Internship Report on

Study of Electric Vehicle Technologies

An internship report submitted in partial fulfillment of the requirements of IV B. Tech II Semester of

Bachelor of Technology

in

Electrical and Electronics Engineering

By

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(Approved by AICTE, Affiliated to JNTUK, Kakinada) Accredited by NBA, NAAC A+

NH-16 Bypass, Vatluru (V), Eluru -534007, Eluru Dist., A.P.

2024-2025

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Department of Electrical and Electronics Engineering

CERTIFICATE

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External Examiner

ACKNOWLEDGEMENT

We would like to take this opportunity to extend our heartfelt gratitude to all those who have supported and guided me in various ways during my internship. It is both my pleasure and responsibility to acknowledge the invaluable help of these individuals.

We sincerely thank **Mr. R NaveenKumar Assistant Professor** in the **Department of Electrical and Electronics Engineering**, for his guidance and assistance in ensuring the successful completion of our internship.

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Finally, we extend our gratitude to everyone who has directly or indirectly contributed to the successful completion of our internship.

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Abstract

Electric vehicles (EVs) represent a transformative advancement in transportation, addressing the urgent need for sustainable and energy-efficient mobility. EVs are powered by electric motors and rely on energy stored in rechargeable batteries or alternative energy sources, such as fuel cells. By eliminating internal combustion engines, EVs significantly reduce greenhouse gas emissions, air pollution, and dependency on fossil fuels. Recent technological advancements have enhanced EV performance, extended driving ranges, and reduced charging times, making them increasingly practical and appealing to consumers.

This work explores the principles, components, and benefits of EVs, along with their challenges, including battery technology limitations, charging infrastructure development, and high initial costs. It also highlights the role of government incentives, renewable energy integration, and innovations like autonomous driving in shaping the future of EV adoption. As EVs continue to evolve, they hold the potential to revolutionize the automotive industry and contribute to global efforts to combat climate change.

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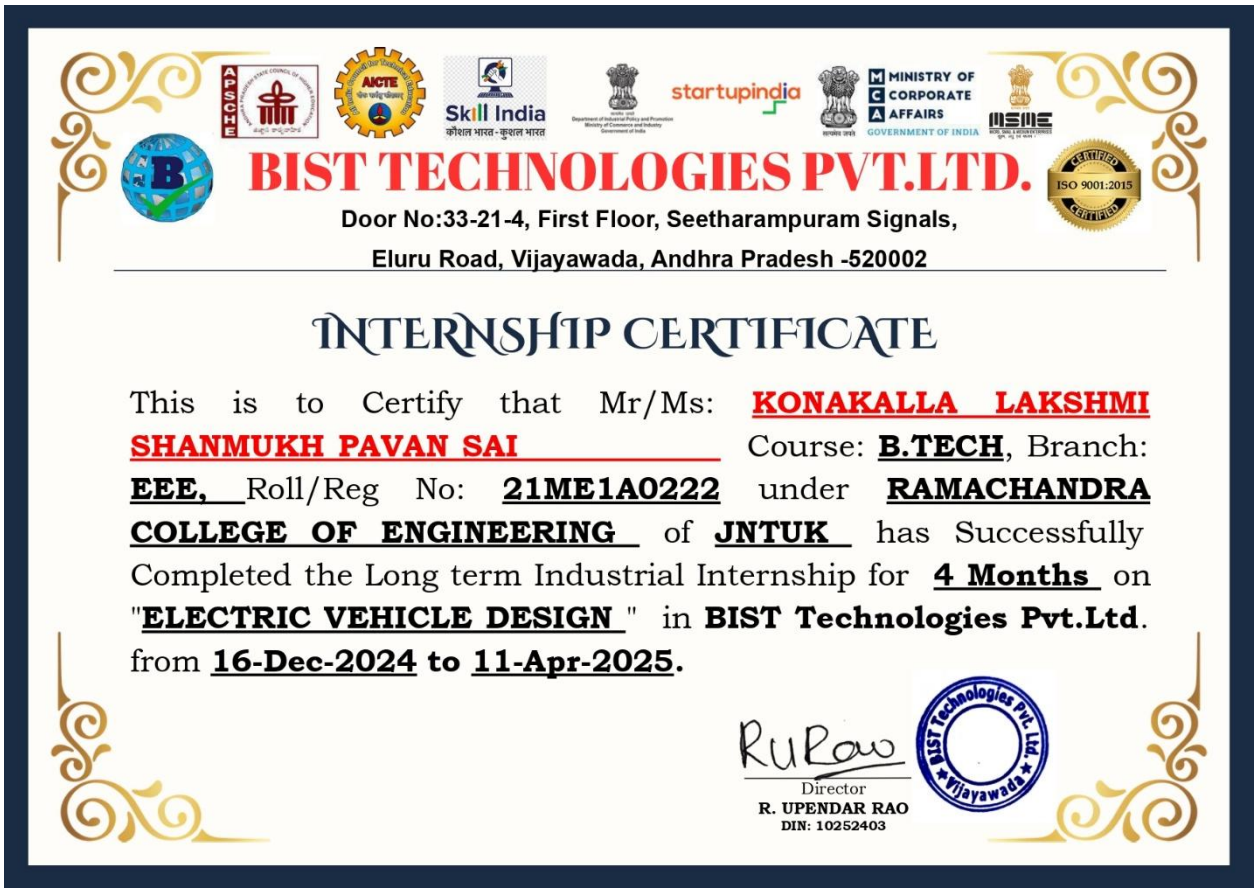

