PREFACE

APPROACH

The formal boundaries of traditional engineering disciplines have become fuzzy following the advent of integrated circuits and computers. Nowhere is this more evident than in mechanical and electrical engineering, where products today include an assembly of interdependent electrical and mechanical components. The field of mechatronics has broadened the scope of the traditional field of electromechanics. *Mechatronics* is defined as the field of study involving the analysis, design, synthesis, and selection of systems that combine electronic and mechanical components with modern controls and microprocessors.

This book is designed to serve as a text for (1) a modern instrumentation and measurements course, (2) a hybrid electrical and mechanical engineering course replacing traditional circuits and instrumentation courses, (3) a stand-alone mechatronics course, or (4) the first course in a mechatronics sequence. The second option, the hybrid course, provides an opportunity to reduce the number of credit hours in a typical mechanical engineering curriculum. Options 3 and 4 could involve the development of new interdisciplinary courses and curricula.

Currently, many curricula do not include a mechatronics course but include some of the elements in other, more traditional courses. The purpose of a course in mechatronics is to provide a focused interdisciplinary experience for undergraduates that encompasses important elements from traditional courses as well as contemporary developments in electronics and computer control. These elements include measurement theory, electronic circuits, computer interfacing, sensors, actuators, and the design, analysis, and synthesis of mechatronic systems. This interdisciplinary approach is valuable to students because virtually every newly designed engineering product is a mechatronic system.

NEW TO THE FOURTH EDITION

The fourth edition of *Introduction of Mechatronics and Measurement Systems* has been improved, updated, and expanded beyond the previous edition. Additions and new features include:

- New sections throughout the book dealing with the "practical considerations" of mechatronic system design and implementation, including circuit construction, electrical measurements, power supply options, general integrated circuit design, and PIC microcontroller circuit design.
- Expanded section on LabVIEW data acquisition, including a complete music sampling example with Web resources.

- More website resources, including Internet links and online video demonstrations, cited and described throughout the book.
- Expanded section on Programmable Logic Controllers (PLCs) includes the basics of ladder logic with examples.
- Interesting new clipart images next to each Class Discussion Item to help provoke thought and inspire student interest, and to improve the visual look of the book.
- Additional end-of-chapter questions throughout the book provide more homework and practice options for professors and students.
- Corrections and many small improvements throughout the entire book.

CONTENT

Chapter 1 introduces mechatronic and measurement system terminology. Chapter 2 provides a review of basic electrical relations, circuit elements, and circuit analysis. Chapter 3 deals with semiconductor electronics. Chapter 4 presents approaches to analyzing and characterizing the response of mechatronic and measurement systems. Chapter 5 covers the basics of analog signal processing and the design and analysis of operational amplifier circuits. Chapter 6 presents the basics of digital devices and the use of integrated circuits. Chapter 7 provides an introduction to microcontroller programming and interfacing, and specifically covers the PIC microcontroller and PicBasic Pro programming. Chapter 8 deals with data acquisition and how to couple computers to measurement systems. Chapter 9 provides an overview of the many sensors common in mechatronic systems. Chapter 10 introduces a number of devices used for actuating mechatronic systems. Finally, Chapter 11 provides an overview of mechatronic system control architectures and presents some case studies. Chapter 11 also provides an introduction to control theory and its role in mechatronic system design. The appendices review the fundamentals of unit systems, statistics, error analysis, and mechanics of materials to support and supplement measurement systems topics in the book.

It is practically impossible to write and revise a large textbook without introducing errors by mistake, despite the amount of care exercised by authors, editors, and typesetters. When errors are found, they will be published on the book website at: **www.mechatronics.colostate.edu/book/corrections_4th_edition.html.** You should visit this page now to see if there are any corrections to record in your copy of the book. If you find any additional errors, please report them to *David.Alciatore@colostate.edu* so they can be posted for the benefit of others. Also, please let me know if you have suggestions or requests concerning improvements for future editions of the book. Thank you.

LEARNING TOOLS

Class discussion items (CDIs) are included throughout the book to serve as thought-provoking exercises for the students and instructor-led cooperative learning activities in the classroom. They can also be used as out-of-class homework assignments to

supplement the questions and exercises at the end of each chapter. Hints and partial answers for many of the CDIs are available on the book website at **www.mechatronics.colostate.edu.** Analysis and design examples are also provided throughout the book to improve a student's ability to apply the material. To enhance student learning, carefully designed laboratory exercises coordinated with the lectures should accompany a course using this text. A supplemental Laboratory Exercises Manual is available for this purpose (see **www.mechatronics.colostate.edu/lab_book.html** for more information). The combination of class discussion items, design examples, and laboratory exercises exposes a student to a real-world practical approach and provides a useful framework for future design work.

In addition to the analysis Examples and design-oriented Design Examples that appear throughout the book, Threaded Design Examples are also included. The examples are mechatronic systems that include microcontrollers, input and output devices, sensors, actuators, support electronics, and software. The designs are presented incrementally as the pertinent material is covered throughout the chapters. This allows the student to see and appreciate how a complex design can be created with a divide-and-conquer approach. Also, the threaded designs help the student relate to and value the circuit fundamentals and system response topics presented early in the book. The examples help the students see the "big picture" through interesting applications beginning in Chapter 1.

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