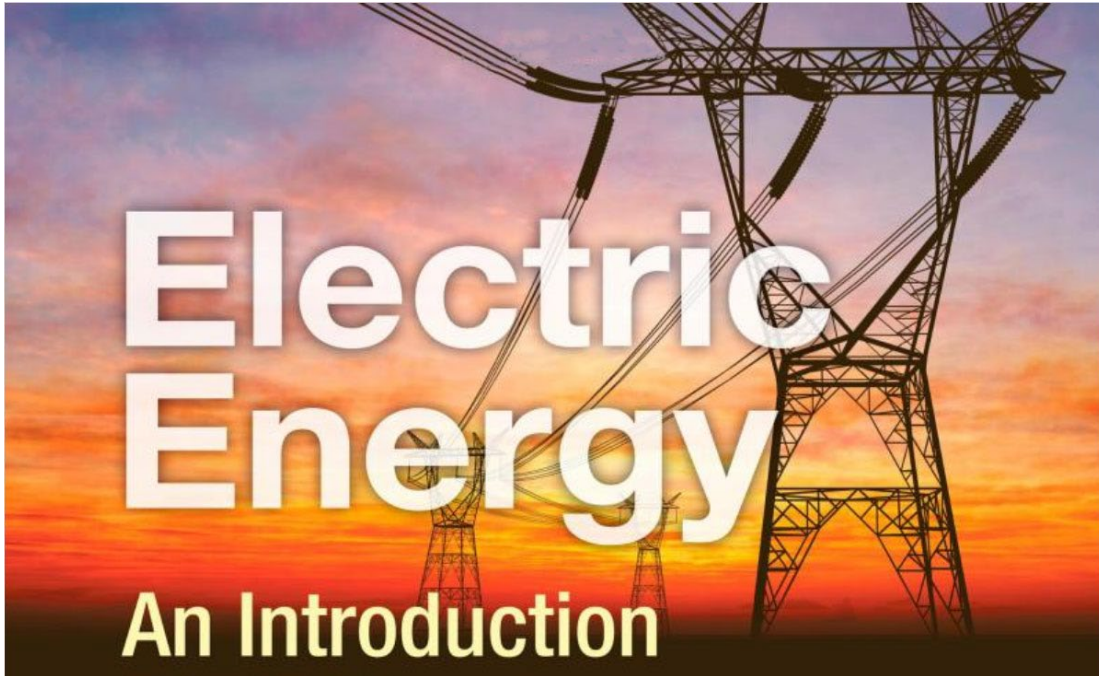


ECE 3072 – Fall 2026
Electric Energy Systems



- Catalog Description:** Non-renewable and renewable/sustainable energy sources. Processes, costs, and environmental impact of conversion into electric energy. Delivery and control of electric energy, electromechanical systems.
- Pre-requisites:** ECE 2040 [min C] or ECE 3710. Students should be very familiar with steady-state AC circuit analysis and phasors. Students should also be familiar with basic principles of magneto-statics.
- Lecture time & place:** Mon/Wed/Fri 15:30-16:20, in van Leer C240. The exact schedule of lecture meetings will be announced in class and on Canvas™. All exams are in the same room.
- Instructor:** Dr. Lukas Graber, lukas.graber@ece.gatech.edu, 404-894-2726
- Office hours:** Mon 16:30-17:30 (after the lecture) or by appointment in van Leer W327.
- TAs:** TBD.
- TA office hours:** TBD.
- Online resources:** Canvas™ Learning Management System: <http://canvas.gatech.edu>. Check daily for updates or set notifications to push to email/messenger.

Textbook (required): Mohamed El-Sharkawi, "Electrical Energy: An Introduction," 3rd ed., CRC Press, 2012. ISBN 978-1-4665-0303-8

Grading:

- 10% Assignments
- 25% Laboratory
- 20% Midterm Exam 1
- 20% Midterm Exam 2
- 25% Final Exam

Extra credit opportunity: Bonus points towards the final exam can be obtained in short in-class quizzes. More information will be announced in class.

