

Course Syllabus

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ENVIRO/ENERGY 590 - Economics of Modern Power Systems



Course Overview

Class Hours

T-Th 11:45 to 13:00 Gross Hall 100C (The Generator)

Instructor

Luana Medeiros Marangon Lima

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Office hours: Tue 10:15-11:15am (Luana's office or [Luana's Zoom](#) ☺), or by appointment.

Teaching Assistant

Yi Guo

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Office hours: Fri 10-11am (Gross Hall 352)

Communication

We will use **Slack** as our **primary platform for class communication**. Slack helps ensure that I see your message/inquiry in a timely manner, while also fostering collaboration and a stronger sense of community among us. You can access Slack on your computer or mobile device. Our workspace has four channels.

- **#announcements** - Instructor- and TA-only posts. All important course updates, reminders, and schedule changes will be posted here. Please check regularly.
- **#general** - Open space for class-wide communication. Use this for course-related discussions, sharing resources, clarifying logistics, or continuing conversations from class.
- **#help** - The place to post questions about course material, assignments, or the final project. Instructor, TA and classmates can respond, so everyone benefits from shared answers.
- **#social** - A space for casual, non-course-related conversation. Feel free to use this channel for community building and sharing events.

Click [here](#) ☺ to join our slack workspace.

Course Description and Learning Outcomes

The electric power grid is in the midst of a significant transformation, driven by the increasing penetration of renewable energy, the rise of electrification, and the changing characteristics of electricity demand. On the generation side, we are witnessing a surge in renewable integration as part of global efforts to reduce CO₂ emissions and combat climate change. On the demand side, electric vehicles, data centers, and distributed energy resources are reshaping consumption patterns, creating large new loads, and challenging traditional grid management.

This course examines the economics of modern power systems, with a focus on how emerging technologies, market mechanisms, and regulatory frameworks interact. Students will study how grids balance supply and demand under uncertainty, the role of energy storage and distributed generation, and the design of pricing and cost allocation mechanisms that support reliable and equitable electricity service. Modules also cover the use of optimization and data-driven tools to evaluate planning and operational decisions.

Students will explore how information and communication technology (ICT) is being integrated into every aspect of electricity generation, delivery, and consumption. By the end of the course, students will have a deep understanding of the economic, technological, and regulatory factors shaping the future of the power grid, preparing them to contribute to the development of sustainable and resilient energy systems.

The class topics are divided into ten modules. Each module will have an assignment associated that could be a simple quiz, a reflection piece or solving a LP model in R, Python or Excel. There will be readings associated with each module.

- M1 - Introduction to Smart/Modern Grids
- M2 - How Electricity Distribution Will Change?
- M3 - How Electricity Generation Will Change? | Intro to Distributed Generation (DG)
- M4 - More on DG: Challenge of DG Integration & Solar Industry Outlook
- M5 - Distributed Energy Resources & Economics of Energy Storage
- M6 - Behind-the-Meter (BTM) Energy Management Systems: PV + battery
- M7 - Economic Dispatch with Renewables
- M8 - Intro to Electric Rates Structure and Economic Regulation
- M9 - Operational Expenditure and Utility Required Revenue
- M10 - Cost allocation principles, assumptions and methods

Course Format and Grading

This course meets twice a week for in-person lectures. All required and optional readings, slides, notes, and videos will be posted in the **Modules** section on Canvas prior to each class.

Each module will include one assignment. Assignments will take two possible formats:

1. **Problem-based** - involving readings and the application of concepts and tools learned in class to a specific dataset or problem.
2. **Journal prompts** - encouraging reflection and synthesis of course material.

Assignments together account for 60% of the final grade. In addition, there will be a final project worth 30% of the grade, and class participation will make up the remaining 10%. Participation includes consistent in-person attendance, engaging in class discussions, asking and answering questions, responding to polls, and contributing to a collaborative learning environment.

You will complete assignments and journals in pairs to ensure you are getting to know each other and also getting experience collaborating. For problem-based assignments, you may choose your partner. For journal assignments, pairs will rotate and will be pre-assigned by the instructor. More information to come later once I have the final roster.

Class Etiquette

You should take responsibility for your education. I expect students to attend every class and get to class on time. If you must enter the class late, please do so quietly. Retain from using phones and tablets for social media during class. Some classes will involve coding on your laptop. I expect you to focus on the assignment and refrain from any web browsing that may disrupt the progress of your work.

Your classmates deserve your respect and support. We will likely have students from many different backgrounds and countries in this class and you should all feel comfortable and make each other comfortable while participating.

Course Policies

Nicholas School Honor Code

All activities of Nicholas School students, including those in this course, are governed by the Duke Community Standard, which states: "Duke University is a community dedicated to scholarship, leadership, and service and to the principles of honesty, fairness, respect, and accountability. Citizens of this community commit to reflect upon and uphold these principles in all academic and nonacademic endeavors, and to protect and promote a culture of integrity. To uphold the Duke Community Standard:

- I will not lie, cheat, or steal in my academic endeavors;
- I will conduct myself honorably in all my endeavors; and
- I will act if the Standard is compromised."

