Numerical Methods for Linear Control Systems

by Biswa N. Datta
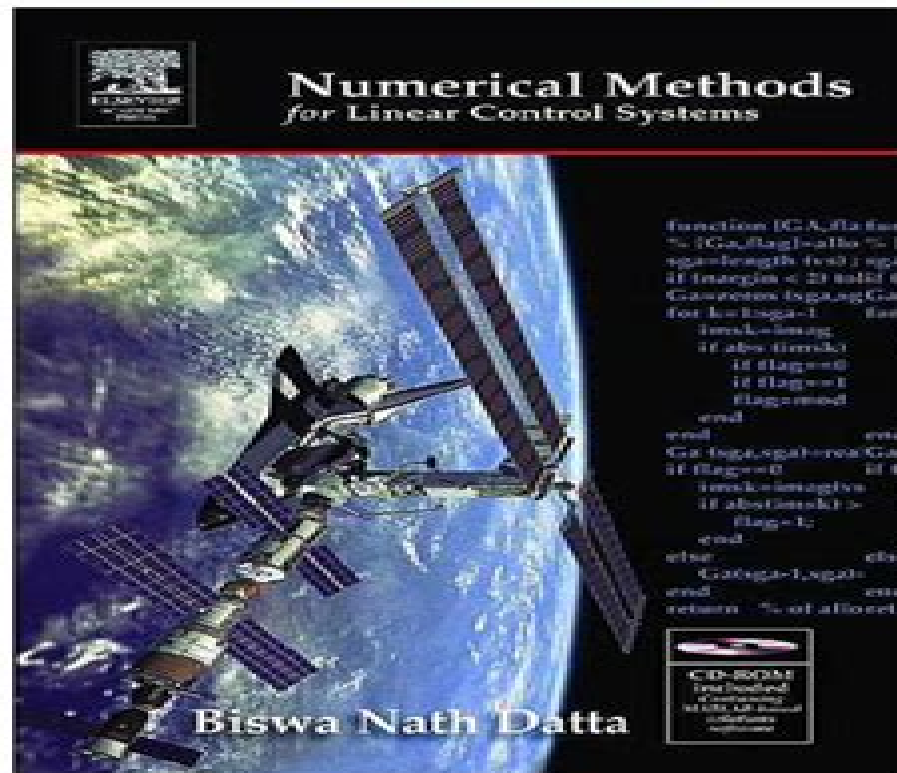
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for Linear Control Systems

Biswa Nath Datta

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Numerical Methods For Linear Control Systems:

   Numerical Methods for Linear Control Systems Biswa Datta,2004 Numerical Methods for Linear Control Systems Design and Analysis is an interdisciplinary textbook aimed at systematic descriptions and implementations of numerically viable algorithms based on well established efficient and stable modern numerical linear techniques for mathematical problems arising in the design and analysis of linear control systems both for the first and second order models Unique coverage of modern mathematical concepts such as parallel computations second order systems and large scale solutions Background material in linear algebra numerical linear algebra and control theory included in text Step by step explanations of the algorithms and examples **Numerical Methods for Linear Control Systems** Biswa Datta,2003-12-31 Numerical Methods for Linear Control Systems Design and Analysis is an interdisciplinary textbook aimed at systematic descriptions and implementations of numerically viable algorithms based on well established efficient and stable modern numerical linear techniques for mathematical problems arising in the design and analysis of linear control systems both for the first and second order models Unique coverage of modern mathematical concepts such as parallel computations second order systems and large scale solutions Background material in linear algebra numerical linear algebra and control theory included in text Step by step explanations of the algorithms and examples **Numerical Linear Algebra Techniques for Systems and Control** IEEE Control Systems Society,1994 A reprint collection of practical papers covering the broad scope of numerical linear algebra in computer aided control system design software Between the 35 page introduction and extensive 21 page bibliography are seven sections general numerical issues in control controllability observability and realizations closeness problems frequency response transfer functions poles and zeros pole assignment and observer design Riccati Lyapunov and Sylvester equations and some relevant results from numerical linear algebra Annotation copyright by Book News Inc Portland OR *Computational Aspects of Linear Control* Claude Brezinski,2013-12-01 Many devices we say dynamical systems or simply systems behave like black boxes they receive an input this input is transformed following some laws usually a differential equation and an output is observed The problem is to regulate the input in order to control the output that is for obtaining a desired output Such a mechanism where the input is modified according to the output measured is called feedback The study and design of such automatic processes is called control theory As we will see the term system embraces any device and control theory has a wide variety of applications in the real world Control theory is an interdisci plinary domain at the junction of differential and difference equations system theory and statistics Moreover the solution of a control problem involves many topics of numerical analysis and leads to many interesting computational problems linear algebra QR SVD projections Schur complement structured matrices localization of eigenvalues computation of the rank Jordan normal form Sylvester and other equations systems of linear equations regulariza tion etc root localization for polynomials inversion of the Laplace transform computation of the matrix exponential approximation theory orthogonal poly

