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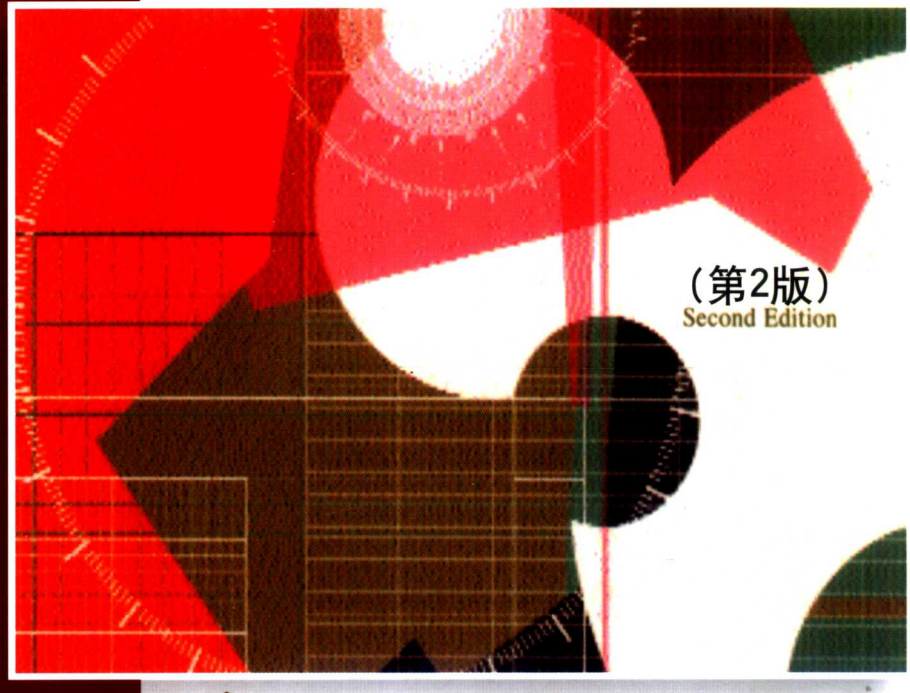
Introduction to Mechatronics and Measurement Systems

机电一体化与测量系统基础教程



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Introduction to Mechatronics and Measurement Systems, Second Edition

影 印 版 序

Mechatronics（机电一体化或机械电子学）是机械学科与信息学科结合的一门交叉学科。相应的名词还有机械电子工程，它不仅包括机械和电子技术，而且与控制技术和计算机技术结合。不少学校设立了机械电子工程课程和专业，拓宽了原来的机类或电类专业。国内外有专门的机械电子学学术会议，会议文章涉及机电（机光电、机电液等）技术一体化、微机电系统集成等内容。这些反映了技术发展和对人才需求的一种趋势，是现代工程技术综合发展的一个重要特征。

本书是一本美国的大学教材，作者在前言中说明本书用于：（1）现代仪器和测量课程；（2）电子和机械工程的一门跨学科课程，可以替代传统的电路和仪器课程；（3）独立的机械电子学课程；（4）机械电子学系列中的初期课程。它的内容包括：机电一体化和测量系统的名词术语、电路基础和电路分析、半导体电子学、机械电子和测量系统的响应、模拟信号处理和运算放大器、数字器件和集成电路、微控制器编程和接口、数据采集和计算机测量系统、传感器、执行器、机械电子系统的控制体系结构。本书未涉及控制理论。

本书的特点是：（1）注重对基本概念和基本知识的阐述，理论联系实际，并附有参考书目，便于阅读；（2）每章有联系实际的课堂讨论题目，每节有大量的例题，习题和思考题，有利于学生深入思考，学习分析和解决问题。培养这些能力十分重要，本书在这方面的努力是值得提倡的。（3）本书综合选择了电路、电子、计算机接口和测试技术的相关内容，这是一种方案。由于机械电子工程专业、机或电类专业设置的课程数量增加，必然要优化教学课程设置和减少课程学时。但根据不同专业的要求，对本课程的内容会有不同考虑的，在宽与深、各模块与体系结构的关系会有不同的选择。

本书的内容结构和我国高校的课程体系虽然有些差别，但仍是一本很好的参考书和英文教材。本书可作为机、电、仪等相关专业的学生、教师和工程技术人员的参考教材或参考书。

周兆英　教授
清华大学精密仪器与机械学系
2004 年 4 月 28 日

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.

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.

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. 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. One mechatronics topic this book does not cover is control theory. This topic is important and should be included in a curriculum that emphasizes mechatronics, but we decided it would be impractical to adequately cover the topic in this book.

LEARNING TOOLS

Class discussion items 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. 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, Class Discussion Item hints, links to mechatronics resources, and other supplemental material, is available on the author's Internet site at

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

These resources, and a complete, password-protected Instructor's Guide containing solutions to all end-of-chapter problems, are also available at the McGraw-Hill Book Website at:

www.mhhe.com/engcs/mech/alciatore/

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David Walrath *University of Wyoming*

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Charles Ume *Georgia Institute of Technology*
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