Applied Physics Lab

Department of Basic Sciences

Khwaja Fareed University of Engineering and
Information Technology
Rahim Yar Khan, Pakistan

Contents

Chapter 1

Lab 1:To study the Variation of photoelectric current with intensity of incident light using photocell

Learning Objective:

The primary purpose of this experiment is to evaluate the impact of distance of source of light on the magnitude of current. Through this experiment, I expect to get an inverse relationship between the two variables. Since, the energy consumption issues are increasing nowadays, and projecting the right consumption has become difficult for policymakers, therefore, there is a need to carry out such research projects that may provide help to energy producing companies. This research aims to assist policymakers and energy producing companies to understand the impact of the factors affecting power generation such as current. Therefore, it is expected that this research will be really useful in understanding an important phenomenon of photoelectric effect, thereby, contributing to environment.

Equipment:

Photo cell, sensitive Galvanometer, battery, rheostat key, electric bulb, suitable casing for the bulb and connecting wires

Theory:

The photoelectric effect is defined as;

Emission of electrons from the surface of matter including metals, gases, liquids and nonmetallic solids when light of a certain frequency is incident on it is known as photoelectric effect.

In other words, it is the process of the removal of electrons from the surface of matter when rays of special frequency fall on the surface of matter. As a result of the flow of these photo-electrons, the photoelectric current is produced.

Factors Affecting Photoelectric Effect:

Photoelectric current is produced as a result of photoelectric effect; therefore, understanding the factors which influence the photoelectric effect is very important. The previous studies on photoelectric effect have presented the following factors which may have a direct impact on photoelectric effect.

1. **Intensity of Light:** If a high intense light of frequency equal or greater than threshold frequency falls on the surface of matter, the photoelectric effect is caused. Since studying the impact of this factor is the focus of this research study, therefore, it would be discussed in detail however; one thing which is very clear is that the emission of electrons does not depend upon the intensity of light unless the frequency of light is greater than the threshold frequency.

2. **Frequency:** If a beam of light with frequency equal to or greater than threshold frequency strike the surface of matter, photoelectric effect is produced. If frequency is less than the threshold frequency then photoelectric effect cannot be seen. The threshold frequency varies from matter to matter.

3. **Number of Photo-electrons:** The increase in intensity of light increases the number of photo-electrons, provided the frequency is greater than threshold frequency. In short, the number of photo-electrons increases the photoelectric current.

4. **Kinetic Energy of Photo-electrons:** The kinetic energy of photo-electrons increases when light of high energy falls on the surface of matter. When energy of light is equal to threshold energy then electrons are emitted from the surface whereas when energy is greater than threshold energy then photoelectric current is produced. The threshold frequency is not same for all kinds of matter and it varies from matter to matter.

Uses of Photo-electric current:

Photoelectric effect is a very useful phenomenon and its importance can be understood from following uses of the photoelectric current. Basically the photoelectric current produced as the result of photoelectric effect is used in different types of photodiodes and phototransistors. The photoelectric current is very useful in many solar light sensitive diodes and solar power such as solar cells. In semiconductors, photoelectric current is produced by exciting the electrons or by kicking out electrons from the valence shells by throwing light even of low energy. This current produced in semiconductors is used for different purposes and has voltages related to the band gap energy. One of the major uses of the photoelectric current is in photomultipliers. In Photomultipliers, the current is used for the detection of low levels of light. In the early days of television, the photoelectric current was also used in video camera tubes. The photoelectric current is produced in Silicon image sensors by knocking out the electrons from outer most shell of the solid but not out of the matter. This photoelectric current is then used in different charged couple devices. In addition, Photoelectric current is also used in gold leaf electroscope which is designed for the detection of electricity.

Photo-electron spectroscopy is also included in one of the main applications of the photoelectric current. The energy of incident photons can be found with the help of photoelectric current because energy of incident photons is equal to the sum of binding energy of material's work function and the energy of photo-electrons. The binding energy is determined by bombarding the matter with ultraviolet source or monochromatic X-ray source. On the other hand, energy of emitted photo-electrons is determined by measuring the kinetic energy of photoelectric current. Photoelectric current of positive or negative charges is also produced in space craft due to the photoelectric effect. The parts of space craft exposed to the shadow develop a negative current of several kilo-volts. On the other hand, the parts of space craft exposed to light produce a positive current. Furthermore, the sunlight hits the lunar dust, they get charged due to photoelectric effect. The surface of the moon is lifted off due the repulsion of this charged dust. So, the photoelectric effect is also used to study the surface of the moon. Apart from all of the above mentioned uses, photoelectric current produced during photoelectric effect also has a great use in night vision devices. The photo-electrons are ejected out when light is fallen on gallium arsenide plate of the night vision devices which are then amplified into cascade of electrons. These amplified electrons are used to lighten up a phosphor screen.

In short, there are various applications of photoelectric effect and current in our daily life.

