

# **AC 2009-289: CREATING A COMPREHENSIVE CENTER FOR ENERGY EDUCATION**

**Max Rabiee, University of Cincinnati**

## Creating a Comprehensive Center for Energy Education

Max Rabiee, Ray Miller and Elvin Stepp

University of Cincinnati

### Abstract:

In the current environment there is an unprecedented priority for educating and training a technologically solid workforce with an energy focus. The ongoing discussion on reducing dependency on fossil fuels, developing alternative energy sources energy conservation initiatives, sustainability and most importantly maintaining a reliable, efficient and environmentally sound energy infrastructure underline the imperative nature of this need.

The College of Applied Science (CAS) at the University of Cincinnati (UC) has maintained a focused mission of serving the needs of utility industry and the community at large as needs arise for technical education in alternative energy. Within the College of Applied Science today we have an Associate Degree program in Electrical Engineering Technology (EET) with option for development of power plant operations and maintenance personnel. The College is also investing resources in development of additional curriculum and funding for Energy Education by creating the Center for Energy Education.

This paper will briefly describe electrical and mechanical energy related courses taught in existing power engineering technology associate degree and existing certificate programs. The paper will primarily focus on describing proposed extension of the current associate level curriculum into a baccalaureate degree program in Power Systems Engineering Technology taught by electrical and mechanical engineering technology departments. Center for Energy Education's scope of work also includes outreach for funding and educating the community in the alternative energy field. During the presentation the acting director of the center who is a mechanical engineer and one electrical engineering technology professor will explain the reason for creating the center. They will also describe the center's broad interdepartmental coordinating tasks for steering the energy education in correct direction to comply with present and future energy education requirements.

### Introduction:

The UC College of Applied Science (CAS), throughout its 180 year history, has instilled the technical skills and knowledge base in our graduates so they can hit the ground running and become contributing team members. Our college has always been focused on responding to the workforce needs and demands of business, industry and our community at large.

*Proceedings of the 2009 American Society for Engineering Education Annual Conference & Exposition  
Copyright ©2009, American Society for Engineering Education*

The College's overall graduate placement rate is outstanding. In the past 10 years, that rate has exceeded 95%, with a number of years with 100% placement. Our co-op students and graduates demonstrate leadership skills and quickly integrate into the culture and work ethic of their new companies. With their unique foundation, our graduates are ready and able to be immediate contributors to Electric Power and Energy sector and their communities.

CAS co-op students and alumni are known for being exceptionally profession and well-prepared in tackling problems and applying what they have learned. Cooperative education with its emphasis on hands-on learning is an important learning experience that has benefited Energy Generation and Distribution companies for many years.

Just in the last four years CAS has had 66 students with 144 placements in co-op (total co-op quarters) assignments with Duke Energy in Ohio and North Carolina across a wide variety of technical fields.

Over 30 Full time graduates have been placed at Duke Energy since July 2000 and many prior to 2000 with advancement into Duke Management including plant operations managers. Several current Duke Energy employees are enrolled in evening classes in pursuit of degrees from CAS.

### **EET and MET Departments' Present Initiative in Power System Technology:**

With the cooperation of Duke Energy and others in the field, the College of Applied Science has already started providing a path for the next generation of utility industry professionals [1]. Our efforts have been recognized by segments of Duke Energy already and there is more work to do.

CAS currently has the following energy related programs:

- Associate Degree in Electrical Engineering Technology with a Power Systems Focus
- Certificate Program in Stationary Engineering
- Certificate Program in Power Systems Technology
- Journeyman Electrician Certificate Program
- Master Electrician Certificate Program
- Plant Maintenance Craftsmanship Program

- Industrial HVAC Craftsmanship Program (Tri-Gen)
- Energy and Technology Expo – (Energy conference coordinated with Tech Expo)
- Welding Skills Certificate – AWS certification planned
- Construction Management
- Architectural Engineering Technology
- Technical Professional Development
  - Fundamentals of Engineering Preparation
  - Professional Engineering Preparation
  - Professional development Continuing Education Units (CEUs)

