Division of Academic Affairs
Technology Fee – Project Proposal
2014

Project Proposal Type

Instructional Technology Enhancement Project (ITEP)

Project Title

Upgrading Power System Laboratory at PNS/REEF Campuses

Total Amount of Funding Requested

$57,656.00

Primary Project Coordinator

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Instructional Technology Enhancement Project Proposal

Proposal Title: Upgrading Power System Laboratory at PNS/REEF Campuses
Investigator: Dr. Bhuvana Ramachandran (PI)
Department: Department of Electrical and Computer Engineering

Project Summary

Power System Laboratory was set up at both PNS and REEF campuses primarily to cater to the needs of electrical power industries located in the gulf coast. Utilities such as Gulf Power are actively recruiting next generation of power engineers due to recent developments taking place in areas such as renewable energy integration into the grid and technological innovations in power transmission, distribution and protection via Smart Grids. To address this need for modern power system engineers and to better equip our undergraduate engineers towards graduate curriculum, it is essential to upgrade the existing power system laboratory at UWF. Hence this project proposal requests funding for upgrading the power system laboratories at PNS and REEF campuses. Proposed additions to the existing power system laboratory are 8 quantities of motor drives, 8 quantities of current transformers and 8 quantities of potential transformers. This equipment will be used in conjunction with the equipment that was gifted to UWF by Gulf Power. The new additions will facilitate addition of motor drives experiments and protective relay based experiments in the lab. Engineering students at UWF will have access to state of the art experimental workbenches by means of which they will be able to control dc motors, ac motors and to study about power system behavior under fault conditions. In addition, this laboratory equipment will aid in conducting specialized training courses for engineers from Gulf Power through Continuing Education Programs and for high school students from schools in Pensacola.

Background

Electrical power systems is an important and vital discipline for widespread integration of renewable and sustainable technologies. Power systems cover a broad range of activities and evolving issues that are of great importance in the field of sustainable and smart power systems. The Power System courses at UWF have been designed to provide students with technical knowledge in the area of power apparatus, in addition to mathematical tools that are necessary for developing new innovative solutions to solve real life issues existing in present day electric grids. These courses provide the students with insights into critical power system domains such as protection against faults due to lightning strikes and storms, control of motors and economical load sharing among generators.

Power System Laboratory started functioning in Bldg 4, Room 249 from the spring of 2014. This laboratory was set up from the $200,000 grant donated by Gulf Power Foundation to UWF's Department of Electrical and Computer Engineering. This grant was a part of Gulf Power's donation to promote power engineering program at UWF. The laboratory was designed as a part of a power program that consists of one required course and three elective courses in the undergraduate electrical engineering curriculum. To support the needs of local power industries in the gulf coast, and to equip our students to meet practical challenges, a new state of the art power laboratory was designed and implemented providing students with experiments related to all topics covered in the required course and elective course. The laboratory experiments

represent a unique blend of traditional and contemporary approach to learning electric machines and power electronics. Modular Lab Volt equipment has been used for experiments related to steady state analysis of electric machines and transformers.

Need for this Project

Besides electrical machines it is power electronics in connection with automation, automatic control and bus technology which are increasingly having an impact on the performance and potential of drive technology. Today, envisioning the world of technology without controllable electric drives would be totally unthinkable. Their huge application spectrum goes from special high powered drives, tooling and production machines and includes household appliances, office machines and applications in automotive technology.

Power system operation is subject to faults and failure of equipment. Electrical equipment failures would cause intolerable outages. There must be additional provisions to minimize damage to equipment and interruptions to the service when failures occur. The function of protective relaying is to cause the prompt removal from service of any element of a power system when it suffers a short circuit, or when it starts to operate in any abnormal manner that might cause damage or otherwise interfere with the effective operation of the rest of the system. Relays are widely used in power industries in transmission and distribution networks. The power laboratory at UWF has 6 of these relays. Gulf Power and Schweitzer Engineering Laboratories have donated these relays to UWF. These relays are on-site relays which could be used in real power systems. To conduct experiments using these relays, Current Transformers (CTs) and Potential Transformers (PTs) are required to reduce the current and voltage levels respectively.

Starting fall semester of 2014, Power System Laboratory will be conducted in two parts, part-1 of this laboratory with be called the Electric Power Apparatus (EPA) Laboratory and will be conducted in parallel with EEL 3211 course. Part-2 of this laboratory will be the Power System Engineering and Simulation (PSES) Laboratory run in parallel with EEL 4213 course.

This project is for purchasing eight quantities of (1) Motor drives, (2) Current transformers and (3) Potential transformers for the PSES laboratory. Incorporating this supplementary equipment with the available Lab Volt equipment will allow addition of 8 experiments in the PSES laboratory at PNS and REEF campuses.

