

Introduction to Thermal Sciences and How They Can Help Save the World!

MIT ESP - HSSP
Summer 2020 Syllabus

Basic Information

Feel free to reach us at S14116-teachers@esp.mit.edu at any point and we will try to respond ASAP.

Instructors

Cody Jacobucci, Carlos Daniel Diaz Martin, Arny Leroy, Simo Pajovic, Chad Wilson

Date/Time

Time: Saturdays from 12:00 to 1:00

Dates: Jul. 11 to Aug. 22, 2020

Location: Zoom

Course Overview

Welcome to *Introduction to Thermal Sciences and How They Can Help Save the World!* This course, brought to you by graduate students of MIT's Rohsenow-Kendall Heat Transfer Laboratory, will give you an overview of some of the most pressing problems of the 21st century and how thermal sciences can contribute to solving them. We hope that you will walk away from this course feeling able to talk about these problems and the basic principles underpinning thermal sciences, and most importantly, what you can do to help save the world! At the end of this course, you will understand the following problems:

- What causes climate change, and what can we do about it? What role do renewables play in decarbonizing our society?
- How is power generated, and what do we do with it when we generate too much? How much more do we generate than we really need?
- What kind of energy comes from the sun, and how do we effectively harness that energy?
- What role do materials play in combating climate change, and how do we characterize and understand them?

- How big of a problem is water scarcity around the world? How can we reduce the energy it takes to procure it? How do we make sure that everyone has access?

It turns out that all of these problems can be broadly understood with only a few very fundamental concepts:

- Thermodynamics and thermodynamic cycles,
- Conductive heat transfer,
- Convective heat transfer,
- Radiative heat transfer, and
- Phase change phenomena

We hope you will find these challenges and ideas as exciting as we do! By the end of this class, you will be well on your way to helping save the world, one thermo problem at a time!

Course Schedule

Day	Date	Topic
1	Jul. 11	Climate Change and Renewable Energy (Chad)
2	Jul. 18	Power Generation and Storage (Carlos)
3	Jul. 25	Solar Energy (Army)
4	Aug. 1	Cool Materials for Thermal Applications (Simo)
5	Aug. 8	Water Scarcity (Cody)
6	Aug. 15	Closure and presentations/Industry guest

Readings

Each seminar will have a set of recommended readings/videos, which are linked below. We recommend that you read/watch at least some of them before each seminar, but they are not required to understand the course material as presented by the instructors. Recommended books (in orange) are also listed—of course, you are not required to purchase them, they are just there for those who may be interested in further reading!

These readings will also be linked on the course website. The instructors may post additional readings and videos on the course website as the course progresses.

Climate change and renewables:

- U.S. Energy Information Administration – www.eia.gov
- NASA - climate.nasa.gov
- Youtube: What countries are to blame?
https://youtu.be/ipVxxxqwBQw?list=PLFs4vir_WsTyXrrpFstD64Qj95vpy-yo1
- Youtube: National Geographic has several climate change impact videos

Power generation and storage:

- Coming Soon!

Solar energy:

- A great introduction to solar energy and light which is currently being developed by a former student of our lab:
<https://brilliant.org/courses/renewable-energy/#chapter-new-introduction>
All courses in the *Introduction* section should be freely available when you sign up. Feel free to go through the first class of that section (*Introduction - The Essential Energy of Sunlight*) before our class on Solar energy. For those of you who are interested in learning more about light and the physics behind it, the other classes in the *Introduction* section are also interesting.

Materials for thermal applications:

- Some great chemistry and physics review from LibreTexts that you may find useful. The basic readings are intended to give you a broad overview of topics we'll talk about a bit more in class. The more advanced readings are intended to give you some depth and a starting point for your own exploration.
 - (Basic) [Atomic structure](#), [Atomic bonding](#), [Energy and heat](#), [Solids, liquids, and gases](#), [Quantum mechanics](#)
 - (More advanced) [Electronic structure](#), [The periodic table and its trends](#), [Covalent bonding](#), [Characteristics of molecules](#), [Phase transformations](#), [Intermolecular interactions](#)
- Materials science topics, some from LibreTexts and some from other sources. This will be the meat of the lecture, so if you're eager to get started, have a read!
 - (Basic) [Materials classification](#), [Anisotropy](#), [Crystals](#), [Thermal conductivity](#), [Heat capacity](#), [Viscosity](#), [Thermal expansion](#), [Thermoelectric materials](#)
 - (More advanced) [Anisotropic thermal conductivity](#), [Phonons](#), [Blackbody radiation](#)

- *Fundamentals of Materials Science and Engineering: An Integrated Approach* by William D. Callister and David G. Rethwisch
- *The New Science of Strong Materials: Or Why You Don't Fall through the Floor* by J. E. Gordon (this one is more about mechanical properties, but it is a fantastic introduction to materials science and very easy to read)

Water scarcity:

- Watch:
 - <https://www.npr.org/sections/thetwo-way/2017/04/14/523796745/researchers-find-a-new-way-to-make-water-from-thin-air> (<5 min)
 - <https://www.youtube.com/watch?v=C65iqOSCZOY> (<20 min)
- Listen: Many podcasts including a few from the popular “Stuff You Should Know” podcast-
<https://www.xylem.com/en-us/making-waves/water-utilities-news/9-water-podcasts-on-the-water-industry-and-water-technology/>
- Read: SDG 8 2018 Synthesis report can be downloaded here-
https://www.unwater.org/publication_categories/sdg-6-synthesis-report-2018-on-water-and-sanitation/
- Get Involved: MIT Water Club’s Junior Water Scholar Program:
https://docs.google.com/document/d/12EQyE-R0kQsTcaxE_47RJed_YV_ATPT_CQmujHGy7YdY/edit- if interested, sign up to hear more here:
<http://mitwater.org/contact>
- Further study:
 - <https://ocw.mit.edu/courses/mechanical-engineering/2-500-desalination-and-water-purification-spring-2009/readings/>

Policies

Participation

We strongly encourage you to ask questions and participate in polls posted through Zoom. The best way for you to get what you want out of this course is to ask those burning questions at the back of your mind, and we’ll do our best to answer.

Conduct

Although this is an online seminar series, the same rules for conduct apply here as in real life. All students and instructors should treat one another with respect and honesty. Harassment of any kind, including online trolling, will not be tolerated.