Optimal Control - Video course

COURSE OUTLINE

Switching devices - ideal and real characteristics, control, drive and protection.

Reactive circuit elements - their selection and design.

Switching power converters - circuit topology, operation, steady-state model, dynamic model.

Analysis, modeling and performance functions of switching power converters.

Review of linear control theory.

Closed-loop control of switching power converters.

Sample designs and construction projects.

COURSE DETAIL

Module 1 : Concept of static optimization problem and its solution.

Lec. No.	Topics
1	An overview of optimization problem, some examples of optimum design problem.
2	Concepts and terms related to optimization problem, necessary and sufficient conditions for a multivariable function.
3	Effects of scaling or adding a constant to an objective function and understanding of constrained and unconstrained optimization problems. Concept of Lagrange multipliers and its application to unconstrained optimization problem.
4	Solution of unconstrained minimization problem using • Gradient descent method. • Steepest descent method. • Newton's method.
5	(Continuation of Lec.-4) • Davison-Fletcher-Powell method. • Exterior point method.
6	Numerical examples are considered to illustrate the algorithmic steps of the above methods.

NPTEL

http://nptel.iitm.ac.in

Electrical Engineering

Pre-requisites:

1. Basic engineering mathematics (UG level), Linear matrix algebra and linear control theory (for module-II only).

Additional Reading:

1. Optimal control --- Frank L. Lewis, John Wiley & Sons, 1986.

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7	Solution of constrained minimization problems using Karush-Kuhn-Tucker (KKT) necessary and sufficient conditions.
8	Numerical examples are considered to illustrate the technique.
9	Understanding the following terms • convex sets, convex and concave functions, • properties of convex function. • definiteness of a matrix and test for concavity of function. Explain with numerical examples.
10	Problem statement of • convex optimization. • quadratic optimization. • quadratically constrained quadratic optimization. • local and global optima.
11	Solution of quadratic programming problems using KKT necessary condition.
12	Basic concept of interior penalties and solution of convex optimization problem via interior point method.
13	Numerical examples are considered to illustrate the techniques mentioned in Lec.-11 and Lec.12.
14	Linear programming: Simple method; matrix form of the simplex method.
15	Illustrate the solution of linear programming problems in tabular form via simplex method.
16	Two-phase simplex method.
17	Primal and dual problem: Determination of primal solution from its dual form solution and vice-versa.
18	Properties of dual problems and sensitivity analysis.
19	Basic concept of multi-objective optimization problem and some definitions.
20	Solution of multi-objective optimization problem and illustrate the methodoly with numerical examples.

Module 2: Dynamic optimization problem and its solution.

Lec. No.	Topics
21	Concept of functional, variational problems and performance indices.
22	Euler-Lagrange equation to find the extremal of a functional. Transversality condition.
23	Application of variation approach to control problems.
24	Continuation of Lecture-23.
25	Statement of Linear quadratic regulator (LQR) problem and establish a mathematical framework to solve this problem.
26	Optimal solution of LQR problem.
27	Different techniques for solution of algebraic Riccati equation.
28	Numerical problem are considered to illustrate the LQR design procedures and discussed the role of state and input weighting matrices on the system performance.
29	Frequency domain interpretation of LQR problem.
30	Stability and robustness properties of LQR design.
31	Optimal control with constraints on input.
32	Optimal saturating controllers.
33	Dynamic programming principle of optimality.
34	Concept of time optimal control problem and mathematical formulation of problem.
35	Solution of time-optimal control problem and explained with a numerical example.
36	Concept of system and signal norms. Small-gain theorem, physical interpretation of H_∞ norm.
37	Computation of H∞ Norm, statement of H_∞ control problem.

38	H_∞ control problem: Synthesis.
39	Illustrative example.
40	Discussion on stability margin and performance of H_∞ based controlled systems.

References:

Static Optimization:

1. Introduction to optimum design—Jasbir S. Arora, -- Elsevier, 2006.
2. An introduction to continuous optimization—Niclas Anreasson, Anton Evgrafov and Michael Patriksson, -- Overseas Press (India) Pvt. Ltd., 2006.
3. Engineering optimization: Methods and Applications – A Ravindran, K.M. Ragsdell, and G.V. Reklaitis , Wiley India Edition, 2006.

Dynamic Optimization:

1. Optimal control systems --- D.S. Naidu, CRC Press, 2003.
2. Optimal control: An introduction --- Arturo Locatelli ---Birkhauser Verlag , 2001.