

**Course Syllabus****ISEN 430 System Engineering Principles of Sustainable Technologies: Grid Planning & Operations (0.5 credit)
Northwestern University**

Instructor: Mark Feasel

Guest Lecturers: TBD

Office Hours: By appointment

Class Assistant: TBD

Classroom: TBD

Class Timing: Fall Quarter

Course Synopsis:

This course serves as a graduate entry-level introduction to the broad subject of grid planning and operations. The course will concentrate on introducing the purpose of the grid, its critical operations and optimization now and in the future. Topics covered will include the regulatory structures and business models that govern the construction and operation of the grid, the physical infrastructure that composes the grid, the digital systems that monitor and control the grid, grid management fundamentals, and the changing nature of electricity transmission and distribution. The course will evaluate the impact of changes such as renewables integration, digitization, decentralization, demand side management, and greenhouse gas (GHG) emissions reductions on grid planning and operations.

In this class you will be treated with respect. I welcome individuals of all ages, backgrounds, beliefs, ethnicity, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability –and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

Course Goals:

- Understand the overall goals, constraints and opportunities associated with grid operations and optimization
- Learn the key players, tools and terms of grid operations
- Assess the trade-off between key metrics in grid operations ranging from economics of reliability, resiliency of an electric power system. Consider value of power quality / power factor, ancillary services etc.
- Understand the impacts of renewable resources to the grid and the various issues associated with integrating such resources to the grid.
- Understand the key concepts and principles of today's grid and likely future grid structures

- Energy Management
- Power Management
- Distributed Energy Resources
- Balancing Supply and Demand
- Business models for the new energy landscape

Grading/Assessment:

Grading will be based on the following rubric:

Component	Weight	Details	Due
Homework	30%	<i>Weekly assignments to be returned before class each week (10%, x3)</i>	Ongoing
Midterm	30%	<i>Exam on first half concepts; offered at the beginning of class in week 4</i>	Weeks 1-4
Final Paper	40%	<i>5-8 page paper analyzing and providing evidence on topic question provided by instructor. Questions provided to students at end of Week 4.</i>	Weeks 5-10

All questions and problems regarding grades must be presented in writing within one week after the test, homework, or project has been returned. The grading scale is fixed; please do not wait until the end of the quarter if you are concerned about the direction of your grade. Grades will be assigned based on all the work you have completed during the quarter using the following scale:

A	93.333 to 100	C	73.333 to 76.666
A-	90.000 to 93.333	C-	70.000 to 73.333
B+	86.666 to 90.000	D+	66.666 to 70.000
B	83.333 to 86.666	D	63.333 to 66.666
B-	80.000 to 83.333	D-	60.000 to 63.333
C+	76.666 to 80.000	F	< 60.000

Required Course Materials:

- Fundamentals of Power System Economics, 2nd Edition by D.S. Kirschen and G. Strbac. John Wiley & Sons Ltd. 2018. ISBN: 978-1-119-21324-6

Additional Course Materials:

- The Grid: The Fraying Wires Between Americans and Our Energy Future by Gretchen Bakke. Bloomsbury USA. 2017. ISBN: 1632865688
- Perfect Power: How the Microgrid Revolution Will Unleash Cleaner, Greener, More Abundant Energy by Kurt Yeager and Robert Galvin. McGraw-Hill. 2008. ISBN: 0071548823

CLASS OUTLINE

Weekly Topic	Description
<p>1: The business and regulatory landscape of the US grid</p>	<ul style="list-style-type: none"> • Key roles and players that make up the US electric utility industry. • Regulatory structures for oversight and governance of the grid • Business Models and Key Drivers • The US Grid today and its regional differences <p>Homework (10%) - due 9/28</p>
<p>2: The Physical Grid and its Operation</p>	<ul style="list-style-type: none"> • Review of the systems that make up the US Grid (Generation, Transmission, Distribution, and Retail) • Description and operations of key infrastructure including generators, substations, feeders, transformers, circuit breakers, protective relays, power and energy metering, reclosers, inverters, batteries, etc.) • Review of how the grid works and the critical risks and opportunities • Solving for Reliability and Resilience • Balancing (Real Time Supply/Demand, frequency control) • Reserve Requirements (Frequency, Regulation, Operating) – what are they & do they exist?

	<ul style="list-style-type: none"> • Role of pricing e.g. Marginal Cost Prices (LMP) • Line and System Losses <p>Homework (10%) due 10/5</p>
<p>3: The Digital Grid and its operation</p>	<ul style="list-style-type: none"> • Tools, technologies and methods to manage and optimize the grid • Energy Management (EMS), Distribution Management (DMS), Visualization, alarming and real time control (SCADA), Outage Management (OMS), Geospatial Information Systems (GIS), Energy Metering Data Management (MDM / AMI) <p>No Homework - Study for Mid Term</p>
<p>4: Long Term Planning & System Reliability</p>	<ul style="list-style-type: none"> • Integrated Resource Plans (IRP) and its role for utility planning • Long-term planning: load loss probability, capacity, ancillary services • Investments in generation and transmission • Financial Transmission Rights <p>Midterm (20%) first half of class</p> <p>Homework (10%) - Due 10/19;</p>
<p>5: The New Energy Landscape</p>	<ul style="list-style-type: none"> • Grid Scale Renewable integration • Demand side management • Greenhouse gas (GHG) emissions reductions • Microgrids

