Optimal Control
Course Code: EE-872

Course Description

This course teaches the fundamentals of optimal control to graduate students. After revisiting fundamental concepts of optimization and calculus of variations, the course focuses on optimal control problem formulations and deriving necessary conditions of optimality. Two fundamental approaches to solution of optimal control, namely the Maximum Principle and Dynamic Programming based Hamilton Jacobi Bellman approach for obtaining the optimal solution to the problems and the pros and cons of each approach are discussed. Numerical algorithms are developed for solving the optimal control problems and the use of available software for solving interesting application problems is considered. Towards the end, connection between optimal control and reinforcement learning are established.

Text Book:

1. Daniel Liberzon, Calculus of Variations and Optimal Control Theory, Princeton University Press 2011. A pdf copy of the book is available for free at http://liberzon.csl.illinois.edu/teaching/cvoc.pdf
2.

Reference Books:

1. Lewis, Vrabie and Syrmos, Optimal Control, Wiley, 2012 (Free pdf available online)
2. Arturo Locatelli, Optimal Control: An Introduction, Birkhauser, 2001
3. Donald E. Kirk, Optimal Control Theory: An Introduction, Dover Publications, 2004.
4. Bryson and Ho, Applied Optimal Control: Optimization, Estimation and Control, Taylor & Francis, 1975
5. David Luenberger and Yinyu Ye, Linear and Nonlinear Programming, Springer 2008

Prerequisites

Recommended EE871 Linear Control Systems; MATH 816 Applied Linear Algebra; MATLAB/Python

ASSESSMENT SYSTEM

Quizzes	10%
Assignments	10%
Mid Terms	35%
ESE	45%

Teaching Plan

Week No	Topics	Learning Outcomes
1-2	Parameter Optimization	Optimality conditions, constraints, numerical methods
3-5	Calculus of Variations	Infinite dimensional optimization, directional derivatives, costates
6-8	The Maximum Principle	Hamiltonians, constraints, bang-bang control.
MID TERM IN WEEK 9		
10-13	LQ design	Dynamic programming, Riccati equations, Linear-Quadratic Regulators.
14-17	Global Methods	Hamilton-Jacobi theory. Hamilton-Jacobi-Bellman Equation, Reinforcement Learning*
END SEMESTER EXAM IN WEEK 18		