Department of Electronics
Carleton University

SREE 3003: Sustainable and Renewable Electricity Generation
Winter 2019

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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: 1:05 pm - 2:25 pm, Tuesday and Thursday, ME4236
Lab: 2:35 pm - 5:25 pm Tuesday, CB 3104 (Canal Building)

(Tentative schedule)	Lab	Lecture	Lecture
	Tuesday	Tuesday	Thursday
Week 1		Jan. 8 (1)	Jan. 10 (2)
Week 2	Guest Lecture	Jan. 15 (3)	Jan. 17 (4)
Week 3		Jan. 22 (5)	Jan. 24 (6)
Week 4	Guest Lecture	Jan. 29 (7)	Jan. 31 (8)
Week 5		Feb. 5 (9)	Feb. 7 (10)
Week 6	Guest Lecture	Feb. 12 (11)	Feb. 14 (12)
Week 7	Winter break		
Week 8		Feb. 26 (13)	Feb. 28 (14)
Week 9	PV Lab (3 groups)	Mar. 5 (15)	Mar. 7 (16)
Week 10	PV Lab (3 groups)	Mar. 12 (17)	Mar. 14 (18)
Week 11	Wind Lab (3 groups)	Mar. 19 (19)	Mar. 21 (20)
Week 12	Wind Lab (3 groups)	Mar. 26 (21)	Mar. 28 (22)
Week 13		Apr. 2 (23)	Apr. 4 (24)
Week 14		Apr. 9(25)	

Course Textbook:

G. M. Masters, Renewable and Efficient Electric Power Systems, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2012. Online version Available in Library
OR:
G. M. Masters, Renewable and Efficient Electric Power Systems, First Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2004. Online version Available in Library

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: Feb. 12, location: in class
2/3 term exam	15%	Tentative date: Mar. 19, 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. 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.
3. 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.
4. Each student will present in class at the end of the term. The performance of the presenter will be evaluated.

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 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. 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: Basics of electric circuits
Lecture 3: Summary on renewable energy sources
Lecture 4: Solar photovoltaic (solar cell, cell equivalent circuit, cell I-V curve)
Lecture 5: Solar photovoltaic (PV arrays, shading, bypass diodes, blocking diodes)
Lecture 6: Solar photovoltaic (PV maximum power point tracking)
Lecture 7: Solar photovoltaic (DC-DC converter, inverter, micro inverter)
Lecture 8: Solar photovoltaic (Grid integration of PV systems, forecasting, islanding)
Lecture 9: Energy storage (introduction on batteries, pumped hydro, supercapacitor, etc.)
Lecture 10: Energy storage (Battery equivalent circuit, charging and discharging batteries)
Lecture 11: **Midterm Exam 1**
Lecture 12: Energy storage (PV systems with battery storage)

Lecture 13: Wind (introduction on wind turbines and wind power conversion)
Lecture 14: Wind (wind turbine power curves, 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: Microgrid Systems 1
Lecture 18: Microgrid Systems 2
Lecture 19: **Midterm Exam 2**
Lecture 20: Tutorial 1
Lecture 21: Tutorial 2
Lecture 22: Student presentation (Renewable Generations)
Lecture 23: Student presentation (Renewable Generations)
Lecture 24: Student presentation (Renewable Generations)
Lecture 25: Course Material Reviews

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 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/

Graduate Attributes
The following GAs will be scored in this course: GA 1.12, GA 2.1, GA 2.2, GA 2.3, GA 2.4, GA 4.1, GA 4.2, GA 4.3, GA 4.4, GA 4.5, GA 4.6, GA 4.7.

Related GA instructions:

1. **A knowledge base for engineering:** Demonstrated competence in university level mathematics, natural sciences, engineering fundamentals, and specialized engineering knowledge appropriate to the program.
2. **Problem analysis:** An ability to use appropriate knowledge and skills to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.
3. **Design:** An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations.