

University of Maryland, College Park  
Mechanical Engineering Department

## **ENME 420/ENME 808M—Data Analytics-Driven Energy Audit/Assessment for De-Carbonization and Sustainability**

Spring 2024, Tuesday and Thursday 2:00-3:15 PM; Room: TBD

**Instructors:** Dr. Michael Ohadi; E-mail: [ohadi@umd.edu](mailto:ohadi@umd.edu); phone: X55263;  
Dr. Andres Sarmiento: Phone: X55186; email: [apsc@umd.edu](mailto:apsc@umd.edu)

**Graduate**

**Student Assistant:** Aditya Ramnarayan; E-mail: [aramnara@umd.edu](mailto:aramnara@umd.edu)

**Course Prerequisites:** ENES 232 (Or permission of the Dept./instructor)

### **Course Objectives:**

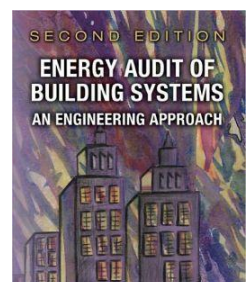
- a) Learn the fundamentals and application of energy analytics and advanced technologies for control of energy flow and CO2 emissions
- b) Understanding of building energy consumption and its major contributing sources
- c) Understanding of utility rate schedules and energy consumption costs
- d) Learn the fundamentals and applications of virtual and hands-on energy audit/assessment for decarbonization and sustainability
- e) Learn about the technologies for building envelopes, HVAC equipment, and controls.
- f) Understanding of technologies for renewable energy production and utilization
- g) Understanding of fundamentals and technologies for electrification applications
- h) Learn the fundamentals of IoT (Internet of Things), data-driven energy analytics, cyber security aspects, and machine learning applications in building energy systems
- i) Reinforce in-depth understanding of the concepts through hands-on projects.

**Office Hours:** There will be no formal office hours. However, questions by e-mail are welcome and will be responded to as quickly as possible. Phone calls or web-based meetings will be scheduled as needed when requested in advance.

**Textbook:** There is no required textbook for the course. However, a specifically recommended textbook and a sample reference book are given below. Power point lecture notes will be provided and uploaded on the course web site the evening before for students to have the opportunity to review the lecture materials ahead of our classroom time.

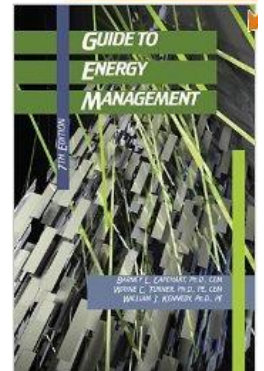
**Recommended  
Reference book:**

Energy Audit of Building Systems: An Engineering Approach,  
Second Edition, by Moncef Krarti, CRC Press, 2010.  
ISBN: 978-1439828717



**Recommended  
Reference Book:**

Guide to Energy Management 7 Ed. by Capehart, Barney L., Wayne C. Turner, and William J. Kennedy. CRC Press, Inc., 2011.

**Course Prerequisites:**

Students are expected to have prior knowledge of undergraduate basic thermodynamics and heat transfer. Knowledge of basic electrical systems and controls is desirable.

**Course Description:**

This course is designed to provide students with fundamentals and applications of De-carbonization of building systems for energy sustainability through energy audit and efficiency measures, renewable energy, and electrification. Topics covered include societal and economics motivations for de-carbonization of buildings; building energy auditing and energy consumption analysis; lighting systems and controls; heating/cooling and ventilation systems; integrated building automation systems; fundamentals of renewable energy for building applications; fundamentals of building electrification and energy storage devices; emerging technologies for building energy sustainability.

**Topics & Lecture Dates:**

Tentative lecture and the exam dates are given in the course lecture schedule (below). The scheduled lectures dates may change subject to weather and other circumstances. However, any changes in the exam dates will be announced at least three days in advance.

