDURE:

1. Connect the terminals as shown in circuit diagram with connecting wires using breadboard.
2. Make sure that Ammeter and LED terminals are properly connected with shown polarities.
3. Measure the Voltage and Current from Voltmeter and Ammeter and note down the readings in Observation Table.
4. Calculate the Unknown Resistance value Mannually and Practically
5. Remove the connections and handover the equipment to instructor

## OBSERVATION TABLE:

| R<br>Color Codes | Fluke Scope Meter<br>Voltage (V) | Fluke Scope Meter<br>Current (I) | $R_{Practical}$<br>=<br>( V / I ) | $R_{Manul}$<br>Color Code Vaule | Accuracy<br>=<br>$(\|R_M-R_P\|/R_M)*100$ |
|---|---|---|---|---|---|
| **R1 =** | | | | | |
| **R2 =** | | | | | |
| **R3 =** | | | | | |

**Notes:**

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**Student Name:** ____________________

**Student ID:**________________ **EXP No.:** ____

**Instructor Signature:** __________

**Date:** / /

# Experiment #4

## Measurement of Resistance Using Wheatstone's Bridge

**AIM:** To measure the unknown value of resistance using a Wheat stone's bridge.

**EQUIPMENTS REQUIRED:**

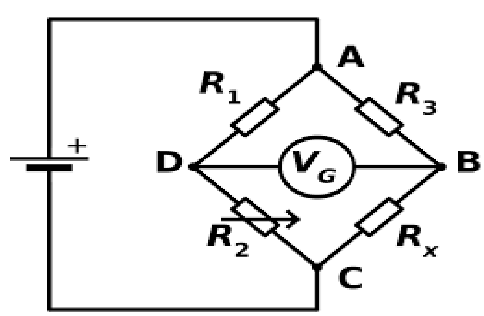
| Item | Quantity |
|---|---|
| Multisim 11.0 Software | **1** |
| Resistors | **4** |
| Mutimeter | **1** |
| AC/DC Power Supply | **1** |
| Ground | **1** |

**THEORY:**

It is an important application of Kirchhoff's rules in Physics. It is applicable to compare resistances and also to determine the unknown resistance in the electrical circuit network. Wheatstone bridge is also known as the resistance bridge.

This is useful to calculate the unknown resistance by balancing two legs of the bridge circuit and one leg includes the component of unknown resistance. It was invented by Samuel Hunter Christie during the year 1833. Later on, it was popularized by Sir Charles Wheatstone in 1843.

This bridge consists of four resistances R1, R2, R3 and RX connected along four sides of a square (say ABCD) shaped circuit. A galvanometer G is also connected in it between the points B and D. The current flowing through the galvanometer is IG and its resistance is G.



Thus, the circuit is composed of two known resistors, one unknown resistor as well as one variable resistor connected in the form of a bridge. This device is very reliable as it gives accurate measurements.

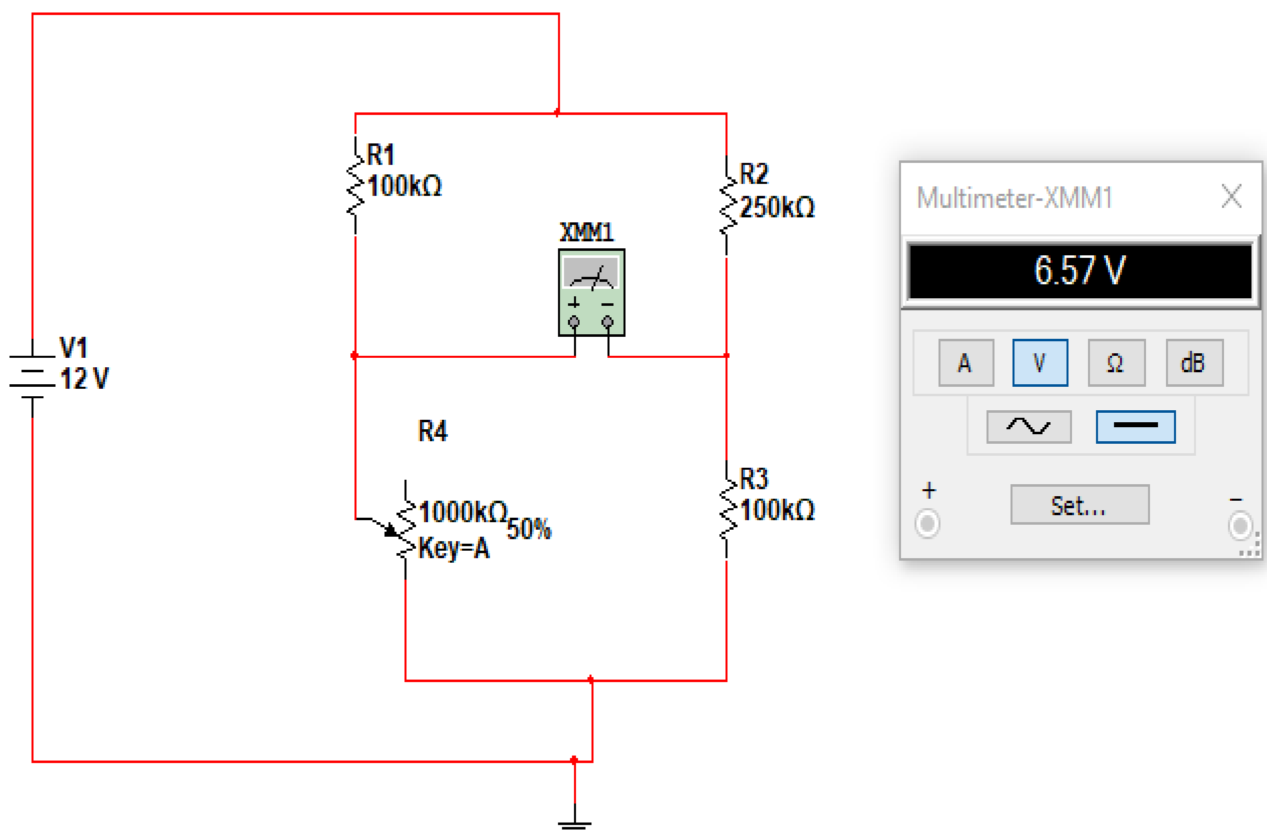
It works on the principle of null deflection, which means the ratio of their resistances are equal and hence no current flows through the circuit. Under normal conditions, the bridge will be in the unbalanced condition where current flows through the galvanometer.

The bridge will be in a balanced condition when no current flows through the galvanometer. One may achieve this condition by adjusting the known resistance and variable resistance.

$$\mathbf{R_x = ( R_2 / R_1 ) * R_3}$$

## CIRCUIT DIAGRAM:

Wheatstone Bridge for Unkown Resistance Measurement



**PROCEDURE:**

1. Make the connections in Multisim 11.0 Software use the resistance values as shown in circuit diagram.
2. Switch on the simulation button on right top corner
3. Vary the variable resistor at $R_2$ to get the nearest point of zero balance (Voltage / Current)
4. Calculate the variable resistance value and note down in observation table
5. Switch of simulation button
6. Calculate $R_4$ Manually.
7. Do the Same procedure for different values of resistance shown in Observation table

**OBSERVATION TABLE:**

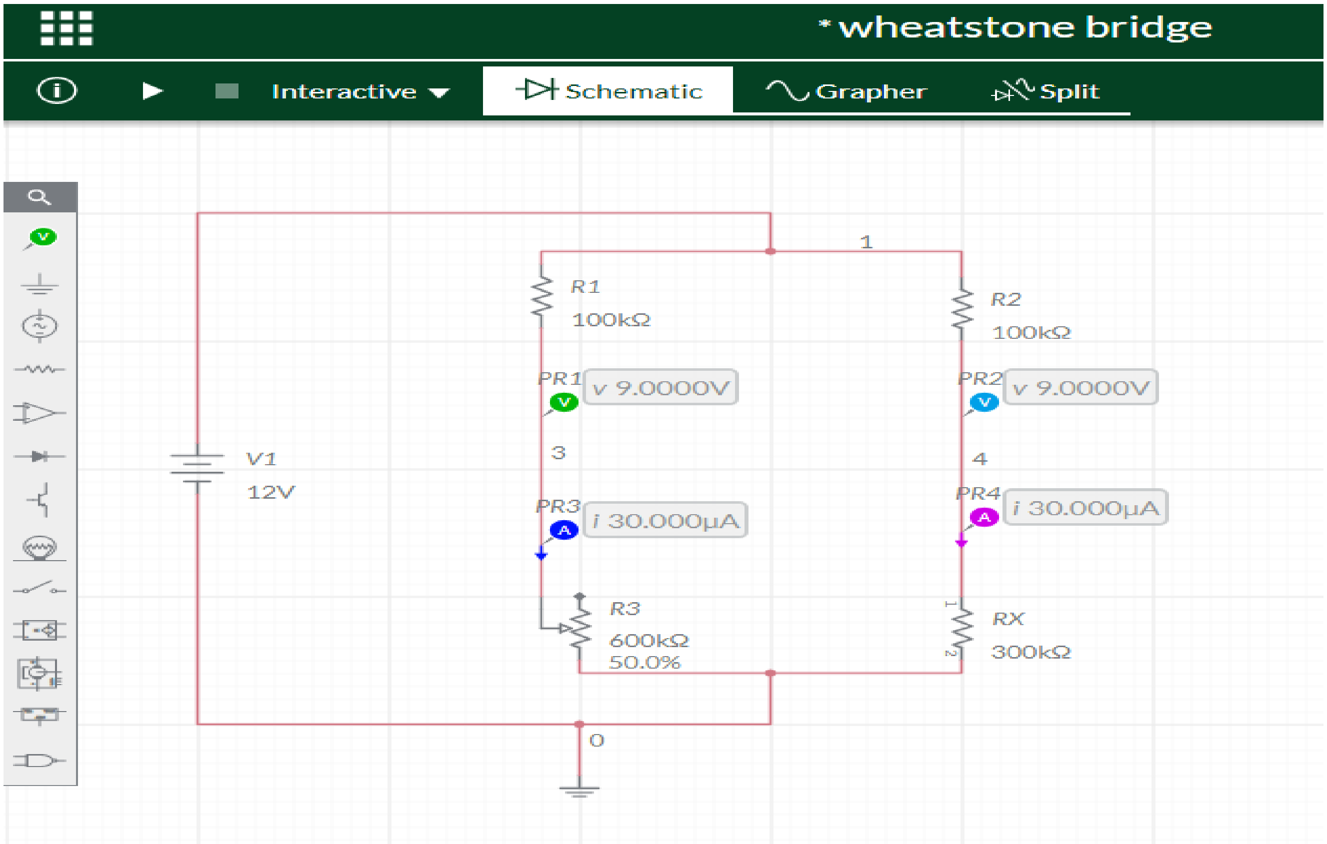
| $R_1$(KΩ) | $R_2$ (KΩ) | $R_3$(KΩ) | $R_3$ / $R_2$ Ratio | $R_{4\ Calculated}$ (KΩ) Calculated | $R_{4\ Practical}$ (KΩ) Practical | Current $I_g$ (A) | Accuracy % |
|---|---|---|---|---|---|---|---|
| 100KΩ | 250KΩ | 100KΩ | | | | | |
| 200KΩ | 250KΩ | 100KΩ | | | | | |
| 100KΩ | 250KΩ | 250KΩ | | | | | |
| 150KΩ | 200KΩ | 225KΩ | | | | | |

