SCHEME :K

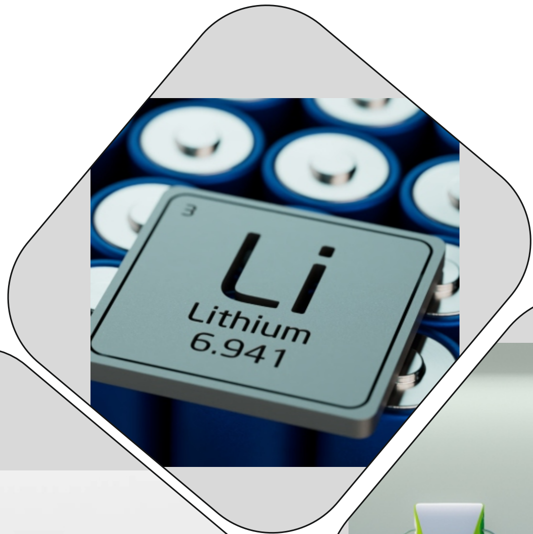
Name :____________________________

Roll No.:__________ Year : 20 ___ 20 __

Exam Seat No. :______________________

LABORATORY MANUAL FOR

ELECTRIC VEHICLE TECHNOLOGY (315335)



ELECTRICAL ENGINEERING GROUP

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI
(Autonomous)(ISO21001:2018)(ISO/IEC27001:2013)

VISION:

To ensure that the Diploma Level Technical Education constantly matches the latest requirements of Technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION:

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the challenging technological & environmental challenges.

QUALITY POLICY:

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programs.

CORE VALUES:

MSBTE believes in the following:

- Skill development in line with industry requirements
- Industry readiness and improved employability of Diploma holders
- Synergistic relationship with industry
- Collective and Cooperative development of all stake holders
- Technological interventions in societal development
- Access to uniform quality technical education.

A Laboratory Manual

For

Electric Vehicle Technology

(315335)

SEMESER-V

"K-SCHEME"

(EE/EK/EP)

Maharashtra State
Board of Technical Education, Mumbai.

(Autonomous) (ISO: 21001:2018) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education, Mumbai
(Autonomous) (ISO: 21001: 2018) (ISO/IEC 27001:2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai – 400051,
(Printed On, 2025)

Maharashtra State
Board of Technical Education, Mumbai.

Certificate

This is to certify that Mr. / Ms. ……………………………………………

Roll No………………………of Fifth semester of Diploma in ……………………………………………………………………..... of Institute………………………………………………………...……………

……………………………………… (Code :……....) has completed the term work satisfactorily in course **Electric Vehicle Technology (315335)** for the academic year 20…… to 20…… as prescribed in the curriculum.

Place: ……………

Date: …………….

Enrollment No: ………………..

Exam. Seat No: …………………

Subject teacher **Head of the Department** **Principal**

Seal of Institution

PREFACE

The laboratory manual for "Electric Vehicle Technology" (Course Code: 315335) begins with a preface that outlines its core philosophy and purpose within the technical education system.

Focus on Industry-Relevant Competencies and Skills: The preface emphasizes that the primary goal of any engineering laboratory or field work in the technical education system is to cultivate essential industry-relevant competencies and skills. This focus is in line with the Maharashtra State Board of Technical Education (MSBTE)'s innovative 'K' Scheme curriculum for engineering diploma programs. This scheme is built upon an outcome-based education model, which is why a substantial amount of time is dedicated to practical work. This allocation of time underscores the critical importance of laboratory work, urging teachers, instructors, and students to maximize every minute to develop these specific outcomes, rather than engaging in less productive activities.

Practical Work as a "Vehicle" for Competency Development: For the successful implementation of this outcome-based curriculum, each practical exercise is intentionally designed to serve as a "vehicle" for developing an industry-identified competency in every student. The manual recognizes that practical skills are challenging to impart through traditional classroom methods like "chalk and duster" activities. Therefore, the 'K' scheme laboratory manual development team created practicals that primarily "focus on the outcomes," shifting away from the conventional, older practice of conducting practicals merely to "verify the theory". While theory verification might occur as a byproduct, it is not the main objective.

Guidance for Students: This laboratory manual is specifically crafted to assist all stakeholders, particularly students, teachers, and instructors, in achieving the pre-determined outcomes. Students are expected to thoroughly read and understand the procedure for the upcoming practical, as well as the relevant theoretical background, at least a day in advance. Each practical in the manual clearly outlines the specific competency, industry-relevant skills, course outcomes, and practical outcomes that serve as the central focus of the exercise. This approach ensures that students are aware of the skills they will gain through the procedures and the necessary precautions to take. This awareness is intended to equip them to apply these skills in solving real-world problems in their future professional careers.

Guidance for Teachers and Instructors: The manual also provides guidance to teachers and instructors, enabling them to effectively facilitate student-centered lab activities. This involves arranging and managing the necessary resources to ensure that students systematically follow the procedures and precautions, thereby achieving the desired outcomes.

First Edition and Continuous Improvement: The preface acknowledges that this is the first edition of the manual, and despite the best efforts to check for errors, perfection may not have been achieved. Therefore, any errors discovered and suggestions for improvement are actively solicited and highly welcome.

Programme Outcome (POs) to be achieved through Practical

PO 1. Basic & Discipline specific knowledge: Apply knowledge of basic mathematics, sciences and engineering fundamentals and engineering specialization to solve the engineering problems.

PO 2. Problem Analysis: Identify and analyze well defined engineering problems using codified standard methods.

PO 3. Design /Development Solutions: Design solutions for well-defined technical problems and assist with the design of systems components or processes to meet specified needs.

PO 4. **Engineering tools experimentation and testing:** Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.

PO 5. Engineering practices for society sustainability and environment: Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO 6. **Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

PO 7. Lifelong learning: Ability to analyze individual needs and engage in updating in context of technological changes.

List of Industry /Employer expected Outcome

The following industry/employer relevant skills expected by implement safe building construction practices with relevant building materials are to be developed in you by undertaking the practical of this laboratory manual.

1. Identify key components and subsystems of various types of electric vehicles.
2. Classify and select suitable electric drives for different EV applications.
3. Test the terminals and characteristics of BLDC, PMSM, IM, and other motors used in EVs.
4. Measure and evaluate EV battery parameters such as voltage, capacity, and state of charge.
5. Select appropriate energy storage systems (Li-ion, NiMH, etc.) for specific EV requirements.
6. Understand and apply Battery Management Systems (BMS) for safe and efficient battery use.
7. Design a battery pack based on mileage and load for a given EV.
8. Calculate and compare charging time using various EV charging methods.
9. Design layouts and simulate public charging stations with safety precautions.
10. Understand and implement concepts of DC-DC, DC-AC, and AC-DC converters used in EVs.
11. Select suitable charging infrastructure and explain bi-directional charging systems (V2G, V2H, etc.).
12. Apply Indian and Maharashtra state EV policies and incentives in real-world scenarios.
13. Document reports and present findings on EV market comparisons and policy impacts.
14. Perform simulations of EV subsystems using open-source software for performance analysis.
15. Demonstrate awareness of sustainability, safety, and future trends in electric vehicle technology.

Guidelines to Teachers

1. Teacher should provide the guideline with demonstration of each practical to the students along with all features involved.
2. Teacher shall explain the relevant prior concepts before starting each practical to ensure conceptual clarity.
3. Involvement of students during the execution of every practical is essential for better understanding.
4. Teacher should ensure that the intended skills and competencies are actually developed in students after completing the practical exercise.
5. Teachers should give students opportunities for hands-on practice after the demonstration to build confidence.
6. It is expected that the teacher explains the skills and competencies to be developed before starting the practical.
7. Additional industry-relevant knowledge and skills may be provided even if they are not explicitly mentioned in the manual.
8. Finally, a practical assignment should be given, and student performance should be assessed to verify whether the outcome matches the instructions given.

Instructions to Students

1. Organize your work in groups effectively and maintain records of all performed tasks and programs.
2. Students shall strive to develop maintenance-related skills as expected by industries. Attempt to develop relevant hands-on skills during the practical sessions to gain technical confidence.
3. Cultivate the habit of generating new ideas, innovations, and related skills that extend beyond the scope of the manual.
4. Refer to technical magazines and literature to stay updated with current advancements in the field.
5. Submit your practical work on or before the scheduled date and time without fail.
6. Be well-prepared and thorough when submitting the write-up of any exercise.
7. Attach or paste extra sheets wherever required to explain diagrams, calculations, or observations clearly.

Practical Course Outcome matrix

Course Outcomes (Cos)

CO1 –Identify components and subsystems used in electric vehicles.
CO2 –Select electrical drives for particular EV application.
CO3 –Test the performance of batteries and energy storage systems used for EV applications.
CO4 –Apply the concept of converters and charging system in EV.
CO5 –Implement Indian and state EV policies for EV applications.

Pr. No.	Title of the Practical	Mapped Course Outcome				
		CO 01	CO 02	CO 03	CO 04	CO 05
01	*Identification of electric vehicle components.	√	--	--	--	--
02	*Identification of subsystems of electric vehicles.	√	--	--	--	--
03	*Identification of terminals of motors used in EVs.	--	√	--	--	--
04	*Comparison of characteristics of EV motors.	--	√	--	--	--
05	*Testing of EV batteries.	--	--	√	--	--
06	Battery Cell balancing.	--	--	√	--	--
07	*Design of battery for EV.	--	--	√	--	--
08	*Charging of EV battery.	--	--	--	√	--
09	Public charging station for EV.	--	--	--	√	--
10	*Calculation of charging time of battery.	--	--	--	√	--
11	*Report on EV policy.	--	--	--	--	√

Content page

List of Practical's and Formative Assessment sheet.

