COLUMBIA UNIVERSITY
School of Professional Studies

Master of Science in Sustainability Management

SUMA PS5135 Analysis for Energy Efficiency
Dates: TBD Location: TBD
3 credits [Area 2Q, Area 3]

Instructor: Tom Sahagian, ts3449@columbia.edu
Office Hours: By appointment, date and time TBD, or after class or via Zoom.
Response Policy: Please send me an email with questions or to set up an appointment. I will respond within 24 hours with an answer or to set up a meeting time.

Course Associate (CA): TBD
Office Hours: By appointment
Response Policy: Shortly after the due date for an assignment or exam, the CA will go over the solutions remotely with the class (see day/time via announcements on Courseworks or email).

Course Overview

This Physical Dimensions/Quantitative Analytics course will provide real-world information about energy management. Through lectures, problem sets, and readings, students will learn about energy audits, analyze the energy performance of various technologies, and evaluate the energy use and financial impacts of upgrades and operational improvements to building systems. Pending permission from various NYC job sites, we will also make a handful of field trips to view various energy-consuming technologies in vivo.

Learning objectives

Energy management is the cornerstone of any sustainability initiative. How energy is used -- and frequently, wasted -- has a significant impact on an organization's cash flow and profitability, not to mention the impact on the environment.

All sustainability managers should be able to distinguish between sustainability projects that are worth pursuing and those that are not.

This Physical Dimensions/Quantitative Analytics course will provide real-world information about energy management and about how energy-consuming systems, especially residential and commercial building systems, operate, and how they can be made to operate more efficiently.

This class requires at least a passing familiarity with Microsoft Excel. Although there are no course prerequisites, some basic math will be necessary to complete the coursework.

If you prefer not to work with technical information and perform calculations, this class is not for you.

Readings

Most weeks students are assigned readings in Courseworks to be completed before each class. The readings are intended to prepare students for the material covered during class and serve as reference material for assignments.

Course Books:

Sustainable Energy — Without the Hot Air, by David J.C. MacKay. The book is available for free in electronic form at https://www.withouthotair.com/order.html, but I *strongly recommend* buying the paperback edition as well. I've asked the CU bookstore to order copies.

Guide to Energy Management (a/k/a GEM), by Barney L. Capehart, Wayne C. Turner and William J. Kennedy Eighth Edition, ISBN: 0-88173-765-8 or ISBN: 978-1-4987-5933-5

Note: The previous edition of this book is available electronically and is suitable for use in the course.

Assignments and Assessments

Problem Sets:

Problem sets will assess the ability of each student to:

1. Follow the analysis method at issue as presented in the lectures (partial credit will be given for partial success) and;
2. Derive the answer to the problem based on the information provided.

Generally, credit for methodology is 50% and credit for the answer is 50%. However, this may vary somewhat depending on the individual homework problem.

You may directly email the instructor or the CA; please cc: both.

Submit assignments in Excel unless otherwise directed; assignments submitted in other than Excel format will receive no credit. Late assignments will lose points as outlined below under Course Policies unless there are extenuating circumstances (to be decided at the sole discretion of the instructor). The chances of receiving an extension will be inversely proportional to the proximity to the due date a student brings the issue to the instructor's attention. Last-minute and after-due-date requests are unlikely to be approved except under the most unusual circumstances.

Presentations

Depending on the size of the class, each student or small group of students may be required to make a brief presentation to the class on a technical topic.

Midterm and Final Exams:

The two exams will be take-home assignments. The midterm will include problems designed to ensure understanding of the key concepts covered in class up to that point. The final will be similar, except that it will address all the material covered during the semester.

Exams are not group assignments. Students who collaborate or receive outside help on an exam will receive a zero for that exam.

As with the problem sets, the exams will be graded on the ability of each student to:

1. Follow the analysis method at issue as presented in the lectures (partial credit will be given for partial success) and;
2. Derive the answer to the problem based on the information provided.

The midterm exam will be posted on TBD between 9:00 pm and 10:00 pm and will be due on TBD by 6:00 pm. Please note that questions about the exam should be submitted before TBD at 6:00 pm. Questions submitted after that time may not be addressed.

The final exam will be posted on TBD between 9:00 pm and 10:00 pm and will be due on TBD by TBD. Please note that questions about the exam should be submitted before TBD at 6:00 pm. Questions submitted after that time may not be addressed.

Questions about either exam must be limited to clarifying the language of the problems. Questions about methodology or whether or not your approach is on the right track will not be answered.

Evaluation and Grading

The final grade will be calculated as described below, based upon a standard A-F scale:

FINAL GRADING SCALE

Grade	Percentage

A+	98–100 %
A	93–97.9 %
A-	90–92.9 %
B+	87–89.9 %
B	83–86.9 %
B-	80–82.9 %
C+	77–79.9 %
C	73–76.9 %
C-	70–72.9 %
D	60–69.9 %
F	59.9% and below

Final grades are calculated by assigning the following weights:

Assignment/Assessment	% Weight	Individual or Group/Team Grade
Class Participation/Class Presentation	10%	Indiv/Group
Problem Sets	40%	Individual
Midterm	25%	Individual
Final Exam	25%	Individual

Midterm exams submitted late will receive a letter grade deduction (10 points off) for each day or part of a day they are late, for up to 5 days; after 5 days the exam grade will be zero. Final exams submitted late will be treated the same way.

