Dr. AMBEDKAR INSTITUTE OF TECHNOLOGY, BANGALORE – 560056

(An Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Skill Lab

on

"Electrical Vehicle Technologies & Application"

Third-Year Students (Batch: 2023)

(23rd Feb 2026 to 28th Feb 2026)

Conducted

by

Department of Electrical and Electronics Engineering

Coordinator(s):	HOP	HOS
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AY 2025-26

Brief Overview and Objectives for a Skill Lab Hands-on Training on 2-Wheeler and 4-Wheeler Electric Vehicle Technologies:

Brief Overview

The Skill Lab on **2-Wheeler and 4-Wheeler Electric Vehicle (EV) Technologies** is designed to provide practical exposure to the architecture, components, operation, and maintenance of electric vehicles. The training focuses on hands-on learning using real EV models, subsystems, and diagnostic tools.

Participants gain practical knowledge of key EV components such as battery packs, Battery Management Systems (BMS), motor controllers, power converters, regenerative braking systems, and charging infrastructure. The lab sessions emphasize safety practices, fault diagnosis, performance analysis, and system integration in both electric two-wheelers and four-wheelers.

The program bridges the gap between theoretical concepts and real-world applications, enabling learners to understand emerging EV technologies and industry standards.

Objectives

1. **To understand EV Architecture**
    - Study the working principles of electric 2-wheelers and 4-wheelers.
    - Compare internal combustion engine (ICE) vehicles with electric vehicles.
2. **To gain knowledge of EV Power train Components**
    - Identify and analyze components such as traction motor, controller, battery pack, inverter, DC-DC converter, and onboard charger.
    - Understand lithium-ion battery technology and BMS operation.
3. **To develop hands-on skills**
    - Perform assembly and disassembly of EV subsystems.
    - Conduct wiring, testing, and parameter measurement.
    - Use diagnostic tools for troubleshooting.
4. **To understand Charging Systems**
    - Study AC and DC charging methods.
    - Learn about charging stations and safety standards.
5. **To analyze Performance and Efficiency**
    - Measure speed, torque, state of charge (SoC), and energy consumption.
    - Evaluate regenerative braking operation.
6. **To ensure Safety Awareness**
    - Follow high-voltage safety procedures.
    - Understand thermal management and electrical protection systems.
7. **To enhance Industry Readiness**

- Develop technical competency aligned with current EV industry requirements.
- Prepare students for careers in EV manufacturing, service, and research.

Impacts of the Skill Lab "Electrical Vehicle Technologies and Its Application" (2-Wheeler and 4-Wheeler)

The Skill Lab on **Electrical Vehicle Technologies and Its Application** focusing on two-wheeler (2W) and four-wheeler (4W) systems has created significant academic, technical, and professional impacts on students.

1. Enhancement of Practical Knowledge

- Students gained hands-on experience with EV subsystems such as battery packs, Battery Management Systems (BMS), motor controllers, DC-DC converters, and regenerative braking systems.
- Practical exposure bridged the gap between theoretical concepts and real-world EV applications.
- Improved understanding of power electronics, electric drives, and energy storage systems.

2. Industry-Relevant Skill Development

- Training aligned with current EV industry requirements in India and globally.
- Students developed troubleshooting and diagnostic skills for electric two-wheelers and four-wheelers.
- Exposure to real-time testing equipment, safety procedures, and EV maintenance practices.

3. Improved Employability

- Enhanced job readiness in EV manufacturing, service centers, charging infrastructure companies, and renewable energy integration sectors.
- Students became competent in handling emerging technologies such as lithium-ion battery systems and motor drive control.
- Increased confidence for internships and placements in EV startups and established automobile companies.

4. Technical Competency in 2W and 4W Systems

- Understanding structural and performance differences between electric 2-wheelers and 4-wheelers.

- Knowledge of drivetrain configurations, power ratings, torque characteristics, and vehicle control strategies.
- Awareness of energy efficiency optimization techniques in different vehicle categories.

5. Awareness of Sustainable Transportation

- Developed understanding of carbon emission reduction and environmental benefits of EV adoption.
- Awareness of government policies and incentives promoting EVs.
- Encouraged innovation in clean and sustainable mobility solutions.

