Course: ENPM 650 – Solar Thermal Energy Systems
Semester: Spring 2022
Day: Wednesday
Time: 7:00- 9:40PM
Location: JMP 2217and online via DETS
Instructor: Prof. B. Valentine
Phone: (571) 337-7447
Email: bvalent2@umd.edu

Course Description

This course will start with a careful review of thermodynamic and heat transfer analysis of thermal systems. The course will introduce low temperature solar applications such as solar hot water, space heating and water distillation, as well as solar energy for solar thermo-chemical processes to produce hydrogen. Finally, we make a detailed study of solar power generation systems. A project of importance to the development of Solar Thermal Power Systems will be assigned. There will be two assignments using the energy systems modeling software, TRNSYS.

ELMS website: https://umd.instructure.com/login

Prerequisites: Undergraduate level courses in thermodynamics, heat transfer, and fluid mechanics, at least one semester each.

Office: 2246 Martin Hall by appointment. Send me an email, arrangements can be made anytime. Call me on the telephone anytime.

Student learning goals: The course goal is to provide the knowledge needed to design renewable energy thermal systems from first principles and determine the costs and overall performance of these. Solar systems will be compared with conventional and other renewable energy systems.

Course Schedule and Due Dates: See attached schedule.

Expectations for Students: Students will not collaborate with anyone on their homework assignments or on their course project. There will be no exams for this course, only homework assignments.

Grading procedures:
Homework assignments: 60%
Course Project: 40%

Textbook:

Solar Energy Engineering: Processes and Systems, 2nd edition by Soteris A. Kalogirou (2213) (required) – Available free online, but not used much.

Detailed Syllabus

Fundamentals of Engineering applied to Thermal Systems

Week 1	Wed	1/26/22	➢ Course overview and objectives • Overview of learning objectives • Overview of topics to be covered	
	Wed	1/26/22	➢ Course Project assignment and discussion • Introduction to TRNSYS modeling software • Overview of course assignments	
2	Wed	2/2/22	➢ System thermal analysis: Thermodynamics • First and second laws • Ideal work and lost work	HW #1 Assigned
	Wed	2/2/22	➢ System Thermal Analysis • Thermodynamic applications	
3	Wed	2/9/22	➢ System Thermal Analysis • Second law analysis	
	Wed	2/9/22	➢ System Thermal Analysis • Second law applications	
4	Wed	2/16/22	➢ System Thermal Analysis • Intro to Radiation Heat transfer	HW #1 Due HW #2 Assigned
4	Wed	2/16/22	➢ System Thermal Analysis • Radiation heat transfer calculations	
5	Wed	2/23/22	➢ System Thermal Analysis • Solar Radiation Heat Transfer • Combined Mode Heat Transfer	

5	Wed	2/23/22	➢ Solar thermal energy calculations • Flat plate solar collector analysis	
6	Wed	3/2/22	➢ Hot water heat using flat plate solar collectors • System design from charts	HW #2 Due HW #3 Assigned (using TRNSYS)
	Wed	3/2/22	➢ Assignment using TRNSYS simulator • Hot water supply calculation	
7	Wed	3/9/22	➢ Solar cooling • Refrigeration cycles • Refrigeration analysis	
	Wed	3/9/22	➢ Solar cooling • Absorption refrigeration • Adsorption refrigeration	
8	**Spring Break**			
Use of Solar Thermal Energy in Buildings and Industry				
9	Wed	3/23/22	➢ Office/factory space heating and cooling systems • Building designs for solar space heating • Heating and cooling load calculation for offices and commercial buildings	HW #3 Due HW #4 Assigned
9	Wed	3/23/22	➢ Solar building technologies • Energy efficient widows • Building design for energy efficiency	

10	Wed	3/30/22	➢ Solar lighting • Daylighting systems • Daylighting calculations • Lighting design	
11	Wed	4/6/22	➢ Other solar thermal applications • Solar desalination • Solar ponds • Hydrogen generation using solar thermal energy	**Friday April 2: Project due**
Solar Thermal Power				
11	Wed	4/6/22	➢ Intro to Solar Thermal Power Systems • Solar concentration • Concentrator design • Optical analysis • Thermal Storage	
12	Wed	4/13/22	➢ The design of solar thermal concentrating collectors: Parabolic trough collectors • Design of the trough for heat collection • Calculation of the heat transfer rates • Analysis of losses in the system	HW #4 Due HW #5 Assigned
	Wed	4/13/22	➢ The design of solar thermal concentrating collectors: Linear Fresnel collectors • Analysis of loss in collection and concentration of sunlight • Analysis of errors introduced • Solar radiation alignment for linear Fresnel collectors	
13	Wed	4/20/22	➢ The design of solar thermal concentrating collectors: linear Fresnel collectors (cont.) • Analysis of fault mechanisms of linear Fresnel collectors • Parasitic power considerations	
	Wed	4/20/22	➢ The design of solar thermal concentrating collectors: Parabolic dish collectors • Parabolic dish collector design • Analysis of loss in collection and concentration of sunlight • Analysis of errors introduced • Tracking systems for parabolic dish collectors	
14	Wed	4/27/22	➢ The design of solar thermal concentrating collectors: Parabolic dish collectors (cont.) • Calculation of efficiencies in heat collector for Stirling engines • Analysis of fault mechanisms of the dish and the engine • Engine mounting considerations	

	Wed	4/27/22	➢ The design of solar thermal concentrating collectors: Central receiver systems • Central receiver design • Complete analysis of loss in collection and concentration of sunlight • Analysis of errors introduced • Heliostat alignment	
15	Wed	5/4/22	Course summary	HW #5 Due Final problems assigned
	Wed	5/4/22	**Employment opportunities with your educational preparation**	
16	**Final exam week. Final problems due Friday 5/14/2022**			