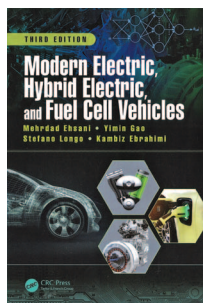




by Marian P. Kazmierkowski
and Fernando A. Silva

Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Third Edition



By Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, CRC Press, 2018, 546 pages, ISBN: 978-1-4987-6177-2.

As the world makes the transition to cleaner, low-carbon vehicles, mathematical modeling and computer simulations are required to achieve the best vehicle performance and environmental tradeoffs. This book explains the dynamic modeling, simulation, and optimization needed for this new transportation paradigm. The book presents a comprehensive overview of technologies and how they are designed, integrated, and controlled. The book begins with environmental issues and transportation history, before continuing to fundamentals of vehicle propulsion and braking, theoretical bases of internal combustion engines, and explanations about vehicle transmission.

Next, the authors explain in a well-structured, clear, and concise manner, information about electric vehicles (EVs), hybrid EVs (HEVs), fuel cell vehicles

(FCVs), and propulsion electric motors together with their controllers. The authors analyze design principles of series, parallel, series-parallel, and soft hybrid electric drive trains, and they explain design and control principles for plug-in hybrid electric vehicles, with examples showing simulation results using the overall drive train system, not just the individual components. A good grasp of such principles is essential for understanding the modeling before conducting research on advanced control methods for switching power converters [1].

Storage (batteries, supercapacitors, fuel cells) and regenerative braking, together with off-road vehicles and their requirements, are expansively analyzed and discussed in this third edition. The

book's concluding chapters cover optimization of full-size engine HEVs and power-trains and include a guide for a multiobjective optimization toolbox.

Technical chapters include design examples, computer simulations, comparisons with available passenger cars, and case studies on optimization using MATLAB software available on the CRC Press website. The chapters are as follows:

- 1) "Environmental Impact and History of Modern Transportation"
 - 1.1) "Air Pollution"
 - 1.2) "Global Warming"
 - 1.3) "Petroleum Resources"
 - 1.4) "Induced Costs"
 - 1.5) "Importance of Different Transportation Development Strategies to Future Oil Supply"
 - 1.6) "History of EVs"
 - 1.7) "History of HEVs"
 - 1.8) "History of Fuel Cell Vehicles"
- 2) "Fundamentals of Vehicle Propulsion and Brake"
 - 2.1) "General Description of Vehicle Movement"
 - 2.2) "Vehicle Resistance"
 - 2.3) "Dynamic Equation"
 - 2.4) "Tire-Ground Adhesion and Maximum Tractive Effort"
 - 2.5) "Vehicle Performance"
 - 2.6) "Operating Fuel Economy"
 - 2.7) "Brake Performance"
- 3) "Internal Combustion Engines"
 - 3.1) "Spark Ignition (SI) Engine"
 - 3.2) "Compression Ignition (CI) Engine"
 - 3.3) "Alternative Fuels and Alternative Fuel Engines"
- 4) "Vehicle Transmission"
 - 4.1) "Power Plant Characteristics"
 - 4.2) "Transmission Characteristics"
 - 4.3) "Manual Gear Transmission (MT)"
 - 4.4) "Automatic Transmission"
 - 4.5) "Continuously Variable Transmission"
 - 4.6) "Infinitely Variable Transmissions (IVT)"
 - 4.7) "Dedicated Hybrid Transmission (DHT)"
- 5) "Electric Vehicles"
 - 5.1) "Configurations of Electric Vehicles"
 - 5.2) "Performance of Electric Vehicles"
 - 5.3) "Tractive Effort in Normal Driving"
 - 5.4) "Energy Consumption"
- 6) "Hybrid Electric Vehicles"
 - 6.1) "Concept of Hybrid Electric Drivetrains"
 - 6.2) "Architectures of Hybrid Electric Drivetrains"

