

Preface

The material presented in this book has been maturing in our minds for more than 10 years and reflect 20 years of research activities on convolutional codes by our graduate students and us. The material presented herein will be of interest to both industry researchers as well as designers. The book was initially written for use as a textbook in graduate level course study.

There has been a great exchange of ideas and theories between us through our own research and that of our graduate students. For example, Harro Osthoff wrote a thesis on list decoding of convolutional codes. As we found that problem both interesting and fun, more work went into extending the theoretical aspects and the result became Chapter 5. Johan Nyström's thesis was devoted to a new algorithm for sequential decoding. Both of us have a long-standing weakness for sequential decoding and thus it constitutes a substantial part of Chapter 6.

We also believed that the appearance of some of David Forney's important structural results on convolutional encoders in a textbook was long overdue. For us, that generated new research problems. This interplay between research and teaching was a delightful experience. This book is the final product of that experience.

Chapter 1 is an introduction to the area of convolutional codes. Shannon's coding limits are discussed and we introduce some terminology. In Chapter 2, we define convolutional codes and convolutional encoders. Various concepts of minimality are discussed in depth. Chapter 3 is devoted to distances of convolutional codes. Upper and lower bounds are derived.

The following four chapters, Chapters 4–7 describe and analyze different decoding methods, viz., Viterbi (maximum-likelihood), list, sequential, and iterative decoding, respectively.

In Chapter 8, we provide lists of good convolutional encoders of various types, rates, and memories. Chapter 9 contains some results on modulation codes.

In Appendix A we demonstrate how to minimize two examples of convolutional encoders and in Appendix B we present Wald's identity and related results that are necessary for our analyses in Chapters 3–6.

For simplicity's sake, we have only considered *binary* convolutional codes. In most of our derivations of the various bounds we have only considered the binary symmetric