11	*Report on EV policy.	60					
Total marks :							

These marks are to be transferred in pro-forma published by MSBTE

- '*' Marked Practical's (LLOs) are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

Practical No. 1: Identification of Electric Vehicle Components

Practical Significance:

To visually identify and understand the different physical components used in various types of electric vehicles.

Industry or Employer Expected Outcome:

Students should be able to identify and explain key EV components like batteries, motors, controllers, and sensors used in EVs.

I. **Course Level Learning Outcome:**

CO1 – Identify components and subsystems used in electric vehicles.

II. **Laboratory Learning Outcome:**

LLO 1.1 – Identify components of various types of electric vehicles.

III. **Relevant Affective domain related Outcome:**

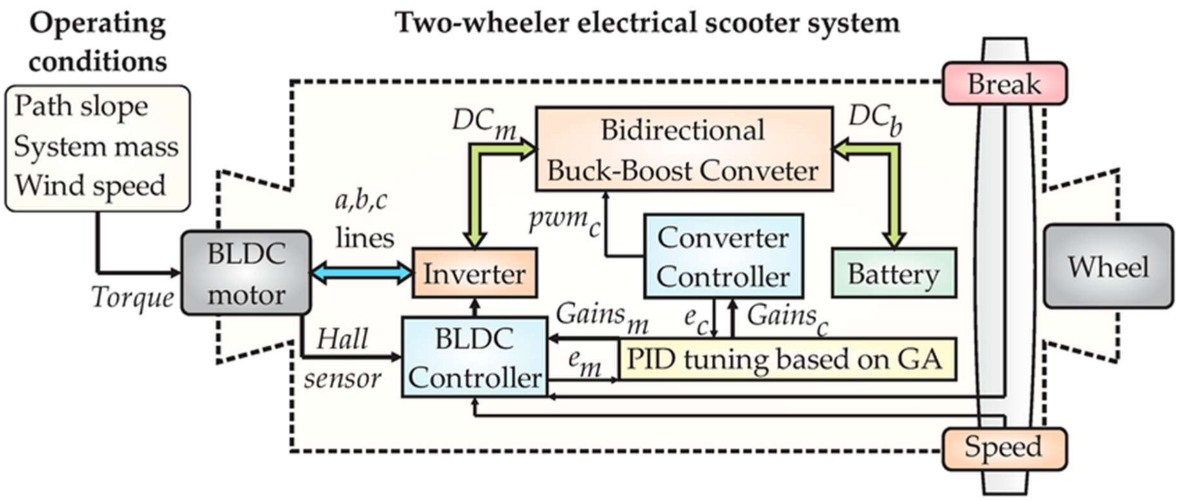
Develops keen observation skills and interest in EV technology as a sustainable alternative.

IV. **Relevant Theoretical Background:**

Electric vehicles consist of key systems such as:

- **Battery Pack** – Energy storage
- **Electric Motor** – Converts electrical energy into mechanical movement
- **Controller/Inverter** – Regulates motor input and output
- **BMS (Battery Management System)** – Manages battery safety and efficiency
- **DC-DC Converter** – Converts high voltage to lower voltage for auxiliary systems
- **Charging Port** – Interface for external charging

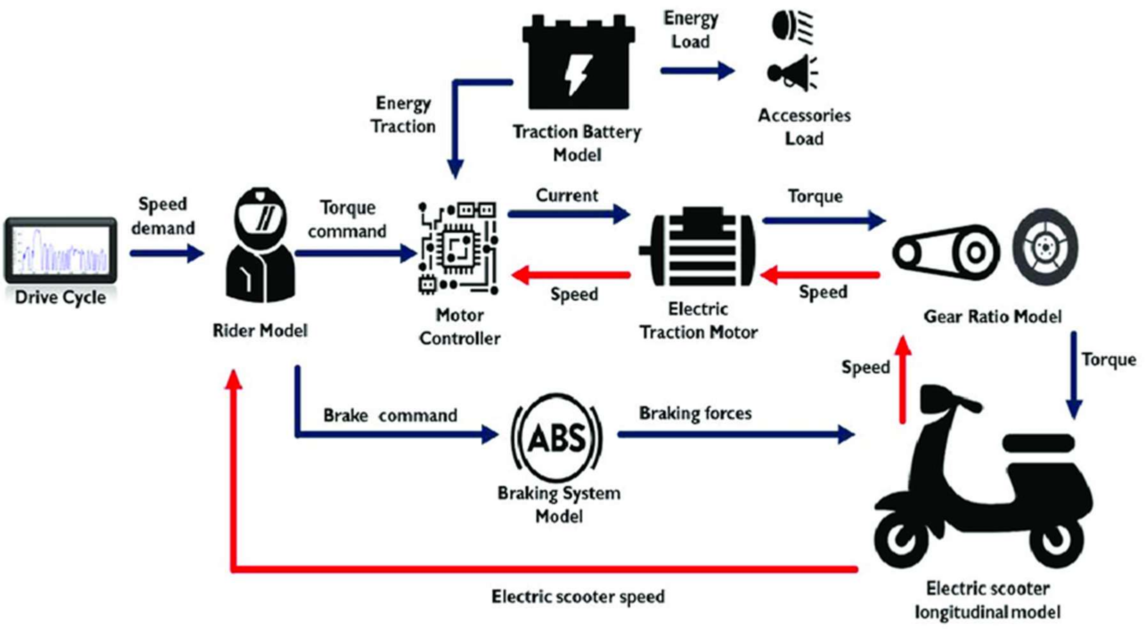
V. **Actual Diagram with Equipment Specification:**



The diagram represents a modern two-wheeler electric scooter powered by a BLDC motor. Key components and their roles:

- **BLDC Motor**: Converts electrical energy into mechanical torque to drive the wheel.
- **Battery**: Stores and supplies energy.
- **Inverter & Converter**: Convert battery DC power into the required form for the motor and other systems.
- **Controllers**: Include BLDC and converter controllers, using sensors and PID logic (with Genetic Algorithm tuning) to optimize performance.
- **Hall Sensor & Speed Feedback**: Provide rotor position and speed data for accurate control.
- **Brake & Wheel**: Controlled output to provide motion and stopping as per user input and terrain.

This structure ensures dynamic performance by adjusting to **operating conditions** such as **path slope, system mass, and wind speed**.



VI. Resources Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Electric Scooter Model	48V, 250W motor	1	Demo unit
2	EV Component Posters	Full labelled block diagram	1	For visual aid
3	Reference Videos	Identification of EV parts	-	For reinforcement

VII. Precautions to be followed

- Do not power ON or connect any electrical part during physical inspection.
- Use only insulated tools (if needed).
- Ensure proper safety while observing Vehicle Components.

VIII. Procedure

1. Observe an actual EV or its working model.
2. Refer to the schematic diagram of the EV layout.
3. Identify each component physically and match with diagram.
4. Record component names, locations, and specifications.
5. Discuss each part's function with group/faculty.

IX. Observation Table

Sr. No.	Component Name	Location in EV	Function
1			
2			
3			
4			
5			

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note: - Teacher should provide various questions related to practical)

1. Name any five major components of an electric vehicle.
2. Explain the role of a controller in an EV?
3. List different types of batteries used in EV with Specification?

(Space for Answers)

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XIV. References / Suggestions for Further Reading

Sr.No.	Link	Description
1	https://youtu.be/2IgZSDDFW-Y?si=Z1tfZO24ljBppzVA	Video – Identification of EV parts
2	https://nptel.ac.in/courses/108103009	NPTEL Course on EV Technology
3	https://www.researchgate.net/figure/General-block-diagram-of-two-wheeler-electrical-scooter-subsystems-and-operating_fig1_371741473	General block diagram of two-wheeler electrical scooter, subsystems, and operating conditions considered.

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 2: Identification of Subsystems of Electric Vehicles

Practical Significance:

To identify and understand the major subsystems that constitute an electric vehicle and their interconnections.

Industry or Employer Expected Outcome:

Students should be able to recognize energy source, propulsion, and auxiliary subsystems in an EV layout or real model.

I. **Course Level Learning Outcome:**

CO1 – Identify components and subsystems used in electric vehicles.

II. **Laboratory Learning Outcome:**

LLO 2.1 – Identify various subsystems of electric vehicles.

III. **Relevant Affective domain related Outcome:**

Fosters a system-level understanding of electric vehicle architecture and encourages teamwork during subsystem analysis.

IV. **Relevant Theoretical Background:**

An Electric Vehicle (EV) operates using electrical energy instead of conventional fossil fuels. It is made up of **three main subsystems** that work together to ensure the vehicle functions efficiently, safely, and sustainably. These subsystems are:

1. Energy Source Subsystem

This subsystem provides the **electric energy** required to power the vehicle. It includes:

- **Battery Pack**: The primary energy storage unit. It stores electrical energy (usually lithium-ion) that powers the motor and other systems.
- **Charging Unit**: Allows the battery to be recharged from external power sources, such as home outlets or fast-charging stations.
- **Battery Management System (BMS)**: Monitors and controls the battery's health, voltage, temperature, and state of charge (SOC) to ensure safety and longevity.

2. Propulsion Subsystem

This is the heart of the EV, responsible for converting electrical energy into mechanical movement. It includes:

- **Electric Motor**: Converts electrical energy into mechanical power to move the wheels.