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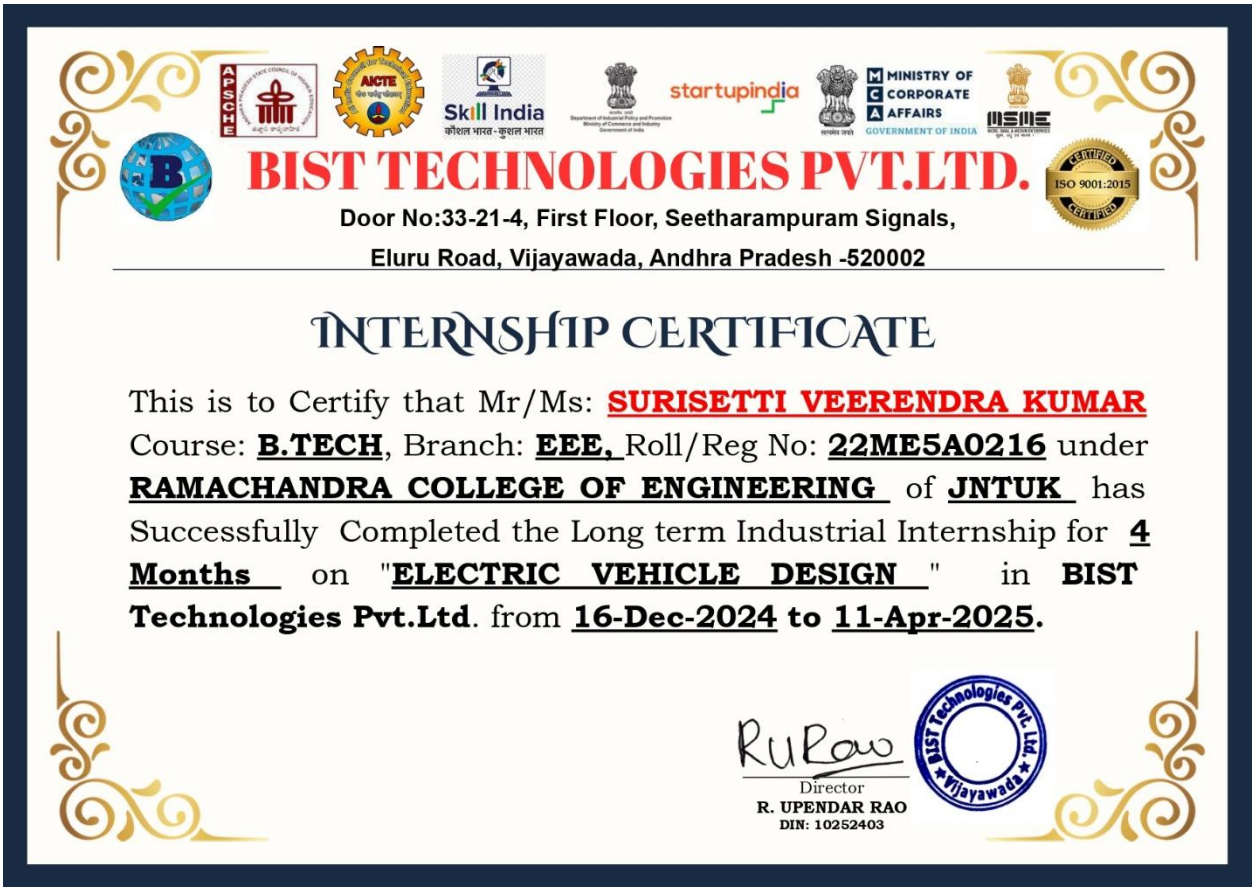

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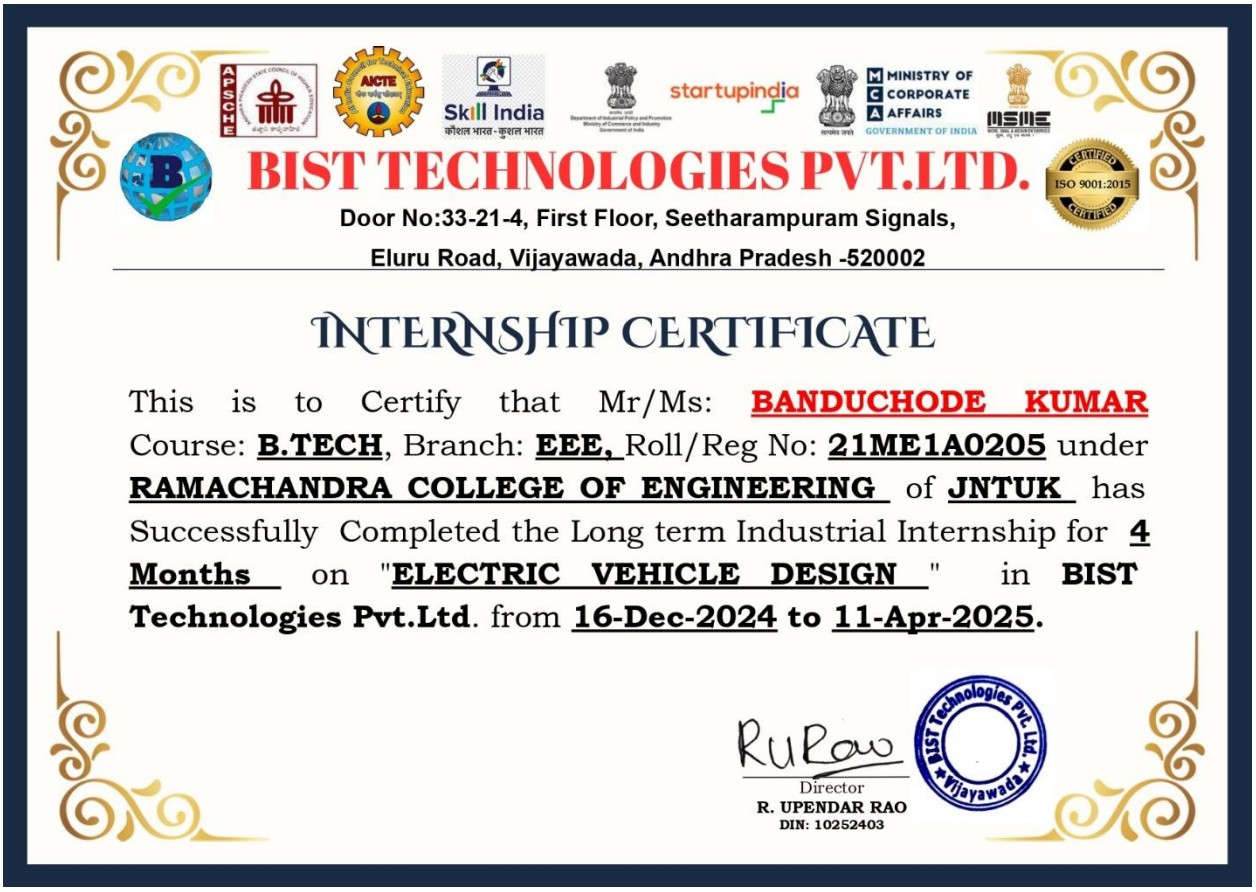

