ENEE 664: Optimal Control (Cr 3)   Spring 2004

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Weekly homework sets will be collected and graded. First mid-term on **Tuesday, March 2**, second mid-term on **Thursday, April 1** and final examination on **Tuesday, May 18, 1:30-3:30 pm**. The breakdown in weighting towards the final grade will be: homework 20%, mid-terms 20% each and finals 40%.

Course Goals: This course is aimed at a rigorous treatment of the fundamentals of static and dynamic optimization with the linear quadratic optimal control problem, the maximum principle and the abstract constrained optimization problem constituting the core. Algorithmic aspects will be considered as an important element of the course, together with the theoretical foundations of algorithms.

Course Prerequisite: ENEE 663 is a co-requisite; it can be waived by instructor consent.

Topic Prerequisite: Advanced calculus (at least Math 410 or equivalent; Math 411 preferred); linear system theory (mostly time-domain aspects).

References

1. D.G. Luenberger, Optimization by Vector Space Methods, J. Wiley Sons (1969).

2. D.G. Luenberger, Linear and Nonlinear Programming, 2nd Ed., Addison-Wesley (1984).

3. R.W. Brockett, Finite Dimensional Linear Systems, Wiley (1970).

4. P.P. Varaiya, Notes on Optimization, Van Nostrand Reinhold (1972).

5. J. Macki and A. Strauss, An Introduction to Optimal Control Theory, Springer-Verlag (1982).

6. A. Avez, Differential Calculus, J. Wiley Sons (1986).

7. B.D.O. Anderson and J.B. Moore, Optimal Control: Linear Quadratic Methods, Prentice-Hall (1990).

8. M.D. Canon, C.D. Cullum, and E. Polak, Theory of Optimal Control and Mathematical Programming, McGraw-Hill (1970).

9. L.S. Pontryagin, V.G. Boltyansky, R.V. Gamkrelidze, and E.F. Mishchenko, The Mathematical Theory of Optimal Processes, Interscience (1962).

10. F.H. Clarke, Optimization and Nonsmooth Analysis, J. Wiley Sons (1983).

11.V.M. Alekseev, V.M. Tikhomirov, and S.V. Fomin, Optimal Control, Plenum Press (1987).

Core Topics

1.**Linear-quadratic optimal control**: fixed and free and point, finite and infinite horizon.

2.**Unconstrained optimization**: first and second order optimality conditions; glance at numerical methods (in particular: Newton's method).

3.**Constrained optimization** (general case (abstract constraint), equality constraints, inequality constraints): first order conditions of optimality (tangent cone, Lagrange, F. John, Karush-Kuhn-Tucker); second order conditions; sensitivity; duality.

4.Discrete-time optimal control: weak maximum principle; Bellman's principle of optimality, dynamic programming.

5.**Continuous-time optimal control**: Pontryagin's maximum principle (linear dynamics, nonlinear dynamics; fixed end time, free end time; minimum time problem); dynamic programming, Hamilton-Jacobi-Bellman equation).

Optional Topics

Numerical methods (unconstrained; constrained; linear programming; interior point methods), **calculus of variations and integrable problems of optimal control**, solution to certain combinatorial optimization problems by gradient methods, **singular optimal control and higher order necessary conditions**.