### **EET and MET Departments’ Shared Future in Energy and Power Systems:**

CAS is a leader in producing the next generation of professionals for power generation, and construction. Recognizing the increasing demand for engineers and technicians due to the upcoming wave of retirements and the increasing electric utility construction budgets for generation, transmission, and distribution systems, CAS is developing new courses and programs to serve the industry. By providing our graduates with specialized instruction in electric power generation, transmission, and distribution; they will be able to provide immediate value the corporation. They will understand traditional utility systems as well as emerging technology such as wind generation, solar generation, and the “smart grid”.

We plan to development the following new programs:

- Bachelor of Science in Electric Power Technology
- Bachelor of Science in Power Plant Technology
- AS in Nuclear Power Technology
- BS in Nuclear Power Technology
- Center for Energy Education
  - K-12 Curriculum Development with regional school districts
  - Cooperative efforts with the EEI Center for Energy Workforce Development
  - Ongoing technical programs for technology professionals
  - Energy Conferences

- Traveling Energy Education Exhibition in cooperation with the Cincinnati Museum Center
  - Development of permanent Energy Education Exhibition at the Cincinnati Museum Center
  - Technology conferences for alternative energy and industry development
  - Career center for power generation industry
  - Career center for power distribution and control industry
  - Community Outreach for conservation projects – Cincinnati Go Green effort
- CAS Online – expansion – provide course content for distance learning in this sector

### **Future Plans:**

Duke Energy and the UC College of Applied Science have a demonstrated long and successful partnership. Working together moving forward, we can establish a nationally recognized energy education infrastructure that plans to provide tremendous benefits to Duke Energy and other electric power utilities. In support of the mission of CAS to meet the needs and demands of industry and out communities CAS is working on the following initiatives for which we seek support from Duke Energy and other industry partners.

We propose to form a Joint Development Team consists of utility industry professionals, CAS faculty members and students’ advisors.

- Develop long term curriculum development plans for power programs
- Confirm roles and responsibilities
- Establish grant writing team to augment resources
  - Department of Labor Grants
  - Department of Energy Grants
  - State of Ohio Grants
- Develop programs for Building Sustainability Initiatives
- Investigate and Study Alternative Energy course work
- Community Outreach to educate community in energy conservation
- Investigate a Center for Energy Workforce Development (CEWD) program leadership

- Identify equipment resource requirements – Duke used assets, new purchases, in kind donations, targeting fund raising.

### **Existing and New EET/MET Power Technology Courses:**

Existing Associate of Applied Science degree entitled “Power System Technology” was described in a previous paper published in the 2008 ASEE proceedings [1]. We are planning to create Bachelor of Science in Electric Power Technology and Bachelor of Science in Power Plant Technology. Existing and New courses that are going to be included in these proposed degrees are listed in this section. In addition we describe content of existing courses.

### **Electrical Engineering Technology (EET) Classes**

- 1) 3-phase Circuit Analysis III (Existing)
- 2) Programmable Logic Controllers I (Existing)
- 3) Programmable Logic Controllers II (Existing)
- 4) Electric Rotating Machines (Existing)
- 5) Electric Transmission and Distribution System Design (New)
- 6) Electric Power System Analysis and Instrumentation (New)
- 7) Electric Power System Protection & Control (New)
- 8) Energy Management & Renewable Resources (New)
- 9) Power Semiconductor Drives (New)

**Circuit Analysis III** is the culmination of the formal circuit analysis sequence where three phase power systems, complex power, magnetic circuits and transformers are covered [2].

