ELECTRICAL&ELECTRONICS ENGINEERING WORKSHOP
(Common to All branches of Engineering)

PART-A

ELECTRICAL ENGINEERING LAB

(LABORATORYMANUAL)

LABCODE: R23ES05 **SCHEME: R23**

DEPARTMENT OF ELECTRICAL&ELECTRONICS ENGINEERING

BEHARA COLLEGE OF ENGINEERING&TECHNIOLOGY

ApprovedbyAICTE.NewDelhi,AffiliatedtoJNTUniversity,GurajadaVizianagaram

88th ward,Narava(V),Visakhapatnam,530027

VISION

DEPARTMENT VISION:

The Electrical and Electronics Engineering department strives To be recognized as a center of excellence for outstanding education and research to produce competent and ethical Electrical Engineers capable of finding solutions to problems related to society, environment and industry using innovative technologies

M1: To organize faculty development programs in need-based areas to enhance their capability in teaching, publishing research papers in peer reviewed journals, filing patents and for their overall career

M2: To deliver knowledge among students through contemporary curriculum and modern pedagogical methods in the areas of electrical engineering and interdisciplinary areas

M3: To enable students, develop skills in solving complex engineering problems of current times and also provide a framework for promoting collaborative and multidisciplinary activities

M4: To nurture the personality traits among the students in different dimensions emphasis the ethical values and to address needs of the nation.

By the completion of Electrical& Electronics engineering program, the students will be to:

PROGRAM EDUCATIONAL OBJECTIVES(PEOS):

PEO1:

Learn Core Skills, skill to understand, analyze, design, create novel products and implementation of complex systems by applying basic concepts in Electrical Engineering like Basic Electrical Engineering, Electrical machines ,Power systems, control systems, power Electronics Special Electrical machines.(Core skills)

PEO2:

Problem solving using hardware and software tools & Lifelong learning, Capability to pursue career in industry or higher studies with continuous learning. (Problem-Solving Skills).

PEO3:

Entrepreneurship Skills, Leadership qualities, team spirit, multi-disciplinary approach, character molding, effective communication skills, lifelong learning and sense of responsibility towards society for a successful professional career. (Professional Career).

PROGRAM SPECIFIC OUT COMES (PEOS):

PSO-1: Design and implementation of complex systems by applying basic concepts in Electrical &Electronics Engineering like Basic Electrical Engineering, Electrical machines, Power systems, control systems, power Electronics Special electrical machines (Core Skills).

PSO-2: Solve complex Engineering problems related to Electrical Engineering, using hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions relevant to the society (Problem-Solving Skills).

PSO-3: Quality in technical subjects for successful higher studies and employment (Professional Career).

PROGRAM OUTCOMES(POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design / development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.
12. **Life- long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

SYLLABUS

PART A: ELECTRICAL ENGINEERING LAB

List of experiments:

1. Verification of KCL and KVL
2. Verification of Superposition theorem
3. Measurement of Resistance using Wheat stone bridge
4. Magnetization Characteristics of DC shunt Generator
5. Measurement of Power and Power factor using Single-phase wattmeter
6. Measurement of Earth Resistance using Megger
7. Calculation of Electrical Energy for Domestic Premises

Reference Books:

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata Mc Graw Hill, 2019, First Edition
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

Note: Minimum Six Experiments to be performed.

During the lab class

Do's

1. Be punctual and regular to the laboratory.
2. Maintain Discipline all the time and obey the instructions.
3. Check the connections properly before turning ON the circuit.
4. Turn OFF the circuit immediately if you see any component heating.
5. Dismount all the components and wires before returning the kit.
6. Any failure/break-down of equipment must be reported to the faculty

Don'ts

1. Don't touch live electric wires.
2. Don't turn ON the circuit unless it is completed.
3. Avoid making loose connections.
4. Don't leave the lab without permission.
5. Do not handle any equipment without reading the

instructions/Instruction Manuals

ABOUT THE LAB

In this lab students will be able to study and verification of the Kirchoff's laws Superposition theorem wheatstone bridge, obtaining magnetization characteristics of DC generator, measurement of power and power factor by 1phase watt meter ,measurement of earth resistance using megger, calculation of electrical energy for domestic premises.

