CHAPTER 6

ELECTRONICS

This chapter discusses electronics at a level somewhere between that of a handbook, which consists essentially of charts, tables, and graphs, and a textbook, where the interesting, important, and useful conclusions come only after well-developed discussions with examples. The aim here is a presentation that has sufficient continuity and readability that individual sections can be profitably read without having to refer to preceding sections or other texts. On the other hand, it is important to have useful and frequently referenced material in the form of readily accessible tables, graphs, and diagrams that are sufficiently self-explanatory that very little reference to the text material is necessary. Another important goal is vocabulary. A large amount of jargon in electronics is meaningless to the uninitiated, but when it is necessary to understand the properties of an electronic device from a written technical description, when writing the specifications for electronic equipment, or when talking to an electronics engineer, salesman, or technician, this vocabulary is essential. With this in mind, terms not current outside of electronics are italicized.

To be used to best advantage, this chapter should be supplemented with manufacturers' catalogs, data books, applications texts, handbooks, and more specialized texts that treat the topic of interest in depth. Manufacturers of laboratory electronic equipment, discrete devices, and integrated circuits have publications that describe, in clear practical terms, the properties of their products and their applications to a wide variety of tasks. Much of this material is also available on the internet, and for this reason internet addresses are given when available.

The material has been organized and written as one explains it to a student or technician coming to work in a laboratory for the first time. The complexity of modern electronics is such that the cut-and-try approach is too inefficient and costly in terms of material and time. There are just too many possibilities when connecting devices and multiple-component circuits, and it is important to establish a systematic approach based on a limited number of simple, well-understood principles. It is probably not reasonable in the laboratory to expect quick solutions to problems that are entirely outside one's previous experience. The number of really new situations that can arise is limited, however, most problems being variations on a few basic situations. The ability to recognize this and to isolate the source of difficulty comes with practice and mastery of basic principles. When confronted with a new situation involving rack upon rack of equipment, the tendency is to believe that an understanding of how everything works is beyond the capabilities of all but expert electronics engineers. This is far from the truth. At the operational level, present-day electronics is the most reliable, easy-to-use, and easy-to-understand element of most experiments.

6.1 PRELIMINARIES

6.1.1 Circuit Theory

An understanding of elementary circuit theory and the accompanying vocabulary permits one to reduce complex circuits consisting of many elements to a few