Lab-Volt Test Benches

The Lab-Volt Power Electronics Training System is a versatile, flexible, modular, and complete teaching system. It consists of all different types of modules including power supplies, data acquisition and control interface, dynamometer, dc motor/dc generator circuits, ac motor/ac generator circuits, transformers, wiring cables, control panels, power meters and various measuring instruments. A modular approach allows:

- Selection of areas of interest for study
- Equipment selection to match budgets
- Setup of complete power systems/generators feeding various devices such as transformers, transmission lines, and others
- Progressive system enhancement

- Use of many modules from the tried and proven Lab-Volt Electro Mechanical System (EMS)
- Fault insertion capability for troubleshooting at the system level
- All device connections are terminated with 4-mm safety banana jacks mounted on the module front panels.
- Ability to combine our own protective relays with the Lab Volt CTs and PTs to develop and build experiments.

Lab-Volt equipment helps students understand the input output characteristics of each module without going into details how each module was actually designed. Lab-Volt test bench is shown on Fig.1.

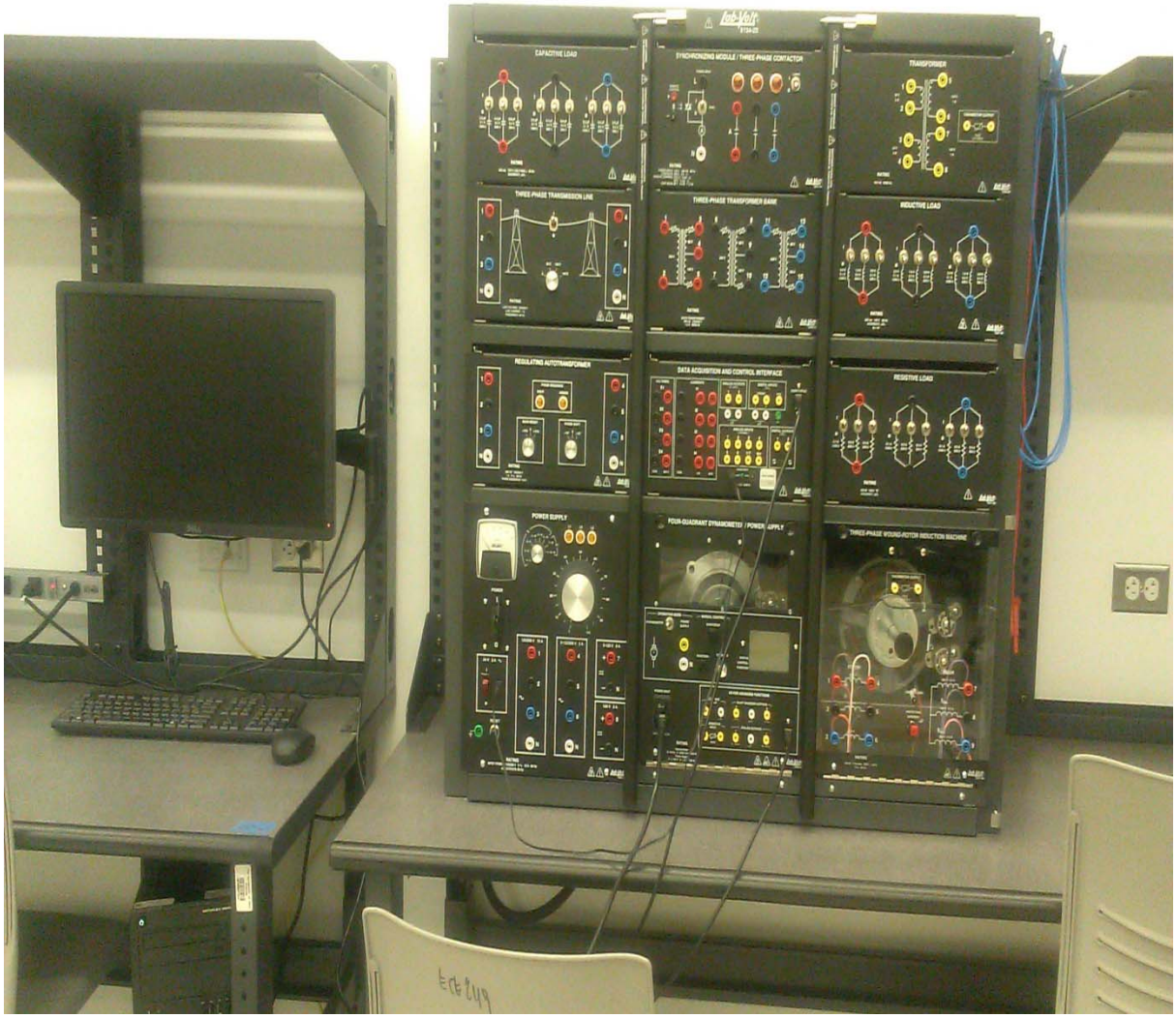

Fig.1 Lab Volt Test Bench in the Power System Laboratory at UWF

Alignment with UWF Strategic Plan

The proposed project strongly aligns with the UWF's strategic commitment to delivering an optimal mix of high-quality programs to meet regional and state needs. UWF currently graduates

around 50 Electrical Engineering undergraduates. The upgraded Power System Laboratory will profit the students and Electrical Power Engineering industry in the panhandle region. The salient benefits of this laboratory would be to

- Provide students with industry level learning experience on motor drives and protective relays.
- Enhance career opportunities for undergraduate electrical engineering students from UWF nationwide and in the panhandle region in particular.
- Engage students in a progressive curriculum that is in tune with the needs of present day "Smart" power systems.

