

EE 446/646 – Photovoltaic Devices and Systems

Course Syllabus

Instructor: Dr. Y. Baghzouz

Office Room # SEB-2167

Tel. # 895-0887

Fax # 895-4075

Email address: baghzouy@unlv.nevada.edu

Office Hours: 1:00-2:30 and 4:00-5:00 TR, and 11:00-12:00 W

Book Title: Gilbert M. Masters, Renewable and Efficient Electric Power Systems, 2nd Edition, Wiley, ISBN 978-1-118-14062-8

References:

1. <http://energy.gov/eere/renewables>
2. Applied photovoltaics, S.R. Wenham, 2007
3. Third generation photovoltaics: Advanced Solar Energy Conversion, M.A. Green, 2006.
4. Polycrystalline thin-film photovoltaics : from the laboratory to solar fields, B. von Roedern, H.S. Ullal, and K. Zweibel, 2006
5. Photovoltaics : design and installation manual : renewable energy education for a sustainable future - Solar Energy International
6. Organic photovoltaics : concepts and realization , C.J. Brabec, 2003
7. Photovoltaic systems / James P. Dunlop, 2010
8. Multijunction photovoltaic technologies for high-performance concentrators [electronic resource] : preprint / R. McConnell and M. Symko-Davies, 2006
9. Photovoltaic incentive design handbook / T.E. Hoff, 2006
10. Photovoltaic Solar Energy Generation / by H.K.V. Lotsch
11. Modeling photovoltaic systems using PSpice / Luis Castañer and Santiago Silverstre
12. IEEE Photovoltaics Specialists Conference Proceedings

Pre- and Co-requisites:

MATH 182 or consent of instructor.

Course Content:

- **Renewable Energy Systems** (Chap. 8): direct solar power conversion (PV), concentrating solar power, wind power, hydro power, biomass, geothermal power, ocean power
- **Solar Resource** (Chap. 4): solar spectrum, sun position, sun path diagrams, solar and clock times, clear sky insolation on a collecting surface, solar radiation measurements, resource of solar data.
- **Photovoltaic Materials** (Chap 5): semiconductor physics, photovoltaic materials, types of cells (Silicon, thin film, multi-junction, organic), cell materials and construction,

- **PV Electrical Characteristics** (Chap 5): equivalent circuit of a PV cell, modules and arrays, I-V curves, impact of temperature, shading impacts.
- **Grid-Connected PV Systems** (Chap 6): interfacing with the power grid, system sizing, and economic considerations.
- **Stand-Alone PV Systems** (Chap 6): load estimation, batteries and their properties, array and battery sizing, hybrid-PV systems, case study of PV-powered water pumping.
- **Other Related Topics:** IEEE Standard 1547, industry trends, microgrids, etc

Computer Usage:

PVWATTS, Excel

Course Outcome:

Students should be able to:

1. Locate the sun position at any given location and time, interpret sun path diagrams, analyze solar insolation on a collecting surface, and measure solar radiation measurements.
2. Understand the inner workings of p-n junctions, determine a circuit model of a PV cell, PV module and PV array, measure and interpret I-V curves, understand the impact of temperature and solar insolation on I-V curves, have a broad knowledge on different types PV technologies and their limitations.
3. Determine the operating point of basic electrical loads connected directly to a PV module or array.
4. Design a grid-connected PV system, including the PV array and balance of system (BOS), conduct an economic analysis, and be familiar with the impact of high PV penetration on the utility grid.
5. Have basic knowledge on different types of batteries and their electrical characteristics.
6. Design a stand-alone PV system by estimating the load, sizing and selecting the batteries, sizing and selecting the PV modules, charge controller and inverter.
7. Have basic knowledge on codes and standards associated with PV Systems.

Tests:

		Value
Midterm	Solar resource, i-v curves	30 Pts
Quizzes	15 min each – once every 10 days	30 Pts
Final	Covers all course material	40 Pts
Total		100 Points

Grading:

A ≥ 85 > B ≥ 70 > C ≥ 60 > D ≥ 50 > F

Notes:

- Graduate students will be given more challenging test questions.
- There will be no make-up tests or quizzes.
- Class attendance and participation is highly encouraged.

