PHYS 9, Spring 2021

SU: Energy and the Environment

Credits: 4
Modality: RMT
Remote meeting on MS Teams;
Meeting Times:
MWF, 9:40-10:30

Instructor
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Office: E-203B Innovation Hall (all meetings on MS Teams)
Office Hours: T, 9:00 a.m.–11:00 a.m.
or by appointment
Phone: 802.656.0050

Course Description: This course will focus on answering one central question: how sustainable is our use of energy? To answer, we will cover many important aspects of energy: what it is, how it is produced and consumed, and ways in which it impacts society and the environment. Readings and weekly assignments will prepare you for informed daily conversations on the theme of energy sustainability. We will develop a quantitative physical understanding of many issues and problems involved with the generation, storage, transport, and usage of various forms of energy in our technological society and their broader economic, ecological, and social impacts. Topics include fossil fuels, hydropower, nuclear, solar, and wind energy, and issues related to energy conservation in everyday life. We will also consider the effects of waste products associated with energy generation and usage on e.g. global warming, ozone depletion, and pollution of the atmosphere. Individual impact will be a central theme of the course, but the question of energy sustainability will be considered from the perspective of the local and global community at time-scales ranging from a few years to many generations. **This course meets the UVM General Education requirement in sustainability.**

Prerequisite(s): High-school level algebra

Credits: 3

Text: *Energy, Environment, and Climate*, 3rd Edition
Author: Richard Wolfson; **ISBN:** 9780393622911
Note: This text must be purchased as an e-book through the Perusall web interface using the course code: SANDERS-TVBHG

Materials: Pocket calculator with trigonometric functions, scientific notation and exponential functions. Smartphone, tablet or laptop to interact with LearningCatalytics during lectures. You may purchase a LearningCatalytics pass for a modest fee online (http://www.learningcatalytics.com).

Online Communication Resources:
All students must have reliable access to the University of Vermont Blackboard course website. (bb.uvm.edu) This access requires internet connection, which is free of charge for all UVM students while on campus. You will need your UVM net ID and password to log into the Blackboard system. All supplementary course materials, course updates and announcements will be made via the Blackboard system. **It is the student's responsibility to check his/her UVM email and Blackboard course website for updates at least once a day!**

Reading & Discussion:
You are required to complete the assigned readings prior to each days class meeting. Assignments will be listed on Blackboard, and must be completed by 8:00 AM on each M,W,F that the class meets. Through the Perusall interface, you will read the e-book and participate in an online discussion of the material. You may highlight portions of the text and annotate with comments that your discussion group and I can read and respond to. Your comments and responses to other comments are graded: 3 points for a good comment, 2 points for an adequate comment, and 1 point for a poor comment. Good comments provide insight, analysis, or express a good question or point of confusion. Adequate comments may provide some basic level of information etc. Poor comments add little value to the discussion. Each reading assignment will be graded based on the average of your top four comment scores, unless otherwise noted. Shorter assignments may require fewer comments. You may create new comments for up to 24 hours after the deadline, but the points awarded will decrease linearly to 0 over the late annotation period. You may also reply to the comments of others for up to 48 hours after the deadline for full credit. This is to promote discussion of points raised near the end of the deadline period. However, you may not earn more credit after the deadline than you received before the deadline. So the total number of points earned after the deadline cannot be greater than the total earned before. As a general piece of advice, it is relatively easy to earn full credit for the Reading & Discussion portion of your grade, provided that you are actively participating in the discussion. If you spend time trying to reach the minimum number of comments, you will likely find it more difficult.

Participation and Attendance:
The course will have daily group activities and concept questions. You will need a web-browser enabled device and a *LearningCatalytics* (LC) license to participate in many of the activities. Some of the LC questions will be conceptual, or trivia-based in nature and will be graded on participation. Some will be based on assigned reading and will be graded for correct answers. I will make the distinction as clearly as possible. Your LC responses will indicate your attendance in the class. I will not count your first three absences against your participation grade. Participation in in-class activities and discussions that do not require the use of LC is also important. Your participation grade can be adjusted up to the maximum (10% of the course grade) for outstanding participation in the course activities. Absence during an exam will result in a score of 0, unless written justification from a doctor, police officer, dean, coach, or other suitable authority figure is provided. In such cases, a date will be scheduled for a make-up exam. Absence during exam 3 will result in a grade of 0. There will be no make-up opportunities for the exam 3, as it occurs during the final exam period. (As explained below, I drop the lowest exam score, so a zero on an exam is not necessarily catastrophic.)

Homework:
Homework will be assigned during (most) Wednesday class meetings and will be due the following Wednesday by the beginning of class, unless otherwise stated. The homework problems will typically be taken from the textbook, or be very similar to the textbook problems. Please either prepare your assignments on a computer, or else scan all handwritten pages of the homework assignment so that you can submit the completed assignments to Gradescope as a pdf file or set of .png or jpg images. More instructions will be forthcoming.

On time	100%
One class session late	80%
More than one class session late	0%

I will drop the lowest individual homework score from your overall homework grade.

Personal Energy Report:
Each student will turn in a final report, worth 25% of the total course grade. The report will summarize a two-month project of tracking and analyzing personal energy use. You will record, plot, and analyze the different ways that you consume energy, including electricity, heating, transportation, food consumption, etc. The final Personal Energy Report will present the accumulated data in a scientific manner, including analysis of the sources, costs, benefits, and byproducts of the energy use. In the report, students will identify local and global impacts of their own energy consumption, and address the sustainability of the various uses and sources of energy. Due on Mon. April 19.

