# Control Systems Theory and Design

1. State Space Models
   - 1.1 From State Space Model to Transfer Function
   - 1.2 From Transfer Function to State Space Model
   - 1.3 Non-Uniqueness of State Space Models and Similarity Transformations
   - 1.4 Solutions of State Equations and Matrix Exponentials
   - 1.5 Stability of Linear System
2. Controllability and Pole Placement / Observability and State Estimation
   - 2.1 The Controllability Gramian
   - 2.2 The Controllability Matrix
   - 2.3 Pole Placement
   - 2.4 Controllable Subspace
   - 2.5 The Observability Gramian
   - 2.6 State Estimation
   - 2.7 Observable Subspace
   - 2.8 Kalman Canonical Decomposition
3. Observer-Based Control
   - 3.1 State Estimate Feedback
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   - 3.3 Closed-Loop Transfer Function
   - 3.4 Symmetric Root Locus Design
4. Lyapunov Stability Theory
   - 4.1 Lyapunov's Direct Method
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   - 4.3 Lyapunov Stability Theorem
   - 4.4 Controllability Gramian Matrix
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5. Linear Matrix Inequalities (LMIs) Technique

5.1 Introduction to LMIs

5.2 General and Standard Forms

5.3 Properties and Applications of LMIs

5.4 Applications of LMIs

5.5 Converting NMIs to LMIs

5.6 LMI Solver Toolbox (Matlab Code)

## References:


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2. H. Werner, “Control systems theory and design”, Lecture notes, Hamburg University of Technology, Germany, 2019.
3. K. Ogata, “Modern Control Engineering”, Fourth Edition, Prentic-Hall, India, 2010.
4. T Apkarian, P., Becker, G., Gahinet, P. and Kajiwara, H., “LMI Techniques in Control Engineering from Theory to Practice”, Workshop Notes CDC, 1996, Kobe, Japan.