MANAV RACHNA UNIVERSITY

Declared as State Private University vide Haryana Act 26 of 2014

BASICS OF ELECTRICAL AND ELECTRONICS LAB

ECH103B-P

LAB MANUAL

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INSTRUCTIONS TO STUDENTS

•Before entering the lab, the student should carry the Identity card issued by the college, Class notes, and Lab File.

•Student must sign in and sign out in the register provided when attending the lab session without fail.

• Students, who are late more than 15 min., will not be allowed to attend the lab.

•Foods, drinks are NOT allowed.

•All bags must be kept near the door.

•Student need to come well prepared for the experiment.

•Work quietly and carefully.

•Be honest in recording and representing your data.

•Do not fiddle with apparatus. Handle instruments with care. Report any breakage to the Instructor. Return all the equipment you have signed out for the purpose of your experiment

SPECIFIC SAFETY RULES FOR BOEE LABORATORY

- You must not damage or tamper with the equipment or leads.
- You should inspect laboratory equipment for visible damage before using it. If there is a problem with a piece of equipment, report it to the technician.
- You should not work on circuits where the supply voltage exceeds 40 volts (both for AC and DC) without very specific approval from your lab supervisor. If you need to work on such circuits, you should contact your supervisor for approval and instruction on how to do this safely before commencing the work.
- Always use an appropriate stand for holding your soldering iron.
- Turn off your soldering iron if it is unlikely to be used for more than 10 minutes.
- Never leave a hot soldering iron unattended.
- Never touch a soldering iron element or bit unless the iron has been disconnected from the mains and has had adequate time to cool down.
- Never strip insulation from a wire with your teeth or a knife, always use an appropriate wire stripping tool.
- Shield wire with your hands when cutting it with a pliers to prevent bits of wire flying about the bench

List of Experiments

Exp. No	Name of experiment	PO,PSO	CO	BT
1	Familiarization with the lab Equipment's(Breadboard, Multimeter, CRO, etc.)	PO1-PO4,PO9-PO12,PSO1	CO1	BT2
2	To verify the Kirchhoff's Voltage Law and Kirchhoff's Current Law	PO1-PO4, PO9-PO12,PSO1	CO1	BT3
3	Introduction to soldering	PO1-PO4, PO9-PO12,PSO1	CO1	BT2
4	Truth table Verification of AND and OR gate using diode	PO1-PO4, PO9-PO12,PSO1	CO2	BT4
5	To implement the diode in Half wave Rectifier(Through V Lab)	PO1-PO4, PO9-PO12,PSO1	CO2	BT3
6	Design of SMPS	PO1-PO4, PO9-PO12,PSO1	CO2, CO3	BT4
7	Transistor Characteristics in CE configuration(V Lab)	PO1-PO4, PO9-PO12,PSO1	CO2	BT3
8	Project using LDR	PO1-PO4, PO9-PO12,PSO1	CO3	BT4
9	Design of 5V power supply or Dancing lights (MINOR PROJECT)	PO1-PO4, PO9-PO12,PSO1	CO3	BT4
10	Op Amp as Inverting and Non-Inverting Amplifier	PO1-PO4, PO9-PO12,PSO1	CO3	BT2
11	Minor project using electronic devices.	PO1-PO4, PO9-PO12,PSO1	CO3	BT4

COURSE OUTCOMES

At the end of this course students will be able to:

CO1. Acquire knowledge of basic electrical principles and techniques, including soldering and verifying Kirchhoff's Laws

CO2. Students analyze and implement various electronic components and circuits, such as rectifiers, transistors in different configurations, and other essential circuit elements.

CO3. Students analyze and implement various electronic components and circuits, such as rectifiers, transistors in different configurations, and other essential circuit elements.

EXPERIMENT NO-01

Familiarization with the Lab Equipment's

Aim: To familiarize with various lab Equipment's used.

Apparatus required:

S.NO	Apparatus	Qty
1.	Bread board	1
2.	Connecting wires	Few
3.	Resistors	1
4.	Multimeter	1

Theory:

Various equipment's and measuring instruments are:

Resistances:

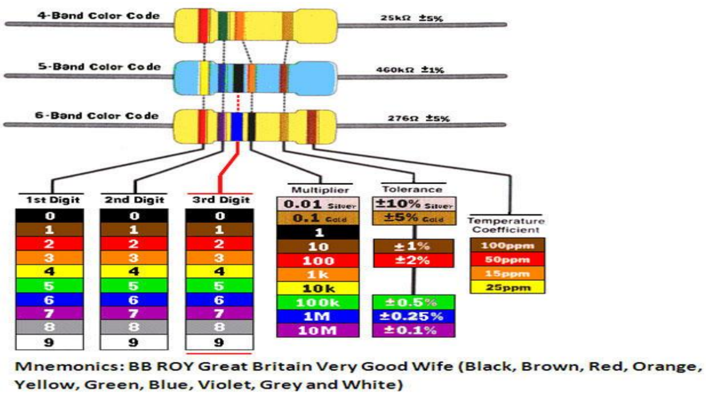
The electrical resistance of an electrical conductor is a measure of the difficulty to pass an electric current through that conductor. The inverse quantity is electrical conductance, and is the ease with which an electric current pass. Electrical resistance shares some conceptual parallels with the notion of mechanical friction. The SI unit of electrical resistance is the ohm (Ω), while electrical conductance is measured in siemens (S).

An object of uniform cross section has a resistance proportional to its resistivity and length and inversely proportional to its cross-sectional area. All materials show some resistance, except for superconductors, which have a resistance of zero.

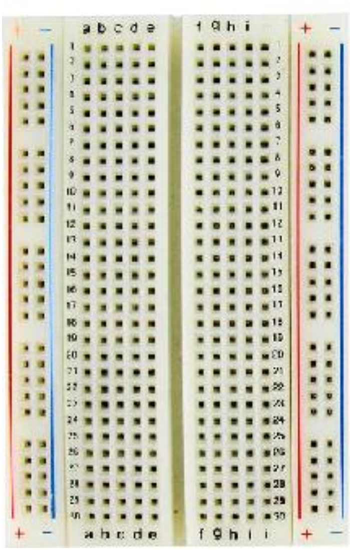
The resistance (R) of an object is defined as the ratio of voltage across it (*V*) to current through it (*I*), while the conductance (G) is the inverse:

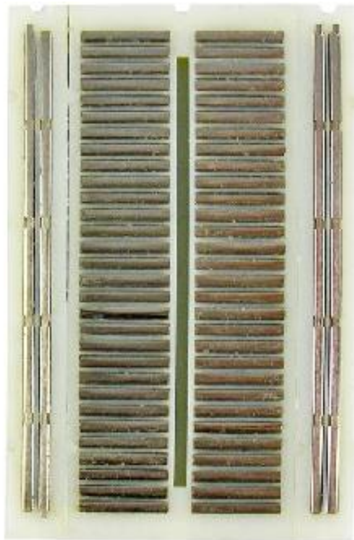
$$R=V/I, \quad G=I/V$$

For a wide variety of materials and conditions, *V* and *I* are directly proportional to each other, and therefore *R* and *G* are constant (although they can depend on other factors like temperature or strain). This proportionality is called Ohm's law, and materials that satisfy it are called ohmic materials.



Breadboard:



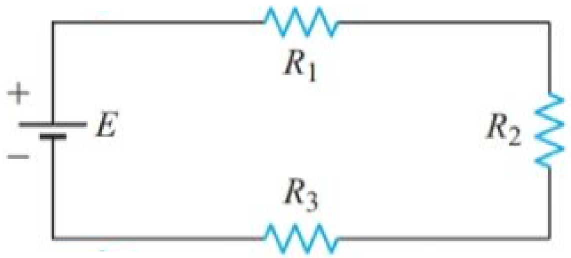


A breadboard is a construction base for prototyping of electronics. Originally it was literally a bread board, a polished piece of wood used for slicing bread. In the 1970s the solderless breadboard (AKA plugboard, a terminal array board) became available and nowadays the term "breadboard" is commonly used to refer to these. "Breadboard" is also a synonym for "prototype".

Digital Multimeter:

A multimeter or a multi-tester, also known as a VOM (volt-ohm meter or volt-ohm-milliammeter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance. Analog multimeters use a microammeter with a moving pointer to display readings. Digital multimeters (DMM, DVOM) have a numeric display, and may also show a graphical bar representing the measured value. Digital multimeters are now far more common due to their cost and precision, but analog multimeters are still preferable in some cases, for example when monitoring a rapidly varying value. A multimeter can be a hand-held device useful for basic fault finding and field service work, or a bench instrument which can measure to a very high degree of accuracy. They can be used to troubleshoot electrical problems in a wide array of industrial and household devices such as electronic equipment, motor controls, domestic appliances, power supplies, and wiring systems.