**Grading Policy:**

Final grades will be based on the following breakdown:

Three Quizzes & the Mid Term      50% (25% + 25%)

Course Project(s)      50% (20% + 30%)

Final Exam      No Final exam. Its time will be devoted to project presentations.

**Tentative Grading Scale:**

A+: 100-96 A: 95-91 A-: 90-89

B+: 88-86 B: 85-82 B-: 81-78

C+: 77-76 C: 75-71 C-: 70-68

D+: 67-65 D: 64-62 D-: 60-61

F: below 60

**Note: The above grading scale is meant to serve as a guideline.**

### **Homework:**

Homework will be assigned but will not be collected. Solutions to homework will be posted on the course website per the schedule listed on the syllabus. You are urged to work on the problems yourself before looking at the solutions.

### **Project(s)**

One residential building will be assigned for energy audit and will require the submission of a PowerPoint presentation report. This can include the student's own residence. A simplified commercial building will be assigned for the Commercial energy audit problem.

### **Quizzes:**

Quizzes are typically designed for a duration of 20 minutes. They may include both statements type as well as problems-to-solve type questions. Thus, you need to have your calculator with you. You need to show your work clearly. This is important for all quizzes, exams, projects, and other assignments to avoid losing points that otherwise are deserved. Grading errors due to lack of clarity in the paper will be your responsibility.

### **Midterm and Final Exams:**

Midterm and final exams typically consist of two parts: the first will focus on statement-type questions, and the 2nd part will focus on problems to solve. Necessary tables are provided, or you are asked ahead of time to bring them with you to the exam. You need to have your calculator with you. The Final Exam will be cumulative and test the knowledge gained in the entire course. Mid-term will be an hour exam (60 minutes duration). No final exam is given, but its duration will be devoted to presenting the Commercial Audit projects.

### **Make Up Policy:**

No makeup will be given for quizzes. If you miss a Quiz and your excuse is accepted, then the weight of that Quiz will be distributed on the remaining Quizzes. Make up for midterm or final examinations will only be given in the exceptional cases when the individual can demonstrate with proper documentations that the emergency involved was beyond his/her control. In case of any religious observance, the student must personally hand over a written notification of the projected absence in the first week of the semester.

### **Academic Honesty:**

All students are expected to uphold the highest ethical and professional of academic honesty (see the University of Maryland Code Of Academic Integrity). A violation of the UMD Code of Academic Integrity includes (but is not limited to) intentionally using or attempting to use unauthorized materials, information, or study aids in any academic exercise. Please be advised that a failure to accept and exhibit the fundamental value of academic honesty may result in a course grade of 'XF'

### **Course Website:**

We will use ELMS (<https://elms.umd.edu>) as the primary site to archive lecture notes and course related materials and share information. If you are unfamiliar with ELMS Learning System, it would be a good idea to familiarize yourself with its features now. In case of any technical difficulty, please send an email to [elms@umd.edu](mailto:elms@umd.edu). Should you prefer assistance over the phone, you can call the OIT Help Desk at 301-405-1400. You are required to check the course website on a regular basis.

**Path to Success in ENME 420/ENME 808M:**

The key factors for success in this course are to stay focused and fulfill your responsibilities. The course material is inherently cumulative such that the material learned in one session will be used in the following sessions. If you lose your focus for a day or two, it will be extremely hard for you to come back to the track. Please feel free to send your questions by e-mail any time. We will be happy to assist you as necessary.

**Course Schedule:**

**The following is a tentative course schedule. It may change during the semester as circumstances arise. Consult the course website for updated versions. Any changes in Quiz and/or Exams dates will be announced at least three days in advance.**

