# LIGHT DEPENDENT RESISTOR & PHOTOCELL

*A PROJECT WORK*

*SUBMITTED TO*

## PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR (C.G.)

*In the partial fulfillment of requirement for the award of degree of*

## MASTER OF SCIENCE IN PHYSICS

*BY*


MONICA S. BAGE

ROLL NO. – 1716016


*Under the guidance of*


MR. K.R. SAHU

(ASSISTANT PROFESSOR, PHYSICS)

MISS MENKA SAHU

(GUEST LECTURER, PHYSICS)


SESSION : 2018-19


DEPARTMENT OF PHYSICS

SANT GURU GHASIDAS GOVT. P.G. COLLEGE, KURUD

DISTRICT – DHAMTARI, (C.G.)

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# CERTIFICATE

This is to certify that the report of the project submitted is an outcome of the project work entitled *LIGHT DEPENDENT RESISTOR AND PHOTOCELL* carried out by Monica S. Bage, M.Sc. Physics (IV Sem.), Roll No. – 1716016 carried out under my guidance and supervision for the award of degree in Master of Science In Physics of Pt. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR (C.G.).

To the best of my knowledge the report

1. Embodies the work of the candidate herself.
2. Has duly been completed.
3. Fulfills the requirement of the ordinance relating to the M.Sc Degree of the University.
4. Is up to the desired standard for the purpose of which is submitted.

SUPERVISOR
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FORWARDED BY
Dr. O.P.Chandrakar
(Principal)
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# CERTIFICATE BY THE EXAMINERS

This is to certify that the project work entitled

**LIGHT DEPENDENT RESISTOR AND PHOTOCELL**

Submitted by

Miss Monica S. Bage

M.Sc. Physics (IV Semester)

has been examined by the undersigned as a part of the examination for the award of degree in

**Master of Science in Physics.**

Kripa Ram Sahu
HOD-Dept. of Physics
Govt. P.G. College Kurai (C.G.)
**Internal Examiner**

**External Examiner**

# DECLARATION BY THE CANDIDATE

I, the undersigned solemnly declare that the report of the project work entitled *LIGHT DEPENDENT RESISTOR AND PHOTOCELL* is based on my own work carried out during the course of my study under the supervision of *Mr. K. R. Sahu (Assistant Professor, Physics)*.

I assert that the statements made and conclusions drawn are an outcome of the project work. I further declare that to the best of my knowledge and believe that the report does not contain any part of work which has been submitted for the award of any other degree certificate in this University of India. Every help and citations used for the preparation of the project have been duly acknowledged.

CANDIDATE

Miss Monica S. Bage

Roll No. 1716016

# ACKNOWLEDGEMENT

It is always a pleasure to remind the fine people for their sincere guidance. I would like to express my special thanks of gratitude to my supervisor Mr. K.R. Sahu (Assistant Professor Physics) and Miss Menka Sahu (Guest Lecturer) as well as our Principal Dr. O.P. Chandrakar who gave me the golden opportunity to do this wonderful project on the topic LIGHT DEPENDENT RESISTOR AND PHOTOCELL. They provided me their invaluable guidance, comments, suggestions and time throughout the course of the project.

This also helped me in doing a lot of research and I came to know about so many new things. Secondly I would also like to thank my parents and classmates who helped me a lot in finalizing this project within the limited time frame.

Miss Monica S. Bage

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# CONTENTS

## INTRODUCTION :-

The project, namely LIGHT DEPENDENT RESISTOR AND PHOTOCELL was assigned to me. In this project, I have to study the basics of photosensors and carry out the observations and satisfy the characteristic curve.

*Photosensors are those electronic components that detect the presence of light such as visible light, infrared transmission and ultraviolet energy .Most photosensors consist of semiconductor having a property called photoconductivity, in which the electrical conductance varies depending on the intensity of radiation striking the material. They have many applications in daily life.*

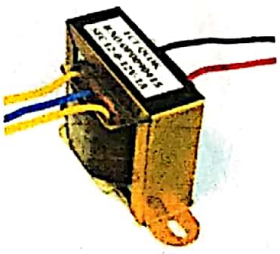
For the very purpose of making this, I started with a research on photosensors, followed by gathering all the basic electronic components and finally assembling and making the device.