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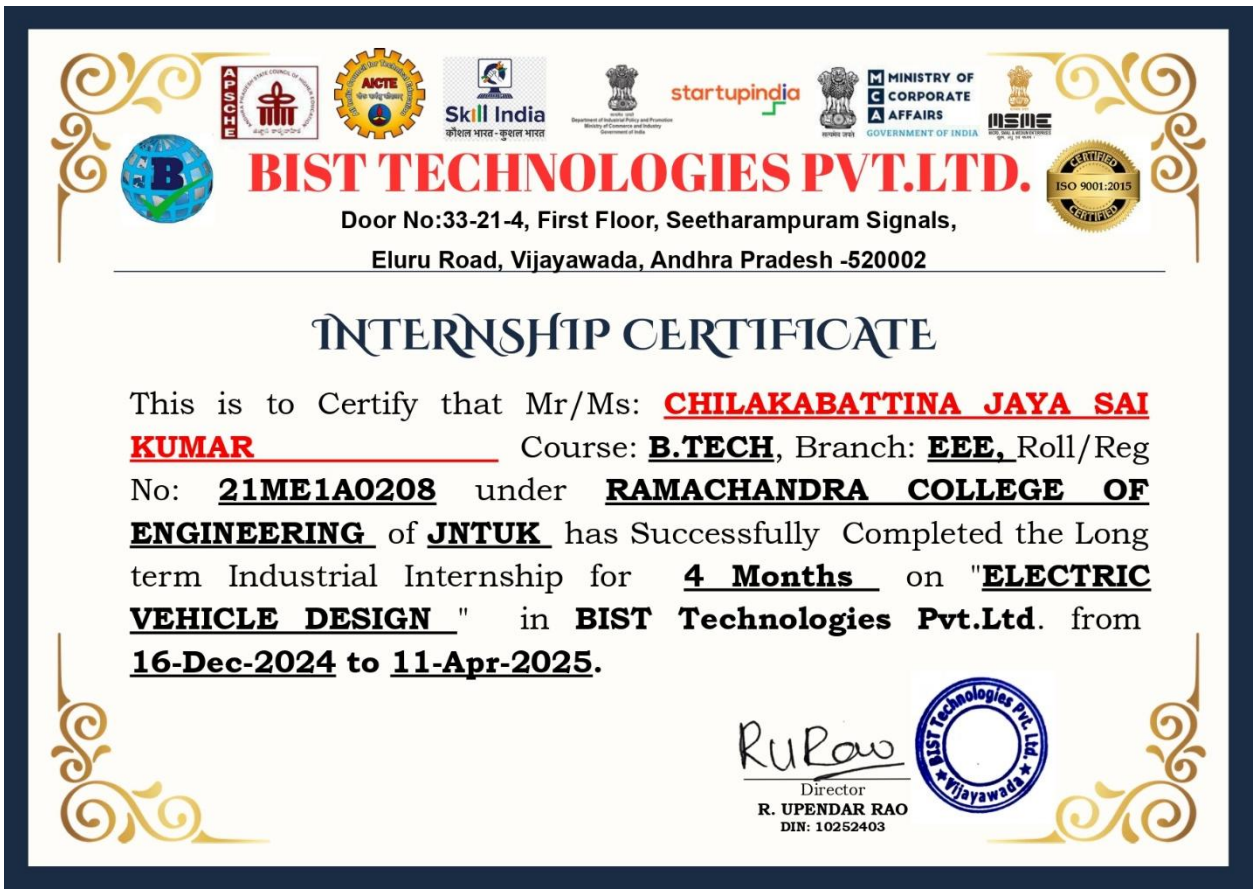