Design/Diagram:

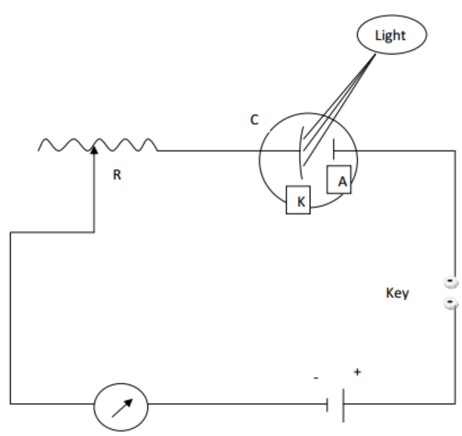

Figure 1.1: Photoelectric Effect

Procedure:

1. Arrearage the apparatus as shown in fig 1. The negative terminal of the battery was connected to cathode K of the photo cell C through a rheostat and galvanometer G. The anode A of the photocell C was connected to the positive terminal of the battery through a key.

2. When switched on the lamp, the light fell on cathode and it emitted electrons. Since cathode was negatively charged therefore, it repelled the electrons and emitted them towards anode, the positive terminal of the photocell. The movement of electrons from cathode to anode produced photoelectric current in the circuit. We would like to mention here, that the photocell which we have used had a concave cathode to give a converging beam of electrons to anode.

3. When the apparatus is well arranged and photoelectric current is being produced, change the distance of the lamp from cathode of photocell and noted down the new dis-

tance. While changing the distance, checke the deflection in the Microammeter. Note down the reading of deflection of Microammeter. The relation between intensity of illumination and distance is as follows:

I=Constant/dˆ2

It means that intensity of light is inversely proportional to the square of distance. Since we are taking the readings of distance and galvanometer therefore, this formula could be used to determine the intensity of light.

4. Similarly take 10 reading of the galvanometer by changing the distance in the regular steps.

5. After taking all readings, plot a graph between 1/ d2 and theta, which is the deflection in galvanometer. The graph will be a straight line and it was showing the direct relationship between photoelectric current and incident light.

Result:

No. of Obs.	Distance of lamp from the photo cell d(cm)	Deflection of galvanometer (θ) (microampere)	d^2 cm^2	1/d^2 cm^-2
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Chapter 2

Lab 2: To determine resistance of a galvanometer by Half deflection method

Learning Objectives:

In this experiment students can understand the various components used in the experiment. Students are to construct circuits based on circuit diagrams. In this experiment students can determine the resistance of a galvanometer by half deflection method.

Equipment:

Galvanometer, High Resistance Box (HRB), Low Resistance Box (LRB), Battery, one way keys, and connecting wires

Theory:

A galvanometer is a device used to detect feeble electric currents in a circuit. It consists of a coil suspended between the poles of a powerful magnet. As current passes through the coil, it deflects. It can be detected from the deflection on galvanometer needle. The deflection is proportional to the current passed through it.

Design/Diagram:

Procedure:

1. First of all make the complete circuit, as shown in the diagram, by connecting Galvanometer, HRB(R), LRB(S) and Keys with the help of connecting wires.

2. HRB is in series and LRB is parallel to Galvanometer.

3. Connect the circuit to the DC power supply through key K1.

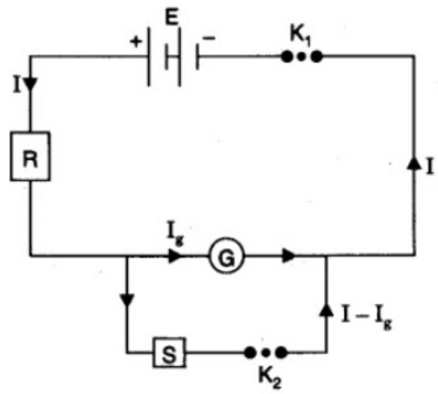

Figure 2.1: Resistance of galvanometer

4. Take some resistance from HRB and close the key K1, note the deflection in galvanometer. Adjust the resistance RH of HRB in such a way that galvanometer showed full deflection i.e. 30 divisions.

5. Then close the second key K2, deflection on scale becomes Zero. I adjusted RL resistance of LRB in such a way that galvanometer shows half deflection i.e. 15 divisions. Note RL.

6. Now repeat the whole procedure and adjust the resistance of HRB and LRB is such a way that deflection in galvanometer becomes 28 divisions and 14 divisions respectfully.

7. Repeat this procedure several times for full deflections of 26,24 and 22 divisions in galvanometer and for half deflections of 13, 12 and 11 divisions θ

Result:

No. of Obs.	Resistance R (ohm)	Deflection in the Galvanometer θ	Shunt resistance S (ohm)	Half Deflection $(\theta/2)$	Galvanometer resistance G=RS/(R-S) (Ohm)
1					
2					
3					
4					
5					

Table 2.1: Resistance of galvanometer by half deflection method

Resistance of the galvanometer =________Ohm

Chapter 3

Lab 3:To convert a moving coil Galvanometer into a volt meter up to 3V (0 - 3 volt range)

Learning Objectives:

The students learns about galvanometer, Voltmeter, shunt resistance and how a galvanometer can be converted into a voltmeter.