SIGNIFICANCE OF THE LAB

Electrical lab is useful for calculating voltage and currents in complex circuits using laws and theorems. Also measuring earth resistance which is very important for electrical equipment protection system in domestic as well as Industries.

The basic Electrical Engineering lab is intended for students to learn about circuit design, calculations, and analyzing. Importance of earth resistance and its crucial role in safe guarding major electrical equipment as well as life of human beings and living things . Also calculating and preparing electrical bill for domestic loads, and getting the knowledge of electrical units.

Course Designed by	Department of Electrical& Electronics Engineering
Category	Application based experiments
Broad Area of Syllabus	Domestic as well as industry

EXP.NO.1 VERIFICATION OF KIRCHOFF'S CURRENT LAW & VOLTAGE LAW

AIM:

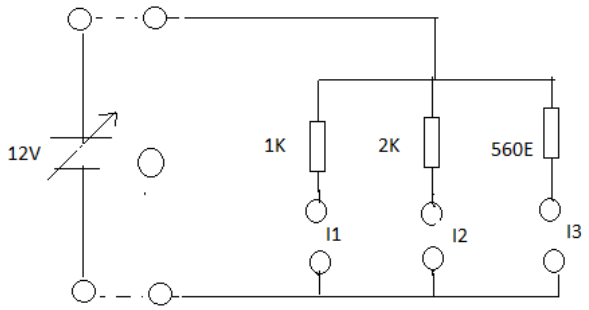
To verify Kirchoff's current law and voltage law in d.c circuit .

APPARATUS:

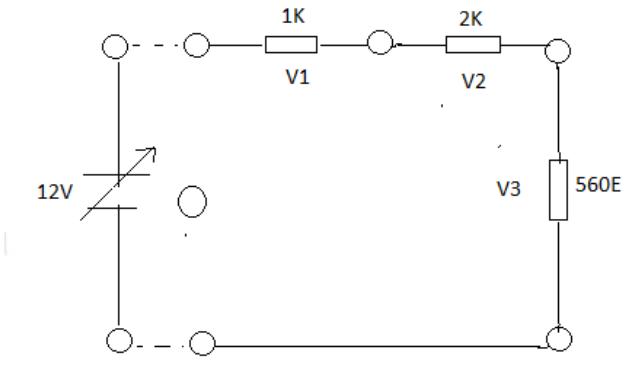
a. Kir ch off law trainer
b. Voltmeter 0-15v
c. Ammeter 0-20mA
d. Patch cards

Circuit diagram:-

Fig(1) **Current Law**



Voltage law:



THEORY:

Kirchoff's current law (KCL) :

The algebraic sum of currents entering any node is zero

Kirchoff's Voltage law (KCL) :

The algebraic sum of voltages around any closed loop is zero

PROCEDURE:

Kirchoff's Current Law :

1. Connect the circuit as per the circuit diagram fig(1).
2. Adjust the input voltage of the regulated power supply to an appropriate value .
3. Note down the voltage drop across each resistor using the voltmeter.
4. Vary the Input Voltages and note down the corresponding voltage Drops across each resistors
5. Disconnect the circuit.

Kirchoff's Current Law :

1. Connect the circuit as per the circuit diagram fig(2).
2. Adjust the output voltage of the regulated power supply to an appropriate value .
3. Note down the current through the resistors using the ammeter.
4. Vary the Input Voltages and note down the corresponding current across each resistors
5. Disconnect the circuit
6.

7. Tabulation:

KVL :

SNO.	Input Voltage (V)	V_1	V_2	V_3

KCL :

SNO.	Input Voltage (V)	I_1	I_2	I_3

Theoretical calculations

KVL :

V = ----- Volt

$I = V / R_1 + R_2 + R_3$:

$V_1 = I^* R_1$

$V_2 = I^* R_2$

$V_3 = I^* R_3$

$V_1 + V_2 + V_3 = V$

KCL :

Prove it using mesh analysis or nodal analysis

RESULT:-

The Practical and theoretical values are found to be the same . Thus the Kirchoff ‘s Voltage and current laws are proved .

EXP NO.2 VERIFICATION OF SUPERPOSITION THEOREM

AIM:

To verify the superposition theorem.

