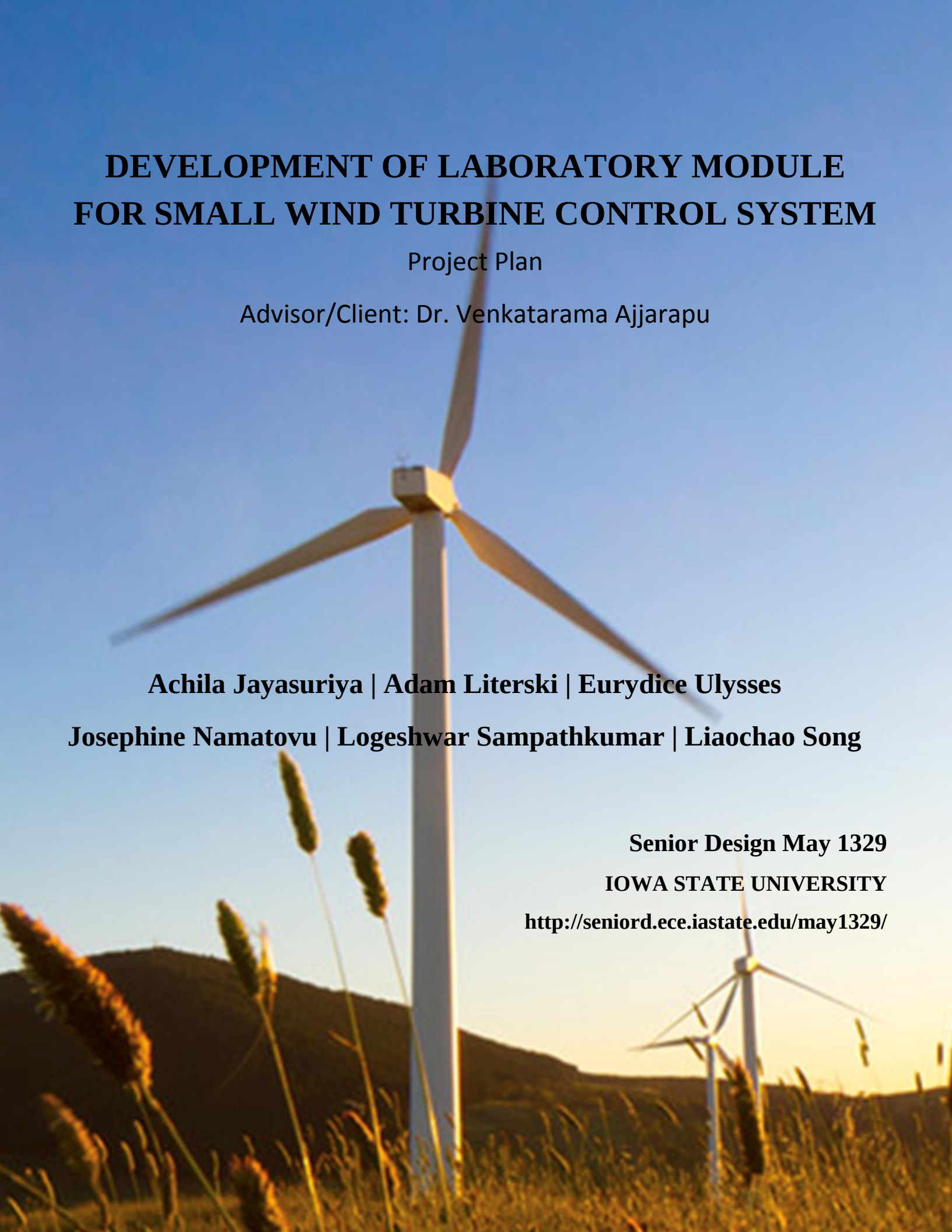


DEVELOPMENT OF LABORATORY MODULE FOR SMALL WIND TURBINE CONTROL SYSTEM

Project Plan

Advisor/Client: Dr. Venkatarama Ajjarapu

Achila Jayasuriya | Adam Literski | Eurydice Ulysses

Josephine Namatovu | Logeshwar Sampathkumar | Liaochao Song

Senior Design May 1329

IOWA STATE UNIVERSITY

http://seniord.ece.iastate.edu/may1329/

PROBLEM STATEMENT

Wind is one of the clean sources of renewable energy used in the United States. Most wind energy comes from turbines that can be as tall as 130 - 400 feet, and have three 200-foot-long blades.

