COURSE HOURS: Thursday: 7:20 – 10:00 pm, S&T I, Room 120.

OFFICE HOURS: Thursday: 5:30 – 6:30 pm, S&T II, Room 235; Other hours by appointment only.

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


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 Thursday, March 5
- Final Exam Thursday, May 7; 7:30 – 10:15 p.m.

Last Day to Drop: Friday, Feb. 20

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 [1,2]

Week 2: **Intro to Dynamic Optimization**: historical context of optimization for engineering (least-squares, norm approximation, smoothing), calculus of variations, classical control (integral-square error, linear quadratic regulators), Pontryagin’s maximum principle, dynamic programming [3-7]

Week 3: **Optimization Theory**: convex sets, convex functions, convex optimization [1]

Week 4: **Intro to Non-Linear Programming (NLP)** [1,2,8,9]  
*Guest Lecturer – Prof. Roman Polyak, GMU/SEOR*

Week 5: **Algorithms for Unconstrained Minimization**: gradient/steepest descent, Newton’s Method [1-7]

Week 6: **Algorithms for Constrained Minimization**: sectioning, modified Newton’s [1-6,8,9]  
*Potential Guest Lecturer on “Computational Methods”*

Week 7: **Midterm Exam**

Week 8: **Intro to Optimal Control**: problem formulation for dynamical systems [3-6]

Week 9: **Trajectory Optimization and Emerging Principles**: path planning and obstacle avoidance for robotics, unmanned vehicle guidance and control, spacecraft attitude control, Bellman’s principle  
*Potential Guest Lecturer: – Prof. I. Michael Ross, Naval Postgraduate School/MAE*

Week 10: **Methods for Solving Optimal Control Problems**: two-point boundary value problem, forward/backward integration, shooting techniques, dynamic programming, spectral methods [3-7]  
*Project Status Due*

Week 11: **Cost Functions as Meaningful Performance Metrics**

Week 12: **Control Applications**: optimal state estimation, adaptive filters, fault-tolerant/reconfigurable control [6]

Week 13: **Classical Control vs. Nonlinear Optimal Control**: complexity, accuracy, computational requirements, stability analysis [7]

Week 14: **Student Project Presentations**

Week 15: **Student Project Presentations & Project Report Due**

**References**


