Panel Session:

Electric Power, Energy Research & Education

Ned Mohan, UMN
ECEDHA Annual Conference
Orlando, FL March 25, 2013
U.S. to Be World’s Top Oil Producer in 5 Years, Report Says

A pump jack near Greensburg, Kan. Increased oil production and new policies to improve energy efficiency mean that the United States will become “all but self-sufficient” in energy in about two decades, the International Energy Agency predicted.

By ELISABETH ROSENTHAL
Published: November 12, 2012 | 249 Comments
Mission:
Enable all universities to Provide a first-rate education and Graduate students in large numbers

Procedure:
Develop and disseminate a Complete Curriculum in Electric Energy Education
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

Join Now!!

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

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Courses on CUSP™

Undergraduate:
1. Power Electronics and Lab
2. Power Systems and Lab
3. Electric Machines and Drives; Lab

Graduate:
1. Graduate Course on Power Electronics (collaborative effort)
2. Graduate Course on Power Systems (collaborative effort)
3. HVDC Transmission Systems (Ani Gole)
4. Electric Machines and Drives: Modeling and Control (Ned Mohan)
5. Power Generation, Operation and Control (Bruce Wollenberg)
6. Designing Electric Machines (Jim Hendershot)
7. Power System Protection (Pratap Mysore)
8. Wind Energy Essentials (collaborative effort)
9. Electricity Markets (Ross Baldick)
10. Synchrophasors (Prof. Phadke and team)
Graduate Course(s) on Power Electronics

1. **Full-bridge DC-DC Conv; Soft-Switching** – H Krishnaswami (UT)
2. **Front-End Rectifiers** – Kaushik Basu (UMN)
3. **Resonant Converters** – Ned Mohan (UMN)
4. **Dual Active Bridge** – Amit Jain (Intel)
5. **Matrix Converters** – Kaushik Basu (UMN)
6. **Multi-Level Converters** – Prasad Enjeti (TAMU)
8. **Applications in Automotive Systems** – K. Rajashekerara (UT-Dallas)
10. **High Power Applications in Power Systems** – Ned Mohan (UMN)
11. **Semiconductor Device Physics** – Bill Robbins (UMN)
12. **Wide Bandgap Devices** – Anant Agrawal (CREE)
13. **Magnetic Design** – Bill Robbins (UMN)
14. **Thermal Design** – Bill Robbins (University of Minnesota)
15. **EMI and EMC** – Chris Henze (Analog Power Design Inc.)
Blended/Flipped-Classroom Pedagogy

• Procedure:
  – **Pre-class**: watch a 15-minute module (5%)
  – **During-class**: real-world, design-oriented problems (15%)
  – **Post-class**: homework problems (15%)
Content of Each Course:

1. Video clips for each lecture:

2. Textbook (Reference Material)

3. In-class discussion problems

4. Labs

5. Homework Problems
“Nationwide Implementation and Assessment of an Undergraduate Flipped-Classroom Teaching Model in STEM”

A Proposal Submitted to NSF with 59 Universities Collaborating
Uniqueness of Our Approach

• **Force Multiplier:**
  – Aimed at faculty to provide all the resources that are needed
  – Teaching the Teachers!

• **Archiving Institutional Knowledge:**
  – Reaching out to best experts in the world

• **Evolving to keep them Current:**
  – Consortium of 168 Universities
Increasing Student Enrollments

Enrollment vs. Year

- PE
- PS
- ED


1999: 33 students
2000: 33 students
2001: 33 students
2002: 33 students
2003: 50 students
2004: 50 students
2005: 50 students
2006: 112 students
2007: 50 students
2008: 50 students
2009: 50 students
2010: 50 students
2011: 50 students

112 students
# NAU Power Engineering = UMN Southwest, Sponsored by APS

## Course Enrollment

<table>
<thead>
<tr>
<th>Course</th>
<th>Term</th>
<th>Final Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EE401/490: Power Systems</strong></td>
<td>Fall 2007</td>
<td>13</td>
</tr>
<tr>
<td>Senior technical elective</td>
<td>Fall 2008</td>
<td>18</td>
</tr>
<tr>
<td>(3 credits lecture)</td>
<td>Spring 2010</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Fall 2011</td>
<td>24</td>
</tr>
<tr>
<td><strong>EE484: Power Electronics</strong></td>
<td>Fall 2010</td>
<td>22</td>
</tr>
<tr>
<td>Senior technical elective</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3 credits: 2 lecture, 1 lab)</td>
<td>Spring 2013</td>
<td><strong>39</strong></td>
</tr>
<tr>
<td><strong>EE490: Electric Drives</strong></td>
<td>Spring 2012</td>
<td>28</td>
</tr>
<tr>
<td>Senior technical elective</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3 credits: 2 lecture, 1 lab)</td>
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### Increasing NAU EE enrollment:

<table>
<thead>
<tr>
<th>AY6-7</th>
<th>AY7-8</th>
<th>AY8-9</th>
<th>AY9-10</th>
<th>AY10-11</th>
<th>AY11-12</th>
<th>AY12-13</th>
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<td>128</td>
<td>147</td>
<td>157</td>
<td>171</td>
<td>219</td>
<td>211</td>
<td>227</td>
</tr>
</tbody>
</table>
Certificates for Practicing Engineers

- Content of courses *free-of-charge*
- Certificates
  - All the material developed
  - Online Homework
  - Proctored Online Exams
  - Credible
Synergy Between Research & Education

Research Focus:
Integrating Power Electronics into Power Systems for Sustainability

PhDs:
2011: Jalpa Shah, Rashmi Prasad, Nathan Weise
2012: Shabari Nath, Apurva Somani, Kaushik Basu

Current PhD-Track Students: 14 (including an NSF Graduate Research Fellowship and DoD NDSEG Fellowship)
Summary

• CUSP™ is resulting in large enrollments and quality education
• Certificates for Practicing Engineers
• Synergy between Research & Education
Nationwide Dissemination through ONR/NSF Funding

Next Workshop - February 6-9, 2014 Napa, CA