



GOVERNMENT POLYTECHNIC SHEOHAR



STATE BOARD OF TECHNICAL EDUCATION, BIHAR

(Department of Science, Technology and Technical
Education (DSTTE), Govt. of Bihar)

*Parihara Chamanpur, Post- Kamrauli, PS- Piprahi,
Dist- Sheohar, PIN-843329.*



DEPARTMENT OF MECHANICAL ENGINEERING

LAB MANUAL

ANNEXURE – II FORMAT

SBTE Bihar – Diploma Programme

ELECTRIC VEHICLE (BASICS) LAB

Course Code: 2000508G

Semester V | Diploma in Mechanical Engineering

Academic Year: 2025–2026

Total Experiments: 07

PLA Marks: 20 (PRA + PDA + Viva-Voce)

Prepared By

MR. SHISHU RANJAN

Lecturer (ME)

Government Polytechnic Sheohar

List of Experiments

S.No.	Title of the Experiments	Relevant CO(s)	PRA %	PDA %	Viva %
1	Practice Using Digital Measuring Instruments and Safety Kits	CO1	30	–	20
2	Identification of Different Types of Electric Motors Used in Electric Vehicles	CO2	15	40	30
3	Identification of the Batteries Available in the Laboratory	CO3	15	40	30
4	Measurement of Open Circuit Voltage (OCV) of an Electric Vehicle Battery	CO3	15	40	30
5	Determination of the Ampere-Hour Capacity of the Given Battery with a Given Load	CO3	15	40	30
6	Identification and Testing of Electrical and Electronic Components Using a Digital Multimeter	CO4	40	20	20
7	Identification of Power Electronic Circuits Used in Electric Vehicles	CO4	40	20	20

Experiment No. 1

Title: Practice Using Digital Measuring Instruments and Safety Kits

1. Practical Significance

Measuring instruments are indispensable in the testing, maintenance, and troubleshooting of electric vehicles (EVs). Proper use of digital meters enables technicians to measure voltage, current, resistance, continuity, illumination, and dimensions accurately. Knowledge of safety equipment minimizes accidents while working with high-voltage EV systems.

2. Relevant Program Outcomes (POs)

PO	Description
PO1	Basic Engineering Knowledge
PO2	Problem Analysis
PO4	Engineering Tools
PO5	Engineering Practices for Society
PO7	Life-long Learning

3. Related Course Outcome (CO)

CO1: Classify the EVs based on configurations.

4. Laboratory Session Outcomes (LSOs)

After completing this experiment, students will be able to:

- Use relevant digital measuring instruments for the given application.
- Use measuring instruments correctly.
- Use safety kits while working in EV laboratories.

5. Practical Skills Developed

- Operating Digital Multimeter
- Measuring AC/DC voltage
- Measuring Current
- Measuring Resistance
- Continuity Testing
- Using Clamp Meter
- Measuring Dimensions using Vernier Caliper
- Measuring Diameter using Micrometer
- Using Lux Meter
- Following Electrical Safety Procedures

6. Minimum Theoretical Background

Digital Multimeter: A Digital Multimeter (DMM) measures

- AC Voltage
- DC Voltage
- Resistance
- Current
- Continuity
- Diode Testing

Clamp Meter: Clamp meters measure current without disconnecting the circuit.

Types:

- AC Clamp Meter
- AC/DC Clamp Meter

Vernier Calliper: Measures External Diameter, Internal Diameter and Depth

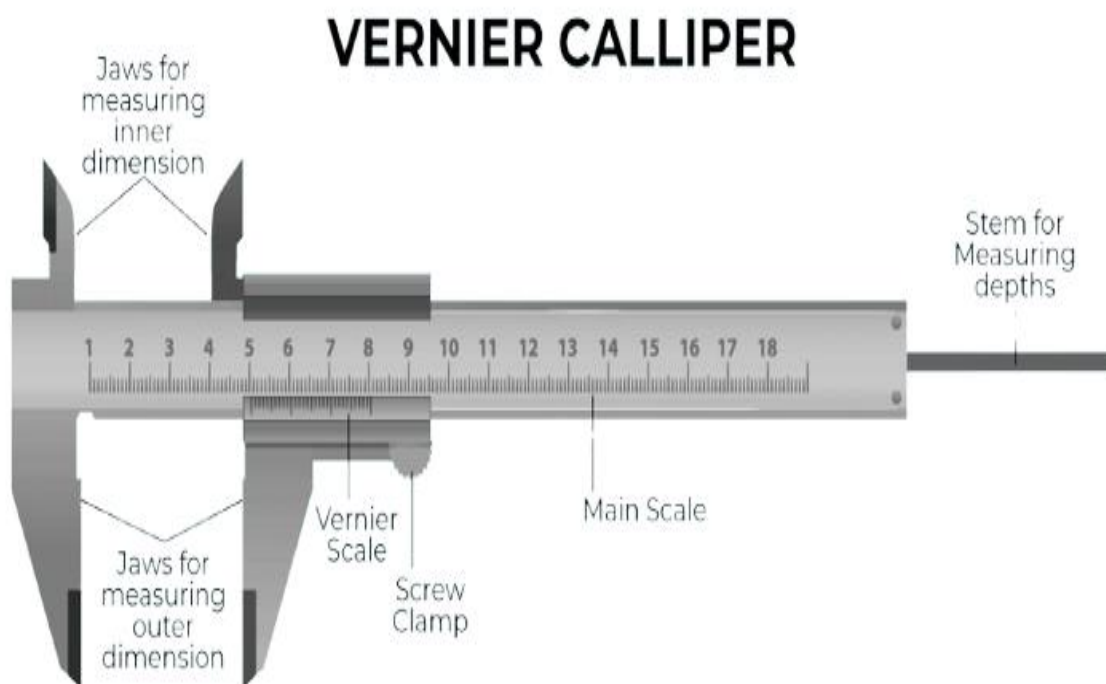
Micrometre: Measures very small dimensions accurately.

Lux Meter: Measures illumination intensity.

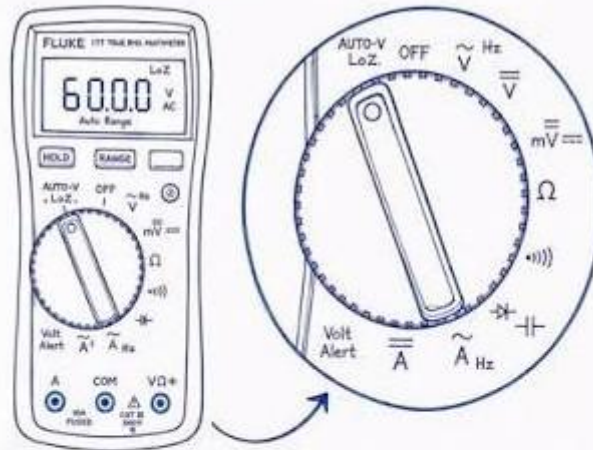
Safety Kit: It Includes

- Safety Gloves
- Safety Shoes
- Helmet
- Goggles
- Fire Extinguisher
- Insulated Mat
- First Aid Box

7. Circuit diagram / layout



Multimeter Symbols



Symbol	Symbol function	Symbol	Symbol function
$V \sim$	AC voltage	$\rightarrow \nabla$	Diode Test
$A \equiv$	DC Current	OFF	Turn off
$V \equiv$	DC Voltage	hFE	Current gain
$\tilde{A}$	Alternating current	 thermometer 	Temperature
$\rightsquigarrow$	Continuity	 capacitor 	Capacitance
Ω	Ohms	Hz	Frequency
HOLD	Hold Button	%	Duty cycle

8. Resources Required

S.No	Equipment	Quantity
1	Digital Multimeter	1
2	Clamp Meter	1
3	Vernier Caliper	1
4	Micrometer	1
5	Lux Meter	1
6	Safety Kit	1 Set
7	Battery (12V)	1

9. Precautions

- Wear safety gloves.
- Wear safety shoes.
- Never touch live terminals.
- Check meter range before measurement.
- Never measure resistance in a live circuit.
- Keep instruments dry.
- Disconnect supply before changing meter settings.
- Handle Vernier Caliper carefully.

