ONR/NSF-sponsored Workshop:

Electric Energy Systems Curriculum for Sustainability

Napa, California
February 2-5, 2012
Project Mission:

Enable all universities to

• Provide a first-rate education and
• Graduate students in large numbers
Group Effort

Curriculum Material:
- Paul Imbertson
- Ned Mohan
- Tom Posbergh
- Bill Robbins
- Bruce Wollenberg

Project Advisor: Dr. Nari Hingorani

Pedagogy: Ned Mohan and Tamara Moore at UMN
          Allison Kipple at Northern Arizona University

Workshop Organization: Heather Dorr, assisted by Jeanine Maiden

Students present:
Gysler Castelino, David Orser, Saurabh Tewari, Eric Severson

www.ece.umn.edu/groups/power
Past Sponsors

• Laboratory Development
  – NSF, NASA, ONR

• Dissemination
  – ONR, NSF, EPRI

Present Sponsors

• Dissemination
  – ONR, NSF, DOE (EPRI, Schweitzer, Electrocon, Nayak Corp, NYISO)

• Pedagogical Research
  – NSF
Include plans for dissemination, especially through new strategies for faculty development, widespread implementation and "commercialization" of materials and techniques, which will result in significant adoption in the majority of engineering schools in the United States. New types of partnerships among students, faculty, publishers, media, private foundations, companies, product designers, and venture capitalists are encouraged.
Why is Curricular Reform Needed?

• Relevance of Power Engineering Education
  – Opportunity and Challenges
  – Our Approach
  – Results

• Continuing Efforts
Only 3 Senior Electives

Core Courses

Power Electronics

Electric Drives

Power Systems

Complementary Course
Undergraduate Curriculum Developed

### Power Electronics

**Features:**
- Switching Power-Pole as the Building-Block
- Includes dc-dc Converters and dc-ac Inverters
- Feedback control of Converters

**Textbook**
- Slides
- Solutions manual

**Hardware Lab**
- Course Learning Objectives
- Online Homework Problems

**Vendor:** HiRel Systems  
Duluth, Minnesota  
Phone: 218-727-3115

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### Electric Drives

**Teaching Machines as a subcomponent of Drive Systems**

**Applications:**
- Harnessing of Wind Energy
- Electric and Hybrid-Electric Vehicles

**Textbook**
- Slides
- Solutions manual

**DSP-Controlled Lab**
- Course Learning Objectives
- Online Homework Problems

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### Power Systems

**Includes Topics such as**
- Renewables/Storage
- HVDC, FACTS
- Voltage Stability

**Textbook**
- Slides
- Solutions manual

**Software-based Lab:**
- MATLAB/Simulink, PowerWorld, EMTDC
- Complete Lab on CD
- 18 Short Video Clips

**Vendor:** HiRel Systems  
Duluth, Minnesota  
Phone: 218-727-3115

Lab Manuals can be downloaded from: www.ece.umn.edu/groups/power
Complementary Courses

• Analog and Digital Control courses
• Embedded Controllers: DSP and FPGAs courses
• Course on Analog Circuit Design
• Programming Language courses
• Course on Heat Transfer
• Course on Thermodynamics

A Senior-Design Project Required
DOE-funded Consortium
“A Nationwide Consortium of Universities to Revitalize Electric Power Engineering”
($4,175,423)

82 Universities

“These 82 schools represented about 25% of all the graduates in electrical engineering in 2008.” – William P. Robbins
NSF-Funded Research
An Innovative Instructional Strategy for Widespread Implementation of EES Curriculum, as a Model in STEM (Ned Mohan, Allison Kipple and Tamara Moore)

Motivation:
– To keep students actively engaged

Procedure:
– Pre-class: watch a 15-minute module and answer a brief online concept quiz – 5% of the Grade
– During-class: discuss and solve real-world, design-oriented, somewhat open-ended problems in small groups; Clickers – 15% of the Grade
– Post-class: online homework problems on individual basis; based on Moodle - 15% of the Grade
Electric Power Curriculum

Junior/Senior

1st Year Graduate

Advanced Graduate Courses
Graduate Courses in Electric Power Curriculum

Sponsored by ONR:

Center for Developing and Disseminating a Graduate/Undergraduate Curriculum in Electric Energy Systems to Universities and Practicing Engineers (2011-2014)

Electric Power Curriculum

[Diagram showing undergraduate and graduate courses]
Nationwide Dissemination

• Over 100 schools are using our course material
Welcome

Welcome to CUSP™, the Consortium of Universities for Sustainable Power. This consortium will include universities that have come together to utilize, collectively evolve and promote the curriculum developed at the University of Minnesota – Twin Cities with the help of funding from various organizations including NSF, ONR (Office of Naval Research), NASA and EPRI.

Available Courses

- Power Electronics
- Electric Power Systems
- Electric Machines and Drives

Join Now!!

Become a member and get access to all the resources. Joining is easy - fill an online request here.

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Faculty Development
State-of-the Art Hardware and Software Laboratories

• Hardware Labs on display

• Afternoon Session
  – PowerWorld: Prof. Tom Overbye, UIUC
  – Power System Analysis and Protection: Pratap Mysore
    • PSCAD/EMTDC – Aung Thant
    • CAPE – Paul McGuire and Sandro Aquiles
    • SEL – Rick VanHatten and Chad Lowmen
Frugality and Sustainability: Can We Afford it? – Chris Farrell
What Are We Hoping For?

Feedback

• Curriculum Advisory Board Working Group
  – Chaired by Nari Hingorani and Allison Kipple
• ECE Dept. Heads and Engineering Deans
  – Chaired by Prof. Sally Wood
• Content of Graduate Courses
• How to Establish a Forum?
Power Systems: First Course

- Prof. Ping Hsu
Power Electronics: First Course

- Switching Power-Pole as a Building Block

- Prof. Hari Krishnaswami
Electric Drives: First Course

- Systems View including PPU and Control

- Prof. Ted Brekken