APPARATUS:

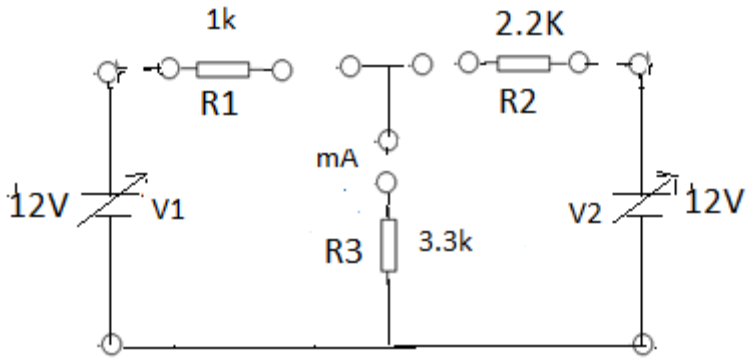
A. Trainer kit
B. Voltmeter 0-15v
C. Milli Ammeter 0-5A
D. Patch cards

Theory:

Super Position Theorem:

In any linear, bilateral, multi source network the response in any element is equal to the algebraic sum of the responses obtained by each source acting separately while all other sources are set equal to zero

CIRCUIT DIAGRAM:



When V_1&V_2 source acting (To find I):-

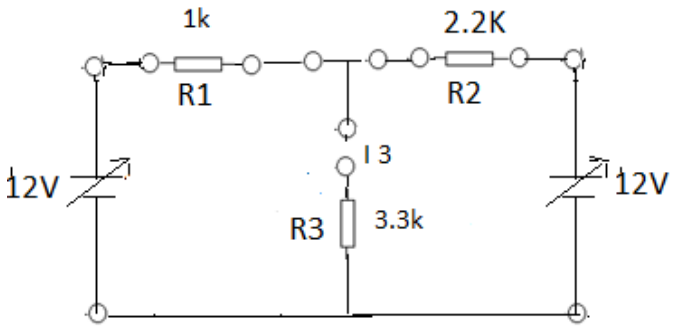
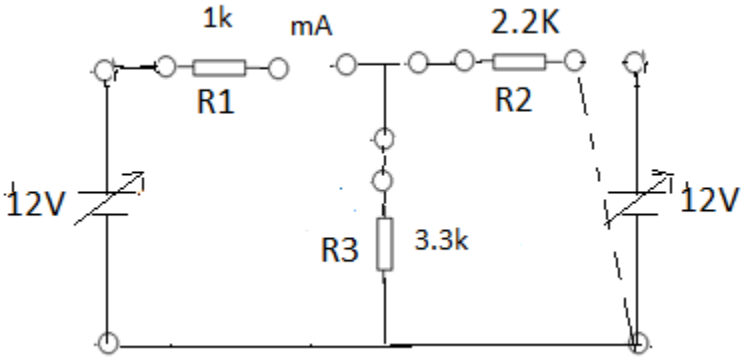


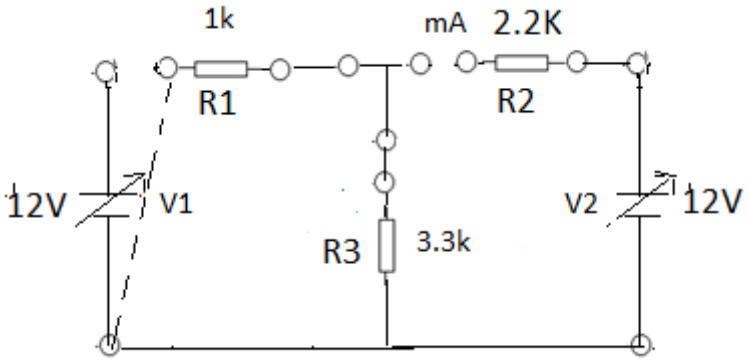
Fig 1;

Fig 2:

WhenV_1 source acting (To find I_1):-



WhenV_2 source acting(To find I_2):-



PROCEDURE:

1. Connect the circuit as per the fig (1).
2. Adjust the output voltage of sources RPSU 1 and 2 to appropriate values
3. Note down the response (current, I) through the branch of interest through ammeter reading.
4. Now set the Source 2(RPSU 2) to 0V as in fig 2 and measure the ammeter reading(I_1)
5. Now set the Source 1(RPSU 1) to 0V as in fig 3 and measure the ammeter reading(I_2).
6. Reduce the output voltage of the sources X and Y to 0V and switch off the supply.
7. Disconnect the circuit.