This project made me learn so many new things. It came up with some ups and downs. While making this device, I was excited. I faced some difficulties like unavailability of components, the sudden stoppage of working of the device and some more. Somehow I managed. The main difficulty I and most of us faced was that I had no idea about the engineering of components. I am a M.Sc. student and was supposed to perform that task which I am not used to. *Thus this project was time taking, learning and experiencing new things.*

## ELECTRONIC COMPONENTS :-

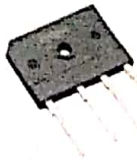
Every electronic equipment requires a constant high dc voltage. For this purpose a device called power supply converts the ac power to dc power. The main components of power supply are transformer (step down), rectifier, filter capacitor and voltage regulator.

### TRANSFORMER –



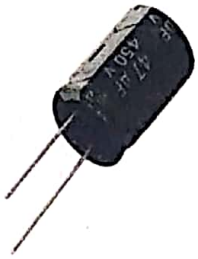
- A *static machine used for transforming power from one circuit to another* without changing frequency.
- Operates on an AC supply.
- Works on the principle of *mutual induction*
- Types – can be categorized on the basis of purpose, use, construction, etc.
- One of the *types – step up and step down* – Generally used for stepping up and down the voltage level of power in transmission and distribution power system network.
- I have used a step down transformer to convert the 230 V AC supply to 12 V AC supply.

## RECTIFIER –



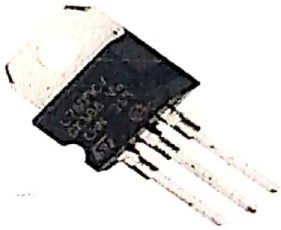
- *Conversion of alternating potential into a direct potential* is called rectification. The device used for this purpose is called a rectifier.
- It converts the whole of the input waveform to one of *constant polarity* (positive or negative)
- They can be made by diodes. Single, double or four manufactured as single components.
- A bridge rectifier ic can be used in the place of diodes.

## CAPACITOR –



- It is *a passive (consumes only) two-terminal electronic component that stores electrical energy* in an electric field.
- Effect of a capacitor is known as capacitance. It is the ratio of the electric charge on each conductor to the potential difference between them.
- *SI unit – farad (F)*; defined as one coulomb (C) per volt (V).
- They are widely used in electronic circuits. For blocking direct current in AC circuit, for smoothing in analog filter networks, for tuning radios to particular frequencies, for stabilizing voltage and power flow in electric power transmission.

## VOLTAGE REGULATOR –



- It is a system designed to automatically *maintain a constant voltage level*.
- Depending on the design, it may be used to regulate one or more AC or DC voltages.
- There are *two types- 1. Linear – series and shunt*
  *2. Switching- step up, step down, inverter.*
- Linear regulators can be *fixed and variable*.
  - Fixed- a three terminal linear regulators are commonly available to generate fixed voltages of 3V,5V,etc.
  - Variable- an adjustable regulator generates a fixed low nominal voltage between its output and its adjust terminal.
- In this project, I have used LM7805 and LM317.

## RESISTOR –

- It is a *passive two terminal electrical component that implements electrical resistance*.
- They are used to reduce current flow, to divide voltages, terminate transmission lines,etc.
- The behavior of an ideal resistor is dictated by *Ohm's law* :

$$V = I.R$$

- SI unit : *ohm (Ω); is equivalent to a volt per ampere*
- They are manufactured in "preferred values" with their resistance value printed onto their body in colored ink.
- The *resistance value, tolerance and wattage rating are printed onto them in the form of colored painted bands.*
- The ***Resistance Color Code*** can be tabulated as below :