Equipment:

Galvanometer , voltmeter (0-3 V) , Low resistance box (LRB), High resistance box (HRB), Two keys , Cells (1.5 vol) and Connecting wire

Theory:

A galvanometer is a device used to detect feeble electric currents in a circuit. It consists of a coil suspended between the poles of a powerful magnet. As current passes through the coil, it deflects. It can be detected from the deflection on galvanometer needle. The deflection is proportional to the current passed through it. Being a sensitive instrument, galvanometer cannot be used for the measurement of heavy current.

Voltmeter

Voltmeter is a voltage meter. Which measures the voltage between the two nodes. We know the unit of potential difference is volts. So it is a measuring instrument which measures the potential difference between the two points. The main principle of voltmeter is that it must be connected in parallel in which we want to measure the voltage. Parallel connection is used because a voltmeter is constructed in such a way that it has a very high value of resistance. So if that high resistance is connected in series than the current flow will be almost zero which means the circuit has become open. If it is connected in parallel, than the load impedance comes parallel with the high resistance of the voltmeter and hence the combination will give almost the same the impedance that the load had. Also in parallel circuit we know that the voltage is same so the voltage between the voltmeter and the load is almost same and hence voltmeter measures the voltage. For an ideal voltmeter, we have the resistance is to be infinity and hence the current drawn to be zero so there will be no power loss in the instrument. But this is not achievable practically as we cannot have a material which has infinite resistance.

Design & Procedure:

1. First of all find the resistance of Galvanometer (RG) by half deflection method.
2. Then make the complete circuit, as shown in the diagram, by connecting Galvanometer, HRB, and Keys with the help of connecting wires.
3. Connect the circuit to the DC power supply through key K1.
4. Adjust the resistance (R) of HRB in such a way that there were deflections of 30 divisions in galvanometer.
5. Then measure the 'emf' of the power supply with volt meter to know the merit of Galvanometer (K).
6. Adjust the resistance (R) of HRB in such a way that there were deflections of 28, 26 and 20 divisions in galvanometer to find the mean value of merit of galvanometer.
7. Calculate the difference between calculated value of voltage measured by converted Galvanometer and that measured by volt meter. It would be near to 0.
8. Find the least count of both meters by dividing their Range by Total number of divisions

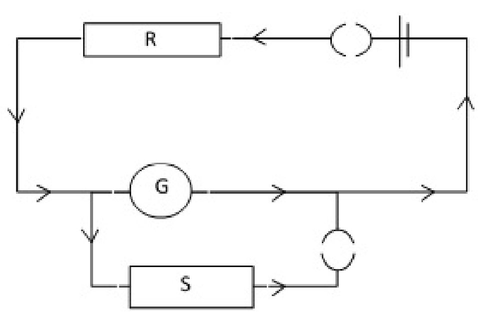

Figure 3.1: Finding Resistance of galvanometer by half deflection method

No. of Obs.	Resistance R (ohm)	Deflection in the Galvanometer θ	Shunt resistance S (ohm)	Half Deflection $(\theta/2)$	Galvanometer resistance G=RS/(R-S) (Ohm)
1					
2					
3					
4					
5					

Table 3.1: Resistance of galvanometer by half deflection method

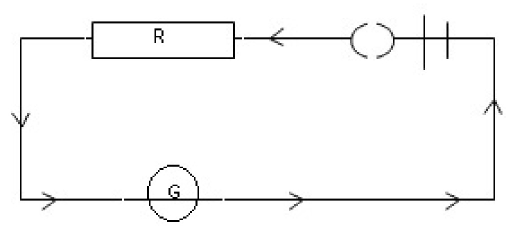

Figure 3.2: To calculate galvanometer current Ig

Full scale deflection current Ig =?
EMF of cell (used) =————————— Volt
Resistance R for Full scale deflection (=30 divisions) =————
Ig = E/(R+Rg) = ——————————- A

Calculation of Rh

Calculation of series high resistance Rh= ?
Range of volt meter V= 3 Volt
Rh=

Calibration of Galvanometer

30 divisions of galvanometer= 3 volt
1 division of galvanometer = 0.1 volt

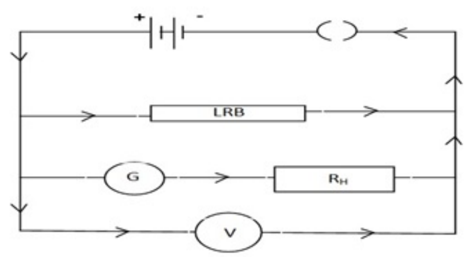

Figure 3.3: Verified Circuit

No. of Obs.	**Reading of Converted Galvanometer**		**Reading of Converted Voltmeter**		**Difference V1-V2**
	Divisions	Volts(V1)	Divisions	Volts(V2)	
1					
2					
3					
4					
5					

Table 3.2: Verification Table

Chapter 4

Lab 4:To convert a moving coil Galvanometer into a Ammeter of desired range

Learning Objectives:

The students learns about galvanometer, Ammeter, shunt resistance and how a galvanometer can be converted into an ammeter.

