University of Vermont, Spring 2020
SU: Electric Energy Conversion - EE113
TH 16:25 - 17:40 PM, Room: Lafayette L200
Lab: MW 17:05PM-19:35PM in Votey 312

Instructor: Professor Mads Almassalkhi
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Office Location: Votey Hall 301c
Office Phone: (802) 656-3405
Office Hours: Tu/Th from 14:30 to 15:30 in V312 (before class)

Lab TA: Mr. Danial Waleed
Office: Votey Hall 312 (TESLa)
Email: dwaleed@uvm.edu
Office Hours: TBD

Web Site: We will use Blackboard

Required Textbook(s):

1. *Electric Energy: An Introduction* by M. A. El-Sharkawi, CRC Press.
   Note: any edition will suffice as I will post problems to Blackboard. Also, the book is freely available online via UVM's library:
   http://proquest.safaribooksonline.com/9781466504318?uicode=uvermont

Other good reference to have/be aware of*:

GM: Renewable and Efficient Electric Power Systems, 2nd edition, by Masters. [Good reference for renewable energy analysis. We will use this book too.]

Overview: This course is designed as a first course in energy conversion for engineering students. In this class you will get a broad introduction to concepts that are expected for anyone starting a career in the electricity industry (including manufacturers of motor/transformer equipment, renewable power companies, electric utilities, energy technology companies, etc.). We will cover a wide range of topics related to the supply, conversion, delivery and consumption of electric energy. These will include energy sources (wind, solar, nuclear, fossil fuels), power plants, efficiency, and emissions, electricity system policy, three-phase power, transformers, motors, generators, and renewable and sustainable energy calculation and numerical feasibility studies.

Pre-requisites: Students entering this course are expected to have some experience in AC electric circuit calculations (EE 100 or EE 4), including a strong handle on KCL, KVL, and Ohm's Law. Students are also expected to use MATLAB or a similar scripting tool (e.g., Python) for numerical energy studies. It is **not** recommended to use MS Excel.

Course Schedule

*The book references are on hold and should be available for 2-hour loans in the UVM main library.

The course has approximately 10 (total) laboratory sessions. The course may also include a tour of a local power station (Essex Hydro or McNeill) and/or utility control room, if time permits.

Topics	
1	History and components of electric grids, energy sources
2	Energy consumption, sources, conversion, power plants
3	Renewable energy generation (hydro, wind, solar PV)
	Exam 1
4	AC/DC circuits, power, energy calculations
5	3-phase power
6	Transformers: single/three-phase, Delta-Wye
	Exam 2
7	Electric machines: induction motors/generators, DC, etc.
8	Power quality
	Final Exam: Thursday, May 9th, 16:30-19:15, in-class

Learning Objectives: Upon successful completion of this course, the student should be able to:

- Perform a wide variety of primary energy conversion calculations. Students should be able to calculate the energy content from wind, solar, fossil fuel (and other chemical) sources, and calculate the energy input and output associated with various conversion processes.
- Discuss the high-level design for a variety of power plants (renewable, fossil fuel, nuclear), along with the relative environmental impacts of these plants.
- Perform and understand calculations necessary to describe an industry-grade wind turbine and solar PV feasibility studies.
- Perform basic AC and DC power calculations for single-phase and three-phase (delta and wye) circuits.
- Perform basic electrical safety calculations.
- Describe the design and theory associated with electromechanical conversion devices:
  - DC motors and generators (standard DC, as well as stepper motors)
  - AC motors and generators (induction motors, synchronous, synchronous motors)
- Describe the design and theory associated with components of an electricity delivery system
  - Transformers (standard single phase, three-phase, phase-shifting)
  - Substations
  - Circuit breakers and relays
  - Capacitors and reactors (series/shunt)
- Discuss current issues in power system operations and management. Students should be able to provide thoughtful descriptions of the following concepts:
  - Reactive power

  - Vertically integrated utility
  - Electricity market deregulation/restructuring/liberalization
  - Cap-and-trade programs for reducing power-plant emissions

- In addition to these topic-oriented objectives, students are expected to become proficient with the use of engineering laboratory tools, as they are related to experimentation with the technology described above.

Sustainability Credit As a "sustainability course" this course seeks to educate students about the challenges and opportunities associated with the ongoing transition toward more sustainable energy systems. This course addresses UVM?s sustainability course learning outcomes as follows:

- Learning outcome 1: Students can have an informed conversation about the multiple dimensions and complexity of sustainability.
  - In this course we will discuss several dimensions of the impact of electric energy production on sustainability, including air emissions from power plants (including global warming gasses, such as CO2, and air emissions with more immediate health effects, such as nitrous oxides and sulfur dioxide), the long-run availability of fossil fuels, and other ecological impacts of energy infrastructure. We will focus in particular on practical engineering and policy solutions that are enabling a transition toward sustainability in various countries.
- Learning outcome 2: Students can evaluate sustainability using an evidence-based disciplinary approach and integrate economic, ecological, and social perspectives.
  - In this class students will develop the ability to calculate the impact of power plants of various types on air emissions, and develop the skills needed to perform other types of environmental and economic assessments.
- Learning outcome 3: Students think critically about sustainability across a diversity of cultural values and across multiple scales of relevance from local to global.
  - In this class we will discuss the transition toward sustainability in several different countries, comparing and contrasting both the technical and policy tools being employed in, for example, China, the United States and Europe.
- Learning outcome 4: Students, as members of society, can recognize and assess how sustainability impacts their lives and how their actions impact sustainability.
  - This class will introduce students to the impact of residential and commercial energy efficiency programs and technologies; energy efficiency is a practical way that individuals can have an impact on the sustainability of energy systems.

