

Preface

This book is the outgrowth of the course “Modern Radio Systems Engineering,” developed and taught by the Dr. H.J. De Los Santos during the 2010/2011 Winter Semester, while he held a German Research Foundation *Mercator Visiting Professorship* at the Institute for High-Frequency Engineering and Electronics (IHE), Karlsruhe Institute of Technology/University of Karlsruhe (TH), Germany. In the German system, the courses consist of lectures and exercises; there is no homework! Both lectures and exercises are held once a week for one and one-half hours. The teaching process entails the literal transfer of information to the student, meaning that all the material required to be learned in a given course must be explicitly given to the student in lecture notes handouts. The American concept of urging/demanding that students learn material by themselves, e.g., “read this chapter on your own,” “convince yourself by deriving a result by yourself,” etc., is nonexistent. This book attempts to recreate this learning experience. In particular, the same team who carried out the lecturing and tutorial exercises in the above course, namely, Dr. H.J. De Los Santos, and former Research Associates (now Drs.) Dr.-Ing. C. Sturm and Dr. Ing. J. Pontes, respectively, has reunited once more to collaborate in producing this book.

The course is aimed at upper-level undergraduates/first-year graduate students, who already have knowledge of devices and circuits for radio-frequency (RF) and microwave communications and are ready to study the systems engineering-level aspects of modern radio communications systems. In particular, the course gives a general overview of radio systems, together with their components. In this context, the focus is on the analog parts of the system, with their non-idealities. Based on the physical functionality of the various building blocks of a modern radio system, block parameters are derived, which allows the examination of their influence on the overall system performance.

The chapters of the book are complemented by tutorial exercises, based on the Keysight SystemVue electronic system-level (ESL) design software. In these tutorials, the readers gain practical experience with slightly simplified real-world design examples of radio systems, both in the area of communications as well as radar sensing. The tutorials cover state-of-the-art system standards and applications and consider the characteristics of typical radio-frequency hardware components. For

all tutorials, a comprehensive description of the tasks, including some hints to the solutions, is provided. The readers are then intended to perform these tasks independently. Then, complete simulation models and solutions to the tutorial exercises is given.

Radio Systems Engineering: A Tutorial Approach fills a niche not addressed by previous books; in fact, it would make an excellent prerequisite for them. For instance, previous books are typically aimed at advanced graduate students and practicing engineers. As a result, they tend to be specialized by providing an in-depth focus on specific applications and technologies, so as to be a resource to individuals developing these applications. This book, on the other hand, facilitates the integration of the knowledge gathered by undergraduate students during their pre-Senior years, which primarily focuses on devices and circuits, and gives them their first exposure to their exploitation in engineering an overall system to fulfill real-life performance requirements.

Radio Systems Engineering: A Tutorial Approach contains nine chapters. Chapter 1 starts by providing an overview of wireless communication systems, defining the fundamental wireless communications problem and motivating approaches to its solution. Chapter 2 introduces system-level block diagrams of Amplitude Modulation (AM) and Frequency Modulation(FM)/Phase Modulation (PM) modulators and demodulators, and explains their respective principles of operation. Chapter 3 addresses a number of topics surrounding system performance parameters as well as a system-level description of component models for systems analysis. Chapter 4 discusses the fundamentals of the radio channel and a discussion of antenna parameters. Chapter 5 deals with the topics of Noise, Nonlinearity and Time Variance as it pertains to relating the performance of building blocks to that of the overall system built as a cascade of them. Chapter 6 focuses on the topics of sensitivity and dynamic range for a receiver, including how the performance of the individual building blocks impacts the overall system. Chapter 7, addresses the topics of transmitter and receiver architectures, and practical aspects impacting the performance of oscillators. Chap. 8 integrates the knowledge presented in Chaps. 1–7 by engaging into a “case study” tutorial discussion that exposes the engineering considerations and thought processes behind the design of two real-life receivers, implemented after the WCDMA and LTE standards, respectively. Chapter 9, includes five tutorial exercises based on the Keysight SystemVue software tool, a free limited- time license of which may be downloaded from <http://www.keysight.com/find/eesof-radio-systems-engineering>.

Radio Systems Engineering

A Tutorial Approach

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