- **Motor Controller**: Acts as a bridge between the battery and the motor, controlling the speed, torque, and direction of the motor based on user input (like pressing the accelerator).
- **Gearbox (if any)**: Some EVs use a simple transmission system to adjust torque and speed, although many EVs operate efficiently without a complex gearbox.

3. Auxiliary Subsystem

This subsystem supports non-driving functions and ensures user comfort and convenience. It includes:

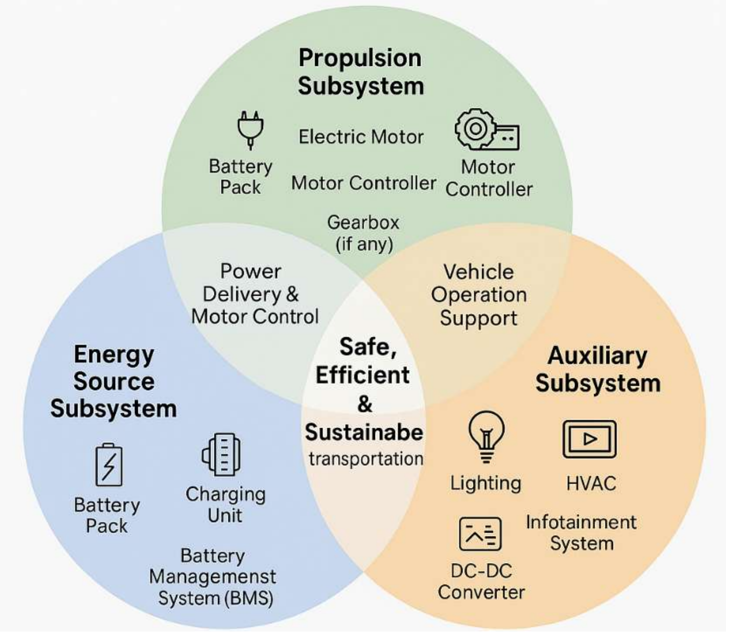
- **Lighting System**: Headlights, taillights, and indicators necessary for road safety.
- **HVAC (Heating, Ventilation, and Air Conditioning)**: Maintains the interior temperature and comfort level for passengers.
- **Infotainment System**: Provides entertainment, navigation, and connectivity.
- **DC-DC Converter**: Converts high-voltage DC power from the battery to low-voltage DC power used by auxiliary systems (like lights and infotainment).

System Integration

These three subsystems are interconnected and must function in harmony. For example:

- The BMS communicates with the motor controller to ensure proper power delivery.
- The DC-DC converter ensures the auxiliary systems receive power without affecting propulsion.
- HVAC and infotainment systems can impact the battery range, so their efficiency is critical.

V. Actual Diagram with Equipment Specification:



VI. Resources Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	EV System Block Diagram	Printed or digital chart	1	Must show all subsystems
2	EV Scooter (demo)	Working/non-working model	1	For observation
3	Poster of EV Layout	A2 Size	1	For explanation
4	Simulation Video	EV animation/video from YouTube	-	Optional

VII. Precautions to be followed

- Ensure EV system is turned OFF while identifying subsystems physically.
- Avoid disconnecting any internal wiring or connectors.
- Follow safety signage around high-voltage labels.

VIII. Procedure

1. Observe the EV model or layout diagram.
2. Visually identify components belonging to each subsystem.
3. Mark and label components on your worksheet.
4. Discuss function of each subsystem with group/faculty.
5. Cross-check your understanding with standard diagrams.

IX. Observation Table

Subsystem Type	Components Included	Function
Energy Source		
Propulsion Subsystem		
Auxiliary Subsystem		

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note:- Teacher should provide various questions related to practical)

1. Name the three major subsystems of an EV.
2. State the reason for using a DC-DC converter in EVs.
3. Differentiate between the propulsion subsystem and the auxiliary subsystem.

(Space for Answers)

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XIV. References / Suggestions for Further Reading

Sr.No.	Link	Description
1	https://nptel.ac.in/courses/108103009	EV System Layout (NPTEL)
2	https://youtu.be/HMeE-z_MR1U	Subsystem-based explanation video
3	https://www.lhpes.com/blog/what-are-electric-vehicle-subsystems-and-their-interactions	What are Electric Vehicle Subsystems and Their Interactions?

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 3: Identification of Terminals of Motors Used in Electric Vehicles

Practical Significance:

To identify and understand the terminals of various electric motors used in electric vehicles such as PMSM, Induction Motor, Synchronous Reluctance Motor, and BLDC motor.

Industry or Employer Expected Outcome:

Students will be able to recognize and correctly wire electric motors used in EVs, which is crucial for repair, installation, and diagnostics.

I. **Course Level Learning Outcome:**

CO2 – Select electrical drives for particular EV application.

II. **Laboratory Learning Outcome:**

LLO 3.1 – Identify the terminals of Permanent Magnet Synchronous Motor (PMSM)

LLO 3.2 – Identify the terminals of Three-phase Squirrel Cage Induction Motor

LLO 3.3 – Identify the terminals of Synchronous Reluctance Motor

LLO 3.4 – Identify the terminals of Brushless DC Motor (BLDC)

III. **Relevant Affective domain related Outcome:**

Encourages safe handling and familiarity with high-precision EV motors.

IV. **Relevant Theoretical Background:**

Each motor has unique characteristics and wiring:

- **PMSM**: 3-phase AC motor, often sensor-controlled
  A three-phase AC motor that uses permanent magnets on the rotor to achieve synchronous rotation with the stator field. PMSMs are typically controlled using advanced controllers with feedback from position sensors for precise operation. Commonly used in electric vehicles and robotics due to high efficiency and power density.

- **BLDC**: Requires Hall sensors for commutation
  Similar in construction to PMSM but typically driven using trapezoidal commutation. BLDC motors require Hall effect sensors for rotor position detection and electronic commutation. They are widely used in drones, computer fans, and e-bikes due to their reliability and low maintenance.

- **Induction Motor**: Robust, 3-phase input
  A robust and widely used three-phase AC motor, where the rotor is energized by electromagnetic induction from the stator. These motors do not require permanent magnets

or sensors, making them cost-effective and durable. Common applications include industrial drives and household appliances.

- **Synchronous Reluctance Motor (SynRM):**
  Similar to PMSMs in operation but do not use permanent magnets**.** Instead, they rely on rotor saliency (difference in magnetic reluctance) to produce torque. SynRMs offer a cost-effective alternative with reduced rare-earth material dependency.

- **Terminal Identification:** Terminal identification includes phases (U, V, W), sensor wires, and ground.

- **Power Terminals:** Typically labelled as U, V, and W, representing the three-phase inputs.

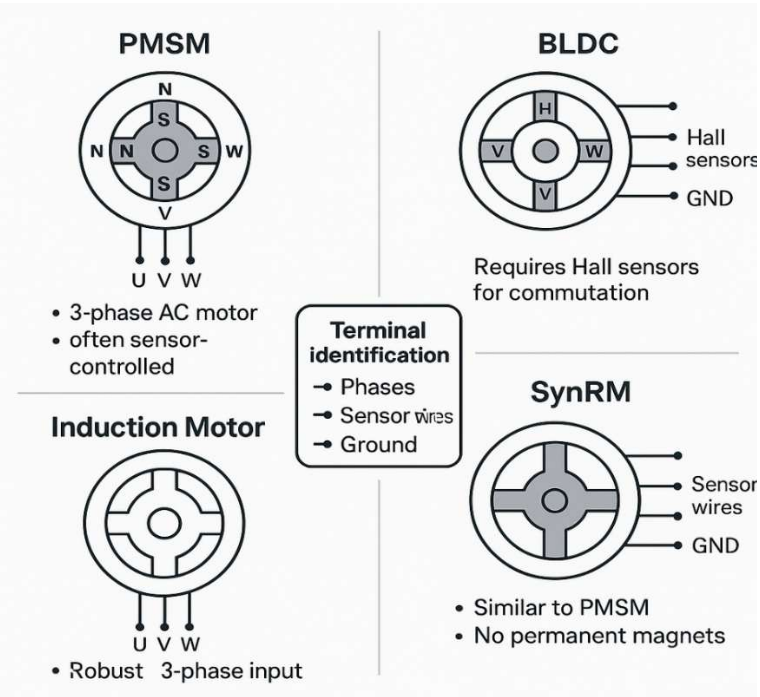
- **Sensor Wires:** Include connections for Hall sensors (in BLDC) or encoders (in PMSM), which are used for commutation and position feedback.

- **Ground (GND):** Common reference terminal for sensor and controller circuits.

V. Actual Diagram with Equipment Specification:

Provide labelled diagrams for each motor:

- 3-phase terminals (U, V, W)
- Hall sensor wires for BLDC
- Ground and auxiliary terminals



VI. Resources Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	BLDC Motor	1 kW, 3000 RPM	1	With Hall sensor
2	PMSM	Low voltage type	1	Educational setup
3	Squirrel Cage Induction Motor	3-phase, 0.5 HP	1	Standard lab type
4	Synchronous Reluctance Motor	Any available size	1	Demo or working model
5	Multimeter	For continuity test	1	For testing terminals

**You can use industrial datasheets of different motors for this experiment.*

VII. Precautions to be followed

- Ensure power is disconnected before touching motor terminals.
- Avoid short-circuiting any terminals.
- Wear insulated gloves and use proper tools.

VIII. Procedure

1. Study the datasheet or label of the motor.
2. Using multimeter, identify continuity between phase terminals.
3. Label U, V, W (for 3-phase) and note sensor wires (for BLDC).
4. Record observations and verify with faculty.