Please add the following affirmation to the end of all assignments, and sign your name beside it: "I have adhered to the Duke Community Standard in completing this assignment."

Attendance

Each class session will also be opened on Zoom for recording purposes. **Students are expected to attend in person**, except when illness or other circumstances prevent it. If you need to join remotely, please notify the instructor or TA in advance by sending a brief message through Slack explaining the reason.

Late Submissions

Assignments are due by the deadline specified on Canvas. To encourage timely submission and fairness across the class, late work will be penalized as follows:

- **Up to 24 hours late:** 10% deduction
- **25–48 hours late:** 20% deduction
- **49–72 hours late:** 30% deduction
- **More than 72 hours late:** Not accepted

Exceptions may be granted in cases of illness, family emergencies, or other circumstances, provided that the instructor or TA is notified as soon as possible.

Artificial Intelligence Use

AI tools may be used in this course to support idea generation, coding, or drafting text, but their use must be responsible, transparent, and consistent with the Duke Community Standard. Any AI-generated content must be critically reviewed, refined, and thoughtfully integrated—submitting unedited output is not acceptable. You are required to clearly disclose how AI was used, including the tool, prompts, and its role in shaping your final submission. Failure to acknowledge AI use will be considered a violation of academic integrity. This course will also adopt the AI Assessment Scale. **For each assignment the instructor will specify the appropriate level of AI engagement.**

1	NO AI	The assessment is completed entirely without AI assistance. This level ensures that students rely solely on their knowledge, understanding, and skills. AI must not be used at any point during the assessment.
2	AI-ASSISTED IDEA GENERATION AND STRUCTURING	AI can be used in the assessment for brainstorming, creating structures, and generating ideas for improving work. No AI content is allowed in the final submission.
3	AI-ASSISTED EDITING	AI can be used to make improvements to the clarity or quality of student created work to improve the final output, but no new content can be created using AI. AI can be used, but your original work with no AI content must be provided in an appendix.
4	AI TASK COMPLETION, HUMAN EVALUATION	AI is used to complete certain elements of the task, with students providing discussion or commentary on the AI-generated content. This level requires critical engagement with AI generated content and evaluating its output. You will use AI to complete specified tasks in your assessment. Any AI created content must be cited.
5	FULL AI	AI should be used as a "co-pilot" in order to meet the requirements of the assessment, allowing for a collaborative approach with AI and enhancing creativity. You may use AI throughout your assessment to support your own work and do not have to specify which content is AI generated.

Academic Accommodations

If you are a student with a disability and need accommodations for this class, it is your responsibility to register with the [Student Disability Access Office](#) (SDAO) and provide them with documentation of your disability. The SDAO will work with you to determine what accommodations are appropriate for your situation. Please note that accommodations cannot be provided until the instructor receives a Faculty Accommodation Letter from the SDAO.

Wellness & Mental Health Resources

Your mental and physical wellbeing is integral to your ability to be academically successful. Below, we have compiled a list of resources around campus that are available to support you. If there is something going on in your personal life that is preventing you from participating fully in this or other courses, please feel free to speak with any of us. You are welcome to share as much or as little as you are comfortable sharing, and we are more than happy to arrange to get you the support you need.

Counseling and Psychological Services: CAPS helps Duke undergraduates, graduates, and professional students, including brief individual and group counseling, couples counseling and more. CAPS staff also provide outreach to student groups, particularly programs supportive of at-risk populations, on a wide range of issues impacting them in various aspects of campus life.

Duke Reach: DukeReach directs students, faculty, staff, parents, and others to the resources available to help a student in need. DukeReach is located in the Dean of Students Office and works with departments and groups across campus and in the community, including Housing, CAPS, Student Health, community health providers, the Academic Resource Center, and more.

DuWell: DuWell helps students focus on their individual wellness by looking at the integration of many areas of their life through areas of wellness promotion and risk mitigation. We engage students through a variety of wellness experiences across campus in an effort to reduce stress and anxiety while emphasizing self-care.

We are always available if a student needs someone to listen or to connect them with resources. As employees of Duke, we are mandatory reporters, meaning that if we receive a report of sexual assault, we are required to confidentially report this to the Office of Student Conduct (OSC).

The OSC will follow up with the student to provide further information, but the student is not required to respond and the student will not be shared beyond ourselves and the OSC. The following resources around campus are not mandatory reporters: The Women's Center, medical providers, campus clergy, and CAPS counselors.

Land Acknowledgment

"What is now Durham was originally the territory of several Native nations, including Tutelo (TOO-tee-lo) and Saponi (suh-POE-nee) - speaking peoples. Many of their communities were displaced or killed through war, disease, and colonial expansion. Today, the Triangle is surrounded by contemporary Native nations, the descendants of Tutelo, Saponi, and other Indigenous peoples who survived early colonization. These nations include the Haliwa-Saponi (HALL-i-wa suh-POE-nee), Sappony (suh-POE-nee), and Occaneechi (oh-kuh-NEE-chee) Band of Saponi. North Carolina's Research Triangle is also home to a thriving urban Native American community who represent Native nations from across the United States.

Together, these Indigenous nations and communities contribute to North Carolina's ranking as the state with the largest Native American population east of Oklahoma.