6. Research and Innovation Orientation

- Motivated students to undertake projects in EV design, battery modeling, charging systems, and hybrid energy integration.
- Strengthened interdisciplinary knowledge in electrical, electronics, and mechanical domains.
- Provided foundation for higher studies and research in electric mobility and smart transportation systems.

7. Safety and Standards Awareness

- Training on electrical safety, high-voltage handling, insulation testing, and protective equipment.
- Knowledge of EV safety standards and battery handling precautions.
- Reduced risk of accidents during maintenance and troubleshooting.

Overall Impact

The Skill Lab on "Electrical Vehicle Technologies and Its Application" has significantly improved students' technical proficiency, practical exposure, employability, and sustainability awareness. It prepares learners to actively contribute to the rapidly growing electric mobility sector and supports national initiatives toward green transportation and energy efficiency.

Suggestions for Improvement of the Skill Lab "Electrical Vehicle Technologies and Its Application" (2-Wheeler and 4-Wheeler)

To enhance the effectiveness, industry relevance, and learning outcomes of the Skill Lab on Electrical Vehicle Technologies, the following improvements are recommended:

1. Infrastructure Enhancement

- Establish a dedicated EV laboratory with separate sections for 2W and 4W systems.
- Procure advanced diagnostic tools, battery analyzers, insulation resistance testers, and CAN communication analyzers.
- Provide high-voltage safety training kits and insulated tools for safe handling practices.
- Install a functional EV charging station (AC and DC fast charger) for live demonstration.

2. Inclusion of Advanced EV Technologies

- Introduce training modules on:
  - Battery Management Systems (BMS) programming and monitoring.
  - Motor control strategies (BLDC, PMSM, and induction motor drives).
  - Regenerative braking systems.
  - Thermal management systems in EVs.
  - Vehicle Control Units (VCU) and CAN protocol communication.
- Add exposure to hybrid vehicle technology concepts.

3. Industry Collaboration and Guest Sessions

- Conduct workshops in collaboration with EV manufacturers and service providers.
- Invite industry experts for guest lectures and live demonstrations.
- Arrange industrial visits to EV manufacturing plants and service centers.
- Develop internship opportunities with EV startups and automobile industries.

4. Structured Hands-on Modules

- Develop step-by-step practical manuals for:
  - Battery pack assembly and testing.
  - Motor controller troubleshooting.
  - Fault diagnosis in 2W and 4W EV systems.
  - Performance analysis under different load conditions.
- Include real-time fault simulation exercises.

5. Integration of Simulation and Software Tools

- Introduce MATLAB/Simulink-based EV modeling.
- Provide exposure to EV system simulation tools.
- Include performance analysis and efficiency optimization exercises.

6. Safety and Standards Training

- Conduct dedicated sessions on:
  - High-voltage safety procedures.
  - Lithium-ion battery safety and disposal methods.
  - National and international EV standards.
- Include mandatory safety certification training for students.

7. Assessment and Outcome-Based Learning

- Implement competency-based assessment methods.
- Include mini-projects and prototype development as part of evaluation.
- Map skill lab outcomes with Program Outcomes (PO) and Program Specific Outcomes (PSO).
- Introduce student innovation challenges related to EV design and energy optimization.

8. Research and Innovation Encouragement

- Encourage students to undertake final-year projects in:
  - EV charging infrastructure.
  - Smart battery monitoring systems.
  - Renewable energy integrated EV charging.
- Establish an EV innovation cell or student club.
- Promote participation in national EV competitions and hackathons.

Conclusion

By enhancing infrastructure, strengthening industry interaction, integrating advanced technologies, and adopting outcome-based assessment, the Skill Lab on "Electrical Vehicle Technologies and Its Application" can become more industry-oriented, research-driven, and aligned with emerging trends in electric mobility.

Challenges of Conducting Skill Lab "Electrical Vehicle Technologies and Its Application" (2-Wheeler and 4-Wheeler)

Conducting a Skill Lab on Electrical Vehicle (EV) Technologies involving two-wheelers (2W) and four-wheelers (4W) presents several technical, infrastructural, financial, and operational challenges.

