COURSE HOURS: Monday: 7:20 – 10:00 pm, East Bldg. Room 134.

OFFICE HOURS: Monday: 5:30 – 6:30 pm, Engineering Bldg. Room 3707/08; Other hours by appointment only.

PREREQUISITES: ECE 521, equivalent, or POI. Some of the homework assignments may require a working knowledge of MATLAB/SIMULINK.

COURSE TEXT: No required textbook. Recommended reading: see references.

OBJECTIVES:
1. To provide students with the purposes, terminology, and fundamental mathematics of optimization and its use for control applications
2. To enable students to formulate control problems with particular emphasis on designing meaningful performance metrics

PROJECT: Course project will consist of individual research on relevant course topic that concludes with class presentation and final report. Details will be provided by Week 2.

GRADING: Homework/Project ......................... .35%
Midterm Exam ........................................ .30%
Final Exam ........................................... .35%

EXAM SCHEDULE:
Midterm Exam Monday, Oct. 19
Final Exam Monday, Dec. 14; 7:30 – 10:15 p.m.

Last Day to Drop: Tuesday, Sep. 15
Labor Day Recess, Sep. 7; no classes
Columbus Day Recess, Oct. 12; classes meet Tuesday
Thanksgiving Recess: Nov. 25-29

HONOR AND EXAM POLICY:
All students are expected to abide by the George Mason University Honor Code. Course projects will be done individually. The midterm exam and the final exam will be open book and open notes. All work must be your own on the projects and the exams. Any reasonable suspicion of an honor violation will be reported.
TENTATIVE CLASS SCHEDULE (subject to modification)

Week 1: **Intro to Mathematical Optimization**: types of optimization problems from various disciplines, solving optimization problems, past/present challenges, fundamentals [1-3]

Week 2: **Intro to Dynamic Optimization**: historical context of optimization for engineering (least-squares, norm approximation, smoothing), calculus of variations, classical control approach (integral-square error, linear quadratic regulators) [1,4-8]

Week 3: **Dynamic Optimization (Cont.) & Optimization Theory**: Pontryagin’s Maximum Principle, dynamic programming, convex sets, convex functions, convex optimization [1,2,4-8]

Week 4: **Intro to Optimal Control**: problem formulation for dynamical systems [1,4-7]

Week 5: **Optimal Control (Cont.)**: conditions for optimality, types of control problems suited for optimization techniques (min time, min control, min fuel, etc.) [1,4-7]

Week 6: **Optimal Control (Cont.)**: cost functions as meaningful performance metrics

Week 7: Midterm Exam

Week 8: **Trajectory Optimization and Emerging Principles**: path planning and obstacle avoidance for robotics, unmanned vehicle guidance and control, spacecraft attitude control, Bellman’s principle [1,5,6]

*Potential Guest Lecturer: – Prof. I. Michael Ross, Naval Postgraduate School/MAE*

Week 9: **Intro to Non-Linear Programming (NLP)** [2,3,9,10]

*Potential Guest Lecturer – Prof. Roman Polyak, GMU/SEOR*

Week 10: **Techniques for Solving Unconstrained/Constrained Minimization Problems**: gradient/steepest descent, Newton’s Method, sectioning, modified Newton’s [2-8,9,10]

*Project Status Due; Potential Guest Lecturer on “Computational Methods”*

Week 11: **Methods for Solving Optimal Control Problems**: two-point boundary value problem, forward/backward integration, shooting techniques, dynamic programming, spectral methods [4-8]

Week 12: **Other Control Applications & Optimal Control Topics**: optimal state estimation, complexity, accuracy, computational requirements, stability analysis, adaptive filters, fault-tolerant/reconfigurable control [1,7,8]

Week 13: **Student Project Presentations**

Week 14: **Student Project Presentations**

Week 15: **Course Review & Project Report Due**

References


