Optimal Control, Guidance and Estimation - Video course

NPTEL

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Aerospace Engineering

COURSE OUTLINE

In this course concepts and techniques of optimal guidance,Control and state estimation will be studied for aerospace vehicles (especially for aircrafts, launch vehicles and missiles), both in linear and nonlinear systems theory framework.

However, the theory as well as some demonstrative examples will be quite generic and hence this course is expected to be useful to the students from other engineering disciplines as well.

COURSE DETAIL

Modules	Topics
1.	**Introduction and Review of Basic Concepts**
	01.Introduction, Motivation and Overview 02.Overview of SS Approach and Matrix Theory 03.Review of Numerical Methods
2.	**Static Optimization**
	04.An Overview of Static Optimization – I 05.An Overview of Static Optimization – II
3.	**Optimal Control through Calculus of Variation**
	06.Review of Calculus of Variations – I 07.Review of Calculus of Variations – II 08.Optimal Control Formulation Using Calculus of Variations
4.	**Classical Numerical Techniques for Optimal Control**
	09.Classical Numerical Methods to Solve Optimal Control Problems
5.	**Linear Quadratic Regulator (LQR) Theory**
	10.Linear Quadratic Regulator (LQR) – I 11.Linear Quadratic Regulator (LQR) – II 12.Linear Quadratic Regulator (LQR) – III 13.Linear Quadratic Regulator (LQR) – III

Pre-requisites:

1. Exposure to Modern Control Theory, Matrix Theory and Differential Equations.

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6.	**Discrete-time Optimal Control**
	14.Discrete-time Optimal Control
7.	**Overview of Flight Dynamics**
	15.Overview of Flight Dynamics – I 16.Overview of Flight Dynamics – II 17.Overview of Flight Dynamics – III
8.	**Optimal Missile Guidance**
	18.Linear Optimal Missile Guidance using LQR
9.	**State Dependent Riccati Equation and θ – D Designs**
	19.SDRE and θ - D Designs
10.	**Dynamic Programming and Adaptive Critic Design**
	20.Dynamic Programming 21.Approximate Dynamic Programming (ADP), Adaptive Critic (AC) and Single Network Adaptive Critic (SNAC) Design
11.	**Advanced Numerical Techniques for Optimal Control**
	22.Transcription Method to Solve Optimal Control Problems 23.Model Predictive Static Programming (MPSP) and Optimal Guidance of Aerospace Vehicles 24.MPSP for Optimal Missile Guidance 25.Model Predictive Spread Control (MPSC) and Generalized MPSP (G-MPSP) Designs
12.	**LQ Observer and Kalman Filter Design**
	26.Linear Quadratic Observer & An Overview of State Estimation 27.Review of Probability Theory and Random Variables 28.Kalman Filter Design – I 29.Kalman Filter Design – II 30.Kalman Filter Design – III
13.	**Integrated Estimation, Guidance and Control**
	31.Integrated Estimation, Guidance & Control – I 32.Integrated Estimation, Guidance & Control – II

14	**Linear Quadratic Guassian Design**
	33.LQG Design; Neighboring Optimal Control& Sufficiency Condition
15	**Constrained Optimal Control**
	34.Constrained Optimal Control – I 35.Constrained Optimal Control – II 36.Constrained Optimal Control – III
16.	**Optimal Control of Distributed Parameter Systems**
	37.Optimal Control of Distributed Parameter Systems – I 38.Optimal Control of Distributed Parameter Systems – II
17.	**Review and Summary**
	39.Take Home Material: Summary – I 40.Take Home Material: Summary – II

References:

1. D. S. Naidu: Optimal Control Systems, CRC Press, 2002.
2. A. Sinha: Linear Systems: Optimal and Robust Control, CRC Press, 2007.
3. A. E. Bryson and Y-C Ho: Applied Optimal Control, Taylor and Francis, 1975.
4. A. P. Sage and C. C. White, III: Optimum Systems Control (2nd Ed.), Prentice Hall, 1977.
5. D. E. Kirk: Optimal Control Theory: An Introduction, Prentice Hall, 1970.
6. J. L. Crassidis and J. L. Junkins: Optimal Estimation of Dynamic Systems, CRC Press, 2004.