1. High Initial Investment

- Procurement of electric two-wheelers and four-wheelers for training involves substantial cost.

- Advanced equipment such as battery analyzers, motor drive test benches, CAN communication tools, and EV chargers require significant capital investment.
- Continuous technology upgrades increase financial burden on institutions.

2. Rapid Technological Advancement

- EV technologies evolve quickly, including developments in lithium-ion batteries, solid-state batteries, advanced motor drives, and smart control systems.
- Keeping laboratory equipment and curriculum updated with industry trends is challenging.
- Risk of equipment becoming outdated within a short time span.

3. Safety Concerns

- Handling high-voltage battery packs poses risks such as electric shock, short circuit, and thermal runaway.
- Improper handling of lithium-ion batteries may lead to fire hazards.
- Requirement of strict safety protocols, insulated tools, PPE, and trained supervision.

4. Lack of Trained Faculty

- EV technology is interdisciplinary, combining electrical, electronics, power electronics, control systems, and automotive engineering.
- Limited availability of faculty with hands-on experience in EV maintenance and diagnostics.
- Need for continuous faculty training and industry exposure.

5. Maintenance and Spare Parts Availability

- EV components such as BMS boards, controllers, and battery modules are expensive and sometimes difficult to procure.
- Delays in spare parts availability affect uninterrupted lab activities.
- Specialized service support may not be locally available.

6. Infrastructure Requirements

- Need for adequate electrical supply, proper earthing, and charging infrastructure.
- Space constraints for accommodating both 2W and 4W EV systems.
- Requirement for ventilation and fire safety systems in battery handling areas.

7. Student Safety and Skill Variation

- Students may have varied technical backgrounds, leading to differences in understanding complex EV systems.
- Risk of improper handling due to lack of prior exposure.
- Requirement of close supervision during practical sessions.

8. Curriculum and Assessment Challenges

- Difficulty in designing competency-based evaluation methods.
- Balancing theoretical understanding with practical skill development.
- Aligning skill lab outcomes with Program Outcomes (PO) and industry expectations.

9. Cost of Consumables and Battery Degradation

- Battery performance degrades over time due to repeated charge-discharge cycles.
- Replacement of battery modules increases recurring expenses.
- Consumables such as connectors, cables, and protective components add to operational cost.

Conclusion

While the Skill Lab on "Electrical Vehicle Technologies and Its Application" provides significant academic and industry benefits, it faces challenges related to cost, safety, technological updates, faculty expertise, and infrastructure. Addressing these challenges through strategic planning, industry collaboration, and continuous upgrading can ensure effective and sustainable skill development in EV technologies.

Description of the Practical Activities and Exercises Undertaken Skill Lab: "Electrical Vehicle Technologies and Its Application" (2-Wheeler and 4-Wheeler)

The following practical activities were conducted to provide hands-on training and real-time exposure to electric vehicle subsystems and applications.

Activity 1: Identification of EV Components (2W & 4W)

- Study and identification of major components such as battery pack, motor, motor controller, DC-DC converter, charger, BMS, and Vehicle Control Unit (VCU).

- Comparison between architecture of electric 2-wheeler and 4-wheeler systems.
- Understanding power flow in EV drivetrain.

Outcome: Students understood the structural layout and subsystem integration of EVs.

Activity 2: Battery Pack and BMS Analysis

- Examination of lithium-ion battery modules.
- Monitoring voltage, current, temperature, and State of Charge (SoC).
- Study of Battery Management System functions: cell balancing, protection, and fault detection.

Outcome: Students gained knowledge of battery safety, monitoring, and performance evaluation.

Activity 3: Motor and Controller Operation

- Study of BLDC/PMSM motor construction and working.
- Testing motor controller under no-load and load conditions.
- Measurement of speed, torque, and efficiency.

Outcome: Improved understanding of electric drive systems and speed control mechanisms.

Activity 4: Charging System and DC-DC Converter Testing

- Demonstration of on-board and off-board charging systems.
- Measurement of charging characteristics.
- Testing DC-DC converter for voltage regulation (high-voltage to 12V auxiliary system).