In this course methods of circuit analysis are applied to three phase voltage-load systems of both Wye and Delta configuration. The concepts of real and complex power are introduced and applied to single phase and three phase systems. Transformers and magnetic circuits are described and analyzed. Finally, classic low pass, high pass and bandpass filters are presented analyzed and designed. Various concepts of pulsed waveforms and corresponding circuit responses are also covered. In lab, students learn to use the D.C. and AC Power supplies on the Hampden stations. They learn to wire AC single phase series, parallel and series-parallel RLC circuits. They also learn how to connect three- phase Wye-Wye, Wye-Delta, Delta-Wye, and Delta-Delta circuits and take measurements. They will measure Real, Reactive, Apparent

powers and calculate Power Factor. Students perform experiments for magnetic circuits and transformers. In addition they will learn how to draw the Bode Plot for finding the voltage gain magnitude and phase shift response of a passive filter.

Introduction to Programmable Logic Controller (PLC) architecture and programming based upon the Allen Bradley Small Logic Controller (SLC 503) series family of controllers are covered in **Flexible Automation I and II** courses [3].

In **Flexible Automation I**, students will learn how to configure the Allen Bradley SLC503 I/O ports and connect the input/output devices to the PLC I/O ports. They will learn to use normally open and normally closed switches and contacts in a PLC ladder logic diagram. They will convert Boolean equations and combinational logic diagrams to PLC ladder logic diagrams and vice versa. They will also study the use of timer and counter functions and utilize them in a control system. In lab, students will use Allen Bradley Small Logic Controller (SLC503) programmable logic controller stations to read input devices and control output devices. They will use the Allen Bradley RSLogix 500 software tool to write their PLC ladder logic. Students also use the LogixPro simulator program to simulate and analyze their routines prior to using AB RSLogix 500 to download their program into PLC memory.

In **Flexible Automation II**, students will learn the use of Move, Jump functions, and Master Control Relay (MCR) in a PLC ladder diagram. They will discuss and use Programmable Logic Controller ADD, SUBTRACT, MULTIPLY, DIVIDE and COMPARE functions. Students will also learn how to use Advance PLC functions such as Shift, Rotate, Sequencer Output (SQO), Sequencer Input (SQI), and Sequencer Compare (SQC) functions. Toward the end of quarter students will learn how to connect PLC devices in a Local Area Network (LAN) and program them to communicate via an industrial network setting.

Following completion of the circuit analysis sequence students take a course in the operation of rotating machinery. This course is Topics of **Rotating Electric Machinery** [4]. Three phase systems are reviewed and transformers are covered in more detail than was done in Circuit Analysis III. The operating principles of practical rotating machines are introduced. These machines include: DC generators and motors, three phase synchronous and induction motors and single phase motors. In labs, students take measurements of power, voltage and current quantities of machines under operating conditions. They are required to make observations of machine efficiencies under various loading conditions.

### **Mechanical Engineering Technology (MET) Classes**

- 1) Power Plant Technology (Existing)  
Power Plant Technology is a study of power plant components: steam generators; turbines; feed-water heaters; cooling towers
- 2) Environmental Regulations (Existing) – Presented by Chemical Technology Dept.  
In depth review of Federal, state and local environmental regulatory guidelines, reporting requirements and measurements are studied.

- 3) Gas Turbine Technology (Existing)  
Comprehensive review of the design, operation and applications of gas turbines are introduced in this course.
- 4) Alternative Energy Technologies (New)  
Focus discussion on the current efforts in wind power, solar, Bio-fuels, tidal power and other alternative technologies.
- 5) Nuclear reactor Operation and design (New)  
Technical review of the details of design, function, operation and maintenance of nuclear reactors used for commercial power production are covered in this course.
- 6) Nuclear fuel – Handling, reprocessing, storage (New)  
One of the most critical issues of nuclear power is fuel. Detailed evaluation of the fuel stream from mining, processing, enrichment, loading, handling, reprocessing and waste storage are studied.
- 7) Environmental Controls (New)  
With strict environmental controls becoming more and more integrated into systems detailed understanding of controlling environmental pollutants in air, water and soil.
- 8) Energy Systems  
A comprehensive presentation of current and upcoming technologies in alternative and traditional energy systems are covered in this course.

**Power Plant Technology** is a study of power plant components: steam generators; turbines; feedwater heaters; cooling towers. Learn the analysis of combustion products and pollutants, air and water pollution control. Study the design and computer simulation of power generations systems [5].

