

VANDERBILT UNIVERSITY — CIVIL AND ENVIRONMENTAL ENGINEERING
CE 4240/5240 — INTRO TO INFRASTRUCTURE SYSTEMS ENGINEERING
Fall 2024

Instructor: Ahmad F. Taha	Time: T,TH 11:00 – 12:15
Email: ahmad.taha@vanderbilt.edu	Place: Featheringill Hall 300

Course Pages:

- Vanderbilt Brightspace: <https://brightspace.vanderbilt.edu>

Office Hours:

- Tuesdays and Thursdays, 12:30 – 14:00
- Or by appointment
- Location: Featheringill Hall 293

TA Info:

- No TA this year. It's just us. :)

Course Description: Systems-level approach to the infrastructure of the built environment. Elements of systems engineering. Case studies of infrastructure under duress. Smart infrastructure. Transportation, building, and water and wastewater supply and distribution systems. Infrastructure interdependencies and concepts of smart cities. Applications to infrastructure system design.

Main References: No textbook is required for the class. **Lecture notes will be provided as handouts or presentation slides. Course Objectives & Expected Outcomes:**

The course presents an introduction to infrastructure systems engineering. In particular, the course takes a system-level perspective on what infrastructure systems engineering is all about. In particular, the class focuses on both specific infrastructure problems (i.e., water, transportation, energy, and power systems) as well as a generic theoretic foundations for infrastructure (i.e., control theory, mathematical optimization, etc..).

Prerequisites:

Familiarity with Matlab/Python or another programming language (e.g., at the level of CS 1101/1103). This course is intended for 4th year undergraduate students and graduate students from CEE or related disciplines.

Course Objectives:

- Students will learn how to mathematically model infrastructure systems.
- Students will improve their programming and data analysis skills.

- Students will learn how to apply multi-objective linear and nonlinear optimization methods to design civil infrastructure systems using economic, social, and technical metrics.
- Students will learn a basic introduction to control theory.
- Students will be knowledgeable about various contemporary engineering problems in transportation, water, and energy systems.
- Students will improve their written and oral scientific presentation skills.
- Students will work in interdisciplinary teams to address complex problems across multiple civil and environmental domains.

Grading Policy

- Homework assignments (30%)
- Midterm 1 (30%)
- Midterm 2 (30%)
- Attendance and instructor evaluation (10%)

Course Grade Cutoffs:

- A-, A, A+: 85–100
- B-, B, B+: 70–84
- C-, C, C+: 55–69
- D-, D, D+: 40–54
- F: ≤ 39

Programming Tools:

MATLAB will be required for homework assignments and course projects. You can definitely use Python if you prefer that. Students can obtain the discounted student version of MATLAB online or through the university bookstore. Also, students are encouraged to use \LaTeX for their homework assignments and course projects. I'm happy to provide latex templates that I use for the slides and homework assignments. Email me and I'll send them to you.

Class Policy:

- **Regular attendance** is essential and expected. The course instructor will occasionally take attendance and this will be counted towards the overall course grade. Students are allowed to miss at most two classes when the attendance is recorded.
- Students are expected to show few minutes **before** the start of the class. It is the student's responsibility to plan ahead of time and inform the course instructor of any emergencies. In case the student anticipates that they will be late for class, he/she should email the instructor before the class starts. Late arrival to class will negatively influence the attendance and instructor's evaluation grade.
- **Late submission policy:** besides medical and family emergencies (a written verification is required), there will be no extensions granted for submissions. Late submissions will be scaled according to lateness, removing 10% from your assignment grade per day late, up to a maximum of 50%. Submissions more than 5 days late will be assigned a score of 0.

- **Changes to the syllabus:** students will be regularly informed about any changes for the course syllabus.

Tentative Course Outline:

Module I — Class Overview & Background	≈ 1 class
█ Course introduction & syllabus, major applications, course overview	
Module II — Introduction to System Optimization	≈ 5-6 classes
█ Crash course on mathematical optimization (linear/quadratic/convex optimization)	
Module III — Introduction to Energy Systems and Climate Change	≈ 2-3 classes
█ Intro to the most stressing problem of our time	
Module IV — Introduction to Dynamic Systems and Control Theory	≈ 5-6 classes
█ Crash course on control theory for infrastructure	
Module V — Introduction to Water Systems	≈ 2-3 classes
█ Intro to various aspects of water systems	
Module VI — Dynamic Models of Infrastructure	≈ 3-4 classes
█ Demonstrating dynamic system models in infrastructure	
Module VII — Introduction to Transportation Systems and Mobility	≈ 3-4 classes
█ Introduction to contemporary problems in transportation	
Module VIII — Real-time Control and Optimization of Infrastructure	≈ 3-4 classes
█ In-depth discussion of how infrastructure are controlled in real-life.	
Module IX— Advanced problems in infrastructure	≈ 3-4 classes
█ Sensor placement, driver node selection, advanced mobility, flood control, renewables adaptation, etc...	