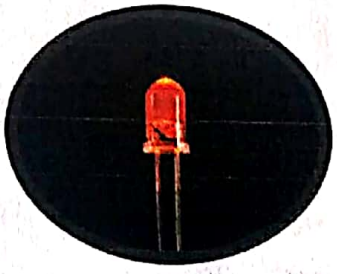
Example resistor:
1 6 0 x1k = 160kΩ

| Color | 1st | 2nd | xth | Multiplier | Tolerance |
|---|---|---|---|---|---|
| Black | 0 | 0 | 0 | x1 | |
| Brown | 1 | 1 | 1 | x10 | ±1% |
| Red | 2 | 2 | 2 | x100 | ±2% |
| Orange | 3 | 3 | 3 | x1k | ±3% |
| Yellow | 4 | 4 | 4 | x10k | ±4% |
| Green | 5 | 5 | 5 | x100k | ±0.5% |
| Blue | 6 | 6 | 6 | x1M | ±0.25% |
| Purple | 7 | 7 | 7 | x10M | ±0.1% |
| Gray | 8 | 8 | 8 | x100M | |
| White | 9 | 9 | 9 | x1,000M | |
| Gold | | | | x0.1 | ±5% |
| Silver | | | | x0.01 | ±10% |

Common Tolerances

## LED –

- A *light emitting diode* (LED) is a semiconductor light source that emits light when current flows through it.
- The semiconductor material employed can be GaAs (gallium arsenide), GaAsP (gallium arsenide phosphide), GaP (gallium phosphide).
- It works on the principle of Electroluminescence (electrons in the semiconductor recombine with holes, releasing energy in the form of photon)
- The color of the light depends on the energy of the band gap and semiconductor materials.
- The color of light emitted is non-coherent and not monochromatic.
- In this device it is used as a power supply indicator.



## POTENTIOMETER –

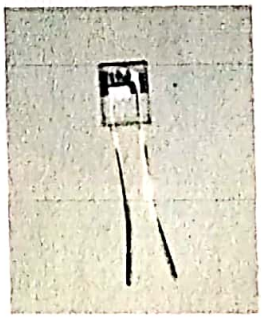
- A potentiometer is a three terminal resistor with a sliding or rotating contact that *forms an adjustable voltage divider*.
- It acts as a variable resistor or rheostat if only two terminals are used, one end and the wiper.
- It is also a passive component.
- There are many types of potentiometer : wiper, linear slider, linear taper, string , digital, etc.
- Most commonly used is the wiper potentiometer.

## LDR (LIGHT DEPENDENT RESISTOR) –

- A LDR is a light controlled resistor.
- The resistance decreases with increase in intensity of incident light.
- It works on the principle of photoconductivity. In the dark, it has high resistance while in the light, it has resistance as low as a few hundred ohms.
- It is a passive type component.
- It can be used in light detector, dark detector, light activated switching circuits.

## PHOTOCELL –

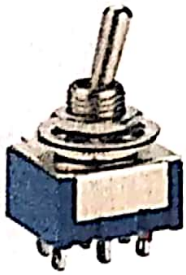
- Photocell is an electronic device which works on the principle of photoelectric effect.
- It converts light energy into electrical energy.
- The most common type consists of two electrodes separated by a light sensitive semiconductor material.
- When light strikes the semiconductor section of the photocell, the current in the circuit increases by an amount proportional to the intensity of the light.
- They are used as switches, light detectors (burglar alarms), light meters, power sources, etc.



## DIGITAL VOLTMETER AND AMMETER –

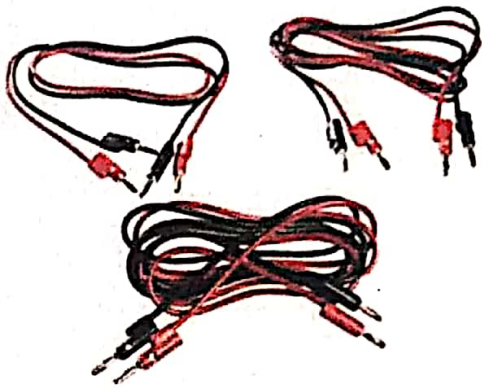
- It is a digital display device.
- The voltage displayed on top and current on the bottom.