10. Procedure

Part A – Digital Multimeter

1. Switch ON the multimeter.
2. Select DC Voltage mode.
3. Connect probes correctly.
4. Measure battery voltage.
5. Record the reading.

Part B – Clamp Meter

1. Select Current mode.
2. Clamp around only one conductor.
3. Read current.

Part C – Vernier Caliper

1. Clean the jaws.
2. Place the object.
3. Read Main Scale.
4. Read Vernier Scale.
5. Calculate measurement.

Part D – Micrometer

1. Place the specimen.
2. Rotate spindle.
3. Lock spindle.
4. Read sleeve scale.
5. Read thimble scale.

Part E – Lux Meter

1. Switch ON.
2. Place sensor.
3. Read illumination.

Part F – Safety Kit

- Gloves
- Goggles
- Shoes

- Fire Extinguisher
- First Aid Box

11. Observation

Observation Table 1

Instrument	Range	Reading	Remarks
Digital Multimeter			
Clamp Meter			
Lux Meter			

Observation Table 2

Instrument	Least Count	Measured Value
Vernier Caliper		
Micrometer		

12. Calculations:

Vernier Caliper

Measurement

= Main Scale Reading

- $(\text{Vernier Coincidence} \times \text{Least Count})$

Micrometer

Measurement

= Sleeve Reading

- $(\text{Thimble Reading} \times \text{Least Count})$

13. Result

The required electrical and mechanical parameters were successfully measured using different digital measuring instruments. All laboratory safety practices were followed during the experiment.

14. Interpretation of Result

The experiment demonstrates that selecting the correct measuring instrument and following proper measurement techniques improves accuracy and ensures safe operation in EV maintenance.

15. Practical Related Questions (Viva)

1. Define a Digital Multimeter.
2. Differentiate between AC and DC Clamp Meters.
3. Define least count.
4. State the reason for not measuring resistance in a live circuit.
5. Define continuity testing.
6. Define a Lux Meter.
7. State the least count of a Vernier Caliper.
8. State the least count of a Micrometer.
9. State the purpose of using safety gloves.
10. State the purpose of a fire extinguisher in the laboratory.

Experiment No.02

Title: Identification of Different Types of Electric Motors Used in Electric Vehicles

1. Practical Significance

Electric motors are the prime movers of electric vehicles. Different types of motors possess different characteristics in terms of efficiency, speed control, torque, cost, and maintenance. Knowledge of these motors helps technicians select the appropriate motor for a specific EV application and perform maintenance and troubleshooting effectively.

2. Relevant Program Outcomes (POs)

PO No.	Program Outcome
PO1	Basic Engineering Knowledge
PO2	Problem Analysis
PO3	Design and Development of Solutions
PO4	Modern Engineering Tools
PO5	Engineering Practices for Society
PO7	Life-long Learning

3. Related Course Outcome (CO)

CO2: Identify various electric motors used in Electric Vehicles and understand their construction, working principle, characteristics, and applications.

4. Laboratory Session Outcomes (LSOs)

After completing this practical, students will be able to:

- Identify various motors used in Electric Vehicles.
- Differentiate between various EV motors based on construction and working principle.
- Identify the terminals and nameplate details of different motors.
- Select a suitable motor for different EV applications.

5. Practical Skills Developed

Students will be able to:

- Identify different EV motors.
- Read motor nameplate details.
- Identify motor terminals.
- Compare motor performance.
- Understand applications of different motors.
- Observe constructional features.
- Follow laboratory safety practices.

6. Minimum Theoretical Background

Electric Motor: An electric motor converts electrical energy into mechanical energy through electromagnetic interaction.

Types of Motors Used in Electric Vehicles

1. DC Motor

Working Principle

A DC motor works on the principle that a current-carrying conductor placed in a magnetic field experiences a mechanical force.

Advantages

- Simple construction
- High starting torque
- Easy speed control

Disadvantages

- Brushes require maintenance
- Sparking occurs

Applications

- Electric rickshaws
 - Small electric vehicles
 - Educational EV kits
-

2. Brushless DC Motor (BLDC)

Working Principle

A BLDC motor uses permanent magnets on the rotor and electronic commutation instead of brushes.

Advantages

- High efficiency
- Low maintenance
- High reliability
- Compact size

Applications

- Electric scooters
 - Electric motorcycles
 - Electric bicycles
-

3. Permanent Magnet Synchronous Motor (PMSM)

Working Principle

The rotor contains permanent magnets and rotates synchronously with the rotating magnetic field produced by the stator.

Advantages

- Very high efficiency
- Excellent torque
- High power density

Applications

- Electric cars
- Hybrid vehicles

4. Induction Motor

Working Principle

Rotor current is induced by electromagnetic induction; therefore, no electrical connection is required to the rotor.

Advantages

- Rugged construction
- Low maintenance
- Economical

Applications

- Electric buses
- High-power EVs

5. Switched Reluctance Motor (SRM)

Working Principle

Rotor moves towards the minimum reluctance position when stator windings are energized sequentially.