Student Learning Outcomes

One of the objectives of an engineering program should be to provide a laboratory experience in which students develop the skills to integrate theoretical and practical aspects of their curriculum. Lack of hands-on laboratory experiences fosters a loss of intuition about the physical meaning and physical magnitude of system outputs. Motor drives and protective relays are critical components of a power system knowledge of which would definitely aid the students understanding of motor control and power system protection. Students respond very positively to hands-on demonstrations and to "real-world" applications of problems that they studied in their course. Presently, the PSES laboratory does not have any motor drive experiment or protective relay experiment. If this project proposal is funded, 8 experiments making use of motor drives module, current transformer module and potential transformer module would be added to the existing list of experiments. In these experiments,

- Students would investigate the characteristics and limitations of current transformers and compare electromechanical relays with modern day digital relays.
- Students will be able to evaluate the validity of theory learned in lecture and build software models to predict occurrence of faults.
- Students could analyze and interpret data collected from testing equipment and software programs.
- Students will be able to simulate a fault in the power system and calculate the corresponding fault currents and voltages.
- Students will analyze the various modes of controlling dc motors and ac motors
- Students would gain insights into AC drives and DC drives.
- Students will become knowledgeable with software packages supplied by Lab Volt along with these modules which offers easy to use graphical interfaces and provides excellent graphical output.

The hands-on experiences gained at UWF PSES laboratory will directly prepare students for entry-level engineering positions. This practical experience for entry-level engineers is important in the current professional climate that is experiencing dwindling numbers of experienced power engineers. This is especially true for the gulf coast, considering the large number of power-related employers such as Gulf Power, Alabama Power, Georgia Pacific, GE Industries etc. The employment challenges faced by the regional electric utility industry present career opportunities for UWF Electrical Engineering graduates; providing educational pathways leading towards these careers is the principle objective of our BS ECE program. The PSES laboratory is a critical

component of this program, ensuring students gain industry-relevant, hands-on experience in preparation for their careers as the next generation of power engineers.

In addition to Electrical Engineering students at UWF, the proposed experiments would be used to educate power engineering professionals working in industries such as Gulf Power through specialized continuing education programs. These experiments would be used to motivate high school students in the areas of computer simulation, control of motors and lightning fault simulations.

Equipment Quote:
The equipment quote for Lab Volt modules (1) Motor drives (2) Current transformer and (3) Potential transformers is provided below. These modules will be used in conjunction with the existing Lab Volt equipment and protective relays in the Power System Laboratory. Table-1 shows a detailed budget and lists the modules to be purchased. It is to be noted that this quote from Lab Volt includes a 3 year warranty for all the modules to be purchased.

Table-1 Budget Request for Purchase of Equipment for Power System Laboratory

Quantity	Item	Unit Price	Price Quantity
8	Motor Drives for EMS	$4001.00	$32,008.00
8	Current Transformer Modules for EMS	$1691.00	$13,528.00
8	Potential Transformer Modules	$1515.00	$12,120.00

3 year warranty included in this pricing

Shipping:	Included
Grand Total:	**$57,656.00**

Evaluation Methodology
Evaluation methodology helps us to assess and continuously improve by looking directly at student's work. Assessment helps us to implement strategies that respond to the diverse needs of our students and to meet the ever changing community and workforce demands. The PI has developed an evaluation methodology that reveals whether students master the skills and knowledge that is imparted to them. The methodology is described below

- Student's performance in the laboratory will be assessed by their laboratory reports. This revealing measure will clearly provide immediate feedback to the instructor to allow modification of instructional techniques using the interactive and modular laboratory environment.
- Discussions and pop up quizzes will be held toward the end of each experiment on motor drives and protective relays to evaluate their level of understanding on these topics.
- Student's interest in these areas of study will be evident through their eagerness and enthusiasm in their capstone design project. The number of students who are interested in

pursuing their capstone design project in the areas of motor drives and protective relays will give a clear indication of the success of this project.

Project Timeline:

The purchase of these 3 modules for the PSES laboratory would begin as early as March/April of 2014 if funds become available.

May/June 2014	- Procurement of modules
July 2014	- Commissioning of equipment
August 2014	- Lab Volt provides training to Faculty
Spring 2015	- PSES lab commences its first session, data related to impact of these modules on student understanding of topics collected.
Summer and Fall 2015	- Data collected about the number of students choosing motor drives and protective relays for their capstone design project. Collected data analyzed, experiments adjusted and fine-tuned for Spring 2016's PSES laboratory session.