Outcome: Students understood EV charging infrastructure and auxiliary power management.

Activity 5: Regenerative Braking Demonstration

- Observation of regenerative braking operation.
- Analysis of energy recovery during deceleration.
- Measurement of voltage/current during regeneration.

Outcome: Awareness of energy efficiency improvement techniques in EVs.

Activity 6: Fault Diagnosis and Troubleshooting

- Simulation of common faults (battery imbalance, controller malfunction, loose connections).
- Use of diagnostic tools and multimeters.
- Interpretation of error codes via CAN interface (if available).

Outcome: Development of practical troubleshooting and maintenance skills.

Activity 7: Performance Analysis of 2W and 4W EV

- Testing under varying load and speed conditions.
- Comparison of power rating, torque characteristics, and efficiency.
- Calculation of energy consumption and range estimation.

Outcome: Analytical understanding of performance parameters in EV systems.

Activity 8: Safety Training and Handling Procedures

- Demonstration of high-voltage safety practices.
- Use of Personal Protective Equipment (PPE).
- Emergency response procedure for battery-related incidents.

Outcome: Students developed awareness of EV safety standards and risk prevention.

Overall Learning Outcome

Through these practical activities, students gained hands-on experience in EV component identification, battery analysis, motor control, charging systems, safety procedures, and fault diagnosis, enhancing their technical competence and industry readiness in electric vehicle technologies.

Details of Hands-on Activities Skill Lab: "Electrical Vehicle Technologies and Its Application" (2-Wheeler and 4-Wheeler)

The Skill Lab was designed to provide experiential learning through structured hands-on activities covering core subsystems of electric two-wheelers (2W) and four-wheelers (4W). The activities focused on component-level understanding, system integration, performance analysis, and safety practices.

1. EV System Architecture Study (2W & 4W)

Hands-on Work:

- Physical identification of battery pack, traction motor, motor controller, DC-DC converter, charger, BMS, and auxiliary systems.
- Study of power flow diagram and wiring layout.
- Comparative analysis of 2W and 4W drivetrain configuration.

Skills Developed:

- System-level understanding of EV architecture.
- Ability to interpret block diagrams and wiring schematics.

2. Battery Pack Assembly and Testing

Hands-on Work:

- Observation of lithium-ion battery module structure.
- Measurement of cell voltage, pack voltage, and current using digital multimeter.
- Monitoring State of Charge (SoC) and temperature parameters.
- Study of Battery Management System (BMS) functions.

Skills Developed:

- Battery health assessment.
- Safe handling and testing of high-energy battery systems.

3. Motor and Motor Controller Operation

Hands-on Work:

- Demonstration of BLDC/PMSM motor construction.
- Testing motor controller for speed control using throttle input.
- Measurement of speed using tachometer.
- Observation of torque characteristics under varying loads.

Skills Developed:

- Understanding of electric drive systems.
- Practical knowledge of speed-torque characteristics.

4. Charging System and Power Electronics Testing

Hands-on Work:

- Demonstration of on-board charger operation.
- Measurement of charging voltage and current.
- Study of AC-to-DC conversion and DC-DC auxiliary supply (HV to 12V).

- Observation of charging time and charging profile.

Skills Developed:

- Understanding EV charging mechanisms.
- Analysis of power electronic converters in EV applications.

5. Regenerative Braking Demonstration

Hands-on Work:

- Practical demonstration of regenerative braking mechanism.
- Measurement of voltage and current during deceleration.
- Observation of energy recovery process.

Skills Developed:

- Understanding energy recovery systems.
- Efficiency improvement concepts in EVs.

6. Fault Diagnosis and Troubleshooting

Hands-on Work:

- Identification of common faults (battery imbalance, loose wiring, controller issues).
- Use of diagnostic tools and multimeter.
- Basic CAN communication monitoring (if available).
- Interpretation of fault indications.

Skills Developed:

- Troubleshooting skills.
- Analytical thinking for real-time problem solving.