Circuit Diagram:



Tabulation:

S.No.	Resistors	Resistance in ohms	
		Calculated	Measured
1	R_1		
2	R_2		
3	R_3		

Calculation:

Result:

Thus few Equipment's used in lab was familiarised.

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EXPERIMENT NO-02

KIRCHHOFF'S VOLTAGE AND CURRENT LAW

Aim: To verify Kirchhoff's Voltage and current Law

Apparatus Required:

S.NO	Apparatus	Qty
1	Bread board	1
2	Connecting wires	Few
3	Resistors	1
4	Multimeter	1
5	DC Power Supply	1

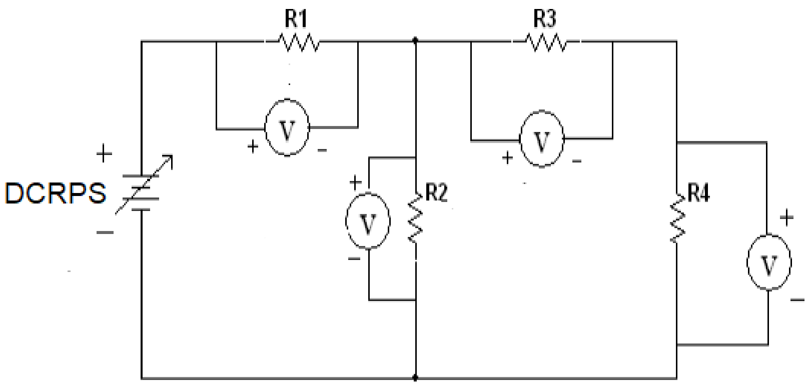
KIRCHHOFF'S VOLTAGE LAW (KVL):

KVL states that "the algebraic sum of all the voltages around any closed loop in a circuit equals zero".

i.e., Sum of voltage drops = Sum of voltage rises

Circuit Diagram:

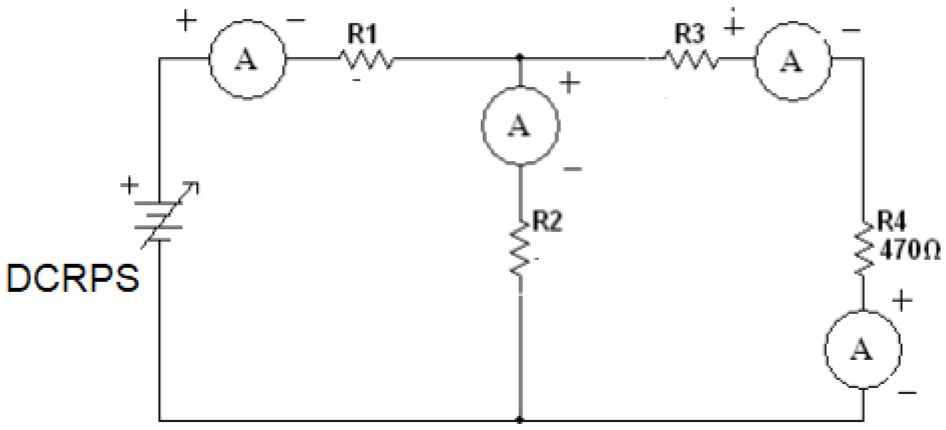
KVL



KIRCHHOFF'S CURRENT LAW (KCL):

KCL states that "the algebraic sum of all the currents at any node in a circuit equals zero".

i.e., Sum of all currents entering a node = Sum of all currents leaving a node



Procedure:

Kirchhoff's Voltage law:

1. Connect the circuit as shown in figure

2. Measure the voltages across the resistors.

3. Observe that the algebraic sum of voltages in a closed loop is

zero.

Kirchhoff's Current law:

1. Connect the circuit as shown in figure

2. Measure the current across the resistors.

3. Observe that the algebraic sum of currents in a node is zero.

Observation table

S.No	**Resistors(in KΩ)**	**Voltage(V)**	
		Measured	**Calculated**
1	$R_{1=}$	$V_{1=}$	

2	R_{2}=	V_{2}=	
3	R_{3}=	V_{3}=	
4	R_{4}=	V_{4}=	

Observation table

S.No	**Resistors(in KΩ)**	**Voltage(V)**	
		Measured	**Calculated**
1	R_{1}=	I_{1}=	
2	R_{2}=	I_{2}=	
3	R_{3}=	I_{3}=	
4	R_{4}=	I_{4}=	

Calculation:

$$\mathbf{V - V_1 - V_2 = 0}$$

Result:

Thus Kirchhoff’s Voltage Law is verified experimentally

Calculation:

$$\mathbf{I_1 - I_2 - I_3 = 0}$$

Result:

Thus Kirchhoff’s Voltage and Current Law is verified experimentally

EXPERIMENT NO-3

Introduction to soldering

Aim: To practice soldering and de-soldering for the electronic circuit by assembling and disassembling in the Printed Circuit Board (PCB) and check for its Continuity.