nomials Pad6 approximation continued fractions and linear fractional transfor mations optimization least squares dynamic programming etc So control theory is also a good excuse for presenting various sometimes unrelated issues of numerical analysis and the procedures for their solution This book is not a book on control **Computational Methods for Approximation of Large-Scale Dynamical Systems** Mohammad Monir Uddin,2019-04-30 These days computer based simulation is considered the quintessential approach to exploring new ideas in the different disciplines of science engineering and technology SET To perform simulations a physical system needs to be modeled using mathematics these models are often represented by linear time invariant LTI continuous time CT systems Oftentimes these systems are subject to additional algebraic constraints leading to first or second order differential algebraic equations DAEs otherwise known as descriptor systems Such large scale systems generally lead to massive memory requirements and enormous computational complexity thus restricting frequent simulations which are required by many applications To resolve these complexities the higher dimensional system may be approximated by a substantially lower dimensional one through model order reduction MOR techniques Computational Methods for Approximation of Large Scale Dynamical Systems discusses computational techniques for the MOR of large scale sparse LTI CT systems Although the book puts emphasis on the MOR of descriptor systems it begins by showing and comparing the various MOR techniques for standard systems The book also discusses the low rank alternating direction implicit LR ADI iteration and the issues related to solving the Lyapunov equation of large scale sparse LTI systems to compute the low rank Gramian factors which are important components for implementing the Gramian based MOR Although this book is primarly aimed at post graduate students and researchers of the various SET disciplines the basic contents of this book can be supplemental to the advanced bachelor s level students as well It can also serve as an invaluable reference to researchers working in academics and industries alike Features Provides an up to date step by step guide for its readers Each chapter develops theories and provides necessary algorithms worked examples numerical experiments and related exercises With the combination of this book and its supplementary materials the reader gains a sound understanding of the topic The MATLAB codes for some selected algorithms are provided in the book The solutions to the exercise problems experiment data sets and a digital copy of the software are provided on the book s website The numerical experiments use real world data sets obtained from industries and research institutes **An Introduction to Linear Control Systems** Thomas E. Fortmann,Konrad L. Hitz,1977-10-01 Stability and Stabilization William J. Terrell,2009-01-26 Stability and Stabilization is the first intermediate level textbook that covers stability and stabilization of equilibria for both linear and nonlinear time invariant systems of ordinary differential equations Designed for advanced undergraduates and beginning graduate students in the sciences engineering and mathematics the book takes a unique modern approach that bridges the gap between linear and nonlinear systems Presenting stability and stabilization of equilibria as a core problem of mathematical control theory the book emphasizes the subject s mathematical coherence and unity and it introduces and