7. Performance Evaluation and Range Estimation

Hands-on Work:

- Testing EV under no-load and load conditions.
- Calculation of power consumption.
- Estimation of vehicle range based on battery capacity.
- Comparative performance study of 2W and 4W EV.

Skills Developed:

- Performance analysis capability.
- Energy efficiency evaluation.

8. Safety Procedures and Risk Management

Hands-on Work:

- Demonstration of high-voltage safety protocols.
- Use of insulated tools and Personal Protective Equipment (PPE).
- Emergency handling procedures for battery faults.

Skills Developed:

- Awareness of EV safety standards.
- Risk mitigation and safe lab practices.

Overall Skill Enhancement

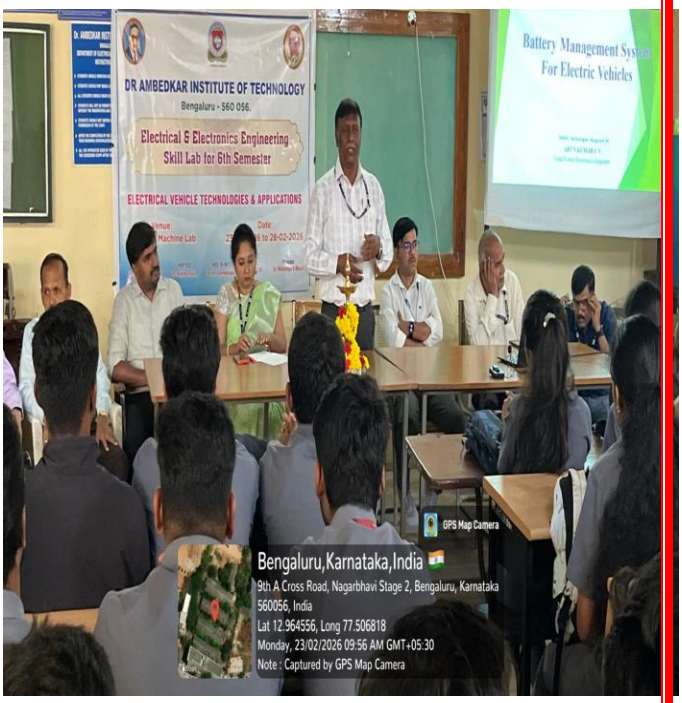
The hands-on activities enhanced students' competencies in:

- EV system integration
- Power electronics applications
- Electric drive systems
- Battery monitoring and safety
- Diagnostic and troubleshooting techniques
- Sustainable mobility technologies

The lab experience significantly improved practical exposure and industry readiness in the field of electric vehicle technologies.

Day 1, Skill lab Inauguration of the program.

HoS Inaugural address delivered.



HoP and HoS delivered his inaugural address

Involved in lightening the traditional lamp

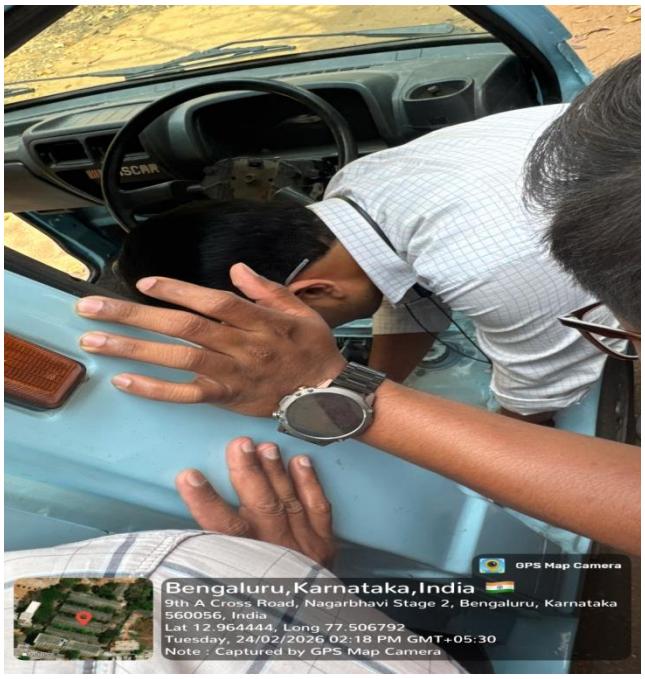
Students and Faculties to involved in lightening the traditional lamp