Advantages

- Simple rotor
- High reliability
- High temperature capability

Applications

- Commercial electric vehicles
- Industrial electric drives

7. Experimental Setup / Layout

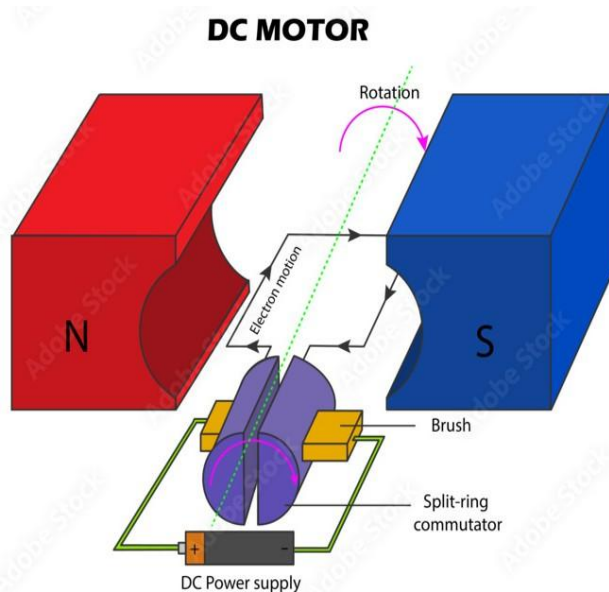


Fig.1: DC MOTOR

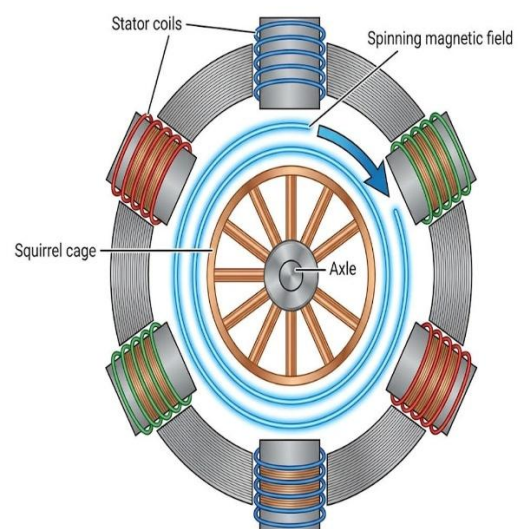


Fig. 2: INDUCTION MOTOR

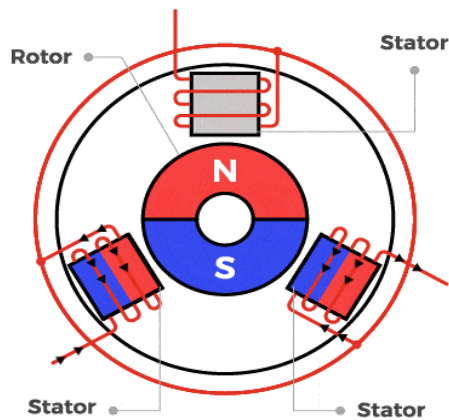


Fig.3: BLDC MOTOR

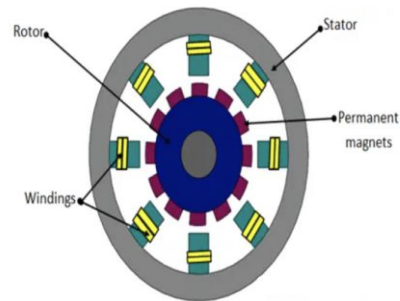


Fig.4 : PMSM

8. Resources Required

S.No	Equipment	Quantity
1	DC Motor	1
2	BLDC Motor	1
3	PMSM	1
4	Induction Motor	1
5	Switched Reluctance Motor	1
6	Digital Multimeter	1
7	Safety Kit	1 Set

9. Precautions

- Wear safety gloves before handling motors.
- Ensure power supply is OFF during identification.
- Do not touch rotating parts.
- Read the motor nameplate carefully.
- Do not dismantle the motor without permission.
- Handle permanent magnet motors carefully.
- Keep the workbench clean.

10. Experimental Procedure

- Observe each motor carefully.

- Identify the motor using its construction.
- Read and record the nameplate details.
- Count the number of terminals.
- Identify rotor and stator construction.
- Compare cooling methods.
- Compare power ratings.
- Record observations in the observation table.
- Discuss applications of each motor.

11. Observation Table

Table 1: Identification of Motors

Motor Type	Construction	Rotor Type	No. of Terminals	Cooling Method
DC Motor				
BLDC				
PMSM				
Induction Motor				
SR Motor				

Table 2: Nameplate Details

Motor	Rated Voltage (V)	Rated Current (A)	Rated Speed (RPM)	Rated Power (W)
DC Motor				
BLDC				
PMSM				
Induction Motor				
SR Motor				

Table 3: Applications

Motor	EV Application	Advantages
DC Motor		
BLDC		
PMSM		
Induction Motor		
SR Motor		

12. Result

Different electric motors used in Electric Vehicles were successfully identified based on their construction, working principle, nameplate specifications, and applications.

13. Interpretation of Result

The study shows that each motor type has unique characteristics. BLDC and PMSM motors are widely used in modern EVs due to their high efficiency and low maintenance, while induction motors are preferred for high-power applications because of their rugged construction.

14. Conclusion and Recommendation

Students learned to identify different EV motors, compare their specifications, and understand their applications. Proper identification of motors is essential for selection, operation, and maintenance of electric vehicles.

15. Practical Related Questions (Viva Voce)

1. Define an electric motor.
2. State the reason for preferring a BLDC motor in electric scooters.
3. Differentiate between a DC motor and a BLDC motor.
4. Identify the motor that does not use brushes.
5. Identify the motor that works on electromagnetic induction.
6. Define a permanent magnet.
7. State the reason for using PMSM in electric cars.
8. State the function of a motor controller.
9. Identify the motor having the highest maintenance requirement.
- 10.** State the advantages of an induction motor.

Experiment No. 03

Title: Identification of the Batteries Available in the Laboratory.

1. Practical Significance

Batteries are the primary energy-storage units used in electric vehicles (EVs). Different battery technologies possess different characteristics in terms of voltage, capacity, chemistry, construction, safety, performance, and maintenance. Correct identification of a battery is essential before testing, charging, connecting, servicing, or replacing it. This experiment helps students identify the batteries available in the laboratory from their physical construction, nameplate details, terminals, rated voltage, capacity, and chemistry.

2. Relevant Program Outcomes (POs)

PO	Description
PO1	Basic Engineering Knowledge
PO2	Problem Analysis
PO4	Modern Engineering Tools
PO5	Engineering Practices
PO7	Life-long Learning

3. Related Course Outcome (CO)

CO3: Test the performance of batteries used in Electric Vehicles.

4. Laboratory Session Outcomes (LSOs)

After completing this practical, the student will be able to:

- Identify different types of batteries used in Electric Vehicles.
- Differentiate batteries based on construction, rated voltage, capacity, and chemistry.
- Read and interpret important battery nameplate specifications.
- Identify common lithium-ion chemistries such as LFP, NMC, and NCA.
- Recognize legacy battery technology such as Nickel-Metal Hydride (NiMH).
- Follow laboratory safety practices while handling batteries.

5. Practical Skills Developed

- Visual identification of batteries
- Reading battery nameplate details
- Identification of battery terminals and polarity
- Identification of battery chemistry
- Identification of rated voltage and capacity
- Recognition of battery pack construction

- Identification of Battery Management System (BMS) presence
- Comparison of different EV battery technologies
- Following electrical and battery safety procedures

6. Minimum Theoretical Background

Battery: A battery is an electrochemical energy-storage device that converts chemical energy into electrical energy during discharge and stores electrical energy in chemical form during charging.

Important Battery Identification Parameters:

Rated Voltage (V): The nominal voltage specified for the battery or battery pack.

Capacity (Ah): The rated charge-storage capacity of a battery.

Battery Chemistry: The electrochemical material system used in the battery.

Polarity: Identification of positive (+) and negative (–) terminals.

Construction: Physical arrangement of cells, casing, terminals, connectors, and protection system.

Battery Management System (BMS): An electronic system used in rechargeable battery packs to monitor and protect the cells.

Battery Chemistry	Full Form	Identification / General Characteristics
LFP	Lithium Iron Phosphate	Lithium-ion chemistry using lithium iron phosphate as the cathode material; known for good thermal stability and long cycle life.
NMC	Nickel Manganese Cobalt	Lithium-ion chemistry using nickel, manganese, and cobalt in the cathode; widely used in EV applications.
NCA	Nickel Cobalt Aluminum	Lithium-ion chemistry using nickel, cobalt, and aluminum in the cathode; associated with high energy-density applications.
NiMH	Nickel-Metal Hydride	Rechargeable nickel-based battery technology used in many hybrid vehicles and regarded as a legacy technology compared with modern lithium-ion systems.

A. Lead-Acid Battery

A lead-acid battery uses lead-based electrodes and an aqueous sulfuric-acid electrolyte. It is commonly available in low-voltage applications and is relatively simple to identify from its heavy construction, casing, terminals, and nameplate markings.

Laboratory battery: 12 V, 7 Ah.

Typical features: comparatively heavy construction, positive and negative terminals, and a rigid outer casing.

Identification is primarily based on the nameplate, construction, rated voltage, capacity, and terminal arrangement.

B. Lithium-Ion Battery

A lithium-ion battery consists of one or more rechargeable cells assembled into a module or battery pack. EV battery packs normally include electrical protection and monitoring arrangements, and the chemistry should be confirmed from the battery label, documentation, or manufacturer information.

Laboratory battery: 48 V, 12 Ah.

Typical features: relatively high energy density, compact construction, multiple cells connected to form a pack, and possible BMS connections.

