Preface

This book addresses the unique needs of today's engineering community with an interest in radio frequency (RF)/microwaves in public health and in medicine as well as those of the medical community. Our decision to embark on this project was made during the time in which the authors served as Members of the IEEE Microwave Theory and Techniques (MTT) Subcommittee on Biological Effects and Medical Applications of Microwaves.

We were even more enthusiastic about writing the book after editing two special issues of *IEEE MTT Transactions* named "Medical Applications and Biological Effects of RF/Microwaves," one in 1996 and the second in 2001. The number of excellent papers accepted for publication in those two special issues required that two volumes be allocated to the subject each year. We then realized that we had the obligation, and the opportunity, to develop a new biomedical course that would encourage further research and produce new researchers in the unique area of RF/microwave interaction with tissue. Thus the book.

The material is divided into six chapters. Chapter 1 summarizes fundamentals in electromagnetics, with the biological mechanisms in mind. Special attention is paid to penetration in biological tissues and skin effect, relaxation effects in materials and the Cole–Cole display, the near field of an antenna, blackbody radiation with the various associated laws, and microwave measurements.

Chapter 2 discusses RF/microwave interaction mechanisms in biological materials. The word *interaction* stresses the fact that end results not only depend on the action of the field but also are influenced by the reaction of the living system. Cells and nerves are described, as well as tissue characterization, in particular dielectric, and measurements in tissues and biological liquids are included. A section is devoted to the fundamentals of thermodynamics, including a discussion on energy and entropy.

Biological effects are the subject of Chapter 3. Dosimetric studies attempt to quantify the interactions of RF fields with biological tissues and bodies. A

variety of effects are described and discussed; they include those on the nervous system, the brain and spinal cord, the blood–brain barrier, cells and membranes, effects at the molecular level, influence of drugs, and effects due to extremely low frequency components of signal modulation. Thermal considerations, related to absorption, are the subject of a significant part of this chapter. The possibility of nonthermal effects is also discussed. This leads to a discussion on radiation hazards and exposure standards.

Chapter 4 is devoted to thermal therapy. Thermotherapy has been used as medical treatment in, for example, rheumatism and muscle diseases. In this chapter, the reader will find a description of applicators and an extensive discussion on the foundation of dielectric heating and inductive heating as well as a variety of technological information. Hyperthermia is also discussed as a noninvasive method, and practical thermometry methods are described.

Recently, electromagnetic (EM) environments have become very complex because of the wide and rapid spread of a number of electric or electronic devices, including recent progress and the increase in use in the area of cellular telephony. As a countermeasure, wave absorbers are being used for protecting biological and medical environments, and knowledge about these absorbers has become important. In Chapter 5, we investigate materials for EM wave absorbers, both from a theoretical and an application point of view. Special attention is paid to ferrite absorbers, for which it has long been a challenge to develop an EM wave absorber at the desired matching frequency. The chapter ends with the description of a method for improving the distribution of RF fields in a small room.

Chapter 6 begins with some of the fundamental aspects of major components used in RF/microwave delivery systems for therapeutic applications. The authors have chosen to detail the research done on the subject of cardiac ablation. The chapter also covers new ideas and research done on the use of RF/microwaves in the development of future measurement techniques, such as blood perfusion, for example, and the use of microwaves in therapeutic applications. New inventions would reduce further the need for surgical or invasive procedures, substituting noninvasive and minimally invasive techniques.

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