Energy Systems in a Sustainable World MECH 1902 (Fall 2023-24)

Instructor: Qing Chen, Room 2556, Tel: 34692234, email: chenqing@ust.hk. Office Hours: Friday from 3:00 to 4:00 pm or by appointment.

	Name	Office	Email	Office Hours	Tel
Head TA	Zilong Wang	4225B	zwangjd@connect.ust.hk	Tuesday from 4:30 to 5:30 pm or by appointment	2358 8120
TA	Yixin Bi	4225B	ybiae@connect.ust.hk	Tuesday from 9:30 to 10:30 am or by appointment	2358 8120

Classes will be held on Wednesday from 4:30 to 5:50 pm and Friday 4:30 to 5:50 pm at Room 2302. Classes will be held in face-to-face-mode.

Why is the course important?

With dwindling energy resources, the environmental impact of fossil fuel utilization, and concerns on energy security, sustainability has gained increasing importance. Modern society relies on a stable and inexpensive energy supply, and renewable energy is a significant component of the new energy mix. The course tackles energy conversion, utilization, and storage for renewable technologies such as wind, solar, biomass, fuel cells, and hybrid systems. Thermodynamics concepts, including the first law and the description of the various forms of energy, will form the basis for identifying, analyzing, and modeling renewable energy systems. The course also touches upon the environmental consequences of energy conversion and how renewable energy systems can be used effectively to mitigate global climate change.

No prior knowledge of science and engineering beyond a good high-school background is required.

Course Objectives

You will develop a general understanding of sustainable energy systems, and you will:

I. Understand and analyze energy conversion, utilization, and storage for renewable technologies such as wind, solar, biomass, fuel cells, and hybrid systems and conventional fossil fuel-based technologies;
II. Use the first and second law of thermodynamics and introductory thermodynamics to analyze renewable energy systems;
III. Understand the environmental consequences of energy conversion and how renewable energy can reduce air pollution and global climate change.

Course Outcomes

At the end of this course, you should have a better understanding of renewable energy systems as indicated in the Course Objectives; in particular, because of this understanding, you should be able to:

I. List and explain the main sources of energy and their primary applications;
II. Describe the challenges associated with the use of various energy sources, including fossil fuels and renewables, about future supply and the environment;
III. Discuss remedies/potential solutions to a secure and steady supply of renewable resources;
IV. Analyze and critique the primary renewable energy resources and technologies about their geographical location;
V. Convert units of energy and power to quantify energy demands and make comparisons among energy uses, resources, and technologies;
VI. Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation;
VII. Practice and develop teamwork and communication skills through an article/report review project.

Assessment

Assessing your understanding of the subject discussed in class is instrumental in helping you achieve the learning outcomes outlined above and to produce evidence of learning. During class, we will spend time checking your understanding of the material with concept questions, discussing difficult or confusing topics, answering questions, working on group exercises, and showing a video. The class will be interactive, and all are expected to participate. Classes will also include a lecture component. The understanding of the material developed during the class will be assessed through homework sets, a mid-term exam, and a final examination. You are also asked to develop a review project. You will review a peer-reviewed scientific article and summarize the article in an executive summary (2 pages maximum, a rubric will be given for guidance).

Each component will be evaluated as follows:

- Homework 10%
- Project report 20%
- Mid-Term Exam 30%
- Final Exam 40%

The homework set should be uploaded in the assignment section of the “MECH 1902” course on Canvas.

You have a chance to gain a 5% bonus if you conduct at least 1/3 (~8) of the pair share exercises that will take place in class.

<u>Notes</u>:

You will be assigned three homework sets, generally due on Friday. The examinations will be open-book and feature a mix of quantitative and qualitative questions.

The tasks required in the project include:

1. forming a group with three other students (4 student group);
2. writing an executive summary of the review (2 pages maximum).

You will form a group as soon as possible (within the first two weeks), and you will find a topic within the first month of instruction. It is mandatory to confirm the chosen article with the instructor. The deadline for report submission is November 30th, 2022.

Learning Environment

It is our responsibility to make this course an engaging and stimulating learning experience for all. While collaborative learning is encouraged both inside and outside the classroom, it is expected that you take full responsibility for your work. For guidelines on proper classroom behavior and academic integrity, please see the following link integrity.

Textbooks

Required:
David JC MacKay. Sustainable Energy - Without the Hot Air. UIT Cambridge Ltd. 1st edition (2009) (textbook is freely available at http://www.withouthotair.com/)

Optional:

- Frank Kreith, Jan F. Kreider. Principles of Sustainable Energy (Mechanical and Aerospace Engineering Series). CRC Press. 1st edition. (2010)
- Jefferson W. Tester et al. Sustainable Energy, Choosing Among Options. The MIT Press. 2nd edition. (2010)

Other freely available references will be given in class.

Schedule (tentative)

1. Introduction to the course and Motivation 1
2. Motivation 2 & 1st law of Thermodynamics
3. 2nd law of Thermodynamics & Transportation Expenses 1 (cars and airplanes)
4. Transportation Expenses 2 (light and gadgets) & Resources 1: Wind energy (Onshore)
5. Resources 1: Wind energy (Offshore), Resources 2: Solar energy (part 1)
6. Resources 2: Solar energy (part 2)
7. Hydro and Wave Energy, Tutorial
8. Round-Up, EROI, and Nuclear energy
9. Midterm review + Midterm exam
10. Geothermal & Expenses 1 (manufacturing), Expenses 2: Food/Farming/Public Services
11. Better Transportation, Energy storage systems (part 1)
12. Energy storage systems (part2), Energy Losses and Ventilation in Buildings
13. Air: Aerothermal and Wind Energy technology, Solar energy technology

Catalog Description

Various fuels used by mankind, fossil and renewable sources; power generation technologies and the controversies; energy-efficient technologies and the applications in buildings and consumable products; energy-efficient manufacturing technologies; low energy infrastructure and impact to modern lifestyle; myths behind sustainable energy systems and the debates; energy entrepreneurship, case studies, and social impact.