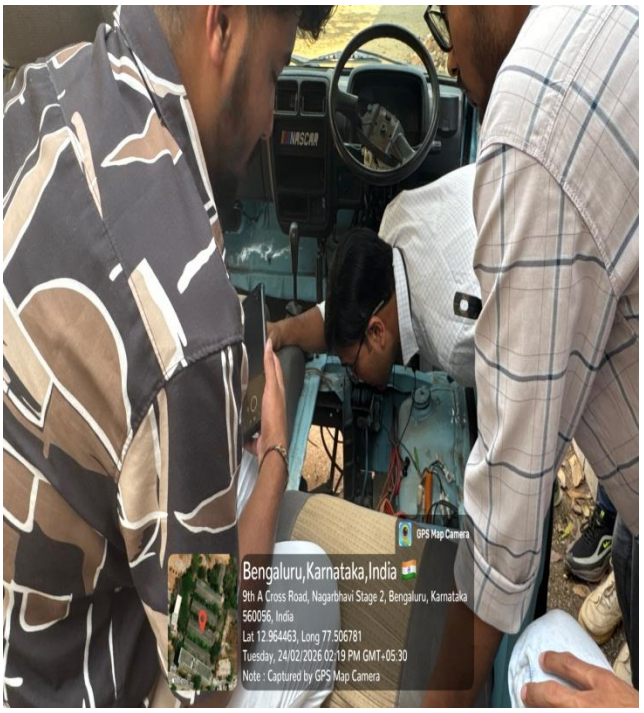
Invocation songs and lightning the deepa in training program

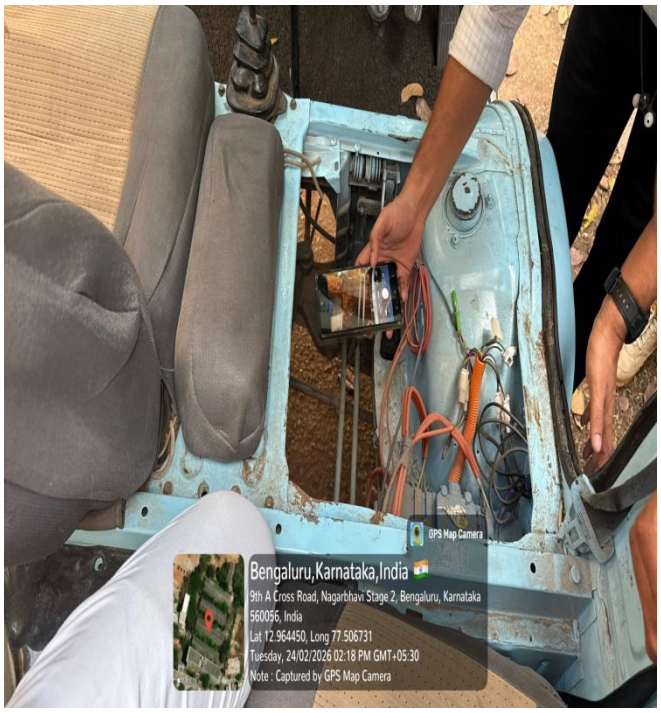
Coordinator Dr. Shankarlingappa CB vote of thanks

