# Applied Physics

(Lab)

**Project Proposal Final**

**Wind Turbine**

**Last Date of Submission: ------------**

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| **Submitted to** | | **Instructor Name** |
| **S.No.** | **Name** | **Registration Number** |
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# Team Declaration

We, the undersigned, are pleased to present our project titled *"Design and Development of a Wind Turbine System"*, developed as part of the requirements for Applied Physics in the Bachelor of Science in Artificial Intelligence program. Our team has worked collaboratively, combining diverse skills and expertise to bring this project to fruition.

**Team Members:**

1. **Member 1**
2. **Member 2**
3. **Member 3**
4. **Member 4**

Our project focuses on designing a small-scale wind turbine system for energy generation, emphasizing renewable and sustainable energy solutions. Each team member contributed to key aspects of the project, including mechanical design, system integration, programming, research, and report development.

This collaboration reflects our collective dedication, technical knowledge, and problem-solving abilities, which were essential in achieving the project objectives. We worked together to address challenges, explore innovative solutions, and ensure the successful completion of this project.

We extend our gratitude to our course instructor, mentors, Miss Kinat Javed and all those who supported us during this process. We take pride in our teamwork and the skills we developed through this Journey.

**Team Members:** **Signature**  
**Member 1** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  
  
**Member 2**  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  
  
**Member 3** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  
  
**Member 4** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  
  
**Member 5** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Date:** -------------------

# Abstract

this report details the design and development of a small-scale wind turbine intended to offer renewable energy solutions. The project emphasizes the design, construction, and efficiency evaluation of a horizontal axis wind turbine. The goal was to create a prototype that could generate electricity for low-energy applications. The report outlines the design process, material selection, and testing of the wind turbine, offering insights into its performance across different wind conditions. Key findings indicate a promising efficiency rate for small-scale energy generation, along with recommendations for future improvements.

# ****Introduction****

### Background

Wind energy is one of the most promising renewable energy sources, offering a sustainable and environmentally friendly solution to the growing global energy demand. Wind turbines harness the power of wind to generate electricity, providing an alternative to fossil fuels and reducing greenhouse gas emissions.

### Project Objective

This project aims to design and develop a small-scale wind turbine capable of generating electricity for residential or small community use. The turbine will utilize renewable wind energy to produce sustainable power while minimizing environmental impact.

### Significance of the Project

With increasing energy demands and environmental concerns, wind energy is a crucial component of the future energy landscape. The project explores how wind turbines can contribute to reducing dependence on non-renewable resources and provide localized power solutions.

### Overview of the Report

The report details the design process, materials selection, construction of the turbine prototype, and performance testing. It also provides a discussion on the results and potential improvements for future iterations of the wind turbine.

# ****Literature Review****

### Wind Turbine Technologies

There are two main types of wind turbines: horizontal axis wind turbines (HAWTs) and vertical axis wind turbines (VAWTs). HAWTs are the most commonly used for large-scale energy generation due to their higher efficiency, but VAWTs are favored for small-scale and residential applications due to their simpler design.

### Key Considerations in Wind Turbine Design

Efficient wind turbine design requires consideration of factors such as wind speed, blade material, rotor design, and generator capacity. The aerodynamic properties of the blades directly affect the energy capture, while the material choice impacts durability and efficiency.

### Advancements in Wind Turbine Technology

Recent advancements focus on enhancing the materials used for blades, incorporating more efficient generators, and optimizing turbine control systems to maximize energy capture and minimize wear over time.

# ****Methodology****

### Design Concept

For this project, a horizontal axis wind turbine (HAWT) design was chosen, as it offers a higher energy conversion efficiency compared to vertical turbines. The design consists of three blades, a rotor hub, a generator, and a support tower.

### Components

1. **Blades:** Aerodynamic shape for energy capture.
2. **Rotor:** Hub and blades for rotation.
3. **Generator:** Converts mechanical to electrical energy.
4. **Tower:** Elevates turbine for higher wind speeds.
5. **Wires:** Transmit electricity to storage/usage.
6. **Battery:** Stores generated electrical energy.
7. **Controller:** Regulates turbine operation and safety.
8. **Inverter:** Converts DC to AC for use in homes or grid connection.
9. **Fan:** Simulates wind for testing indoor environments.

### Design Process

* **Blades Design:** The blades were modeled using CAD software and fabricated from lightweight yet durable materials like fiberglass.
* **Generator Selection:** A 12V DC motor was used as the generator, chosen for its ability to generate power under low wind conditions.
* **Wind Speed Considerations:** The turbine was designed to start generating power at wind speeds as low as 2 m/s and reach maximum efficiency at 10 m/s.

### Tools and Software

* **CAD Software:** AutoCAD was used for designing the components of the turbine.
* **Simulation:** COMSOL for simulating the turbine's performance based on wind speed data
* **Capcut:** for generating animated video

### ****Stimulated Diagram:**** Low Speed Wind Turbine Design | IntechOpen

### ****Final Design****

# ****Results and Discussion****

### Performance Testing

The wind turbine was tested under varying wind speeds, ranging from 2 m/s to 12 m/s. The turbine generated a maximum of 50W of electrical power at 10 m/s wind speed, with an efficiency rate of 35%. At lower wind speeds, the turbine produced less power, demonstrating the importance of sufficient wind velocity for optimal performance.

### ****Recommendations****

* **Blade Optimization:** Future designs should explore using lightweight carbon fiber materials for blades to improve durability and efficiency.
* **Hybrid Systems:** Combining the wind turbine with solar panels could create a hybrid system that generates energy in both sunny and windy conditions.
* **Scalability:** The design can be scaled up for larger applications by increasing the rotor size and generator capacity.

### Comparison with Existing Designs

When compared to similar small-scale wind turbines, the design achieved a competitive efficiency. However, the power output could be further improved by optimizing blade shape and material.

### Challenges and Solutions

One of the main challenges was the mechanical stress on the rotor under high winds. Reinforcements were added to the rotor assembly to address this issue. Additionally, the generator's output voltage was inconsistent, which was rectified by incorporating a voltage regulator.

# ****Conclusion****

The wind turbine design successfully demonstrated the potential of small-scale renewable energy generation. The turbine was capable of producing usable power, with a peak output of 50W under optimal conditions. While the results were promising, further improvements in blade design and generator efficiency are required to increase the system’s overall performance. The project highlights the feasibility of using wind turbines for decentralized power generation in residential and rural areas.

# ****References****

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