Course evaluations: There will be a Georgia Tech CIOS evaluation at the end of the semester. A few additional informal evaluations are planned throughout the semester. Participation is highly encouraged.

General Info.: The midterm exams and the final exam are closed book and closed notes. One formula sheet (both sides of 8.5" x 11" paper) is allowed for the first midterm exam, two for the second, and three for the final exam. The formula sheet(s) should be handwritten originals; not photocopied. The final exam is comprehensive. It will cover all the material presented in the course.

Questions concerning a grade given for any assignment or exam must be presented to the instructor within 5 days after the grade is received. *No exceptions to this rule will be permitted at any time, for any reason.*

Attendance: Class attendance is **very strongly** encouraged, but will not be verified. It is the student's responsibility at all times to keep abreast of course procedural announcements, obtain handouts, etc. All homework, solutions, handouts, etc., will be posted on Canvas.

If, for some extremely important, verifiable reason (i.e., written excuse from doctor, etc.), you cannot take any of the exams at the scheduled time, the instructor must be notified **prior** to the exam time, so proper arrangements can be made to administer the exam. *No excuses after the date of the exam will be considered. No makeup exams will be given unless you notify Dr. Graber via email prior to the scheduled time and have a legitimate excuse for absence.* There will be no dropping of any exam grades. Failure to complete an exam will result in a score of zero.

Homework: Homework due dates will be announced on Canvas and submitted on Canvas™. Homework may be solved in groups provided that all in the group participate fully. Copying is not permitted. If copying on homework is suspected, no credit

will be given. Late homework will receive a penalty in grade (-10 pts for every 24 hours). No homework will be accepted after the solutions have been posted.

Academic Honesty: Suspected cases of academic misconduct, as defined in the Georgia Tech Student Honor Code, will be turned over to the Office of Student Integrity (OSI).

Student-Faculty Expectations Agreement: At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See <http://www.catalog.gatech.edu/rules/22/> for an articulation of some basic expectation that you can have of us and that we have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, we encourage you to remain committed to the ideals of Georgia Tech while in this class.

Accommodations for Students with Disabilities: At Georgia Tech we strive to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please contact Dr. Hughes to discuss options. If you have already established accommodations with the Offices of Disability Services, please communicate your approved accommodations at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through Disability Services, you are welcome to contact that office at 404-894-2563, dsinfo@gatech.edu, or <http://disabilityservices.gatech.edu>.

Course Outcomes:

This course serves as an introduction to electric energy and various energy conversion technologies, from an electrical standpoint. Upon successful completion of this course, students should be able to:

1. Perform basic calculations based on relationships involving energy in its various forms (mechanical, thermal, electrical, atomic);
2. Determine factors of CO₂ emissions for various generation sources;
3. Perform life cycle analysis and energy return on investment in making energy systems decisions;
4. Analyze economic factors in energy systems investments;
5. Calculate the cost and energy efficiency of traditional electric energy conversion sources (fossil fuel, nuclear, hydro);
6. Analyze geometry of the solar cell yields and perform engineering and economic analysis of the PV systems;
7. Estimate the capacity and capacity factor of the wind turbine and determine basic elements of turbine design;

8. Calculate the phasor relationships between voltages, currents, power and energy in three-phase and single-phase AC circuits;
9. Calculate the magnetic field, stored energy, and inductance for simple magnetic circuits used in modeling electric machines;
10. Perform energy efficiency and performance calculations on simple equivalent circuits for basic electric machines;
11. Calculate the input-output relationships, energy efficiency and basic design of DC/DC, AC/DC and DC/AC converters;
12. Calculate the force and torque in solenoids and electromechanical transducers such as relays;
13. Perform energy efficiency and performance calculations of power supplies used for electronic equipment.

