

# Preface

The life of people has changed tremendously in view of the rapid growth of mobile and wireless communication. Channel coding is the heart of digital communication and data storage. The traditional block codes and convolutional codes are commonly used in digital communications. To approach the theoretical limit for Shannon's channel capacity, the length of a linear block code or constant lengths of convolutional codes have to be increased, which in turn makes the decoder complexity to become high and may render it physically unrealizable. The powerful turbo and LDPC codes approach the theoretical limit for Shannon's channel capacity with feasible complexity for decoding. MIMO communications is a multiple antenna technology which is an effective way for high speed or high reliability communications. The MIMO can be implemented by space-time coding. However, a single book which can serve as a textbook for Bachelor and Master students on this topic is lacking in the market.

In this book, many illustrative examples are included in each chapter for easy understanding of the coding techniques. An attractive feature of this book is the inclusion of MATLAB-based examples with codes to encourage readers to implement on their personal computers and become confident of the fundamentals and gain more insight into coding theory. In addition to the problems that require analytical solutions, MATLAB exercises are introduced to the reader at the end of each chapter.

The book is divided into 11 chapters. Chapter 1 introduces the basic elements of a digital communication system, statistical models for wireless channels, capacity of a fading channel, Shannon's noisy channel coding theorem and the basic idea of coding gain. Chapter 2 gives an overview of the performance analysis of different modulation techniques, and also deals with the performance of different diversity combining techniques in a multi-channel receiver. Chapter 3 introduces Galois fields and polynomials over Galois fields. Chapter 4 covers linear block codes including RS codes because of their popularity in burst error correction in wireless networks. Chapter 5 discusses the design of a convolutional encoder and Viterbi decoding algorithm for the decoding of convolutional codes, as well as the performance analysis of convolutional codes over AWGN and Rayleigh fading

channels. In this chapter, punctured convolutional codes are also discussed. Chapter 6 provides a treatment of the design of turbo codes, BCJR algorithm for iterative decoding of turbo codes, and performance analysis of turbo codes. Chapter 7 focuses on the design and analysis of Trellis-coded modulation schemes using both the conventional and turbo codes. Chapter 8 describes the design of low parity check codes (LDPC), decoding algorithms and performance analysis of LDPC codes. The erasure correcting codes like Luby transform (LT) codes and Raptor codes are described in Chap. 9. Chapter 10 provides an in-depth study of multiple-input multiple-output (MIMO) systems in which multiple antennas are used both at the transmitter and at the receiver. The design of space-time codes and implementations of MIMO systems are discussed in Chap. 11.

Salient features of this book are as follows:

- Provides comprehensive exposure to all aspects of coding theory for wireless channels with clarity and in an easy way to understand
- Provides an understanding of the fundamentals, design, implementation and applications of coding for wireless channels
- Presents illustration of coding techniques and concepts with several fully worked numerical examples
- Provides complete design examples and implementation
- Includes PC-based MATLAB *m*-files for the illustrative examples are included in the book.

The motivation in writing this book is to include modern topics of increasing importance such as turbo codes, LDPC codes and space-time coding in detail, in addition to the traditional RS codes and convolutional codes, and also to provide a comprehensive exposition of all aspects of coding for wireless channels. The text is integrated with MATLAB-based programs to enhance the understanding of the underlying theories of the subject. These MATLAB codes are free to download from the book's page on [Springer.com](https://www.springer.com).

This book is written at a level suitable for undergraduate and master students in electronics and communication engineering, electrical and computer engineering, computer science, and applied physics as well as for self-study by researchers, practicing engineers and scientists. Depending on the chapters chosen, this text can be used for teaching a one or two semester course on coding for wireless channels. The prerequisite knowledge of the readers in principles of digital communication is expected.

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