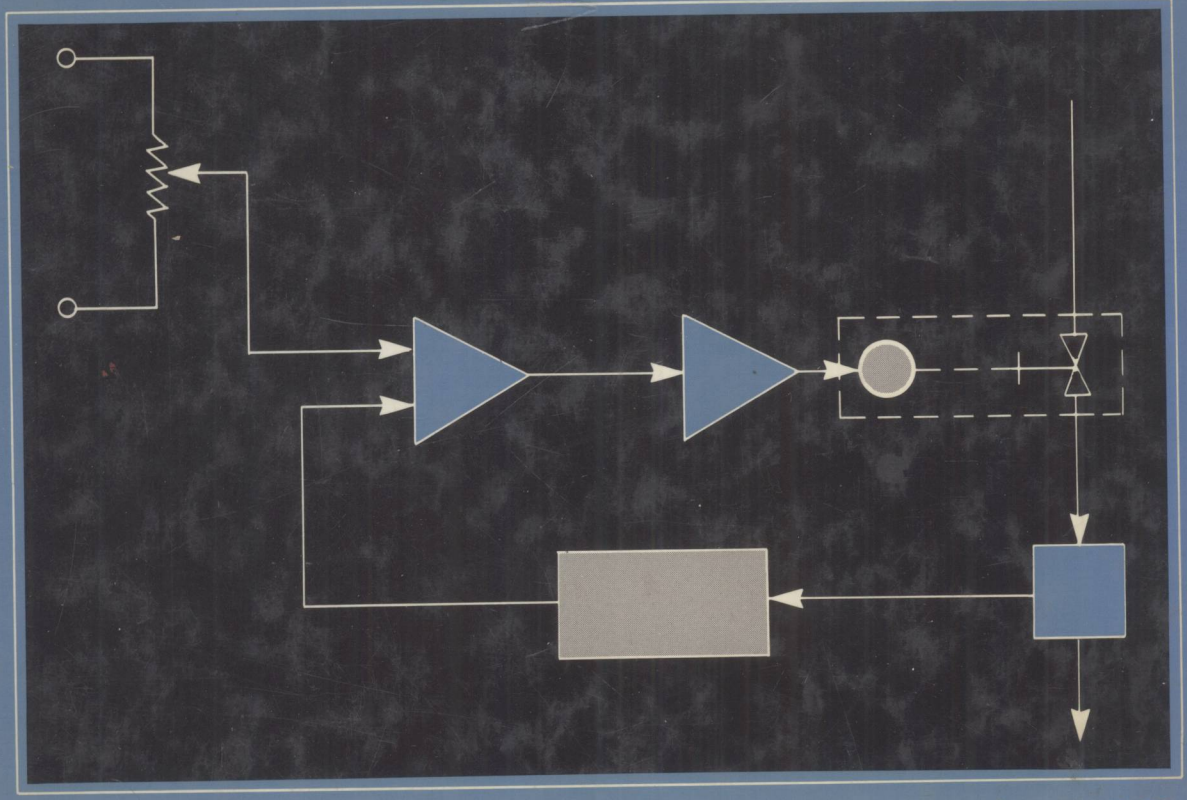
AUTOMATIC CONTROL SYSTEMS AND COMPONENTS



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PRENTICE HALL Englewood Cliffs, New Jersey 07632

Library of Congress Cataloging-in-Publication Data

Carstens, James R.
Automatic control systems and components / James R. Carstens.
p. cm.
ISBN 0-13-054297-0
1. automatic control. 2. Process control. I. Title.
TJ213.C293 1990
629.8—dc20 89-37977
CIP

Editorial/production supervision and
interior design: **Diane M. Delaney**
Cover design: **Wanda Lubelska Design**
Manufacturing buyer: **Dave Dickey**

A Division of Simon & Schuster
Englewood Cliffs, New Jersey 07632

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

ISBN 0-13-054297-0

Prentice-Hall International (UK) Limited, *London*
Prentice-Hall of Australia Pty. Limited, *Sydney*
Prentice-Hall Canada Inc., *Toronto*
Prentice-Hall Hispanoamericana, S.A., *Mexico*
Prentice-Hall of India Private Limited, *New Delhi*
Prentice-Hall of Japan, Inc., *Tokyo*
Simon & Schuster Asia Pte. Ltd., *Singapore*
Editora Prentice-Hall do Brasil, Ltda., *Rio de Janeiro*

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To my wife, Sandy, and to my two children, Sig and Lesley,
all of whom have given meaning to my life.

