Preface

This book is meant to serve both as a textbook and a reference book for practicing engineers. Most undergraduates studying microwave engineering hope to shortly become practicing engineers. This book is meant to stay with the student when the student becomes a practicing engineer. During the approximately 25 years I spent at the former Collins Radio Company and Rockwell International, I had the privilege of working with some great microwave engineers, who were real practitioners. Much of what I accomplished in those years can be attributed to their patience and desire to train me in good experimental techniques in the microwave laboratory. They reinforced my conviction that good microwave design is built upon good characterization. Good characterization is proven in the laboratory. Although I have written well over 25,000 lines of Fortran code for microwave circuit analysis, I still believe in proving the circuit in the laboratory. Design cycle time and costs are very important to engineers in the microwave industry. The experimentalist knows the value of computer-aided design, but also knows when the intelligence contained in the program is not sufficient to mimic and model what occurs in the laboratory. First-time design success is the goal of many engineers and is required of many managers. One purpose of this book is to help engineers reach that goal.

Much of the material contained in Chapters 1 to 3, 5, 7 to 9, and 10 has been used in a lecture in a one-semester course at Iowa State University. The material in Chapter 6 is usually learned by those students in the concurrent laboratory assignments. At Iowa State University, the microwave student designs a 1-GHz oscillator, amplifier, and filter on a printed circuit board during the first two-thirds of the semester. During the last one-third of the semester, the boards are fabricated and the student assembles, tests, and analyzes the design and compiles a report on the performance of the small power module that was designed.

The material in Chapter 4 is meant for the engineer working in the mixed-mode analog-digital MMIC area. The mixed-mode three- and four-port scattering parameter measurement and analysis technique is covered in that chapter. The undergraduate student or practicing engineer who is interested in two-port circuits only can skip that chapter.

The material is arranged in an order that enables an engineer first to gain an appreciation of component parasitics, then to learn the scattering parameter technique and subse-

quently apply both of these knowledge bases to an amplifier design. The amplifier design procedure is then applied to an oscillator design. High-efficiency amplifier design is inserted between amplifiers and oscillators in order to provide a basis for optimum power generation in an oscillator. Filter design procedures follow oscillator design and give the engineer the tools to provide spectrum cleanup for oscillator outputs.

Noise, detection, and mixing (Chapters 10 and 11) follow these chapters. Portions of these chapters can be included in a one-semester course, but these chapters plus Chapters 12 and 13 provide a basis for a second-semester course in RF and microwave engineering. The material in Chapter 13 provides a beginning analysis for bridging the gap between analog and high-speed digital microwave circuits. Parts of the material in Chapter 4 could be used in a second-semester course as well.

The last two chapters of the book, Chapters 14 and 15, should be read along with Chapters 1 through 8. Chapter 15 contains a more detailed worked example of a 1-GHz oscillator, amplifier, and printed circuit board filter. The reader can easily use that chapter as a basis for a printed circuit board or monolithic microwave integrated circuit design. Chapter 14 contains some details about bias components and concerns that are often overlooked.

Material for the book was first compiled in order to teach an on- and off-campus course when I was an adjunct instructor at the University of Iowa while working at Rockwell International. That content has been used during the 13 years I have been on the faculty of Iowa State University. I thank all of my former students for their comments; some of the comments have been enlightening and others encouraging. My teaching assistants who helped in the laboratory deserve special thanks. I was privileged to take a six-month professional development leave from Iowa State University, which provided me with relief from pressing day-to-day duties and with an opportunity for further study in the microwave area, as well as the environment necessary for the final details of the book to be completed.