APPARATUS REQUIRED

S.NO	NAME OF THE APPARATUS	RANGE	QUANTITY
1.	PCB Board	-	1
2.	Soldering iron	60/40 grade	1
3.	Solder	-	As Required
4.	Soldering Flux	-	As Required
5.	Capacitor	100µf	As Required
6.	Resistor	1kΩ	As Required
7.	Multimeter	-	1

THEORY:

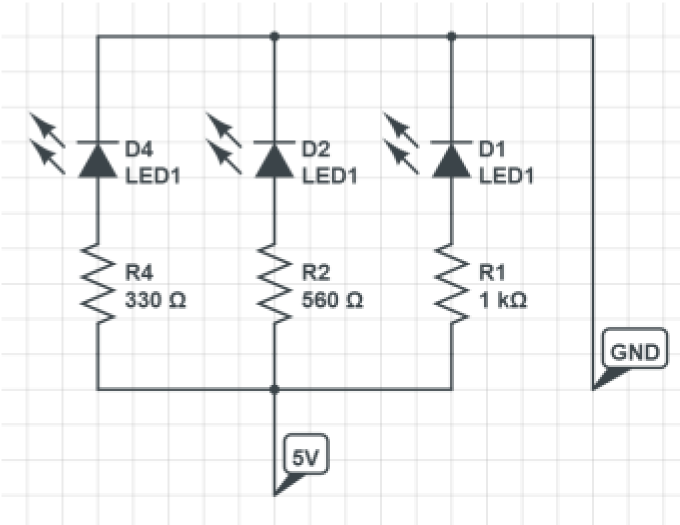
- Soldering is the process of joining electrical parts together to form an electric connection, us molten mixture of lead and tin (solder), with a soldering iron.
- Soldering Iron:
- It supplies sufficient heat to melt solder by heat transfer, when the iron tip is applied to a connection to be soldered.
- The soldering iron temperature is selected according to the work to be performed. Soldering Iron Stand:
- The stand is the safe place to put the iron when we are not holding it.
- The stand includes a sponge which can be dampened for cleaning the tip of the iron. Solder:
- It is alloy of low melting metals like tin, lead, cadmium, silver etc.

- The most commonly used alloy combination is 63% tin and 37% lead. Soldering Flux:

- It is a resin, applied on the work piece to be soldered, preventing contact with the atmosphere.
- It maintains a clean surface and dissolves oxides thereby enabling good soldering.
- Aluminium chloride or zinc chloride are commonly used as flux.
- The flux also assists in the transfer of heat from the soldering iron tip to the joint area

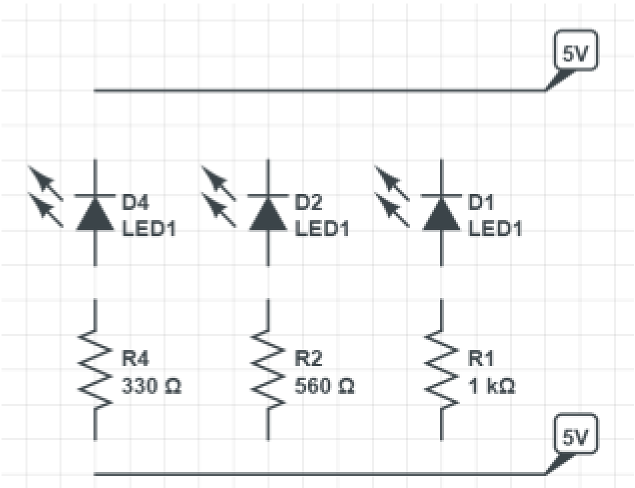
SOLDERING:

CIRCUIT DAIGRAM:



DESOLDERING:

CIRCUIT DAIGRAM:



EXPERIMENT NO-04

Design AND & OR gate using diode

Aim: To verify Truth table Verification of AND and OR gate using diode

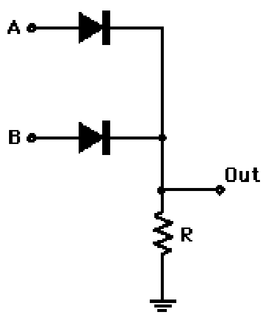
Apparatus Required:

S.NO	Apparatus	Qty
1.	Bread board	1
2.	Diode(1N4001)	3
3.	Multimeter	1
4.	Power supply	3
5.	Connecting wires	Few
6.	Resistor(1K)	1

Theory: Diode logic (DL) or diode resistor logic (DRL) is a logic family that uses only diodes and the resistors in the implementation of the logic functions. AND and OR functions can be implemented using the diode logic very easily. The main drawback of the diode logic family is that it is not complete. The inverter (NOT) function cannot be implemented using diode logic.