TABULATION:

From Fig(1) - When V_1 & V_2 source acting(To find I):-

S. No	Applied voltage (V_1) Volt	Applied voltage (V_2) Volt	Current I (mA)

From Fig(2) When V1 Acting Find I

S. No	Applied voltage (V_1) Volt	Current I_1 (mA)

From Fig 3

S. No	Applied voltage (V_2) Volt	Current I_2 (mA)

THEORITICAL CALCULATIONS

From Fig(2)

$$I_T = V_1/(R_1+(R_2//R_3))$$

$$I_1 = I_T * R_2/(R_2+R_3)$$

From Fig(3)

$$I_T = V_2/(R_2+(R_1//R_3))$$

$$I_2 = I_T * R_1/(R_1+R_3);$$

$$I = I_1 + I_2$$

RESULT:

The theoretical and practical values for the Superposition theorem are formulated and proved as below

S.No	Load current	**Theoretical Values**	Practical Values
1	When Both sources are acting, I_L		
2	When only source 1 is acting, I_1		
3	When only source 2 is acting, I_2		

EXP.NO.3 WHEATSTONE BRIDGE

AIM

To find a Unknown value of resistance using a Wheatstone bridge

Apparatus :

1. Wheatstone bridge trainer
2. Multi meter
3. Patch cards

A Wheatstone bridge is an electrical circuit used to measure an unknown electrical resistance by balancing two legs of a bridge circuit, one leg of which includes the unknown component. Its operation is similar to the original potentiometer. It was invented by Samuel Hunter Christie in 1833 and improved and popularized by Sir Charles Wheatstone in 1843. One of the Wheatstone bridge's initial uses was for the purpose of soils analysis and comparison.

Operation

In the figure, $R_x$is the unknown resistance to be measured; R_1, $R_2$and $R_3$are resistors of known resistance and the resistance of $R_2$is adjustable. If the ratio of the two resistances in the known leg $(R_2/R_1)$is equal to the ratio of the two in the unknown leg (R_x/R_3), then the voltage between the two midpoints (**B** and **D**) will be zero and no current will flow through the galvanometer V_g. If the bridge is unbalanced, the direction of the current indicates whether $R_2$is too high or too low. $R_2$is varied until there is no current through the galvanometer, which then reads zero.

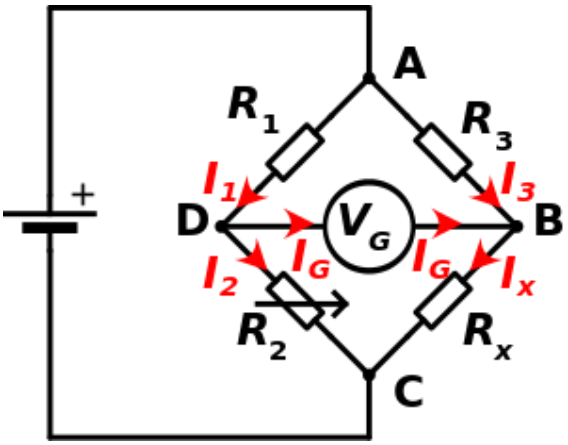
Detecting zero current with a galvanometer can be done to extremely high accuracy. Therefore, if R_1, $R_2$and $R_3$are known to high precision, then $R_x$can be measured to high precision. Very small changes in $R_x$disrupt the balance and are readily detected.

At the point of balance, the ratio of

$$\frac{R_2}{R_1} = \frac{R_x}{R_3}$$
$$\Rightarrow R_x = \frac{R_2}{R_1} \cdot R_3$$

Alternatively, if R_1, R_2, and $R_3$are known, but $R_2$is not adjustable, the voltage difference across or current flow through the meter can be used to calculate the value of R_x, using Kirchhoff's circuit laws (also known as Kirchhoff's rules). This setup is frequently used in strain gauge and resistance thermometer measurements, as it is usually faster to read a voltage level off a meter than to adjust a resistance to zero the voltage.

