Carleton University

Department of Electronics

Winter 2025

SREE3003: Sustainable and Renewable Electricity Generation

Introduction

In this course you will learn the fundamentals of sustainable and renewable electricity generation with a focus on photovoltaic generation, wind generation, and battery storage. Students will be trained to independently and collaboratively conduct research and present research results.

Course Description and Requirements

Course Description:
Modeling, analysis and calculations of the focused renewable energy generation systems, i.e., photovoltaic, wind, and battery storage, steady-state voltage, current, power, and other related factors.
Includes: Experiential Learning Activity
Prerequisite(s): SREE 3001 and (ELEC 2501 or ELEC 3605).
Lectures: 3 hours per week.
Laboratory and problem analysis: 3 hours per week alternate weeks.

Instructor

Professor: Xiaoyu Wang, Room CB 4203
Email: xiaoyuw@carleton.ca
Course Webpage: on Brightspace

Textbook:

1) G. M. Masters, Renewable and Efficient Electric Power Systems, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2012 ($156.82 Amazon).

2) Reference textbook (not required): “Stephen J. Chapman, Electric Machinery Fundamentals, Fifth Edition, McGraw-Hill, BAE SYSTEMS Australia.”

3) Reference textbook (not required): “Mohan, Undeland and Robbins, Power Electronics, Converters, Applications and Design, John Wiley & Sons, Inc., Hoboken, New Jersey, 2003.”

Lecture Outline

In person, Tuesday and Thursday, 2:35 pm - 3:55 pm, ME4236.

The following topics will be covered during the course lectures with an approximate schedule:

Week 1: Review on renewable energy sources, Solar photovoltaic (solar cell, cell equivalent circuit, I-V curve)
Week 2: PV arrays, shading, bypass diodes, blocking diodes, PV maximum power point tracking

Week 3: DC-DC converter, inverter, micro inverter, PV system faults and diagnosis
Week 4: Grid integration of PV systems, forecasting, islanding. introduction on Energy storage systems.
Week 5: Battery equivalent circuit, charging/discharging, PV systems with battery storage, BMS
Week 6: Electric vehicle and vehicle-to-grid
Week 7: Introduction on wind turbines and wind power conversion, wind turbine power curves
Week 8: Average power in the wind, wind generators, induction generator, PMSG, DFIG
Week 9: Wind generation converters and control, wind farm, grid integration of wind generators
Week 10: Distributed generation and feed-in-tariff (FIT)
Week 11: Pumped hydro, concentrated solar power, geothermal and fuel cell
Week 12: Wave and tidal, biowaste and biogas

Laboratory and Problem Analysis Sessions

3 hours (alternate weeks) as per schedule and location posted on Brightspace.

Notes for Labs

- There are 2 labs as follows:
  Lab 1: Photovoltaic lab
  Lab 2: Wind lab
- Labs are 3 hours in duration and will be held in Room CB 3104. Labs and PA sessions will be held according to the schedule shown on the course module in Brightspace. You must attend your lab in the session you are registered. Changing sessions is not allowed without the instructor's permission. A TA will take attendance at each lab session.
- If for some reason a Lab needs to be rescheduled OR a Lab falls on one of the University holidays, students in those sections must try to rearrange their schedule to make up the lab in another of the regularly scheduled lab sessions, as arranged by the instructor.
- Attend each lab punctually. Be prepared for the lab experiment by reading the lab instruction sheets before entering the lab.
- A lab report will be submitted online for each lab and by each student. A template for each lab report will be provided. Lab reports are due by midnight on the day of the lab. Late lab reports must still be submitted. One day late it will only be worth 50%. Two days late, it is worth 0.

Notes for PA Sessions

- Several problems will be assigned each week as homework to help understand the lecture material, prepare for the midterm exams and final exam. To learn the course material, **IT IS ESSENTIAL THAT YOU ATTEMPT SOLUTIONS FOR THESE PROBLEMS BEFORE THE PA SESSION**. Solutions to these problems will be reviewed in the PA sessions.

Self-Declaration form and Deferred Term work

Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for submitting a self-declaration form no later than three (3) days after the date/deadline of term work including test/midterm, labs, assignments. Any alternate arrangements made with the instructor for submission of term work should be made as soon as possible but within 3 days of the missed due date. If this is not possible after

discussion with the instructor, alternate arrangements must be made before the last day of classes in the term as published in the academic schedule.

Instructors can require (or not) the student to submit the self-declaration form. Include the following statement if you require the student to submit a completed self-declaration form:

> **Consult with the instructor no later then 3 days after any missed course work or midterm examination.**
>
> or
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> **Contact the instructor with the completed self-declaration form no later than 3 days after the date/deadline of term work including test/midterm, labs, assignments.**

Evaluation and Grading Scheme

The cumulative course grade will be determined as follows:

- 70% Final Exam on campus during normal scheduled exam period. Final exams are for evaluation purposes only and will not be returned to the student.
- 15% for midterm exam on campus scheduled outside of class time. midterm, date and room TBA
- 15% Laboratories and you must complete and submit all 2 lab reports on due date and time.