IX. Observation Table

Motor Type	Terminals Identified (Count)	Terminal Names
BLDC		
PMSM		
Induction Motor		
SynRM		

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note: - Teacher should provide various questions related to practical)

1. State the importance of terminal identification in EV motors?
2. Difference between PMSM and BLDC in terms of commutation?
3. Explain which motor type does not require a sensor for operation?

(Space for Answers)

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XIV. References / Suggestions for Further Reading

Sr.No.	Link	Description
1	https://youtu.be/2IgZSDDFW-Y?si=Z1tfZO24ljBppzVA	Terminal identification for BLDC
2	https://nptel.ac.in/courses/108103009	EV motor fundamentals (NPTEL)

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 4: Comparison of Characteristics of EV Motors

Practical Significance:

To study, analyse, and compare the key performance characteristics of various electric vehicle motors such as BLDC, PMSM, Induction Motor, and SynRM.

Industry or Employer Expected Outcome:

Students should be able to select appropriate EV motors based on application requirements like torque, speed, cost, and efficiency.

I. **Course Level Learning Outcome:**

CO2 – Select electrical drives for particular EV application.

II. **Laboratory Learning Outcome:**

LLO 4.1 – Determine and compare the characteristics of given EV motors.

III. **Relevant Affective domain related Outcome:**

Students will develop analytical thinking and critical comparison skills for real-world motor selection in EVs.

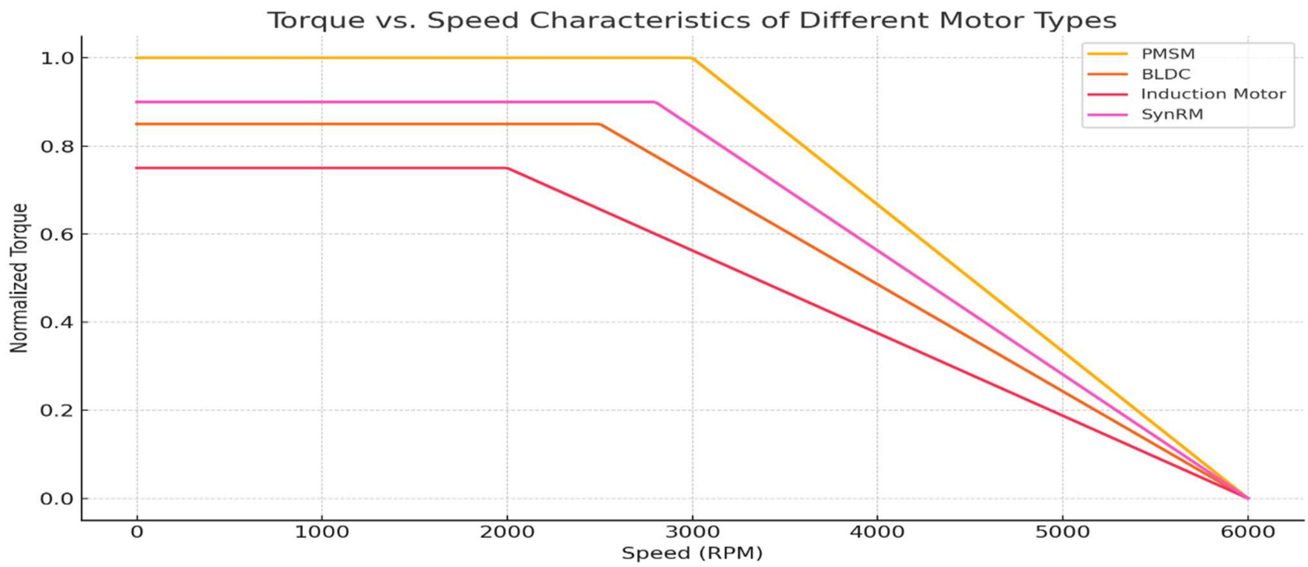
IV. **Relevant Theoretical Background:**

EV motors commonly used include:

- **Brushless DC Motor (BLDC):**
  Known for high efficiency and compact size, BLDC motors require a dedicated controller with Hall sensors for electronic commutation. Commonly used in consumer electronics, drones, and lightweight EV applications.
- **Permanent Magnet Synchronous Motor (PMSM):**
  Offers excellent torque and speed control with high dynamic performance. Frequently used in premium electric vehicles (EVs) due to their efficiency and precision (e.g., BMW i3, Nissan Leaf).
- **Induction Motor:**
  Rugged and cost-effective, these motors do not require magnets or sensors for basic operation. They are widely used in industry and electric vehicles, including earlier versions of the Tesla Model S.
- **Synchronous Reluctance Motor (SynRM):**
  Characterized by simpler construction and the absence of magnets, SynRMs are gaining popularity for their cost advantages and growing efficiency with modern control strategies. Increasingly considered for industrial and automotive use.

V. Actual Diagram with Equipment Specification:

Use comparative charts/graphs showing Torque vs. Speed curves for various motor types.



VI. Resources Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Motor Specification Sheets	BLDC, PMSM, IM, SynRM	4	Printed or digital
2	Data Charts / Comparison Table	Power vs. Speed, Torque vs. Speed	1 set	For classroom display
3	Internet Access or Textbook	For reference and verification	-	NPTEL/YouTube/Books

VII. Precautions to be followed

- Do not connect actual motors to power sources without supervision.
- Use verified data sheets and credible sources only for comparison.
- Use official manufacturer data for accurate specifications rather than guessing.

VIII. Procedure

1. Study the datasheet or reliable source for each motor.
2. Note values for power, torque, efficiency, speed range, etc.
3. Prepare a comparative table.
4. Discuss where each motor is best suited.
5. Record interpretation and recommendation.

IX. Observation Table – Comparison of Motor Characteristics

Parameter	BLDC Motor	PMSM	Induction Motor	SynRM
Max Efficiency (%)				
Torque-Speed Range				
Controller Cost				
Motor Cost				
Power-to-Weight Ratio				
Maintenance				
Used in EV Type				

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note: - Teacher should provide various questions related to practical)

1. Write the major differences between BLDC and PMSM motors?
2. State the reason why induction motor preferred in Tesla vehicles?
3. Explain factors affect the selection of EV motors?

(Space for Answers)

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XIV. References / Suggestions for Further Reading

Sr.No.	**Link**	**Description**
1	https://nptel.ac.in/courses/108103009	NPTEL Course on EV Drives
2	https://www.mdpi.com/1996-1073/10/8/1217	EV Motor Comparison Paper

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 5: Testing of EV Batteries

Practical Significance:

To test the health and capacity of batteries used in electric vehicles and identify their charging condition.

Industry or Employer Expected Outcome:

Ability to test and interpret the condition of EV batteries using multimeter and standard procedures.

I. Course Level Learning Outcome:

CO3 – Test the performance of batteries and energy storage systems used for EV applications.

II. Laboratory Learning Outcome:

LLO 5.1 – Measure open circuit voltage of a given battery using multimeter

LLO 5.2 – Identify the charged, discharged and dead battery condition

LLO 5.3 – Determine Amp-hour (Ah) capacity of battery

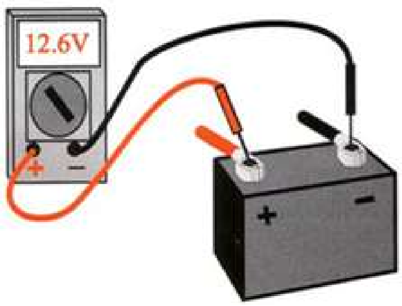
III. Relevant Affective domain related Outcome:

Develop a safety-conscious and analytical approach towards battery testing.

IV. Relevant Theoretical Background:

- EV batteries commonly used: Lithium-Ion, NiMH, Lead-Acid.
- Open Circuit Voltage (OCV) is a key indicator of battery health.
- Ah capacity defines how much energy the battery can store.
- Discharged batteries can affect EV performance; overcharging can reduce battery life.

V. Actual Diagram with equipment specification:



VI. Resources Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Lithium-Ion battery	48V, 20Ah	1	Sample pack
2	Digital Multimeter	3½ Digit, 0–100V DC range	1	For OCV reading
3	Battery data sheet	Printed sheet	1	For reference
4	Connection wires	Standard red/black test leads	1	Safety tested

VII. Precautions to be followed

- Always wear insulated gloves while testing.
- Do not short battery terminals.
- Ensure multimeter is in correct voltage range before connecting.

VIII. Procedure

1. Set the multimeter to DC voltage mode.
2. Connect the probes to the battery terminals correctly.
3. Note the open circuit voltage.
4. Compare with rated values to determine charge condition.
5. Use manufacturer formula or standard methods to estimate Ah capacity.

IX. Observation Table

Battery Type	Rated Voltage	Measured Voltage	Condition

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note:- Teacher should provide various questions related to practical)

1. Define Open Circuit Voltage (OCV)?
2. How can you identify if a battery is discharged or dead?
3. How do you calculate Ah capacity of a battery?

(Space for Answers)

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XIV. References / Suggestions for Further Reading

Sr.No.	Link	Description
1	https://nptel.ac.in/courses/108103009	NPTEL EV Battery Basics
2	https://batteryuniversity.com/article/bu-903-how-to-measure-state-of-charge	Measuring State of Charge

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 6: Battery Cell Balancing

Practical Significance:

To understand and perform **active cell balancing** in Lithium-Ion batteries using a balancing setup on a non-conductive platform.

Industry or Employer Expected Outcome:

Students should be able to **balance lithium cells** for uniform performance, safety, and longer battery life — a key skill in EV battery maintenance.