Homework Policy:

- Homework assignments are submitted via Blackboard and highlight important topics from lecture and allows the student to understand the kind of problems they are expected to be able to solve.

- Students are encouraged to work in study groups on their homework, but should submit separate written work. If you do your work electronically, you should make sure that you did the final write-up independently (identical assignments will *both* get a 0 score). Never copy someone else's work.
- Late homework will not be accepted under any circumstance. To make up for this inflexibility on my part, I will drop your lowest HW grade at the end.

Grade Policy: Grades are based on achievements in different topics and are weighted as follows:

- Three exams: two midterms and one final (15% + 15% + 20%, respectively).
  - The final exam will be cumulative, but with a focus on material covered in the final third of the course.
- Regular homework assignments (25%).
  - Homework assignments will be assigned approximately weekly and submitted via blackboard as a single PDF file.
  - If the assignment required MATLAB code, you must include your own commented code that explains how the code works.
  - HW is meant to reinforce key topics from course lectures and are your responsibility to study, learn, and understand.
  - Selected HW problems will be graded to provide you with feedback on your understanding. Disorganized or illegible submissions will not be graded.
- Laboratory Participation (25%).
  - Lab meets in TESLA: **T**he **E**nergy **S**ystems **LA**boratory: Votey 312.
  - The laboratory component of the class will be graded primarily based on laboratory reports, with some weight for (a lack of) participation.
  - There will be approximately 10 lab projects throughout the semester.
  - **NEVER WORK IN THE LAB ALONE!** If you are found working in the lab along you risk failing the class (not to mention the risk of potentially deadly shock).
  - Please contact the TA, if you need to do your lab work outside of the allotted time period. We will not allow students to work in The Energy Systems Lab (TESL@UVM) in V312 unless the TA or instructor are present, because the labs involve dangerous voltages.
  - Pre-labs, when posted, are REQUIRED to be completed and turned in BEFORE YOUR LAB begins and are worth 10% of the lab grade (i.e., 2.5% of your overall grade). They help you get up to speed with the labs.
  - Lab reports are to be submitted one per team. For each report, please note lead author. Each student is expected to be lead author at least three times per semester.
  - 60% of your lab grade (i.e. 15.0% of total grade) will be based on the technical content of your report (i.e. did you correctly perform the entire procedure, do you results make sense, why, etc.).

  - The remaining 30% (i.e. 7.5% of total grade) of your lab grades will be based on the presentation quality of your report (writing quality, notation, graphical excellence, etc.).

- Grades will be recorded on the course blackboard site (bb.uvm.edu) so check this. Letter grades will be assigned at the end of the course, based on the standard breakdown:

Score (%)	<60	60+	70	73+	77+	80+	83+	87+	90+	93+
Grade	F	D	C-	C	C+	B-	B	B+	A-	A

  I reserve the right to adjust the score-to-grade mapping from the above scheme.

Academic Integrity: It is expected that everything that you submit with your name on it is your own work. Anything that is not 100% your own work should be clearly labeled as such (credit your sources, group members, etc.). Students who submit others' work as their own will not pass the course and will be referred to the Center for Student Ethics and Standards for further discipline. The UVM policy on academic integrity is a useful guide:
https://www.uvm.edu/policies/student/acadintegrity.pdf.

University Attendance Policy: Please refer to the most recent UVM Catalogue: *"Students are expected to attend all regularly scheduled classes. The instructor has the final authority to excuse absences."*

Student Learning Accommodations: In keeping with University policy, any student with a documented disability interested in utilizing accommodations should contact ACCESS, the office of Disability Services on campus. ACCESS works with students to create reasonable and appropriate accommodations *via an accommodation letter to their professors as early as possible each semester.* Contact ACCESS: A170 Living/Learning Center - 802-656-7753 - access@uvm.edu.

Alcohol, Cannabis, Tobacco, and Other Drug Use: The University of Vermont is committed to sustaining an academic environment that both respects individual freedom and promotes the health, safety, and well-being of all members of our community. It is essential that the members of this community recognize that the misuse and abuse of Alcohol, the use Tobacco on University Property, the use of Cannabis and other Illicit Drugs, and the Illicit Use of Controlled Substances constitute a threat to the educational mission of the University, a violation of federal and/or state law and a violation of University policy.

Religious Holidays: Students have the right to practice the religion of their choice. If you need to miss class to observe a religious holiday, *please submit the dates of your absence to me in writing by the end of the second full week of classes.* You will be permitted to make up work within a mutually agreed-upon time.

Extra Help: Do not hesitate to come to my office during office hours or by appointment to discuss a homework problem or any aspect of the course. If asked nicely, the TA may be willing to meet as well.

ϟ I am looking forward to an energetic semester ϟ