Instructor: Prof. Ravi Prakash

Email: ravi.prakash@carleton.ca

Office: 5160 Mackenzie Building

Ph: 613-520-2600 ext. 5758

Office hours: Mondays, 1 pm – 4:30 pm (Please email me in advance if you need advising for more than 30 mins)

Teaching Assistants:

1. Md Abduhu Ruhul Fatin, Email: mdabduhuruhulfatin@cmail.carleton.ca Office hours: TBD
2. Ivan Amor, Email: ivan.amor@carleton.ca Office hours: TBD

Marking Scheme (Tentative)[a,b]: Quiz: 10%; Midterm: 20%; Labs 30% (4x5% + 10%); Final Exam: 40%
[a]The final exam is exclusively for the purpose of evaluating student performance and will not be returned.
[b]You must obtain a grade > 50% on the final exam to pass the course.

Website: Course information will be posted on **cuLearn** (https://www.carleton.ca/culearn/). Check it at least weekly for course related information (schedule changes for instance), lab instructions, and additional material.

Lectures:
Time: Wednesdays and Fridays: 11:35 – 12:55
Location: Mackenzie Building, Room: 4236
Note: February 18th -23rd: No classes or labs during the winter reading break.

Lab Sessions: Labs will be conducted in ODD weeks starting week 1.
Time: Mondays: 08:35 – 11:35
Location: Mackenzie Building, Room: 4135

Description: As part of the laboratory activities, you will be designing and testing a silicon solar cell that will be fabricated in Carleton's Microfabrication facility. There are 5 labs sessions for this course. An introductory lab will be held on Jan. 7th. Details of report requirements will be posted shortly on cuLearn. Brief outline of lab activity is provided below.

Lab 0: Introduction to Solar Cell testing setup
Lab 1: Simulation and analysis of the effect of doping concentrations on cell performance
Lab 2: Design of the front metal contact grid
Lab 3: Analysis and design of the anti-reflection coating
Lab 4: Solar cell testing part 1
Lab 5: Solar cell testing part 2

Additional reading material: I will provide text excerpts and written lecture notes as necessary course reading materials. In addition, I will also share web-based additional learning resources that students can utilize. The following texts are not mandatory but may serve as useful reading material.

Reference texts:
S. R. Wenham, M. A. Green, M. E. Watt, and R. Corkish, Applied Photovoltaics, Earthscan, 2007.
S. Pizzini (Editor), Advanced Silicon Materials for Photovoltaic Applications, Wiley, 2012. (electronic)
S. Fonash, Solar Cell Device Physics, Elsevier, 2nd Ed., 2010. (electronic)

Suggested Reading:
1. http://pveducation.org/pvcdrom
2. S.M. Sze, Physics of Semiconductor Devices, Wiley, 2006.
3. P. A. Lynn, Electricity from Sunlight: an introduction to photovoltaics, Wiley, 2010.

Course Schedule:

Week 1: Solar Radiation
Week 2: Review of semiconductor materials and P-N junction
Week 3-4: Solar cell operation and properties
(**Quiz 1 in week 4**; Date: TBD)
Week 5-6: Design of silicon solar cells
Winter break: February 18-23
Midterm exam: (Duration: 60 minutes): February 28
Week 7-8: Fabrication of silicon solar cells
Week 9-10: Characterization
Week 11-12: PV modules and systems

Learning Objectives:

Upon successful completion of this course, students will be able to:
1. Determine the solar spectrum or light source spectrum.
2. Determine the photon energy as well as the material absorption.
3. Understand the relationship between photon energy and material absorption.
4. Calculate the bandgap energy, bandgap wavelength.
5. Understand the temperature effects on solar cell performance (eg, bandgap energy, IV characteristics)
6. Understand the bandgap effects on the IV characteristic of solar cells.
7. Understand the fabrication process of a simple homojunction solar cell.
8. Design an optimal anti-reflection coating/coating stack to reduce reflection and increase efficiency.
9. Design an optimal finger/busbar metal grid system for efficient current collection.
10. Understand the difference between series and shunt parasitic resistances.
11. Understand the design trade-off for efficient and economic solar cells.
12. Determine the shading losses and the recombination losses.
13. Determine the total losses due to the solar module design.
14. Design an optimal solar PV module by utilizing blocking and bypass diodes.
15. Calculate carrier lifetime based on the doping level and temperature.
16. Understand the limiting factors for overall efficiency of the solar PV module.
17. Design optimal tandem PV cells.
18. Complete an optimal design on a single junction silicon based solar cell.
19. Test and characterize the solar cells fabricated using the design parameters using a solar simulator.
20. Provide design improvements to enhance the solar cell efficiency.

Plagiarism and Cheating

The Carleton University Academic Integrity Policy defines principles and consequences of student academic integrity (http://carleton.ca/senate/wp-content/uploads/Academic-Integrity-Policy1.pdf). Instructors, advisors and/or supervisors must report all suspected cases of violation of this Policy to the Faculty Dean who will review the case and recommend the appropriate sanction.

Academic Accommodation

You may need special arrangements to meet your academic obligations during the term.

To arrange accommodation for pregnancy or 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 (https://carleton.ca/equity/accommodation/academic/students/)

To arrange accommodation for a disability, please contact The Paul Menton Centre for Students with Disabilities (PMC)): http://carleton.ca/pmc/students/accommodations/

For support regarding human rights and related issues, please contact Equity Services (https://carleton.ca/equity/).