- 7) "Electric Propulsion Systems"
 - 7.1) "DC Motor Drives"
 - 7.2) "Induction Motor Drives"
 - 7.3) "Permanent Magnetic BLDC Motor Drives"
 - 7.4) "SRM Drives"
- 8) "Design Principle of Series (Electrical Coupling) Hybrid Electric Drivetrain"
 - 8.1) "Operation Patterns"
 - 8.2) "Control Strategies"
 - 8.3) "Design Principles of a Series (Electrical Coupling) Hybrid Drivetrain"
 - 8.4) "Design Example"
- 9) "Parallel (Mechanically Coupled) Hybrid Electric Drivetrain Design"
 - 9.1) "Drivetrain Configuration and Design Objectives"
 - 9.2) "Control Strategies"
 - 9.3) "Parametric Design of a Drivetrain"
 - 9.4) "Simulations"
- 10) "Design and Control Methodology of Series-Parallel (Torque and Speed Coupling) Hybrid Drivetrain"
 - 10.1) "Drivetrain Configuration"
 - 10.2) "Drivetrain Control Methodology"
 - 10.3) "Drivetrain Parameters Design"
 - 10.4) "Simulation of an Example Vehicle"
- 11) "Design and Control Principles of Plug-In Hybrid Electric Vehicles"
 - 11.1) "Statistics of Daily Driving Distance"
 - 11.2) "Energy Management Strategy"
 - 11.3) "Energy Storage Design"
- 12) "Mild Hybrid Electric Drivetrain Design"
 - 12.1) "Energy Consumed in Braking and Transmission"
 - 12.2) "Parallel Mild Hybrid Electric Drivetrain"
 - 12.3) "Series-Parallel Mild Hybrid Electric Drivetrain"
- 13) "Peaking Power Sources and Energy Storages"
 - 13.1) "Electrochemical Batteries"
 - 13.2) "Ultracapacitors"
 - 13.3) "Ultra-High-Speed Flywheels"
 - 13.4) "Hybridization of Energy Storages"
- 14) "Fundamentals of Regenerative Braking"
 - 14.1) "Braking Energy Consumed in Urban Driving"
 - 14.2) "Braking Energy versus Vehicle Speed"
 - 14.3) "Braking Energy versus Braking Power"
 - 14.4) "Braking Power versus Vehicle Speed"
 - 14.5) "Braking Energy versus Vehicle Deceleration Rate"
 - 14.6) "Braking Energy on Front and Rear Axles"
 - 14.7) "Brake System of EV, HEV, and FCV"
- 15) "Fuel Cells"
 - 15.1) "Operating Principles of Fuel Cells"
 - 15.2) "Electrode Potential and Current-Voltage Curve"
 - 15.3) "Fuel and Oxidant Consumption"
 - 15.4) "Fuel Cell System Characteristics"
 - 15.5) "Fuel Cell Technologies"
 - 15.6) "Fuel Supply"
 - 15.7) "Non-Hydrogen Fuel Cells"
- 16) "Fuel Cell Hybrid Electric Drivetrain Design"
 - 16.1) "Configuration"
 - 16.2) "Control Strategy"
 - 16.3) "Parametric Design"
 - 16.4) "Design Example"
- 17) "Design of Series Hybrid Drivetrain for Off-Road Vehicles"
 - 17.1) "Motion Resistance"
 - 17.2) "Tracked Series Hybrid Vehicle Drivetrain Architecture"
 - 17.3) "Parametric Design of the Drivetrain"
 - 17.4) "Engine/Generator Power Design"
 - 17.5) "Power and Energy Design of Energy Storage"
- 18) "Design of Full-Size Engine HEV with Optimal Hybridization Ratio"
 - 18.1) "Design Philosophy of Full-Size Engine HEV"
 - 18.2) "Optimal Hybridization Ratio"
 - 18.3) "10-25 kW Electrical Drive Packages"
 - 18.4) "Comparison with Commercially Available Passenger Cars"
- 19) "Power Train Optimization"
 - 19.1) "Power Train Modeling Techniques"
 - 19.2) "Defining Performance Criteria"
 - 19.3) "Power Train Simulation Methods"
 - 19.4) "Modular Power Train Structure"
 - 19.5) "Optimization Problem"
 - 19.6) "Case Studies: Optimization of Power Train Topology and Component Sizing"
- 20) "User Guide for the Multiobjective Optimization Toolbox"
 - 20.1) "About the Software"
 - 20.2) "Software Structure"
 - 20.3) "Capabilities and Limitations of the Software."

References are listed in each chapter. The appendix includes a technical overview of the Toyota Prius. Other elements of the book are the table of contents, preface, acknowledgments, author biographies, and index.

The authors are known around the world as specialists in power electronics; motor drives; hybrid vehicles and their control systems; architecture, modeling, and design of electric and hybrid electric drive trains; energy management and power-train control; mechatronic systems; and sustainable energy engineering.

Dr. Mehrdad Ehsani, IEEE Life Fellow, is the Robert M. Kennedy professor of electrical engineering at Texas A&M University, where he is the director of the Advanced Vehicle Systems Research Program and the Power Electronics and Motor Drives Laboratory. Dr. Yimin Gao is a senior research associate in the Advanced Vehicle Systems Research Program at Texas A&M University. Dr. Stefano Longo, IEEE Senior Member, is an associate professor in automotive control and optimization and the course director for the master of science degree in automotive mechatronics at Cranfield University, United Kingdom, and honorary research associate at Imperial College London. Dr. Kambiz M. Ebrahimi, a member of the American Society of Mechanical Engineers and the Society of Automotive Engineers, is professor of advanced propulsion in the Aeronautical and Automotive Engineering Department at Loughborough University, United Kingdom.

Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, a book of outstanding value, is ideal for electrical engineers

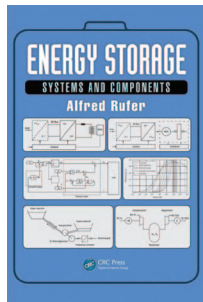
wanting to know more about car mechanical dynamics and for mechanical engineers who want to know about electrical power trains. The book's wide-ranging content meets the needs of readers from beginners to experts and from university students in senior elective courses to practicing professionals. The book is also a valuable tool for mechatronics engineers, researchers, and others who need to understand the operation of EVs.

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Reference

- [1] J. F. Silva and S. F. Pinto, "Linear and nonlinear control of switching power converters," in *Power Electronics Handbook*, 4th ed., M. H. Rashid, Ed. Oxford, U.K.: Butterworth-Heinemann, 2017, pp. 1141–1220.

Energy Storage: Systems and Components



By Alfred Rufer,
CRC Press, 2018,
274 pages,
ISBN-13: 978-1-138-08262-5.

This textbook, by Prof. Emeritus Alfred Rufer of the Swiss Federal Institute of Technology Lausanne, Switzerland, appears just when energy magazines are in wide use in the development of intelligent networks and of electromobility. This well-balanced book is easy to understand and contains no unnecessary theoretical ballast. The book's ten chapters are as follows:

- 1) "Generalities on Energy Storage"
- 2) "Energy Storage Systems"
- 3) "Comparative Ratings and Properties"
- 4) "Electrochemical Energy Storage"

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- 5) "Energy Storage by Means of Supercapacitors"
- 6) "Energy Storage Systems Based on Compressed Air"
- 7) "Hydropower and Pumped Storage Facilities"
- 8) "Flywheel Systems"
- 9) "Energy Storage Based on Hydrogen"
- 10) "System Arrangements and Applications."

The first chapter, an introduction, briefly presents the history of energy storage and gives the physical and technical definitions used in the book. The second chapter details the general types of energy storage systems in two groups: physical systems (hydro-pumped, compressed air, flywheels) and electrical systems (superconductive magnetic energy storage systems, supercapacitive systems, electrochemical systems, flow batteries, fuel cells, and hydrogen systems).

Chapter 3 discusses criteria for designing appropriate energy storage solutions and gives comparative ratings (energy density, power density, specific power, Ragone chart, and others). Several examples are provided. Chapter 4 (50 pages) is extensive and contains a detailed description of the operation, basic parameters, and models of different types of electrochemical batteries. It also touches on issues related to aging and battery management systems.

Chapter 5 describes the characteristics, modeling, and thermal aspects of energy storage involving supercapacitors and includes examples of applications related to power electronics systems. The author has unique experience in the design of compressed air energy storage (CAES), which makes the succinct analysis of such systems in Chapter 6 especially valuable. Although electrochemical energy stores are common, they have significant drawbacks, such as limited number of cycles

(because of nonreversible aging). Also, this technology is burdened by problems associated with recycling sensitive materials. By comparison, CAES systems do not have these disadvantages and, therefore, represent a promising alternative. Chapter 7 deals with hydropower and pumped storage, technologies in use since ancient times. Basic principles of operation and modeling are presented along with a number of examples using fixed and variable pumping speeds. The chapter also provides examples of high-power modern pumped storage arrangements. Chapter 8 includes basic examples of how flywheel storage systems are designed.

THIS WELL-BALANCED BOOK IS EASY TO UNDERSTAND AND CONTAINS NO UNNECESSARY THEORETICAL BALLAST.

Chapter 9 describes hydrogen production and storage as well as conversion from hydrogen to electricity (fuel cells). Chapter 10 contains an overview and examples of such storage arrangements as grid component systems, hybrid power plants that incorporate photo-

voltaic systems, fast battery-charging technologies, and uninterruptible power supplies. The book also includes an appendix that contains a brief description of the principles of power electronics and circuits used in energy storage systems.

Each chapter contains a list of references as well as examples and seven exercises with detailed solutions, which makes multidisciplinary issues in energy storage systems easier to understand and gives the book attributes of an effective textbook. Therefore, I recommend the book for students of electrical and energy departments as well as for practicing engineers employed in the design of modern distributed and renewable energy systems.

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