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# A First Course in Power: Can a Single Course Serve All Students?

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# A First Course in Power: Can a Single Course Serve All Students?

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***Abstract* - This paper is part of a panel entitled "Modernizing the First Course in Power Systems." In this paper the authors discuss the first power course requirement at the University of Missouri-Rolla. Undergraduate students are required to take a power course, but they may select between a power systems course or a electromechanical conversion course.**

***Index Terms* - power engineering education**

## I. Introduction

THERE is currently an anticipated deficit in the number of electrical engineering students graduating in the next decade who will have sufficient expertise to fill the expected openings in the power industry. As a result, many universities are resurrecting their power curricula and offering courses in power engineering. However, many universities are under considerable pressure to reduce the number of hours in their BS curriculum – this has led to a reduction in the number of specialization courses that undergraduates can take. For this reason, many students may get, at most, one course in power engineering.

Several institutions, including the IEEE Power Engineering Society and the National Science Foundation, have focused their attentions recently on gathering input and making recommendations as to what content should be included in a first, and in many cases only, course in power engineering for the undergraduate electrical engineering student.

At the University of Missouri-Rolla (UMR), we have taken a slightly different approach to the issue of a first course content. Over five years ago, the department underwent a complete curriculum review and update. Prior to that time, all undergraduate electrical engineering students were required **both** a power systems course and an electromechanical energy conversion course. During the curriculum revision, it was decided to reduce the power engineering requirement to a single course. At that time, the faculty decided that rather than trying to condense both courses into a single "one size fits all" course, that both courses would still be offered (with slight modifications) and students could select one or the other course to fulfill their undergraduate requirements.

## II. Power System Analysis and Design

The catalog course description for this class is:

> Power system components and transmission lines, three phase balanced power system theory, analysis and design including economic and reliability considerations, and fault analysis. A power system design project using a graphical power flow program is included.

This course is accompanied by a laboratory which is mostly computer based. However, certain experiments, involving single- and three-phase transformer and synchronous machine operation are carried out in the laboratory. Figure 1 shows an example of the newly developed graphic user interface GUI which is used in both the Power System and Electromechanics courses. The computer based lab experiments use several graphical programs including:

> Computer aided analysis of voltage regulation, power flow, compensation, and economic analysis.

## III. Electromechanics

The catalog course description for this class is:

> Magnetics and magnetically coupled circuits, electromechanical energy conversion, rotating magnetic fields, stepper motors, DC machines, induction machines, synchronous machines, and brushless DC machines.

and the accompanying hardware laboratory:

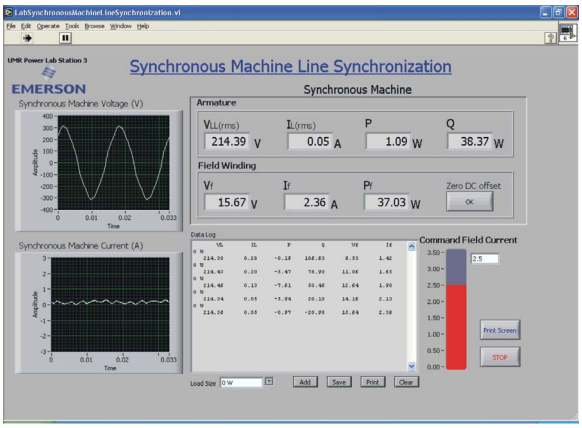


Figure 1. Synchronous machine experiment GUI.

> Experiments with power measurement, transformers, magnetically coupled circuits, rotating fields, stepper motors, DC machines, induction machines, synchronous machines, and brushless DC machines.

This laboratory was described more fully in [1].

[1] The authors are with the Electrical & Computer Engineering Department at the University of Missouri-Rolla, Rolla, MO 65409.

## III. Power Engineering Curricula

From one of these first two courses, students have satisfied their power engineering requirement for graduation. However, students may also continue on and take more specialized courses in power engineering. To be considered to have a "power emphasis" an undergraduate student must take at least three power courses and/or do their senior design project under the advisement of one of the power engineering faculty. The possible courses that students may take are summarized in Figure 2.