Derivation



Directions of currents arbitrarily assigned

FORMULA USED

$$RX = \frac{R1}{R2} * R3$$

PROCEDURE

- Connections are made as per the connection diagram.
- Connect the decade resistance box at Rx terminal (or) Connect resistance to be measured at Rx terminals.
- No switch ON the unit and vary the resistance R1and R3 to get the nearest point of balance.
- Now vary the R2 to get exact point of balance.
- Switch off the unit and remove the patching at R2.
- Now measure the resistance at R2 by using multimeter.
- Tabulate the reading and find the value of unknown resistance.

SL NO	R1 (ohms)	R2 (ohms)	R3 (ohms)	RX practical	RX (Theoretical)

RESULT : Thus the value of unknown resistance was measured using a Wheatstone bridge

-

EXP.NO4 MAGNETIZATION CHARACTERISTICS OF DC SHUNT GENERATOR

AIM: To obtain magnetization characteristics of a DC shunt generator &to find its critical resistance at constant rated speed and critical speed

NAMEPLATE DETAILS:

Term	D .C Shunt Motor	D.C Shunt Generator
Power		
Voltage		
Current		
Speed		
Field current		

FUSE RATING:

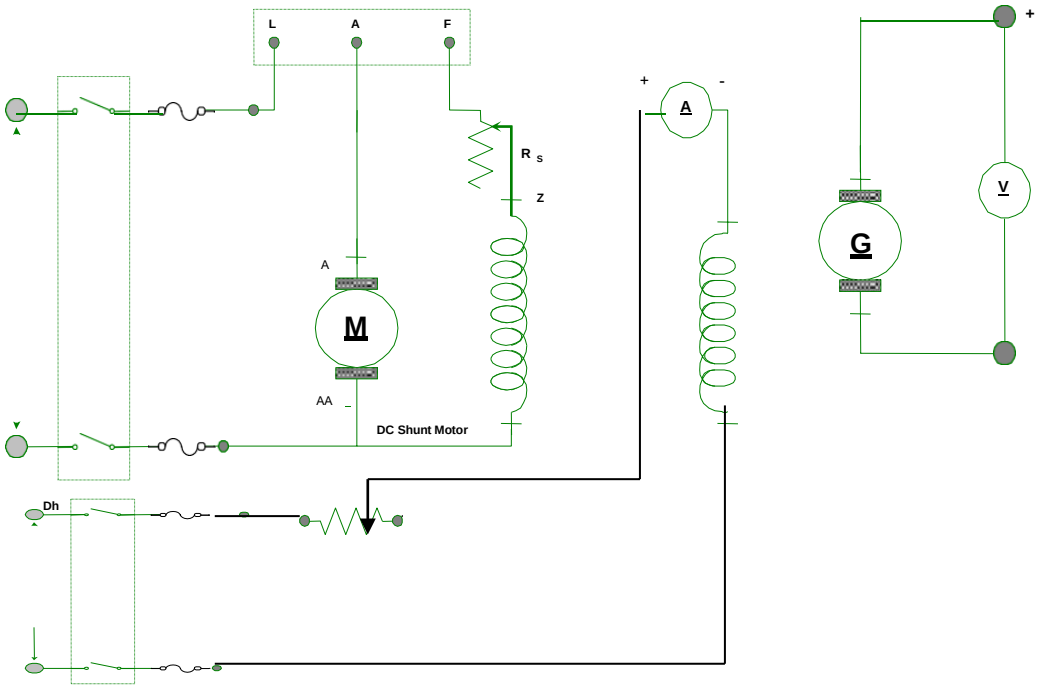
Motor side:

125% of rated current of DC Motor

APPARATUSREQUIRED:

S. No	Name of the Apparatus	Range	Type	Quantity	Availability
1	Ammeter				
2	Voltmeter				
3	Rheostats				
4	RPM meter				
5	Connecting Wires				

CIRCUIT DIAGRAM:



Meters required:

s/no	Meter	Quantity required	Range /Specification
1	Ammeter		
2	Voltmeter		
3	Rheostat		
4	Tachometer		

