Operational Amplifiers and Linear Integrated Circuits

6th Edition

Robert F. Coughlin
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SIXTH EDITION

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Preface

The authors' intention in all previous editions of *Operational Amplifiers and Linear Integrated Circuits* has been to show that operational amplifiers and other linear integrated circuits are easy to use and fun to work with. This sixth edition has kept that basic philosophy. For the fundamental circuits, we have continued to use devices that are readily available, easy to use, and forgiving if a wiring error is made. Newer devices are introduced where the application requires it. We have preserved our original objective of simplifying the process of learning about applications involving signal conditioning, signal generation, filters, instrumentation, timing, and control circuits. This edition continues to reflect the evolution of analog circuits into applications requiring transducer signals that must be conditioned for a microcontroller's analog-to-digital input.[1] We have kept circuit simulation using OrCAD® PSpice®. A laboratory manual is now available to accompany

[1] A detailed procedure on how to design circuits that interface between the physical world and microcontrollers is presented in *Data Acquisition and Process Control with the M68HC11 Microcontroller, 2nd Edition,* by F. Driscoll, R. Coughlin, and R. Villanucci, published by Prentice Hall (2000).

this sixth edition.[2] It includes both detailed hardware and simulation exercises. Some exercises are step-by-step; others are design projects. The exercises follow the text material.

Chapters 1 through 6 provide the reader with a logical progression from op amp fundamentals to a variety of practical applications without having to worry about op amp limitations. Chapter 7 shows how op amps combined with diodes can be used to design ideal rectifier circuits as well as clamping and clipping circuits. PSpice models and simulations are included in these chapters.

Chapter 8 shows applications that require measuring a physical variable such as temperature, force, pressure, or weight and then having the signal conditioned by an instrumentation amplifier before being input into a microcontroller's A/D converter. Instrumentation amplifiers are required when a designer has to measure a differential signal, especially in the presence of a larger noise signal.

As previously mentioned, in order not to obscure the inherent simplicity and overwhelming advantages of using op amps, their limitations have been left for Chapters 9 and 10. Dc limitations are studied in Chapter 9 and ac limitations are covered in Chapter 10. An expanded discussion on common-mode rejection ratio has been included in this edition. Many limitations have been made negligible by the latest generations of op amps, as pointed out in these chapters.

Active filters, low-pass, high-pass, band-pass, and band-reject, are covered in Chapter 11. Butterworth-type filters were selected because they are easy to design and produce a maximally flat response in the pass band. Chapter 11 shows the reader how to design a variety of filters easily and quickly.

Chapter 12 introduces a linear integrated circuit known as the multiplier. The device makes analysis and design of AM communication circuits simpler than using discrete components. Modulators, demodulators, frequency shifters, a universal AM radio receiver, and analog divider circuits all use a multiplier IC as the system's basic building block. This chapter has been retained because instructors have written to say that the principles of single-side band suppressed carrier and standard amplitude-modulation transmission and detection are clearly explained and quite useful for their courses.

The inexpensive 555 IC timer is covered in Chapter 13. This chapter shows the basic operation of the device as well as many practical applications. The chapter also includes a timer/counter unit.

In previous editions, analog-to-digital and digital-to-analog converters have been covered in a single chapter. This edition separates these topics into two chapters so that more device specifications can be included as well as practical applications. Chapter 14 deals only with analog-to-digital converters, while the new Chapter 15 covers digital-to-analog converters. A serial ADC connected to a Motorola microprocessor is shown (with assembly language code) in Chapter 14.

Chapter 16 shows how to design a regulated linear power supply. This chapter begins with the fundamentals of unregulated supplies and proceeds to regulated supplies. It shows how IC regulators are used for building low-cost 5 V and ± 15 V bench supplies.

[2] *Laboratory Manual to Accompany Operational Amplifiers and Linear Integrated Circuits, 6th Edition,* by R. Coughlin, F. Driscoll, and R. Villanucci published by Prentice Hall (2001).

This edition has more than enough material for a single-semester course. After the first three chapters, instructors often take chapters out of sequence depending on the class interest, need to complement another course (such as a design course), or availability of lab equipment or class time. Therefore, Chapters 4 through 16 have been written as stand-alone chapters for this very reason. The circuits have been tested in the laboratory by the authors and the material is presented in a form useful to students or as a reference to practicing engineers and technologists. Each chapter includes learning objectives and problems, and most chapters have PSpice simulations. The reader should refer to the accompanying laboratory manual for lab exercises and additional simulation exercises.

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Finally, we thank our students for their insistence on relevant instruction that is immediately useful and our readers for their enthusiastic reception of previous editions and their perceptive suggestions for this edition.

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