$$R_{4\ Calculated} = (R_3 / R_2) * R_1$$

$$\text{Accuracy} = (|R_{4\ Calculated} - R_{4\ Practical}| / R_{4\ Calculated}) * 100$$

## Activity:

Open in browser www.multisim.com, register with a new user and draw the following Circuit and simulate for results.




## Notes:

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**Student Name:** ______________________

**Student ID:**____________________ **EXP No.:** ____

**Instructor Signature:** __________

**Date:** / /

# Experiment #5

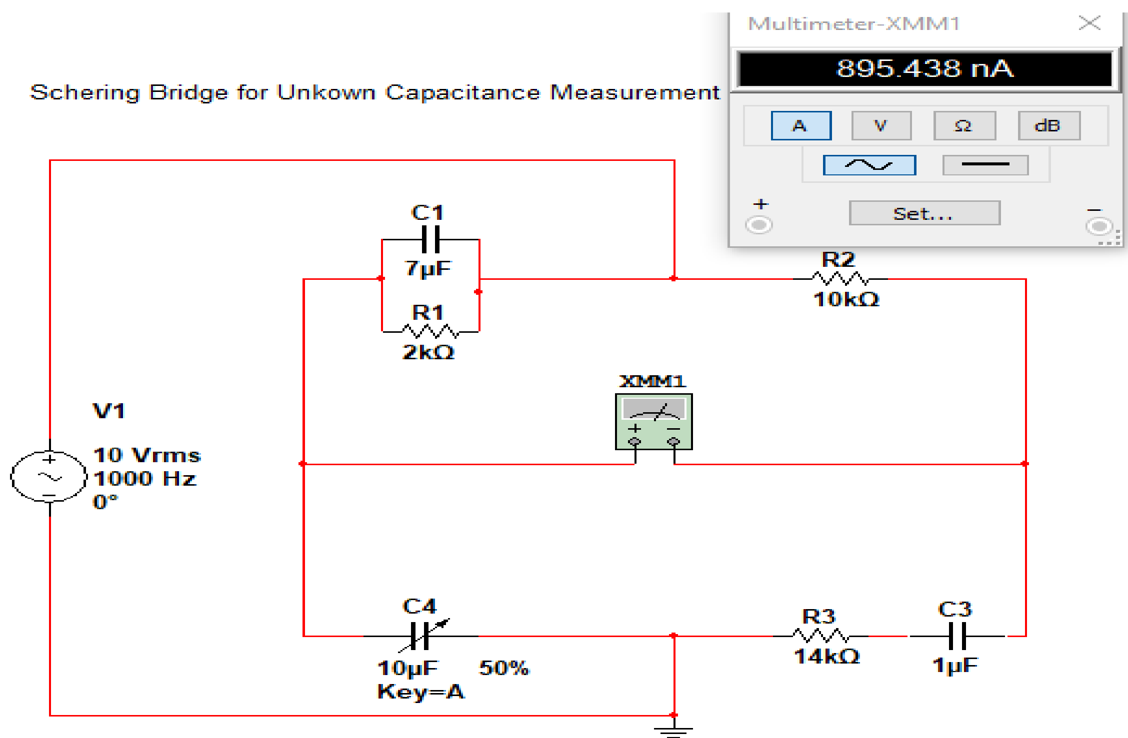
## Measurement of Capacitance Using Schering Bridge

**AIM:** To measure the unknown value of Capacitance using a Scherin bridge.

**EQUIPMENT REQUIRED:**

| Item | Quantity |
|---|---|
| Multisim 11.0 Software | **1** |
| Resistors | **3** |
| Capacitors | **3** |
| Mutimeter | **1** |
| AC/DC Power Supply | **1** |
| Ground | **1** |

**CIRCUIT DIAGRAM:**



## PROCEDURE:

1. Make the connections in Multisim 11.0 Software use the resistance and Capacitance values as shown in circuit diagram.
2. Switch on the simulation button on right top corner
3. Vary the variable resistor at $R_2$ to get the nearest point of zero balance Current
4. Calculate the variable resistance value and note down in observation table
5. Switch of simulation button
6. Calculate $C_4$ Manually.
7. Do the Same procedure for different values of resistance shown in Observation table

## OBSERVATION TABLE:

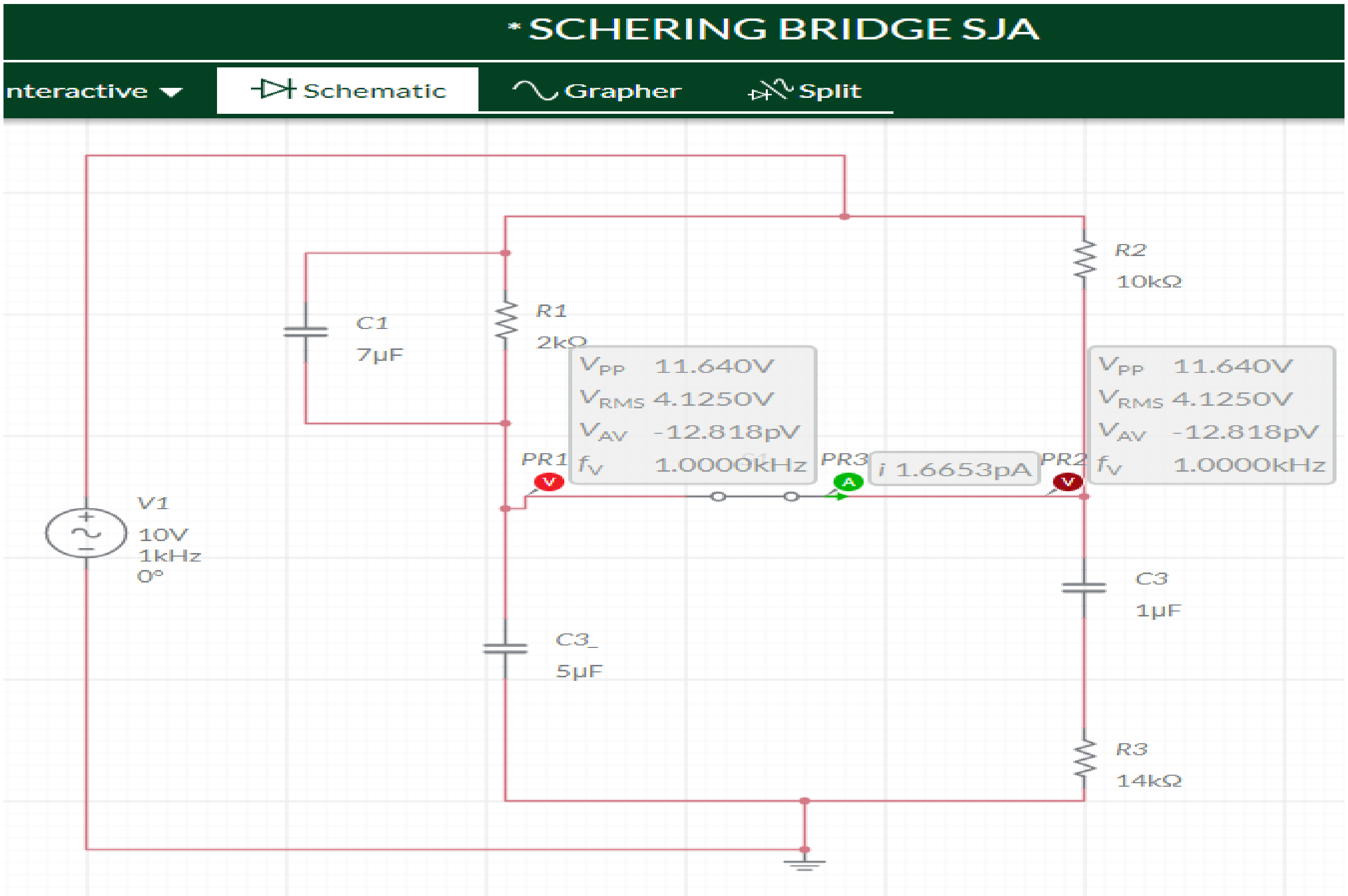
| $R_1$ (KΩ) | $R_2$ (KΩ) | $R_3$ (KΩ) | $C_1$ (uF) | $C_3$ (uF) | $R_2$ / $R_3$ Ratio | Ammeter $I_G$ (A) | $C_{4\ Calculated}$ (uF) Calculated | $C_{4\ Practical}$ (uF) Practical | Accuracy % |
|---|---|---|---|---|---|---|---|---|---|
| 2KΩ | 5KΩ | 20KΩ | 10uF | 20uF | | | | | |
| 2KΩ | 10KΩ | 14KΩ | 7uF | 1uF | | | | | |
| 8KΩ | 8KΩ | 10KΩ | 2uF | 10uF | | | | | |
| 10KΩ | 18KΩ | 5KΩ | 6uF | 4uF | | | | | |