	<ul style="list-style-type: none">• New Business Models <p>Final Paper Due - 10/26</p>
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COVID-19 Classroom Expectations Statement

Students, faculty, and staff must comply with University expectations regarding appropriate classroom behavior, including those outlined below and in the [COVID-19 Code of Conduct](#). With respect to classroom procedures, this includes:

- Policies regarding masking and social distancing evolve as the public health situation changes. Students are responsible for understanding and complying with current masking, testing, Symptom Tracking, and social distancing requirements.
- In some classes, masking and/or social distancing may be required as a result of an Americans with Disabilities Act (ADA) accommodation for the instructor or a student in the class even when not generally required on campus. In such cases, the instructor will notify the class.
- No food is allowed inside classrooms. Drinks are permitted, but please keep your face covering on and use a straw.
- Faculty may assign seats in some classes to help facilitate contact tracing in the event that a student tests positive for COVID-19. Students must sit in their assigned seats.

If a student fails to comply with the [COVID-19 Code of Conduct](#) or other University expectations related to COVID-19, the instructor may ask the student to leave the class. The instructor is asked to report the incident to the Office of Community Standards for additional follow-up.

Class Recording

This class or portions of this class will be recorded by the instructor for educational purpose and available to the class during the quarter. Your instructor will communicate how you can access the recordings. Portions of the course that contain images, questions or commentary/discussion by students will be edited out of any recordings that are saved beyond the current term.



Unauthorized student recording of classroom or other academic activities (including advising sessions or office hours) is prohibited. Unauthorized recording is unethical and may also be a violation of University policy and state law. Students requesting the use of assistive technology as an accommodation should contact [AccessibleNU](#). Unauthorized use of classroom recordings – including distributing or posting them – is also prohibited. Under the University’s [Copyright Policy](#), faculty own the copyright to instructional materials – including those resources created specifically for the purposes of instruction, such as syllabi, lectures and lecture notes, and presentations. Students cannot copy, reproduce, display, or distribute these materials. Students who engage in unauthorized recording, unauthorized use of a recording, or unauthorized distribution of instructional materials will be referred to the appropriate University office for follow-up.

Expectations for Class Participation

Being prepared for class is about more than just showing up, it’s also about making sure you’ve completed the readings, homework, etc. so that you are able to make thoughtful contributions during class. Sitting silently and/or being unprepared can damage your participation grade. When in a virtual class, we expect students to keep their camera and mute on as much as possible. When in the classroom, we expect students to keep their phones off and put away.

Academic Integrity

Academic integrity is taken very seriously at Northwestern. Students are responsible for reading and understanding Northwestern’s Academic Integrity policies. All suspected violations will be reported to the McCormick College of Engineering’s Dean’s Office. These include cheating, plagiarism, fabrication, unfair advantage, unauthorized collaboration, and aiding and abetting of academic dishonesty. Students found in violation of academic integrity may receive a zero on the assignment or a failing grade for the course and may be suspended or permanently expelled from the University. See [Academic Integrity: A Basic Guide](#) for more information.

The Writing Place

When working on writing assignments for this class, I encourage you to visit the Writing Place, Northwestern’s peer writing center. You will work with juniors and seniors who have been trained to provide you feedback and assistance on any type of writing at any stage in the writing process. They will not edit your work. Rather, they will work with you to brainstorm ideas, organize or outline an essay, clarify your argument, document your sources correctly, or refine grammar and style.



Accessibility Statement

Northwestern University is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the university's established accommodation process (e: accessiblenu@northwestern.edu; p: 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

Illness and Medical Leave of Absence

Review the University's [policy](#) on missing academic work due to illness. Your instructor cannot waive an assignment missed due to illness unless the illness can be verified (e.g., by University Health Services or other licensed health professionals).

Discrimination and Sexual Harassment

Northwestern's Policies on Discrimination, Harassment, and Sexual Harassment apply to all members of the University community, including students, staff, faculty, and third parties. Any student, staff, faculty member, or third party who believes that they have been discriminated against or harassed on the basis of their race, color, religion, national origin, sex, sexual orientation, gender identity, gender expression, pregnancy, parental status, marital status, age, disability, citizenship, veteran status, genetic information or any other classification protected by law, should contact the Office of Equity at (847) 467- 6571. Additional information about the University's discrimination and harassment policies, including the campus resources available to assist individuals with discrimination or harassment concerns, is available online on the [Office of Equity Website](#). Students, staff, and faculty who report harassment, discrimination, or sexual misconduct are also protected under the [University's Policy on Non-Retaliation](#).

Sexual Misconduct and Reporting

Northwestern University is committed to fostering an environment where students are safe and free from sexual misconduct. [Confidential resources](#) are available to those who have experienced sexual misconduct. Faculty and instructors are not confidential resources and are required to report incidents of sexual misconduct, whether discussed in your assignments or in person, to the Office of Equity, which can provide information about resources and options. We encourage students who have experienced

sexual misconduct to talk with someone to get support. For more information, including how to request interim protective measures and academic accommodations or file a complaint, see the [Get Help page](#).

Other Resources

Students can find useful resources for safety and security, academic support, and mental and physical health and well-being at the [NUhelp website](#).