

Vacuum-tube and Semiconductor Electronics

JACOB MILLMAN, Ph.D.

*Professor of Electrical Engineering
Columbia University*

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VACUUM-TUBE AND SEMICONDUCTOR ELECTRONICS

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PREFACE

AT COLUMBIA UNIVERSITY the undergraduate electrical engineering curriculum contains a two-year sequence in electronics. This book is intended to serve as the text covering approximately the first year of this course. The sequence then continues with a study of pulse circuits using about one-half of the material in Millman and Taub, "Pulse and Digital Circuits." The rest of the course is devoted to the teaching of communication circuits (a-m and f-m modulation and detection, etc.) and to electronic systems generally.

The text has three primary objectives. The first aim is to present a clear, consistent picture of the internal physical behavior of vacuum, gaseous, and semiconductor devices. A study of physical electronics leads to an appreciation of the usefulness and also the limitations of these devices. Furthermore, it is only through such basic knowledge, particularly of solid-state physics, that one can understand the new electronic devices that are being developed in the research and industrial laboratories.

The second goal is to integrate the study of semiconductor devices with that of vacuum tubes. The integrated nature of the presentation may be noted from the following. The consideration of the electronic theory of a metal leads immediately into a discussion of the nature of a semiconductor. After the analysis of the vacuum diode, the p - n junction is given careful consideration. The treatment of vacuum photocells is followed directly by that of semiconductor photodevices. A study of vacuum-triode characteristics and equivalent circuits is immediately followed by a corresponding analysis of transistors, etc.

The third objective is to teach electronic circuit theory in such a manner as to provide an intimate understanding of, and intuitive feeling for, each vacuum-tube or semiconductor device as a circuit element. Methods of analysis and characteristics which are common to many different devices and circuits are emphasized. For example, a good deal of attention is given to the concept of the load line and the bias curve, to input and output impedances, to small-signal equivalent circuits, to Thévenin's and Norton's representations, to large-signal nonlinear distortions, to frequency response, to the effects of feedback, etc. However, in order that the student may appreciate the different applications of the various circuits, the basic building blocks (such as rectifiers, untuned voltage

amplifiers, audio power amplifiers, feedback amplifiers, and oscillators) are each discussed in a separate chapter. In designing or analyzing a complex electronic system it must be resolved into its component parts according to function, and hence the above arrangement of material is of practical importance.

Approximately 600 homework problems are included at the end of the book. Some of these are theoretical and others are numerical. They have been chosen to illustrate some physical principle, technique, or circuit discussed in the text.

Special mention must be made of the freedom with which the author drew on his text "Electronics" (by J. Millman and S. Seely, McGraw-Hill Book Company, Inc., New York, 1951). With the permission of Dr. Seely a great deal of the material parallels that in the earlier book.

The author is grateful to the many companies who supplied technical data and to the following persons for their assistance: Professor R. C. Retherford of the University of Wisconsin offered constructive criticism of "Electronics." Mr. M. G. Scheraga of the A. B. Du Mont Laboratories, Inc., supplied data on cathode-ray tubes and multiplier phototubes. Mr. L. B. Lambert of Columbia University and Mr. J. F. Ossanna, Jr., of the Bell Telephone Laboratories supplied valuable information on semiconductor electronics. Mr. P. M. Mauzey of Columbia University read a good deal of the text, and his criticism was most helpful.

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