$$C_{4\ Calculated} = (R_2 / R_3) * C_1$$

$$Accuracy = (\,|C_{4\ Calculated} - C_{4\ Practical}| \,/\, C_{4\ Calculated}) * 100$$

## Activity:

Open in browser www.multisim.com, register with a new user and draw the following Circuit and simulate for results.




## Notes:

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**Student Name:** ______________________ **Instructor Signature:** __________

**Student ID:**__________________ **EXP No.:** ____ **Date:** / /

# Experiment #6

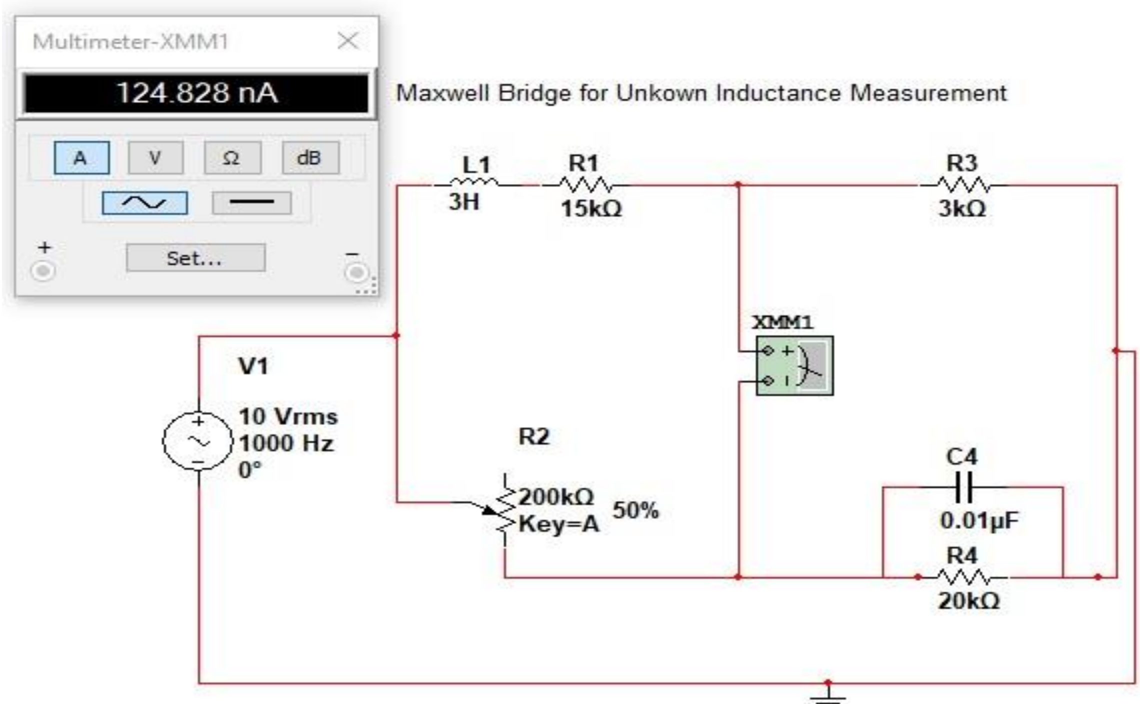
## Measurement of Inductance Using Maxwell Bridge

**AIM:** To measure the unknown value of Inductance using a Anderson bridge.

**EQUIPMENTS REQUIRED:**

| Item | Quantity |
|---|---|
| Multisim 11.0 Software | 1 |
| Resistors | 3 |
| Inductors | 3 |
| Mutimeter | 1 |
| AC/DC Power Supply | 1 |
| Ground | 1 |

**CIRCUIT DIAGRAM:**

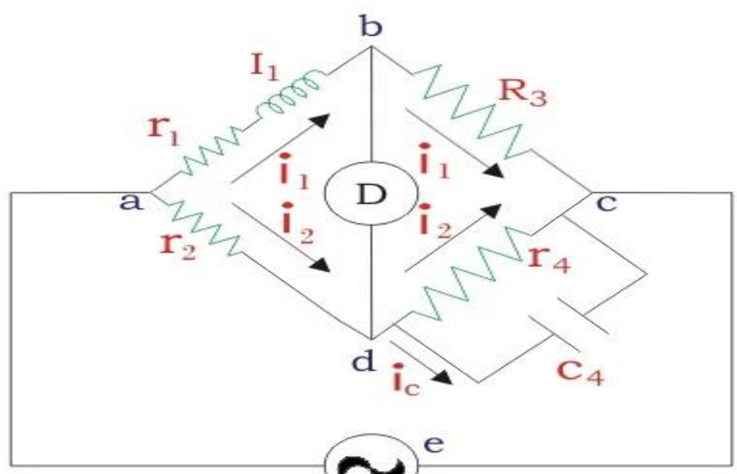


**THEORY:**

It is well known for its accuracy of measuring inductors from a few micro Henry to several Henry. The unknown value of the self inductor is measured by the method of comparison of the known value of electrical resistance and capacitance.

In this **Maxwell Bridge**, the unknown inductor is measured by the standard variable capacitor.

**Maxwell's inductor capacitance bridge** is very useful for the wide range of measurement of inductor at audio frequencies




$$l_1 = r_2 \cdot r_3 \cdot C_4$$

**PROCEDURE:**

1. Make the connections in Multisim 11.0 Software use the resistance, Capacitance and Inductance values as shown in circuit diagram.
2. Switch on the simulation button on right top corner
3. Vary the variable resistor at $R_2$ to get the nearest point of zero balance Current
4. Calculate the variable resistance value and note down in observation table
5. Switch of simulation button
6. Calculate $L_1$ Manually.
7. Do the Same procedure for different values of resistance shown in Observation table

## OBSERVATION TABLE:

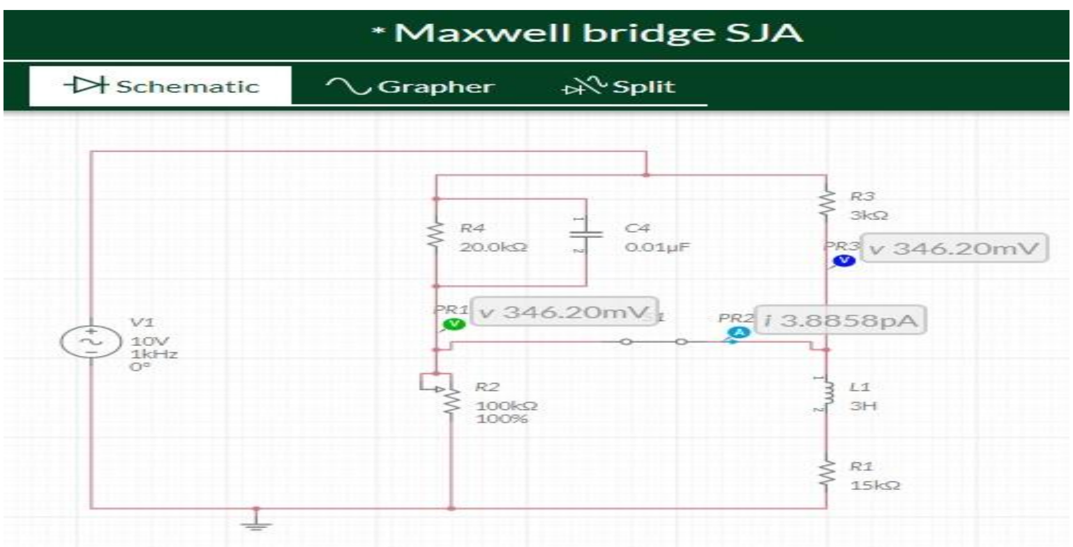
| $R_1$ (KΩ) | $R_3$ (KΩ) | $R_4$ (KΩ) | $C_4$ (uF) | $R_2$ (KΩ) | Ammeter $I_G$ (A) | $L_1$ Theoritical (H) Practical | $L_1$ Practical (H) Practical | Accuracy % |
|---|---|---|---|---|---|---|---|---|
| 15KΩ | 3KΩ | 20KΩ | 0.01uF | | | 3H | | |
| 15KΩ | 6KΩ | 20KΩ | 0.02uF | | | 6H | | |
| 15KΩ | 5KΩ | 20KΩ | 0.03uF | | | 30H | | |
| 15KΩ | 10KΩ | 20KΩ | 0.05uF | | | 10H | | |

$$L_{1\,Practical} = R_2 * R_3 * C_4$$

$$Accuracy = ( |L_{1\,Theoritical} - L_{1\,Practical}| / L_{1\,Theoritical}) * 100$$

## Activity:

Open in browser www.multisim.com, register with a new user and draw the following Circuit and simulate for results.