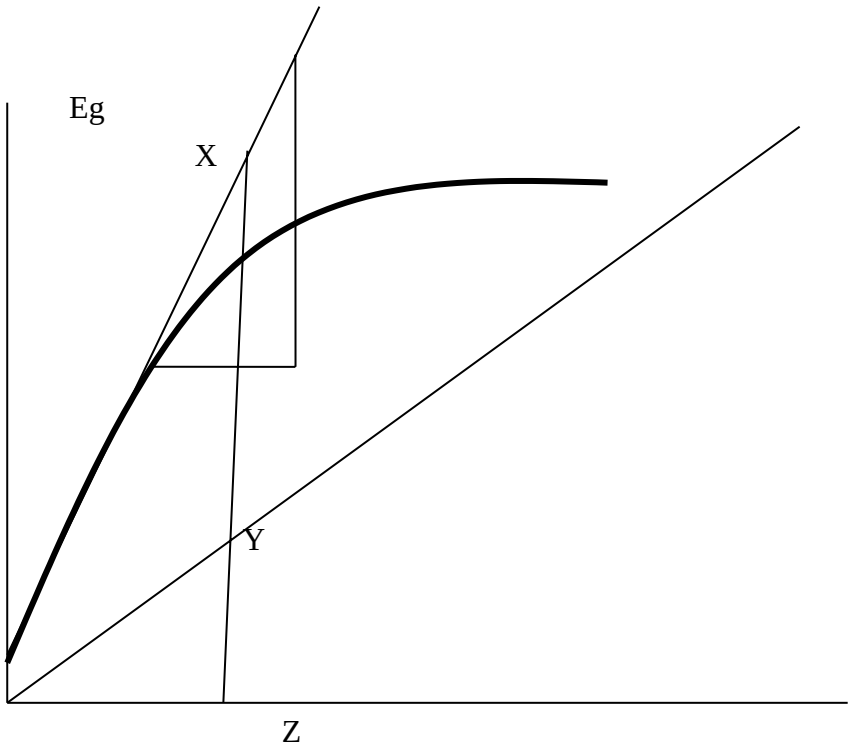
PROCEDURE:

1.Connections are given as per the circuit diagram.
2.Set the potential divider to zero output keeping motor fieldrheostat in minimum resistance position.
3.Switch on the supply and start the motor with the help of the starter. Adjust the Speed of the motor generator set to the rated speed of the generator by controlling the Motor field resistance the set speed is to be maintained constant through out the experiment. Note down the voltmeter reading at zero field current. Increase the field Current uniformly in steps, by moving the potential divider jockey, simultaneously noting down the field current and the terminal Voltage across the generator armature Terminals.
4.Continue the experiment till saturation of the field is reached.

Result: Magnetization characteristic curves of DC Shunt generator obtained.

Expected Graphs:

The graph is drawn in between Field Current (I_f) on X-Axis Vs Generated EMF E_G on y-Axis for both increasing and decreasing values of field current and the average curve is drawn.



Sl No:	Field Current If (A)	Generated EMF Eg (V)
1.		
2.		

Result:

The open circuit characteristics of DC Shunt generator are drawn and the Critical field resistance is determined.

