Problem Statement 1: AI-Powered EV Safety & Reliability

India's EV adoption is accelerating rapidly, with 1.7 million EVs sold in FY 2023–24 and a national target of 30% penetration by 2030. Yet, **safety and reliability remain major barriers**. EV batteries are prone to thermal runaway, fire hazards during fast charging, and water ingress under humid or flood-prone conditions. In addition, India's highly diverse climate (extreme heat, monsoon humidity, snow, and coastal salinity) stresses imported battery management systems (BMS) that were never optimized for such conditions.
At the same time, charging networks suffer from inconsistent standards and limited diagnostic capabilities, making it hard to build consumer confidence. Real-time monitoring and predictive analytics for EV safety can transform this challenge into an opportunity for India's green mobility transition.

Objective

Develop a data-driven backend system powered by AI/ML and Reinforcement Learning (RL) to predict EV battery safety risks, generate a Battery Health Index (BHI), and recommend optimal charging/discharging strategies. The system should not only detect anomalies but also learn policies that minimize long-term battery degradation and safety risks. Decent User Interface will be a plus!

Data to be Used

Participants can source according to the requirements:

1. **Battery Cycling Data:** Charge/discharge cycles with voltage, current, and temperature readings (e.g., NASA Battery Dataset, CALCE Dataset).
2. **Environmental Stress Data:** Synthetic or open datasets reflecting conditions like high heat, humidity, or cold-start stresses.
3. **Charging Pattern Data:** Logs simulating fast charging, partial charging, and irregular charging behavior.
4. **Fault Event Data:** Historical or synthetic datasets showing instances of thermal runaway, over-current, and short-circuit scenarios.
5. **Reward Function Design Data:** Students can design synthetic rewards (e.g., penalize overheating, reward stable SoC within safe ranges, penalize fast charging under high ambient temperature).
6. https://www.nrel.gov/transportation/battery-failure
7. https://data.nasa.gov/dataset/randomized-and-recommissioned-battery-dataset
8. https://data.nasa.gov/dataset/li-ion-battery-aging-datasets
9. https://data.mendeley.com/datasets/t42ynjk936/1

10. https://onedrive.live.com/?redeem=aHR0cHM6Ly8xZHJ2Lm1zL2YvcyFBbkU4QmZIZTNJT2xnMTN2Mmx0VjBlUDEtQWdQP2U9OW80emdM&id=A583DCDEF1053C71%21477&cid=A583DCDEF1053C71
11. https://data.nasa.gov/dataset/randomized-battery-usage-1-random-walk

What Participants Need to Do:

- Train an ML/DL model to predict risk of overheating, failure, or abnormal discharge patterns.
- Compute a **Battery Health Index (BHI)** in real time.
- Detects anomalies such as sudden voltage drops, abnormal charging times, or rapid temperature rise.
- Classify severity into *low, medium, high risk*.
- Implement a simple RL agent that **recommends charging actions** (e.g., fast charge, trickle charge, pause charging) based on state inputs like SoC, temperature, and ambient conditions.
- Define reward function for RL:
    - **+ve reward** for stable battery temp, safe SoC window, and minimal degradation etc.
    - **–ve reward** for overheating, deep discharge, or unsafe charge rate etc.
- Show how RL learns to avoid risky charging patterns.
- Backend should push alerts for high-risk anomalies.
- The advisory panel should display RL-driven safe charging recommendations (e.g., *'Switch to slow charging due to high temperature'*). In addition to analysis, the dashboard should also provide actionable insights on the dashboard.
- All project work, including version control and team collaboration, should be managed through a GitHub repository.

Expected Deliverables

1. **Battery Health Monitoring Model** (anomaly detection + BHI calculation).
2. **Reinforcement Learning Agent** (safe charging decision-making with defined reward function).
3. **Alert & Advisory System** (real-time alerts + charging recommendations).
4. Build a robust backend where all APIs are fully synchronized and integrated.
5. **Dashboard** (battery health, alerts, RL recommendations with actionable insights).
6. **Technical Report** (methodology, datasets, model design, reward function, validation results).
7. **Demonstration** (working prototype with simulated data stream).