## SWITCH –



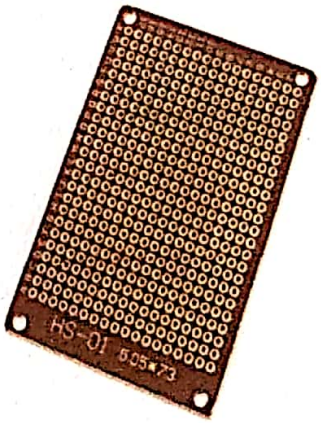
- An electronic switch is a device that can either interrupt the current or divert it from one conductor to another.
- It can be manual and automatic.
- Two vital components of switch : pole and throw.
- Pole : amount of circuits controlled by the switch is indicated by poles.
  Throw : different output connections every pole can connect its input to.
- In this device, a DPDT (Double pole double throw) switch is used.

## CONNECTION WIRES –



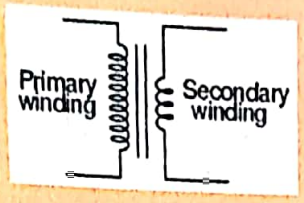
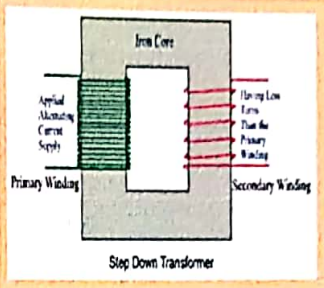
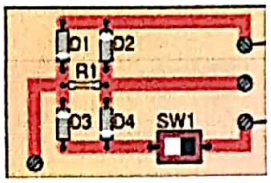
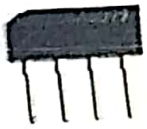
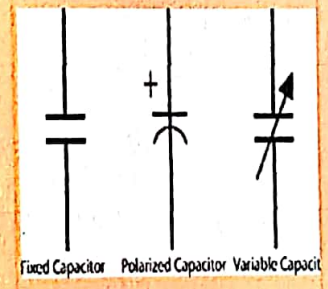
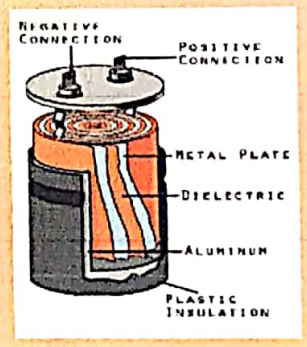
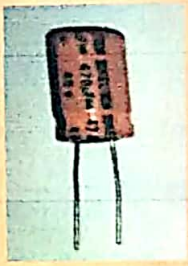
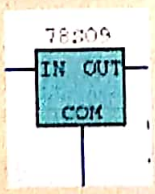
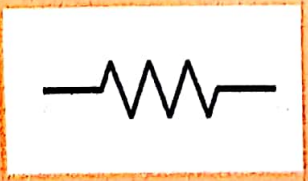
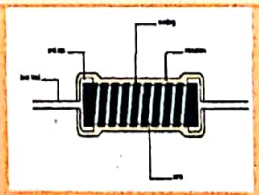
- They connect two terminals by allowing the current to pass through them.
- They are made of copper and aluminium.
- Mostly, copper is used due to its high conductivity and cheaper price.

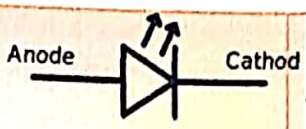
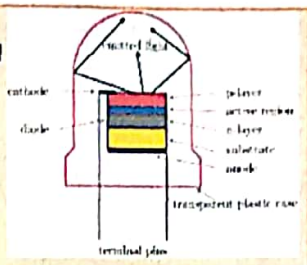
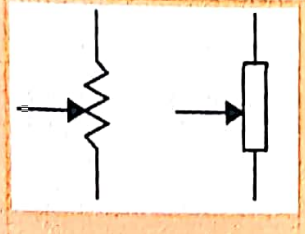
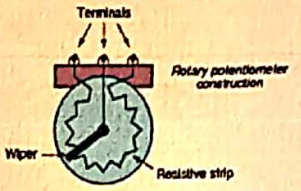
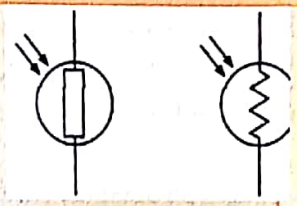
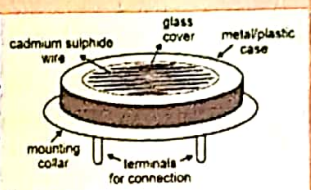
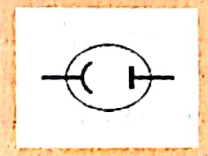
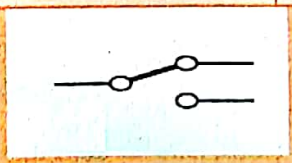
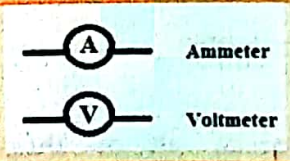
## VEROBOARD (STRIPBOARD) –




