

APHY 520 Solar Thermal Systems

Catalog Description

Physics of the solar energy resource, solar collection, concentration, thermal conversion, energy storage, and the design and performance of solar thermal energy systems. (3 credit hours)

Prerequisite: PHYC 122; MATH 162 or 166

Not open to students who have credit in APHY 420.

Course Objectives

Course objectives include learning:

About the nature, quality and quantity of the solar radiation resource and about methods to predict the amounts of solar energy incident on a solar collector;

How to analyze the optical and thermal performance of solar collectors and concentrators;

How to describe and model the various methods for transporting and storing thermal energy;

About the characterization and measures of end loads;

About solar energy system design and performance modeling.

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. Supplying thermal energy in various temperature regimes for a myriad of tasks and processes is a primary end use of our energy resources. The collection of solar energy, its conversion to thermal energy, thermal energy transport, and the end uses of that energy are the topics of this course.

Course Content, Format, and Bibliography

Content

Introduction: Energy statistics, exponential growth, conservation

Solar radiation

Radiation characteristics of opaque and transparent materials

Selected topics in heat transfer

Methods for solar collection: Concentrating and non-concentrating collectors

Active solar thermal systems

Theory of flat plate collectors

Flat plate collector performance

Concentrating collectors

Solar thermal process loads

Thermal energy transfer and storage

Component thermal calculations

System modeling, design and analysis

Solar water heating

Solar space heating

Industrial process heating

Solar cooling systems

Passive solar thermal systems

Basic types and components

Design patterns

Direct gain, storage wall, greenhouse, and other systems

Thermal loads

Thermal energy transfer and storage

Component thermal calculations

System modeling, design and analysis

Solar water heating

Solar space heating

Solar cooling 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 programs, and hands-on laboratory experimentation in a team format. 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

Solar Engineering of Thermal Processes, J. Duffie and W. Beckman, John Wiley & Sons, 1991.

Solar Thermal Engineering, P. Lunde, John Wiley & Sons, 1980.

The Sun, D. McDaniels, John Wiley & Sons, 1984.

Principles of Solar Engineering, F. Kreith and J. Kreider, McGraw-Hill Book Company, 1978.

Introduction to Solar Technology, M. Fisk and H.C. Anderson, Addison-Wesley Publishing Company, 1982.

The Passive Solar Energy Book, E. Mazria, Rodale Press, 1979.

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