**Notes:**

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**Student Name:** ____________________

**Student ID:** ____________________ **EXP No.:** ____

**Instructor Signature:** __________

**Date:** / /

# Experiment #7

## Introduction to Arduino and Sensors

**AIM:** To Introduce and help you to understand the main concepts of the hardware and the software that will be used in the experiments.

Learn how to turn a single LED on or off by using an I/O port. Since the Arduino Uno board itself has an LED (connected to Pin 13), we will use the LED to accomplish this experiment for convenience.

**EQUIPMENT REQUIRED:**

| Item | Quantity |
|---|---|
| Arduino Uno board | 1 |
| USB cable | 1 |
| Resistors | 1 |
| Bread Board | 1 |
| LED | 1 |

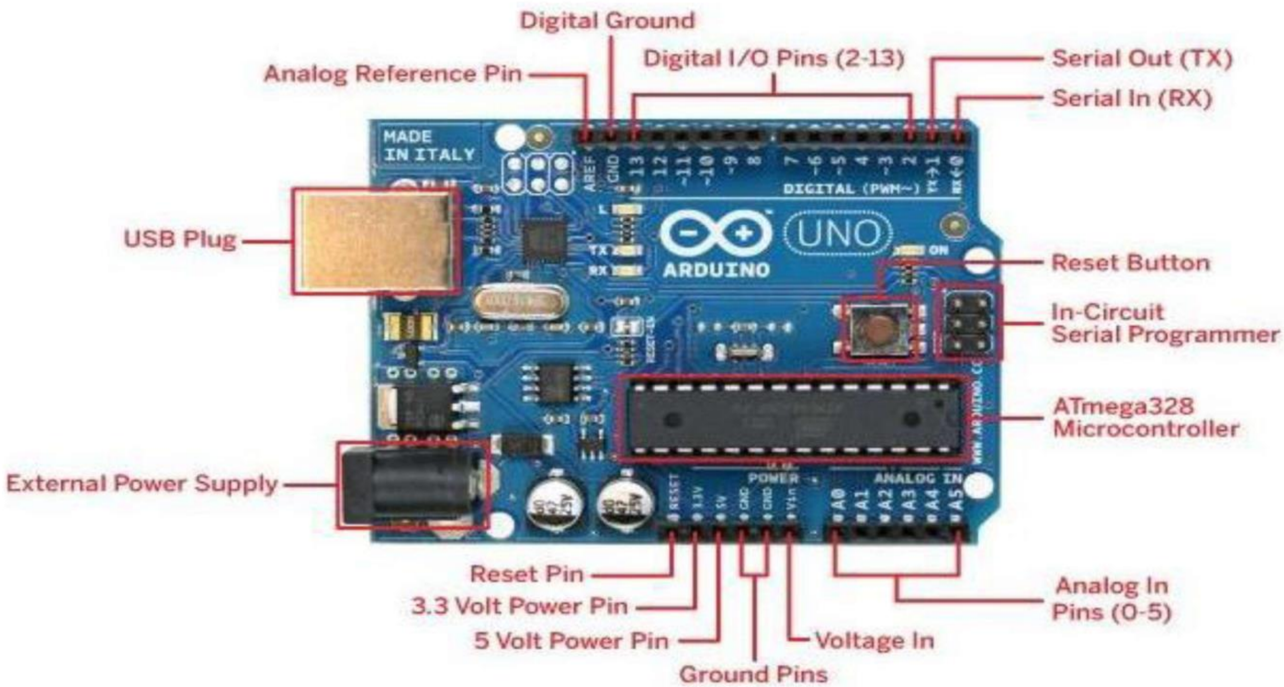
**THEORY:**

### Arduino:

Arduino is an open-source electronics platform based on easy-to-use hardware and software.

Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter

message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.




The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a

USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started

**In addition, some pins have specialized functions:**

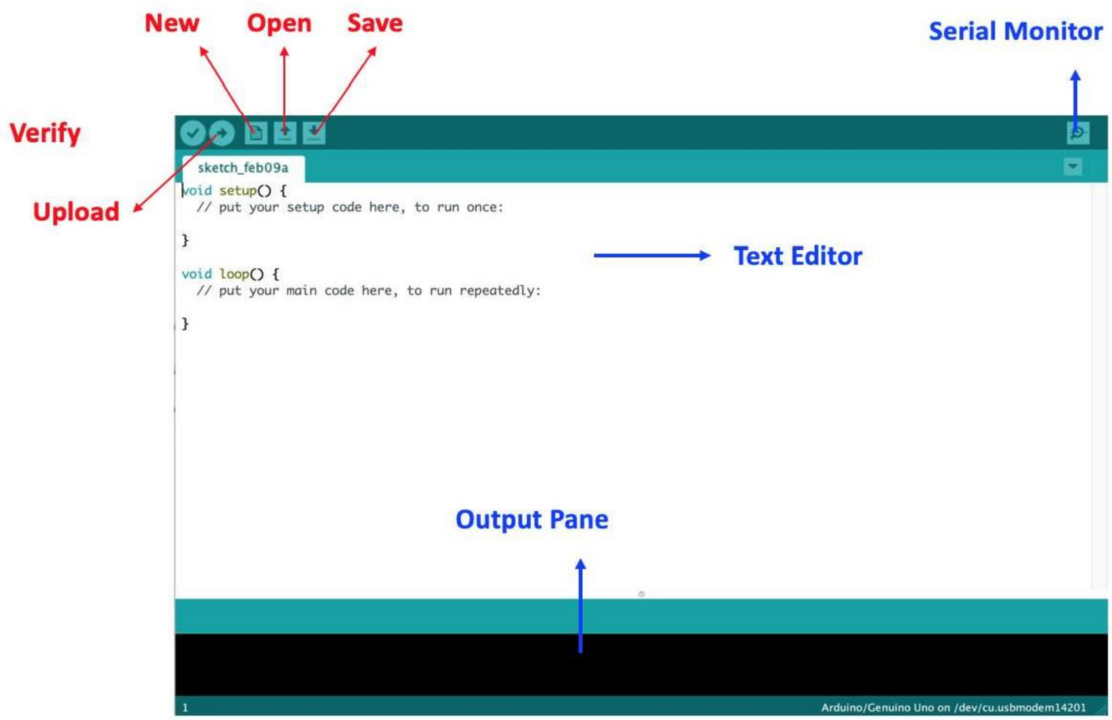
- Seria: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.
- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- LED: 13. There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library

- The Uno has 6 analog inputs, labeled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference() function
- AREF. Reference voltage for the analog inputs. Used with analog Reference()
- Reset. Bring this line LOW to reset the microcontroller

## Arduino Comparison Chart

| | Processor | Processor Voltage | Supply Voltage | Flash | SRAM | Digital I/O Pins | PWM Pins | Analog Inputs | Hardware Serial Ports | Dimensions | Shield Compatibility | Notes and Special Features |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Uno | 16MHz Atmega 328 | 5v | 7-12v | 32Kb | 2Kb | 14 | 6 | 6 | 1 | 2.1"x2.7" 53x75mm | Excellent (most will work) | |
| Uno Ethernet | 16MHz Atmega 328 | 5v | 7-12v | 32Kb | 2Kb | 14 | 6 | 6 | 1 | 2.1"x2.7" 53x75mm | Very Good (some pin conflicts) | Has Ethernet Port. Requires FTDI cable to program. |
| Mega | 16MHz Atmega 2560 | 5v | 7-12v | 256Kb | 8Kb | 54 | 14 | 16 | 4 | 2.1"x4" 53x102mm | Good (some pinout differences) | |
| Mega ADK | 16MHz Atmega 2560 | 5v | 7-12v | 256Kb | 8Kb | 54 | 14 | 16 | 4 | 2.1"x4" 53x102mm | Good (some pinout differences) | Works with Android Development Kit. |
| Leonardo | 16MHz Atmega 32U4 | 5v | 7-12v | 32Kb | 2.5Kb | 20* | 7 | 12* | 1 | 2.1"x2.7" 53x75mm | Fair (many Pinout Differences) | Native USB capabilities. USB Micro B programming port. |
| Due | 84MHz ARM SAM3X8E | 3.3v | 7-12v | 512Kb | 96Kb | 54 | 12 | 12 | 4 | 2.1"x4" 53x102mm | Poor (voltage and pinout differences) | Fastest processor. Most memory. 2-channel DAC. USB micro B programming port. Native micro AB port. |
| Micro | 16MHz Atmega 32U4 | 5v | 5v | 32Kb | 2.5Kb | 20* | 7 | 12* | 1 | 0.7"x1.9" 18x49mm | N/A | Smallest board size. Native USB capabilities |
| Flora | 8MHz Atmega 32U4 | 3.3v | 3.5-16v | 32Kb | 2.5Kb | 8* | 4 | 4* | 1 | 1.75" dia 44.5mm dia | N/A | Sewable Pads. Fabric-friendly design. Native USB Capabilities |
| DC Boarduino | 16MHz Atmega 328 | 5v | 7-12v | 32Kb | 2Kb | 14 | 6 | 6 | 1 | 0.8"x3" 20.5x76mm | N/A | Can build without headers or sockets for smaller size. Requires FTDI cable for programming |
| USB Boarduino | 16MHz Atmega 328 | 5v | 5v (USB) | 32Kb | 2Kb | 14 | 6 | 6 | 1 | 0.8"x3" 20.5x76mm | N/A | Can build without headers or sockets for smaller size. USB Mini B programming port. |
| Menta | 16MHz Atmega 328 | 5v | 7-12v | 32Kb | 2Kb | 14 | 6 | 6 | 1 | 0.8"x3" 20.5x76mm | Excellent (most will work) | Mint-Tin Size and Prototyping Area. Requires FTDI cable for programming. |