- Stripboard is the generic name for electronic prototyping board.
- It has holes and parallel strips of copper cladding running in one direction on one side of the board.
- It is not designed for surface mount components.
- The base board material is a phenolic board (SRBP – synthetic resin bonded paper).
- The components are placed in the holes and the soldered from the back on the board.

# LIST OF ELECTRONIC COMPONENTS :-

| S.NO. | COMPONENT NAME | DESCRIPTION | SYMBOL | CONSTRUCTION | IMAGE |
|---|---|---|---|---|---|
| 1. | Step down transformer | Used to decrease the AC voltage |   |   Step Down Transformer |  |
| 2. | Rectifier | Used to convert voltage from AC to DC |  |   |  |
| 3. | Capacitor | Smoothening |   |   |  |
| 4. | Voltage Regulator | For regulation of voltage |   | |  |
| 5. | Resistor | To reduce current flow |  |  |  |

| | | | | | |
|---|---|---|---|---|---|
| 6. | LED (Light Emitting Diode) | For indication of power supply |   |  |  |
| 7. | Potentiometer | For variable resistance |  |   |  |
| 8. | LDR (Light Dependent Resistor) | Light detector |  |   |  |
| 9. | Photocell | Light detector |  | |  |
| 10. | Connection wire | To connect terminals |  | |  |
| 11. | Switch | To interrupt or divert current |  | |  |
| 12. | Digital Voltmeter Ammeter | For reading volts and amperes |   | |  |
| 13. | Veroboard | For component mounting | | |  |

**Optoelectronic devices** are light-operated (photoelectric) devices, light emitting devices (like LED), or devices that modify light. Photoelectric devices can be categorized as photo-emissive, photo-conductive, and photo-voltaic.

In Photo-emissive devices, radiation falling upon a cathode causes electrons to be emitted from the cathode surface, for example photocell. In photo-conductive devices, the resistance of the material is changed when it is illuminated, for example light dependent resistor (LDR). Photovoltaic cells generate an output voltage that is proportional to radiation intensity, for example solar cell.

## LIGHT DEPENDENT RESISTOR (LDR):-

### INTRODUCTION :-

A Light Dependent Resistor (LDR) or a photo-resistor is a device whose resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices and fall under the category of photo-conductive cells. Thus, they are also called photo-conductors. They are made up of semiconductor materials having high resistance. The performance of a photo-conductor is measured in terms of:

(i) Photoconductivity gain (ii) the response time of the detector.

LDR can be classified into two types depending on the material used -

(A) INTRINSIC Photo resistors – (Undoped semiconductor) These are pure semiconductor materials (such as Silicon or Germanium). Electrons get excited from the valence band to conduction band when photons of enough energy fall on it and charge carriers increase.

(B) EXTRINSIC Photo resistors – (Doped semiconductor) These are semiconductor materials doped with impurities (called dopants); which create new energy bands above the valence band filled with electrons. This reduces the band gap and requires less energy to excite them. These are used for longer wavelengths.

