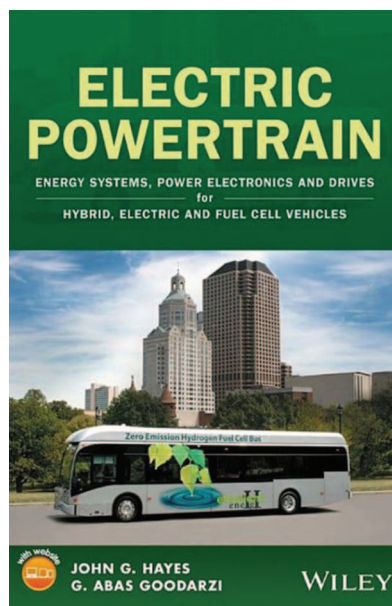


Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles

Find *Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles* to be timely and relevant for automotive engineers and engineering students seeking a deeper appreciation of what vehicle electrification means. The book was years in preparation and reflects the authors' own wealth of industrial and academic experience.

It has been almost three decades since General Motors (GM) displayed the Impact concept car at the Los Angeles Auto Show in January 1990. The Impact inspired the design of the GM EV1, the first modern production electric car, and for California to subsequently issue its zero-emissions mandate. The EV1 became available to lease in 1996 and demonstrated to the public that electric cars were feasible. Automakers at the time recognized that it would require very considerable education for the electric car to go mainstream, and in fact, it still does.

The automobile is a complex machine that has undergone continuous refinement ever since Henry Ford rolled out the first Model T in 1908 as an affordable mass-produced vehicle. By the 1990s, the motoring public was accustomed to the automobile's refined propulsion and highly tuned ride and handling. Replacing the



internal combustion engine (ICE) and gasoline tank with an electric traction drive and a relatively massive battery pack constituted a quantum jump in engineering for manufacturers to just stay on par and for potential buyers to comprehend just what *all-electric* means. What buyers do know is that, regardless of hybrid, fuel cell, or battery electric, these vehicles must match or exceed their expectations.

The authors, Dr. John G. Hayes and Dr. G. Abas Goodarzi, both veterans of the GM EV1 program, have focused their considerable talent and experience on teaching the inner workings of the electric car. Readers, whether engineers, students, or the interested

public, will find this book a treasure trove of knowledge on modern automotive technology.

The book is divided into four parts in 16 chapters, starting with “Part I: Vehicles and Energy Sources.” This section is actually a stand-alone, concise description of what a more highly electrified automobile is. The reader is taken on a path that traverses our present dependence on fossil fuels and carbon-dioxide emissions of the ICE into the world of fuel cells and battery energy storage as the electric fuel for the traction motor. What is most refreshing in all the chapters of this book are the worked examples, exercises that expand on these, and computer simulations of the more complex topics. The specific examples and problems get further refined as the reader moves into each new section of the book.

The next section, “Part II: Electric Machines,” is a painstakingly deep dive into the four main players in electric traction motors: brushed dc, induction, surface permanent magnet, and interior permanent magnet types. Engineers familiar with electric machines will find these chapters an ideal refresher, students will find the topics fascinating, and the informed lay person will garner a deeper appreciation of how that stored electric fuel gets converted into mechanical energy for vehicle propulsion.

“Part III: Power Electronics” is a more esoteric topic as many readers

wishing for a deeper understanding of the electric car will view these chapters as really getting under the hood. This is the world of power converters, inverters, and how they are controlled. Most will recognize these five chapters as a real strong suit of the authors because of their ability to describe with such clarity the dc transformer and ac synthesizer. The reader is led by an expert hand through switch-mode power conversion and is shown the intricacies of the complementary behavior of active (transistor) and passive (diode) switching devices. Examples, again, reinforce their knowledge of not only computing average and root mean square quantities of signals but of realistic power dissipation and efficiency computations. All are extremely beneficial to the practicing design engineer and fundamental to understanding by

the student and inquiring reader. My favorite chapter was on battery charging because of the need to not only understand the role of power factor correction to meet utility grid power quality regulations but also to minimize ripple exposure of the battery. Some readers may need to brush up on their control theory as the examples in Chapter 15 get into tuning the inner current/torque loop and the outer voltage/speed loop for the electric vehicle drivetrain.

Finally, "Part IV: Basics" is another stand-alone section, but this time it is a single chapter on electromagnetism and energy conversion topics that are, in fact, fundamental. The section includes topics that are basic to understanding not only electric machines but the electrified automobile in general. My recommendation is that readers may find some topics in

Parts II and III more understandable by consulting Chapter 16 first, while others may actually wish to read over Chapter 16 following Part I.

My overall impression is that this book was well worth the investment, and one that I will proudly display on my shelf. For those wishing to dig even deeper, or for appreciation of sources, the authors provide excellent references after each chapter. My conclusion—what a great book!

About the Reviewer

John M. Miller (jmmiller35@aol.com) is an industry consultant with more than 42 years of experience in electrical engineering across various industries. He is an IEEE Life Fellow, a fellow of the SAE, and a registered Professional Engineer in Michigan (1980) and in Texas (2014).



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