## Arduino IDE and Sketch Overview:
### Let's take a look at some of the buttons on the Arduino IDE:




The Arduino Integrated Development Environment (IDE) is the main text editing program used for Arduino programming. It is where you'll be typing up your code before uploading it to the board you want to program. Arduino code is referred to as sketches

- The button that looks like a checkmark is called "verify". When you press this, your code will be compiled, and any errors will be displayed in the window at the bottom. The shortcut key for verify is Control + R
- The button in the shape of an arrow pointing right is the upload button. When you press this, the sketch will be uploaded to your Arduino board. The shortcut key for upload is Control + U
- The button on the far-right side of the screen is the serial monitor button. When you use the serial monitor functions, you can send and receive information from your Arduino board while it is running. We will talk much more about serial monitor later, but I just wanted to point it out now. The shortcut key for serial monitor is Shift + Control + M

## Activity for Experiment – 7

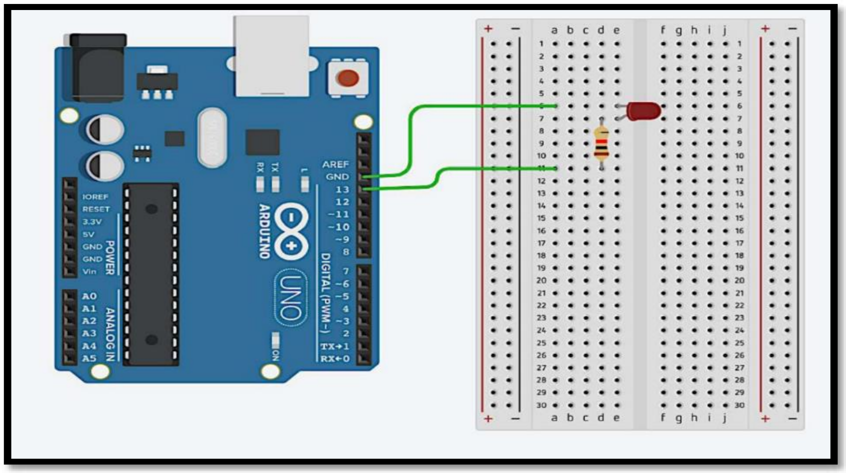
This example shows the simplest thing you can do with an Arduino or Genuino to see physical output: it blinks an LED.

**Step 1:** **Connect circuit as shown inthe diagram**

**Step 2:** **Write the Program.**

**Step 3:** **Verify and Compile the program**

**Step 4:** **Burn or upload the program into Arduino Uno board**




## CODE:

### Example-1: Blinking LED ON and OFF with Digital Output

```
void setup()
{
pinMode(13, OUTPUT); // initialize digital pin 13 as an output.
}

void loop()
{
digitalWrite(13, HIGH); // turn the LED on (HIGH is the voltage level)
delay(1000);  // wait for a second
digitalWrite(13, LOW); //turn the LED off by making the voltage LOW
delay(1000);  // wait for a second
}
```

| SlNo | LED ON/OFF | | Observation of Light Blinking | Reason for Not Visible |
|---|---|---|---|---|
| | Delay in Program | Delay in Seconds | Visible / Not Visible | |
| 1 | 1000 | 1 | | |
| 2 | 100 | 0.1 | | |
| 3 | 50 | 0.05 | | |
| 4 | 20 | 0.02 | | |
| 5 | 15 | 0.015 | | |
| 6 | 10 | 0.01 | | |

## Example-2: LED Brightness Increasing and Decreasing with Analog output

```
void setup()
{
pinMode(11, OUTPUT); // Initialize Analog pin 11 as output
}

void loop()
{
analogWrite(11,0);   // Turn the LED ON with 0% Brightness
delay(0);            // Delay in milli seconds
analogWrite(11,25); // Turn the LED ON with 10% Brightness
delay(250);          // Delay in milli seconds
analogWrite(11,128);// Turn the LED ON with 50% Brightness
delay(500);          // Delay in milli seconds
analogWrite(11,192);// Turn the LED ON with 75% Brightness
delay(750);          // Delay in milli seconds
analogWrite(11,255);// Turn the LED ON with 100% Brightness
delay(1000);          // Delay in milli seconds
analogWrite(11,192);// Turn the LED ON with 75% Brightness
delay(1250);          // Delay in milli seconds
analogWrite(11,128);// Turn the LED ON with 50% Brightness
delay(1500);          // Delay in milli seconds
analogWrite(11,25);// Turn the LED ON with 10% Brightness
delay(1750);          // Delay in milli seconds
analogWrite(11, 0);// Turn the LED ON with 0% Brightness
delay(2000);          // Delay in milli seconds
}
```

**Notes:**

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**Student Name:** ______________________

**Student ID:**__________________ **EXP No.:** ____

**Instructor Signature:** __________

**Date:** / /

# Experiment #8

## Temperature & Humidity Sensor

**AIM:** In this experiment, you will learn how to use Temperature & Humidity Sensor DHT11. After you performed all the steps, you will see the temperature & humidity data collected by DHT11 display on the serial monitor.

**EQUIPMENTS REQUIRED:**

| Item | Quantity |
|---|---|
| Arduino Uno board | **1** |
| USB cable | **1** |
| Bread Board | **1** |
| DHT11 Sensor | **1** |

**THEORY:**

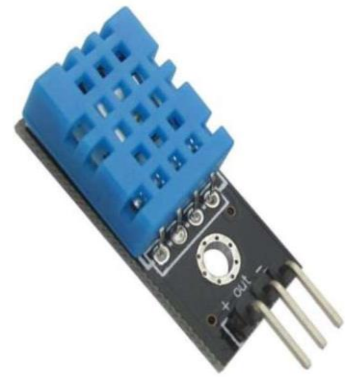
The DHT11 sensor can detect temperature (C and F) & humidity. It has everything it requires built into it, Sensor including resistive humidity sensing component and NTC temperature testing component so it will work very well with the Arduino Uno. This sensor is used in conjunction with the DHT11 library.

- **Temperature range: 0-50 $^{O}$C**
- **Humidity range: 20-90% RH**

# Activity for Experiment – 8

**Step 1: Connect circuit as shown in the next diagram:**

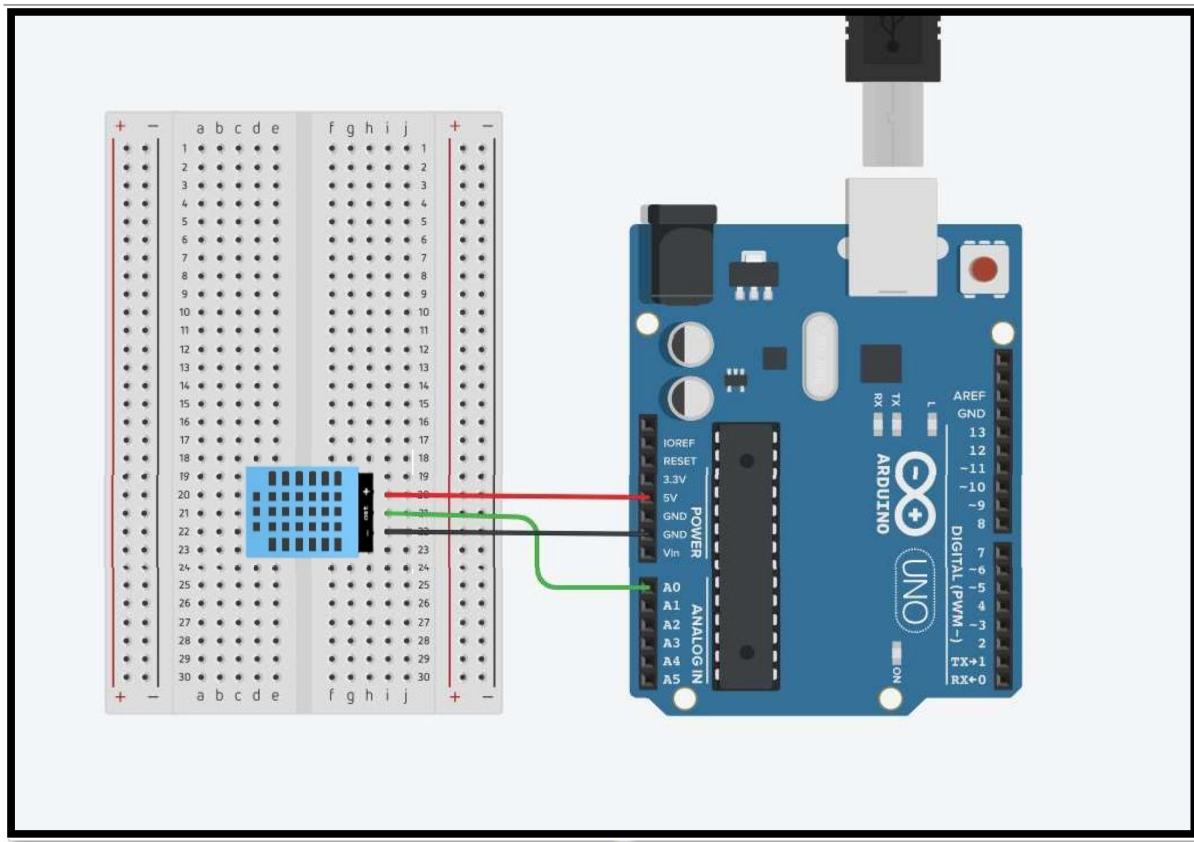
| Arduino | DHT11 Module | |
|---|---|---|
| A0 | out | (Data) |
| 5V | + | (VCC) |
| GND | _ | (GND) |




