Preface

This textbook, *Foundation of Radiological Physics* evolves from my many years of lectures to radiation therapy students, nuclear medicine technology students, medical dosimetrists, diagnostic radiology residents, radiation oncology residents, medical physics post-doctoral students, and medical physics residents. I undertook the task of writing this textbook because I was not able to find a concise textbook that adequately covers the fundamentals of radiological physics as set forth by the curriculum guides of American Association of Radiologic Technologists (ASRT),[1,2] Society of Nuclear Medicine (SNM),[3] American Association of Medical Dosimetrists (AAMD),[4] American College of Radiology (ACR), and American Association of Physicists in Medicine (AAPM).[5] Although it was a challenging task that required a significant amount of my effort and time, I feel it was a worthwhile undertaking. My colleagues have shared my ambition, such that they have been willing to invest their efforts and time to serve as reviewers.

The core requirements for all students entering the field of radiology and radiation oncology are basically the same. Most of these students come from diverse educational backgrounds with limited or no knowledge of physics, let alone atomic physics or nuclear physics. The *Foundation of Radiological Physics* becomes a basic textbook for these students. In addition, it is also a preparatory textbook for those students who will eventually pursue advanced courses in radiological sciences. This textbook is written as an introductory "ONE SEMESTER" course covering 4 months of study. The primary materials covered in this textbook are atomic physics, nuclear physics, interaction of radiation with matter, health physics, and radiobiology. It offers

[1] ASRT. *The curriculum guide for radiation therapy technology programs*. Albuquerque: The American Society of Radiologic Technologists; 1991.
[2] ASRT. *The professional curriculum for radiography*. Albuquerque: The American Society of Radiologic Technologists, 1993.
[3] SNM. *Curriculum guide for nuclear medicine technologists*. New York: Society of Nuclear Medicine, 1992.
[4] AAMD. *Medical Dosimetry Education Programs Curriculum Guidelines Version 2*. Med. Dosm. 25: 275-308; 2000.
[5] ACR and AAPM. *The physics of diagnostic and therapeutic radiology – syllabus and study guide*. Baltimore: 1987.

a basic conceptual understanding of radiation sources, how radiation is produced and its interactions with matter. Of great importance to the students is how to behave in a radiation environment. This involves the understanding of the effects of radiation, regulatory guidelines, and the principles of safe operation of equipment. A lack of knowledge of radiation safety can cause radiation hazards and/or radiation accidents, which can be catastrophic. Additional chapters such as mathematics, physics, computer, and radiobiology are added for review, if needed.

My teaching of the fundamentals of radiological physics starts with an introduction to radiation in Chapter 1. This chapter is intended to remind the students that they are studying in a radiation environment. A session on mathematics to explain exponential decay follows Chapter 1. At this time, the students should have met with the radiation safety officer of their institution to discuss radiation effects, compliance with regulatory requirements, practice in a radiation environment, and radiation emergency in a hospital. These meetings with the radiation safety officer are important since each hospital must meet its own regulatory requirements, in addition to those required by state and federal governments. Any unintended use of radiation can cause serious injuries to the patients, staff personnel, and the students themselves. To emphasize the need to practice safe use of radiation, Chapters 13 and 14, which deal with health physics, are taught immediately following Chapter 1. After that, Chapters 6 to 10 are taught for the basic understanding of the atomic and nuclear models. Lastly, the interaction of radiation with matter is discussed in Chapter 11. After completing Chapter 11, the students should be ready to proceed with specialized courses in radiation oncology, nuclear medicine or diagnostic radiology. The textbook, *Therapeutic Radiological Physics* is written as an advanced textbook to follow this *Foundation of Radiological Physics* textbook for the radiation oncology track.

This textbook is written with the following philosophy in mind. Formulas, which are so common in the field of physics, are intentionally included as part of the text. Familiarity with the formulas that concisely document observed physical phenomena, is essential for studying physics. However, students are not required to derive the formulas. In addition, this textbook also emphasizes common terminology used in radiological physics, which is important when operating radiation-producing equipment. The textbook has been organized with exercises, summaries, study guides, problems, and multiple-choice questions in each chapter. The exercises are generally derivations associated with the formulas presented in the text. It would be useful for those students who have strong mathematical background to work out these exercises. The summary serves as a review of important points in the chapter. The study guide seeks to provide a general overview of the subject matter. All students should rigorously go through the study guide. Questions with asterisks (*) are more difficult, requiring a higher level of comprehension and stronger mathematical background. They are suitable for advanced students or physics trainees interested in derivations. The multiple-choice questions give a limited overview of the subject matter.

The prerequisites for students to effectively use this textbook are minimal. However, it is advisable to have an introduction to physical sciences and mathematics (pre-algebra) at the high school level. Chapters 2 and 3, which are reviews of mathematics at the pre-algebra level are directed at radiation therapy students, nuclear medicine students, and radiologic technology students. Chapters 4 and 5, which are reviews of college level physics are directed at radiation oncology residents, radiology residents, medical physics post-doctoral students, and medical physics residents.

I have been very fortunate to have many dedicated colleagues willing to contribute to this textbook through reviewing and providing critical comments that resulted in invaluable clarification of many aspects of the subject matter. Their contributions are therefore an integral part of this textbook, which I am honored to acknowledge. I also do appreciate the comments given by students in my classes. They are helpful in guiding me in writing this textbook. Although there are many others who have contributed, I would like to explicitly recognize the following persons: Ms. Christy Huettl, my former student who educated me on chemistry; Dr. Deborah Hunsberger from Department of Allied Sciences, University of Nebraska, who edited my lecture notes; Mr. Raj Selveraj who proofread this textbook; Mr. Don Kucera and Mr. Tyler Pearson from Peter Kiewit Middle School who provided some photographs; and Dr. Dragoset from NIST for providing the periodic table for this textbook.

The following persons served as reviewers: Komanduri M. Ayyangar, Ph.D., Radiation Oncology, University of Nebraska Medical Center, Omaha, NE; Ms. Pam Jones, Radiation Oncology, Mercy Medical Center, Cedar Rapids, IA; K. V. Krishna, Ph.D., Radiation Medicine, University of Kentucky Chandler Medical Center, Lexington, KY; Dr. Cheng K. Saw, Lawrence Livermore National Laboratory, Livermore, CA; Zhen Zheng, Ph.D., Radiation Oncology, Rhode Island Hospital, Providence, RI; Maung Yoe-Sein, M.S., Radiation Oncology, University of Nebraska Medical Center, Omaha, NE; Sicong Li, D.Sc., Radiation Oncology, University of Nebraska Medical Center, Omaha, NE; Frank Rutar, M.S., Office of Radiation Safety, University of Nebraska, Omaha, NE; Lai K. Leong, Ph.D., Radiology, Baylor College of Medicine, Houston, TX; and John G. Sharp, Ph.D., Genetics Cell Biology & Anatomy, University of Nebraska Medical Center, Omaha, NE.

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Cheng B. Saw, Ph.D.
cbsaw2003@yahoo.com
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