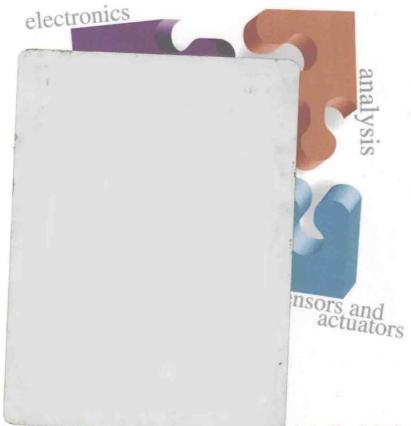
Introduction to

# **MECHATRONICS**

and Measurement Systems



Michael B. Histand David G. Alciatore

# INTRODUCTION TO MECHATRONICS AND MEASUREMENT SYSTEMS

Michael B. Histand and David G. Alciatore

Department of Mechanical Engineering Colorado State University



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#### INTRODUCTION TO MECHATRONICS AND MEASURMENT SYSTEMS

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# **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 which 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 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 three and four could involve the development of new interdisciplinary courses.

Currently, most 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 approach is valuable to students since virtually every newly designed engineering product is a mechatronic system.

#### Content

Chapter 1 introduces mechatronics and measurement systems. Chapter 2 provides a review of basic electrical relations, circuit elements, and circuit analysis. Chapter 3

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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 logic and the use of integrated circuits. Chapter 6 also provides an introduction to the microprocessor and microcontroller. Chapter 7 deals with issues involved with coupling microprocessors and computers to measurement systems in order to automate data acquisition and analysis. Chapter 8 provides an overview of the many sensors common in mechatronic systems. Chapter 9 introduces a number of devices used for actuating mechatronic systems. Finally, Chapter 10 provides an overview of mechatronic system control architectures and presents some case studies. 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. Two mechatronics topics this book does not cover directly are control theory and microprocessor programming. These topics are important and should be included in a curriculum that emphasizes mechatronics, but we decided it would be impractical to adequately cover these topics in this book.

### **Learning Tools**

Class discussion items are included throughout the book to serve as thought-provoking exercises for the students as instructor-led cooperative learning activities in the classroom. They can also be used as out-of-class homework assignments to supplement the questions at the end of each chapter. 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. 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.

### **Supplements**

More information, including a recommended course outline, a typical laboratory syllabus, MathCAD files for examples from the book, and other supplemental material, is available on the Internet at:

http://www.engr.colostate.edu/~dga/mechatronics.html

An instructor guide is also available from the publisher. It includes complete solutions for all end-of-chapter problems.

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