Measurement, Instrumentation and Experiment Design in Physics and Engineering

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Preface

The art of the physicist combines a broad theoretical understanding of phenomena with an ability to make careful measurements. Physicists and Engineering Physicists are adept as problem solvers, bringing novel theoretical and experimental insights into the problems encountered in other areas of science and technology.

The objectives of this book are to demonstrate the principles of experimental practice in physics and physics-related engineering, to show how measurement, experiment design, signal processing and modern instrumentation can be used most effectively, and to encourage the creative use of experimental and theoretical physics in areas which may be unfamiliar. A knowledge of basic electricity and magnetism and circuit theory is assumed along with some introduction to aspects of semiconductor and quantum physics. Extensive opportunities are provided to use spreadsheet methods in experimental design and evaluation.

The important topics dealt in the text are experiment design, signal to noise enhancement and the use of electronics, operational and phase sensitive amplifiers for the acquisition and processing of data. This includes computer-based instrumentation system with a particular emphasis on standard interfaces such as the IEEE488.

Primarily addressed to students at the advanced undergraduate and introductory graduate level in physics, applied and engineering physics, and engineering, the book will serve as background material for a wide range of experimental physics and engineering. It is not a compendium of all types of transducers and experimental measurements. The emphasis has been to review the background physics and experimental techniques in important areas of application so that a reader develops his or her own insight and knowledge to work with any instrument and its manual. Questions are provided throughout to assist in this end. Since most of the laboratory practices involve some aspects of temperature measurement, optical techniques, vacuum practice, electrical measurements and nuclear instrumentation, these areas are covered in detail.

In a world increasingly conscious of the potential effects of science and technology on the environment, laboratory safety and the safety of the public at large are of importance. International and national aspects of these matters are reviewed in Chapter 12.

Measurement and instrumentation is not a passive and isolated subject that can be defined in terms of specific experiments. Real experiments involve complex systems, considered approximations, and compromises between competing