Our objective is to develop a laboratory module for a small wind turbine system that will resemble a small scale renewable electric system. This will be a learning module for students interested in familiarizing themselves with wind power generation. In order to accomplish this, we will take wind measurements and simulations to get a power output at a given system.

CUSTOMER NEEDS

- The system should accurately simulate wind conditions implemented in MATLAB to the turbine, which is coupled to a motor
- Voltage, current, power, and speed of all components should be easily monitored used in the system
- Presence of a suitable control system so that load first utilizes the power produced by the wind and, use the battery as a backup power supply
- There should be a graphical user interface (GUI) for the control system in LabView for easier visual communication

SYSTEM DESCRIPTION

This project acts as an educational tool for students learning about the effects of wind energy on a power system. The objective of the project is to take wind measurements and simulate the power output to the system. Being Phase V of the project, our goal is to improve the existing system and build upon or alter Phase IV according to the required specifications.

Sub-Group 1: Hardware Testing

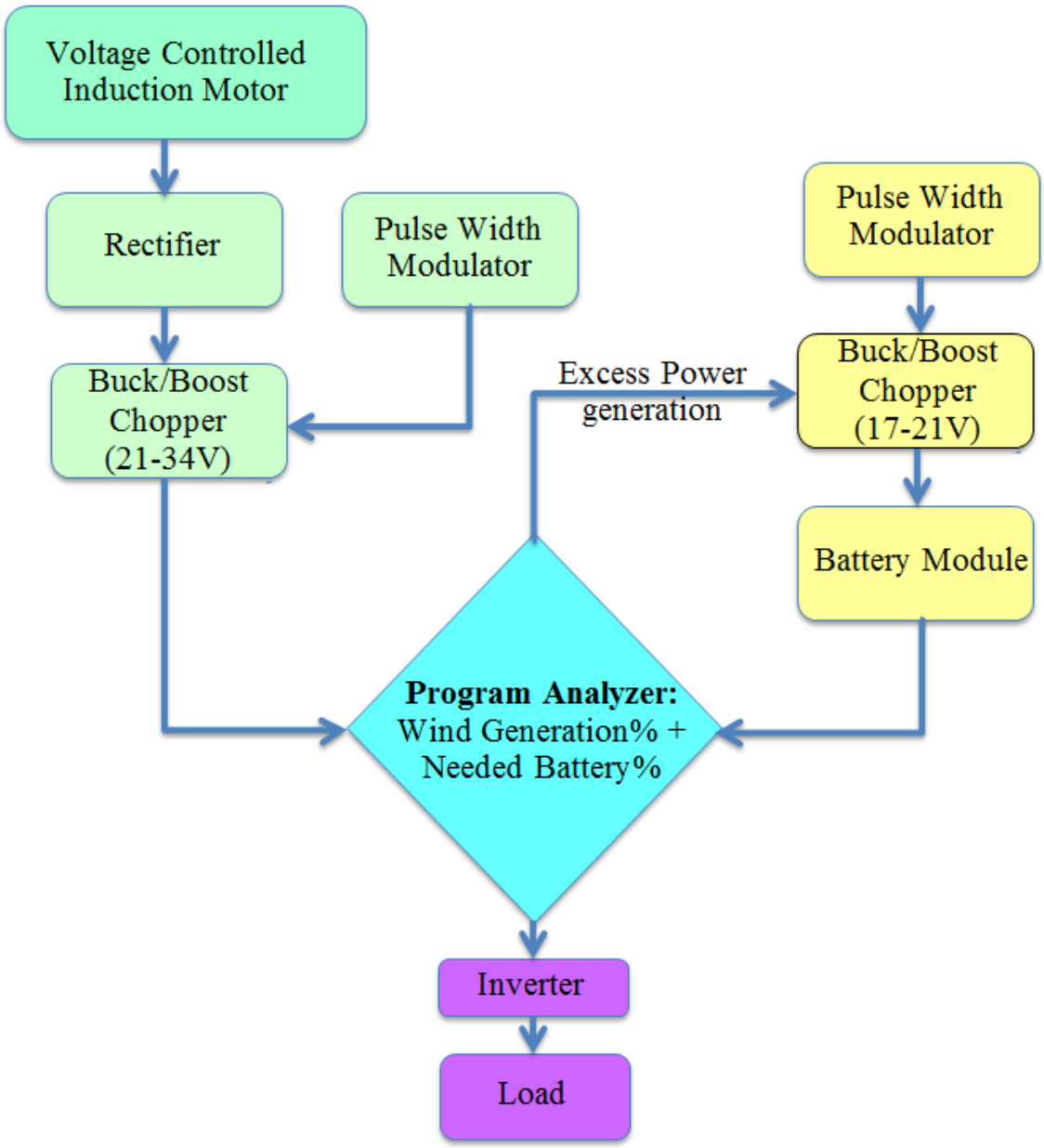
- Rearranging Phase IV circuitry and rebuilding upon hardware wiring to match schematic while maintaining secure connections.
- Soldering rectifier and buck-boost components of the circuits, and rewiring the induction generator into working condition.
- Mounting modules inside the buck-boost converter, PWM, and current transformer in order to restrict wobbling and to maintain safe conditions.
- Worked with Mr. Harker to set up the variable voltage source to the induction motor.