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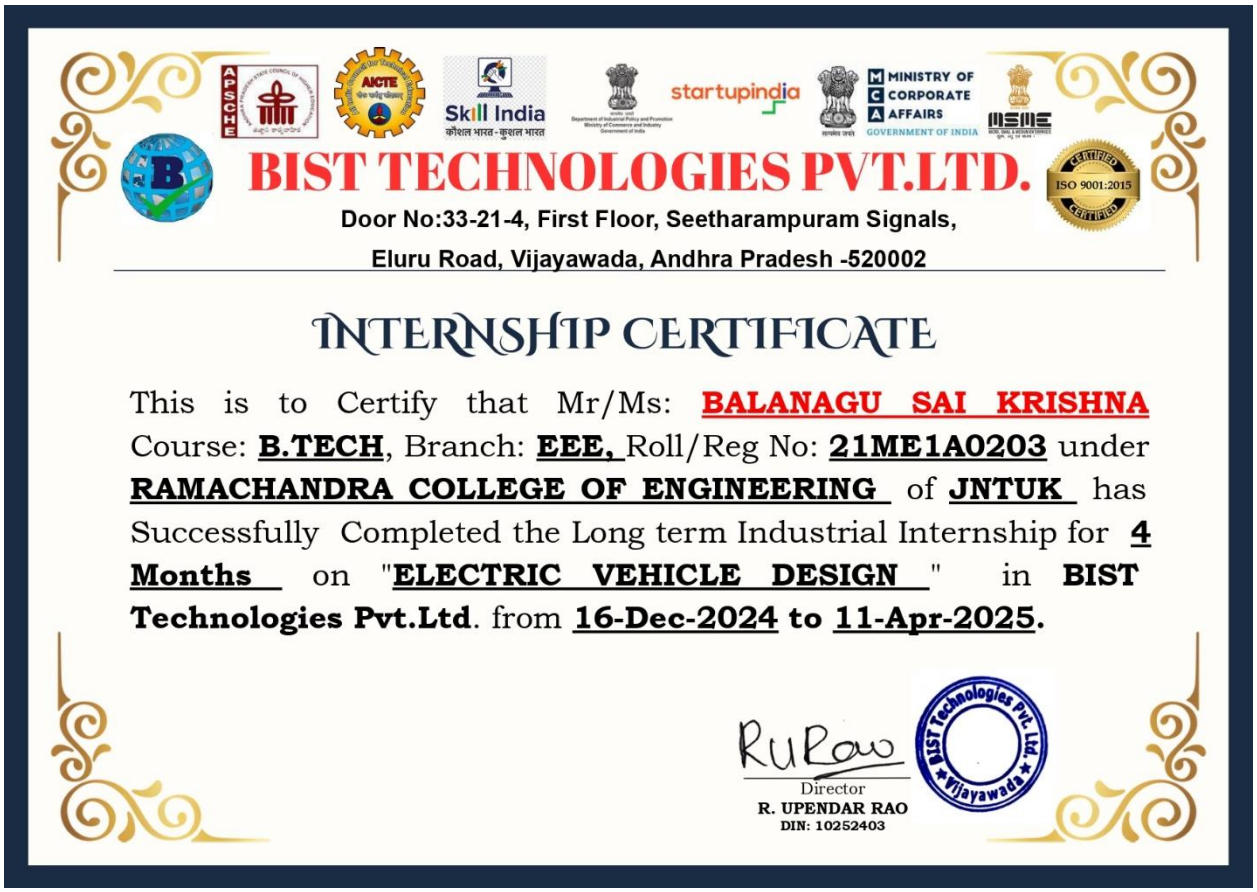

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Learning Objectives/Internship Objectives

- Internships are generally thought of to be reserved for college students looking to gain experience in a particular field. However, a wide array of people can benefit from Training Internships in order to receive real world experience and develop their skills.

- An objective for this position should emphasize the skills you already possess in the area and your interest in learning more.

- Internships are utilized in a number of different career fields, including architecture, engineering, healthcare, economics, advertising and many more.

- Some internship is used to allow individuals to perform scientific research while others are specifically designed to allow people to gain first-hand experience working.

- Utilizing internships is a great way to build your resume and develop skills that can be emphasized in your resume for future jobs. When you are applying for a Training Internship, make sure to highlight any special skills or talents that can make you stand apart from the rest of the applicants so that you have an improved chance of landing the position.

WEEKLY OVERVIEW OF INTERNSHIP ACTIVITIES

Week	Date	Day	Name of topic / Module completed
	16-12-2024	Monday	Introduction to EV technology
I	22-12-2024	Sunday	History of EV
II	23-12-2024	Monday	Benefits of EVs
III	29-12-2024	Sunday	Types of EVs
	30-12-2024	Monday	Quiz

Week	Date	Day	Name of topic / Module completed
	06-01-2025	Monday	Energy sources
	12-01-2025	Sunday	Types of super capacitors
IV	13-01-2025	Monday	Selection of batteries
V	19-01-2025	Sunday	Battery technical specifications
VI	20-01-2025	Monday	Components of an elector chemical cell
	26-01-2025	Sunday	Assignment
	27-01-2025	Monday	Quiz

Week	Date	Day	Name of topic / Module completed
	28-01-2025	Tuesday	Major components of EVs
VII	03-02-2025	Monday	How a car is made up of
	04-02-2025	Tuesday	Types of drive systems
VIII	10-02-2025	Monday	Tesla model S-AWD
	11-02-2025	Tuesday	Regenerative breaking
IX	17-02-2025	Monday	Assignment
	18-02-2025	Tuesday	Quiz

Week	Date	Day	Name of topic / Module completed
	19-02-2025	Wednesday	Selection of motors
X	25-02-2025	Tuesday	Characteristics of vehilcle
	26-02-2025	Wednesday	Capacity of the battery
XI	04-03-2025	Tuesday	Tractive effort
	05-03-2025	Wednesday	EV VISIT
XII	11-03-2025	Tuesday	Battery management system
	12-03-2025	Wednesday	Quiz