## IV. Why Not a Single First Course?

There are several compelling reasons why the faculty at UMR chose not to offer a single first course for all students. There are a few "must know" topics such as three phase power, power factor correction, and transformer operation that are considered crucial for all electrical engineering students. These topics are covered in both power classes. We felt however, that trying to cover a full breadth of power engineering topics in one class ended up in a survey of topics without producing real understanding of even a single aspect of power engineering. By making the decision to have two "first" classes, we recognize that some students may leave electrical engineering without knowing the basics of rotating machines or power flow analysis, but we accept this shortcoming in knowing that students will have a more thorough background in the area they choose that may serve them well. Through effective advising, we have been able to suggest the courses that we feel may be more useful for students in their career goals: students interested in manufacturing, electronics, or digital control may find electromechanics more useful. Whereas students interested in communications, computers, or systems are typically more interested in the power systems course.

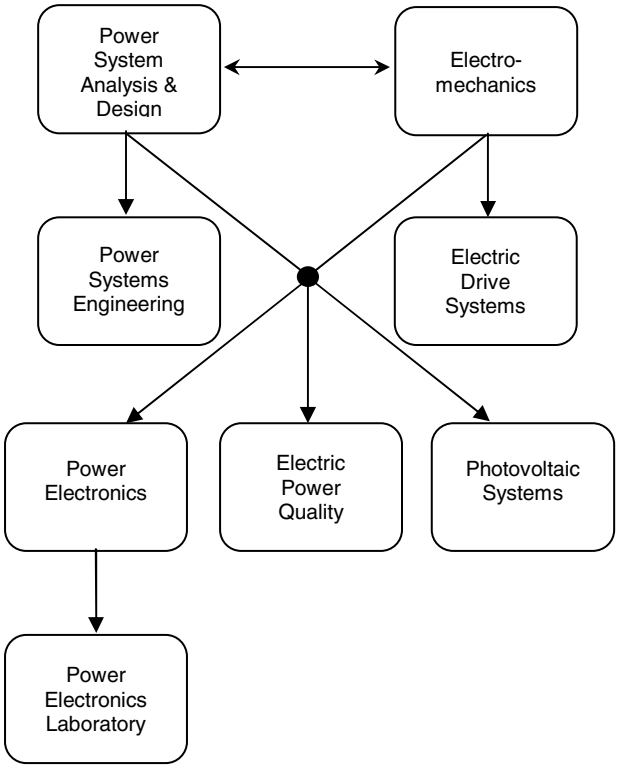


Figure 2: Undergraduate Power Engineering Courses

Over the past few years, the course enrollments for both courses has been roughly split 50%-50%. On average, students do not show a preference for one course over another and many students end up taking both courses by the time they graduate.

## V. Conclusions

The University of Missouri-Rolla has taken the approach of allowing undergraduate electrical engineering students to choose which power engineering course to have as their "first" course. This not only allows students to specialize their power education more closely to their individual career interests, but also provides the opportunity to cover course topics in greater detail.

## VI. References

[1] K.A. Corzine and M.L. Crow, "Power Engineering Laboratory Facility and at the University of Missouri-Rolla," *Proceedings of the IEEE Power Engineering Society General Meeting*, volume 2, pages 1187-1191, June 2005.

## VII. Biographies

**Mariesa L. Crow** received her BSE degree from the University of Michigan, and her Ph.D. degree from the University of Illinois. She is the F. Finley Distinguished Professor of Electrical and Computer Engineering at the University of Missouri-Rolla. Her area of research interests have concentrated on developing computational methods for dynamic security assessment and the application of power electronics in bulk power systems.

**Badrul H. Chowdhury** obtained his M.S. and Ph.D. degrees in Electrical Engineering from Virginia Tech, Blacksburg, VA in 1983 and 1987 respectively. He is currently a Professor in the Electrical & Computer Engineering department of the University of Missouri-Rolla. From 1987 to 1998 he was with the University of Wyoming's Electrical Engineering department. Dr. Chowdhury's research interests are in power system modeling, analysis and control.

**Keith Corzine** received the B.S., M.S., and Ph.D. degrees in Electrical Engineering from the University of Missouri - Rolla, in 1992, 1994, and 1997, respectively. He taught at the University of Wisconsin - Milwaukee, from 1997 to 2004 and is now an Associate Professor at the University of Missouri - Rolla. His research interests include power electronics, motor drives, naval ship propulsion systems, and electric machinery analysis.

**Mehdi Ferdowsi** received his Ph.D. degree in electrical engineering from Illinois Institute of Technology in 2004. He joined the Electrical and Computer Engineering Department of the University of Missouri-Rolla, where he is currently an assistant professor, in August 2004. His major research interests include digital control of switched mode power converters, battery charge equalization, electric and hybrid vehicles, and multi level converters.