University of Illinois Urbana-Champaign
Department of Aerospace Engineering
Spring 2026

AE 353: Aerospace Control Systems

3 credit hours

This syllabus is not an exhaustive description of all details of the course; the students are free to contact the instructor with any additional questions or concerns at any time.

Personnel

Instructor:
Melkior Ornik (mornik@illinois.edu)

Teaching assistants (TAs):
Gokul Puthumanaillam (gokulp2@illinois.edu), Manav Vora (mkvora2@illinois.edu)

Contact and Office Hours

The primary mode of communication will be Canvas. Students should make sure to be enrolled in the appropriate Canvas page, and be set up to quickly receive announcements from Canvas. *All important announcements will be communicated over Canvas*.

Students are welcome to email the instructor or the TAs with questions about the course logistics, but all questions on the course material *must* be posted on Canvas' discussion section, unless there is a reason to post them privately (e.g., they contain personal information or solutions to assigned questions). Any emailed questions on the material, except the ones that have a good reason to remain private, will remain unanswered. Students are encouraged to answer each other's questions; the instructor and the TAs will answer the questions that have not been answered by students after an appropriate amount of time.

To promote public online discussion, the instructor's and the TAs' office hours will only be held by previous appointment. Office hours are primarily intended for high-level conceptual help: students should make sure to try to find an answer to any specific questions, first by themselves and then by posting the question to Canvas, before arranging for office hours. The instructor and the TAs, supported by additional course assistants (CAs) might hold additional group office hours or workshop sessions prior to course milestones. Students are encouraged to request such opportunities during the course.

Course Delivery

The course material will primarily be delivered in person. Classes are scheduled to take place on **MWF 11am-11:50am in 2310 Everitt Laboratory**. To help students prepare for their exams or projects, individual classes might be canceled, rescheduled, or replaced by optional office hours and study sessions. All such changes will be announced during the semester.

Attendance at lectures is *not* mandatory – students are welcome to adjust their course experience to their learning style, as long as doing so respects learning styles of the others. Naturally, students who do come to class are required to engage in appropriate behavior to protect the educational benefits, health, and safety of the community.

Online course materials (notes, homeworks, project descriptions, etc.) will be primarily divided over two web sites:

- **Canvas** and links contained therein will be used for all announcements, all written course material, discussions on the material, submission of design projects, and for grade accounting,
- **PrairieLearn** will be used for homeworks.

It is the students' responsibility to sign up and remain active on course-related elements at both of the above web sites. For simplicity of presentation, the design projects will likely be posted on a **separate GitHub page**, but the work will need to be submitted on Canvas. Additionally, we will likely use UIUC's existing **Reference Pages (https://www.refpages.org/)** for summaries of course material. However, the presentation of those summaries might slightly differ from the order or the focus of the material presented in class.

Course Description

AE 353 is a modern, challenging aerospace take on a standard undergraduate controls course. It seeks to use formal mathematical methods to answer a fundamental engineering question: *How can I ensure that the system does what I want it to do?*

On a more technical level, the primary objective of the course is to expose students to the notion of continuous-time, continuous-space controlled system dynamics, and explore the design of control signals to drive the system to a desired outcome. We will do so by formulating *state space representations*, relating the system's control inputs, states, and outputs through a set of ordinary differential and algebraic equations. Even when such relationships are simple, performing control design in such a representation will require us to develop the method for computing a solution to a system of ordinary differential equations: the notion of a *matrix exponential* plays a significant role. Using a significant amount of linear algebra, we will then devote a large part of the course to discussing some of the central questions of control theory: *can I drive the system to a particular state?* (controllability)*, how can I do it in the quickest or cheapest way possible?* (optimal control), and *can I do it even if I don't know everything about the system at every given time?* (observability)*.* This year, we will also make an effort to expose students to some relevant recent research in robotics, providing insight into the high-level purpose of the techniques that we are developing in class. Finally, we will connect the developed machinery of modern state-space-based control design to a classical method of frequency-domain-based control design – a "dual" of the state space representation that often simplifies control design methods, but pays the price of reduced applicability to more complicated dynamics models and control objectives.

Deliverables and Grading

The deliverables for the course will consist of:

- many (~20) homework assignments,
- two 50-minute midterms,
- three design projects, and
- a 3-hour final exam with questions based on the homework assignments and midterms.

The weights for the deliverables will be nominally distributed as follows:

- homeworks: 20% total (around 1% each),

- midterms: 30% total (15% each),
- design projects: 30% total (10% each),
- final exam: 20%.

Additional extra credit may be offered during the semester.

The final grades will be calculated by the following formula: A-/A/A+ = 90-100, B-/B/B+ = 80-89.99, C-/C/C+ = 70-79.99, D-/D/D+ = 60-69.99, F = 0-59.99, where the "-" modifier will be assigned to those grades with the unit digit 0-1 (e.g., 91.87 = A-) and "+" modifier to those grades with the unit digit 8-9 (e.g., 78.02 = C+). The grades will *not* be rounded up, rounded down, nor "curved".

