

L. Guzzella
A. Sciarretta

Vehicle Propulsion Systems

Introduction to Modeling
and Optimization

Second Edition

 Springer

Modeling And Optimization Of Vehicle Propulsion Systems

L. Guzzella, Antonio Sciarretta



Modeling And Optimization Of Vehicle Propulsion Systems:

Vehicle Propulsion Systems L. Guzzella, Antonio Sciarretta, 2005 Automobiles are responsible for a substantial part of the world's consumption of primary energy mostly fossil liquid hydrocarbons The reduction of the fuel consumption of these vehicles has become a top priority Many ideas to reach that objective have been presented In most cases these systems are more complex than the traditional approaches For such complex systems a heuristic design approach fails The only way to deal with this situation is to employ model based methods This text provides an introduction to the mathematical modeling and subsequent optimization of vehicle propulsion systems and their supervisory control algorithms Vehicle Propulsion Systems Lino Guzzella, Antonio Sciarretta, 2007-09-21 In this book the longitudinal behavior of road vehicles is analyzed The main emphasis is on the analysis and minimization of the fuel and energy consumption Most approaches to this problem enhance the complexity of the vehicle system by adding components such as electrical motors or storage devices Such a complex system can only be designed by means of mathematical models This text gives an introduction to the modeling and optimization problems typically encountered when designing new propulsion systems for passenger cars It is intended for persons interested in the analysis and optimization of classical and novel vehicle propulsion systems Its focus lies on the control oriented mathematical description of the physical processes and on the model based optimization of the system structure and of the supervisory control algorithms This text has evolved from a lecture series at ETH Zurich Prerequisites are general engineering topics and a first course in optimal control theory Modeling and Optimal Control of Heavy-Duty Powertrains Vaheed Nezhadali, 2016-05-30 Heavy duty powertrains are complex systems with components from various domains different response times during transient operations and different efficient operating ranges To ensure efficient transient operation of a powertrain e.g. with low fuel consumption or short transient duration it is important to come up with proper control strategies In this dissertation optimal control theory is used to calculate and analyze efficient heavy duty powertrain controls during transient operations in different applications This is enabled by first developing control ready models usable for multi phase optimal control problem formulations and then using numerical optimal control methods to calculate the optimal transients Optimal control analysis of a wheel loader operating in a repetitive loading cycle is the first studied application Increasing fuel efficiency or reducing the operation time in such repetitive loading cycles sums up to large savings over longer periods of time Load lifting and vehicle traction consume almost all of the power produced by a diesel engine during wheel loader operation Physical models are developed for these subsystems where the dynamics are described by differential equations The model parameters are tuned and fuel consumption estimation is validated against measured values from real wheel loader operation The sensitivity of wheel loader trajectory with respect to constraints such as the angle at which the wheel loader reaches the unloading position is also analyzed A time and fuel optimal trajectory map is calculated for various unloading positions Moreover the importance of simultaneous optimization of wheel loader

trajectory and the component transients is shown via a side to side comparison between measured fuel consumption and trajectories versus optimal control results In another application optimal control is used to calculate efficient gear shift controls for a heavy duty Automatic Transmission system A modeling and optimal control framework is developed for a nine speed automatic transmission Solving optimal control problems using the developed model time and jerk efficient transient for simultaneous disengagement of off going and engagement of in coming shift actuators are obtained and the results are analyzed Optimal controls of a diesel electric powertrain during a gear shift in an Automated Manual Transmission system are calculated and analyzed in another application of optimal control The powertrain model is extended by including driveline backlash angle as an extra state in the system This is enabled by implementation of smoothing techniques in order to describe backlash dynamics as a single continuous function during all gear shift phases Optimal controls are also calculated for a diesel electric powertrain corresponding to a hybrid bus during a tip in maneuver It is shown that for optimal control analysis of complex powertrain systems minimizing only one property such as time pushes the system transients into extreme operating conditions far from what is achievable in real applications Multi objective optimal control problem formulations are suggested in order to obtain a compromise between various objectives when analyzing such complex powertrain systems