I. **Course Level Learning Outcome:**

CO3 – Test the performance of batteries and energy storage systems used for EV applications.

II. **Laboratory Learning Outcome:**

LLO 6.1 – Perform Active Lithium-Ion Cell balancing using Plastic Platform Scale.

III. **Relevant Affective domain related Outcome:**

Develop awareness of energy efficiency, safety, and sustainability in EV battery management.

IV. **Relevant Theoretical Background:**

- Battery cells have slight differences in capacity and voltage.
- Over time, imbalance occurs leading to decreased efficiency and safety issues.
- Active balancing redistributes charge between cells to maintain uniform voltage.
- Used widely in EV Battery Management Systems (BMS).

Active Cell Balancing:

Active balancing is a method where excess energy from higher-voltage cells is transferred to lower-voltage cells using electronic circuits. This improves overall efficiency and battery life.

How It Works:

- An Active Balancer Circuit (usually DC-DC converter based) monitors the voltage of each cell.
- If one cell has a higher voltage, the circuit transfers charge from it to a cell with lower voltage.
- This maintains uniform voltage across all cells without wasting energy as heat.

Example:

If Cell 1 is at 4.2V and Cell 3 is at 4.0V,
→ the active balancer will shift charge from Cell 1 to Cell 3,
→ so both cells balance closer to a common voltage level.

This method is energy-efficient, as no energy is wasted — it's just redistributed among the cells.

Why Use Active Balancing?

- Maintains higher energy efficiency.
- Enhances battery pack performance and extends life.
- Essential for Electric Vehicles (EVs) where energy efficiency and safety are critical.

You do NOT need to charge the batteries externally during the experiment.

Here's Why:

- The focus is on balancing the voltages of already partially charged cells.
- The active balancer module only redistributes charge between the cells — it does not add charge from an external charger.
- You should use pre-charged lithium-ion cells that have slight voltage differences (e.g., 4.15V, 4.10V, 4.05V, etc.).

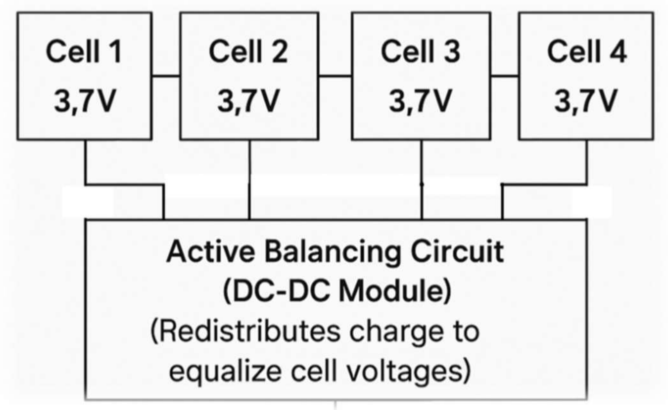
Important:

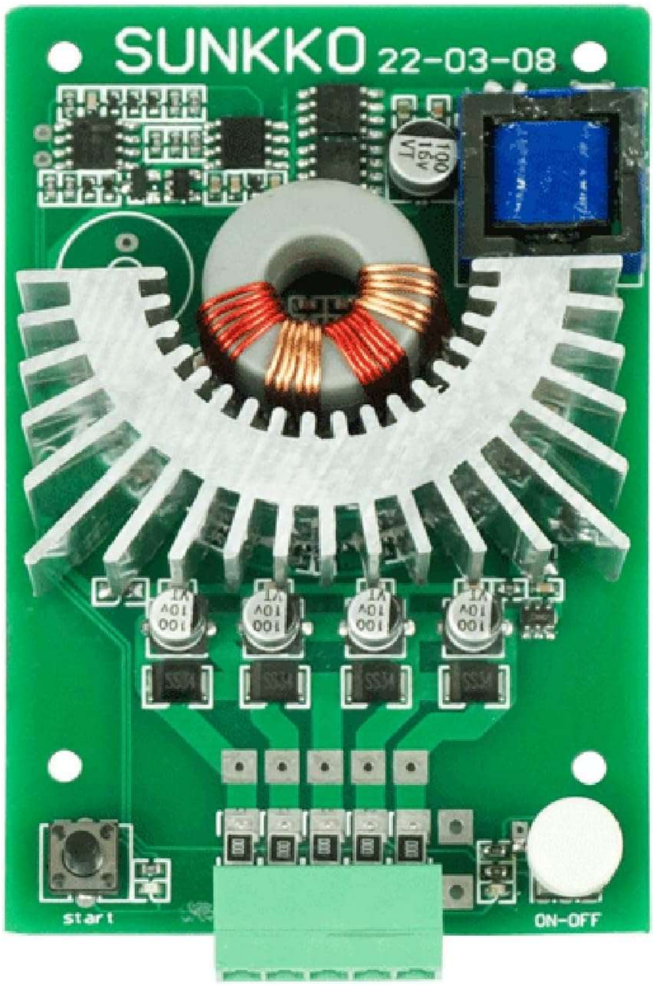
- If the cells are too low (e.g., <3.5V) or fully charged (e.g., 4.20V each), balancing will not be visible.
- Use cells in the mid-range (around 3.9V to 4.2V) with slight differences for best demonstration.

Why Use a Plastic Platform?

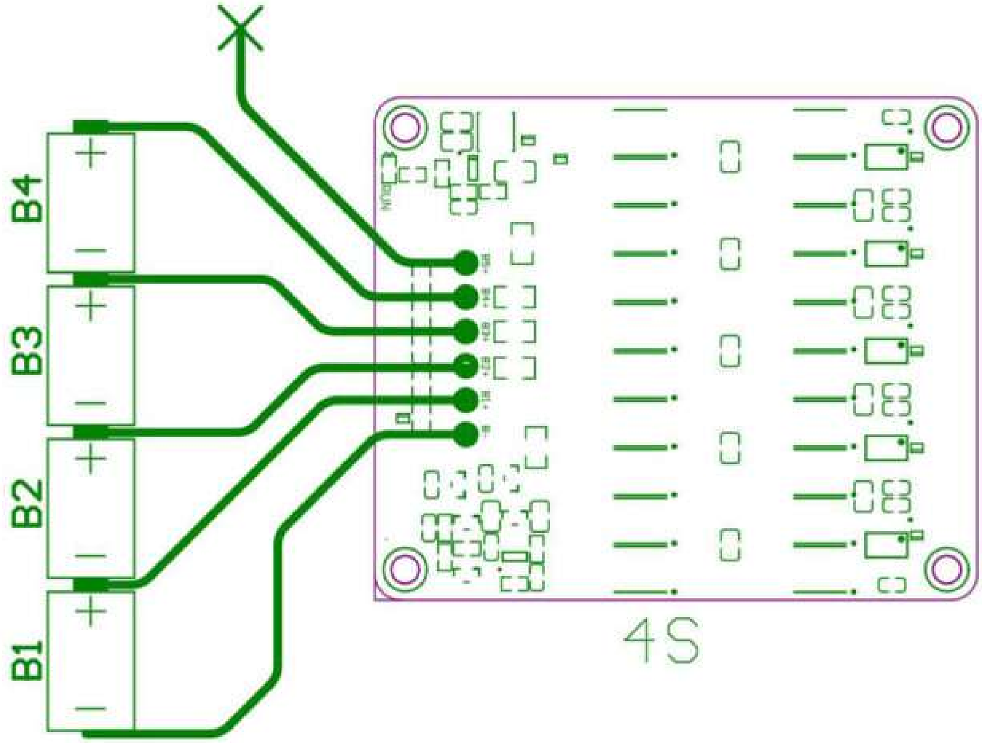
- Acts as a non-conductive base to safely hold and organize cells.
- Prevents short circuits during the balancing process.
- Ensures safe wiring, stability, and easy voltage monitoring.
- While not mandatory for 4 cells, it becomes essential for larger packs.

V. Actual Diagram with equipment specification:





SUNKKO 4S 5A Active Balancer Equalizer Module



VI. Resources Required

Sr. No.	Item	Specification	Quantity	Purpose
1	Plastic Platform (Non-conductive base)	A3 Size	1	To safely mount cells
2	Lithium-Ion Cells	3.7V, 2500mAh	4	Balancing required
3	Active Balancing Circuit	4S, 5A (e.g., SUNKKO)	1	Charge shifting
4	Connecting Wires	Standard insulated leads	1 set	Safe connection

VII. Precautions to be followed

- Use cells of the same type, rating, and charge level.
- Ensure correct polarity during connection.
- Avoid short circuits and physical damage.
- Use in a well-ventilated, fire-safe area.

VIII. Procedure

1. Record the initial voltage of each cell using a multimeter.
2. Place all cells on the plastic platform.
3. Connect the cells in series to the active balancer module.
4. Power on the circuit and observe voltage equalization.
5. After balancing, disconnect and record final voltages.

IX. Observation Table

Cell No.	Initial Voltage (V)	Final Voltage (V)	Condition Balanced/Unbalanced
Cell 1			
Cell 2			
Cell 3			
Cell 4			

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note:- Teacher should provide various questions related to practical)

1. Explain the importance of cell balancing in EV batteries.
2. Differentiate between active and passive balancing.
3. Predict what will happen if one cell in a series is undercharged.

(Space for Answers)

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XIV. References / Suggestions for Further Reading

Sr.No.	Link	Description
1	https://batteryuniversity.com/article/bu-803a-cell-matching-and-balancing	Cell balancing fundamentals
2	https://nptel.ac.in/courses/108103009	NPTEL BMS and balancing section

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 7: Design of Battery for Electric Vehicle

Practical Significance:

To design a battery pack suitable for specific EV requirements in terms of voltage, current, and capacity.