| Week | Date           | Topics Covered                                                                                                                                                                            |
|------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | 1/25/23        | Introduction of the course and review of relevant fundamentals                                                                                                                            |
| 2    | 1/30/23        | Societal and economic motivations for de-carbonization of energy systems/buildings. <a href="#">HW No 1 assigned</a>                                                                      |
|      | 2/1/23         | Utility Rate Schedules--Understanding energy consumption costs;                                                                                                                           |
| 3    | 2/6/23         | Energy Audit Procedures and Energy Benchmarking/ Energy Use Intensity (EUI); <a href="#">HW No 1. Solutions posted</a> ;                                                                  |
|      | 2/8/23         | Residential Energy Audit; <b>Also Quiz 1; Residential Audit Project Assigned.</b>                                                                                                         |
| 4    | 2/13/23        | Residential Energy Audits (Cont.); <a href="#">HW No 2 assigned</a> ;                                                                                                                     |
|      | 2/15/23        | Lighting System Audit,                                                                                                                                                                    |
| 5    | 2/20/23        | Building Envelope Audit, I; <a href="#">HW No 2 solutions posted</a> ;                                                                                                                    |
|      | 2/22/23        | Building Envelope Audit II; <a href="#">Also, Residential Audit Progress Presentations.</a>                                                                                               |
| 6    | 2/27/23        | HVAC Audit I;                                                                                                                                                                             |
|      | 3/1/23         | HVAC Audit II; <b>Also Quiz 2</b> ; <a href="#">Also; HW No 3 Assigned</a>                                                                                                                |
| 7    | 3/6/23         | Energy Economics Analysis;                                                                                                                                                                |
|      | 3/8/23         | LEED and Energy Star Standards; <b>Res. Audit Reports Due</b> ;                                                                                                                           |
| 8    | 3/13/23        | Leeds & Energy Star (Cont.); ASHRAE Energy Efficiency Standards; <b>Commercial Audit Project Assigned</b> ; <a href="#">HW No 3 solutions posted</a> ; <a href="#">HW No 4 Assigned</a> . |
|      | 3/15/23        | <b>Presentation of Residential Energy Audit projects</b>                                                                                                                                  |
| 9    | 3/21/23        | No Class, Spring break                                                                                                                                                                    |
|      | 3/23/23        | No Class, Spring break                                                                                                                                                                    |
| 10   | 3/27/23        | Boiler/steam systems principles & energy-saving technologies.                                                                                                                             |
|      | 3/29/23        | Building Automation and Control Systems; <b>Also 30% Status updates Commercial Audit project presentations.</b> <a href="#">HW4 solutions posted</a>                                      |
| 11   | <b>4/03/23</b> | <b>Commercial audit project walkthrough/site visit, Bldg. 223, Energy Research Facility</b>                                                                                               |
|      | 4/05/23        | <b>MIDTERM EXAM</b>                                                                                                                                                                       |
| 12   | <b>4/10/23</b> | Renewable energy and its applications in buildings; <a href="#">HW No 5 Assigned</a> .                                                                                                    |
|      | 4/12/23        | <b>Site visit, Kim Engineering building;</b>                                                                                                                                              |
| 13   | 4/17/23        | Renewable energy and its applications in bldgs; <b>Also, 65% Proj. 2 status presentations.</b>                                                                                            |

|            |         |                                                                                                                                                                             |
|------------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            | 4/19/23 | Renewable energy and its applications in buildings                                                                                                                          |
| 14         | 4/24/23 | Renewable energy (Cont.); Also, Fundamentals of Bldg Electrification. <a href="#">HW5 solutions posted</a> ;                                                                |
|            | 4/26/23 | Fundamentals of Bldg Electrification (Cont). <b>Commercial Audit Reports Due by 11 PM</b>                                                                                   |
| 15         | 5/01/23 | Fundamentals of Building Electrification (Cont).                                                                                                                            |
|            | 5/03/23 | Energy Audit & Thermal management of Data Centers/mission critical facilities; <b>Also Quiz 3</b>                                                                           |
| 16         | 5/8/23  | Emerging technologies for energy sustainability in buildings—Net Zero Energy Buildings, other technologies. <b>Also, Project 2 presentations: 4:30 -6:00 PM. (Room TBD)</b> |
|            | 5/10/23 | Emerging technologies for energy sustainability (Cont.). Overview of the course; Questions/Discussions session                                                              |
| Final exam |         | <b>No final exam, in lieu of earlier in the semester project Presentations.</b>                                                                                             |