Common Lithium-Ion Chemistries Used in EV Applications

Battery Specimen	Identification	Nameplate
Lead-Acid Battery	Observe construction and terminals	Record 12 V, 7 Ah
Lithium-Ion Battery	Observe pack construction and connectors	Record 48 V, 12 Ah
LFP / NMC / NCA / NiMH	Identify from marking/documentation	Record available specifications

7. Experimental Setup / Layout

Arrange the batteries/specimens available in the laboratory on a clean and dry workbench. Keep the battery labels and nameplates visible. Identify the terminals and other visible constructional features without opening or dismantling the battery.

Fig.1: Battery Identification Setup

8. Resources Required

S.No	Equipment	Quantity
1	Lead-Acid Battery (12 V, 7 Ah)	1
2	Lithium-Ion Battery (48 V, 12 Ah)	1
3	Battery specimens / identification information for LFP, NMC, NCA and NiMH	As available
4	Digital Multimeter	1

5	Connecting Leads	1 Set
6	Safety Gloves	1 Pair
7	Safety Goggles	1 Pair
8	Safety Kit	1 Set

9. Precautions

- Wear insulated safety gloves and safety goggles while handling batteries.
- Keep battery terminals away from metallic objects to prevent accidental short circuit.
- Do not reverse battery polarity during measurement or connection.
- Do not open, dismantle, puncture, or modify a battery pack.
- Do not connect or disconnect high-voltage battery connectors without permission and proper procedure.
- Check the battery nameplate before selecting the measuring range of the digital multimeter.
- Never measure resistance across an energized battery terminal using a normal resistance range.
- Keep batteries away from heat, flame, water, and sources of mechanical damage.
- If swelling, leakage, unusual heating, or physical damage is observed, stop the experiment and inform the laboratory instructor.

10. Procedure

- a. Wear the required personal protective equipment (PPE).
- b. Place the battery specimens on a clean, dry, and stable workbench.
- c. Observe the external construction, casing, terminals, connectors, labels, and safety markings.
- d. Read and record the battery manufacturer's name, model, rated voltage, and capacity from the nameplate.
- e. Identify the positive (+) and negative (–) terminals without making any short circuit.
- f. Identify whether the battery is lead-acid, lithium-ion, NiMH, or another type from the nameplate and available documentation.
- g. For lithium-ion specimens, identify the stated chemistry, such as LFP, NMC, or NCA, wherever it is explicitly marked or documented.
- h. Observe whether a BMS, protection board, communication connector, or other battery-management arrangement is provided.
- i. Set the digital multimeter to an appropriate DC-voltage range if voltage measurement is permitted for the specimen.
- j. Measure the terminal voltage carefully, observing correct polarity.
- k. Record all observations in the observation tables.

1. Compare the identified batteries with respect to voltage, capacity, chemistry, construction, and application.

11. Observation

Observation Table 1: Physical Identification of Batteries

Battery Type	Construction	Rotor / Cell Arrangement	No. of Terminals	Identification Remarks
Lead-Acid				
Lithium-Ion				
LFP				
NMC				
NCA				
NiMH				

Observation Table 2: Nameplate Details

Battery Type	Rated Voltage (V)	Rated Capacity (Ah)	Measured Voltage (V)	Chemistry
Lead-Acid	12	7		Lead-Acid
Lithium-Ion	48	12		Lithium-Ion
LFP				LFP
NMC				NMC
NCA				NCA
NiMH				NiMH

Observation Table 3: Comparative Identification

Battery Type	Main Chemistry	Typical Application
Lead-Acid	Lead-based	Auxiliary / low-voltage applications
Lithium-Ion	Lithium-based	Electric vehicles
LFP	Lithium Iron Phosphate	EV and energy-storage applications
NMC	Nickel Manganese Cobalt	EV applications
NCA	Nickel Cobalt Aluminum	High-energy applications
NiMH	Nickel-based	Hybrid / legacy applications

12. Calculations

No numerical calculation is required for basic battery identification. However, nominal battery energy may be estimated from rated voltage and capacity:

Nominal Energy (Wh) = Rated Voltage (V) × Rated Capacity (Ah)

For 12 V, 7 Ah Lead-Acid Battery: Nominal Energy = $12 \times 7 = 84$ Wh

For 48 V, 12 Ah Lithium-Ion Battery: Nominal Energy = $48 \times 12 = 576$ Wh

13. Result

The batteries available in the laboratory were successfully identified based on their physical construction, nameplate specifications, rated voltage, capacity, terminals, and battery chemistry. The laboratory specimens included a 12 V, 7 Ah lead-acid battery and a 48 V, 12 Ah lithium-ion battery, with LFP, NMC, NCA, and NiMH technologies studied for identification and comparison.

14. Interpretation of Result

The experiment demonstrates that correct battery identification is essential before testing, charging, connecting, servicing, or replacing an EV battery. Rated voltage and capacity indicate important electrical characteristics, while construction, nameplate information, manufacturer documentation, and chemistry markings distinguish different battery technologies.

15. Conclusion and Recommendation

Students learned to identify different battery technologies and interpret important battery specifications. Correct identification of battery type, rated voltage, capacity, chemistry, polarity, and protection arrangement is essential for safe EV operation and maintenance.

16. Practical Related Questions (Viva Voce)

1. Define a battery.

2. Define the rated voltage of a battery.
3. Define battery capacity in Ah.
4. State the rated voltage and capacity of the lead-acid battery available in the laboratory.
5. State the rated voltage and capacity of the lithium-ion battery available in the laboratory.
6. Expand LFP and state its meaning.
7. Expand NMC and state its meaning.
8. Expand NCA and state its meaning.
9. Expand NiMH and state its common applications.
10. State the importance of correctly identifying battery chemistry before charging or servicing a battery.

Experiment No. 04

Title: Measurement of Open Circuit Voltage (OCV) of an Electric Vehicle Battery

1. Practical Significance

Open Circuit Voltage (OCV) is the voltage measured across the battery terminals when no load is connected. OCV is an important parameter for estimating the battery's State of Charge (SOC) and checking its health. This test is simple, non-destructive, and commonly performed during EV battery inspection and maintenance.

2. Relevant Program Outcomes (POs)

PO	Program Outcome
PO1	Basic Engineering Knowledge
PO2	Problem Analysis
PO4	Modern Engineering Tools
PO5	Engineering Practices
PO7	Life-long Learning

3. Related Course Outcome (CO)

CO3: Test the performance of batteries used in Electric Vehicles.

4. Laboratory Session Outcomes (LSOs)

After completing this experiment, the student will be able to:

- Measure the open circuit voltage of the given battery.
- Select the correct measuring range on a digital multimeter.
- Interpret the battery condition from the measured OCV.

5. Practical Skills

- Safe handling of EV batteries.
- Selection and operation of a digital multimeter.
- Measurement of DC voltage.
- Recording and interpretation of observations.

6. Minimum Theoretical Background

Open Circuit Voltage (OCV): Open Circuit Voltage is the voltage available across the battery terminals when no electrical load is connected.

