# APHY 522 Photovoltaics

## Course Description

Photovoltaics. (3) Physics of photovoltaic systems, including basic operating principles, design and technology, and performance of individual solar cells and solar cell systems.

Prerequisite: PHYC 260; MATH 162 or 166. (3 credit hours)

Not open to students who have credit in APHY 422.

## Course Objectives

The goal is to provide students with basic knowledge and training in the fundamentals of photovoltaic systems. An objective is student learning of the physical principles on which photovoltaic technologies are based. An objective is to familiarize students with the various types of photovoltaic cells, with emphasis on silicon solar cells. An objective is to teach students about the design aspects of solar cells. An objective is student learning about the components and functions of components of photovoltaic systems.

## Course Rationale

The depletion of fossil energy resources and the need for environmentally benign energy sources will result in increased world reliance on solar energy in its various forms. Small solar cell systems are now used in many applications where considerations include remote locations, the nature of the load, and/or legal, aesthetic, independence, and conservation issues. Photovoltaic systems will increasingly be used for peak and base load electrical power generation. The collection, direct conversion of solar to electrical energy, and the distribution and end uses of photovoltaic-generated electrical energy are the topics of this course. This course is designed to serve the needs of students with interests in the technical aspects of solar cell systems. The course lays the technical foundation for students to work in the photovoltaics industry.

## Course Content, Format, and Bibliography

*Content*

The basic physics of the photovoltaic effect;

The materials, fabrication techniques, and testing of semiconductor solar cells;

The descriptive equations for the current-voltage characteristics and power characteristics of the solar cell;

Semiconductor properties important to the operation of solar cells;

The generation, recombination, and transport of charge carriers in semiconductors;

The properties and theories of p-n junction diodes;

The effects of sunlight intensity and spectral content on solar cell operation;

The effects of temperature on solar cell operation;

Limits of the efficiency of solar cells;

Silicon solar cell technology and the design of silicon cells;

Concentrating photovoltaic systems;

Components of photovoltaic systems.

*Format*

Several teaching methods are used in this course to achieve the course objectives. Some descriptors of these methods include lecture, peer instruction, cooperative problem-solving, class discussions of conceptual questions and technology applications, live demonstrations, computer simulations, video clips, and web-based assignments. These methods provide a range of pedagogical opportunities for students to achieve the course objectives.

This course is taught as a dual undergraduate/graduate course. Students will be required to complete activities appropriate for the level of the course in which they are enrolled. Student performance on homework, exams and/or labs will be evaluated using different standards for undergraduate and graduate students.

*Bibliography*

Silicon Solar Cells: Advanced Principles & Practice, M. Green, U. New South Wales, 1994.

Applied Photovoltaics, S. Wenham, M. Green, and M. Watt, U. New South Wales, 1994.

Solar Cells, Operating Principles, Technology, and System Applications, M. Green, Prentice-Hall, 1982.

Practical Photovoltaics: Electricity from Solar Cells, R. Komp, Aatec Pubns; 3.1 edition (February 2002).

Solar Electricity, 2nd ed., T. Markvart (Editor), John Wiley & Sons; 2nd ed. (May 12, 2000).

Silicon Processing for Photovoltaics, I and II (Materials Processing, Theory and Practices, Vols 5 and 6), Chandra P. Khattak, K.V. Ravi (Editor) Elsevier Science Ltd; ASIN: 0444869336; (October 1985).