Master Final Year Project Proposal

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Field: Electrical Engineering

Title: **Performance Enhancement of Automatic Voltage Regulators in Engine-Generator Sets for Microgrids**

Abstract:

This project aims to design and implement an Automatic Voltage Regulator (AVR) specifically tailored for engine generator sets operating within a smart micro-grid environment. As micro-grids increasingly integrate renewable energy sources and advanced control systems, maintaining voltage stability becomes critical, especially when engine generator sets are employed as backup or primary power sources. The proposed AVR will be designed to ensure consistent voltage regulation in the face of variable load conditions and intermittent renewable energy input.

The project will involve the development of a robust AVR system that can dynamically adjust the excitation of the generator to maintain voltage stability. This will include the design of both hardware and software components, with a focus on ensuring compatibility with smart micro-grid infrastructures. Key considerations will include response time, reliability, and the ability to interface with other micro-grid control systems.

Simulation and practical testing will be conducted to validate the performance of the AVR under various operating conditions, including load variations, grid-connected, and islanded modes. The outcome of this project is expected to contribute to the enhancement of voltage control strategies in smart micro-grids, providing a reliable solution for integrating engine generator sets into modern energy systems.

Index Terms: Microgrids, engine-generator sets, Automatic Voltage Regulator (AVR), and Droop Control technique.

1. Introduction and Background

In microgrids, the reliability and efficiency of power generation are critical, especially in systems that incorporate renewable energy sources and distributed generation. Engine-generator sets (gensets), commonly used as backup or primary power sources in microgrids, depend on Automatic Voltage Regulators (AVRs) to maintain consistent voltage levels despite load variations. However, traditional AVRs often struggle in dynamic environments, particularly when integrated with renewable energy sources, leading to challenges in voltage stability and power quality.

As microgrids play an increasingly vital role in integrating renewable energy and providing reliable power in isolated or off-grid locations, the performance of AVRs in gensets becomes even more crucial. The dynamic nature of microgrids, characterized by varying loads and intermittent renewable inputs, can result in suboptimal voltage regulation, reduced efficiency, and increased wear on generator components.

This project aims to address these challenges by developing and implementing advanced control strategies to enhance the performance of AVRs in engine-generator sets specifically designed for microgrid applications. By improving the AVR's adaptability and response to the dynamic conditions of microgrids, this research seeks to contribute to more stable and efficient microgrid operations, ensuring reliable power generation under varying conditions.

2. Objectives of this Master FYP research proposal

- To study the limitations of conventional AVRs used in engine-generator sets within microgrids.
- To design and implement advanced control algorithms that enhance the dynamic response and stability of AVRs.
- To evaluate the performance of the enhanced AVR system through simulation and experimental testing.

3. Methodology:

- Literature Review:Conduct a comprehensive review of current AVR technologies, their applications in microgrids, and existing challenges.
- System Modeling: Develop mathematical and simulation models of the engine-generator set and AVR within a microgrid environment using tools like MATLAB/Simulink.
- Algorithm Design: Design advanced control algorithms (e.g., PID controllers, adaptive control, fuzzy logic) tailored to enhance AVR performance.
- Simulation and Testing: Simulate the enhanced AVR in various operational scenarios to assess improvements in voltage regulation and stability.
- Experimental Validation: Implement the proposed solution on a physical testbed to validate simulation results and refine the algorithm based on real-world data.

- Performance Analysis: Evaluate the effectiveness of the enhanced AVR system in maintaining voltage stability and improving microgrid performance.

4. Expected Benefits:

- **Understanding of the limitations of Existing AVR:** A detailed understanding of the limitations of traditional AVR systems in microgrid applications.
- **Enhanced AVR Performance:** A novel control algorithm or set of algorithms that significantly enhance the performance of AVRs in dynamic environments.
- Increased Reliability and Longevity: Reduction in the wear and tear on generator components due to more effective voltage control, potentially extending the lifespan of these systems.
- Scalable Solutions: Development of control strategies that can be adapted to various types of engine-generator sets and microgrid configurations, making them broadly applicable.

5. Timeline

The research is expected to be completed over a period of one year, with the following timetable:

Month	Task to be performed
Months 1-2	Literature review and problem definition,
Months 3-4	System modeling and initial algorithm design,
Months 5-6	Simulation of the enhanced AVR system and analysis of results,
Months 7-8	Experimental validation and refinement of the control algorithm,
Month 9	Final performance analysis and documentation of findings,
Month 10	Thesis writing and preparation for the final presentation.

6. Research Plan

- **Monthly Meetings:** A half monthly meeting (either face-to-face or virtual) will be held to present research progress and facilitate discussions.
- **Progress Reports:** A detailed progress report will be submitted every two months.

- **Final Thesis and Presentation:** The candidate will be expected to write final thesis and present his/her project.

7. Bibliography

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