EXP.NO.5 MEASUREMENT OF POWER AND POWER FACTOR

AIM : To measure power and power factor in single phase AC circuit

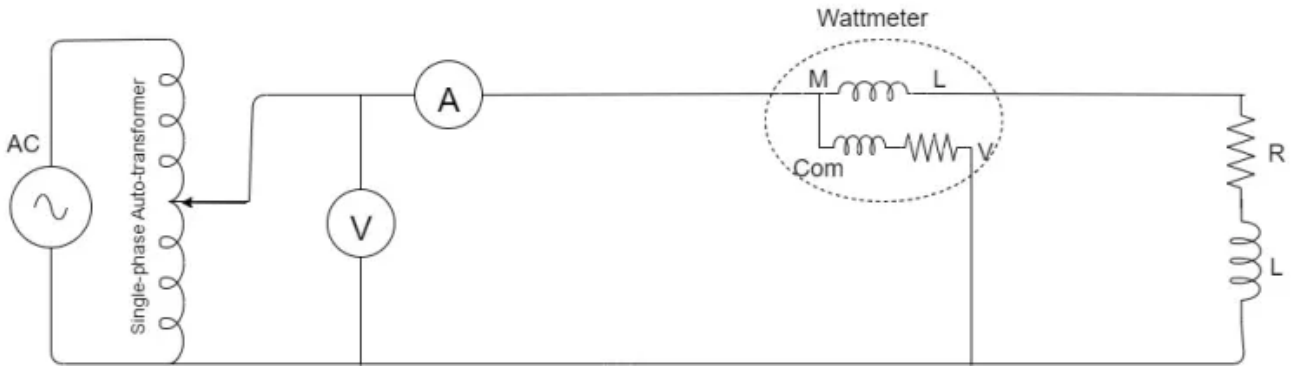
REQUIREMENT

- Single phase watt meter (Dynamo meter type)
- Patch chords/connecting wires
- Electrical load

Power Measurement Using Wattmeter

The circuit for measurement of power by wattmeter is shown in Fig. Here, the current coils (CC) of the wattmeter is connected in series with the load and the voltage coil (PC)of the watt meter is connected in parallel with the load. When a single phase AC supply is given to the load the wattmeter directly gives of the power consumed by the circuit. from the readings of voltmeter and Ammeter power factor is to be calculated.

Circuit diagram :



TABULAR FORM:

S.NO	Ammeter reading(I)	Volt meter reading(V)	Wattmeter reading (W) with MF	Power factor= W/VI
1				
2				
3				
4				
5				

Result : As per the readings obtained from the connected ammeter voltmeter and wattmeter , power and power factor is found.

EXP.NO 6 MEASUREMENT OF EARTH RESISTANCE WITH EARTH TESTER

Aim: To measure Earth Resistance using Megger

Apparatus /meters Required:

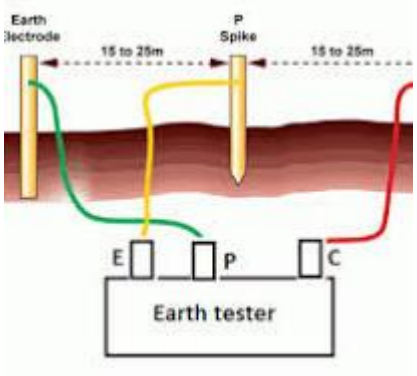
1. Digital Earth resistance tester
2. Earthing rods
3. Auxiliary earth associated with tester
4. Cables associated with tester

PROCEDURE:

1.Connect the earth tester as shown in figure.
2.Switch ON the earth tester.
3.Adjust the resistance range button between 10Ω to 1000Ω and set to 10Ω. 4.Change the position of electrode B by 1m on the either side and observe the earth resistance by pressing the test button. 5.Draw the graph and find Earth Resistance

THEORY:

All the electrical installations and appliances should be earthed properly for ensuring human safety.
A separate wire, known as earth wire runs along the supply line and is connected to the ground through an earth electrode.
The total resistance of the earthing system should be small so that in the event of any fault, the fault current is sufficiently high to blow off the fuse.
The earth resistance is the resistance offered by the soil and the electrode to the flow of earth leakage current, which will flow in case of earth fault only.
The earth tester is a special type of ohmmeter which sends ac through earth and dc through the measuring instruments as shown in Fig.



The direction of flow of current in the ground keeps on alternating due to current reverse whereas current directions in the two reverser and potential reverser are mounted on the main shaft of hand driven dc generator.

The working principle of an earth tester is identical to that of megger. There are two moving coil viz.

potential and current coil, which are deflected in the magnetic field of a permanent magnet.

The hand driven generator or a set of batteries supply power to these coils.

It has four terminals P1, E1, P2 and E2. Terminals P1 and E1 are shorted to form a common point which is connected to the earth electrode under test.

The other two terminals E2 and P2 are connected to the auxiliary electrode A and B respectively. The value of earth resistance is indicated directly on the scale when the test button is pressed.

The value of earth resistance depends upon the soil condition and its moisture contents. In hilly areas the earth resistance is higher if electrodes are not place properly in contact with the earth.

Water content in the soil decreased the earth resistance. The normal value of earth resistance should lie between 1 to 2Ω

Result: Found earth resistance of a earth pit.

EXP.NO 7 CALCULATION OF ELECTRICAL ENERGY FOR DOMESTIC PREMISES

Aim:
To calculate Electrical Energy for Domestic Premises

What Is Load in Electrical?

