The Development of a New Core Electrical Engineering Course in Energy Processing Systems:
 a work in progress
by
LJ Bohmann, BA Mork, NN Schulz, DO Wiitanen
Michigan Technological University

The National Science Foundation and the Electric Power Research Institute have awarded six grants to seven universities as part of the Innovations in Electric Power Education Initiative. As part of this initiative, we are developing a new introductory course in Energy Processing Systems that we hope will be a model for other universities to adopt. The course looks at all aspects of electric energy production, transmission and distribution, and utilization. It will introduce technical concepts as well as explain business, economic, regulatory, environmental, and historical issues. We will attempt to give the students the big picture, how electric energy affects their lives and the world around them. The idea is to create a course which all electrical engineers will find relevant, and thus EE departments throughout the country can be justified in using all or part of the material we develop for a required course in electric energy.

More so than any other area of electrical engineering, the electric energy sector is multidisciplinary. In developing this course, we can use this to strengthen the concept that electrical engineering is not an isolated field and it is greatly affected by the world at large. We can easily introduce mechanical engineering, environmental engineering, chemistry, business and public policy concepts. We can also use this course to demonstrate that energy engineering is the synthesis of many subspecialties within electrical engineering. The class will be an example of integrating material from several disciplines, emphasizing one aspect lacking in many students education.

We are in the middle of a three-year project in developing this course and have come to some conclusion on the proper mix of material for the course. Since the goal of this project is to develop the course for others to use, we are seeking comments, suggestions, and criticisms so that we may make the appropriate mid stream corrections.

A brief outline of the course is:
• Introduction: including complex math, phasors, 3 phase circuits and per unit system of measurements.
• Sources of Electric Energy: including a look at the economics, and the regulatory and environmental concerns of each form; a look at the combustion of fossil fuels and biomass, and their use with steam turbines, gas turbines, and combined cycles plants; also photovoltaics, fuel cells, batteries, wind turbines, hydropower, pumped storage; and SMES.
• Fundamentals of Electromechanical Energy Conversion: including magnetic materials, induced voltages and forces, and rotating magnetic fields.
• Transformers; including ideal transformers and non-ideal transformers.
• Fundamentals of Power Electronics: including devices, rectifiers, choppers, and inverters.
• Synchronous Machines: including the equivalent circuit, solid state exciters, the power-angle relationships, and mechanical considerations such as heat and vibration.
• Coal Fired Power Plant Operation: which will integrate the synchronous generator with the turbine, coal handling, and environmental controls; also a look at economics and merchant generation.
• Power System Overview: will look at ac and dc transmission with simple mathematical models and some problems such as geomagnetic storms; distribution systems including, industrial systems and home wiring; load diversity and V/I characteristics; and commerce including wheeling, brokering, and rate setting.
• Faults and Protection: including lightning, protection equipment, and simple coordination.
• Industrial Distribution: including motor control centers, voltage drop calculations, reliability, and industrial applications of FACTS (custom power).
• Industrial Loads: including induction motors, motor drives, and motor control using motor drives.
• Electromechanical Applications in Transportation: including ac and dc locomotives and maglev trains, automobiles, and aircraft.

The course material should be exciting and interesting to the student, emphasizing high tech developments. The presentation of the materials will take advantage of present computer hardware and software capabilities. We will package the material on a CD-ROM and use a web browser to access it, allowing the seamless integration of text, photos, videos, computer simulations, and computer animations.

Our presentation will show some of the interactivity we are trying to develop and demonstrate the integration of several media types. As a work in progress, we would appreciate critical discussions on our chosen course content and delivery method.