develops many of the core concepts of systems and control theory There are five chapters on linear systems and nine chapters on nonlinear systems an introductory chapter a mathematical background chapter a short final chapter on further reading and appendixes on basic analysis ordinary differential equations manifolds and the Frobenius theorem and comparison functions and their use in differential equations The introduction to linear system theory presents the full framework of basic state space theory providing just enough detail to prepare students for the material on nonlinear systems Focuses on stability and feedback stabilization Bridges the gap between linear and nonlinear systems for advanced undergraduates and beginning graduate students Balances coverage of linear and nonlinear systems Covers cascade systems Includes many examples and exercises **Computational Methods for Linear Control Systems** Petko Hr. Petkov,Nikolai D. Christov,Mihail M. Konstantinov,1991-01-01 Linear Control System Analysis and Design with MATLAB Constantine H. Houpis,Stuart N. Sheldon,2013-10-30 This book uses numerous in depth explanations diagrams calculations and tables to provide an intensive overview of modern control theory and control system design Mathematics is kept to a minimum and engineering applications are stressed throughout Completely updated and packed with student friendly features the sixth edition presents a range of updated examples using MATLAB as well as an appendix listing MATLAB functions for optimizing control system analysis and design Over 75 percent of the problems presented in the previous edition have been revised or replaced Piecewise Linear Control Systems Mikael K.-J. Johansson,2003-07-01 2 Piecewise Linear Modeling 9 2 1 Model Representation 9 2 2 Solution Concepts 2 3 Uncertainty Models 2 4 Modularity and Interconnections 26 2 5 Piecewise Linear Function Representations 28 2 6 Comments and References 30 3 Structural Analysis 32 3 1 Equilibrium Points and the Steady State Characteristic 32 3 2 Constraint Verification and Invariance 35 3 3 Detecting Attractive Sliding Modes on Cell Boundaries 37 3 4 Comments and References 39 4 Lyapunov Stability 41 4 1 Exponential Stability 41 4 2 Quadratic Stability 42 4 3 Conservatism of Quadratic Stability 46 4 4 From Quadratic to Piecewise Quadratic 48 4 5 Interlude Describing Partition Properties 51 4 6 Piecewise Quadratic Lyapunov Functions 55 4 7 Analysis of Piecewise Linear Differential Inclusions 61 4 8 Analysis of Systems with Attractive Sliding Modes 63 4 9 Improving Computational Efficiency 66 4 10 Piecewise Linear Lyapunov Functions 72 4 11 A Unifying View 77 4 12 Comments and References 82 5 Dissipativity Analysis 85 5 1 Dissipativity Analysis via Convex Optimization 86 21 14 Contents Contents 5 2 Computation of 2 induced Gain 88 5 3 Estimation of Transient Energy 89 5 4 Dissipative Systems with Quadratic Supply Rates 91 5 5 Comments and References 95 Controller Design 96 6 1 Quadratic Stabilization of Piecewise Linear Systems 97 6 2 Controller Synthesis based on Piecewise Quadratics 98 6 3 Comments and References 105 7 Selected Topics 107 7 1 Estimation of Regions of Attraction *Methods of Optimization and Systems Analysis for Problems of Transcomputational Complexity* Ivan V. Sergienko,2012-07-27 This work presents lines of investigation and scientific achievements of the Ukrainian school of optimization theory and adjacent disciplines These include the development of approaches to mathematical theories methodologies methods and application

systems for the solution of applied problems in economy finances energy saving agriculture biology genetics environmental protection hardware and software engineering information protection decision making pattern recognition self adapting control of complicated objects personnel training etc The methods developed include sequential analysis of variants nondifferential optimization stochastic optimization discrete optimization mathematical modeling econometric modeling solution of extremum problems on graphs construction of discrete images and combinatorial recognition etc Some of these methods became well known in the world s mathematical community and are now known as classic methods *Design of Linear Multivariable Feedback Control Systems* Joseph J. Bongiorno Jr.,Kiheon Park,2020-07-09 This book contains a derivation of the subset of stabilizing controllers for analog and digital linear time invariant multivariable feedback control systems that insure stable system errors and stable controller outputs for persistent deterministic reference inputs that are trackable and for persistent deterministic disturbance inputs that are rejectable For this subset of stabilizing controllers the Wiener Hopf methodology is then employed to obtain the optimal controller for which a quadratic performance measure is minimized This is done for the completely general standard configuration and methods that enable the trading off of optimality for an improved stability margin and or reduced sensitivity to plant model uncertainty are described New and novel results on the optimal design of decoupled non interacting systems are also presented The results are applied in two examples the one and three degree of freedom configurations These demonstrate that the standard configuration is one encompassing all possible feedback configurations Each chapter is completed by a group of worked examples which reveal additional insights and extensions of the theory presented in the chapter Three of the examples illustrate the application of the theory to two physical cases the depth and pitch control of a submarine and the control of a Rosenbrock process In the latter case designs with and without decoupling are compared This book provides researchers and graduate students working in feedback control with a valuable reference for Wiener Hopf theory of multivariable design Basic knowledge of linear systems and matrix theory is required **Springer Handbook of Automation** Shimon Y. Nof,2023-06-16 This handbook incorporates new developments in automation It also presents a widespread and well structured conglomeration of new emerging application areas such as medical systems and health transportation security and maintenance service construction and retail as well as production or logistics The handbook is not only an ideal resource for automation experts but also for people new to this expanding field **Polynomial and Rational Matrices** Tadeusz Kaczorek,2007-01-19 This book reviews new results in the application of polynomial and rational matrices to continuous and discrete time systems It provides the reader with rigorous and in depth mathematical analysis of the uses of polynomial and rational matrices in the study of dynamical systems It also throws new light on the problems of positive realization minimum energy control reachability and asymptotic and robust stability **Aircraft Control and Simulation** Brian L. Stevens,Frank L. Lewis,Eric N. Johnson,2015-10-02 Get a complete understanding of aircraft control and simulation Aircraft Control and Simulation

