

2006-1820: AN INTEGRATED UTILITIES MASTERS OF ENGINEERING PROGRAM

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Frank Barnes received his B.S. in Electrical Engineering in 1954 from Princeton University and his M.S., Engineer, and Ph.D. degrees from Stanford University in 1955, '56, and '58 respectively. He was a Fulbright Scholar in Baghdad, Iraq in 1958 and joined the University of Colorado in 1959 where he is currently a Distinguished Professor. He has served as Chairman of the Department of Electrical Engineering, Acting Dean of the College of Engineering, and in 1971 as cofounder/Director with Professor George Coddling of the Political Science Dept. of the Interdisciplinary Telecommunications Program, ITP.

He has served as Chair of the IEEE Electron Device Society, President of the Electrical Engineering Department Heads Association, Vice President of IEEE for Publications, Editor of the IEEE Student Journal and the IEEE Transactions on Education as well as President of the Bioelectromagnetics Society and U.S. Chair of Commission K—URSI. He is a Fellow of AAAS, IEEE, International Engineering Consortium and he is a member of the National Academy of Engineering.

Dr. Barnes has been awarded the Curtis McGraw Research Award from ASEE, the Leon Montgomery Award from the International Communications Association, the 2003 IEEE Education Society Achievement Award, Distinguished Lecturer for IEEE Electron Device Society, the 2002 ECE Distinguished Educator Award from ASEE, The Colorado Institute of Technology Catalyst Award 2004, and the Bernard M. Gordon Prize from National Academy of Engineering for Innovations in Engineering Education 2004 He was born in Pasadena, California in 1932 and attended numerous elementary schools throughout the country. He and his wife, Gay, have two children and two grandchildren.

AN INTEGRATED UTILITIES MASTERS OF ENGINEERING PROGRAM

Abstract

Engineers and managers of electric, water, gas and transportation utilities face severe challenges associated with security, quality, availability, reliability and profitability issues. They must solve interrelated system problems with respect to generation of electricity, transportation of fuel, and potable and wastewater. To solve these problems, engineers and managers of utilities will be required to be proficient in a broader range of disciplines than the traditional engineering Master of Science, MS, in electrical or civil engineering. The University of Colorado is addressing this educational opportunity with an Integrated Utilities Management Program for master of engineering, ME, candidates. The ME program consists of three interdisciplinary courses covering utility history, management, law and policy, and economics. These courses include topics on business, management, and legal issues as they relate to federal and state regulation, as well as people-related leadership issues. The electric utilities option of this program will be centered on three core courses that include conventional and renewable energy sources, transmission and distribution, security and availability, power quality and reliability. Elective courses will include courses on power electronics, data communication, and control systems. A planned capstone course consists of either operations research or the investigation and resolution of a pending utility project such as the right-of-way of transmission lines, specification of new power plants, retrofitting of power plants or their impact on the environment. The Civil Engineering portion of the program has a similar core of courses related to water resources or transportation and includes courses on life cycle engineering and civil infrastructure systems. The Interdisciplinary Telecommunications Program has a core of communications courses center on data communications, wireless, and security. A unique feature of the proposed program is bringing students with these three diverse areas of interest together to share experiences and different approaches to common problems.

It is expected that candidates for this MS Program or ME will have a Bachelor of Science degree in engineering or science and many will be currently employed by utilities, in private industry and public agencies. Full-time students or part-time students can complete the ME program within one or two years of intensive study, respectively. Courses will be taught both on campus and nationwide via the distance education facilities of the Center for Advanced Engineering and Technology Education (CAETE) of the University of Colorado.

Introduction

The utilities are all facing major changes including the changes in the technologies available to them and the changes in society's expectations and structure. Optical and wireless communications along with very cheap computing power change the way we can operate large water, power, sewer and traffic systems and they are completely changing our communications systems. Security is an issue in away we have not faced for more that half a century where there are groups of people who want to cause

maximum damage to our society. All these utilities have some common characteristics in that they involve large amounts of capital, significant technical problems, and a need to work with the public at the local, state and federal levels. They share different histories with respect to being public or privately owned. However, many of the same issues reoccur with respect to monopoly control and regulation. It is our hypothesis that there is value for students who intend to work in the utility industry to have a broader background than just the particular area of their special interest. Thus we have proposed a masters program in utility engineering and management to address some of these areas of common interest while maintaining the technical depth in a given area to allow them to work on specific projects such as power or sewer systems. An outline of the initial program is given as follows.

An Integrated Utility Engineering and Management Masters Degree Program

The University of Colorado has initiated a new program that is designed to provide students a strong technical background as well as perspective on economic, historical and legal / political issues surrounding the utility industry. The program is jointly sponsored by the departments of Electrical and Computer Engineering, Civil, Environmental and Architectural Engineering and the Interdisciplinary Telecommunications Program. Students are expected to have an undergraduate degree and to have an interest in utilities. Major sources of current interests include the impacts of renewable energy sources on the environment, pollution and urban growth. To address these issues some common interdisciplinary courses have been initiated and some of the current courses are being modified to contain new material. The program requirements include three courses from the following list.