Equipment:

Galvanometer , ammeter , Low resistance box (LRB), High resistance box (HRB), Two keys , Cells (1.5 vol) and Connecting wire

Theory:

Galvanometer

A galvanometer is a device used to detect feeble electric currents in a circuit. It has a coil pivoted (or suspended) between concave pole faces of a strong laminated horse shoe magnet. When an electric current passes through the coil, it deflects. The deflection is proportional to the current passed. The galvanometer coil has a moderate resistance (about 100 ohms) and the galvanometer itself has a small current carrying capacity (1 mA).

Ammeter

An ammeter is a device used for measuring large electric currents in circuits. For this purpose, it is put in series with the circuit in which the current is to be measured. How to convert a Galvanometer into an Ammeter? A galvanometer can detect only small currents. Thus, to measure large currents it is converted into an ammeter. It can be converted into an ammeter by connecting a low resistance called shunt resistance in parallel to the galvanometer. Let G be the resistance of the galvanometer and Ig be the current for full scale deflection in the galvanometer, the value of the shunt resistance required to convert the galvanometer into an ammeter of 0 to I ampere is,

```
S=(Ig*G)/(I-Ig)
```

Design & Procedure:

1. First of all find the resistance of Galvanometer (RG) by half deflection method.
2. Then make the complete circuit, as shown in the diagram, by connecting Galvanometer, HRB, and Keys with the help of connecting wires.
3. Connect the circuit to the DC power supply through key K1.
4. Adjust the resistance (R) of HRB in such a way that there were deflections of 30 divisions in galvanometer.
5. Then measure the 'emf' of the power supply with volt meter to know the merit of Galvanometer (K).
6. Adjust the resistance (R) of HRB in such a way that there were deflections of 28, 26 and 20 divisions in galvanometer to find the mean value of merit of galvanometer.
7. Calculate the difference between calculated value of voltage measured by converted Galvanometer and that measured by volt meter. It would be near to 0.
8. Find the least count of both meters by dividing their Range by Total number of divisions

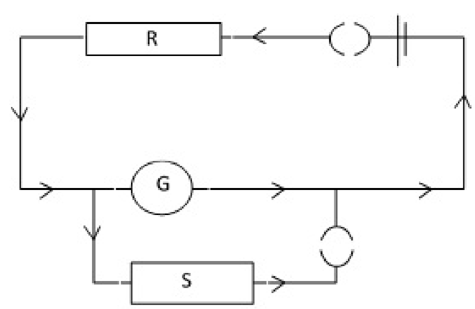

Figure 4.1: Finding Resistance of galvanometer by half deflection method

No. of Obs.	Resistance R (ohm)	Deflection in the Galvanometer θ	Shunt resistance S (ohm)	Half Deflection $(\theta/2)$	Galvanometer resistance G=RS/(R-S) (Ohm)
1					
2					
3					
4					
5					

Table 4.1: Resistance of galvanometer by half deflection method

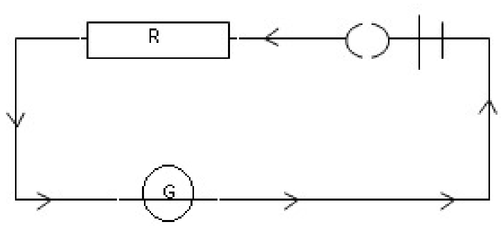

Figure 4.2: To calculate galvanometer current Ig

Full scale deflection current Ig =?
EMF of cell (used) =———————— Volt
Resistance R for Full scale deflection (=30 divisions) =————
Ig = E/(R+Rg) = ——————————- A

Calculation of Rh

Calculation of series high resistance Rh= ?
Range of volt meter V= 3 Volt
Rh=

Calibration of Galvanometer

30 divisions of galvanometer= 3 volt
1 division of galvanometer = 0.1 volt

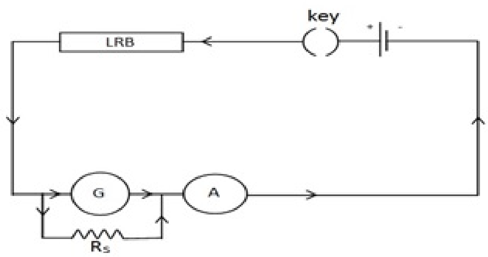

Figure 4.3: Verified Circuit

No. of Obs.	**Reading of Converted Galvanometer**		**Reading of Converted Ammeter**		**Difference A1-A2**
	Divisions	Ampere(A1)	Divisions	Ampere(A2)	
1					
2					
3					
4					
5					

Table 4.2: Verification Table

Chapter 5

Lab 5:To study Forward & Reverse Bias Characteristics of PN Junction Diode

Learning Objectives:

To study and verify the functionality of PN junction diode in forward bias and reverse bias and to Plot Volt-Ampere Characteristics of P-N Diode, Plot Volt-Ampere Characteristics of P-N Diode in XY mode. Find cut-in voltage for P-N Junction diode. Find static and dynamic resistances in both forward and reverse biased conditions.