To pass the course you need:

- Minimum overall grade of 50%.
- In addition to having a passing grade for the entire course, students must also have obtained a passing grade in the laboratory portion of the course as well.
- Two assignments will be assigned throughout the term.
- If you miss the midterm exam and have a valid reason, the equivalent of the term portion of the final grade will be shifted to the final exam. If you miss of the term exam without a valid reason, you will receive a grade of 0 on the term exam missed.
- Each student will present in class at the end of the term. The performance of the presenter will be evaluated by the other students in the class.
- The final exam is for evaluation purposes only and will not be returned to students. Textbook and lecture slides can be brought into the final exam and the midterm exams.

Learning Outcomes

Upon successful completion of this course, students will be able to:

(1) explain principles of the focused renewable energy generation systems, i.e., photovoltaic, wind, and battery storage.
(2) analyze equivalent circuits of the focused renewable energy generation systems and calculate steady-state voltage, current, power, and other related factors (e.g., capacity factor) of the equivalent circuits.
(3) understand the interconnection (to the main power grid) issues caused by renewable energy generation systems.
(4) gain hands-on experience making measurements, recording and plotting data.
(5) review literature, identify questions, discuss solutions, and present results in the research area of renewable energy generation.

Graduate Attributes

The Canadian Engineering Accreditation Board requires graduates of undergraduate engineering programs to possess 12 attributes: Graduate-Attributes.pdf (engineerscanada.ca) or GA's. Courses in all four years of our programs evaluate students' progress towards acquiring these attributes. Aggregate data (typically, the data collected in all sections of a course during an academic year) is used for accreditation purposes and to guide improvements to programs. Some of the assessments used to measure GAs may also contribute to final grades; however, the GA measurements for individual students are not used to determine the student's year-to-year progression through the program or eligibility to graduate. Accreditation metrics are based on courses common to all students in a program.

This following list provides the GAs that will be measured in this course, along with the indicators that are intended to develop and assess these attributes.

Graduate Attribute and Level	Indicator or Area of Specialization	Methods used to Evaluate
1. GA-1 Knowledge base for Engineering Level I	DOE-7 Electronics DOE-8 Energy conversion and transmission DOE-12 Technology/Society/Environment	Dedicated exam questions
2. GA-2 Problem Analysis Level D	2.1 Problem definition 2.2 Approach to the problem 2.3 Use of assumptions 2.4 Interpreting the solution, validity of results	Dedicated exam questions
3. GA-4 Engineering Design Level D	4.1 Clear design goals 4.2 Detailed design specifications and requirements (4.3 eliminated) 4.4 Design solution(s) 4.5 Design implementation, task(s) definition 4.6 Alternate solution(s) definition 4.7 Evaluation based on engineering principles	Dedicated exam questions

Academic Integrity and Plagiarism

a) Please consult the Faculty of Engineering and Design information page about the Academic Integrity policy and our procedures: https://carleton.ca/engineering-design/current-students/fed-academic-integrity. Violations of the Academic Integrity Policy will result in the assignment of a penalty such as reduced grades, the assignment of an F in a course, a suspension or, expulsion.

b) One of the main objectives of the Academic Integrity Policy is to ensure that the work you submit is your own. As a result, it is important to write your own solutions when studying and preparing with other students

and to avoid plagiarism in your submissions. The University Academic Integrity Policy defines plagiarism as "presenting, whether intentionally or not, the ideas, expression of ideas or work of others as one's own." This includes reproducing or paraphrasing portions of someone else's published or unpublished material, regardless of the source, and presenting these as one's own without proper citation or reference to the original source.

Examples of violations of the policy include, but are not limited to:

- Any submission prepared in whole or in part, by someone else;
- Using another's data or research findings without appropriate acknowledgment;
- Submitting a computer program developed in whole or in part by someone else, with or without modifications, as one's own;
- Failing to acknowledge sources of information through the use of proper citations when using another's work and/or failing to use quotations marks; and
- Unless explicitly permitted by the instructor in a specific course, the use of generative AI and similar tools to produce assessed content (such as text, code, equations, images, summaries, videos, etc.).

Academic Accommodations

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: Contact us with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For accommodation regarding a formally-scheduled final exam, you must complete the Pregnancy Accommodation Form (click here).

Religious obligation: Contact us with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details click here.

Academic Accommodations for Students with Disabilities: The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send us your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, contact us, if needed, to ensure that accommodation arrangements are made.

You should request your academic accommodations in the Ventus Student Portal, for each course at the beginning of every term. For in-term tests or midterms, please request accommodations at least two (2) weeks before the first test or midterm.

Please consult the PMC website for the deadline to request accommodations for formally-scheduled exams (if applicable).

Survivors of Sexual Violence: As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton's Sexual Violence Policy. For more information

about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/equity/sexual-assault-support-services

Accommodation for Student Activities: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation will be provided to students who compete or perform at the national or international level. Contact us with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist: https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf