

COURSE NUMBER: ME 5312, 4 credits	COURSE TITLE: Solar Thermal Engineering
TERMS OFFERED: Spring, alternate even years.	PREREQUISITES: ME 3331, 3332, 3333 Thermal Sciences I, II, III, IT upper division or Grad student.
TEXTBOOKS/REQUIRED MATERIAL: “Solar Thermal Engineering of Thermal Processes” by J.A. Duffie and W.A. Beckman, Wiley.	PREPARED BY: Jane H Davidson DATE OF PREPARATION: May 2007
COURSE LEADER(S): J.H. Davidson	CLASS/LABORATORY SCHEDULE: Two 90 minutes sessions per week CONTRIBUTION OF COURSE TO MEETING PROFESSIONAL OBJECTIVES: 100 % Engineering Topics
CATALOG DESCRIPTION: In this course we will start with consideration of solar energy itself, including radiation fundamentals, measurement, and data processing required to predict solar irradiance with respect to time, location and orientation. Then we will examine the characteristics of various components in solar thermal systems (with particular emphasis on flat plat and concentrating collectors, heat exchangers, and thermal storage) to understand how they work and how their performance is influenced by their design. This will lead us to an examination of systems and system performance, including system design, predicted energy savings and economics. The focus will be on low temperature applications for solar hot water, space heating and water distillation. Concentrating solar energy, including solar thermo-chemical processes to produce hydrogen and solar power systems, and photovoltaics will be introduced. A solar design project will be assigned.	COURSE TOPICS: <ol style="list-style-type: none"> 1. Overview of current technology and emerging trends in the application of solar energy systems 2. Introduction to solar thermal design systems 3. Solar radiation: definitions, angles, extraterrestrial radiation, spectral radiation properties, radiation on sloped surfaces. 4. Solar radiation measurement and data processing 5. Heat Transfer analysis of flat-plate collectors with review and application of radiation, conduction and convective heat transfer. 6. Liquid and air collector characterization and test procedures. 7. Heat exchanger design and characterization 8. Energy storage, both sensible and phase change 9. Solar process loads 10. System analysis and computational tools to predict annual energy savings 11. Optical considerations for concentrating collectors. 12. Introduction to solar chemistry to produce hydrogen in concentrating systems 13. Introduction to photovoltaic systems and their application 14. Design methods including f-Chart and Utilizability 15. Economic analyses of solar systems including payback and life cycle costing

COURSE OBJECTIVES	<ol style="list-style-type: none"> 1. Apply thermodynamic principles to determine the thermal performance (energy savings) of solar thermal systems 2. Apply fundamental principles of conductive, radiative, and convective heat transfer to the design analysis of solar energy components 3. Strengthen understanding of basic radiation through analysis of solar radiation data and collector design 4. Obtain physical insight unique to solar thermal systems, in particular the limitations imposed by individual component design and operating conditions. 5. Strengthen understanding of chemical thermodynamics through the analysis of high temperature production of hydrogen in several chemical systems. 6. Apply economic analysis to evaluate various energy production technologies 7. Gain a working knowledge of the theory of photovoltaic solar cells. 8. Apply state of the art simulation tools to evaluate solar systems for specific application and geographic locations. 9. Carry out a team design project to size and cost a solar system.
COURSE OUTCOMES	<p>(Letters shown in brackets are linked to program outcomes a-k)</p> <ol style="list-style-type: none"> 1. Consider the solar energy options and role of solar energy in achieving a sustainable energy future.[f, h, j] 2. Demonstrate the application of mass, momentum, energy balances applied to solar thermal systems and their design.[a, c, e] 3. Understand the measurement of solar radiation and analyze available data to predict solar irradiance as a function of time, geographic location and orientation[a, b, e, h, j] 4. Apply heat transfer analysis to collectors, heat exchangers and thermal storage.[a, e] 5. Use f-chart or other appropriate software to design solar thermal systems[a, c, e, j, k] 6. Understand how photovoltaic cells operate[a, e] 7. Understand thermo-chemical processes to produce solar fuels [a, e, j] 8. Apply economic analyses to evaluate solar and competing non-solar technologies[a, e, h, j, k] 9. Work as part of a team to design a solar system and present the design in a class presentation and written report [a, c, d, e, g, k]
ASSESSMENT TOOLS:	<ol style="list-style-type: none"> 1. Exams (1 mid-term and 1 final exam) 2. In class problems & discussion 3. Homework problem sets 4. Design project

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Nature of Changes:

This document was reviewed by Jane Davidson May, 2007 and no changes were made.