Circuit diagram:

OR Gate



AND Gate:

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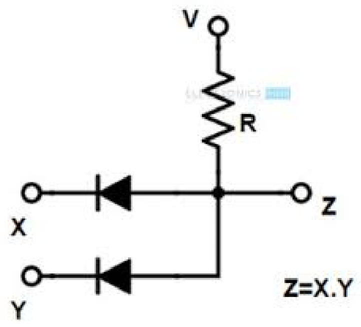


Truth Tables:

Result:

EXPERIMENT NO-05

Characterstics of PN junction diode

Link: http://vlabs.iitkgp.ernet.in/be/exp5/index.html

Write up from VLAB

EXPERIMENT NO-06

Study of Switched-Mode Power Supply (SMPS)

Aim: To understand the working and characteristics of a Switched-Mode Power Supply (SMPS) and to measure its efficiency and voltage regulation.

Objective:

1. To study the operation of SMPS and its various components.
2. To observe the voltage and current at different stages of the SMPS.
3. To calculate the efficiency and voltage regulation of the SMPS.

Apparatus Required

1. SMPS module (e.g., a DC-DC buck converter)

2. Function generator
3. Oscilloscope
4. Digital multimeter
5. Load resistor
6. Power supply
7. Connecting wires
8. Breadboard (if required)

Theory: Switched-Mode Power Supplies (SMPS) convert electrical power efficiently using high-frequency switching and transformers. SMPS can step up, step down, or invert the input voltage. Common topologies include buck, boost, and buck-boost converters. The efficiency of SMPS is generally higher than linear regulators due to reduced power dissipation.

Precautions

1. Ensure all connections are tight and secure to prevent short circuits.
2. Do not exceed the rated voltage and current of the components.
3. Be cautious while handling high voltage components.
4. Verify the power supply output before connecting it to the circuit.
5. Avoid contact with live circuits.

Circuit Setup:

- Connect the SMPS module as per the circuit diagram provided.
- Connect the input power supply to the SMPS input terminals.
- Connect the load resistor across the output terminals.

Measurement:

- Set the desired input voltage and measure it using a multimeter.
- Measure the output voltage and current under no-load and full-load conditions.
- Observe the output waveform using an oscilloscope.

Efficiency Calculation:

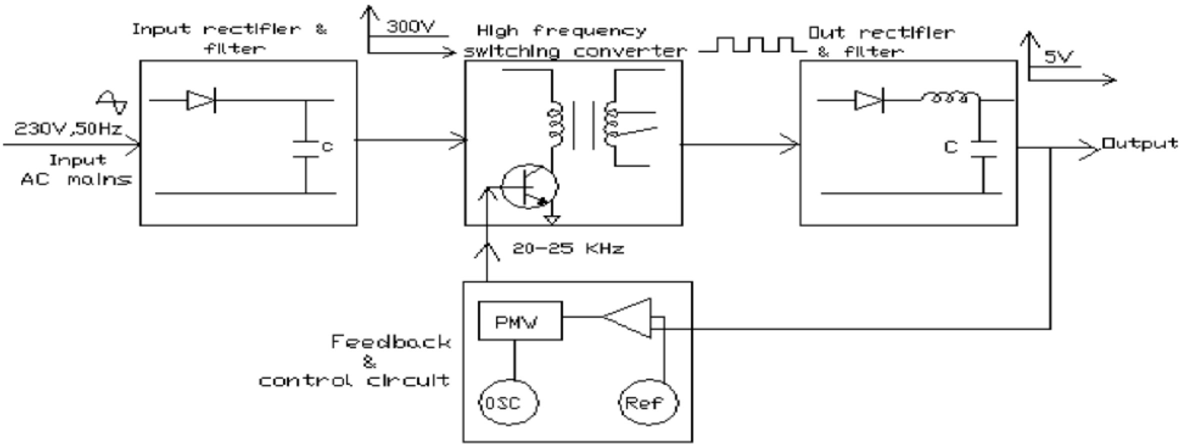
- Calculate the input power Pin using the formula $Pin=Vin \times Iin$
- Calculate the output power Pout using the formula $Pout=Vout \times Iout$
- Calculate the efficiency using the formula $\eta=(Pout/Pin) \times 100\%$

Voltage Regulation:

- Measure the output voltage at no-load (Vnl) and full-load (Vfl).