Modern lifestyle depends on electrically-powered appliances and fixtures. An electrical load calculation assesses the electrical burden of running everything connected to an electric circuit in a household. The common devices your electrical load table may include but not be limited to:

- Incandescent lights
- Toasters
- Ovens
- Space heaters
- Dishwashers
- Washing machines
- Refrigerators
- Air conditioners
- Electric motors
- Smart gadgets
- Medical devices, if used recurrently
- And more

A home electrical load calculator is a key tool in figuring out the impact of your electrical load on your energy cost. Also, the information helps you with your decisions associated with solar and battery storage.

When approaching “how to calculate the load of a house”, it’s important to understand that an electrical load can be defined and further classified in several ways. The most important definitions that homeowners would want to comprehend first are:

- An electrical load is any equipment that uses electrical energy to function and converts it into a different energy form.
- Electronic gadgets also consume electrical energy and convert it into motion, light, and heat among other electrical energy transformations.

House electrical load calculator measures electrical load represented by the total quantity of electricity required to run appliances, machines, lights, and other outlets.

For an accurate electrical load calculation formula, one should carefully factor in every appliance in a household that uses electric power to function. Your circuits mustn’t carry a load to its maximum capacity to avoid electrical overload. Practical advice is to keep it to 80 percent.

How to Calculate Electrical Load for a Home the Right Way

Do you want to pick the right solar energy system size? Perhaps you wish to ensure your electrical service is capable of meeting your home's energy demand in all seasons. In such cases, "how to calculate electrical load in a house" is an important question.

Homeowners can figure out their electrical load through this widely-used formula of load established by industry experts. This approach calculates the total units of power (measured in amps) required in your home.

For this load calculation formula, remember to keep a 20% margin to not overload the main circuit and ensure the safe functioning of all the appliances.

Calculating the electrical load formula for a piece of equipment requires identifying its amps (a measure of current), volts (a measure of voltage), and watts (a measure of power generated).

Ampere = Watts/Volt

Watts = Volt x Ampere

Using these formulas, you can put together a detailed load calculation sheet and determine the capacity of the main circuits and individual circuits. Start by jotting down the power consumption of your household appliances.

Here's a representation of common appliances and their average power rating (in watts):

Appliances/Fixtures	**Power Rating (in watts)**
Incandescent lamp	40 – 150
LED Bulb	4 – 25
LED tube light	8 – 36
Fluorescent tube light	18 – 60
Table fan	30 – 70

Induction motor Ceiling fan	60 – 80
Cooler	100 – 500
AC (1 ton)	3,517
Refrigerator	150 – 400
Computer	100 – 250
TV	60 – 120
Smartphone charger	4 – 7
Space Heater	1,000 and up
Washing Machine	300 – 500
Microwave	700 – 1,400
Coffee maker	800
Toaster oven	1,400
Blow dryer	300 – 1,200

To get to the bottom of the "how to electrical load calculation formula", let's assume you use the following appliances. Here's how to calculate the load of electricity of a house:

Number of Appliances	**Power Rating**	**Daily Use in Hours**	**Load Calculation**
4 LED Bulb	9-watt each	10	4 x 9W x 10 = **360 watt**
1 Cooler	400-watt	6	1 x 400W x 6 = **2,400 watt**
2 Ceiling fans	70-watt each	18	2 x 70W x 18 = **2,520 watt**
1 TV	100-watt	4	1 x 100W x 4 = **400 watt**
1 Refrigerator	300-watt	12	1 x 300W x 12 = **3,600 watt** (approximately)
Total			9,280 Watt Hour

1 watt = 0.001 kW

Therefore, your daily load is 9.28 kWh or **9.28 units per day**.

Considering that you use these appliances for the same number of hours daily, your monthly power consumption will be 9.28 x 30 = **278.4 units per month**.

If the electricity tariff for your region is Rs. 8 per unit, your monthly energy bill will be Rs. 2,227.2.

PRACTICAL CALCULATION OF ELECTRICITY BILL (LABORATOTY EXPERIMENT)

TABULAR FORM:

S/NO	NO.OF LAMPS	WATTAGE OF EACH LAMP	NO.OF HOURS OF CONSUMING POWER	TOTAL KWHS	RATE PER KWH	ELECTRICITY BILL
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						