Vermont Law School Course
Three Essentials of the Electric Grid: Engineering Essentials
Instructor: Chris Root (croot@Vermontlaw.edu and croot@velco.com)

Course Text: Electric Power Systems: A Conceptual Introduction by Alexandra von Meier. John Wiley and Sons, Inc. 2006

May 26 – May 29 10:30AM – Noon and 1PM-2:30PM

Grading: 30% Homework, 10% Classroom Participation, 60% Final Exam

Final Exam: Take home due Monday June 1 at 8 AM.

HOMEWORK

#1 Before First Class - Read Chapter 1 & 2 in Text. Questions 1 - 7 (except #2) on Homework Problems after first class.

#2 Before Second Class - Read Chapters 3, 5 and 6 in Text. Homework problems # 2, 8-13 after second class.

#3 Before Third Class- Read Chapter 8. Homework problems 14-16 after third class.

4 Before Fourth Class- Read Chapter 9, Take home final

FINAL is due Monday, June 1 at 8AM. Email it to Chris Root at croot@velco.com

Topics Covered by Class

1. **Tuesday, May 26**
    a. Forms of energy and basic concepts
    b. Laws of Physics
    c. Electric Power and Circuits
    d. Generators
    e. Loads
    f. Introduction to AC Power
2. **Wednesday, May 27**

a. Power System Overview
b. Major Power System Elements
c. Power, Energy, Losses
d. Power system protection basics
e. Transmission and Distribution
f. Overhead vs Underground lines
g. Three phase power fundamentals
h. HVDC Basics
i. Reactive Power

3. Thursday, May 28

a. Operations
    i. Purpose of the Control Room
    ii. VELCO as part of ISO-NE Operations
    iii. What is an EMS and a SCADA system?
    iv. What are the responsibilities of the control room operator?
    v. What is a contingency analysis?
    vi. How does the monitored information get back to Rutland?
    vii. What role does the FERC/NERC/NPCC play in Operations?
b. ISO Relations
    i. What is an energy market?
    ii. What are the major parts of the NE energy market and how does it work?
    iii. What is a Regional Transmission Rate as compared to Local Transmission Rates?
c. Transmission Planning
    i. Basics of Planning Criteria
    ii. Voltage and Thermal criteria
    iii. What is a load flow and what does it do?
    iv. What is a bus, load forecast, generation plan?
    v. N-1 and N-1-1 Criteria in planning
    vi. Non-transmission alternatives

4. Friday, May 29

a. Introductions & the Changing Utility Landscape

b. Issues/Challenges/Opportunities with Distributed Energy Resources
    i. Increasing complexity and situational awareness
    ii. Integrating Intermittent Resources: time and location matters
    iii. Distribution System challenges
c. Constrained areas?
d. Blackouts?
e. What is a Smart Grid?
f. What is a MicroGrid?
g. Energy Storage?
    i. Why is it important?
    ii. How is it used?
    iii. What is its future?
h. Vermont Weather Analytics Center (VWAC)
    i. What is it?

5. Instructor Evaluation