Industry or Employer Expected Outcome:

Students should be able to calculate and design battery configurations for real-world electric vehicles.

I. **Course Level Learning Outcome:**

CO3 – Test the performance of batteries and energy storage systems used for EV applications.

II. **Laboratory Learning Outcome:**

LLO 7.1 – Design battery pack for specified capacity of EV.

III. **Relevant Affective domain related Outcome:**

Students will demonstrate responsibility for designing safe and efficient energy systems.

IV. **Relevant Theoretical Background:**

- EVs require specific voltage and current for operation.
- Series connection increases voltage; capacity (Ah) remains the same.
  Parallel connection increases capacity (Ah); voltage remains the same.
- Total energy (Wh) = Voltage × Capacity (Ah)
- The configuration is selected based on motor voltage, required range, and current demand of the EV.
- When battery cells are connected in series, their voltages add up, but the Ah capacity remains the same as that of a single cell.
  Example-If the required battery pack is 48V, 30Ah and each cell is 3.7V, 2.5Ah:
  Series cells = 48 / 3.7 ≈ 13 cells (13S)
  Parallel strings = 30 / 2.5 = 12 (12P)
  Total = 13 × 12 = 156 cells

V. Actual Diagram with equipment specification:

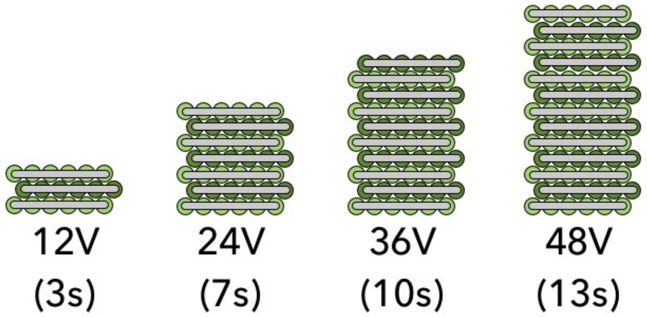

Fig 1. Cell Combination

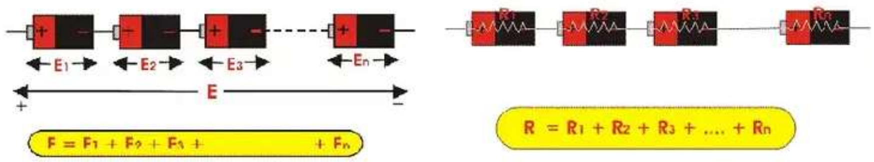

Fig 2. Series Connected Batteries Cells

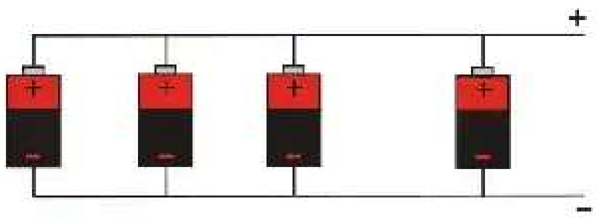

Fig 3. Parallel Connected Batteries Cells

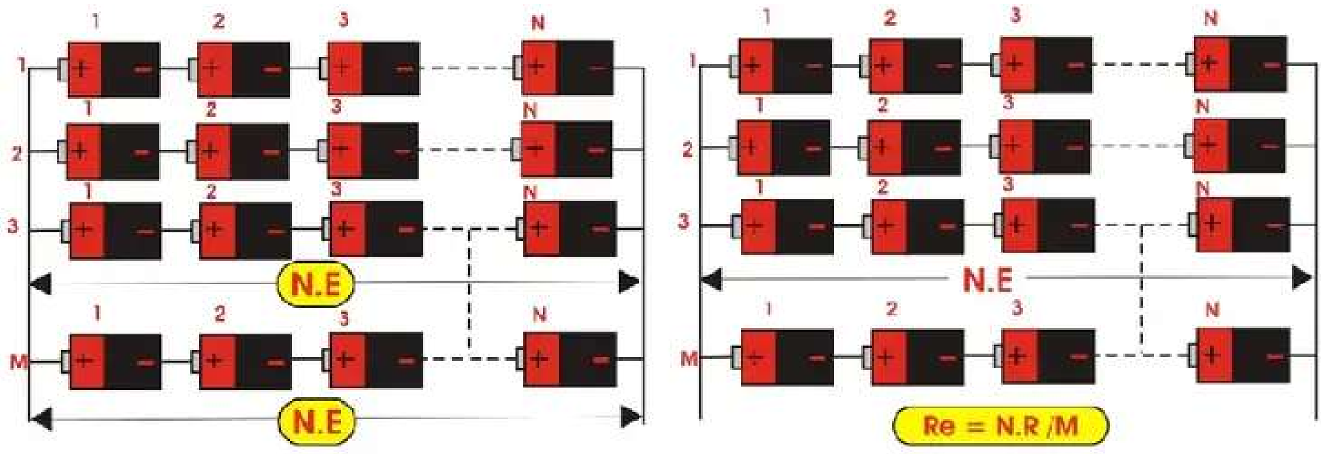

Fig 3. Mixture of Series and Parallel Batteries Cells

VI. Resources Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Lithium-Ion cell (3.7V)	2500mAh, cylindrical	Multiple	For calculation
2	Battery specification sheet	Data for different battery types	1	Reference

VII. Precautions to be followed

- Ensure accurate cell specifications before calculation.
- Avoid assuming values without data sheets.
- Design must consider safety factors and BMS compatibility.

VIII. Procedure

1. Determine required battery pack voltage and capacity (e.g., 48V, 30Ah).
2. Calculate number of cells in series:

$$= \frac{\text{Required Voltage}}{\text{Cell Voltage}}$$

3. Calculate number of parallel strings:

$$= \frac{\text{Required Capacity}}{\text{Cell Capacity}}$$

4. Multiply to get total number of cells.
5. Draw series-parallel configuration.

IX. Observation Table

Cell / Battery Type:		
Required Battery to be design	_____ V / _____ Ah	
Cell Voltage (V)		
Cell Capacity (AH)		
Total Cells Required in Series	$Ns = \frac{\text{Required Voltage}}{\text{Cell Voltage}}$	
Total Cells Required in Parallel	$Np = \frac{\text{Required Capacity}}{\text{Cell Capacity}}$	
Total Number of Cells	N=Ns×Np	

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note: - Teacher should provide various questions related to practical)

1. State the purpose of connecting battery cells in parallel.
2. Explain the reason for using 13 cells in series for a 48V system.
3. List the factors that affect battery design in EVs.

(Space for Answers)

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XIV. References / Suggestions for Further Reading

Sr.No.	Link	Description
1	https://skill-lync.com/student-projects/project-1-mechanical-design-of-battery-pack-555	Basics of battery configuration
2	https://nptel.ac.in/courses/108103009	NPTEL Battery Design Module

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 8 Charging of EV Battery

Practical Significance:

To understand and perform charging of an EV battery using different methods and evaluate charging time and efficiency.

Industry or Employer Expected Outcome:

Ability to safely charge EV batteries and assess time and efficiency of various charging methods.

I. **Course Level Learning Outcome:**

CO4 – Apply the concept of converters and charging system in EV.

II. **Laboratory Learning Outcome:**

LLO 8.1 – Charge an EV battery using various methods and record charging times and efficiency.

III. **Relevant Affective domain related Outcome:**

Develop safety consciousness and systematic approach while handling charging equipment.

IV. **Relevant Theoretical Background:**

- Charging methods include slow (trickle), fast (AC), and rapid (DC) charging.
- Efficiency is determined by comparing energy input vs. stored energy.
- Overcharging or incorrect methods can damage the battery.
- Charging time

$$\text{Charging Time T} = \frac{\text{Battery Capacity(Ah)}}{\text{Charging Current(A)}}$$

$$\text{Efficiency (\%)} = \frac{\text{Energy Stored in Battery}}{\text{Energy Supplied by Charger}} \times 100$$

Calculate Energy Stored
Energy Stored=Battery Voltage (V) × Battery Capacity (Ah)

Calculate Energy Supplied
Energy Supplied=Charging Voltage × Charging Current × Time (hours)

- **Trickle Charging (Slow Charging):**

Uses a very low current (e.g., 1A).

Time-consuming but safe and battery-friendly.

Mostly used for small capacity EVs or battery conditioning.

- **AC Charging (Standard Charging): Residential**

  Uses a standard 230V AC supply and an onboard charger.

  Charging current usually 3A–5A.

  Suitable for residential or overnight charging.

  Charging time: ~4–8 hours depending on battery capacity.

- **DC Fast Charging (Rapid Charging): Charging Station**

  Direct current applied directly to battery terminals.

  Requires off-board charging station with high current (10A+).

  Can charge up to 80% in 30–45 minutes.

  More heat generation and stress on battery.