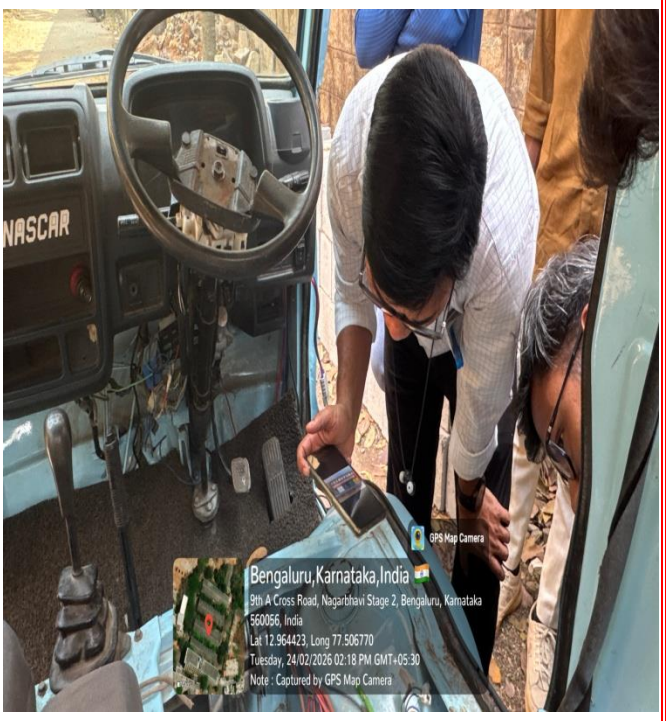
Training program from experts

4 wheel drive electrical vehicle demonstration







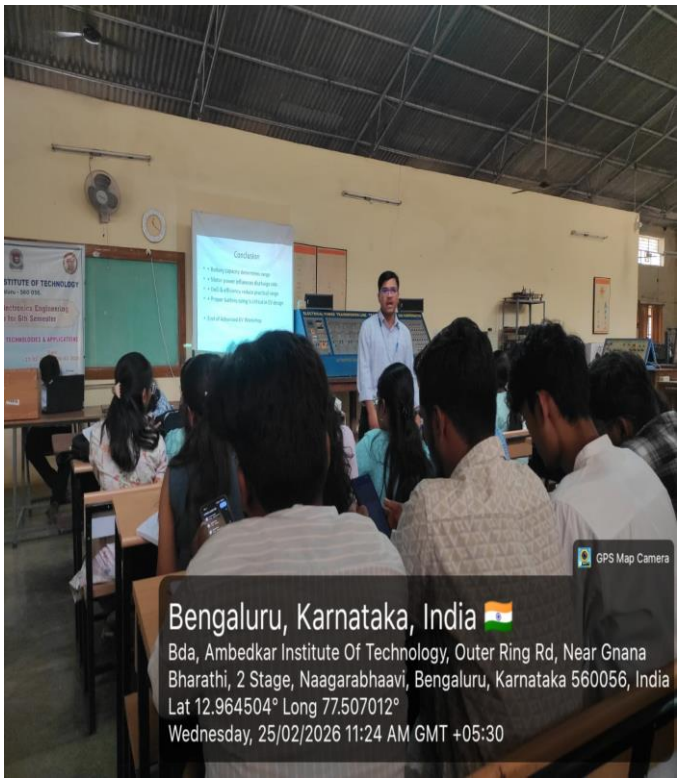


EV Training program from experts

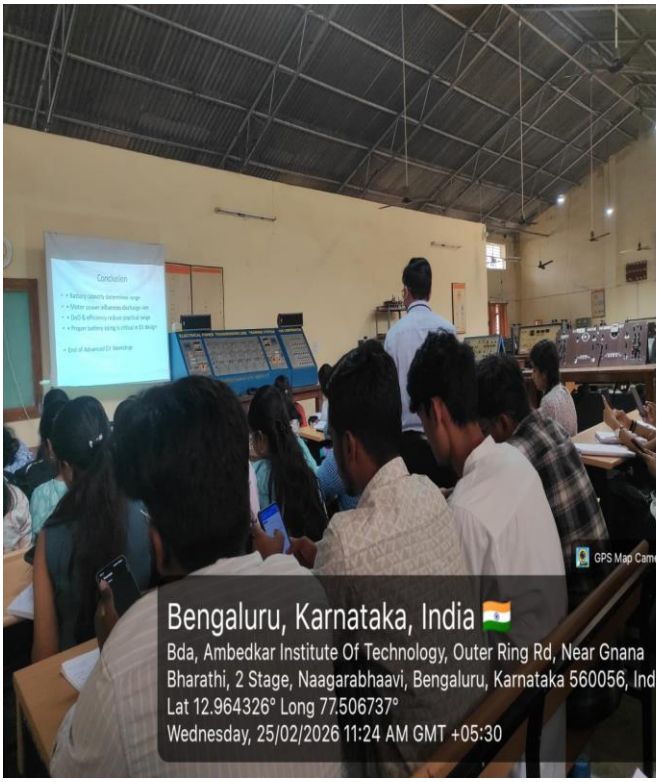
Students EV project activity

Hands-on activity

Students EV projects

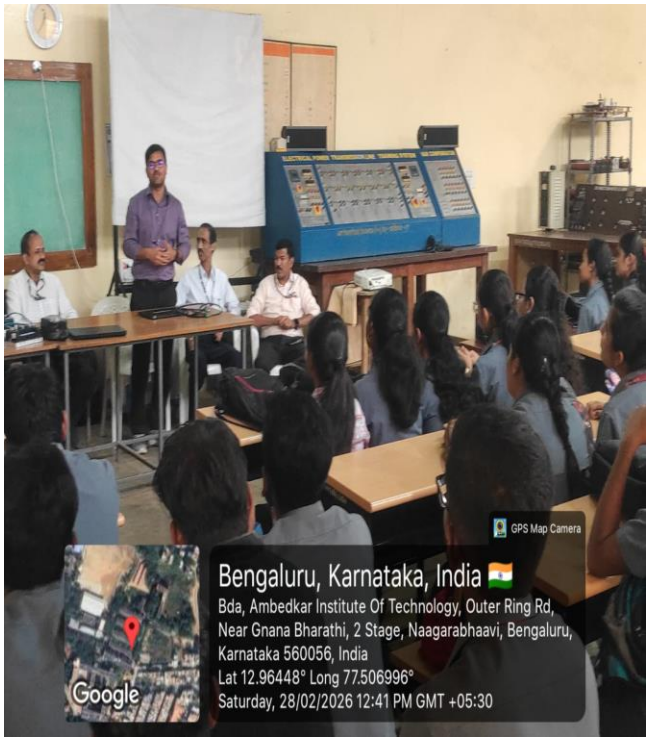


Experts speech of EV projects