OCV depends on:

- Battery chemistry
- State of Charge (SOC)
- Battery temperature
- Battery age

For a healthy 12 V lead-acid battery:

Battery Condition	OCV (Approx.)
Fully Charged	12.6–12.8 V
75% Charged	12.4 V
50% Charged	12.2 V
25% Charged	12.0 V
Discharged	<11.9 V

7. Circuit Diagram / Experimental Setup

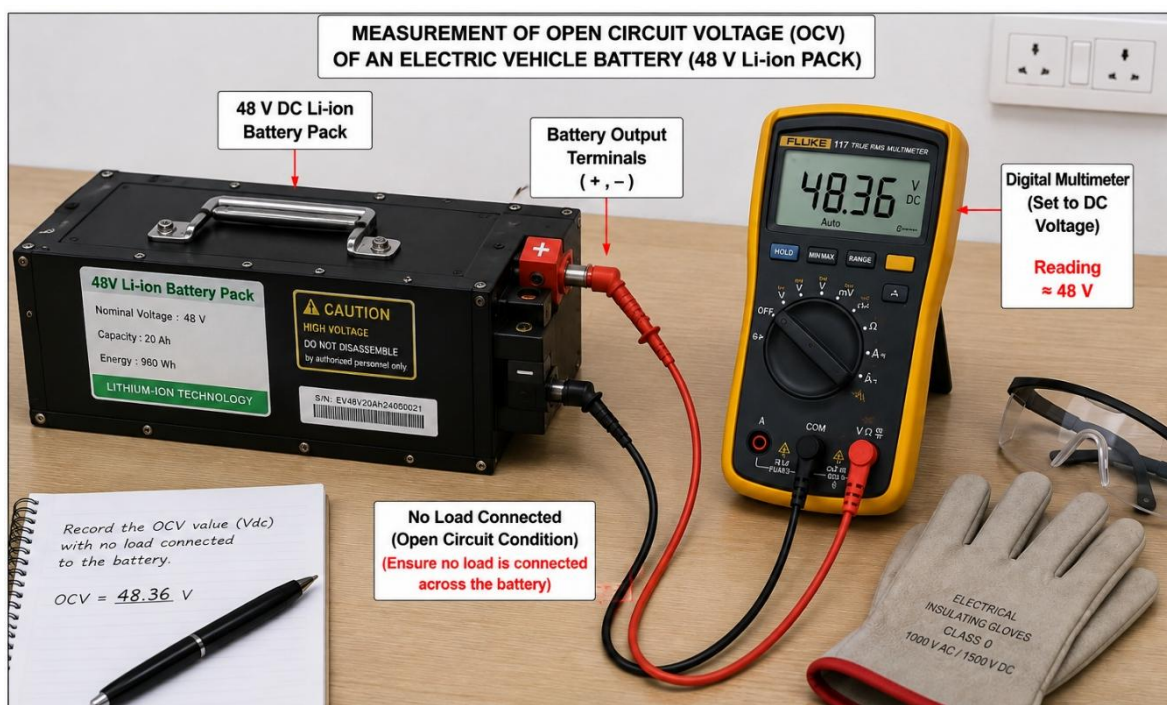


Fig. 1: Experimental Setup

8. Resources Required

S.No.	Equipment
1	12 V EV Battery (Lead-acid/Li-ion)
2	Digital Multimeter

S.No.	Equipment
3	Connecting Leads
4	Safety Gloves
5	Safety Goggles

9. Precautions

- Ensure the battery is disconnected from any load or charger.
- Set the multimeter to the correct DC voltage range.
- Observe correct polarity.
- Never short the battery terminals.
- Wear insulated gloves while handling the battery.

10. Procedure

- a. Wear the required personal protective equipment (PPE).
- b. Ensure the battery is not connected to any load or charger.
- c. Set the digital multimeter to the DC voltage mode.
- d. Connect the red probe to the positive (+) terminal.
- e. Connect the black probe to the negative (–) terminal.
- f. Observe and record the voltage displayed.
- g. Compare the measured OCV with the standard values.

11. Observation Table

Battery Type	Rated Voltage (V)	Measured OCV (V)	Battery Condition
Lead-acid	12		
Lithium-ion	12		

12. Calculations

Compare the measured value with the standard OCV table to estimate the battery's State of Charge (SOC).

13. Result

The open circuit voltage of the given battery was measured as _____ V using a digital multimeter. Based on the measured value, the battery was found to be in _____ condition.

14. Interpretation of Result

The measured OCV indicates the approximate State of Charge (SOC) of the battery. A lower-than-expected OCV may indicate that the battery requires charging or further inspection.

15. Practical Related Questions (Viva Voce)

1. Define Open Circuit Voltage (OCV).
2. State the reason for keeping the battery under no-load condition while measuring OCV.
3. Identify the instrument used to measure OCV.
4. Differentiate between OCV and terminal voltage under load.
5. State the relationship between OCV and State of Charge (SOC).
6. State the precautions to be taken while measuring battery voltage.
7. State the importance of polarity during measurement.
8. State the voltage of a fully charged 12 V battery.
9. State whether OCV alone is sufficient to determine battery health.
10. State the function of a Battery Management System (BMS).

Experiment No. 05

Title: Determination of the Ampere-Hour capacity of the given battery with a given load.

1. Practical Significance

The ampere-hour (Ah) capacity of a battery indicates the quantity of electrical charge that the battery can deliver under specified discharge conditions. Determination of battery capacity is important for evaluating battery performance, estimating operating duration, and selecting a suitable battery for electric vehicle applications. In this experiment, the given battery is discharged through a given load and the discharge current and time are used to determine its ampere-hour capacity.

2. Relevant Program Outcomes (POs)

PO	Description
PO1	Basic Engineering Knowledge
PO2	Problem Analysis
PO4	Modern Engineering Tools
PO5	Engineering Practices
PO7	Life-long Learning

3. Related Course Outcome (CO)

CO3: Test the performance of batteries used in Electric Vehicles.

4. Laboratory Session Outcomes (LSOs)

After completing this experiment, the student will be able to:

- Measure the discharge current of the given battery with a specified load.
- Measure the discharge time of the battery under the given load.
- Determine the ampere-hour capacity of the given battery.
- Record and interpret the battery discharge observations safely.

5. Practical Skills Developed

- Connecting a battery to a specified load
- Measuring DC current
- Measuring battery terminal voltage
- Recording discharge time

- Calculating ampere-hour capacity
- Observing battery discharge behaviour
- Following battery safety procedures

6. Minimum Theoretical Background

Ampere-Hour Capacity: The ampere-hour capacity of a battery is the quantity of electrical charge that can be delivered by the battery during a specified discharge period under specified conditions.

For approximately constant discharge current, the ampere-hour capacity is calculated by:

$$\text{Battery Capacity (Ah)} = \text{Discharge Current (A)} \times \text{Discharge Time (h)}$$

The measured capacity depends on the discharge rate, temperature, battery condition, and the specified end-of-discharge condition.

Discharge Current (I): Current supplied by the battery to the given load.

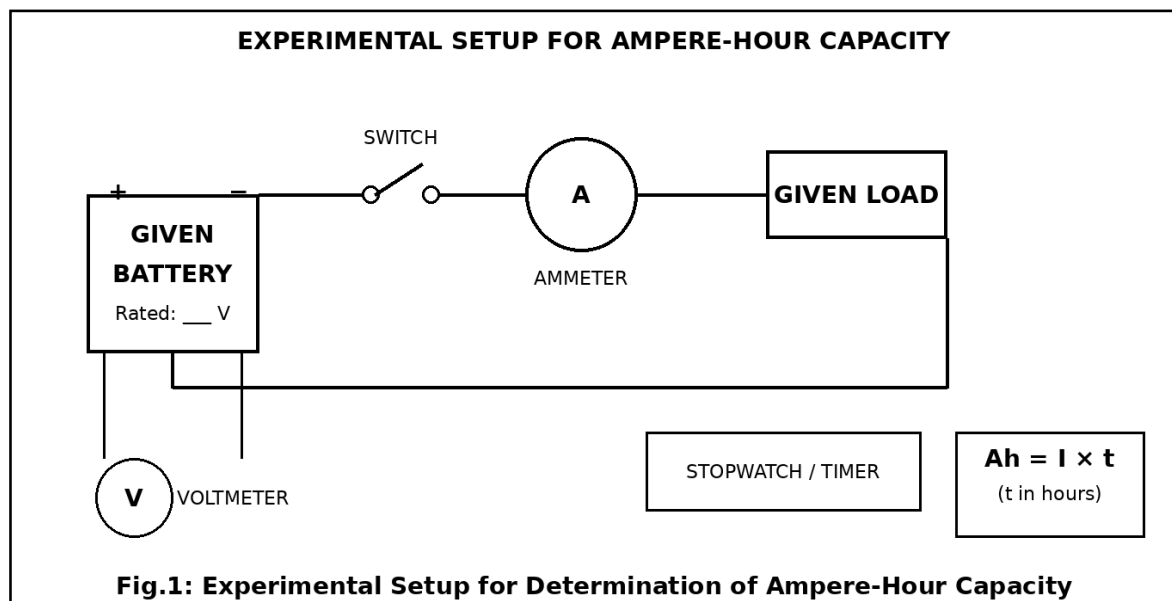
Discharge Time (t): Time for which the battery supplies the load until the specified test termination condition is reached.