V. Actual Diagram with equipment specification:

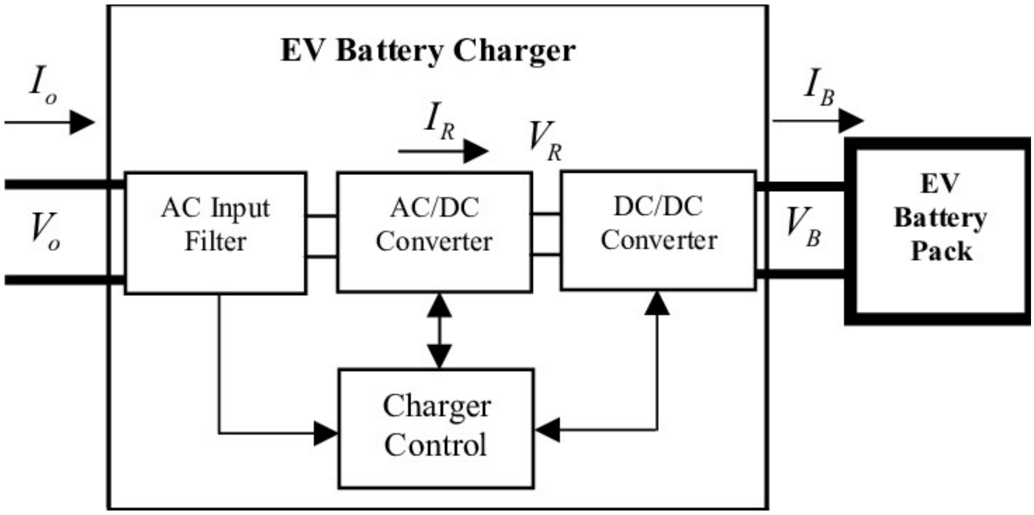

Fig. Block Diagram of EV Charging- AC Charging

Battery Pack

Charger

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VI. Resources Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	EV Battery	48V, 20Ah Lithium-Ion	1	Standard sample
2	EV Charger	48V output, 5A current	1	AC charging unit
3	Digital Multimeter	0–100V DC range	1	Voltage monitoring
4	Timer / Stopwatch	Digital or app-based	1	To measure time

VII. Precautions to be followed

- Connect charger terminals correctly.
- Do not charge beyond rated voltage.
- Ensure charger and battery ratings match.
- Stay away from high-voltage parts during charging.

VIII. Procedure

1. Measure initial battery voltage.
2. Connect the charger as per circuit diagram.
3. Start the stopwatch and begin charging.
4. Record voltage at fixed time intervals.
5. Calculate total charging time and efficiency.

IX. Observation Table

Sr. No	Time (min)	Voltage (V)	Current (A)	Remarks

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note: - Teacher should provide various questions related to practical)

1. List the different methods of charging EV batteries.
2. Explain the calculation of charging time for EV batteries.
3. List the precautions to follow while charging a Li-Ion battery.

(Space for Answer)

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XIV. References / Suggestions for Further Reading

Sr.No.	Link	Description
1	https://batteryuniversity.com/article/bu-403-charging-lithium-ion	Charging Li-Ion battery principles
2	https://nptel.ac.in/courses/108103009	NPTEL EV Charging Module
3	https://www.omnicalculator.com/everyday-life/battery-charge-time	

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 9 Public Charging Station for EV

Practical Significance:

To understand the layout, component selection, and design of an electric vehicle (EV) public charging station.

Industry or Employer Expected Outcome:

Ability to plan and simulate a real-world EV charging station including components, layout, and electrical connections.

I. **Course Level Learning Outcome:**

CO4 – Apply the concept of converters and charging system in EV.

II. **Laboratory Learning Outcome:**

LLO 9.1 – Develop a charging station layout

LLO 9.2 – Select appropriate components of charging station

LLO 9.3 – Draw a single-line diagram of a charging station

LLO 9.4 – Simulate the charging process using open-source software

III. **Relevant Affective domain related Outcome:**

Students gain appreciation for infrastructure design and adopt a systems approach to EV ecosystem planning.

IV. **Relevant Theoretical Background:**

- EV public charging stations can include Level 1 (slow), Level 2 (fast), and Level 3 (DC rapid) chargers.
- Components: Power supply panel, charger modules, connectors, billing system, transformer, control units.
- Smart systems include V2G (Vehicle-to-Grid), IoT monitoring, safety protocols.
- Single-line diagrams help in planning power distribution and protection.

V. Actual Diagram with Equipment Specification:

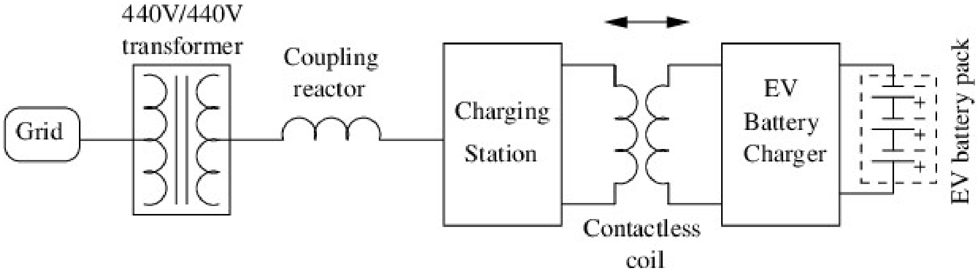

Fig. Single line diagram of Charging Station

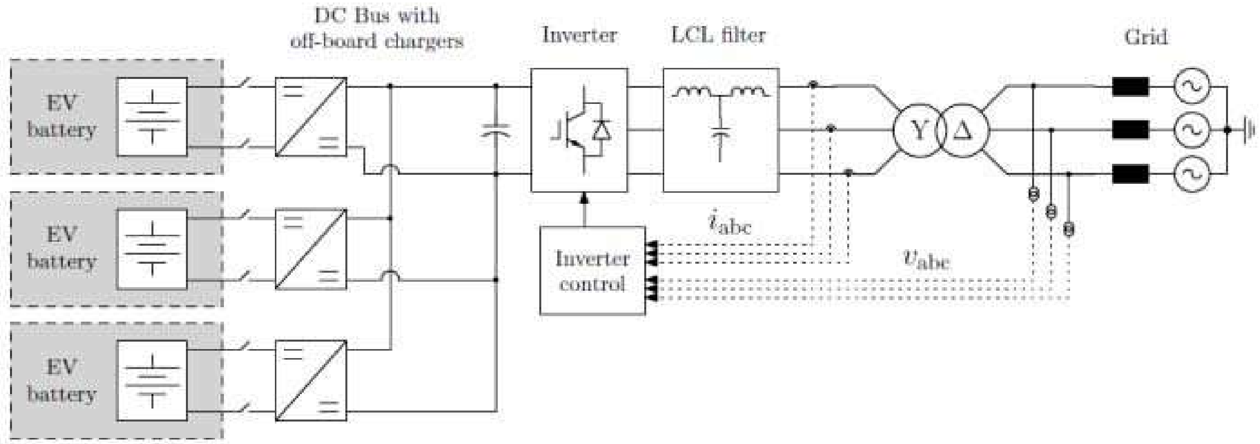

Fig. Block Diagram of Charging Station

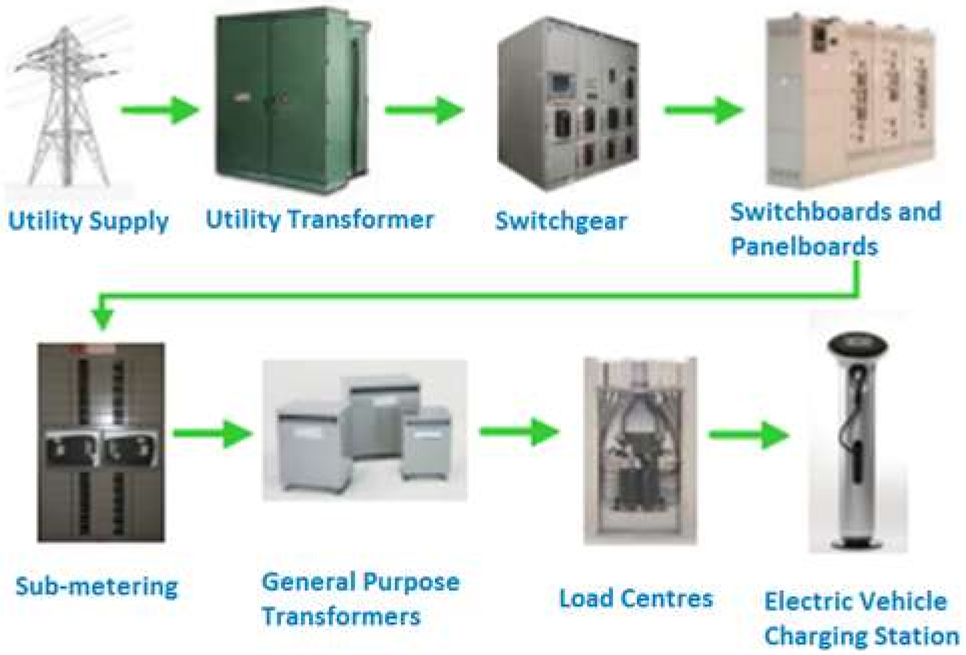

Fig. Components used in Charging Station

VI. Resources Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Simulation Software	Tinker cad / AutoCAD / MATLAB Simulink	1	For layout and SLD
2	Public charging station layout	Standard EVSE infrastructure blueprint	1	Reference document
3	Component catalogue	Chargers, transformers, connectors, etc.	1	For selection
4	EV load calculator	Online or Excel-based tool	1	For load estimation

Draw or Paste Simulation Diagram-

VII. Precautions to be followed

- While simulating, ensure electrical parameters match EV charging standards.
- Avoid overload in layout planning.
- Adhere to government EV policy guidelines for safety.

VIII. Procedure

1. Study the requirements of EV public charging infrastructure.
2. Select appropriate charger types and other components.
3. Prepare layout plan showing charging bays and electrical room.
4. Draw single-line diagram (SLD) using simulation or drawing software.
5. Simulate the charging process to check load distribution and connection logic.

