Preface

Energy-saving technology is one of the most important research directions nowadays in auto industry. It improves product competitiveness and strives for market initiative for vehicle companies. At present, the hybrid technology is hot in the field of energy-saving technology. Its cores comprise the configurations of the power-split hybrid system and the design methods of the power-split device (PSD).

In this book, the actual energy consumption of the vehicle is analyzed from the vehicle power demand through visual chart statistics in driving cycles. Energy consumption and power demand are the original input of the power-split vehicle. Research in this aspect is one of the important topics of energy-saving technology. In addition, how to calculate the power demand of the power-split vehicle is one of the most important problems to be solved. This book presents a practical method to calculate the total power of the vehicle directly through the acceleration capability, and it is verified by examples.

Nowadays, a large number of hybrid vehicles appear in the market and series–parallel hybrid vehicle has become the mainstream. Most series–parallel hybrid vehicles use planetary gears as the PSD, which can achieve the function of electric continuously variable transmission (EVT) and have obvious advantages on dynamic performance and fuel economy performance. Toyota Prius, the most successful hybrid vehicle, is equipped with the PSD. Detailed introduction to the typical PSD configuration adopted by Toyota and GM corporation is given in this book. The former is mainly about input power-split configuration and Toyota Hybrid System (THS) is the representative. The latter is mainly about the combined power-split configuration, which is generally called Advanced Hybrid System (AHS). Then the working principle and analysis method for the two configurations are discussed in detail. A new PSD configuration, Differential-based Hybrid System (DHS), is also proposed and analyzed in this book.

As an important technology in the research and development of hybrid vehicle, simulation technology can not only adjust design scheme and optimize design parameters flexibly, but also reduce research cost and shorten development cycle. At present, the widely used softwares in the hybrid vehicle simulation include ADVISOR, CRUISE, and AMESim. Combined with simulation examples, the
typical applications of hybrid vehicle modeling on the above simulation platforms are introduced in detail.

The power-split hybrid system is currently the promising hybrid system. This book proposes a multi-factor integrated parametric design method for a power-split Hybrid Electric Bus (HEB). This method takes the power source efficiency, transmission efficiency, driving cycle, and primary control strategy into account. Then it is applied to a specified city bus. Followed by that, system efficiency is analyzed, and the parametric design method is validated on the co-simulation platform of MATLAB/Simulink and CRUISE. The above research will contribute to the design method for the power-split HEB.

Since multi-power sources are highly coupled in PSD during mode shifting, the research on Dynamic Coordination Control Strategy (DCCS) to reduce system shock is rather important. This book proposes a predictive-model-based DCCS and builds the dynamic model of the objective power-split vehicle. Based on the model, the mode shifting process is analyzed to determine the reason for the system shock. According to the principle of the nonlinear observer, the book designs the engine torque estimation algorithm and establishes the prediction model of the degree of shock based on the model predictive control. Then, the adaptive DCCS for a complex driving cycle is realized by combining the feedback control and the prediction model.

In this book, a design method of PSD is mainly illustrated in the condition of multi-field coupling. A redesigned model of a DHS (as an example of the PSD) is developed and its bench test is conducted. The thermal analysis method and contact analysis method of the DHS are introduced. Finally, the multi-objective optimization design method based on surrogate model for the DHS is illustrated in detail.

We believe that readers could master the configuration, performance, analysis, and design method of PSD in general according to the methods and figures described in this book.

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Due to the limitation of editors, errors and inaccuracies are inevitable. We expect readers and colleagues feel free to criticize and correct.

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