Week	Date	Day	Name of topic / Module completed
	14-03-2025	Friday	Various types of BMS
XIII	22-03-2025	Saturday	Why do batteries fail?
XIV	30-03-2025	Sunday	Different ports and their working
XV	05 -04-2025	Saturday	Presentation
	11-04-2025	Friday	Certification

Introduction to Electric Vehicles (EVs)

Electric vehicles (EVs) represent a transformative shift in the automotive and transportation industry, offering a cleaner and more sustainable alternative to traditional internal combustion engine (ICE) vehicles. EVs are powered by electricity stored in batteries, eliminating the need for fossil fuels and reducing greenhouse gas emissions**.**

Key Features of EVs:

1. Electric Powertrain: EVs rely on an electric motor for propulsion, which is powered by energy stored in a rechargeable battery.
2. Zero Tailpipe Emissions: Unlike conventional vehicles, EVs produce no tailpipe emissions, making them environmentally friendly.
3. Energy Efficiency: EVs are significantly more energy-efficient than ICE vehicles, converting a higher percentage of energy into motion.
4. Quiet Operation: The electric motor operates silently, reducing noise pollution.

Types of Electric Vehicles:

1. **Battery Electric Vehicles (BEVs):** Fully electric, relying solely on a battery to power the motor. Example: Tesla Model 3.
2. **Plug-in Hybrid Electric Vehicles (PHEVs):** Combine an electric motor with an ICE, allowing operation on electricity or gasoline. Example: Toyota Prius Prime.
3. **Hybrid Electric Vehicles (HEVs):** Use an ICE and an electric motor but do not plug in for charging. Example: Toyota Prius.
4. **Fuel Cell Electric Vehicles (FCEVs):** Use hydrogen fuel cells to generate electricity. Example: Toyota Mirai**.**

Benefits of Electric Vehicles:

1. **Environmental Sustainability:** EVs reduce dependence on fossil fuels and decrease air pollution.
2. **Lower Operating Costs:** Electricity is cheaper than gasoline, and EVs require less maintenance.
3. **Government Incentives:** Many governments offer tax credits, rebates, and other incentives to encourage EV adoption.

4. **Energy Security:** Reduces reliance on imported oil and promotes the use of renewable energy.

Challenges and Opportunities:

1. **Charging Infrastructure:** Expanding the network of charging stations is crucial for widespread adoption.
2. **Battery Technology:** Improvements in battery range, charging speed, and recyclability are ongoing.
3. **Cost:** While initial costs are higher, falling battery prices are making EVs more affordable.

The shift to electric vehicles is an essential step toward achieving a sustainable future, addressing global challenges such as climate change, air pollution, and energy resource depletion.

Battery Management System (BMS)

A **Battery Management System (BMS)** is an electronic system that monitors, manages, and controls the performance and safety of rechargeable batteries, particularly in applications like electric vehicles (EVs), renewable energy storage, and portable devices. It ensures the battery operates within safe and optimal conditions while maximizing its lifespan and efficiency.

Key Functions of a BMS:

1. **Monitoring:**
    - Tracks voltage, current, temperature, and state of charge (SoC).
    - Monitors the state of health (SoH) to assess battery degradation over time.
2. **Protection:**
    - Prevents overcharging, over-discharging, and overheating.
    - Detects short circuits or abnormal conditions and disconnects the battery if necessary.
3. **Balancing:**
    - Ensures all cells within a battery pack maintain the same voltage level to avoid imbalances, which can reduce performance or cause failures.
4. **Energy Management:**
    - Optimizes energy usage by adjusting charge and discharge rates.

- Provides data to external systems (e.g., a vehicle's powertrain control unit) to enhance overall system efficiency.

5. **Communication:**
    - Interfaces with external systems via protocols like CAN, UART, or I2C to relay battery status and diagnostics.
6. **Fault Detection:**
    - Identifies issues such as thermal runaway, aging, or cell failures, enabling preventive maintenance.

Applications:

- **Electric and Hybrid Vehicles**: Manages high-voltage battery packs for EVs and hybrids.
- **Renewable Energy Systems**: Controls energy storage in solar and wind applications.
- **Consumer Electronics**: Ensures safety and performance in devices like laptops and smartphones.
- **Industrial Equipment**: Supports energy storage in robotics and uninterruptible power supplies (UPS).

By ensuring safety, reliability, and efficiency, a BMS is a critical component in any system using rechargeable batteries.

EV Motors and Types

a. Based on Application

- **DC Motors**: For precise speed and torque control.
- **AC Motors**: For general-purpose applications.
    - Induction Motor: For constant-speed applications.
    - Synchronous Motor: For precise speed and high efficiency.
- **Servo Motors**: For precise motion and positioning.
- **Stepper Motors**: For discrete steps or angular positioning.

b. Voltage and Current

- Match the motor to the available power supply (AC/DC, voltage level, phase).

c. Mechanical Compatibility

- Frame size: Ensure the motor fits within the physical space.
- Shaft size: Match the coupling or load connection.
- Mounting type: Horizontal, vertical, or customized.

d. Efficiency and Energy Considerations

- Efficiency rating: Higher efficiency reduces energy costs (e.g., IE2, IE3).
- Power factor: Consider for high-power applications.

e. Evaluate Starting and Control Requirements

- Starting method: Direct-on-line (DOL), star-delta, or soft starter.
- Speed control: Fixed or variable-speed control (using VFD or controllers).

f. Manufacturer and Standards Compliance

- Choose motors from reputed manufacturers.
- Ensure compliance with standards (e.g., IEC, NEMA, ISO).

Example Case Study

If selecting a motor for a conveyor:

1. Determine load torque and speed (e.g., 100 Nm, 1500 RPM).
2. Check available power supply (e.g., 3-phase, 400V, 50 Hz).
3. Select an induction motor for general use.
4. Confirm size, mounting, and IP rating based on environmental factors.

Analysis of Design of EVs

1. **Types of Electric Vehicles**

- Battery Electric Vehicles (BEVs): Fully electric, powered solely by rechargeable batteries. Examples: Tesla Model 3, Nissan Leaf.
- Plug-in Hybrid Electric Vehicles (PHEVs): Combine an electric motor and an internal combustion engine, can be charged from an external power source. Examples: Toyota Prius Prime, BMW i3.
- Hybrid Electric Vehicles (HEVs): Powered by both a combustion engine and a battery that charges through regenerative braking, without plug-in capability. Examples: Toyota Prius.

2. **Advantages of EVs**

Environmental Benefits

- Reduced Emissions: EVs emit no tailpipe pollutants, significantly reducing greenhouse gas emissions, especially when powered by renewable energy.
- Lower Air Pollution: Improved air quality in urban areas due to the absence of exhaust fumes.

Economic Advantages

- Lower Operating Costs: Electricity is generally cheaper than gasoline, and EVs have fewer moving parts, reducing maintenance costs.
- Government Incentives: Subsidies, tax breaks, and rebates are offered in many countries to promote EV adoption.

Performance

- High Efficiency: Electric motors convert 85-90% of energy into motion, compared to 20-30% for internal combustion engines.
- Instant Torque: Provides quick acceleration and smooth driving experience.

3. **Challenges of EVs Cost**

- High Initial Purchase Price: EVs are often more expensive than traditional vehicles due to the cost of batteries.
- Battery Replacement Costs: Although rare, battery replacement can be expensive.

Infrastructure

- Charging Stations: Limited availability of charging networks in some regions poses a challenge.
- Charging Time: EVs take longer to charge compared to refueling a conventional vehicle.

Battery Technology

- Range Anxiety: Concerns about the limited range of EVs on a single charge.
- Environmental Concerns: Mining materials like lithium, cobalt, and nickel for batteries has environmental and ethical implications.

4. Market Trends

- Growth: EV adoption is accelerating, driven by advances in battery technology, decreasing costs, and stringent emission regulations.
- Global Leaders: Countries like Norway, China, and the U.S. lead in EV sales and infrastructure development.
- Innovation: Development of solid-state batteries, wireless charging, and improved energy density.

5. Future Prospects

Opportunities

- Renewable Integration: EVs can complement renewable energy sources by serving as energy storage systems.
- Autonomous Driving: EVs are well-suited for integration with autonomous driving technologies.
- Economic Growth: EV industries create new jobs in manufacturing, software development, and charging infrastructure.

Key Challenges

- Grid Impact: Increased EV adoption may strain electricity grids without proper upgrades.
- Policy Support: Continued government incentives and investments are crucial for widespread adoption.

Electric vehicles represent a transformative shift in the automotive industry. While they offer numerous environmental and economic benefits, challenges such as infrastructure development, cost reduction, and sustainable battery production need to be addressed. With ongoing advancements and policy support, EVs are poised to become a dominant mode of transportation in the near future.

Technology

Electric Vehicle (EV) technology is built on a combination of advanced hardware and software systems that enable the vehicle to operate efficiently, with minimal environmental impact. Below is a breakdown of the key technologies used in EVs:

1. Electric Powertrain

The electric powertrain is at the heart of every EV, and it differs significantly from traditional internal combustion engine (ICE) vehicles.

a. Electric Motor

- Types: Most EVs use either induction motors or permanent magnet synchronous motors (PMSM).
    - Induction Motors (e.g., used in Tesla Model S): No permanent magnets, relying on the electromagnetic field generated by alternating current.
    - Permanent Magnet Motors: More efficient and compact, but often use rare earth elements like neodymium.
- Function: Converts electrical energy from the battery into mechanical motion, providing propulsion. Electric motors are highly efficient, converting 85-90% of energy into movement.

b. Inverter

- Function: Converts the direct current (DC) from the battery into alternating current (AC) required by most electric motors. It also manages the flow of electricity to control motor speed and torque.

2. Battery Technology

The battery is one of the most crucial components of an EV, and advancements in battery technology directly impact performance, range, and cost.

a. **Lithium-Ion Batteries (Li-ion)**

Most Common: Lithium-ion is currently the most common battery chemistry used in EVs, known for its high energy density, long lifespan, and relatively low weight.

- Components: Made of lithium cobalt oxide ($LiCoO_2$) for the cathode and graphite for the anode, with an electrolyte to facilitate ion movement.
- Energy Density: Lithium-ion batteries can store large amounts of energy relative to their weight, allowing for longer driving ranges.

b. **Battery Management System (BMS)**

- Function: A crucial component that ensures the safe operation of the battery by monitoring parameters like temperature, voltage, and current to prevent overcharging or deep discharging.
- Thermal Management: Since batteries can heat up during operation, BMS also manages cooling systems to optimize performance.

3. Charging Systems

The charging infrastructure is essential for the widespread adoption of EVs. There are different methods of charging, which affect convenience and time taken to charge.

a. **Charging Modes**

- AC Charging (Level 1 & 2):
  - Level 1: Uses a standard 120V outlet, charging slowly (up to 5 miles of range per hour).
  - Level 2: Requires a 240V outlet, charging faster (up to 25 miles per hour of charging).
- DC Fast Charging (Level 3):
  - Uses direct current (DC) and is much faster than AC charging, enabling a full charge in 20-30 minutes, depending on the system and battery size.
  - Superchargers (Tesla) and CHAdeMO are common DC fast-charging standards.

b. **Wireless Charging**

- Inductive Charging: In development, wireless charging allows for charging without plugging in the vehicle by using electromagnetic fields to transfer energy from a pad to a receiver installed in the car.

4. **Regenerative Braking**

EVs are equipped with regenerative braking systems that recover kinetic energy during braking, which is typically lost in conventional vehicles. This energy is converted back into electrical energy and stored in the battery.

- Function: When the driver applies the brakes, the motor acts as a generator, slowing the vehicle down while simultaneously charging the battery.

5. **Vehicle Control Systems**

EVs rely on sophisticated software to manage vehicle functions and optimize performance.

a. **Electronic Control Unit (ECU)**

- Function: The ECU is the brain of the EV, managing power delivery, battery charging, thermal regulation, and regenerative braking, ensuring smooth and efficient operation.

b. **Energy Management System (EMS)**

- Function: Monitors the entire powertrain system, including the motor, battery, and inverter, to optimize energy consumption based on driving conditions and battery state of charge.

c. **Autonomous Driving**

- Integration with EVs: Many EVs, especially those from Tesla, are integrated with autonomous driving systems. These systems use a combination of sensors, cameras, radar, and machine learning to assist in or fully control driving tasks.

6. **Thermal Management Systems**

Managing the temperature of the EV's battery, motor, and other components is crucial for optimal performance and longevity.

- Battery Cooling: Liquid-cooled systems are common for maintaining battery temperatures within an optimal range.
- Motor Cooling: Electric motors are also cooled through air or liquid-cooling systems to maintain efficiency.

7. Vehicle-to-Grid (V2G) Technology

V2G technology allows an EV to discharge its stored energy back to the electrical grid, helping to balance load and even provide backup power during outages. This can enhance the stability of the grid, especially with higher penetration of renewable energy sources.

8. Sustainability and Recycling

As EV adoption increases, manufacturers are focusing on making the production and disposal of batteries more sustainable.

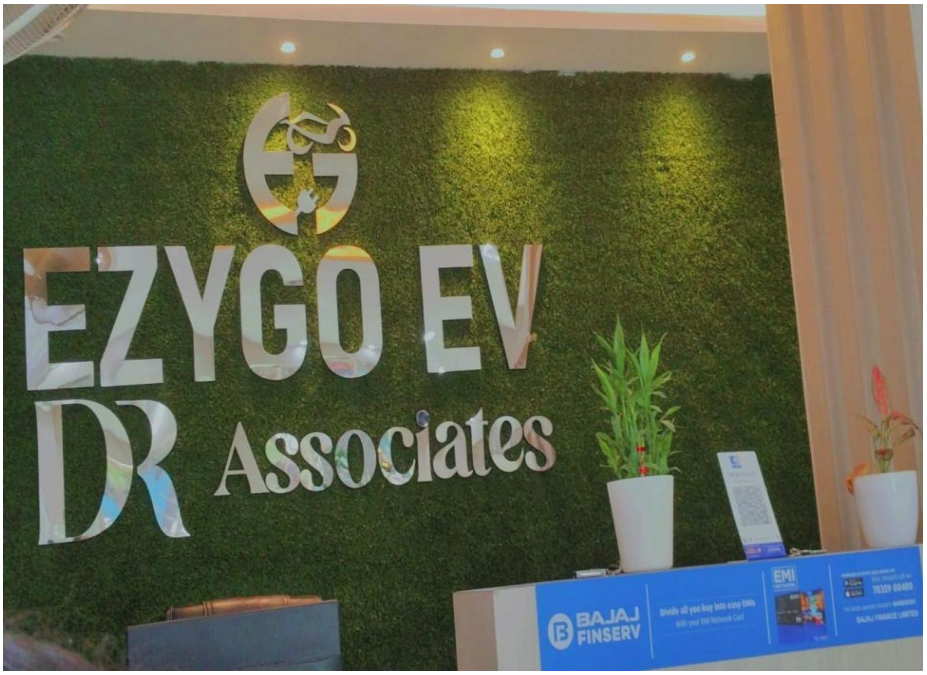
- Battery Recycling: New methods are being developed to recycle lithium-ion batteries, which can reduce the need for raw materials and minimize environmental impact.
- Sustainable Manufacturing: Many EV manufacturers are striving to use sustainable materials in production and lower carbon footprints during the manufacturing process.

