University of Manitoba | Price Faculty of Engineering
Department of Electrical and Computer Engineering

Course Outline

Instructor
- Athula Rajapakse, P.Eng.
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Office Hours
- By appointment

Teaching Assistant
- TBD

Contact Hours
- 4 credit hours
- Lectures:
  3 hours x 13 weeks = 39 hours
- Laboratories:
  3 hours x 5 weeks = 15 hours

Prerequisites:
- ECE 3650 Electric Machines
- ECE 4300 Electrical Energy Systems 1

Course Website:
http://umanitoba.ca/umlearn

Traditional Territories Acknowledgement

The University of Manitoba campuses and the Department of Electrical and Computer Engineering are located on the original lands of the Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation.

We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

ECE 4860 T12 – Renewable Energy Systems

Winter 2022

IMPORTANT NOTICE

Lectures and laboratories in this course will initially be conducted via remote instruction but will return to *in-person instruction* the week of February 28th 2022. All students are required to be present for in-person instruction at that time. Furthermore, University policy requires all students to be fully vaccinated against COVID-19 in order to attend campus and participate in this course.

Course Objectives

To introduce renewable energy sources and systems used for electricity generation. The topics include the characterization of renewable energy resources, energy conversion technologies, and grid connection of renewable energy systems.

Course Content

- The role of renewable energy sources in responding to climate change.
- Hydro resource, hydro turbines, generator technologies.
- Solar resource, sun position calculation and radiation models, solar photovoltaics (PV) cells, PV cell equivalent circuits and operating characteristics, effect of shading and maximum power point tracking, PV systems.
- Wind resource, power in the wind, temperature and altitude effects, wind turbines, efficiency and Betz limit, power curves, wind turbine generators, induction generator and permanent magnet generator characteristics.
- Feasibility assessment of renewable energy systems.
- Wind and solar energy conversion technologies, , converter technology and control systems.
- Regulatory requirements of interconnection of renewable energy sources, calculation of steady state power transfer limits and effect of system strength, assessment of dynamic performance of solar and wind power plants.
- Introduction to energy storage systems, role of energy storage in renewable energy development.

Textbook

Renewable and Efficient Electric Power Systems, Gilbert M. Masters, Wiley-IEEE, second edition, 2013.

Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the *General Academic Regulations* on *Academic Integrity*, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

Copyright Notice

Learning Outcomes

1. Evaluate energy generation potential of hydro and wind sites.
2. Predict the instantaneous and long-term output of solar PV systems.
3. Assess the life cycle cost of renewable electricity generating systems.

Important Dates

- **Term Test**
  Friday, March 18th, 2022
  6:00PM – 8:00PM
- **Voluntary Withdrawal Deadline**
  April 25th, 2022
- **Louis Riel Day**
  February 21st, 2022
  No classes or examinations
- **Spring Break**
  February 22nd – 25th, 2022
  No classes or examinations
- **Good Friday**
  April 15th, 2022
  No classes or examinations

Accreditation Details

Accreditation Units

- Mathematics: 0%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 100%
- Engineering Design: 0%

Graduate Attributes

KB: A knowledge base for engineering
PA: Problem analysis
IN: Investigation
DE: Design
ET: Use of engineering tools
IT: Individual and team work
CS: Communication skills
PR: Professionalism
IE: Impact of engineering on society/ environment
EE: Ethics and equity
EP: Economics and project management
LL: Life-long learning

Competency Levels

1 - Knowledge (Able to recall information)
2 - Comprehension (Ability to rephrase information)
3 - Application (Ability to apply knowledge in a new situation)
4 - Analysis (Able to break problem into its components and establish relationships.)
5 - Synthesis (Able to combine separate elements into a whole)
6 - Evaluation (Able to judge the worth of something)

4. Explain the structure and control of wind and solar energy conversion systems.
5. Analyze the steady state operating limits and dynamic performance of grid connected solar and wind generation systems with respect to regulatory requirements.

Expected Competency Levels

Outcome	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
1	3	4	4		3		1		1			3
2	5	4	4	3	3		1		1			1
3	3	3	3		3		1				1	1
4	2	2	2		3		1					1
5	4	4	3		3		1					1

CEAB Graduate Attributes Assessed

KB.4 – Recalls and defines, and/or comprehends and applies information, first principles, and concept in specialized engineering science.

DE.3 – Develops/implements possible solutions to an open-ended design problem, leading to an appropriate recommendation.

Evaluation

The final course grade is determined by the student's performance in laboratories, on the project and presentation, and on an examination. Students must complete all the laboratories in order to be eligible to receive a passing grade.

Component	Value (%)	Method of Feedback	Learning Outcomes Evaluated
Assignments	20	F, S	1, 2, 3, 4, 5
Laboratories	15	F, S	1, 2, 3, 4, 5
Term Test	25	F, S	1, 2, 3
Final Examination	40	S	1, 2, 3, 4, 5

* Method of Feedback: **F** - Formative (written comments and/or oral discussion), **S** - summative (numerical grade)

Requirements/Regulations

- Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a passing final grade.
- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with the University's General Academic Regulations, as well as Section 3 of the Faculty of Engineering Academic Regulations dealing with incomplete term work, deferred examinations, attendance and withdrawal.
- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, wireless communication or data storage devices) are allowed in examinations unless approved by the course instructor.
- Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices as well as documentation of key University policies e.g. Academic Integrity, Respectful Behaviour, Examinations and related matters.

Supplemental Resources

Grading Scale

Letter	Mark
A+	95–100
A	85–94
B+	80–84
B	70–79
C+	65–69
C	55–64
D	45–54
F	< 45

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure consistency of grading from year-to-year.

Retention of Student Work

Students are advised that copies of their work submitted in completing course requirements (i.e. assignments, laboratory reports, project reports, test papers, examination papers, etc.) may be retained by the instructor and/or the department for the purpose of student assessment and grading, and to support the ongoing accreditation of each Engineering program. This material shall be handled in accordance with the University's *Intellectual Property Policy* and the protection of privacy provisions of *The Freedom of Information and Protection of Privacy Act (Manitoba)*. Students who do not wish to have their work retained must inform the Head of Department, in writing, at their earliest opportunity.