Modeling and Control of Hybrid Propulsion System for Ground Vehicles Yuan Zou,Junqiu Li,Xiaosong Hu,Yann Chamailard,2018-07-02 This book focuses on the systematic design of architectures parameters and control of typical hybrid propulsion systems for wheeled and tracked vehicles based on a combination of theoretical research and engineering practice Adopting a mechatronic system dynamics perspective principles and methods from the fields of optimal control and system optimization are applied in order to analyze the hybrid propulsion configuration and controller design Case investigations for typical hybrid propulsion systems of wheeled and tracked ground vehicles are also provided **16th**

International Symposium on Advanced Vehicle Control Giampiero Mastinu,Francesco Braghin,Federico Cheli,Matteo Corno,Sergio M. Savaresi,2024-10-03 This open access book highlights the latest advances innovations and applications in the field of vehicle systems dynamics and control as presented by leading international researchers at the 16th JSAE International Symposium on Advanced Vehicle Control AVEC held at Politecnico di Milano Milan Italy on September 2 6 2024 It covers a diverse range of topics such as vehicle dynamics theory steering brake tire suspension chassis control powertrain electrified vehicles stability enhancement systems driver vehicle systems advanced driver assistance systems and automated driving systems driving simulator dynamics and control The contributions which were selected by means of a rigorous international peer review process present a wealth of exciting ideas that will open novel research directions and foster multidisciplinary collaboration among different specialists 8th EASN-CEAS Workshop on Manufacturing for Growth and Innovation Konstantinos Kontis,Spiros Pantelakis,2019-09-27 This Special Issue contains selected papers from works presented at the 8th EASN CEAS European Aeronautics Science Network Council of European Aerospace Societies

Workshop on Manufacturing for Growth and Innovation which was held in Glasgow UK 4-7 September 2018. About 150 participants contributed to a high level scientific gathering providing some of the latest research results on the topic as well as some of the latest relevant technological advancements in interesting articles which cover a wide range of topics including characterization analysis and design as well as numerical simulation are contained in this Special Issue.

Control of Uncertain Systems: Modelling, Approximation, and Design Bruce A. Francis, 2006-03-07. This Festschrift contains a collection of articles by friends, co-authors, colleagues and former Ph.D. students of Keith Glover, Professor of Engineering at the University of Cambridge, on the occasion of his sixtieth birthday. Professor Glover's scientific work spans a wide variety of topics, the main themes being system identification, model reduction and approximation, robust controller synthesis and control of aircraft and engines. The articles in this volume are a tribute to Professor Glover's seminal work in these areas.

The Control Handbook William S. Levine, 2018-10-08. At publication, *The Control Handbook* immediately became the definitive resource that engineers working with modern control systems required. Among its many accolades, that first edition was cited by the AAP as the Best Engineering Handbook of 1996. Now 15 years later, William Levine has once again compiled the most comprehensive and authoritative resource on control engineering. He has fully reorganized the text to reflect the technical advances achieved since the last edition and has expanded its contents to include the multidisciplinary perspective that is making control engineering a critical component in so many fields. Now expanded from one to three volumes, *The Control Handbook: Second Edition* organizes cutting edge contributions from more than 200 leading experts. The second volume, *Control System Applications*, includes 35 entirely new applications organized by subject area. Covering the design and use of control systems, this volume includes applications for automobiles including PEM fuel cells, Aerospace, Industrial control of machines and processes, Biomedical uses including robotic surgery and drug discovery and development, Electronics and communication networks. Other applications are included in a section that reflects the multidisciplinary nature of control system work. These include applications for the construction of financial portfolios, earthquake response control for civil structures, quantum estimation and control, and the modeling and control of air conditioning and refrigeration systems. As with the first edition, the new edition not only stands as a record of accomplishment in control engineering but provides researchers with the means to make further advances. Progressively organized, the other two volumes in the set include *Control System Fundamentals* and *Control System Advanced Methods*. *The Control Handbook (three volume set)* William S. Levine, 2018-10-08. At publication, *The Control Handbook* immediately became the definitive resource that engineers working with modern control systems required. Among its many accolades, that first edition was cited by the AAP as the Best Engineering Handbook of 1996. Now 15 years later, William Levine has once again compiled the most comprehensive and authoritative resource on control engineering. He has fully reorganized the text to reflect the technical advances achieved since the last edition and has expanded its contents to include the

