

ME420/520 Renewable & Sustainable Energy Systems Spring 2021

In addition to providing technical competence in the analysis of energy systems, this advanced undergraduate/introductory graduate course intends to instruct a critical view of energy utilization and its impact on environment and health. Basic thermodynamics and heat engines are reviewed at the beginning of the course to have necessary fundamentals to analyze fossil-fueled thermal and renewable-energy systems such as wind turbines, solar collectors and hydrogen converters. As an example of sustainable energy resources, the nuclear energy will be discussed. Subject to in-class progress, energy storage and distribution technologies will be analyzed as well. Students must be familiar with thermodynamics (ENS202 or ENS207) and thermal-fluid sciences (ME307 and ME309) at undergraduate level; some basics will be reviewed but will not be extensive.

TEXTBOOKS:

Fundamentals of Renewable Energy Processes, 3e, Aldo Vieira da Rosa, Academic Press, 2013 (should be available in Homer, and on reserve in the library).

Sustainable Energy — without the Hot Air, David JC MacKay, 2010 (available via free download from <http://www.withouthotair.com/>).

REFERENCES:

Renewable and Efficient Electric Power Systems, Gilbert M. Masters, Wiley, 2003.

Principles of Sustainable Energy Systems, 2e, Frank Kreith, CRC Press, 2014.

Fundamentals of Engineering Thermodynamics, 8e, Moran, Shapiro, Boetner & Bailey, Wiley.

Fundamentals of Heat & Mass Transfer, 7e, Frank P. Incropera and David P. Dewitt, Wiley, 2011.

GRADING:

Open-book take-home midterm: 30% (ME420), 25%(ME520) Your webcam and microphone should be on during the exams (midterm & final). In the case of non-compliance with this and other declared exam procedures, your exam will be void. Make sure to check that your webcam and microphone function properly before the exam. In case of non-compliance with any of exam instructions a follow-up oral exam will be held. If the student refuses to take the oral exam, their exam will count as not-attended.

Open-book final exam: 35% (ME420), 25%(ME520)

In-class quizzes: 10% (ME420), 10%(ME520)

Take-home assignments: 15% (ME420), 15%(ME520)

Note: take-home assignments are subject to the same conditions as the exams, plagiarism will be subject to disciplinary action and NA grade conditions. If a take-home assignment is considered as plagiarism, it will be treated as not turned in. You may discuss the solution strategy with your friends and use online resources available for similar problems. In order to avoid plagiarism: **you must ensure to answer the problems with your own explanations and in your own words.**

Project: 25% (ME520 only)

ME520 students must present a report on the analysis of a modern energy system; examples are hybrid solid oxide fuel cell (SOFC) and gas turbine (GT) systems, vertical axis wind turbines (VAWT) and PEMFC/Lithium Hybrids. The report must include fundamental advantages and disadvantages of the idea including the practical issues such as cost and feasibility, and an in-depth analysis of one of the fundamental issues based on recent publications on the topic, for example thermal modeling of SOFC-GT systems or control of VAWTs. Projects are subject to the approval of the instructor.

- Attendance & participation bonus: 10% (ME420) (Based on participation in quiz attendance (not quiz score) (40%), polls (about one in every lecture) (40%) and zoom lectures (20%) with total duration of 40 minutes or more per lecture. Total attendance score must be more than 70%, otherwise the bonus is set to the quiz score. Attendance bonus is calculated according to the following formula:

$$AttendanceBonus = QuizScore + \max\left\{0, 100 \times \frac{AttendanceScore - 70}{30}\right\}$$

- Attendance is compulsory and consists of zoom lectures (you must be present in the lecture for at least 40 minutes otherwise you may be considered as absent), participation in polls during lectures (one-minute each) and participation in quizzes, typically at the beginning or the end of lectures. NA (not-attended) grade will be given in case of one of the following conditions:
 - less than 50% attendance score.
 - 3 or less take-home assignments turned-in with reasonable effort.
 You must attend the synchronous Zoom lectures, recitations, online exams with your SU email account.

TENTATIVE SCHEDULE

Week 1-2: Introduction, utilization of energy, energy resources, environmental impact, global energy flow, renewable and nuclear capacity.

Week 2-5: Thermodynamic fundamentals, first and second laws, ideal Carnot cycle, gas power systems (Otto, Diesel, Brayton and Stirling cycles), steam power systems (Rankine cycle) refrigeration and heat pump cycles.

Week 6-7: Solar energy utilization, solar collectors, photovoltaics (Midterm)

Week 8-10: Wind & hydro

Week 11-12: Nuclear fission, radiation & fusion

Week 13: Fuel cells & batteries

Week 14: ME520 Project presentations