ECE4575 Course Syllabus

ECE4575

Numerical Methods for Optimization and Optimal Control (3-0-0-3)

CMPE Degree
This course is Elective for the CMPE degree.

EE Degree
This course is Elective for the EE degree.

Lab Hours
0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Yezzi,Anthony Joseph

Prerequisites
ECE 3084 Signals and Systems OR ECE 3550 Feedback Control Systems

Corequisites
None

Catalog Description
Algorithms for numerical optimization and optimal control, Gradient-descent techniques, linear programming, numerical linear system solvers, second-order methods for optimizing performance of dynamical systems.

Textbook(s)
No Textbook Specified.

Course Outcomes
Upon successful completion of this course, students should be able to:

1. Students will be able to write computer code to implement linear system constructs learned in prior S+C courses.
2. Students will understand the types of errors than can arise in these implementations, and how to quantify them.
3. Students will be able to construct computer algorithms to solve other problems which don't benefit from closed form constructs acquired in previous
4. Students will know which types of models should be paired with which types of numerical optimization algorithms based on properties such as convexi
5. In cases were multiple choices of numerical optimization algorithms are suitable for a given problem, students will understand the relative advanta

Student Outcomes
In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.
“M” for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.
“LN” for “little to none” indicates that the course does not contribute significantly to this

outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (LN) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. (LN) An ability to communicate effectively with a range of audiences
4. (LN) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. (M) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. (P) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (M) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

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I. Numerical Methods
I.1 Review of numerical issues when using machine number systems
I.2 Direct Linear systems solvers (LU, Cholesky, iterative refineme
I.3 Scalar nonlinear equation solvers (bisection, Newton, secant me
I.4 Numerical differentiation and Integration

II. Optimization
II.1. Introduction to nonlinear programming
II.2. Optimality conditions for constrained and unconstrained probl
II.3. Algorithms: gradient descent, Newton-Rhapson, conjugate-gradi
II.4. Least-square problems and algorithms
II.5. Optimization problems with equality and inequality constraint

III. Algorithms for optimal control problems
III.1. Discrete-time optimal control: necessary optimality conditio
III.2. Continuous-time optimal control: the Hamiltonian
III.3. The linear-quadratic optimal control problem and feedback-ba
III.4. The Pontryagin?s Maximum principle
III.5. Examples: minimum-time problems and minimal-path problems
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