332: 510 — Synthesis of Optimum Control Systems — Spring 2000

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Class Web Page: http://www.ece.rutgers.edu/~gajic/510.html

Text: A. Bryson, *Dynamic Optimization*, Addison Wesley, 1999.

Recommended Reading: D. Kirk, *Optimal Control Theory*, Prentice Hall, 1970.

Topics:

Week 1: Introduction to static optimization (Bryson, Chapter 1, see also class notes).

Week 2: Introduction to calculus of variations (Kirk Chapter 4, see also class notes). Minimization of functionals. Fundamental theorem of calculus of variations. Four basic variational problems and the Euler equation with corresponding boundary conditions.

Week 3: Introduction to calculus of variations (Kirk Chapter 4, see also class notes). Piece-wise-smooth extremals and Weierstrass-Erdmann corner conditions. Constrained minimization of functionals with algebraic equality constraints, differential equation constraints, and integral (isoperimetric) constraints. Necessary conditions for optimal control in terms of the Hamiltonian (class notes).

Week 4: Dynamic optimization in continuous- and discrete-time domains (Bryson, Chapter 2, see also class notes).

Week 5: Mayer's formulation of the optimal control problem and dynamic optimization with terminal constraints. Optimization with open (free) final time (Bryson, Chapters 3 and 4, see also class notes).

Week 6: Continuous-time soft terminal constraints. Optimal tracking and disturbance rejection problems (Bryson, Sections 5.1–5.2, see also class notes).

Week 7: Discrete-time soft terminal controllers via the system transition matrix and via the Riccati equation (Bryson, Sections 5.3, more details about the Riccati equation can be found in the class notes).

Week 8: Continuous- and discrete-time hard terminal constraints (Bryson, Sections 5.4 and 5.5, see also class notes).

Week 9: Exam I

Week 10: Continuous– and discrete-time regulators (Bryson, Sections 6.2 and 6.3, see also class notes for more details). Linearization of nonlinear systems (class notes).

Week 11: MATLAB and SIMULINK in optimal control.

Week 12: Dynamic programming. Hamilton-Jacobi-Bellman equation. Pontriagin's minimum principle (Bryson, Chapter 7).

Week 13: Singular optimal control problem (Bryson, Chapter 10).

Week 14: Static and dynamic optimization with inequality constraints (Bryson, Chapter 9).

Grading:

Exam I (Lectures 1–7) 40%

Project (Chapters 5 and/or 6) 20%

Final (Lectures 8, 10–14) 40%