Terminal Voltage: Battery voltage measured during discharge.

Ampere-Hour Capacity: Product of discharge current and discharge time for approximately constant current.

7. Circuit Diagram / Experimental Setup

Connect the given battery to the specified load through an ammeter and switch. Connect the voltmeter across the battery terminals. Record the discharge current and discharge time during the test.



8. Resources Required

S.No	Equipment	Quantity
1	Given Battery	1
2	Given Load / Load Bank	1
3	DC Ammeter / Digital Multimeter	1
4	DC Voltmeter / Digital Multimeter	1
5	Connecting Leads	1 Set
6	Stopwatch / Timer	1
7	Switch	1
8	Safety Kit	1 Set

9. Precautions

- Wear insulated gloves and safety goggles while handling the battery.
- Check the battery polarity before making any connection.
- Ensure the load rating is suitable for the given battery.
- Connect the ammeter in series with the load.
- Connect the voltmeter across the battery terminals.
- Do not short-circuit the battery terminals.
- Do not leave the battery connected to the load unattended.
- Monitor battery voltage and temperature during the test.
- Stop the test when the specified end-of-discharge condition is reached.
- Disconnect the load after completion of the experiment.

10. Procedure

- Wear the required personal protective equipment (PPE).
- Check the battery nameplate and record its rated voltage and capacity, if available.
- Select the given load and verify that its rating is suitable for the battery.
- Connect the ammeter in series with the battery and load.
- Connect the voltmeter across the battery terminals.
- Check all connections and ensure correct polarity.

- Keep the switch in the OFF position and note the initial battery voltage.
- Switch ON the load and start the stopwatch simultaneously.
- Measure and record the discharge current.
- Observe and record the battery terminal voltage at suitable time intervals.
- Continue the discharge test until the specified end-of-discharge condition is reached.
- Stop the stopwatch and switch OFF/disconnect the load.
- Record the total discharge time.
- Convert the discharge time into hours.
- Calculate the ampere-hour capacity using Capacity (Ah) = $I \times t$ for approximately constant current.
- Record the final result and safely disconnect all equipment.

11. Observation

Observation Table 1: Initial and Final Parameters

Parameter	Initial Reading	Final Reading
Battery Terminal Voltage (V)		
Discharge Current (A)		
Battery Temperature (°C)		
Discharge Time		

Observation Table 2: Discharge Readings

Time (min)	Battery Voltage (V)	Discharge Current (A)	Remarks
0			
10			
20			
30			
40			

50			
60			

12. Calculations

For approximately constant discharge current:

$$\text{Ampere-Hour Capacity (Ah)} = \text{Discharge Current (A)} \times \text{Discharge Time (h)}$$

$$\text{Capacity} = \text{_____ A} \times \text{_____ h} = \text{_____ Ah}$$

For a varying discharge current, the current-time contributions at the recorded intervals should be considered for a more accurate capacity determination.

13. Result

The ampere-hour capacity of the given battery with the specified load was determined as _____ Ah.

14. Interpretation of Result

The measured ampere-hour capacity represents the electrical charge delivered by the battery under the specified load and test conditions. The obtained value may vary with discharge current, battery condition, temperature, and the specified end-of-discharge condition.

15. Conclusion and Recommendation

The ampere-hour capacity of the given battery was determined by measuring the discharge current and discharge time with the specified load. Proper control of the load and safe monitoring of battery voltage are essential for obtaining reliable results.

16. Practical Related Questions (Viva Voce)

1. Define ampere-hour capacity of a battery.
2. State the unit of battery capacity.
3. State the formula used for determining ampere-hour capacity at constant discharge current.
4. Mention the function of the given load during the capacity test.
5. Mention the function of an ammeter in the experimental setup.
6. Mention the function of a voltmeter in the experimental setup.
7. State the importance of measuring discharge time.
8. Mention the significance of the end-of-discharge condition.

9. State two factors affecting the measured battery capacity.
10. Mention the main safety precaution during a battery discharge test.

Experiment No. 06

Title: Identification and Testing of Electrical and Electronic Components Using a Digital Multimeter.

1. Practical Significance

Electrical and electronic components are basic building blocks of electric-vehicle electrical and control systems. Correct identification and testing of components such as resistors, capacitors, diodes, LEDs, fuses, switches, relays, and connectors are essential for circuit assembly, maintenance, troubleshooting, and replacement. This experiment develops hands-on skills in identifying components from their physical appearance and markings and checking their basic electrical condition using a digital multimeter.

2. Relevant Program Outcomes (POs)

PO	Description
PO1	Basic Engineering Knowledge
PO2	Problem Analysis
PO4	Modern Engineering Tools
PO5	Engineering Practices
PO7	Life-long Learning

3. Related Course Outcome (CO)

CO4: Identify and test basic electrical and electronic components used in Electric Vehicles.

4. Laboratory Session Outcomes (LSOs)

After completing this experiment, the student will be able to:

- Identify common electrical and electronic components used in EV circuits.
- Read component markings and identify nominal ratings.
- Measure resistance using a digital multimeter.
- Perform continuity and diode tests using a digital multimeter.
- Differentiate healthy and faulty components using basic test results.
- Follow safe laboratory practices while testing components.

5. Practical Skills Developed

- Visual identification of electrical and electronic components
- Reading component markings and ratings
- Measuring resistance using a digital multimeter
- Continuity testing
- Diode and LED testing
- Identification of component terminals and polarity
- Basic fault identification
- Safe use of a digital multimeter

6. Minimum Theoretical Background

Electrical Component: A component is an element used to perform a specific electrical function in a circuit.

Common components considered in this experiment include:

Resistor: A passive component that opposes the flow of electric current and is specified mainly by its resistance value and power rating.

Capacitor: A component that stores electrical energy in an electric field and is specified by capacitance and voltage rating.

Diode: A semiconductor device that permits current mainly in one direction.

LED: A light-emitting diode that produces light when forward biased.

Fuse: A protective component designed to open a circuit when excessive current flows.

Switch: A device used to open or close an electrical circuit.

Relay: An electrically operated switching device used to control a circuit.

Transformer: A static electromagnetic device used to transfer AC electrical energy between circuits, normally with electrical isolation.

Connector: A mechanical and electrical interface used to establish a detachable electrical connection.

Digital Multimeter Tests:

Resistance Test (Ω): Used to measure the resistance of suitable components such as resistors.

Continuity Test: Used to check whether an electrical path is continuous.

Diode Test: Used to check the forward conduction behaviour of a diode or LED.

DC Voltage Test: Used where voltage verification is required and the component/circuit is energized safely.