Exams:
There will be three exams given, with the third occurring during the final exam period. The questions on the exams will be similar to the end of chapter questions and exercises in the textbook. You will be permitted to bring a calculator and a single sheet of 8.5" by 11" paper on which you can cover both sides with notes. I will also provide an information sheet that will essentially give the information that is found on the flyleaves of the textbook. This information sheet will be available to view on Blackboard in advance of each exam. Each exam will focus on the class material that we looked at during the last 4 or 5 weeks in class, but the last exam, during finals week, will possibly be a bit more comprehensive. Each exam will count for 10% of your grade, but I'll only use the top two scoring exams. This means that if you are happy with your exam average at the end of the semester, you can skip the last exam during finals week with no negative impact on your overall course grade.

Exams will occur on these dates:

Exam 1	F 3/5
Exam 2	F 4/9
Exam 3	during our designated final exam slot – date and time TBD by registrar

Course Grades:

Each student will receive a total grade based on the grades of the exams, homework, laboratory work, and class participation. The individual components will be scaled and converted to letter grades according to:

Readings and Discussions	20%
Exams	20%
Energy Report	25%
Homework	25%
Class participation	10%

A	=	90 - 100%
B	=	80 - 89.9%
C	=	70 - 79.9%
D	=	60 - 69.9%
F	=	59.9% or below

Within each letter grade, the + and - will indicate above and below the corresponding 7% and 3%. For example, grades above 77% but below 80% will receive a C+.

All grades will be posted on Blackboard to ensure privacy. It is each student's responsibility to verify the accuracy of the postings regularly. **Report any discrepancies promptly.**

Academic Dishonesty Disclosure:

Academic dishonesty **will not be tolerated.** Perceived failures to abide by the standards of academic integrity will be prosecuted as set forth in the University of Vermont Code of Academic Integrity. The code states the four standards of academic integrity; that students may not plagiarize, fabricate, collude, or cheat. Note that there is a great but subtle difference between collusion and collaboration. Collaboration is one of the greatest tools for learning and creativity in science, and is highly encouraged on homework assignments. This will help you to expand your perspective and your arsenal of problem solving techniques. Exams, however, will be a purely individual effort.

Disability Services:

In keeping with University policy, any student with a documented disability interested in utilizing accommodations should contact ACCESS, the office of Disability Services on campus. ACCESS works with students and faculty in an interactive process to explore reasonable and appropriate accommodations, which are communicated to faculty in an accommodation letter. All students are strongly encouraged to meet with their faculty to discuss the accommodations they plan to use in each course. A student's accommodation letter lists those accommodations that will not be implemented until the student meets with their faculty to create a plan. Contact ACCESS: A170 Living/Learning Center; 802-656-7753; access@uvm.edu; or www.uvm.edu/access.

Course Outline:

- **Fundamentals of Energy** - Introducing some basic physics and facts about energy consumption to prepare for our evidence-based physics approach to energy sustainability.
- **Fossil Fuels** - Analysis of our finite resources, the Hubbert curve, geology, fossil fuel production techniques will define what is possibly the most important economic, technological, and social problem of the 21st century.
- **Heat Engines** - We bring in some more basic physics, including the laws of thermodynamics to reinforce our understanding of the fundamental limits of energy generation and storage.
- **Solar Energy** - The passive, active, and direct conversion of solar energy into useful forms provides perhaps the most promising energy solution and brings fascinating physical and socio-economic perspectives. Incident solar energy is uniformly distributed throughout the world, and is therefore difficult to centralize. Is it the most democratic energy source?
- **Alternative Energy Sources** - The physical principles and broader impacts of wind, hydro, biomass, geothermal, tidal energy are introduced. While each of these energy sources are economically sound at certain levels, they all have physical limitations, as well as distinct impacts on lifestyles and life-cycles. We will further discuss the challenges related to power distribution, specifically related to adding alternative sources to the grid and smart-grid alternatives.
- **Nuclear Energy** - The basic physics of nuclear energy will motivate our discussion of the advantages, costs, and risks associated with it. We will introduce the familiar nuclear fission technology, and discuss the prospects of future thorium/molten-salt based fission reactors as well as the physics and current progress in nuclear fusion. With the first firing of the Wendelstein 7-x Stellarator in Dec. 2015, firing of the Chinese HL-2M Tokamak (Artificial Sun) in 2018, and scheduled firing of the ITER Tokamak in 2025, fusion is an exciting, promising, and currently relevant topic in physics.
- **Energy Conservation** - One of the most direct ways an individual can positively impact energy sustainability is through energy conservation. Conservation measures for homes, industries, heating, appliances, and recycling will be introduced.
- **Transportation Issues** - Transportation in planes, trains and automobiles (among other modes) constitutes a significant portion of the energy sector. We will analyze how we move now and how we will likely move in the future across local and global distances.
- **Pollution** - Energy production and consumption produces unwanted byproducts. No source, in- cluding the renewables, are guiltless in this respect. The physical processes and limits to mitigating these pollutants will be discussed in the context of their social and environmental impacts.
- **Global Climate Effects** - The greenhouse effect (an incontrovertible physical process) is a topic of much recent public debate. We will reinforce the physics behind the process and the direct consequence of global warming. Reinforcing the thermodynamic concepts introduced in chapter 3, we will calculate to a high degree of accuracy the temperature of all planets in the solar system. By changing the infrared absorption coefficient of the Earth's atmosphere, we will see how the average temperature of the Earth will change accordingly, independent of weather and politics. This quantitative understanding will form an evidenced-based approach for our discussion of the ecological, economic, and social consequences of global warming.