**Step 2: Write the code.**

**Step 3: Verify and Compile the code.**

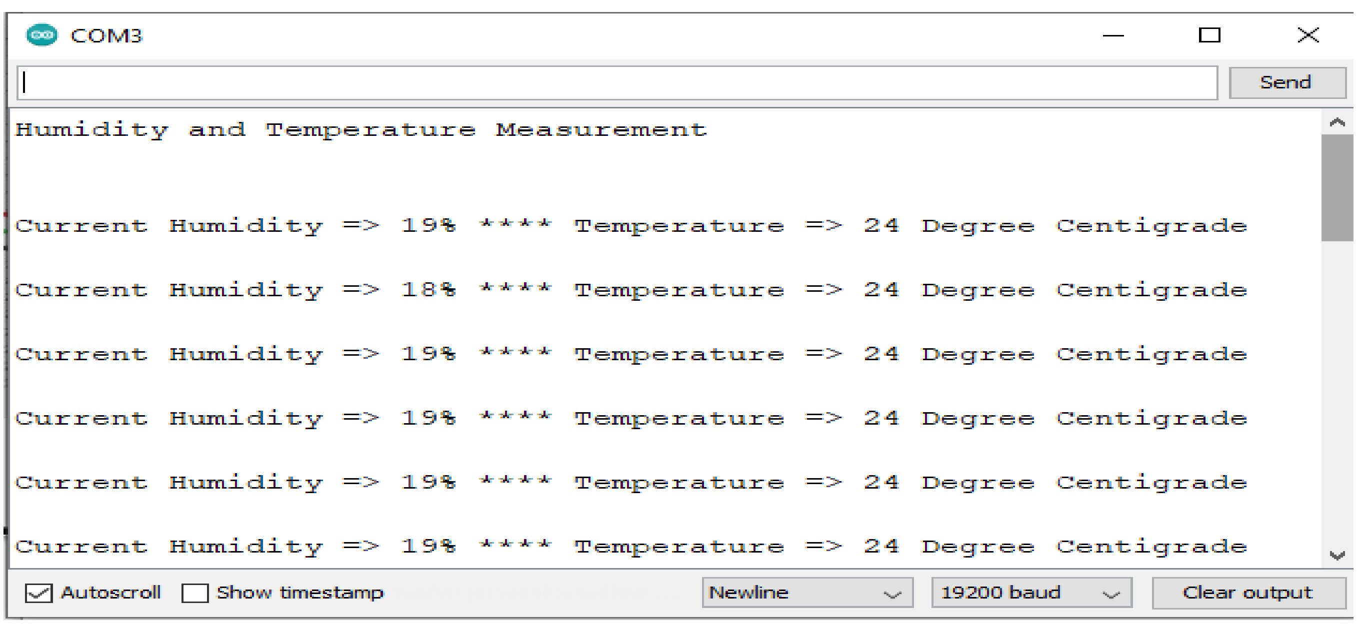
**Step 4: Burn or upload the program into Arduino Uno board.**



## CODE:

```
#include <dht.h>
#define dht_dpin A0
dht DHT;
void setup()
{
Serial.begin(9600);
delay(300);
Serial.println("Humidity and temperature\n\n");
delay(700);
}
void loop()
{
DHT.read11(dht_dpin);
Serial.print("Current humidity = ");
Serial.print(DHT.humidity);
Serial.print("% ");
Serial.print("temperature = ");
Serial.print(DHT.temperature);
Serial.println("C \n ");
delay(800);
}
```

## OUTPUT:



## Tasks

- Use formula to calculate temperature in Fahrenheit in program and see result.
- Print temperature in Centigrade and Fahrenheit in same program and see result.

## OBSERVATION TABLE:

| S.No. | Observation Method | Humidity in | Temperature | |
|---|---|---|---|---|
| | | % | $^oC$ | $^oF$ |
| 1 | Class Room | | | |
| 2 | Shadow | | | |

**Notes:**

Student Name: __________________________ Instructor Signature: ____________

Student ID:_____________________ EXP No.: _____ Date: / /

# Experiment #9

## MQ-2 Gas Sensor

**AIM:** In this experiment, you will learn how to use the MQ-2 gas sensor. With the value displaying on the serial monitor, you can intuitively know the concentration value of surrounding combustible gas. The higher the concentration of combustible gas is, the greater the value is; the lower the concentration is, the smaller is the value.

**EQUIPMENT REQUIRED:**

| Item | Quantity |
|---|---|
| Arduino Uno board | **1** |
| USB cable | **1** |
| Bread Board | **1** |
| MQ−2 gas sensor | **1** |
| Buzzer | **1** |

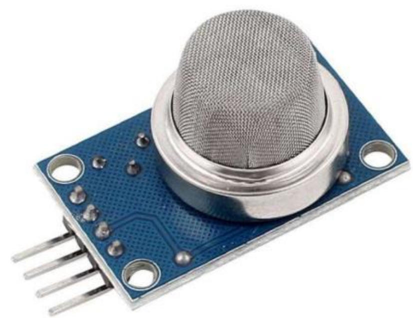
**THEORY:**

MQ-2 gas sensor belongs to surface ion N type semiconductor, which is made of tin oxide semiconductor gas sensitive material. With the gas concentration rising, the sensor's conductivity increases and its output resistance decrease

MQ-2 gas sensor has high sensitivity to natural gas, LPG and other smoke. You can read out gas concentration value with Arduino built-in ADC module according to the principle of voltage division.

**Buzzer:** A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke

# Activity for Experiment – 9



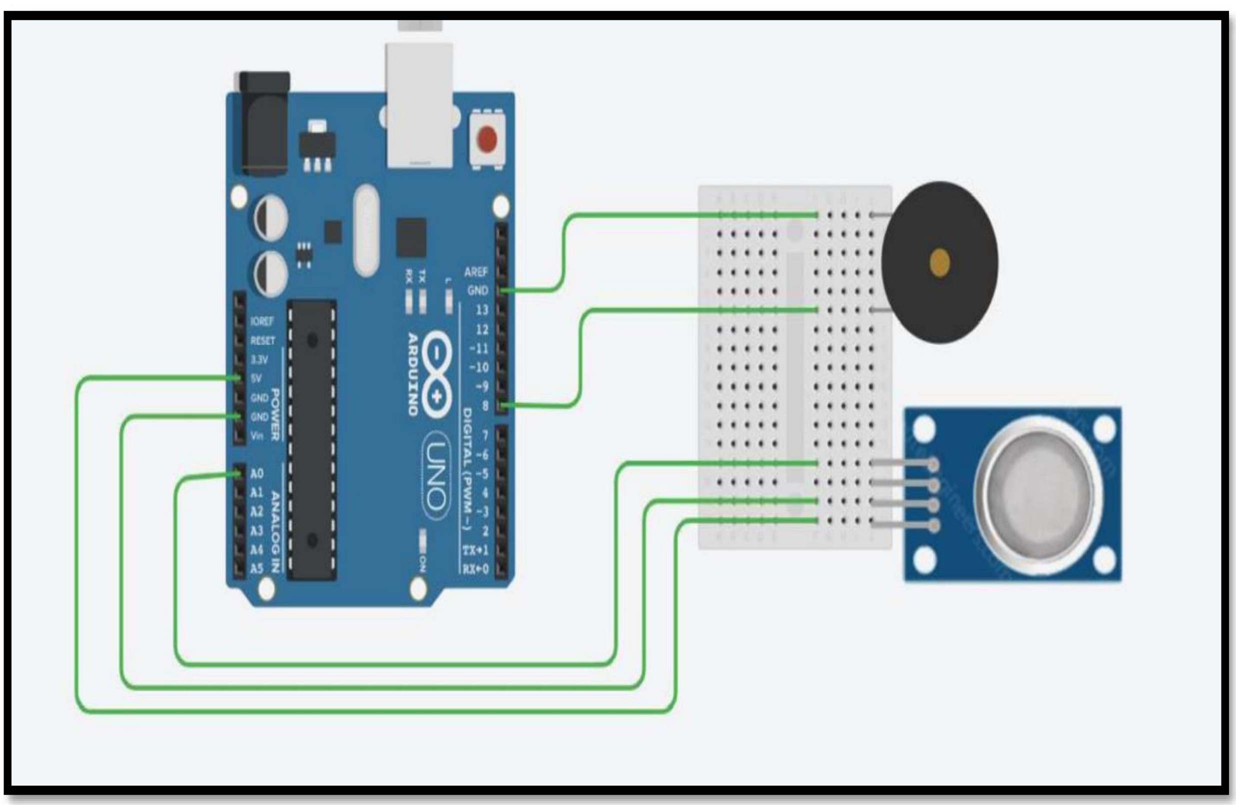
**Step 1: Connect circuit as shown in the next diagram:**

| **Arduino** | **MQ-2 Module** |
|---|---|
| **A0** | **A0** |
| **5V** | **VCC** |
| **GND** | **GND** |

**Step 2: Write the code.**

**Step 3: Verify and Compile the code.**

**Step 4: Burn or upload the program into Arduino Uno board.**



## CODE:

```
 int sensorPin= A0;
 int buzzerPin= 7;
 int smoke_level;
void setup()
{
  Serial.begin(9600);// sets the serial port to 9600
  pinMode(sensorPin, INPUT); //the smoke sensor will be an input to the arduino
  pinMode(buzzerPin, OUTPUT); //the buzzer serves an output in the circuit
  Serial.println("Gas sensor warming up!");
  delay(20000); // allow the MQ-6 to warm up
}
void loop()
{
smoke_level = analogRead(sensorPin); // read analog input pin 0

  Serial.print("Sensor Value: ");
  Serial.print(smoke_level);

  if(smoke_level > 300)
  {
    Serial.print(" | Smoke detected!");
    digitalWrite(buzzerPin,HIGH);
  }
else {
digitalWrite(buzzerPin,LOW);
}
  Serial.println("");
  delay(2000); // wait 2s for next reading
}
```

## Task

- Repeat the above experiment and make the following changes: replace buzzer with LED.

