

Solar Energy Utilization - EML 4930/6417

Fall 2021 Syllabus

MWF Period 3 (9:35 AM –10:25 AM)



Course Location: CSE E122. Recorded lectures will be made available through Canvas immediately following lecture.

Course Description: Gain an understanding of the fundamentals of solar radiation; apply basic heat transfer and thermodynamic topics to solar engineering applications; learn fundamentals of solar concentrating devices and flat plate solar absorbers; critically evaluate state of the art solar technologies, including thermal storage, concentrating power generation systems, thermochemical storage technologies, electrochemical storage technologies and photovoltaic systems. *Prerequisites:* None. *Credits:* 3

Instructor: Prof. Jonathan Scheffe, Department of Mechanical and Aerospace Engineering, *Office:* MAE-A 208, *Email:* jscheffe@ufl.edu, *Office Phone:* 352-392-0839

Graduate TA: Caroline Hill, Department of Mechanical and Aerospace Engineering, *Office:* MAE-A 315, *Email:* caroline.hill@ufl.edu

Graduate Grader: Faisal Altwijri, Department of Mechanical and Aerospace Engineering, *Email:* faltwijri@ufl.edu

Textbook: No textbook is required for this class. Material will be taken from a variety of sources and relevant readings will be available electronically on Canvas using the “Course Reserves” tab or as otherwise noted. Relevant textbooks for the course are indicated below.

“*Solar Engineering of Thermal Processes*”; John A. Duffie and William Beckmann; Wiley (**This will be used most often and is available for free electronically through UF libraries**)

“*Principles of Solar Engineering*”; Yogi Goswami; CRC Press

Complimentary Textbooks

Thermodynamics Textbook – your preference, e.g. “*Fundamentals of Engineering Thermodynamics*”; Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Baily; Wiley;

Heat Transfer Textbook – your preference, e.g. “*Fundamentals of Heat and Mass Transfer*”; Bergman, Lavine, Incropera, Dewitt; Wiley

Calculus Textbook – your preference

Optics Textbook – “*Nonimaging Optics*”; Winston, Roland; Miñano, Juan C; Benítez, Pablo; Welford, W. T; Elsevier or “*Introduction to Nonimaging Optics*”; Chaves, Julio; CRC Press

Other Useful Course Related Resources:

Thermochemical Tables - <https://janaf.nist.gov/>

Thermophysical Properties - <https://webbook.nist.gov/chemistry/fluid/>

NIST Chemistry WebBook - <https://webbook.nist.gov/chemistry/>

Python and Jupyter - <https://www.anaconda.com/>

Cantera - <https://cantera.org/>

Office Hours: Zoom office hours for Prof. Scheffe and TA's are indicated below. Zoom links are provided in the Canvas course shell under the "Zoom Conferences" tab.

	Monday	Tuesday	Wednesday	Thursday	Friday
8:30 - 10:00					
10:00 - 11:30		Scheffe			
12:30 - 14:00	Hill				
14:00 - 15:30			Hill	Scheffe	
15:00 - 16:30					
16:00 - 17:30					

Online Course Information: Canvas

Course Objectives: The objective of this course is for students to learn about solar energy and techniques to utilize it efficiently and cost effectively. Students will learn about the fundamentals of solar energy necessary for designing a wide array of solar utilization systems. A substantial portion of the class will be devoted to the conversion of sunlight to heat for either direct usage or further conversion to other energy carriers. This includes high technology readiness level (TRL) technologies such as solar hot water heaters and concentrated solar power plants and lower TRL technologies such as thermochemical processes for the production and storage of sunlight as fungible fuels. Students will also learn about direct photo-conversion and electro-conversion methods with high and low TRL levels. These include industrially viable technologies such as photovoltaic cells and laboratory scale technologies such as photo-electrochemical conversion methods.

Relevance: All (or almost all) energy ultimately is derived from the sun. In nature, the sun's photons are converted to heat, wind, biomass and rain, all of which can be further transformed into heat, work or electricity via a number of processes and thermodynamic cycles; or given enough time even broken down into hydrocarbon based fuels. The sun's photons may also be actively captured with various technologies and utilized to drive a wide variety of more efficient processes than nature is capable. Technologies range from the production of industrial waste heat, electricity, chemical commodities or potential energy in the form of chemical bonds (e.g. H₂). This may be achieved by absorbing the sun's photons as heat (e.g. think absorption of black surface on a hot sunny day, or even better using optics such as a magnifying glass to concentrate sunlight further prior to absorption) or directly driving chemical processes using the photons directly (photovoltaic conversion, photosynthesis, either natural or artificial).

