

**PART II**

# Integrated-Circuit Amplifiers

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**H**aving studied the MOSFET and the BJT and become familiar with their basic circuit applications, we are now ready to consider their use in the design of practical amplifier circuits that can be fabricated in integrated-circuit (IC) form. Part II is devoted to this rich subject. Its six chapters constitute a coherent treatment of IC amplifier design and can thus serve as a second course in electronic circuits.

Beginning with a brief introduction to the philosophy of IC design, Chapter 7 presents the basic circuit building blocks that are utilized in the design of IC amplifiers. However, the most important building block of all, the differential pair configuration, is deferred to Chapter 8, where it is the main topic. Chapter 8 also considers the design of amplifiers that require a number of cascaded stages.

As mentioned at various points in Part I, amplifiers have finite bandwidths. Chapter 9 is devoted to the frequency-response analysis of amplifiers; it provides a comprehensive study of the mechanisms that limit the bandwidth and the tools and methods that are utilized to estimate it for a wide variety of amplifier circuit configurations. While the study of the first half or so of Chapter 9 is essential, some of its later sections can be postponed to a later point in the course or even to subsequent courses.

An essential tool in amplifier design is the judicious use of feedback. Chapter 10 deals with this exceedingly important subject. A thorough understanding of feedback concepts, insight into feedback configurations, and proficiency in the use of the feedback analysis method are invaluable to the serious circuit designer.

In Chapter 11, we switch gears from dealing with primarily small-signal amplifiers to those that are required to handle large signals and large amounts of power. Finally, Chapter 12 brings together all the topics of Part II in an important application: namely, the design of operational amplifier circuits. We will then have come full circle, from considering the op amp as a black box in Chapter 2 to understanding what is inside the box in Chapter 12.

Throughout Part II, MOSFET and BJT circuits are treated side-by-side. Because over 90% of ICs today employ the MOSFET, its circuits are presented first. Nevertheless, BJT circuits are presented with equal depth, although sometimes somewhat more briefly. In this regard, we draw the reader's attention to Appendix 7.A, which presents a valuable compilation of the properties of both types of transistors, allowing interesting comparisons to be made. As well, typical device parameter values are provided for a number of CMOS and bipolar fabrication process technologies.