

AE 6511 - OPTIMAL GUIDANCE AND CONTROL

Fall 2026

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Time & Place

MW 3:30–4:45am; [J. Erskine Love Manufacturing 184](#)

Office Hours

By appointment via zoom or in my office (Date/time TBD)

Teaching Assistants

TBA

Description

This course is indented as an introduction to the elements of Optimal Control theory and Calculus of Variations. Although the main emphasis will be on applications from aerospace engineering, several examples will be provided on the use of optimal control to other disciplines such as, economics, mechanical systems, human behavior, etc.

Prerequisites

Some familiarity with ordinary differential equations and elementary linear algebra is helpful, but not required.

Tentative Outline

1. Finite-dimensional optimization problems; minima and maxima of functions
2. Variational cones; Gâteaux and Fréchet derivatives
3. Necessary and sufficient conditions
4. Existence and uniqueness conditions; Weirstrass theorem
5. Minima and maxima subject to constraints
6. Lagrange multipliers; Kuhn-Tucker conditions
7. Infinite-dimensional optimization problems; minima and maxima of functionals
8. Elements of calculus of variations
9. Lagrange-Euler necessary conditions
10. Legendre and Jacobi conditions; conjugate points; Erdmann corner conditions
11. Optimal control problems with control constraints

12. Pontryagin Maximum Principle
13. Legendre-Clebsch condition; bang-bang control
14. Optimal control problems with state and control constraints
15. Singular optimal control
16. Optimal feedback control
17. Dynamic programming and Hamilton-Jacobi theory
18. The Linear quadratic control problem; the Riccati equation
19. Neighboring optimal guidance
20. Elements of differential games; pursuit-evasion games; \mathcal{H}_∞ control

Textbook

There is no required textbook. A clear, detailed set of lecture notes should be enough. Selected chapters from the book *A Course in Classical Optimal Control* by D. Bernstein and P. Tsiotras (in preparation) will be provided and will be used extensively during the semester. As an additional resource you can use the book *Optimal Control Theory with Aerospace Applications* by J. Ben-Asher, AIAA Publishing, 2010 or *Applied Optimal Control*, by A. E. Bryson, Jr. and Y.-C. Ho, Hemisphere Publishing Corporation, New York, 1975.

References

There exist many excellent books on the subject. Below is a partial list. Please feel free to consult these and any other books you may want that will assist you in comprehending the class material. Additional handouts and selected articles from the literature will be disseminated via the class website. Good reference material is available online, and can be found using [google](#) or [wikipedia](#)

- D. Liberzon, *Calculus of Variations and Optimal Control Theory: A Concise Introduction*, Princeton University Press, 2012.
- D. Kirk, *Optimal Control Theory: An Introduction*, Prentice Hall, New Jersey, 1970.
- M. Athans and P. L. Falb, *Optimal Control: An Introduction to the Theory and Its Application*, McGraw-Hill, New York, 1965.
- E. B. Lee and L. Markus, *Foundations of Optimal Control Theory*, John Wiley, New York, 1967.
- G. Ewing, *Calculus of Variations with Applications*, Dover, New York, 1985.
- D. Luenberger, *Linear and Nonlinear Programming*, (2nd Ed.), Addison-Wesley, Reading, 1989.
- E. Pinch, *Optimal Control and the Calculus of Variations*, Oxford University Press, Oxford, 1993.

Website

All relevant information on the class will be disseminated electronically via [Canvas](#).

Grading Policy

The grades will be determined based on homework assignments, one mid-term, and a final exam/project. The tentative final grade distribution will be as follows:

$$\text{Final Grade} = \text{Homework} \times 20\% + \text{Mid-Term} \times 35\% + \text{Final Exam/Project} \times 45\%$$

Participation includes attendance at lectures (please see attendance policy below), asking/answering questions, and participation during in-class discussions. Feedback on your participation will be given halfway through the semester.

The grades will be assigned according to the tentative following policy

| | |
|---|------------|
| A | 85 & above |
| B | 70 – 84 |
| C | 51 – 69 |
| D | 46 – 50 |
| F | 45 & below |

Attendance

All students are expected to attend as many lectures as possible and participate in the question/answer part of the discussion with the instructor. Each student will be responsible for obtaining notes and homework assignments of the days he/she will miss class. Class participation may influence your grade in borderline cases. Please also see <http://www.catalog.gatech.edu/rules/4/> for more information about institute expectations and restrictions around attendance, including information about excused absences.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404) 894-2563 or <http://disabilityservices.gatech.edu>, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Homework

One set of homework problems will be assigned approximately once every couple of weeks. Assignments will be turned in electronically via Canvas at the designated due time. Homework should be neat and legible. You must show all important steps in the solution. Begin each problem on a new page. Clearly mark your final answer. Use units when appropriate. Deductions will be made for improper homework format. The homework will be graded and returned. No late homework will be accepted without prior consent from the instructor. In any case, grade for late homeworks will be adjusted accordingly. For any questions regarding the homework you should contact the Teaching Assistants.

Computer Programming

Some assignments will require the use of computer programming. Although MATLAB is recommended, you may use any language of your choice (C/C++, python, julia, etc) to complete these programming assignments.

Honesty and Collaboration

The School of Aerospace Engineering values honesty and integrity of all members of our community. An important aspect of this value system is the [Academic Honor Code](#). Although some collaboration for solving homework problems can be helpful in learning and, in that respect, is encouraged, it is expected that all homeworks will be completed individually unless specified otherwise. This implies that collaboration is acceptable only as a means for exchanging ideas, generating thought-provoking discussions and, in general, for obtaining a deeper understanding of the course material. Any collaboration during in-class or take-home exams will not be tolerated, however.

Health and Well-Being

Georgia Tech and the School of Aerospace Engineering understand that many students experience stress through a variety of academic, financial and personal experiences. We value you and want to make you aware of resources available to you should you need them. Your well-being and mental health are important, and we are here for you.

Center for Assessment, Referral and Education (CARE)

<https://care.gatech.edu>

Georgia Crisis and Access Line: 800-715-4225

National Suicide Prevention Lifeline: 800-273-TALK (8255)

<https://suicidepreventionlifeline.org>

Crisis Text Line: Text HOME to 741741

VOICE: Victims Survivor Support: (404) 385-4464 (or 4451)

<http://healthinitiatives.gatech.edu/well-being/voice>

Stamps Health Services

<https://health.gatech.edu/contact>

Campus Resources for Students

Office of Disability Services

<https://disabilityservices.gatech.edu>

Center for Assessment, Referral and Education (CARE)

<https://care.gatech.edu>

Campus Police (any emergency): 404-894-2500

<http://www.police.gatech.edu>

Counseling Center: 404-894-2575

<https://counseling.gatech.edu>

Dean of Students Office: 404- 894-6367

<https://studentlife.gatech.edu>