Grading: A: 93-100, A-: 90-92, B+: 87-89, B: 83-86, B-: 80-82, C+: 77-79, C: 73-76, C-: 70-72, D+ 67-69, D: 63-66, D-: 60-62, Fail: <60

Grading Scale: Participation: 10% Homework: 25%, Exam 1: 20%, Exam 2: 20%, Final Group Report/Presentation: 25%

Participation: Participation will be based on attendance and feedback during guest seminars.

Homework: A series of homework questions will be provided every one to two weeks to complete. Assignments will be given at least one week prior to their due date (during class and posted on Canvas), and must be turned in electronically through Canvas prior to class on the due date. 50% of the grade will be based on correctness of the work and 50% based on effort. All homework must be submitted as a pdf through Canvas.

Exams: Two mid-term exams will be given. Each mid-term examination is worth 20% of the course grade. All exams will be graded based on the correctness of final answers but partial credit will be given. 100% credit will be given for correct answers with appropriate work shown. Full credit will be given for answers that are incorrect because of previously incorrect answers (i.e. cascading effects will not be possible). No examinations will be dropped.

Equation Sheet: We will provide a weekly updated and comprehensive equation sheet with relevant equations that you can use on homework and exams. This will be available in the Canvas files folder. For exams, we will provide the equation sheet (i.e. do not print it off on your own).

Final Group Report and Presentations: *Undergraduate Students* – Teams of 4-5 students will prepare a 15 minute presentation on a topic to be determined. *Graduate Students* – Teams of 4-5 students will prepare a 15 minute presentation and written report at least 2000 words on a topic to be determined. *Edge Graduate Students* – Students will write a 3000 word report on a topic of their choosing, pending approval by Prof. Scheffe.

Python Programming: An understanding of basic programming will be helpful for this class. I recommend installing Python through the Anaconda Distribution (<https://www.anaconda.com/>) because several examples and homework's will be provided that require a Python interpreter – I will provide a quick overview in class but expect that you take the initiative to familiarize yourself.

Make-up Policy: Late homework will not be accepted, except under extenuating circumstances. Make-up exams will not be granted except in cases of emergency and will be handled on a case by case basis. **If you need extra accommodations for homework or exams please reach out to the Disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/> - more information below.**

Course Schedule: Below is a rough timeline of the expected course schedule but is subject to change. Any changes will be clearly indicated during class and posted to Canvas.

	Monday	Wednesday	Friday
August	23 rd Introduction	25 th Solar Radiation Fundamentals	27 th Solar Radiation Fundamentals
September	30 th Solar Radiation Fundamentals	1 st Solar Radiation Fundamentals	3 rd Solar Optics
	6 th Holiday	8 th Solar Optics	10 th Solar Optics
	13 th Solar Optics	15 th Solar Optics	17 th Selected Heat Transfer Topics
	20 th Selected Heat Transfer Topics	22 nd Selected Heat Transfer Topics	25 th Solar Thermal Collectors
October	27 th Solar Thermal Collectors	29 th Exam Review	1 st Exam #1

	4 th Sensible Heat Storage	6 th Latent Heat Storage	8 th Holiday
	11 th Thermochemical Energy Storage	13 th Solar Thermal Power Generation	15 th Solar Thermal Power Generation
	18 th Solar Thermal Power Generation	20 th Thermochemical Fuel Production Technologies	22 nd Thermochemical Fuel Production Technologies
	25 th Photovoltaics	27 th Photovoltaics	29 th Photovoltaics Team/Topic Selections
November	1 st Other Applications	3 rd Other Applications	5 th Exam Review
	8 th Exam #2	10 th Emerging Technologies	12 th Emerging Technologies
	15 th Emerging Technologies	17 th Emerging Technologies	19 th Emerging Technologies
	22 nd Emerging Technologies	24 th Holiday	26 th Holiday
December	29 th Guest Presentations: TBD	1 st Guest Presentations: TBD	3 rd Group Presentation
	6 th Group Presentations	8 th Group Presentations Reports Due (Grad and Edge)	10 th Reading Day

Students Requiring Accommodations: Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation: Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

In-Class Recording: Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and

delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy: UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Conduct Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment: The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources: *Health and Wellness*

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or

<http://www.police.ufl.edu/>.

COVID-19

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.

- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.