Sub-Group 2: Software Simulation

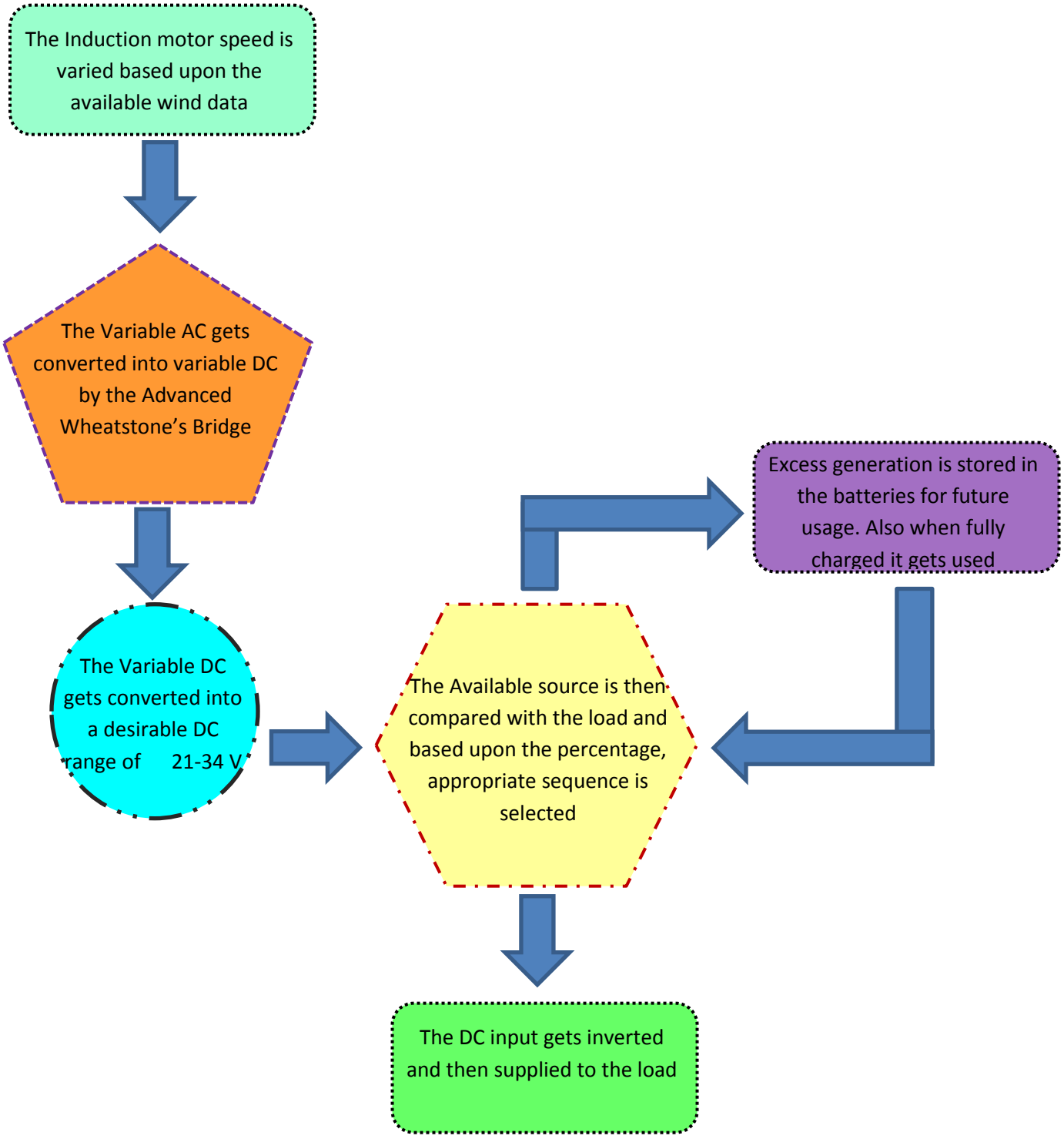
- Implementing NI Multisim and MATLAB PLECS in order to design and simulate the rectifier, regulator, PWM, and buck-boost components of the circuit.
- Listing all datasheets for parts and components required for the design of the circuitry, and collaborating with Hardware Team with regards to parts that need to be purchased.
- Collaborating with Hardware Team regarding voltage, current, power, and frequency input and output requirements for the overall system.