It is every student's responsibility to confirm they have successfully submitted their homework and exams into Courseworks prior to the relevant deadline. Excuses along the lines of "I thought I submitted it but then after the deadline, I discovered I hadn't" will not be accepted.

If you encounter a problem submitting an assignment or exam into Courseworks, please immediately contact CUIT or the Instructor for support.

Expectations

We cover a lot of material in this class. To make the most of our collective time, and to keep from needlessly having points deducted from your final grade, please take care to:

- Check your CU email at least once a day. Some class announcements will be made via Courseworks, but others will be via email. If you receive an email from either the instructor or the CA, and it asks you to confirm receipt, please do so asap.
- It is the student's responsibility to secure the instructor's prompt and timely approval for their presentation topic. If the instructor has for some reason not responded to a student's proposal, the student must actively follow up with the instructor.
- Attend every class, and arrive on time. If you plan to skip class, for whatever reason, please inform the instructor in advance.
- Leave your phone off and in your bag or backpack during class
- I'd prefer it if you took notes on paper instead of your laptop, but it's up to you. Studies show that more information is retained when students write notes longhand.
- Read all the assigned material before the relevant class
- Include your name or initials in your Excel homework files and filenames
- Use commas in numbers greater than 999
- Avoid excessive decimal places in your homework answers

Course Schedule/Course Calendar (field trip dates are tentative)

Note: Readings should be completed before the relevant class. Each week will include readings in addition to the course book sections shown below. A homework (HW) assignment due date will generally be the day before the following class.

Date	Topics and Activities	Course Book Readings	Assignments
Week 1	Course Intro; Intro to Building Systems	GEM Chapter 5 except Sec. 5.15 (read before the first class session)	HW
Week 2	Energy Audits & Modeling	GEM Chapter 2; Sec 11.3 Mackay pp viii-34, Sec. A	HW
Week 3	Energy Benchmarking and Consumption Measurement	GEM Sec. 1.6.3.1 Mackay Sec. 5-10, Sec. C	HW
Week 4	Utility Rates and Billing; Lighting	GEM Chapters 3 and 6; Sec. 8.10.5 Mackay Sec. 11-17, Sec. F, G, H	HW
Week 5	Ventilation; Properties of Air; Stack Effect; Air Handling	GEM Sec. 8.1-8.3; 8.6-8.8; 8.11 Mackay Sec. 18-20	HW
Week 6	Building Envelope and Heat Transfer	GEM Sec. 8.10; Chapter 13 Mackay Sec. 21-24; Sec. E pp. 289-300	HW Field Trip 1
Week 7	Review for midterm		Midterm
Week 8	Space Heating and Domestic Hot Water	GEM Chapter 9-	HW Field Trip 2
Week 9	Space Cooling; Heat Pumps	GEM Sec. 8.4, 8.5, 8.9, 15.7.2 Mackay Sec. 25-27, Sec. E pp. 300-306	HW Field Trip 3
Week 10	TBD		TBD
Week 11	Controls; Electrification	GEM Sec. 8.14, 11.1, 11.2, Chapter 17 Mackay Sec. 28-32	HW; Field Trip 4
Week 12	Passive House, Solar Photovoltaics, Wind Power	GEM Sec. 15.2--15.5 Mackay Sec. B, D	HW; Field Trip 5
Week 13	Time Value of Money	GEM Chapter 4	HW
Week 14	Guest Lecture – Carbon Capture		HW
Week 15	Optional Final Exam Review Session. Final Exam Due TBD, by TBD pm.		

Course Policies

Participation and Attendance: You are expected to complete all assigned readings, attend all class sessions, and engage with others in class discussions. Your participation will require that you answer questions, defend your point of view, and challenge the point of view of others. If you need to miss a class for any reason, please discuss the absence with the instructor in advance.

Late Work: Homework other than exams that is not submitted on the relevant due date without advance notice and permission from the instructor will have 5 points deducted for every day or part of a day it is late.

Citation & Submission: All written assignments must use APA, cite sources, and be submitted to the course website via the assignments link (not via email, unless arranged specifically).

School Policies

Copyright Policy: Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or

reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity: Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based.

Academic honesty in class assignments and exams is expected of all students at all times. SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility: Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website.

Class Recordings: All or portions of the class may be recorded at the discretion of the instructor to support your learning. At any point, the instructor has the right to discontinue the recording if it is deemed to be obstructive to the learning process.

If the recording is posted, it is considered confidential and it is not acceptable to share the recording outside the purview of the faculty member and registered class.