Dynamics Controls Design and Autonomous Systems Third Edition is a comprehensive guide to aircraft control and simulation This updated text covers flight control systems flight dynamics aircraft modeling and flight simulation from both classical design and modern perspectives as well as two new chapters on the modeling simulation and adaptive control of unmanned aerial vehicles With detailed examples including relevant MATLAB calculations and FORTRAN codes this approachable yet detailed reference also provides access to supplementary materials including chapter problems and an instructor s solution manual Aircraft control as a subject area combines an understanding of aerodynamics with knowledge of the physical systems of an aircraft The ability to analyze the performance of an aircraft both in the real world and in computer simulated flight is essential to maintaining proper control and function of the aircraft Keeping up with the skills necessary to perform this analysis is critical for you to thrive in the aircraft control field Explore a steadily progressing list of topics including equations of motion and aerodynamics classical controls and more advanced control methods Consider detailed control design examples using computer numerical tools and simulation examples Understand control design methods as they are applied to aircraft nonlinear math models Access updated content about unmanned aircraft UAVs Aircraft Control and Simulation Dynamics Controls Design and Autonomous Systems Third Edition is an essential reference for engineers and designers involved in the development of aircraft and aerospace systems and computer based flight simulations as well as upper level undergraduate and graduate students studying mechanical and aerospace engineering

Perturbation Theory for Matrix Equations M. Konstantinov,D. Wei Gu,V. Mehrmann,P. Petkov,2003-05-20 The book is devoted to the perturbation analysis of matrix equations The importance of perturbation analysis is that it gives a way to estimate the influence of measurement and or parametric errors in mathematical models together with the rounding errors done in the computational process The perturbation bounds may further be incorporated in accuracy estimates for the solution computed in finite arithmetic This is necessary for the development of reliable computational methods algorithms and software from the viewpoint of modern numerical analysis In this book a general perturbation theory for matrix algebraic equations is presented Local and non local perturbation bounds are derived for general types of matrix equations as well as for the most important equations arising in linear algebra and control theory A large number of examples tables and figures is included in order to illustrate the perturbation techniques and bounds Key features The first book in this field Can be used by a variety of specialists Material is self contained Results can be used in the development of reliable computational algorithms A large number of examples and graphical illustrations are given Written by prominent specialists in the field

Numerical Methods for Large-Scale Linear Time-Varying Control Systems and related Differential Matrix Equations Norman Lang,2018 This thesis is concerned with the linear quadratic optimal control and model order reduction MOR of large scale linear time varying LTV control systems In the first two parts particular attention is paid to a tracking type finite time optimal control problem with application to an inverse heat conduction problem and the balanced truncation

BT MOR method for LTV systems In both fields of application the efficient solution of differential matrix equations DMEs is of major importance The third and largest part deals with the application of implicit time integration methods to these matrix valued ordinary differential equations In this context in particular the rather new class of peer methods is introduced Further for the efficient solution of large scale DMEs in practice low rank solution strategies are inevitable Here low rank time integrators based on a symmetric indefinte factored representation of the right hand sides and the solution approximations of the DMEs are presented In contrast to the classical low rank Cholesky type factorization this avoids complex arithmetic and tricky implementations and algorithms Both low rank approaches are compared for numerous implicit time integration methods   **Large-Scale Scientific Computing** Ivan Lirkov,Svetozar D. Margenov,Jerzy Wasniewski,2009-03-26 Coverage in this proceedings volume includes robust multilevel and hierarchical preconditioning methods applications for large scale computations and optimization of coupled engineering problems and applications of metaheuristics to large scale problems   *Curriculum Handbook with General Information Concerning ... for the United States Air Force Academy* United States Air Force Academy,1989   Scientific and Technical Aerospace Reports ,1995

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