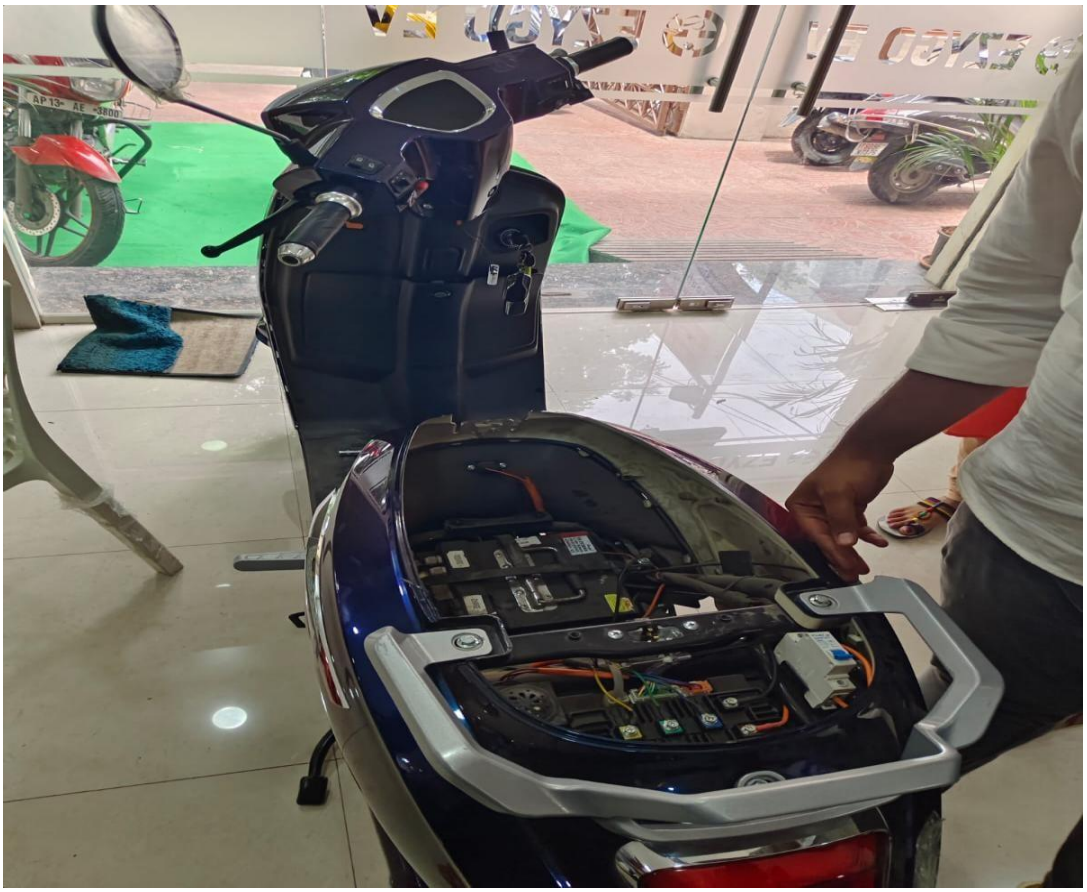
9. **Smart Features and Connectivity**

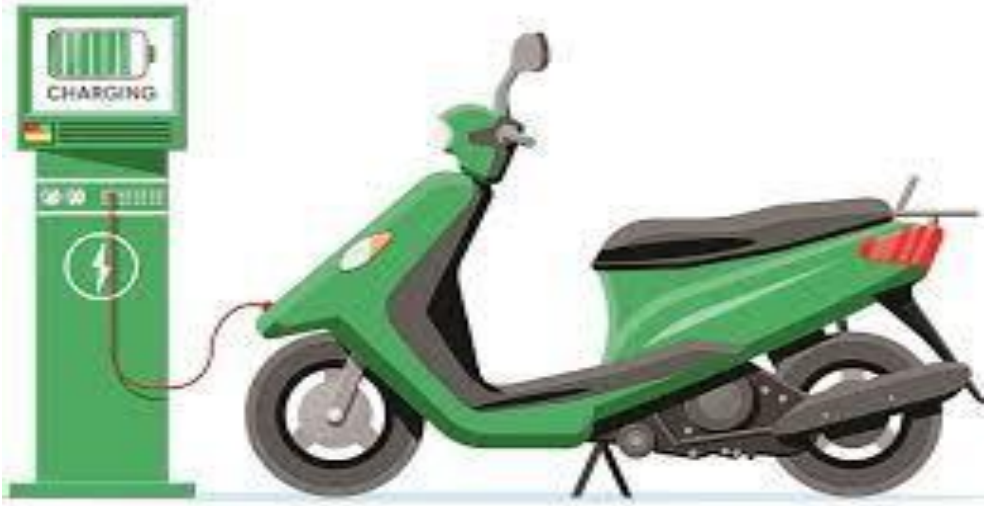
Modern EVs are equipped with advanced infotainment systems, over-the-air updates, and various connectivity features, allowing users to interact with the vehicle through smartphone apps, smart assistants, and cloud-based services.

- Range Optimization: Many EVs feature intelligent systems that predict the remaining range based on driving behavior, terrain, and weather conditions.
- Over-the-Air Updates: Manufacturers like Tesla deliver software updates remotely to improve performance, add new features, and fix bugs.

Glimpses of Visit






CHARGING

Conclusion

Electric vehicle (EV) design is rapidly evolving, driven by technological advancements, environmental concerns, and changing consumer demands. The conclusion on EV design can be summarized as follows:

1. Sustainability and Environmental Focus

- EVs are designed to minimize environmental impact, with a focus on reducing carbon emissions and promoting energy efficiency. This has led to innovations in battery technology, lightweight materials, and sustainable manufacturing processes.

2. Battery Technology and Range

- Battery design is central to EV performance. Improvements in energy density, charging speed, and lifespan are key goals. Solid-state batteries, advanced lithium-ion technologies, and recyclability are critical areas of focus.

3. Aerodynamics and Efficiency

- EV designs emphasize aerodynamics to maximize efficiency and extend range. Smooth, sleek shapes with minimal drag are standard, reflecting the balance between functionality and aesthetics.

4. User-Centric Design

- Modern EVs integrate cutting-edge technologies like smart infotainment systems, autonomous driving capabilities, and app-based connectivity. User comfort and experience are prioritized through spacious interiors and innovative features.

5. Scalability and Versatility

- Flexible platform designs allow manufacturers to produce multiple models (e.g., sedans, SUVs, trucks) using shared components. This scalability reduces costs and accelerates innovation.

6. Challenges and Opportunities

- EV design must address challenges such as charging infrastructure, cost reduction, and material sourcing. Advances in renewable energy integration and grid optimization offer significant opportunities for sustainable growth.