MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Department of Physics

Physics of Energy (8.21) — Fall 2015

Welcome to 8.21

We will study the fundamental physics of energy usage, conversion, and conservation.

In the first part of the course, we will focus energy usage, such as transportation, heating, cooling, and lighting, with an emphasis on basic principles of mechanics, electromagnetism, thermodynamics and quantum mechanics. We will also study fossil fuels, and climate change. In the second part, we will focus on alternative sources of energy: nuclear, solar, wind, water, geothermal, and biomass. Along the way we will study the basic principles of nuclear physics, semiconductor physics, and fluid mechanics.

Throughout, our emphasis will be on order-of-magnitude analysis, and developing a clear understanding of the differences between fundamental physics limitations and engineering/economic challenges.

Our goal is to provide a quantitative foundation in energy physics that will help you analyze and understand energy technologies and policy choices. We also hope you will find (as we do) that this subject is fascinating.

Prerequisites

General Institute Requirements in physics, chemistry, and calculus (8.01 and 8.02; 18.01 and 18.02; 5.11 or 3.091; or equivalents).

People

Lecturer	Prof. Joshua Winn	37-664b, `jwinn@mit.edu`
Graduate Teaching Assistant	Mr. Matthew Schram	8-308, `schram@mit.edu`
Course Manager	Ms. Nancy Boyce	4-315, `nboyce@mit.edu`

Weekly schedule

- Lectures: Mondays, Wednesdays, and Fridays from 1-2, in 56-114.
- Recitations: Thursdays 10-11 in 56-162; or Thursdays 1-2 in 56-180. Please ask the lecturer's permission before switching recitations.
- Office hours: Prof. Winn on Tuesdays from 2-3 in 37-664b, or by appointment; TA Schram on Wednesdays from 2-3 in 8-308.
- Weekly problem sets, due in class.
- Two exams: Fri. Oct. 9, and Mon. Nov. 9, in the usual lecture time and place.
- Comprehensive 3-hour final exam: Thursday, Dec. 17, from 9-12 in 56-114.

Calendar

Wed Sep 09	Introduction, Mechanical energy
Fri Sep 11	Electromagnetic energy
Mon Sep 14	Heat and thermal energy
Wed Sep 16	Heat transfer
Fri Sep 18	Quantum mechanics
Mon Sep 21	Entropy and temperature
Wed Sep 23	Energy in matter
Fri Sep 25	Fossil fuels
Mon Sep 28	Thermal energy conversion
Wed Sep 30	Internal combustion engines
Fri Oct 02	Phase-change energy conversion
Mon Oct 05	Thermal power and heat extraction cycles
Wed Oct 07	Energy and climate
Fri Oct 09	Quiz 1
Mon Oct 12	No class — Columbus Day
Tue Oct 13	Fundamental forces of nature
Wed Oct 14	Quantum phenomena in energy systems
Fri Oct 16	Nuclear I: Overview, natural decay mechanisms
Mon Oct 19	Nuclear II: Fission
Wed Oct 21	Nuclear III: Fission and fusion reactors
Fri Oct 23	Nuclear IV: Fission and fusion reactors
Mon Oct 26	Ionizing radiation
Wed Oct 28	Solar I: Insolation
Fri Oct 30	Solar II: Thermal
Mon Nov 02	Solar III: Photovoltaics
Wed Nov 04	Solar IV: Photovoltaics
Fri Nov 06	Solar V: Photovoltaics
Mon Nov 09	Biological
Wed Nov 11	No class — Veterans Day
Fri Nov 13	Quiz 2
Mon Nov 16	Wind I
Wed Nov 18	Wind II
Fri Nov 20	Wind III
Mon Nov 23	Water I: Hydroelectric, Tides
Wed Nov 25	Water II: Surface waves, Marine current, OTEC
Fri Nov 27	No class — Thanksgiving
Mon Nov 30	The Grid
Wed Dec 02	Storage
Fri Dec 04	Geothermal
Mon Dec 07	Synthesis I
Wed Dec 09	Synthesis II

Required textbook

The Physics of Energy by R. L. Jaffe and W. Taylor, available as a "course reader" at MIT Copytech in several installments.

Grades

Your grade will be based on the problem sets (40%), midterm exams (15% each), and final exam (30%). Small grade adjustments will be made to reward class participation.

Other Policies

- The course web site provides a calendar with lecture topics, reading assignments, and office hours. Announcements, problem sets and solution sets, and other materials will also be distributed using the web site:

  `http://stellar.mit.edu/S/course/8/fa15/8.21`

- Each lecture has a corresponding reading assignment. Please read the assigned material before the lecture, or immediately afterward.

- We encourage you to work together on problem sets. You should wrestle with a problem yourself, then discuss it with your friends, and then write up the solution by yourself. You may *not* consult solution sets from previous years.

- Late problem sets will not be accepted.