Submission of Deliverables

Homework assignments will be completed online using PrairieLearn. Homeworks are submitted individually, but students are allowed, and encouraged, to discuss these assignments with their peers.

Midterms will be completed in person, likely during the regular lecture times; the *tentative* midterm dates are March 2 and April 15. Students will not be allowed to communicate with each other or with the outside world during the quizzes. The midterms will be solved on paper, with access to any written material, but without access to computational tools.

The design projects will require students to submit Python code and a report written in LaTeX. Both will be submitted online. Design projects are written and submitted individually, but students are allowed, and encouraged, to discuss these assignments with their peers.

Design projects will be posted at least 2 weeks prior to the submission deadline. The full week of classes prior to the deadline will be dedicated to joint work and Q&A sessions on the projects guided by the TA. The *tentative* design project submissions deadlines are February 15, March 15, and April 26.

The final exam will be completed in person, possibly as a combination of a paper submission and PrairieLearn. Students will not be allowed to communicate with each other or with the outside world during the quizzes, but will have access to any written material and desired computational tools.

Students are responsible for timely submission of the deliverables. Late submission of a particular deliverable, if not agreed with the instructor or allowed by the instructions specific to the deliverable, may be penalized at the rate of up to 50% of the deliverable's total weight. There may be bonus points for early submissions, equaling no more than 5% of the total weight of the deliverable.

Emergencies do happen, and the students' first focus should be on preserving their physical and mental well-being. When faced with unavoidable obstacles, students should contact the instructor for any modifications to the submission schedules.

Prerequisites and Literature

The formal prerequisites for the course are credit in MATH 225, MATH 285, and TAM 212 (or equivalent). The course cannot be taken for credit if a student already has credit in GE 320 or ME 340.

There is no required text for the course. With possible small exceptions intended for independent study, all new topics required for success in the course will be discussed by the instructor. The course material will partly overlap with the following textbooks:

- *Feedback Systems: An Introduction for Scientists and Engineers*, K. J. Åström and R. M. Murray

- *Control System Design: An Introduction to State-Space Methods*, B. Friedland
- *Feedback and Control for Everyone*, P. Albertos Pérez and I. Mareels
- *Modern Control Engineering*, K. Ogata
- *Modern Control Systems*, R. C. Dorf and R. H. Bishop

Students are not required to purchase any textbooks or other materials. The first book on the list above was made freely available by the authors and can be found online. All of the books on the list should be available in some format from the university library. Please note that, while each of above books has substantial overlap with the course material, the material covered will be significantly smaller than the material of the union of these books.

Academic Integrity

While students are welcome to consult peers on their homework assignment and the design projects, they are required to write their own submissions and respond to any subsequent questions on the submitted material by the instructor themselves. The answers to the instructor's questions may play a role in the assigned grade. Students are expected to work entirely alone on the midterms and the final exam.

Students are required to familiarize themselves with the University's Academic Integrity Policy and Procedure, available at https://studentcode.illinois.edu/article1/part4, and abide by that policy in full.

Respect and Growth in the Classroom

The effectiveness of every course is dependent upon creating a safe and encouraging environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all. Growing as a whole person is far more important than growing in a scientific discipline, and includes growing in respect and understanding of others. While everyone has different personalities and perspectives and it takes time to adapt to one another, maintaining an environment where everyone can freely and joyfully contribute is an explicit goal of the class. In support of everyone's feeling of belonging, the Aerospace Engineering department offers a reporting process for undesirable incidents. In case of conflict that undermines anyone's sense of respect, self-respect, or belonging, students should consider using their resources: https://aerospace.illinois.edu/diversity/reporting.

Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students that require special accommodations must contact the instructor and the Disability Resources and Educational Services (DRES) as soon as possible. Students are welcome to contact the instructor at any time with any accommodation-related needs. To contact DRES, visit 1207 S. Oak St., Champaign, e-mail disability@illinois.edu, or visit https://dres.illinois.edu. If a student is concerned that they have a disability-related condition that is impacting their academic progress, there are academic screening appointments available that can help diagnosis a previously undiagnosed disability. These may be accessed by visiting the DRES website.

Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. If there is a conflict between course deadlines and any religious observances, students should notify their instructor and follow the procedure described

at https://odos.illinois.edu/resources/students/religious-observances to request appropriate accommodations. These steps should be conducted in the first two weeks of classes.

Privacy and Reporting

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options. A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: https://wecare.illinois.edu/resources/students. Other information about resources and reporting is available here: https://wecare.illinois.edu.

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ for more information on FERPA.

Campus Emergency Plan

The university's emergency response recommendations and appropriate campus building floor plans can be found at https://police.illinois.edu/.

Modifications to the Syllabus

The instructor reserves the right to modify any and all parts of this syllabus throughout the semester. All modifications will be made solely in the interest of time scheduling, accurate measurement of the students' success, and improvement of the students' educational outcomes. Any modifications will be transparently communicated to the students.