multidisciplinary perspective that is making control engineering a critical component in so many fields Now expanded from one to three volumes The Control Handbook Second Edition brilliantly organizes cutting edge contributions from more than 200 leading experts representing every corner of the globe They cover everything from basic closed loop systems to multi agent adaptive systems and from the control of electric motors to the control of complex networks Progressively organized the three volume set includes Control System Fundamentals Control System Applications Control System Advanced Methods Any practicing engineer student or researcher working in fields as diverse as electronics aeronautics or biomedicine will find this handbook to be a time saving resource filled with invaluable formulas models methods and innovative thinking In fact any physicist biologist mathematician or researcher in any number of fields developing or improving products and systems will find the answers and ideas they need As with the first edition the new edition not only stands as a record of accomplishment in control engineering but provides researchers with the means to make further advances

Design and Control of Automotive Propulsion Systems Zongxuan Sun,Guoming G. Zhu,2014-12-20 Better Understand the Relationship between Powertrain System Design and Its Control Integration While powertrain system design and its control integration are traditionally divided into two different functional groups a growing trend introduces the integration of more electronics sensors actuators and controls into the powertrain system

Electric Vehicles for Smart Cities Evanthia A. Nanaki,2020-10-07 Electric Vehicles for Smart Cities Trends Challenges and Opportunities uniquely examines different approaches to electric vehicle deployment in the context of smart cities It provides a holistic picture of electromobility within urban areas offering an integrated approach to city transportation systems by considering the energy systems latest vehicle technologies and transport infrastructure Electric Vehicles for Smart Cities addresses the interaction between grid infrastructure vehicles costs and benefits and operational reliability within an integrated framework The book examines the role electric vehicles play in the social and political aspects of climate change mitigation as well as a renewable energy based economy It explains how electric vehicles and their system requirements work including recharging techniques and infrastructures and discusses alternative market deployment approaches Includes case studies from cities around the world including Amsterdam London Oslo Barcelona Los Angeles New York Silicon Valley Los Angeles Beijing Shanghai Tianjin Tokyo and Goto Islands Traces the developments innovations advantages and disadvantages in the electric car industry Provides learning aids such as discussion questions and text boxes

Automotive Control Systems A. Galip Ulsoy,Huei Peng,Melih Çakmakci,2012-04-30 This textbook introduces advanced control systems for vehicles including advanced automotive concepts and the next generation of vehicles for ITS

Diesel Engine System Design Qianfan Xin,2011-05-26 Diesel Engine System Design links everything diesel engineers need to know about engine performance and system design in order for them to master all the essential topics quickly and to solve practical design problems Based on the author s unique experience in the field it enables engineers to come up with an appropriate specification at an early stage in the product

development cycle Links everything diesel engineers need to know about engine performance and system design featuring essential topics and techniques to solve practical design problems Focuses on engine performance and system integration including important approaches for modelling and analysis Explores fundamental concepts and generic techniques in diesel engine system design incorporating durability reliability and optimization theories **Proceedings of the 2nd**

International Conference on Mechanical System Dynamics Xiaoting Rui,Caishan Liu,2024-06-18 The 2nd International Conference of Mechanical System Dynamics ICMSD2023 is devoted to Technology Innovations by Understanding Mechanical Dynamics with 18 sessions to promote research in dynamic theories on complex structures multidisciplinary integration and advanced technologies for applications It is held on September 1 5 in Peking University Beijing China The conference is expected to provide a platform for academic researchers and engineers in the field of mechanical system dynamics to exchange scientific and technical ideas *Modeling, Dynamics, and Control of Electrified Vehicles* Haiping Du,Dongpu