7. Circuit Diagram / Experimental Setup

Arrange the available components on a clean workbench. Identify each component from its physical appearance and markings. Use the digital multimeter with the appropriate function to measure resistance, check continuity, or perform diode testing. Components should be isolated from any energized circuit before resistance or diode testing.

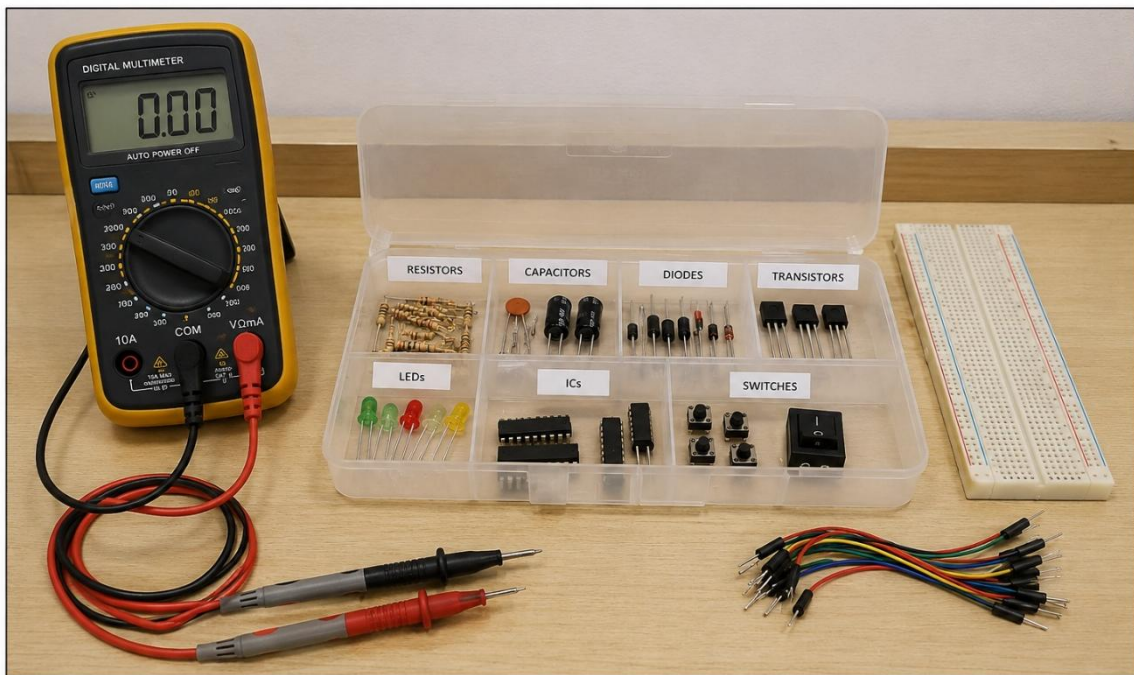


Fig.1: Experimental Setup

8. Resources Required

S. No	Equipment	Quantity
1	Digital Multimeter	1
2	Resistors of different values	As available
3	Capacitors of different values	As available
4	Diodes	As available

5	LEDs	As available
6	Fuses	As available
7	Switches	As available
8	Relays	As available
9	Connectors / other components	As available
10	Safety Kit	1 Set

9. Precautions

- Wear appropriate personal protective equipment while working in the laboratory.
- Ensure the component is disconnected from any energized circuit before resistance or diode testing.
- Select the correct multimeter function and range before measurement.
- Do not measure resistance across a powered circuit.
- Observe correct polarity during diode and LED testing.
- Do not exceed the rated voltage or current of any component.
- Discharge capacitors safely before resistance or continuity testing.
- Do not replace a fuse with an unsuitable rating.
- Keep the multimeter probes and workbench dry and clean.
- Report damaged, burnt, swollen, or otherwise abnormal components to the laboratory instructor.

10. Procedure

- Wear the required personal protective equipment (PPE).
- Collect the available components and arrange them on the workbench.
- Observe the physical appearance, markings, colour bands, terminals, polarity indicators, and ratings.
- Identify each component and record its nominal value or rating from the marking/nameplate.

- Switch ON the digital multimeter and select the appropriate function.
- For resistors, select the resistance (Ω) range and measure the resistance between the terminals.
- For capacitors, identify the capacitance and voltage rating from the marking; do not perform resistance testing unless the capacitor has been safely discharged.
- For diodes, select the diode-test function and connect the probes in forward and reverse directions.
- For LEDs, identify anode and cathode and perform a suitable diode test without exceeding the test limits.
- For fuses, use the continuity function to check the conducting path after confirming that the fuse is isolated.
- For switches, operate the switch and check continuity in the ON and OFF positions.
- For relays and connectors, identify the terminals and perform only the permitted continuity/resistance checks with the component isolated.
- Record all observations and compare the measured condition with the expected component behaviour.
- Identify components showing abnormal or open/short conditions and report them for further inspection.
- Switch OFF the multimeter and arrange all components safely after completion.

11. Observation

Observation Table 1: Identification of Components

Component	Identification / Marking	Nominal Rating	Terminal / Polarity	Condition
Resistor				
Capacitor				
Diode				
LED				

Fuse				
Switch				
Relay				
Connector				

Observation Table 2: Multimeter Test Results

Component	Test Selected	Measured Value / Indication	Expected Condition	Remarks
Resistor	Resistance (Ω)			
Capacitor	Identification / safe check			
Diode	Diode Test			
LED	Diode Test			
Fuse	Continuity			
Switch	Continuity			
Relay	Continuity / Resistance			

12. Calculations

For a resistor, the measured value may be compared with the nominal value marked on the component.

$$\text{Percentage Error} = |\text{Measured Value} - \text{Nominal Value}| / \text{Nominal Value} \times 100$$

For components without a direct numerical measurement in this experiment, identification is based on markings, terminal arrangement, polarity, and the appropriate multimeter test result.

13. Result

The electrical and electronic components available in the laboratory were successfully identified and their basic electrical condition was tested using a digital multimeter.

14. Interpretation of Result

The experiment demonstrates that correct identification, appropriate multimeter selection, and safe testing procedures are essential for reliable component-level troubleshooting. Comparison of measured indications with nominal markings helps identify normal and abnormal components.

15. Conclusion and Recommendation

Students developed practical skills in identifying common electrical and electronic components and performing basic resistance, continuity, and diode tests. It is recommended that component ratings, polarity, and test conditions be verified before any component is connected to an EV circuit.

16. Practical Related Questions (Viva Voce)

1. Define a resistor.
2. State the unit of electrical resistance.
3. State the function of a capacitor in an electrical circuit.
4. Define a diode.
5. State the purpose of diode-test mode in a digital multimeter.
6. Identify the terminals of an LED.
7. State the function of a fuse in an electrical circuit.
8. State the purpose of a continuity test.
9. Mention the safety condition required before resistance measurement.
10. Differentiate between a normal component and a faulty component using a multimeter test.

Experiment No. 07

Title: Identification of Power Electronic Circuits Used in Electric Vehicles

1. Practical Significance

Power electronic circuits are essential in electric vehicles for power conversion, control, regulation, charging and efficient transfer of electrical energy. Identification of these circuits helps students understand their functions, terminals, ratings and applications in EV systems. This experiment develops practical skills in recognizing commonly used EV power electronic modules such as DC–DC converters, motor controllers/inverters and charging power converters.

2. Relevant Program Outcomes (POs)

PO	Description
PO1	Basic Engineering Knowledge
PO2	Problem Analysis
PO4	Modern Engineering Tools
PO5	Engineering Practices
PO7	Life-long Learning

3. Related Course Outcome (CO)

CO-4: Distinguish between the EV Charging stations based on their Configurations.