IX. Observation Table

S.N	Component	Function	Remark
1	EV Charger		
2	Transformer		
3	Circuit Breaker		
4	Connector (Type 2/CCS)		
5	Control Unit		
6	Billing System		

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note:- Teacher should provide various questions related to practical)

1. List key components of a public EV charging station?
2. Draw & State single-line diagram important in EV infrastructure?
3. Enlist safety parameters must be considered while designing EV stations?

(Space for Answers)

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XIV. References / Suggestions for Further Reading

Sr.No.	Link	Description
1	https://www.niti.gov.in/sites/default/files/2023-02/EV_Handbook_Final_14Oct.pdf	Handbook on EV Charging Infrastructure
2	https://maitri.mahaonline.gov.in/PDF/EV%20Policy%20GR%20 2021.pdf	Maharashtra EV Policy 2021
3	https://www.eai.in/blog/2018/12/components-of-ev-charging-infrastructure.html	Electric Vehicle Equipment

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			Dated Signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 10: Calculation of Charging Time of Battery

Practical Significance:

To calculate the charging time of EV batteries using given parameters such as battery capacity and charger current.

Industry or Employer Expected Outcome:

Students should be able to estimate the time required to charge EV batteries, which is essential for planning battery charging infrastructure and user guidance.

I. **Course Level Learning Outcome:**

CO4 – Apply the concept of converters and charging system in EV.

II. **Laboratory Learning Outcome:**

LLO 10.1 – Calculate the charging time for different battery capacities using given formulas.

III. **Relevant Affective domain related Outcome:**

Enhances mathematical thinking and real-world applicability in energy and time management for EVs.

IV. **Relevant Theoretical Background:**

Charging Time TTT is calculated using the formula:

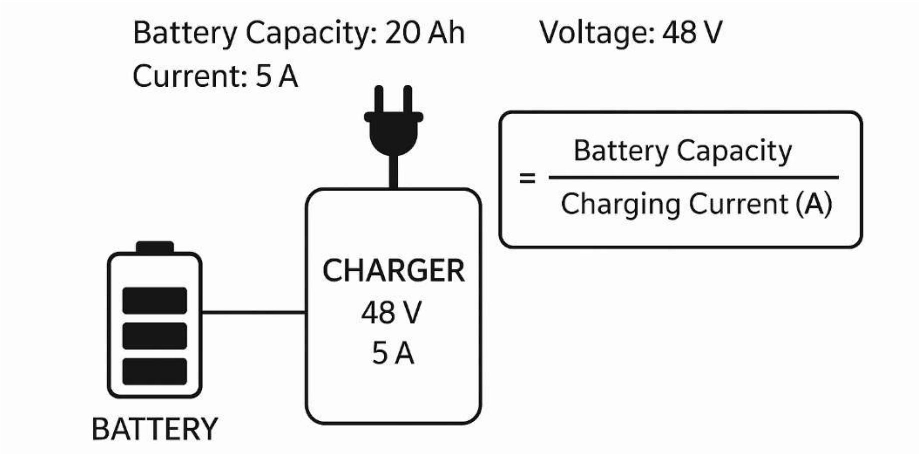
$$T = \frac{\text{Battery Capacity (Ah)}}{\text{Charging Current (A)}} X \frac{1}{\text{Charging Efficiency}}$$

- Charging efficiency is usually between 0.8 to 0.9 (i.e., 80% to 90%).
- Charger power (W) = Voltage (V) × Current (A)
- The higher the charger current, the faster the charging—up to a safe limit.
-

Recommended Assumed Values:

- Li-ion battery: 85% to 95% (use 0.85 or 0.9 commonly)
- Lead-acid battery: 70% to 80% (use 0.75 if doing a comparison)

V. Actual Diagram with Equipment Specification:



VI. Resources Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	Battery Specification	48V, 20Ah Li-ion battery	1	Assumed values
2	Charger Details	48V, 5A AC Charger	1	Hypothetical case

VII. Precautions to be followed

- Ensure data used in calculation is accurate.
- Use correct units (Ah, A, %, hours).
- Consider safety margins for practical application.

VIII. Procedure

1. Note down the battery capacity (Ah) and voltage (V).
2. Take the charger current from specifications.
3. Assume charging efficiency (e.g., 85%).
4. Apply formula and compute charging time.
5. Repeat for different battery capacities and charging currents.

IX. Observation Table

Battery Capacity (Ah)	Charger Current (A)	Efficiency (%)	Charging Time (Hours)

Formula used:

$$T = \frac{\text{Battery Capacity (Ah)}}{\text{Charging Current (A)}} X \frac{1}{\text{Charging Efficiency}}$$

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note:- Teacher should provide various questions related to practical)

1. List the factors that affect EV battery charging time.
2. Explain the importance of charging efficiency in calculating charging time.
3. Analyse the impact of increasing charger current on charging time and battery life.

(Space for Answers)

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XIV. References / Suggestions for Further Reading

Sr.No.	Link	Description
1	https://batteryuniversity.com/article/bu-808-how-to-prolong-lithium-based-batteries	Battery charging time and efficiency
2	https://nptel.ac.in/courses/108103009	EV Charging Theory Module

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			Dated Signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Practical No. 11: Report on EV Policy

Practical Significance:

To understand, analyse, and summarize key features of Indian and Maharashtra Electric Vehicle Policies, which guide the promotion and adoption of EVs across the country.

Industry or Employer Expected Outcome:

Students should be aware of EV-related schemes, incentives, and policy frameworks to comply with industry requirements and government norms while working in the EV ecosystem.

I. **Course Level Learning Outcome:**

CO5 – Implement Indian and state EV policies for EV applications.

II. **Laboratory Learning Outcome:**

LLO 11.1: Prepare a report on Indian EV Policy (NEMMP 2020)

LLO 11.2: Prepare a report on Maharashtra EV Policy, 2021

III. **Relevant Affective Domain Related Outcome:**

Develops civic awareness, responsible citizenship, and interest in public policy shaping the green mobility future of India.

IV. **Relevant Theoretical Background**

- **NEMMP 2020 (National Electric Mobility Mission Plan):**
    - Aimed at achieving national fuel security by promoting electric and hybrid vehicles.
    - Focus on demand creation through FAME scheme, technology development, charging infra.
- **FAME Scheme:**
    - Faster Adoption and Manufacturing of Hybrid and Electric Vehicles.
    - Provides financial incentives to buyers and manufacturers.
- **Maharashtra EV Policy 2021:**
    - Offers demand incentives, scrappage benefits, charging station subsidies.
    - Encourages EV manufacturing and retrofitting industry.
    - Goal: 10% of new vehicle registrations to be electric by 2025.

V. Actual Diagram with Equipment Specification

Prepare a flowchart showing: (Draw Flowchart)

- Central and State Government roles
- EV Infrastructure Providers
- Buyers and manufacturers
- Interactions through policy mechanisms

VI. Resources Required

Sr. No.	Particulars	Specification	Quantity	Remark
1	NEMMP 2020 PDF	Govt. of India official document	1	Downloaded from website
2	Maharashtra EV Policy 2021	State Government Policy PDF	1	Downloaded from MAITRI
3	Laptop/Computer	Internet enabled	1 per group	For reading documents
4	MS Word or Google Docs	For report preparation	1	Required for formatting

VII. Precautions to be Followed

- Always refer to the latest government websites for accurate information.
- Avoid copying from unreliable blogs or outdated articles.
- Cite sources properly in the report.

VIII. Procedure

1. Visit official government portals (e.g., niti.gov.in, heavyindustries.gov.in, *maitri.mahaonline.gov.in*).
2. Download and study the EV policy documents.
3. Highlight the objectives, incentives, targets, and implementation strategy.
4. Summarize these into two separate reports:
    - National EV Policy (NEMMP 2020)
    - Maharashtra EV Policy (2021)
5. Include comparisons and visual representations (charts, flowcharts).
6. Submit the final typed report.

IX. Observation Table

Policy	Year	Objective	Key Incentives

X. Result

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XI. Interpretation of Results

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XII. Conclusions and Recommendations

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XIII. Practical Related Questions (Note:- Teacher should provide various questions related to practical)

1. List the goals of the NEMMP 2020.
2. Explain the incentives offered by Maharashtra under its EV policy.
3. Analyse how the FAME scheme influences electric vehicle sales in India.

(Space for Answers)

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XIV. 📚 References / Suggestions for Further Reading

Sr.No.	Link	Description
1	https://niti.gov.in/sites/default/files/2023-02/EV_Handbook_Final_14Oct.pdf	Handbook on EV Charging Infra (NITI Aayog)
2	https://maitri.mahaonline.gov.in/PDF/EV%20Policy%20GR%202021.pdf	Maharashtra EV Policy 2021 (Govt. of Maharashtra)
3	https://heavyindustries.gov.in/sites/default/files/2023-07/NEMMP-2020.pdf	NEMMP 2020 Official Document

XV. Suggested Assessment Scheme

Performance Indicators		Weightage
Process Related (60%)		15 Marks
1	Handling of the components	10%
2	Identification of component	20%
3	Measuring value using suitable instrument	20%
4	Working in team	10%
Product Related (40%)		10 Marks
5	Calculate theoretical values of given component	10%
6	Interpretation of result	5%
7	Conclusions	5%
8	Practical related questions	15%
9	Submitting the journal in time	5%
	Total:	100%

Marks Obtained			**Dated Signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	