Student Resources and University Policies:



Academic Misconduct—Academic integrity is a legitimate concern for every member of the campus community; all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility, and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy and are encouraged when faced with choices to always take the ethical path. Students enrolling at UNLV assume the obligation to conduct themselves in a manner compatible with UNLV's function as an educational institution. An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another, from the Internet or any source, without proper citation of the sources. See the *Student Academic Misconduct Policy* (approved December 9, 2005) located at: <https://www.unlv.edu/studentconduct/student-conduct>.



Copyright—The University requires all members of the University Community to familiarize themselves with and to follow copyright and fair use requirements. You are individually and solely responsible for violations of copyright and fair use laws. The university will neither protect nor defend you, nor assume any responsibility for employee or student violations of fair use laws. Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional information can be found at: <http://www.unlv.edu/provost/copyright>.



Disability Resource Center (DRC)—The UNLV Disability Resource Center (SSC-A 143, <http://drc.unlv.edu/>, 702-895-0866) provides resources for students with disabilities. If you feel that you have a disability, please make an appointment with a Disabilities Specialist at the DRC to discuss what options may be available to you. If you are registered with the UNLV Disability Resource Center, bring your Academic Accommodation Plan from the DRC to the instructor during office hours so that you may work together to develop strategies for implementing the accommodations to meet both your needs and the requirements of the course. Any information you provide is private and will be treated as such. To maintain the confidentiality of your request, please do not approach the instructor in front of others to discuss your accommodation needs.



Final Examinations—The University requires that final exams given at the end of a course occur at the time and on the day specified in the final exam schedule. See the schedule at: <http://www.unlv.edu/registrar/calendars>.



Incomplete Grades—The grade of I—Incomplete—can be granted when a student has satisfactorily completed three-fourths of course work for that semester/session but for reason(s) beyond the student's control, and acceptable to the instructor, cannot complete the last part of the course, and the instructor believes that the student can finish the course without repeating it. The incomplete work must be made up before the end of the following regular semester for undergraduate courses. Graduate students receiving "I" grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the time indicated, a grade of F will be recorded and the GPA will be adjusted accordingly. Students who are fulfilling an Incomplete do not register for the course but make individual arrangements with the instructor who assigned the I grade.



Religious Holidays Policy—Any student missing class quizzes, examinations, or any other class or lab work because of observance of religious holidays shall be given an opportunity during that semester to make up missed work. The make-up will apply to the religious holiday absence only. It shall be the responsibility of the student to notify the instructor within the first 14 calendar days of the course for fall and spring courses (excepting modular courses), or within the first 7 calendar days of the course for summer and modular courses, of his or her intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit: <http://catalog.unlv.edu/content.php?catoid=6&navoid=531>.



Rebelmail—By policy, faculty and staff should e-mail students' Rebelmail accounts only. Rebelmail is UNLV's official e-mail system for students. It is one of the primary ways students receive official university communication such as information about deadlines, major campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the university. Students' e-mail prefixes are listed on class rosters. The suffix is always @unlv.nevada.edu. **Emailing within WebCampus is acceptable.**



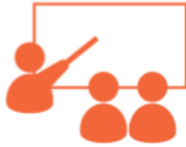
Library Resources—Students may consult with a librarian on research needs. Subject librarians for various classes can be found here: https://www.library.unlv.edu/contact/librarians_by_subject. UNLV Libraries provides resources to support students' access to information. Discovery, access, and use of information are vital skills for academic work and for successful post-college life. Access library resources and ask questions at <https://www.library.unlv.edu/>.



UNLV Writing Center—One-on-one or small group assistance with writing is available free of charge to UNLV students at the Writing Center, located in CDC-3-301. Although walk-in consultations are sometimes available, students with appointments will receive priority assistance. Appointments may be made in person or by calling 702-895-3908. The student's Rebel ID Card, a copy of the assignment (if possible), and two copies of any writing to be reviewed are requested for the consultation. More information can be found at: <http://writingcenter.unlv.edu/>.



Tutoring and Coaching—The Academic Success Center (ASC) provides tutoring, academic success coaching and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, visit <http://www.unlv.edu/asc> or call 702-895-3177. The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of SSC A (ASC Coaching Spot). Drop-in tutoring is located on the second floor of the Lied Library and College of Engineering TBE second floor.



Transparency in Learning and Teaching—The University encourages application of the transparency method of constructing assignments for student success.

Please see these two links for further information:

- <https://www.unlv.edu/provost/teachingandlearning>
 - <https://www.unlv.edu/provost/transparency>
-