- Calculate the voltage regulation using the formula Voltage Regulation=((Vnl−Vfl)/Vfl)×100%

Circuit Diagram



Observation Table

S.No.	Input Voltage (V)	Input Current (I)	Output Voltage (V)	Output Current (I)	Input Power (W)	Output Power (W)	Efficiency%
1.							
2							

Calculations

1. **Input Power Calculation:** Pin=Vin×Iin
2. **Output Power Calculation:** Pout=Vout×Iout
3. **Efficiency Calculation:** η=(Pout/Pin)×100%
4. **Voltage Regulation:** Voltage Regulation=(Vnl−Vfl/Vfl)×100%

Result

1. The efficiency of the SMPS is found to be ___%.
2. The voltage regulation of the SMPS is ___%.

EXPERIMENT NO-07

Transistor Characteristics in CE configuration(V Lab)

Link: Basic Electronics (iitkgp.ac.in)

Write up from VLAB

EXPERIMENT NO-08

Design and Implementation of a Street Light Controller

Aim: To design and implement an automatic street light controller using a Light Dependent Resistor (LDR) and relay circuit.

Objective

1. To understand the working principle of an automatic street light controller.
2. To design a circuit that automatically switches street lights ON at dusk and OFF at dawn.
3. To analyze the behaviour of the circuit under different lighting conditions.

Apparatus Required

1. Light Dependent Resistor (LDR)
2. Operational amplifier (Op-Amp, e.g., LM358)
3. Relay module
4. NPN transistor (e.g., BC547)
5. Resistors (various values)
6. Potentiometer
7. LED or lamp as the street light
8. Power supply (12V DC)
9. Breadboard and connecting wires
10. Multimeter

Theory: A street light controller automatically turns on street lights when ambient light levels fall below a certain threshold and turns them off when light levels rise. An LDR is used to sense the ambient light, changing its resistance based on the light intensity. The output from the LDR is processed using an Op-Amp in a comparator configuration, which controls the relay and, in turn, the street light.

Precautions

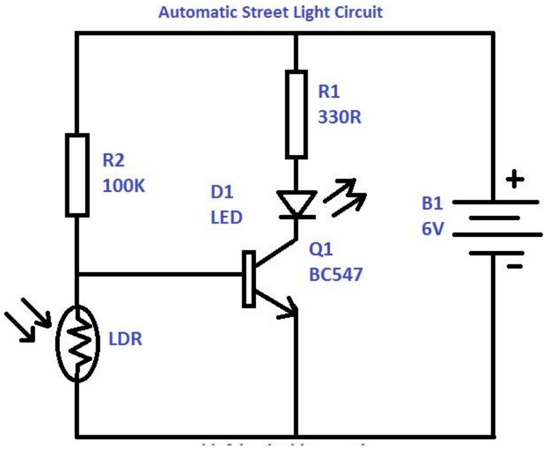
1. Ensure all connections are made securely to avoid short circuits.
2. Handle electronic components with care, especially the LDR and Op-Amp.
3. Verify the voltage ratings of components before applying power.
4. Keep the circuit away from moisture and static electricity.

Procedure

1. **Circuit Setup:**
   - Connect the LDR in series with a resistor to form a voltage divider. The junction of the LDR and resistor is connected to the inverting input of the Op-Amp.
   - Connect a potentiometer to the non-inverting input of the Op-Amp to set the reference voltage.
   - The output of the Op-Amp is connected to the base of the NPN transistor through a current-limiting resistor.
   - The collector of the transistor is connected to the relay module, which controls the street light (LED/lamp).
   - Connect the power supply to the circuit.
2. **Calibration:**
   - Adjust the potentiometer so that the output of the Op-Amp changes state at the desired ambient light level (dusk).
3. **Operation:**
   - In bright light conditions, the resistance of the LDR is low, causing the output of the Op-Amp to remain low, keeping the transistor and relay OFF.
   - In low light conditions, the resistance of the LDR increases, causing the Op-Amp output to go high, turning ON the transistor and activating the relay, thus turning on the street light.
4. **Observation:**

- Observe the point at which the street light turns ON and OFF by varying the ambient light and record the values.

Circuit Diagram:



Calculations

1. LDR Resistance Calculation: Rldr (measured using a multimeter)
2. Output Voltage Calculation: Vout(Op-Amp output)
3. Threshold Adjustment: Adjust potentiometer to set desired threshold

Result

1. The street light controller was successfully designed and implemented.
2. The street light automatically turned ON when the ambient light intensity fell below ___ lux and turned OFF when the intensity rose above ___ lux.

S.No	Ambient Light Intensity (lux)	LDR Resistance (Ω)	Reference Voltage (V)	Output Voltage (V)	Light Status (ON/OFF)
1					
2					

EXPERIMENT NO-09

Design and Implementation of a 5V Power Supply

Aim: To design and implement a regulated 5V DC power supply using a transformer, rectifier, filter, and voltage regulator.

Objective

1. To understand the process of converting AC voltage to a regulated DC voltage.
2. To design a power supply circuit that provides a stable 5V output.
3. To analyze the performance and characteristics of the power supply.

Apparatus Required

1. Step-down transformer (230V AC to 12V AC)
2. Bridge rectifier (4 diodes, e.g., 1N4007)
3. Capacitor (1000 µF, 25V) for filtering
4. Voltage regulator IC (7805)
5. Capacitors (0.1 µF for decoupling)
6. Resistors (for testing load)
7. Multimeter
8. Oscilloscope (optional)
9. Breadboard and connecting wires
10. Soldering kit (if assembling on PCB)

Theory

A regulated power supply converts AC voltage to a stable DC output. The power supply consists of four main stages:

1. Transformer: Steps down the high AC mains voltage to a lower AC voltage.
2. Rectifier: Converts AC to pulsating DC using diodes.
3. Filter: Smooths the rectified DC signal to reduce ripple.
4. Voltage Regulator: Provides a constant output voltage regardless of variations in input voltage or load conditions.

Precautions

1. Ensure proper insulation of the transformer and high voltage connections.
2. Verify all connections before powering the circuit to prevent damage.
3. Use appropriate ratings for components to handle the desired current and voltage.
4. Avoid short circuits and static discharge by handling components properly.

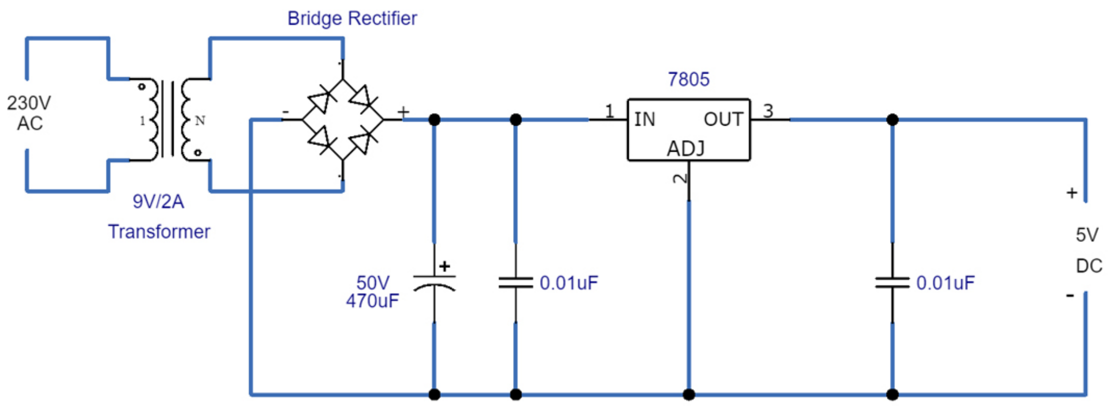
Procedure

1. **Circuit Assembly:**
   - Transformer: Connect the primary winding to the 230V AC mains supply. The secondary winding should provide 12V AC.

   Rectifier: Construct a bridge rectifier using four diodes. Connect the AC input from the transformer secondary to the bridge, and take the DC output across the load resistors.

   - Filter: Connect a large capacitor (1000 µF) across the rectifier output to filter out the AC ripples, providing a smoother DC voltage.
   - Voltage Regulator: Connect the filtered DC voltage to the input pin of the 7805 voltage regulator. The output pin provides the regulated 5V DC, and the ground pin is connected to the common ground of the circuit.
   - Decoupling Capacitors: Connect a 0.1 µF capacitor across the input and output of the voltage regulator to stabilize the voltage and reduce noise.
2. **Testing and Measurement:**
   - Apply the mains voltage to the transformer and measure the AC voltage at the secondary winding.
   - Measure the DC voltage at the output of the bridge rectifier.
   - Measure the filtered DC voltage across the capacitor.
   - Measure the regulated 5V output voltage across the output terminals.
   - Use different load resistors to observe the voltage regulation under various load conditions.

Circuit Diagram:



Observation Table:

S.No	Load Resistance (Ω)	Output Voltage (V)	Output Current (mA)	Output Power (W)	Input Voltage (V)
1					
2					

Calculations

1. Output Power Calculation: Pout=Vout×Iout
2. Efficiency Calculation: η=(Pout/Pin)×100%
3. Load Regulation: Load Regulation=((VNL−VFL/VFL))×100%

4. Ripple Voltage Measurement: Measure the peak-to-peak voltage fluctuation using an oscilloscope.

Result

1. The designed power supply provided a regulated 5V output.
2. The voltage regulation and ripple voltage were within acceptable limits.
3. The power supply efficiency was calculated and noted.
4. The circuit successfully demonstrated stable output under various load conditions.

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EXPERIMENT NO-10

Inverting and non-inverting amplifier

Aim: To Implement Inverting and Non-Inverting Amplifier, using Op-Amp.

Apparatus required:

S.NO	Apparatus	Qty
1.	Bread board	1
2.	Function Generator	1
3.	Multimeter	1
4.	Power supply	3
5.	Connecting wires	Few
6.	Resistor(1K)	1
7.	IC 741	1
8.	Capacitor(100µF)	1

Theory:

Inverting Amplifier: This is the most widely used of all the Op-amp circuits. The output V_0 is fed back to the inverting input through the R_f – R_{in} network as shown in figure where R_f is the feedback resistor. The input signal V_i is applied to the inverting input terminal through R_{in} and non-inverting input terminal of Op-amp is grounded. The output V_0 is given by

$$V_0 = V_i\,(-R_f / R_{in}) \text{ where, the gain of amplifier is } - R_f / R_{in}$$

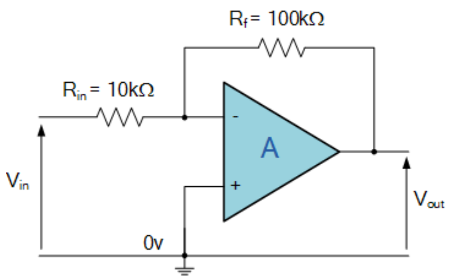
The negative sign indicates a phase-shift of 180 degrees between V_i and V_0. The effective input impedance is $R_{i.}$ An inverting amplifier uses negative feedback to invert and amplify a voltage. The R_{in}, R_f resistor network allows some of the output signal to be returned to the input. Since the output is 180° out of phase, this amount is effectively subtracted from the input, thereby reducing the input into the operational amplifier. This reduces the overall gain of the amplifier and is dubbed negative feedback.

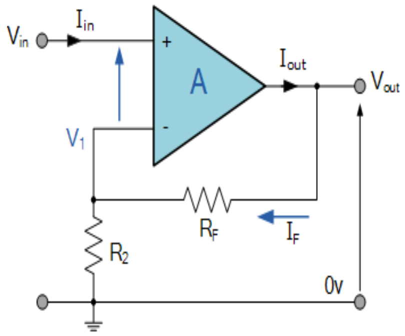
The circuit diagram of non – inverting amplifier is shown in figure. Here, the signal is applied to the non – inverting input terminal and feedback is given to inverting terminal. The circuit amplifiers the input signal without inverting it. The gain for non-inverting is given by

$$A = 1 + \frac{Rf}{R2}$$

Compared to the inverting amplifier, the input resistance of the non-inverting is extremely large.

Circuit Diagram:





a) Inverting Amplifier **b) Non-Inverting Amplifier**

Procedure:

Inverting & Non – inverting amplifier: Make connections as given in fig 1 & fig 2 for inverting and non-inverting amplifiers respectively.

1. Give sinewave input of V_i volts using AFO with the frequency of 1 KHZ.
2. The output voltage V_0 observed on a CRO. A dual channel CRO to be used to see V_i & Vo.
3. Vary R_f and measure the corresponding V_0 and observe the phase of V_0 with respect t /V0.
4. Tabulate the readings and verify with theoretical values.

Observations:

	R_f	R1	GAIN	Observed V_0	Calculated V_0 $V_0 = V_i (-R_f / R_{in})$
INVERTING AMPLIFIER					
NON-INVERTING AMPLIFIER					

Result: