Mechanical Engineering Design

SEVENTH EDITION

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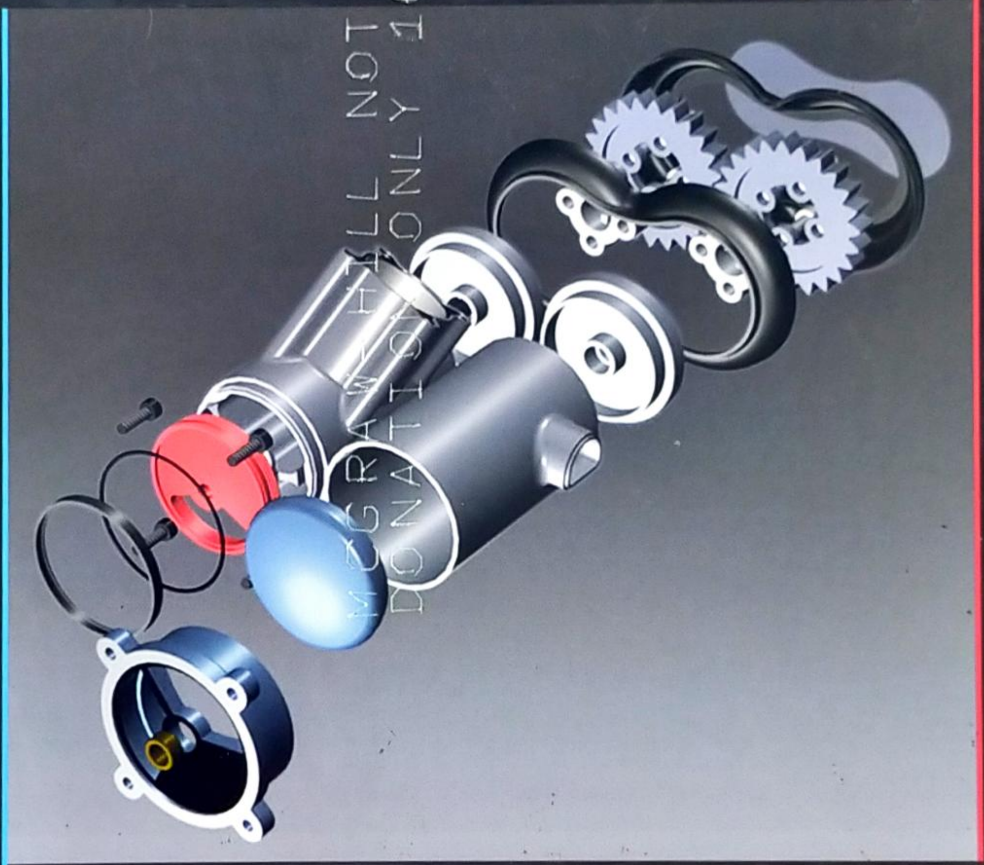

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Mechanical Engineering Design

Seventh Edition

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Dedication

To the many people who have encouraged me to grow professionally and spiritually over the years, especially my wife, Joanne, and my late mother, Inez. Included also are a great many fellow educators, students, and designers that I am indebted to.

Richard G. Budynas

To the over 3500 of my students who asked many good questions of me, learned to ask them of themselves, to answer them, and then went on to make their Alma Maters proud.

Charles R. Mischke

About the Authors

Joseph E. Shigley (deceased May 1994)
He was Professor Emeritus at the University of Michigan, Fellow in the American Society of Mechanical Engineers, received the Worcester Reed Warner medal in 1977, and their Machine Design Award in 1985. He was the author of eight books, including *Theory of Machines and Mechanisms* (with John J. Uicker, Jr.), and *Applied Mechanics of Materials*. He was Coeditor-in-Chief of the *Standard Handbook of Machine Design*. He began *Machine Design* as sole author in 1956, and it evolved into *Mechanical Engineering Design,* setting the model for such textbooks.

He was awarded the B.S.M.E. and B.S.E.E. degrees of Purdue University, and the M.S. of the University of Michigan.

Joseph Edward Shigley indeed made a difference.

Charles R. Mischke has held faculty positions at the University of Kansas, Pratt Institute, New York, and Iowa State University. He has received many awards for teaching and scholarship, including the Machine Design Award of ASME and Life Fellow of ASME. In addition to numerous research papers, he has authored Elements of Mechanical Analysis, 1963, Introduction to Computer-Aided Design 1968, Mathematical Model Building, 1980, coauthored Mechanical Engineering Design, 1986, 2001, and was Co-Editor-in-Chief of the award-winning Standard Handbook of Machine Design, 1986, 1993.

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Preface

Objectives

This text is intended for students beginning the study of mechanical engineering design. It can also serve as a basic reference book for practicing engineers. The objectives of the text are to:

- Cover the basics of machine design, including the design process, engineering mechanics and materials, failure prevention under static and variable loading, and characteristics of the principal types of mechanical elements.
- Offer a practical approach to the subject through a wide range of real-world applications and examples.
- Encourage readers to link design and analysis.

General Approach: A Return to the Basics

The seventh edition has retained and enhanced the most popular features of earlier editions, while removing many nonessential elements. Coverage focuses on mainstream machine design, with only moderate discussion of statistical methods.

A practical approach is emphasized throughout the text. Concise design problems and examples illustrating the decision-making process are presented.

The writing style is accessible and direct, with many chapters containing reduced discussion of advanced topics.

New to This Edition

The goal has been to make this seventh edition easier for readers to "navigate" in terms of key concepts and procedures in mechanical design. The text contains several new and enhanced features. Among the highlights are:

- *Practical coverage of basic machine design.* Coverage has been streamlined, focusing on major topics that better fit the typical engineering curriculum. Readers can better identify major concept development.
- *Improved coverage of engineering mechanics and failure prevention.* Enhanced discussion of key topics such as fracture and fatigue is provided. Topics are presented in a logical order and coverage is condensed.
- *Enhanced coverage of machine component design.* This edition improves upon the already practical and authoritative earlier coverage of design considerations for major machine components.
- *Revised and expanded problem sets.* Problems have been updated, and new ones have been added. Problems are arranged to progress from basic to challenging in a consistent way. Statistically oriented problems have been drastically reduced, emphasizing deterministic solution of fundamental design problems.