Equipment:

Bread board, Diodes (1N4007), Resistor (1KΩ), Dual DC Regulated Power Supply, Digital Multimeter/ Digital Voltmeter (0-20V) and Connecting wires.

Specifications:

List of Parameters SILION DIODE: (1N4007)
Maximum Forward Current: 1A
Maximum Reverse Current: 5.0μA
Maximum Forward Voltage: 0.8V
Maximum Reverse Voltage: 1000V
Maximum Power Dissipation: 30mW
Temperature -65 to 200Âř C

Theory:

A PN junction diode is formed when a single crystal of semiconductor is doped with acceptors impurities (Pentavalent) on one side and donor impurities (Trivalent) on the other side. It has two terminals called electrodes, one each from P-region and N-region. Due to two electrodes it is called (i.e., Di-electrode) Diode.

Biasing of PN junction Diode:

Applying external D.C. voltage to any electronic device is called biasing. There is no current in the unbiased PN junction at equilibrium. Depending upon the polarity of the D.C. voltage externally applied to diode, the biasing is classified as forward biasing and Reverse biasing.

Forward bias operation:

The P-N junction supports uni-directional current flow. If +ve terminal of the input supply is connected to anode (P-side) and -ve terminal of the input supply is connected the cathode. Then diode is said to be forward biased. In this condition the height of the potential barrier at the junction is lowered by an amount equal to given forward biasing voltage. Both the holes from p-side and electrons from n-side cross the junction simultaneously and constitute a forward current from n-side cross the junction simultaneously and constitute a forward current (injected minority current due to holes crossing the junction and entering P-side of the diode). Assuming current flowing through the diode to be very large, the diode can be approximated as short- circuited switch.

Reverse bias operation:

If negative terminal of the input supply is connected to anode (p-side) and -ve terminal of the input supply is connected to cathode (n-side) then the diode is said to be reverse biased. In this condition an amount equal to reverse biasing voltage increases the height of the potential barrier at the junction. Both the holes on P-side and electrons on N-side tend to move away from the junction there by increasing the depleted region. However the process cannot continue indefinitely, thus a small current called reverse saturation current continues to flow in the diode. This current is negligible; the diode can be approximated as an open circuited switch.

Design/Diagram:

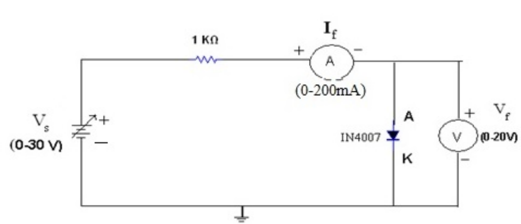

Figure 5.1: Forward Bias Condition

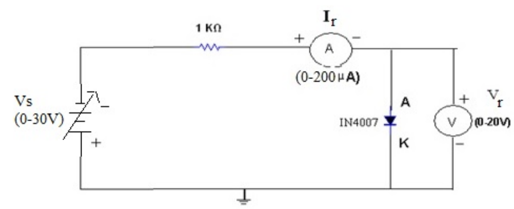

Figure 5.2: Reverse Bias Condition

Design/Diagram:

Procedure:

Forward Bias Condition:

1. Connect the circuit as shown in figure (1) using PN Junction diode.
2. Initially vary Regulated Power Supply (RPS) voltage Vs in steps of 0.1 V. Once the current starts increasing vary Vs from 1V to 12V in steps of 1V and note down the corresponding readings V_f and I_f
3. Tabulate different forward currents obtained for different forward voltages.

Reverse Bias Condition:

4. Connect the circuit as shown in figure (2) using PN Junction diode.
5. Vary Vs in the Regulated Power Supply (RPS) gradually in steps of 1V from 0V to 12V and note down the corresponding readings V_r and I_r.
6. Tabulate different reverse currents obtained for different reverse voltages.
7. To get the graph in reverse region (theoretically), remove voltmeter and with reference to the supply voltage note down the reverse current readings in Ammeter because current always selects low reactance path.(Diode have infinite resistance in reverse bias ideally).To get the graph in reverse region (theoretically), replace voltmeter with nano ammeter. Voltmeter has less load resistance when compared to diode. Current conducts in low resistance path.

Diode Characteristics in XY mode:

8. Adjust CRO TIME/DIV knob in X-Y mode.
9. Give the input as triangular voltage waveform from Function Generator.
10. Connect the CRO CH1 across the input and CH2 across resistor. P-N Junction diode characteristics can be observed.