Cao,Hui Zhang,2017-10-19 Modelling Dynamics and Control of Electrified Vehicles provides a systematic overview of EV related key components including batteries electric motors ultracapacitors and system level approaches such as energy management systems multi source energy optimization transmission design and control braking system control and vehicle dynamics control In addition the book covers selected advanced topics including Smart Grid and connected vehicles This book shows how EV work how to design them how to save energy with them and how to maintain their safety The book aims to be an all in one reference for readers who are interested in EVs or those trying to understand its state of the art technologies and future trends Offers a comprehensive knowledge of the multidisciplinary research related to EVs and a system level understanding of technologies Provides the state of the art technologies and future trends Covers the fundamentals of EVs and their methodologies Written by successful researchers that show the deep understanding of EVs

Hybrid Systems, Optimal Control and Hybrid Vehicles Thomas J. Böhme,Benjamin Frank,2017-02-01 This book assembles new methods showing the automotive engineer for the first time how hybrid vehicle configurations can be modeled as systems with discrete and continuous controls These hybrid systems describe naturally and compactly the networks of embedded systems which use elements such as integrators hysteresis state machines and logical rules to describe the evolution of continuous and discrete dynamics and arise inevitably when modeling hybrid electric vehicles They can throw light on systems which may otherwise be too complex or recondite Hybrid Systems Optimal Control and Hybrid Vehicles shows the reader how to formulate and solve control problems which satisfy multiple objectives which may be arbitrary and complex with contradictory influences on fuel consumption emissions and drivability The text introduces industrial engineers postgraduates and researchers to the theory of hybrid optimal control problems A series of novel algorithmic developments provides tools for solving engineering problems of growing complexity in the field of hybrid vehicles Important topics of real relevance rarely found in text books and research publications switching costs sensitivity of discrete decisions and there

impact on fuel savings etc are discussed and supported with practical applications These demonstrate the contribution of optimal hybrid control in predictive energy management advanced powertrain calibration and the optimization of vehicle configuration with respect to fuel economy lowest emissions and smoothest drivability Numerical issues such as computing resources simplifications and stability are treated to enable readers to assess such complex systems To help industrial engineers and managers with project decision making solutions for many important problems in hybrid vehicle control are provided in terms of requirements benefits and risks

Concepts in Turbocharging for Improved Efficiency and Emissions Reduction Mehrdad Zangeneh, 2014-09-22 Legislative requirements to reduce CO₂ emissions by 2020 have resulted in significant efforts by car manufacturers to explore various methods of pollution abatement One of the most effective ways found so far is by shortening the cylinder stroke and downsizing the engine This new engine then needs to be boosted or turbocharged to create the full and original load torque Turbocharging has been and will continue to be a key component to the new technologies that will make a positive difference in the next generation engines of years to come Concepts in Turbocharging for Improved Efficiency and Emissions Reduction explores the many ways that turbocharging will deliver concrete results in meeting the new realities of sustainable green transportation This collection of very focused technical papers selected by Mehrdad Zangeneh PhD a professor of thermo fluids at University College in London provides an assessment of several novel designs intended to improve fuel consumption and cap emissions while maintaining torque at all speeds The book is divided into four sections each addressing the most cutting edge technologies on the market today o Two Stage Turbocharging o Variable Geometry Compressors o Unconventional Compressor Configurations o Electrically Assisted Turbocharging

Reinforcement Learning-Enabled Intelligent Energy Management for Hybrid Electric Vehicles Teng Liu, 2022-06-01 Powertrain electrification fuel decarburization and energy diversification are techniques that are spreading all over the world leading to cleaner and more efficient vehicles Hybrid electric vehicles HEVs are considered a promising technology today to address growing air pollution and energy deprivation To realize these gains and still maintain good performance it is critical for HEVs to have sophisticated energy management systems Supervised by such a system HEVs could operate in different modes such as full electric mode and power split mode Hence researching and constructing advanced energy management strategies EMSs is important for HEVs performance There are a few books about rule and optimization based approaches for formulating energy management systems Most of them concern traditional techniques and their efforts focus on searching for optimal control policies offline There is still much room to introduce learning enabled energy management systems founded in artificial intelligence and their real time evaluation and application In this book a series hybrid electric vehicle was considered as the powertrain model to describe and analyze a reinforcement learning RL enabled intelligent energy management system The proposed system can not only integrate predictive road information but also achieve online learning and updating Detailed powertrain modeling predictive algorithms and online updating

technology are involved and evaluation and verification of the presented energy management system is conducted and executed

