Slide 1: Title Page
This slide introduces the presentation, titled "Secure Integration of Renewable Energy in DC Microgrid." It identifies the presenter as Nivas D. Navghare and the guide as Dr. Arti V. Tare from COEP Technological University, Pune (p. 1).

Slide 2: Presentation Overview
This slide repeats the presentation title and adds the objective of "Ensuring reliable and safe renewable power delivery" (p. 2).

Slide 3: Introduction
This slide provides an introduction to DC microgrids, covering their emergence, advantages, applications, and challenges (p. 3).

- **Emergence of DC Microgrids:** They integrate renewable sources like photovoltaic (PV), wind turbines, and Battery Energy Storage Systems (BESS) for efficient energy management (p. 3).
- **Advantages of DC Microgrids:** They reduce conversion losses, offer modularity, and improve overall energy efficiency (p. 3).
- **Applications of DC Microgrids:** They are used in various settings, including rural electrification, smart buildings, and data centers (p. 3).
- **Challenges in Deployment:** The challenges include a lack of standardization, protection issues, harmonic distortions, and cybersecurity risks (p. 3).

Slide 4: Literature Survey
This slide presents a table summarizing a literature survey of several research papers published between 2023 and 2025. The papers cover topics such as AI-based adaptive protection, cybersecurity vulnerabilities, real-world deployments, power quality, distributed generation integration, and stochastic optimization for microgrids (p. 4).

Slide 5: Research Gap
This slide identifies several research gaps in the field of DC microgrids, including:

- **Lack of a Unified Framework:** There is no universal protection and control framework for diverse DC microgrid systems (p. 5).
- **Limited AI and ML Application:** The use of artificial intelligence (AI) and machine learning (ML) for cyber-resilience is minimal and underdeveloped (p. 5).

- **Underdeveloped Adaptive Coordination:** Real-time adaptive relay coordination mechanisms require further advancement to enhance system reliability (p. 5).
- **Need for Integrated Approaches:** There is a need to integrate optimization and protection strategies to improve microgrid performance (p. 5).

Slide 6: Motivation/Necessity
This slide outlines the motivations and necessity for the research, which are driven by:

- **Renewable Integration Challenges:** The growth of renewable energy requires secure and reliable integration with power systems that are specifically tailored to DC characteristics (p. 6).
- **Adaptive Fault Protection:** Traditional protection methods are insufficient for DC systems, necessitating adaptive and AI-driven strategies (p. 6).
- **Cybersecurity Concerns:** The digitalization of microgrids introduces cybersecurity risks that need to be mitigated for system resilience (p. 6).
- **Need for Standardization:** A lack of uniform interoperability standards complicates integration, highlighting the need for comprehensive frameworks (p. 6).

Slide 7: Problem Statement
This slide summarizes the main problems addressed by the research:

- **Lack of Standardization:** The absence of universal standards for DC microgrids impacts interoperability and safety (p. 7).
- **Inadequate Protection and Cybersecurity:** Existing protection mechanisms and cybersecurity measures are insufficient to secure DC microgrids against threats (p. 7).
- **Intermittency and Stability Issues:** The intermittent nature of renewable energy sources causes reliability and stability challenges for DC microgrids (p. 7).
- **Control System Limitations:** Current control systems are not adaptable enough to handle disturbances and dynamic changes in the grid environment (p. 7).

Slide 8: Research Objectives
This slide lists the research objectives:

- **Analyze Security and Stability:** The research aims to identify security and stability challenges in DC microgrids to improve reliability (p. 8).
- **AI-Enabled Protection Framework:** The goal is to develop a secure, AI-based framework to protect DC microgrid operations effectively (p. 8).
- **Optimized Distributed Generation:** The research seeks to enhance system resilience by optimizing the integration of distributed generation sources (p. 8).
- **Simulation-Based Validation:** The performance of the proposed solutions will be validated using simulation testing methodologies (p. 8).

Slide 9: Methodology/Theme
This slide outlines the research methodology:

- **Microgrid Modeling:** A microgrid model integrating PV, wind, energy storage systems, and loads will be created using MATLAB/Simulink for simulations (p. 9).
- **AI and ML Applications:** AI and ML techniques will be used for fault detection, anomaly prediction, and adaptive relay coordination (p. 9).
- **Performance Validation:** System performance will be validated using metrics like THD (Total Harmonic Distortion), SAIFI (System Average Interruption Frequency Index), and SAIDI (System Average Interruption Duration Index) through detailed simulation studies (p. 9).

Slide 10: Expected Outcomes
This slide lists the expected outcomes of the research:

- **AI-Based Adaptive Control:** The development of AI-driven adaptive protection and control systems will enhance the efficiency of DC microgrids (p. 10).
- **Improved Power Quality:** The system is expected to improve power quality and resilience, ensuring stable and reliable DC microgrid operation (p. 10).
- **Enhanced Cybersecurity:** The research aims to produce enhanced cybersecurity measures to protect microgrid infrastructure from digital threats (p. 10).
- **Global Standardization Support:** The research is intended to contribute to global standardization, which would promote the widespread adoption of DC microgrid technologies (p. 10).

Slide 11: Action Plan Timeline
This slide shows a Gantt chart outlining the timeline for the project from July 2025 to July 2026. The activities include a literature survey, research gaps, algorithm selection, simulation execution, simulation analysis, results and analysis, dissertation writing, and dissertation submission (p. 11).

Slide 12: References
This slide lists the academic references and publications that were used as a foundation for the presentation (p. 12).

Slide 13: Thank you
This is the concluding slide, with a "Thank you" message (p. 13).