- Calculating parameter values for circuit components and ensuring they contribute to the above requirements as per the Hardware Team's recommendations.

CONCEPT SKETCH



SYSTEM BLOCK DIAGRAM



ASSIGNED RESPONSIBILITIES

☑ **Hardware Group:**

Adam Literski – Breakdown of system requirements/adjust project desires/analyze minimum components
Achila Jayasuriya – Test old components and functionality. In addition repair broken components.
Logeshwar Sampathkumar – Optimize wiring and read schematic wiring diagrams for correct wiring diagram setup.

☑ **Software Group:**

Liaochao Song – Research given phase (4) programs and merging new changes with old.
Eurydice Ulysses – Redesign and test Pulse Width Module/Buck-Boost converter
Josephine Namatovu – Redesign and test rectifier

DELIVERABLES

Our expected end product will provide a multilayered system that will allow variation input determined on gathered wind data which will control our induction motor. Depending on motor output will determine what level of the circuit will be engaged and what wont. Our client/advisor requested that we get of one chamber from our senior design group.

Case 1: Power output over exceeds demand

This option will engage the main system of the rectifier, pulse width module, and buck/boost converter from the induction power. The main supply will transition to the inverter that will then power our load. In addition from that there will be another side system with pulse width module and buck/boost converter charging the battery with the additional power. Once fully charged it will dissipate the excess power.

Case 2: Power output meets demand

This option will engage the main system of the rectifier, pulse width module, and buck/boost converter from the induction power. The main supply will transition to the inverter that will then power our load. There will be no charging of the battery in this case.

Case 3: Power output less then demand

This option will engage the main system of the rectifier, pulse width module, and buck/boost converter from the induction power. The main supply will transition to the inverter that will then power a portion of load. The remaining power will be made up from our battery portion of our system until its depleted voltage.

Required Design & Technical Documents

- ✓ Project Plan Document
- ✓ Project Design Document

OPERATING ENVIRONMENT

When simulating the system, everything will be done in a controlled lab environment where the induction motor will be mounted to a table. The original design of the wind turbine was going to be placed on a building in the university, however due to safety reasons that got changed. Therefore, the project is centrally located in our power systems lab. Since our AC induction motor is in replace of our wind turbine, we will manually record our readings at set values relating to our wind sensor. The wind senor will accurately record real wind conditions so we can simulate the system to see

PRECAUTIONS

- Follow the laboratory rules and regulations, and read the laboratory safety manual
- Read the manuals for the equipment in the lab
- At least two people should be in the laboratory at all times when working on the project
- All team members should sign in whenever using the laboratory
- Take note of the standards required for this project i.e. the IEEE standards

FUNCTIONAL REQUIREMENTS

Motor

Motor is to simulate outdoor wind speed with 1.5 Horsepower; Motor has maximum frequency 60 Hz and maximum voltage 230V. The full load amps is 4.08 A and full load rpm is 3570 rpm.

Turbine

Turbine will generate 24V DC output; Turbine generator will have a 400W peak output; the turbine will supply the battery bank when the batteries are below 24V; Input DC voltage is between 21 and 34 volts.

Wind vane and anemometer to transmit outdoor wind profiles

NON - FUNCTIONAL REQUIREMENTS

All work i.e. calculations, simulations, and schematics should be documented

Through project designing, we need enough patience and a lot of time to solve the problem that we had.

FUNDING

Funding	Amount
Client – Dr. Venkatramana Ajjarapu	$500.00
Total	$500.00

CONTACT INFORMATION

FACULTY ADVISOR & CLIENT	Email
Dr. Venkataramana Ajjarapu	vajjarap@iastate.edu
TEAM MEMBERS	
Adam Literski (Team Lead)	literski@iastate.edu
Achila Jayasuriya (Hardware Lead)	achila@iastate.edu
Eurydice Ulysses (Communication Liason)	eulysses@iastate.edu
Josephine Namatovu (Project Lead)	josephin@iastate.edu
Logeshwar Sampathkumar (Web Master)	sklogesh@iastate.edu
Liaochao Song (Software Lead)	lsong@iastate.edu

TIMELINE – CLICK HERE