## OBSERVATION TABLE:

| S. No. | GAS Sensor Condition | Smoke Value | Buzzer Condition<br>Smoke Detected (Yes / No) |
|---|---|---|---|
| 1 | Normal Condition | | |
| 2 | When Smoke Detected | | |

**Notes:**

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**Student Name:** ______________________

**Instructor Signature:** ___________

**Student ID:**____________________ **EXP No.:** ____

**Date:** / /

# Experiment #10

## Sound Sensor

**AIM:** In this experiment, you will learn how to use the Sound sensor. we are going to connect the Arduino sound sensor module to the LED so that the LED will light up every time the sensor detects sound.

**EQUIPMENTS REQUIRED:**

| Item | Quantity |
|---|---|
| Arduino Uno board | 1 |
| USB cable | 1 |
| Bread Board | 1 |
| Sound Sensor | 1 |
| LED | 1 |

**THEORY:**

The Sound sensor module for the Arduino shown in the image has the ability to detect different sizes of sound. This sensor can be used for a variety of uses from industrial to simple hobby or playing around.

**Technical Details:**

**Working Voltage: 5V**

**PCB Board Size : 34 x 16mm/ 1.3" x 0.6" (L*W) Hole Size : 3mm/ 0.12"**

**For sound detection Module has two outputs:**

- AO, analog output, real-time output voltage signal of the microphone
- DO, when the sound intensity reaches a certain threshold, the output high and low signal The threshold-sensitivity can be adjusted via potentiometer on the sensor
- When the sound level exceeds the set point, an LED on the module is illuminated and the output is sent low.

# Activity for Experiment – 10

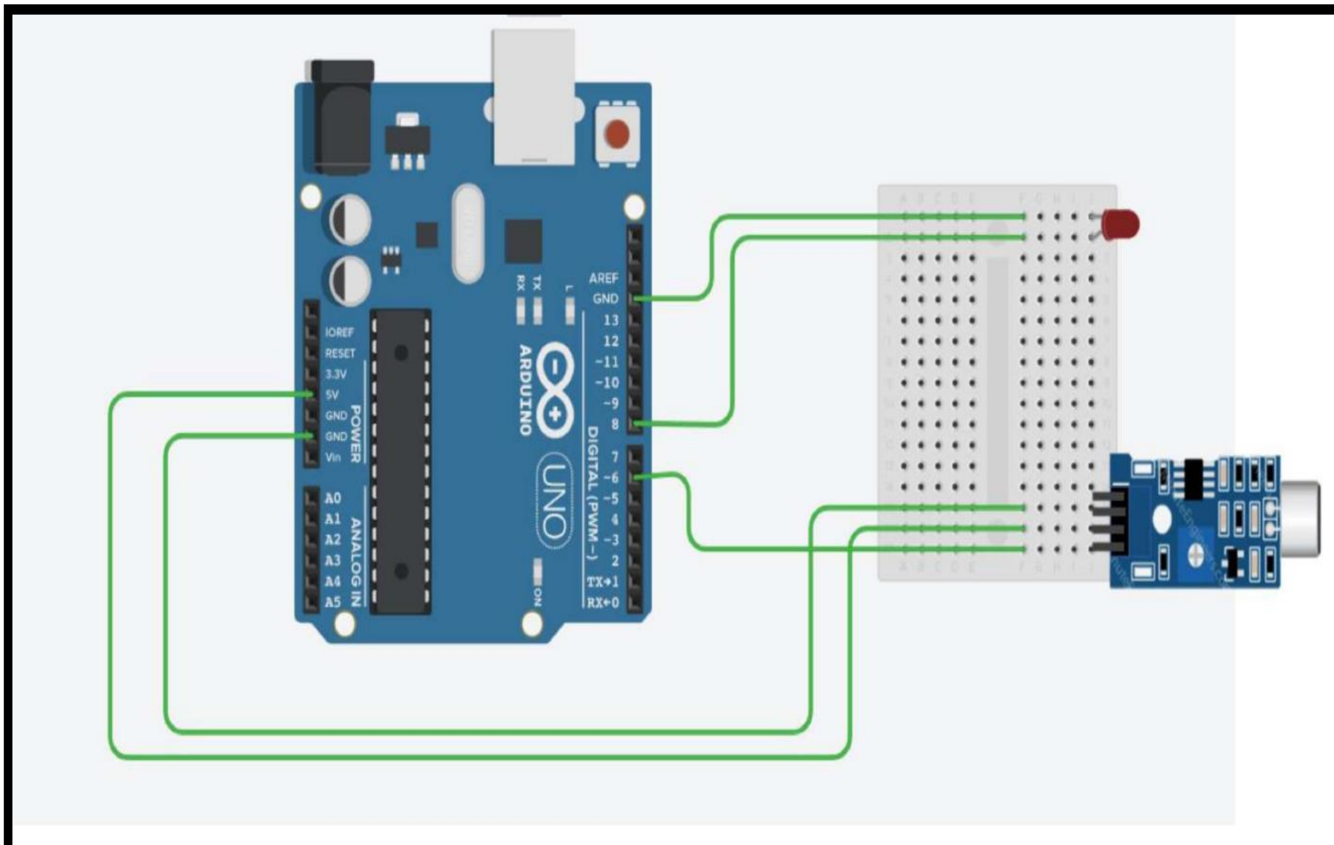
**Step 1: Connect circuit as shown in the next diagram:**

| Arduino Module | Sound Sensor |
|---|---|
| 6 | D0 |
| 5V | VCC |
| GND | GND |

**Step 2: Write the code.**

**Step 3: Verify and Compile the code.**

**Step 4: Burn or upload the program into Arduino Uno board**



## CODE:

```
int MIC = 6;  // define D0 Sensor Interface
int ledPin = 7; // define LED Interface
int sound =0; // define numeric variables val

    void setup()
    {
      pinMode(MIC, INPUT); //the sound sensor will be an input to the arduino
      pinMode(ledPin, OUTPUT); //the LED serves an output in the circuit
    }
    void loop()
    {
    sound = digitalRead(MIC); // read digital input pin D0

      if(sound == 1)
      {
        digitalWrite(ledPin,HIGH);
      }
    else {
    digitalWrite(ledPin,LOW);
    }
    }
```

## Task

- Repeat the above experiment and make the following changes:

1- Add another LED . 2- Connect Sound Sensor Pin with Analog Pin.

**Notes:**

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Student Name: ______________________

Student ID: ____________________ EXP No.: ____

Instructor Signature: __________

Date: / /

# Experiment #11

## Photoresistor Sensor

**AIM:** In this experiment, we are going to work with a sensor, which is a resistor that depends on light. In a dark environment, the resistor will have a very high resistance. As photons (light) land on the detector, the resistance will decrease. The more light is we will have a lower resistance. By reading different values from the sensor, we can detect if is it light, dark or a value between them.

Another element that we are going to use on this experiment is Piezo Buzzer

**EQUIPMENTS REQUIRED:**

| Item | Quantity |
|---|---|
| Arduino Uno board | **1** |
| USB cable | **1** |
| Bread Board | **1** |
| Photoresistor sensor | **1** |
| Buzzer | **1** |
| Resistor ( 10 k) | **1** |

**THEORY:**

A photoresistor or photocell is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light- sensitive detector circuits, and light- and dark-activated switching circuits. The resistance of the photoresistor changes with incident light intensity. If the incident light intensity is high, the resistance reduces; if low, increases.