Fig. : LDR

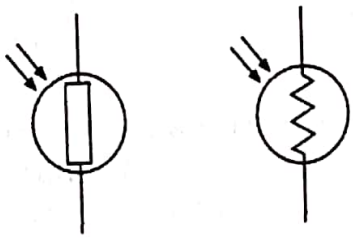
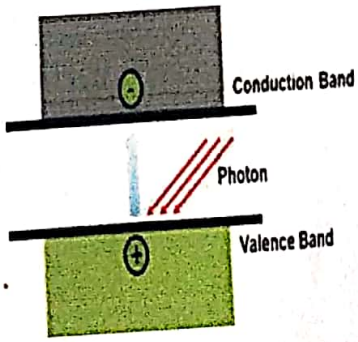


Fig. : LDR Symbol

### PRINCIPLE :-

A light dependent resistor works on the principle of photoconductivity. Photoconductivity is an optical phenomenon in which the materials conductivity increases (hence resistivity decreases) when light is absorbed by the material.

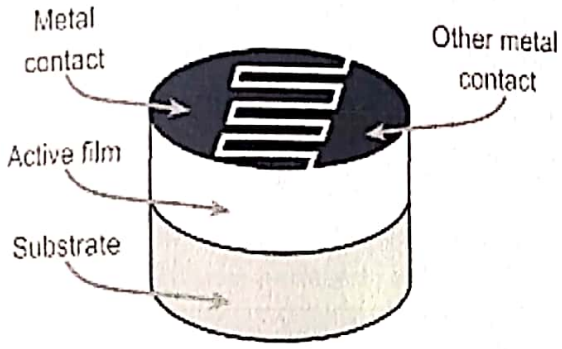


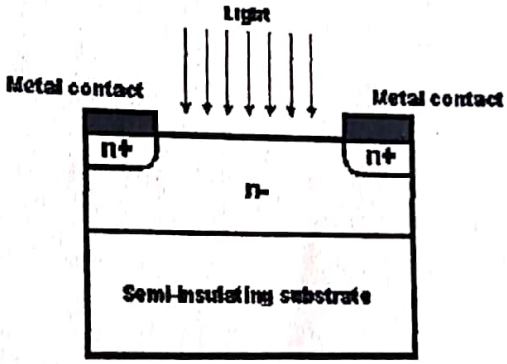

When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are

excited to the conduction band. These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump. Hence, when light having enough energy is incident on the device more and more electrons are excited to the conduction band. This results in large number of charge carriers. The result of this process is that more and more electric current starts flowing and hence this makes the resistance of the device to be decreased.

## ❖ CONSTRUCTION :-

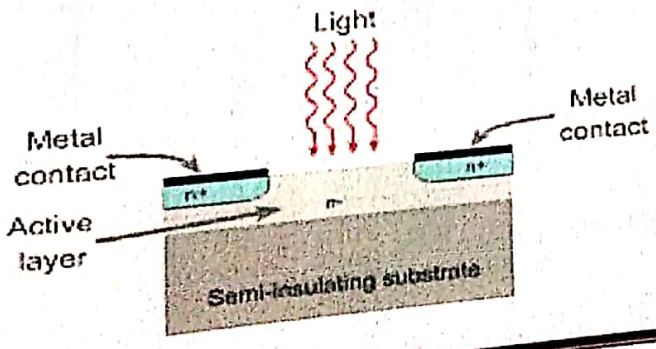
- The structure of a light dependent resistor consists of a light sensitive material which is deposited on an insulating substrate such as ceramic.
- The material is deposited in *zig-zag pattern* in order to obtain the desired resistance and power rating. This zigzag area separates the metal deposited areas into two regions.
- Then the ohmic contacts are made on the either sides of the areas. The resistance of these contacts should be as less as possible to make sure that the resistance mainly changes due to the effect of light only.
- Materials normally used are CdS (Cadmium sulphide), InSb (Indium antimonide), etc.