Observations:

No. of Obs.	**RPS Voltage V_S (Volts)**	**Forward Voltage across the diode V_f (volts)**	**Forward current through the diode I_f (mA)**
1			
2			
3			
4			
5			

Table 5.1: Forward Bias Condition

No. of Obs.	**RPS Voltage V_S (Volts)**	**Reverse Voltage across the diode V_f (volts)**	**Reverse current through the diode I_f (mA)**
1			
2			
3			
4			
5			

Table 5.2: Reverse Bias Condition

Graph:

1. Take a graph sheet and divide it into 4 equal parts. Mark origin at the center of the graph sheet.
2. Now mark +ve X-axis as V_f, -ve X-axis as V_r, +ve Y-axis as I_f and -ve Y-axis as I_r.
3. Mark the readings tabulated for Si forward biased condition in first Quadrant and Si reverse biased condition in third Quadrant

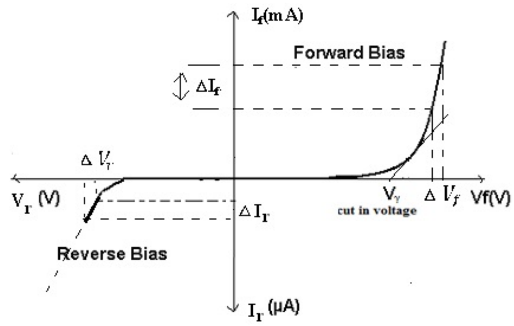

Figure 5.3: Reverse Bias Condition

Calculations from Graph:

Cut in Voltage $V\gamma$

Static forward Resistance $R_{dc} = V_f / I_f \Omega$

Dynamic Forward Resistance $r_{ac} = \Delta V_f / \Delta I_f \Omega$

Static Reverse Resistance $R_{dc} = V_r / I_r \Omega$

Dynamic Reverse Resistance $r_{ac} = \Delta V_r / \Delta I_r \Omega$

Forward Bias of PN Junction Diode:

1. The Cut in Voltage or Knee Voltage (Vγ) of 1N4007 is ———Volts.
2. The Dynamic Forward resistance of 1N4007 is ——Ω.
3. The Static Forward resistance of 1N4007 is ——Ω.

Reverse Bias of PN Junction Diode:

1. The Dynamic Reverse resistance of 1N4007 is ——-Ω.
2. The Static Reverse resistance of 1N4007 is ——-Ω.

Chapter 6

Lab 6:To study the operation of Half- Wave Rectifier with and without filter

Learning Objectives:

The purpose of this experiment is to to recognize a half-wave rectified sinusoidal voltage, understand the term 'mean value' as applied to a rectified waveform and to understand the effect of a reservoir capacitor upon the rectified waveform and its mean value

Equipment:

Bread board, Diodes (1N4007), Resistor (1KΩ), Capacitor (100μF), Transformer with Center Tapped Secondary (9 - 0 - 9) V, Digital Multimeter/ Digital Voltmeter (0-20V), Cathode Ray Oscilloscope (CRO) (0-20MHz) and Connecting wires.

Theory:

The conversion of AC into DC is called Rectification. Electronic Devices can convert AC power into DC power with high efficiency. Consider the given circuit. Assume the diode to be ideal i.e., Vf = 0, Rr = Infinite, Rf = 0. During the positive half cycle, the diode is forward biased and it conducts and hence a current flows through the load resistor. During the negative half cycle, the diode is reverse biased and it is equivalent to an open circuit, hence the current through the load resistance is zero. Thus the diode conducts only for one half cycle and results in a half wave rectified output.

Design/Diagram:

Procedure:

1. Connect the circuit as shown in the circuit diagram.
2. Connect the primary side of the transformer to AC mains and the secondary side to rectifier input

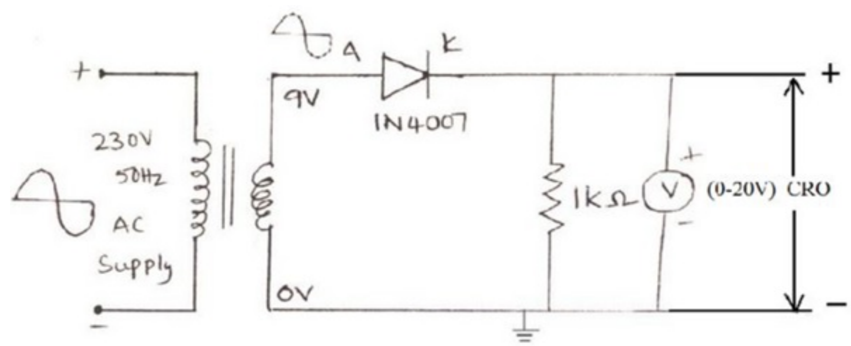

Figure 6.1: Half Wave Rectifier (Without Filter)

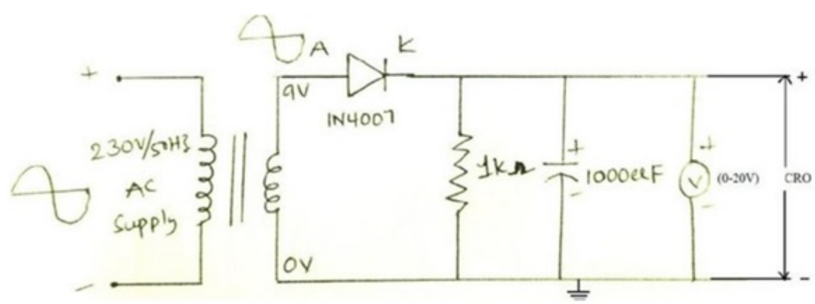

Figure 6.2: Half Wave Rectifier (With Filter)

3. Using a CRO, measure the maximum voltage Vm of the AC input voltage (at the anode) of the rectifier and AC voltage (at the cathode) at the output of the rectifier.
4. Using a DC voltmeter, measure the DC voltage at the load resistance.
5. Observe the Waveforms at the secondary windings of transformer and across load resistance for a load of 1K.
6. Calculate the ripple factor (γ).