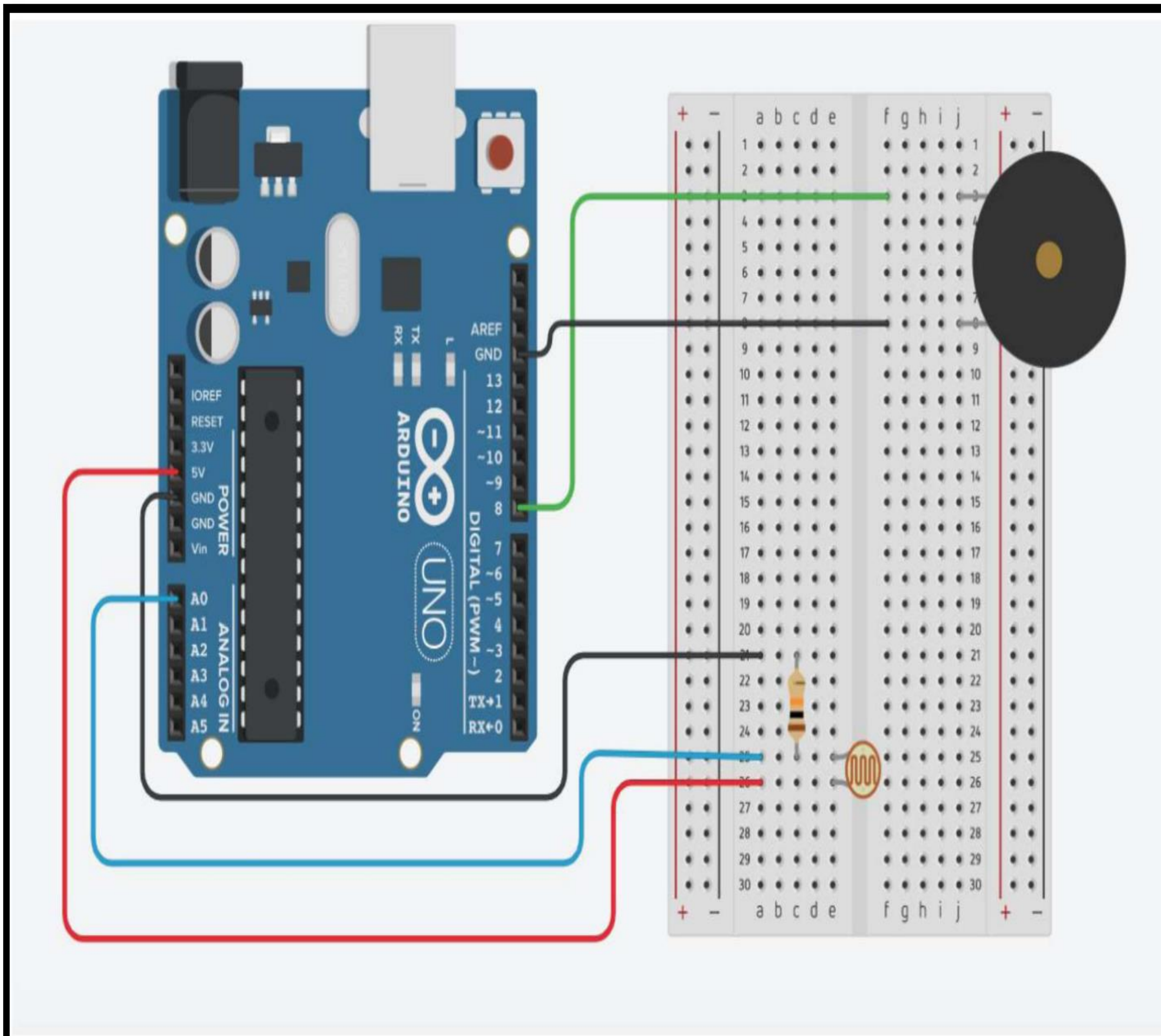
# Activity for Experiment – 11

**Step 1:** **Connect circuit as shown in the next diagram:**

**Step 2:** **Write the code.**

**Step 3:** **Verify and Compile the code.**

**Step 4:** **Burn or upload the program into Arduino Uno board**



## CODE:

```
 int piezoPin = 8; // Declaring Piezo Buzzer on Pin 8
 int ldrPin = A0; // Declaring LDR on Analog Pin A0
 int ldrValue = 0; // Reading different values from the LDR

void setup()
{
  pinMode(ldrPin, INPUT); //the Photot sensor will be an input to the arduino
  pinMode(piezoPin, OUTPUT); //the buzzer serves an output in the circuit

}
void loop()
{
ldrValue = analogRead(ldrPin); // read analog input pin A0

  if(ldrValue >= 400)
  {
tone(piezoPin,300);

  }
else {
noTone(piezoPin);

}
}
```

## Task

- Repeat the above experiment and make the following changes:
  1- Add a LED beside the Buzzer. 2- Connect Sound Sensor Pin with Digital Pin

**Notes:**

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**Student Name:** ____________________

**Instructor Signature:** __________

**Student ID:** ________________ **EXP No.:** ____

**Date:** / /

# Experiment #12

## Touch Sensor

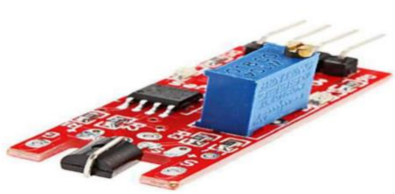
**AIM:** In this experiment, we are going to work with a Touch sensor, Two color LED and Piezo Buzzer. When the touch sensor is senses a human body, the LED color will change and the Piezo Buzzer will continue beeping.

**EQUIPMENTS REQUIRED:**

| Item | Quantity |
|---|---|
| Arduino Uno board | 1 |
| USB cable | 1 |
| Bread Board | 1 |
| Touch Sensor | 1 |
| Buzzer | 1 |
| 3 Color led Module KY−016 | 1 |

**THEORY:**

When you touch the bare wire folded over the end of the transistor mains hum present all around us in a modern house or office is injected into a high gain amplifier. The output of this amplifier is connected to a comparator IC such as an LM358 and the induced AC signal is converted to a square wave as the AC sine wave switches the comparator.



The level that switches the circuit is set by the small blue variable resistor and when the output is switched on a LED is lit. If you look carefully at the LED while it is on it appears to be almost flickering rather than steadily lit. This is due to the output being a 50 Hz square wave rather than a steady HIGH voltage.

**3 Color led Module KY-016:**

RGB LED module consists of a plug-in full color LED made by R, G, B three pin PWM voltage input can be adjusted section three primary colors :

R = RED G=GREEN B=BLUE

in order to achieve full color mixing effect. Control of the module with the Arduino can be achieved cool lighting effects

## Activity for Experiment – 12

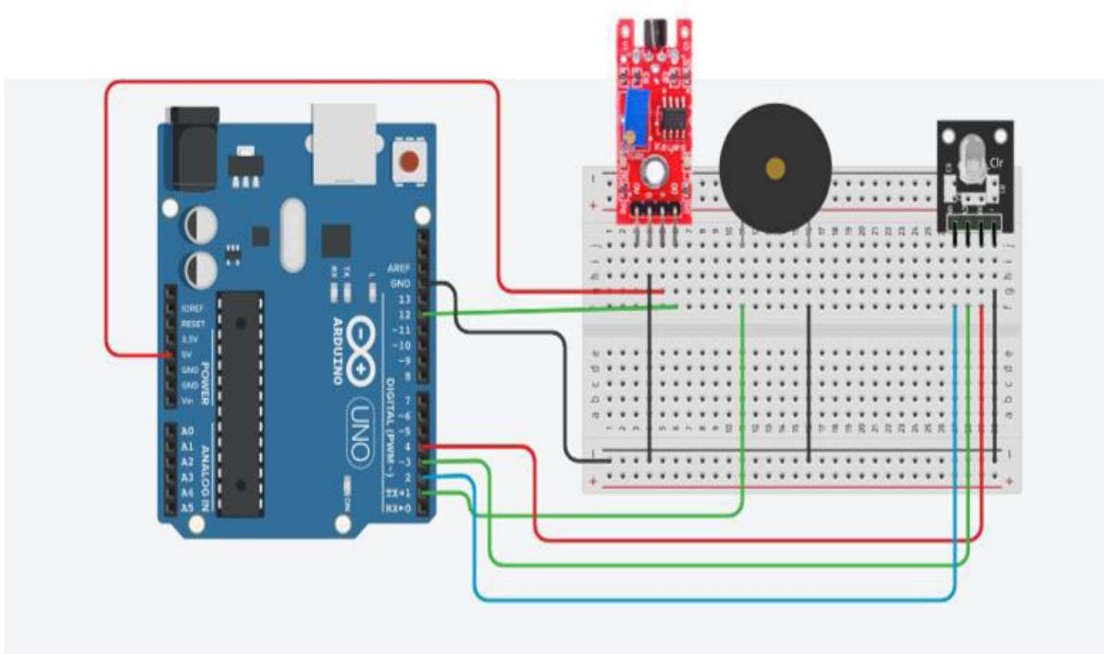
**Step 1: Connect circuit as shown in the next diagram:**

| Arduino Module | Touch Sensor |
|---|---|
| 12 | D0 |
| 5V | + |
| GND | GND |

**Step 2: Write the code.**

**Step 3: Verify and Compile the code.**

**Step 4: Burn or upload the program into Arduino Uno board**



## CODE:

```
int GreenLed = 2;
int BlueLed = 3;
int RedLed = 4;
int piezoPin = 1;
int TouchSensor = 12;
int val;


void setup()
{
  pinMode (GreenLed, OUTPUT);
  pinMode (BlueLed, OUTPUT);
  pinMode (RedLed, OUTPUT);
  pinMode (piezoPin, OUTPUT);
  pinMode (TouchSensor, INPUT);

}
```

```
void loop()
{
val = digitalRead (TouchSensor) ;
if (val == HIGH)
{
digitalWrite (BlueLed, HIGH);
digitalWrite (GreenLed, LOW);
tone(piezoPin,1000);  // Play a 1000Hz tone from the
delay(500);
noTone(piezoPin);
delay(500);
}
 else
{
digitalWrite (BlueLed, LOW);
digitalWrite (GreenLed, HIGH);
digitalWrite (piezoPin, LOW);
}
}
```

## Task

- Repeat the above experiment and make the following changes:
  Replace buzzer with a separate LED

**Notes:**

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**Student Name:** ______________________________

**Instructor Signature:** __________

**Student ID:**________________________ **EXP No.:** _____

**Date:** / /

# REFERENCES


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