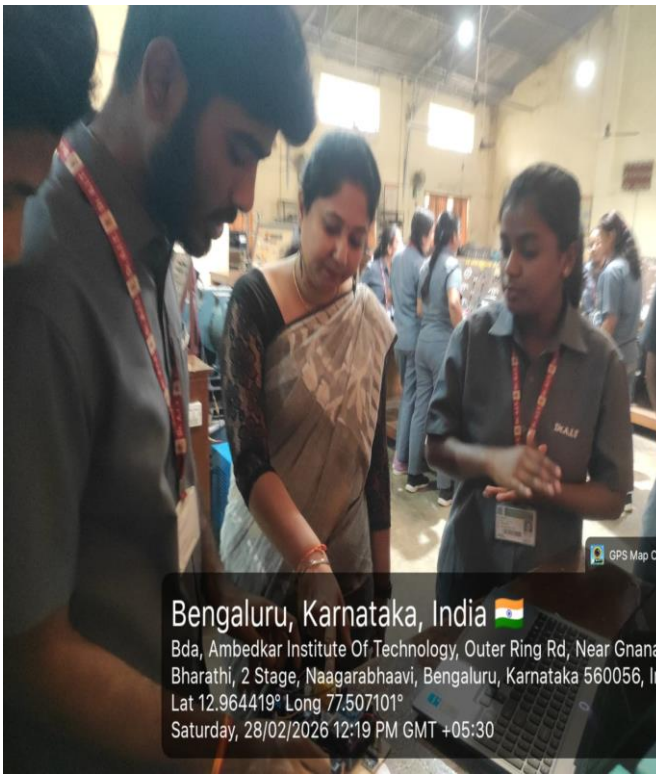
Student Group photo’s and skill lab valedictory function

Skill lab valedictory function



Skill lab valedictory function

EV project demonstration



EV project demonstration

EV project demonstration

Co-ordinator(s)	HoP EEE	HOS
Dr. Mukundaswamy MS	**Dr. Arpitharaju B**	**Dr. Govindaraju HV**
Dr, Shankarlingappa CB		