Preface

This book is intended to be a textbook for students in engineering and engineering technology. However, it is also intended to be a textbook for those engineers in industry who find themselves involved in a project dealing with automatic controls and would like to have a more-or-less self-taught refresher course. I can't count the number of times I found myself in exactly this position while in industry and unable to find a practical book on the subject so that I could become an instant expert and impress my peers. While I certainly don't pretend to call myself an expert on automatic controls, I hope that I have remedied this situation for a substantial number of inquiring minds by writing this book.

I have always felt that physics was the great key to unlocking engineering problems. This is one subject where theory is so important. I have my own theory that says, if a person is observant enough, and if he or she can relate a seemingly complicated technical explanation to an easily observed everyday living example, this would help in understanding that explanation and it would certainly help in making that person feel more at home with the explanation. And speaking of theories, the aforementioned is exactly the theory behind this book. A fairly good background in basic physics coupled with a keen eye for observing things will go a long way in understanding many of the concepts that I presented in this book.

There is a fair quantity of math involved in my discussions of control theory. I have attempted to keep the math on a moderate level by circumventing much of the differential and integral calculus normally used in dealing with this subject. I feel that if one can learn a subject using a low-powered approach, why destroy the interest in that subject by using a much higher powered approach? I

do love calculus; it's fun and illuminating to use. However, when it comes to explaining everyday happenings, there are better approaches to take. Why use a bulldozer in preparing a flower bed when a spade shovel will get the job done? This book is intended to be a straightforward hands-on attack on automatic controls. I don't believe calculus is the tool to use for that particular undertaking, at least at this beginning stage. There are more important things to be understood at this point.

Chapter 1 may appear to be an intense review of electronics, and that is exactly what I intended it to be. I have attempted to cover as much electronic theory as possible that deals with the area of controls. If you feel weak in this area, this chapter will boost your electronics knowledge level to the point of understanding the material that follows. You will undoubtedly find some portions of this review not being directly applicable to the rest of the book. I believe, however, that you can't know too much about electronics when delving into control systems. Someday you will need and want this additional information.

In Chapter 3 I have introduced a math concept for those of you who feel especially comfortable with algebra. The concept is called Laplace transformation. Laplace transforms are necessary in order to avoid differential and integral calculus. Including this concept was certainly not an original idea of mine, since other automatic control text authors have done it before me. However, I like to think that I have applied these transformations to a greater extend than perhaps some of the others have done. Using transforms is like using logarithms to avoid multiplication and division. For those of you who are familiar with computers, you might want to think of Laplace transforms as macros. Many of the more often used calculus expressions have been transformed into these macros to reduce the number of software statements and keystrokes. Transforms allow you to maintain your sanity while working through some of the more difficult moments encountered in automatic control system theory. They represent a very neat concept that is readily understood by most technical people. And a concept understood is a concept that's a friend for life, I always say.

Control systems are fun and impressive to watch. There is a certain amount of beauty in watching a system perform a function and then make self-adjustments and then continue functioning with no outside supervision. With the advent of the microprocessor, the automatic control system is certainly approaching what is best described as the closest thing we have for artificial intelligence (or real ignorance, depending on its application). Chapter 12 deals specifically with this subject of computers and automatic control systems.

In Chapter 4 you will find considerable material on electrical components, namely, transducers. There is also an extensive discussion of the transfer function. That discussion, along with the discussions on electrical transducers, is a keystone to understanding the later material.

In the following chapters, I introduce many design problems along with their solutions. I tried presenting them in a manner which I felt closely resembles the thought paths taken by a typical design engineer. That is, the first idea for a

solution may not be the final solution used, but instead forms the basis for another approach.

At the end of this book are appendices that contain some rather interesting, but simple, software programs. If you have a computer, try them. You'll have a lot of fun with them, proving out the concepts discussed in the text.

I want to give special thanks to those individuals who have made this entire writing venture possible. I thank professors Walter Anderson and Robert Stebler for their vocal encouragement and for making much-needed writing resources and secretarial help available. I also thank students Heather Baab and Todd Coulter for the dedication and eagerness they showed in generating the much-needed artwork this book required, using the School of Technology's CAD facilities. It's young people like these that make engineering technology and teaching so enjoyable and full of hope.

I sincerely thank one of my manuscript reviewers, P. Erik Liimatta, professor of engineering and technologies at Anne Arundel Community College in Arnold, Maryland, for his excellent comments and suggestions in reviewing this manuscript. I know it was a time-consuming task, and I am indebted to his patience which certainly contributed in making this a better book.

But most of all, I thank the members of my family. They showed tremendous patience while my many hours at the keyboard resulted in my being an absentee husband and father. Certainly, without their encouragement, patience, and understanding, none of this would have been possible.

And finally, it is my hope that you, the reader, will get as much enjoyment out of reading and understanding this material as I had in writing it.

J.R.C.
Houghton, Michigan

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