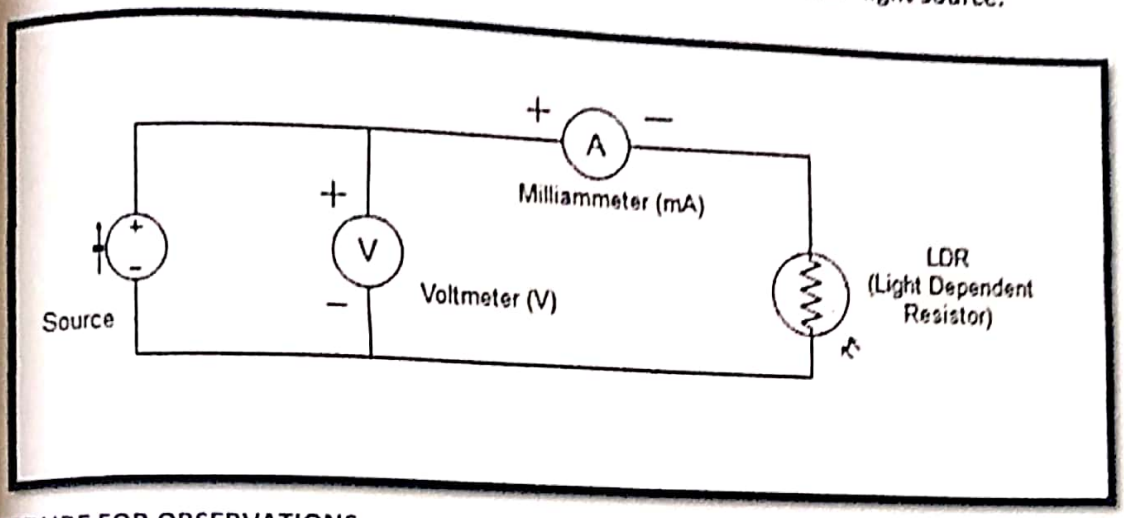

## ❖ WORKING :-

The working principle of LDR is photoconductivity. When light is incident on the semiconductor surface, electrons are excited from the valence band into the conduction band. *Light striking on the surface can provide enough energy to cause electrons within the material to break away from their atoms*. Thus, free electrons and holes (charge carriers) are created within the material, consequently reducing the resistance. The conductivity of the material increases owing to the increased number of charge carriers. The charge carriers are generated either by band to band transitions (intrinsic) or by transitions involving forbidden energy gap (extrinsic).



## ❖ EXPERIMENTAL SETUP :-

- It consists of a input source, a voltmeter, an ammeter , a LDR and a light source.



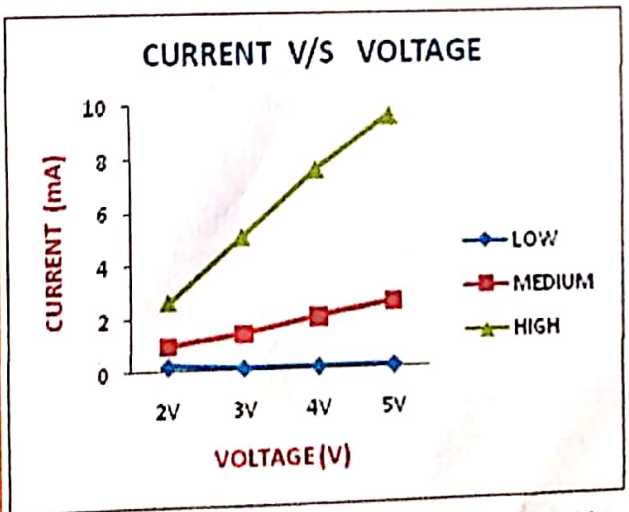

**PROCEDURE FOR OBSERVATIONS:**

1. Connect the patch cords as per the circuit.
2. Turn the power switch on .
3. The minimum reading of voltmeter is 1.5V.
4. When the toggle switch is on the left side, it will connect the photocell and when right; LDR will be connected.
5. Place the light source in front of ldr and measure the current through multimeter (used as ammeter).
6. Now tuning the voltage will give results.
7. Take observations (voltage and current) and calculate the resistance.
8. Plot the graph between resistance and intensity.