CVEN 5836 Utility Management and Policy
TLEN 5010 Network Economics and Finance or CVEN5620 Applied Microeconomics for Energy and Environmental Systems
LAWS 7241 Telecom Law and Policy or LAWS 6302 Water Resources Law or LAWS 7202 Environmental Law

Additionally at least two course are required from one of the sponsoring departments. For example students interested in working with the electrical utilities might take ECEN 5007 Conventional and Renewable Energy Issues and ECEN 5797 Power Electronics. The first of these courses has been designed to involve the students in design problems that deal with many of the current issues facing electrical utilities in integrating such things as wind and solar cell farms into the current distribution systems. These sources add variability to the power generation system that is not easily controlled and add value to systems that can store energy that can be efficiently converted to electrical power. Other power courses that might well be included are
ECEN 5737 Adjustable Speed Drives
ECEN 5777 Power Generation
ECEN 5787 Power Quality

In Civil Engineering, the courses might be taken from the following list.
CVEN 5524 Lifecycle Engineering of Civil Engineering Infrastructures
CVEN 5276 Civil Infrastructure Systems

CVEN 5236 Construction Planning & Schedule
CVEN 5246 Legal Aspects of Construction
CVEN 5423 Water Resources Engineering Design
CVEN5393 Water Resources Development & Management
CVEN 5524 Drinking Water Treatment
CVEN 5534 Wastewater Treatment

An example of the new courses that are being given this spring is CVEN 5836 Utility Management and Policy that is being given by Paul Chinowsky. This course description is as follows.

“The Fundamentals of Utility Policy course introduces students to the new issues facing utility managers and the influences that are driving utilities to a new integrated model. Specifically, this model emphasizes the interaction and collective dependence that infrastructure utilities now have with each other. The focus of this introduction is to prepare students to enter management positions within the industry and provide the foundation for students to take specialized courses within the utilities management field. The course provides students with simulation exercises to demonstrate how issues such as national security, natural disasters, and global ownership are reinforcing the need for greater knowledge and cooperation between utility managers. Additionally, the course provides opportunities for students to analyze the current and future operating plans of infrastructure organizations that directly affect their lives”

A second example is: ECEN 5017 Conventional and Renewable Energy Issues which is being given by Ewald F. Fuchs. A brief description is as follows. “The structure of the electric utility system is changing due to the deployment of renewable energy sources such as solar and wind power plants in the MW range, and distributed plants (e.g., on roof tops) in the kW ranges. The effects of these changes within the power system call for a study of the present-day load and frequency control approaches. Islanding operations will result in an enhancement of reliability and local availability of electric power, mitigating the occurrence of large-scale power outages. The reliance on intermittent power generation complicates short-term load forecasting. Power system analysis tools which are available, such as special transformer configurations, symmetrical components and short-circuit calculations within a distribution feeder, will be reviewed and applied. The frequency- and load control for islanding and interconnected power pools plays an important role for power system operation. Improved conventional and emerging renewable energy sources including energy storage facilities will be designed within the framework homework assignments that is, case studies. Various techniques for the optimal power flow, reactive power compensation, and filtering within a distribution feeder will be reviewed, and reliability indices and on-line measurement techniques will be applied to decrease power outages”

Other courses are being revised to consider factors such as security and the advances in control, planning and modeling that are possible by the use of modern information communications and processing systems. For example, weather modeling is much more accurate than it was a few years ago and protection against terrorism is a relatively new issue.

The telecommunications program is basically the same one we have been offering for some years and includes courses on the basic structure of the public communications system, data communications, wireless, fiber optics and foundations of computer and network security.

The combined program offers the flexibility of allowing students to take some courses in all the areas mentioned above, as well as drawing on courses from our Engineering Management program. All the courses are available to distance learning students either over the Internet or by videotape through our CAETE program. It is expected that this program will be of interest to employees in utility engineering and management that find holes in their academic background and a need to meet changing requirements that did not exist when they were undergraduates.

The program is evolving. In the first term in which it is being offered one full time student is enrolled and approximately 25 more are enrolled in courses that are major parts of the program. Considerable more students are taking courses in the three sponsoring departments that are listed above. Utility executives have express considerable interest in the program and seeing it meet some their needs for both engineering and management talent. However, recruiters from a dozen or so local utilities have shown minimal interest in this or any other program leading to a graduate degree. Their primary need is for linemen and plant operators and they are looking to raise the interest in K-12. This is in spite of data indicating that more than half the engineers and managers will be eligible to retire in the next five years.