Introduction to Modeling and Control of Internal Combustion Engine Systems Lino

Guzzella, Christopher Onder, 2009-12-21 Internal combustion engines ICE still have potential for substantial improvements particularly with regard to fuel efficiency and environmental compatibility In order to fully exploit the remaining margins increasingly sophisticated control systems have to be applied This book offers an introduction to cost effective model based control system design for ICE The primary emphasis is put on the ICE and its auxiliary devices Mathematical models for these processes are developed and solutions for selected feedforward and feedback control problems are presented The discussions concerning pollutant emissions and fuel economy of ICE in automotive applications constantly intensified since the first edition of this book was published Concerns about the air quality the limited resources of fossil fuels and the detrimental effects of greenhouse gases exceedingly spurred the interest of both the industry and academia in further improvements The most important changes and additions included in this second edition are restructured and slightly extended section on superchargers short subsection on rotational oscillations and their treatment on engine test benches complete section on modeling detection and control of engine knock improved physical and chemical model for the three way catalytic converter new methodology for the design of an air to fuel ratio controller short introduction to thermodynamic engine cycle calculation and corresponding control oriented aspects

Modern Electric, Hybrid Electric, and Fuel Cell Vehicles Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi, 2018-02-02 This book is an introduction to automotive technology with specific reference to battery electric hybrid electric and fuel cell electric vehicles It could serve electrical engineers who need to know more about automobiles or automotive engineers who need to know about electrical propulsion systems For example this reviewer who is a specialist in electric machinery could use this book to better understand the automobiles for which the reviewer is designing electric drive motors An automotive engineer on the other hand might use it to better understand the nature of motors and electric storage systems for application in automobiles trucks or motorcycles The early chapters of the book are accessible to technically literate people who need to know something about cars While the first chapter is historical in nature the second chapter is a good introduction to automobiles including dynamics of propulsion and braking The third chapter discusses in some detail spark ignition and compression ignition Diesel engines The fourth chapter discusses the nature of transmission systems James Kirtley Massachusetts Institute of Technology USA The third edition covers extensive topics in modern electric hybrid electric and fuel cell vehicles in which the profound knowledge mathematical modeling simulations and control are clearly presented Featured with design of various vehicle drivetrains as well as a multi objective optimization software it is an estimable work to meet the needs of automotive industry Haiyan Henry Zhang Purdue University USA The extensive combined experience of the authors have produced an extensive volume covering a broad range but detailed topics on the principles design and architectures of Modern Electric Hybrid Electric and

Fuel Cell Vehicles in a well structured clear and concise manner The volume offers a complete overview of technologies their selection integration control as well as an interesting Technical Overview of the Toyota Prius The technical chapters are complemented with example problems and user guides to assist the reader in practical calculations through the use of common scientific computing packages It will be of interest mainly to research postgraduates working in this field as well as established academic researchers industrial R D engineers and allied professionals Christopher Donaghy Sparg Durham University United Kingdom The book deals with the fundamentals theoretical bases and design methodologies of conventional internal combustion engine ICE vehicles electric vehicles EVs hybrid electric vehicles HEVs and fuel cell vehicles FCVs The design methodology is described in mathematical terms step by step and the topics are approached from the overall drive train system not just individual components Furthermore in explaining the design methodology of each drive train design examples are presented with simulation results All the chapters have been updated and two new chapters on Mild Hybrids and Optimal Sizing and Dimensioning and Control are also included Chapters updated throughout the text New homework problems solutions and examples Includes two new chapters Features accompanying MATLABTM software

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