Course Outline:

1. History & Introduction
 - a. AC vs. DC
 - b. Core Issues
2. Basic Components of Power Systems
 - a. Power Plants
 - b. Transformers and Modeling
 - c. Transmission and Distribution
 - d. Substations
 - e. 50 Hz vs. 60 Hz
3. AC Power
 - a. Real and Reactive Power
 - b. Power Factor
 - c. Non-Sinusoidal Waveform Analysis
4. Three-Phase Systems
 - a. Wye and Delta Connections
 - b. Wye-Delta Transformation
 - c. Three-Phase Power
 - d. Per-Phase Analysis
5. Transformers
 - a. Ideal, Single-phase Transformer
 - b. Three-phase Transformer
 - c. Real Transformer
6. Rotating Machines
 - a. Rotating Magnetic Field
 - b. Synchronous Generators
7. Power Electronics

- a. Elements of Power Electronics
- b. Basic Converter Topologies
- 8. Energy Resources and Statistics
- 9. Power Plants
 - a. Hydro Power
 - b. Fossil Fuel Power
 - c. Nuclear Power
- 10. Environmental Issues
 - a. Carbon Emissions
 - b. Global Warming and Greenhouse Effect
 - c. Issues with Hydro Power and Dams
- 11. Solar Energy
 - a. Solar Energy and its Advantages and Disadvantages
 - b. Solar Cell Modeling
 - c. Solar Arrays
 - d. Solar System Control
- 12. Wind Energy
 - a. Wind Resources
 - b. Wind Turbine Operation
 - c. Turbine Types
- 13. Electric Safety
 - a. Shock Hazard
 - b. Ground Resistance
 - c. Neutral vs. Ground
 - d. Home Wiring

Appendix: Support Services and Resources:

In your time at Georgia Tech, you may find yourself in need of support. Below you will find some resources to support you both as a student and as a person.

a) Academic support

- Center for Academic Success <http://success.gatech.edu>
 - 1-to-1 tutoring <http://success.gatech.edu/1-1-tutoring>
 - Peer-Led Undergraduate Study (PLUS) <http://success.gatech.edu/tutoring/plus>
 - Academic coaching <http://success.gatech.edu/coaching>
- Residence Life's Learning Assistance Program <https://housing.gatech.edu/learning-assistance-program>
 - Drop-in tutoring for many 1000 level courses
- OMED: Educational Services (<http://omed.gatech.edu/programs/academic-support>)
 - Group study sessions and tutoring programs
- Communication Center (<http://www.communicationcenter.gatech.edu>)
 - Individualized help with writing and multimedia projects

b) Personal Support (Georgia Tech Resources)

- The Office of the Dean of Students: <http://studentlife.gatech.edu/content/services>; 404-894-6367; Smithgall Student Services Building 2nd floor
 - You also may request assistance at https://gatech-advocate.symplicity.com/care_report/index.php/pid383662?
 - Counseling Center: <http://counseling.gatech.edu>; 404-894-2575; Smithgall Student Services Building 2nd floor
 - Services include short-term individual counseling, group counseling, couples counseling, testing and assessment, referral services, and crisis intervention. Their website also includes links to state and national resources.
 - Students in crisis may walk in during business hours (8am-5pm, Monday through Friday) or contact the counselor on call after hours at 404-894-2204.
 - Students' Temporary Assistance and Resources (STAR): <http://studentlife.gatech.edu/content/need-help>
 - Can assist with interview, clothing, food, and housing needs.
 - Stamps Health Services: <https://health.gatech.edu>; 404-894-1420
 - Primary care, pharmacy, women's health, psychiatry, immunization and allergy, health promotion, and nutrition
 - OMED: Educational Services: <http://www.omed.gatech.edu>
 - Women's Resource Center: <http://www.womenscenter.gatech.edu>; 404-385-0230
 - LGBTQIA Resource Center: <http://lgbtqia.gatech.edu/>; 404-385-2679
 - Veteran's Resource Center: <http://veterans.gatech.edu/>; 404-385-2067
- Georgia Tech Police: 404-894-2500