ELEE 5780: Optimization and Optimal Control

University of Detroit Mercy

Term I, 2013-2014

Course Description: Fundamental concepts of calculus of variations. Functionals of a single and several independent functions, constrained optimization. Necessary conditions for optimal control. Linear regulatory problem. Pontryagin's minimum principle. Introduction to dynamic programming.

Prerequisites: ENGR 4220/5220 (Controls I)
ELEE 4700 (Controls II) or ELEE 5720 (Linear Systems) is recommended

Prerequisites by topic: differential equations, transfer functions, root locus and Bode plot construction, state-space methods (state feedback and observers), `MATLAB` and `Simulink`

Instructor: Rick Hill, Assistant Professor
Department of Mechanical Engineering
Room E274
hillrc@udmercy.edu

Class meetings: MW 5:15-6:30 pm, Room E134

Office hours: MW 2:00 - 3:30 pm, T 3:00 - 5:00 pm, TH 4:00 - 5:00 pm

Course homepage: http://knowledge.udmercy.edu

Required text:

Elements of a range of sources will be employed in the course.

Additional References:

Anderson, B.D., and Moore, J.B., *Optimal Control: Linear Quadratic Methods*.
Kirk, D.E., *Optimal Control Theory*.
Naidu, S.N., *Optimal Control Systems*.
Stengel, R.F., *Optimal Control and Estimation*.

Class Elements: Homework - Problem sets will be assigned approximately every one to two weeks over the course of the semester.

Exams - Two cumulative midterms will be given during the semester in addition to a cumulative final.

Class Policies: Late work - Homework must be turned in at the beginning of class. Late homework is not accepted. Extenuating circumstances can be discussed on a case-by-case basis.

Exams - Exams will in general be closed-book and closed-note. You may be allowed to bring in an equation sheet. Make-up exams will only be given if prior arrangements have been made with me.

Regrades - If you feel a mistake has been made in the grading of an assignment or exam, you have one week from the date of its return to submit the item for a regrade.

Academic Integrity - Any suspected cheating will be dealt with according to the College policy - see the Engineering Science Student Handbook. In the case of homework, working together is encouraged, but you must write your own solutions that reflect your own understanding of the material.

Students with Disabilities - It is very important for students to be proactive with regard to requesting disability accommodations. While it is never required that you disclose your disability to your professors, all students at UDM are encouraged to talk to their professors to discuss their concerns. Faculty cannot provide disability accommodations without official notification from the Disability Support Services office. If you need an accommodation because of a disability, if you have emergency medical information to share, or if you need special arrangements in case the building must be evacuated, please contact Emilie Wetherington as soon as possible to schedule an appointment (gallegem@udmercy.edu or (313) 578-0310). Disability Support Services is located in the Student Success Center, Room 319, on the 3rd Floor of the Library, McNichols Campus.

Grading:

Homework	20%
2 Midterm Exams	50% (25% each)
Final exam	30%

Scale:

Percentage	93-100	90-92	87-89	83-86	80-82	77-79	70-76	60-69	< 60
Grade	A	A-	B+	B	B-	C+	C	D	F

Possible Course Topics:

1. Calculus of Variations (Pontryagin's Minimum Principle)
   (a) Optimization of functions and functionals
2. Linear Quadratic Control
   (a) Finite and infinite horizon
   (b) Regulator and tracking problems
   (c) Classical interpretation
   (d) Choosing weighting matrices
3. Dynamic Programming (Bellman's Principle of Optimality)
4. Optimal State Estimation
   (a) Kalman-Bucy filter
   (b) Linear Quadratic Gaussian