Observations:

1. Peak Voltage, Vm=————(From CRO for HWR with and without filter)
2. Dc Voltage, V_DC(Full load)=———(From Voltmeter/ Multimeter for HWR with and without filter)
3. No Load DC Voltage, V_DC(No load) =——— (From Voltmeter/ Multimeter for HWR with and without filter)
4. Ripple Voltage, Vr =——— (From CRO for HWR with filter)

Calculations:

$V_{rms} = \frac{V_m}{2}$

$V_{dc} = \frac{V_m}{\pi}$

Ripple factor (Theoretical)= $\sqrt{(\frac{V_{rms}}{V_{dc}})^2 - 1} = 1.21$

Ripple Factor(practical) $\gamma = \frac{V_{ac}}{V_{dc}}$ where $V_{ac} = \sqrt{(V^2_{rms} - V^2_{dc})}$

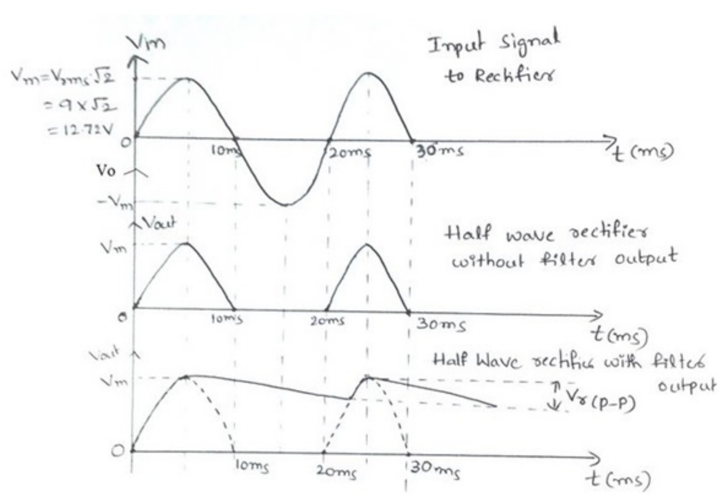

Figure 6.3: Expected Waveforms

Lab 7:To study the operation of Full- Wave Rectifier with and without filter

Learning Objectives:

The purpose of this experiment is to to recognize a Full-wave rectified sinusoidal voltage, understand the term 'mean value' as applied to a rectified waveform and to understand the effect of a reservoir capacitor upon the rectified waveform and its mean value.

Equipment:

Bread board, Diodes (1N4007), Resistor (1KΩ), Capacitor (100μF), Transformer with Center Tapped Secondary (9 - 0 - 9) V, Digital Multimeter/ Digital Voltmeter (0-20V), Cathode Ray Oscilloscope (CRO) (0-20MHz) and Connecting wires.

Theory:

The conversion of AC into pulsating DC is called Rectification. Electronic Devices can convert AC power into DC power with high efficiency. The full-wave rectifier consists of a center-tapped transformer, which results in equal voltages above and below the center-tap. During the positive half cycle, a positive voltage appears at the anode of D1 while a negative voltage appears at the anode of D2. Due to this diode D1 is forward biased. It results a current Id1 through the load R. During the negative half cycle, a positive voltage appears at the anode of D2 and hence it is forward biased, resulting a current Id2 through the load. At the same instant a negative voltage appears at the anode of D1, reverse biasing it and hence it doesn't conduct.

Ripple Factor

Ripple factor is defined as the ratio of the effective value of AC components to the average DC value. It is denoted by the symbolγ.

$$\gamma = \frac{V_{ac}}{V_{dc}}, (\gamma = 0.48)$$

Peak- Inverse - Voltage (PIV):

It is the maximum voltage that the diode has to withstand when it is reverse biased. PIV = 2V_m

Advantages of Full wave Rectifier:

1.γ is reduced.

Disadvantages of Full wave Rectifier:

1. Output voltage is half of the full secondary voltage.
2. Diodes with high PIV rating are to be used.
3. Manufacturing of the center-tapped transformer is quite expensive and so Full wave rectifier with center-tapped transformer is costly.