Academic honesty:

Cheating, plagiarism, or any act of dishonesty will NOT be tolerated. This includes, but is not limited to, copying from another student's paper or assignment and copying from published material. Students are responsible for the content of the Honor Code. Any violation will be reported to the Honor Council. Students are bound by all provisions of the Honor Code, found in the Vanderbilt Student Handbook (http://www.vanderbilt.edu/student_handbook/the-honor-system/).

Other pertinent material may be found at the Honor Council's website, <https://studentorg.vanderbilt.edu/honorcouncil/>. Report any violation of the Honor Code at https://cm.maxient.com/reportingform.php?VanderbiltUniv&layout_id=2

Specific considerations for this course include:

- Use of Chegg, Slader, Course Hero or similar sites is not allowed in this course.
- Collaborative work with classmates is encouraged, however all work you submit must be your own. Copying someone else's work, with or without their permission, is an Honor Code violation in this class.
- If you have questions or concerns about Honor Code issues in this class, please talk with me

Excellence and Inclusion

It is my belief that everyone in this class can excel and that our collective learning experience is improved by including everyone fully. Toward that end, I commit to doing my best to use inclusive language and practices. If you observe actions in which I am not respectful or inclusive, please bring those to my attention.

Accommodation Policy

Vanderbilt is committed to equal opportunity for students with disabilities, as am I. If you need course accommodations due to a disability, please contact VU Student Access Services (<https://www.vanderbilt.edu/student-access/>) to initiate that process. After SAS has notified me of relevant accommodation(s) and you and I have discussed how this(these) may best be approached in this class, I will facilitate the accommodation(s).

Mental Health & Wellness

If you are experiencing undue stress that may be interfering with your ability to perform academically, Vanderbilt's Student Care Network offers you a range of support services. The Office of Student Care Coordination (OSCC) is the central and first point of contact to help you navigate and connect to appropriate resources. You can schedule an appointment with the OSCC at

<https://www.vanderbilt.edu/carecoordination/> or call 615-343-WELL

If you or someone you know needs to speak with a professional counselor immediately, the University Counseling Center offers Urgent Care Counseling. Students should call the UCC at (615) 322-2571 during office hours to speak with an urgent care clinician. You can also reach an on-call counselor after hours or on the weekends by calling (615) 322-2571 and pressing option 2 at any time. You can find additional information at <https://www.vanderbilt.edu//ucc/>.

Sexual Misconduct or Power-Based Personal Violence

If you have experienced sexual misconduct or power-based personal violence, please contact Project Safe (<https://www.vanderbilt.edu/projectsafe/>), VU Police Department, or the nearest emergency room as best fits your needs. If you share with me any information about such experiences, I am required by law to report this to Vanderbilt's Title IX Coordinator.

Emergency Evacuation Plan

In the event of a fire or other emergency requiring evacuation, the occupants of this class should leave the building through the exits closest to the classroom. If you need special assistance during an evacuation, please discuss this with me as soon as possible. Vanderbilt University policy forbids reentry to a building in which an alarm has occurred without authorization by Vanderbilt Security.

Important information – COVID-19

Health and Safety: Our mutual commitment to health and safety is vital. Toward that end, in this class we will all: Wear masks that fully cover nose and mouth at all times; Maintain 6' or greater separation from each other; Stay away from the classroom when not feeling well, when instructed to isolate or quarantine, and when not scheduled to be present in person.

Attendance: If you have any reason to believe that you may be ill or have been a close contact of someone who is COVID-19 positive, do NOT come to class in person. Contact Student Health right away. Participate remotely until you are cleared to return to classes.

No portion of your grade will be tied to in-person attendance.

Online Engagement/Technology Requirements

- All students in this class must have a portable computer that meets the specifications at <https://engineering.vanderbilt.edu/transit/ComputerRecommendation.php> or those that were in effect during year of entry to VU.
- You must have internet access with a minimum bandwidth of 3 Mbps.

- You must have earphones/headphones with a microphone. These need not be fancy. I do recommend ones that fully occlude the ear canal to cut down on extraneous noise.
- Your full engagement in class sessions is essential not only for your own learning but for the shared educational experience of the class. Toward that end, no use of social media, email, etc. during class is permitted. When participating remotely, you must have your video camera on unless I have granted specific permission otherwise.