## RESULT :-

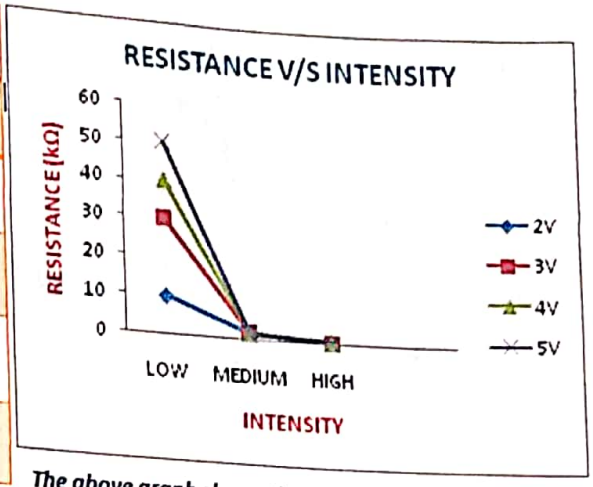
## ❖ OBSERVATIONS AND CHARACTERISTICS GRAPH :-

| S. NO. | VOLTAGE (V) | CURRENT (mA) | | |
|---|---|---|---|---|
| | | At low intensity | At medium intensity | At high intensity |
| 1. | 2 volt | 0.2 | 1.0 | 2.6 |
| 2. | 3 volt | 0.1 | 1.4 | 4.9 |
| 3. | 4 volt | 0.1 | 2.0 | 7.5 |
| 4. | 5 volt | 0.1 | 2.5 | 9.5 |




*The above graph shows that the current increases with increase in voltage*

| S.NO. | VOLTAGE (V) | RESISTANCE (R=V/I) (kΩ) | | |
|---|---|---|---|---|
| | | At low intensity | At medium intensity | At high intensity |
| 1. | 2V | 10 | 2 | 0.76 |
| 2. | 3V | 30 | 2.14 | 0.612 |
| 3. | 4V | 40 | 2 | 0.53 |
| 4. | 5V | 50 | 2 | 0.52 |




*The above graph shows that the resistance decreases with increase in intensity.*

## LIGHT UNITS :-

The total light energy output, or *luminous flux*, from a source can be measured in *milliwatt* (mW) or in *lumens* (lm) where

1 lm = 1.496 mW

*Light intensity* is the amount of light that falls on a unit area.

$$light\ intensity = \frac{luminous\ flux}{unit\ area}$$

### ❖ ADVANTAGES:-

1. It is replacement of variable resistance and also has dependency on the light.
2. Its resistance decreases when light falls on it and increases in the dark.
3. They are cheap and available in various shapes and sizes.
4. They require very small power and voltage for its operation.
5. It can be used to create simple circuits.
6. It has no polarity. It is bi-directional and can be connected in any direction.

### ❖ DISADVANTAGES:-

1. It is less sensitive to light compare to photodiode or phototransistor.
2. Cadmium sulphide used in photoresistor construction is hazardous to environment.
3. If applied voltage exceeds rated maximum voltage for short duration. It will cause irreversible damage to the photoresistor.
4. It has very slow response time of about 10s or 100s of milliseconds.
5. It is temperature sensitive.
6. It has nonlinear characteristics (graph is not a line).

## ❖ APPLICATIONS :-

1. They are used for automatic contrast and brightness control in television receivers.
2. They are used in infrared astronomy.
3. They are used as dark and light detectors.
4. They are used as smoke detectors.
5. Used in light activated circuits, street light control circuits.
6. They are also used in camera light meters, security alarm, relay, switch, etc.


## ❖ CONCLUSIONS :-

The graph obtained experimentally is similar to the ideal graph for light dependent resistor. The differences occur due to the variation in range of electronic components. LDR obeys the principle of photoconductivity. Cell sensitivity can be expressed in terms of cell current for a given voltage and given level of illumination. It is seen that the resistance is greater than 100kΩ when the cell is not illuminated. This is known as the *dark resistance* of the cell.

During the study I learnt some interesting facts of the electronic components such as :

1. The potentiometer is actually a variable resistor.
2. The range of applied voltage is different for each component.
3. Before using the components we should know about the polarity of the components and to recognize them.
4. To use the integrated circuits in place of complicated ones.

I also learnt that the light dependent resistor has many applications in our daily life. For example; sensors in smart phones, fire alarms, etc..