Design/Diagram:

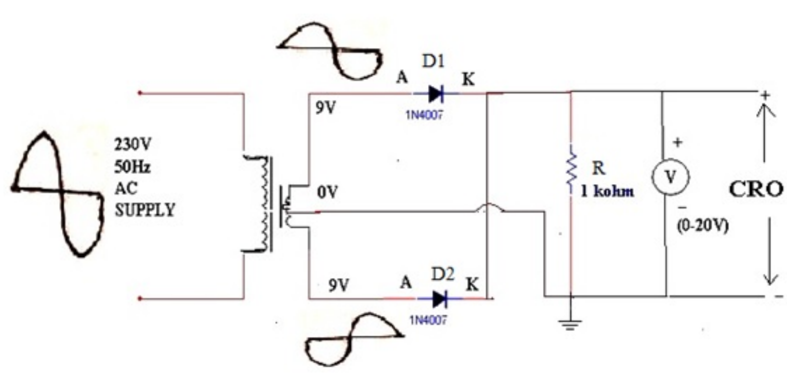

Figure 7.1: Full Wave Rectifier (without filter):

Procedure:

1. Connect the circuit as shown in the circuit diagram.
2. Connect the primary side of the transformer to AC mains and the secondary side to rectifier input.

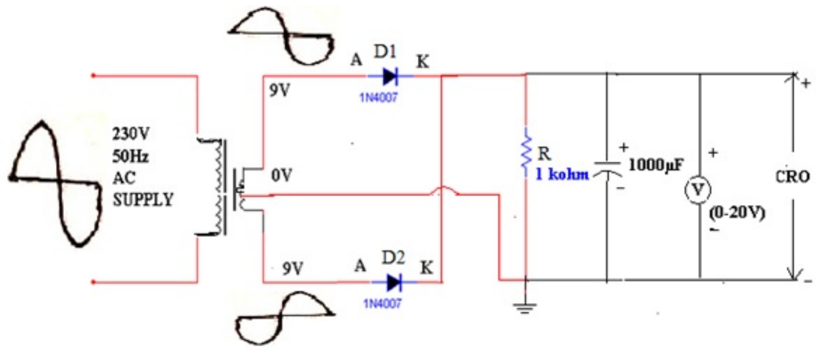

Figure 7.2: Full Wave Rectifier (with filter)

3. Using a CRO, measure the maximum voltage Vm of the AC input voltage of the rectifier and AC voltage at the output of the rectifier.
4. Using a DC voltmeter, measure the DC voltage at the load resistance.
5. Observe the Waveforms at the secondary windings of transformer and across load resistance for a load of 1KΩ.
6. Calculate the ripple factor γ.

Observations:

1. Peak Voltage, Vm=————(From CRO for HWR with and without filter)
2. Dc Voltage, V_DC(Full load)=———(From Voltmeter/ Multimeter for HWR with and without filter)
3. No Load DC Voltage, V_DC(No load) =———- (From Voltmeter/ Multimeter for HWR with and without filter)
4. Ripple Voltage, Vr =——— (From CRO for HWR with filter)

Calculations:

$$V_{rms} = \frac{V_m}{2}$$

$$V_{dc} = \frac{V_m}{\pi}$$

Ripple factor (Theoretical)= $\sqrt{(\frac{V_{rms}}{V_{dc}})^2 - 1} = 1.21$

Ripple Factor(practical) $\gamma = \frac{V_{ac}}{V_{dc}}$ where $V_{ac} = \sqrt{(V^2_{rms} - V^2_{dc})}$

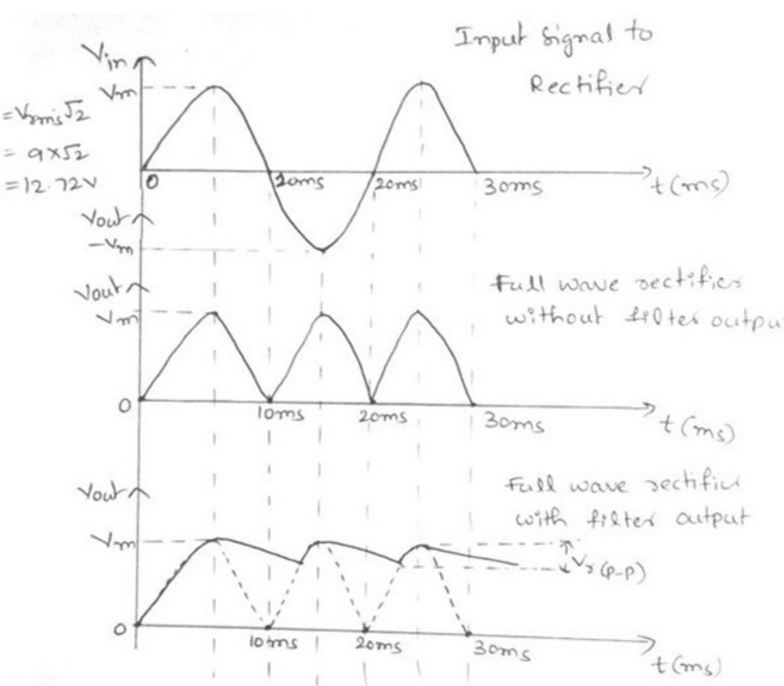

Figure 7.3: Expected Waveform