**Energy Systems** Study and comparisons of alternative large-scale energy sources: fossil fuels, shale, synthetic fuels; biomass, wood, solar, wind, ocean, hydro, fission, fusion. Study the availability of resources, status of technology, costs and environmental effects [6].

### **Conclusion:**

This paper demonstrated how critical it is that higher education institutions educate more students and public in energy fields. In conclusion there are few other educational imperatives than providing for a populace educated and informed about the realities and technologies of energy. The consequences of an ill informed population and political leaders will lead to ongoing political, financial and environmental challenges.

New centers for energy educations similar to the one discussed in this paper are starting to be offered by universities and community colleges all over the United States of America (USA).

*Proceedings of the 2009 American Society for Engineering Education Annual Conference & Exposition  
Copyright ©2009, American Society for Engineering Education*



Putting the investment into centers for energy education with similar missions to the University of Cincinnati's College of Applied Science Center for Energy Education (CAS CEE) will work towards restoring the United States of America (USA) to a leadership position moving forward. Students who graduate with associate and baccalaureate degrees offered through these energy centers gain valuable knowledge that is necessary for working in energy sector of the United States workforce.

## Bibliography

1. "Power Engineering Technology Program Development", 2008 American Society for Engineering Education (ASEE) Annual Conference Proceedings, Energy Conversion and Conservation Session Number 2533, June 2007.
2. Boylestad, *Introductory Circuit Analysis, Eleventh Edition*, 2005, Prentice-Hall Publishing Company, Upper Saddle River, NJ.
3. Webb, John and Reis, Ronald, *Programmable Logic Controller: Principals and Applications, Fifth Edition*, 2002, Prentice-Hall Publishing Company, Upper Saddle River, NJ.
4. Charles Hubert, *Electrical Machines, Second Edition*, 2002, Prentice-Hall Publishing Company, Upper Saddle River, NJ.
5. Elliott, Chen and Swanekamp; *Standard Handbook of Powerplant Engineering; Elliott, Chen and Swanekamp; Second Edition*, 1997; McGraw-Hill.
6. Kalpakjian, Serope and Schmid, Steven; *Manufacturing Engineering and Technology, Fifth Edition*, 2006; Pearson Prentice-Hall

## Biography

**Max Rabiee** earned his Ph.D. degree in Electrical Engineering from the University of Kentucky in 1987. He is professor and department head in the Electrical and Computer Engineering Technology (ECET) at the University of Cincinnati. Professor Rabiee is a registered professional engineer (since 1988), and a senior member of the Institute of Electrical and Electronic Engineers (IEEE). He is also a member of the American Society of Engineering Education (ASEE), the Eta Kappa Nu Electrical Engineering Honor Society, and the Tau Beta Pi Engineering Honor Society. Dr. Rabiee has published 6 textbooks and lab manuals, and 36 refereed papers in IEEE and ASEE journals.

**Ray Miller** graduated from Case Institute of Technology with a BS in Fluid and Thermal Sciences in 1977. Over his 30 career in the energy field Ray built large commercial power plants for several utilities. He has also become an AEE Certified Energy Manager, and an AWS CWI. He has taught as an adjunct at the College of Applied Science for over 20 years and has served on the industrial advisory boards of the Mechanical Engineering Technology and Electrical and Computer Engineering Technology departments. Ray is a member of the AWS, AFE, ASME and AEE. Ray is also the Acting Director of the CAS Center for Energy Education and heads energy conferences.

**Elvin Stepp** earned his M.S. degree in Electrical Engineering from University of Cincinnati in 1973. He is a professor of Electrical and Computer Engineering Technology (ECET) at the University of Cincinnati. Professor Stepp is a registered professional engineer (since 1976), and a senior member of the Institute of Electrical and Electronic Engineers (IEEE). He is also a member of the American Society of Engineering Education (ASEE), the Eta Kappa Nu Electrical Engineering Honor Society, and the Tau Beta Pi Engineering Honor Society.