4. Laboratory Session Outcomes (LSOs)

After completing this experiment, the student will be able to:

- Identify common power electronic circuits/modules used in EVs.
- Identify a DC–DC converter from its physical construction, terminals and nameplate.
- Identify an EV motor controller/traction inverter.
- Recognize charging power-conversion circuits used in EV charging systems.
- Differentiate DC–DC, DC–AC and AC–DC power-conversion functions.

- Follow safe practices while handling power electronic modules.

5. Practical Skills Developed

- Visual identification of power electronic modules
- Reading nameplate and terminal information
- Recognition of input and output terminals
- Identification of converter/controller function
- Recognition of heat sinks and switching devices
- Identification of EV application
- Safe handling of power electronic equipment

6. Minimum Theoretical Background

Power Electronics: Power electronics deals with conversion and control of electrical power using semiconductor switching devices and associated control, protection and cooling arrangements.

Common Power Electronic Circuits / Modules Used in EVs:

DC–DC Converter: Converts one DC voltage level to another DC voltage level and is used for auxiliary power conversion and voltage regulation in EVs.

EV Motor Controller / Traction Inverter: Controls the electrical power supplied to the traction motor; a typical traction inverter converts DC battery power into controlled AC power.

DC–AC Inverter: Converts DC battery power into AC power for suitable traction motors or AC loads.

AC–DC Charging Converter / On-Board Charger: Converts AC input into controlled DC power for charging the EV battery in suitable charging systems.

Power Electronic Controller: Combines switching devices, gate-drive/control circuits, sensing and protection functions to regulate power flow.

Identification Parameters:

- Input and output voltage/current ratings
- Input and output connector arrangement
- Power semiconductor devices and heat-sink arrangement
- Nameplate/model information
- Cooling arrangement

- Control and communication connectors
- Application in the EV system

7. Circuit Diagram / Experimental Setup

Place the available power electronic modules on a clean laboratory workbench. Identify the DC–DC converter, EV motor controller/inverter, inverter and charging converter from their physical appearance, terminals, labels and application. No energized connection is required for basic identification.

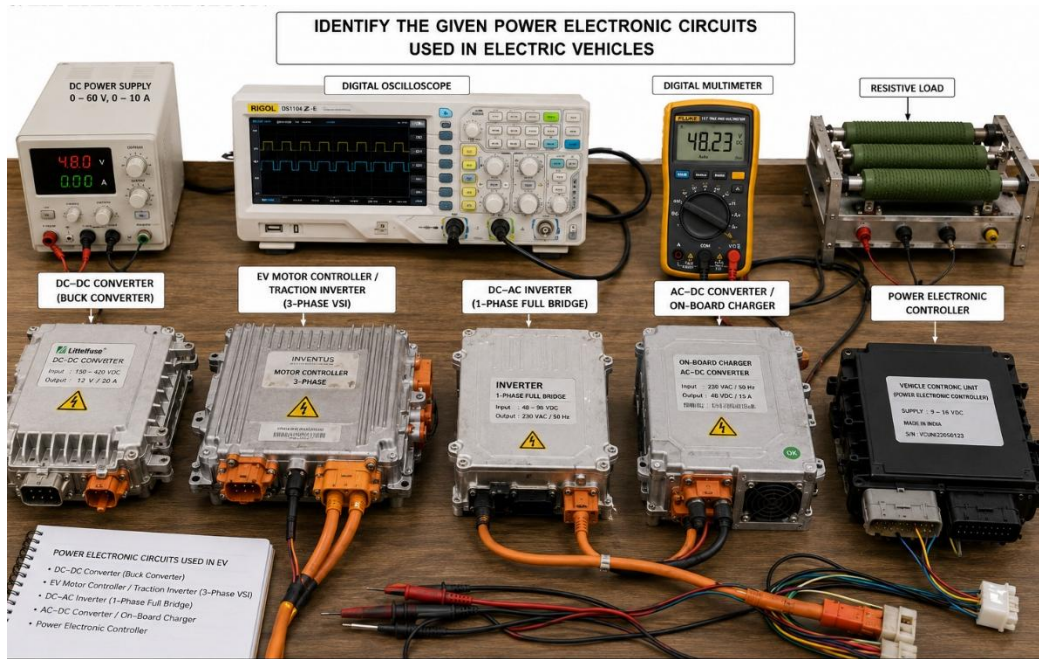


Fig. 1: Experimental Setup

8. Resources Required

S. No	Equipment / Module	Quantity
1	DC–DC Converter Module	1
2	EV Motor Controller / Traction Inverter	1
3	DC–AC Inverter / Power Electronic Module	1
4	EV Charging Power Converter / OBC sample	1
5	Digital Multimeter	1

6	Connecting Leads	1 Set
7	Manufacturer datasheet / nameplate	As available
8	Safety Kit	1 Set

9. Precautions

- Do not energize any module unless specifically permitted by the instructor.
- Verify module ratings and terminal identification before connection.
- Do not touch exposed terminals or capacitors of an energized module.
- Ensure DC-link capacitors are safely discharged before handling.
- Use a multimeter only for permitted de-energized checks.
- Do not short-circuit or interchange input and output terminals.
- Use insulated tools and appropriate PPE.
- Do not remove protective covers or dismantle modules.
- Report damaged insulation, loose terminals or burnt components immediately.

10. Procedure

- Wear the required PPE.
- Collect the available power electronic modules.
- Observe construction, heat sinks, cooling arrangement, connectors and nameplate.
- Identify input and output terminals without energizing the module.
- Identify the DC–DC converter and record its input/output ratings.
- Identify the EV motor controller/traction inverter and its battery-side and motor-side terminals.
- Identify the DC–AC inverter/power module.
- Identify the charging converter/OBC and its AC input and DC output, where applicable.
- Identify control, communication and sensing connectors, if provided.
- Record manufacturer, model, rated voltage, current and power.
- Compare modules according to conversion function and EV application.
- Perform only permitted de-energized multimeter checks.
- Record observations and return modules safely.

11. Observation

Observation Table 1: Identification of Power Electronic Circuits

Circuit / Module	Input	Output	Main Function	EV Application
DC–DC Converter				
EV Motor Controller / Traction Inverter				
DC–AC Inverter				
AC–DC Charging Converter / OBC				

Observation Table 2: Nameplate and Physical Details

Module	Rated Voltage	Rated Current / Power	Terminals / Connectors	Cooling / Heat Sink
DC–DC Converter				
Motor Controller / Inverter				
DC–AC Inverter				
Charging Converter / OBC				

12. Calculations

No numerical calculation is required for basic identification. Rated voltage, current and power values may be recorded from the nameplate or manufacturer datasheet.

13. Result

The power electronic circuits/modules available in the laboratory were successfully identified based on their construction, nameplate information, terminals, conversion function and EV application.

14. Interpretation of Result

The experiment demonstrates that different power electronic circuits perform different power-conversion and control functions in an EV. DC–DC converters provide DC voltage conversion, motor controllers/inverters regulate traction-motor power, and charging converters perform the required AC–DC conversion during charging.

15. Conclusion and Recommendation

Students developed practical skills in identifying major power electronic circuits used in electric vehicles. The module nameplate, terminal configuration, voltage/current rating and safety requirements should be verified before any testing or connection.

16. Practical Related Questions (Viva Voce)

1. Define power electronics.
2. State the main function of a DC–DC converter in an EV.
3. State the main function of an EV motor controller.
4. State the power conversion performed by a DC–AC inverter.
5. State the main function of an on-board charger.
6. Identify the input and output sides of a typical DC–DC converter.
7. Mention two identification features of an EV motor controller.
8. State the purpose of a heat sink in a power electronic module.
9. Mention two power electronic circuits used in EV applications.
10. State the main safety precaution before handling a power electronic module.