

Department of Electronics  
Carleton University

SREE 3003: Sustainable and Renewable Electricity Generation  
Winter 2023

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**Course Objectives:**

Sustainable and renewable energy technologies, together with advances in energy efficiency, are being used globally to reduce greenhouse gas emissions and to relieve the energy crisis brought on by the depletion of fossil fuels. This course introduces the fundamentals of sustainable and renewable electricity generation with a focus on photovoltaic generation, wind generation, and battery storage. The main objectives of the course are:

- (1) to help students gain a thorough understanding of the basic concepts and techniques of sustainable and renewable electricity generation;
- (2) to provide students with the fundamental knowledge necessary to design sustainable energy systems connected to the main power grid;
- (3) to enable students to acquire hands-on experience on operation of renewable energy generation units;
- (4) to give student opportunities to learn industrial cases (renewable energy industry) and to interact with professionals from industry;
- (5) to train students to independently and collaboratively conduct research and present research results.

By the end of the course students should 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) review literature, identify questions, discuss solutions, and present results in the research area of renewable energy generation.

**Course Schedule:**

Lecture: 10:05 am – 11:25 am, Tuesday and Wednesday, ME4236  
 Lab/PA: 2:35 pm - 5:25 pm Monday, CB 3104 (Canal Building)

(Tentative schedule)	PA/Lab	Lecture	Lecture
	Monday	Tuesday	Thursday
Week 1 (Jan. 9)		1	2
Week 2 (Jan. 16)		3	4
Week 3 (Jan. 23)		5	6
Week 4 (Jan. 30)		7	8
Week 5 (Feb.6)		9	10
Week 6 (Feb.13)		11	12
Week 7	Winter break		
Week 8 (Feb.27)		13	14
Week 9 (Mar.6)	Photovoltaic lab	15	16
Week 10 (Mar.13)		17	18
Week 11(Mar.20)	Wind lab	19	20
Week 12 (Mar.27)		21	22
Week 13 (Apr.3)		23	24
Week 14 (Apr.10)		25	N/A

**Course Textbook:**

G. M. Masters, Renewable and Efficient Electric Power Systems, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2012.

**References:**

- [1] Stephen J. Chapman, Electric Machinery Fundamentals, Fifth Edition, McGraw-Hill, BAE SYSTEMS Australia.
- [2] Mohan, Undeland and Robbins, Power Electronics, Converters, Applications and Design, John Wiley & Sons, Inc., Hoboken, New Jersey, 2003.

**CULearn:**

CULearn will be used for communication and posting of course material, including lecture slides. The CULearn site can be accessed from <https://www.carleton.ca/culearn/>. Please refer to the CULearn site frequently in order to keep up-to-date with the course material that is posted there.

**Marking Scheme:**

Final exam	50%	
1/3 term exam	15%	Tentative date: <b>Feb. 16</b> , location: in class
2/3 term exam	15%	Tentative date: <b>Mar. 21</b> , location: in class
Labs reports	10%	
Presentation	10%	

Note:

1. 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.
2. Two assignments will be assigned throughout the term.
3. In the event that you miss the 1/3 term exam or the 2/3 term 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 any of the term exams without a valid reason, you will receive a grade of 0 on the term exam(s) missed.
4. 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.
5. 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.

### **Labs:**

The objective of the labs is to gain hands-on experience making measurements, recording and plotting data, not to write lengthy reports. Labs will be graded partly on the ability to demonstrate your experimental work to the TA, and partly on lab reports. Lab reports are normally due at the end of the laboratory period. Late labs are worth 0 and must still be handed in. In order to pass SREE3003, it is necessary to complete all 2 labs. If you miss a lab due to illness or other valid reason you must arrange a time to complete a make-up lab. All lab results are to be written directly in the space provided in the instruction sheets. A completed lab will include the introduction sheets, instruction sheets and any closing sheets. All is to be stapled together and handed to the TA at the end of the lab period. The TA will also sign you in at the start of the lab and sign you out at the end of the lab. No laboratory exemptions are given to students who are repeating the course. Each laboratory is worth 10% of your final grade. All laboratory pages are to be printed by the student from CULearn.

**Lecture Topics:** The list below indicates possible topics covered in the course.

Lecture 1: Review on power systems

Lecture 2: Summary on renewable energy sources

Lecture 3: Solar photovoltaic (solar cell, cell equivalent circuit, cell I-V curve)

Lecture 4: Solar photovoltaic (PV arrays, shading, bypass diodes, blocking diodes)

Lecture 5: Solar photovoltaic (PV maximum power point tracking)

Lecture 6: Solar photovoltaic (DC-DC converter, inverter, micro inverter)

Lecture 7: Solar photovoltaic (Grid integration of PV systems, forecasting, islanding)

Lecture 8: Energy storage (introduction on batteries, pumped hydro, supercapacitor, etc.)

Lecture 9: Energy storage (Battery equivalent circuit, charging and discharging batteries)

Lecture 10: Energy storage (PV systems with battery storage)

Lecture 11: Wind (introduction on wind turbines and wind power conversion)

**Lecture 12: Midterm Exam 1**

Lecture 13: Wind (wind turbine power curves)

Lecture 14: Wind (Average power in the wind)

Lecture 15: Wind (Wind generators, induction generator, PMSG, DFIG)

Lecture 16: Wind (Wind farm, grid integration of wind generators)

Lecture 17: Distributed generation and feed-in-tariff (FIT)

Lecture 18: Introduction on smart grid

### Lecture 19: Midterm Exam 2

Lecture 20: Student presentation (Geothermal)

Lecture 21: Student presentation (Wave and tidal)

Lecture 22: Student presentation (Concentrating Photovoltaic)

Lecture 23: Student presentation (Fuel cell)

Lecture 24: Student presentation (Biowaste and biogas)

Lecture 25: Student presentation (Electric vehicle)

### Academic Accommodation

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

**Pregnancy obligation:** write to me 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 see the Student Guide

**Religious obligation:** write to me 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 see the Student Guide

**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](mailto:pmc@carleton.ca) for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me 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, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable).

You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at <http://www.carleton.ca/equity/>