BOOK 1

Introductory

EXPERIMENTS IN DIGITAL ELECTRONICS

and

8080A

MICROCOMPUTER PROGRAMMING AND INTERFACING

by

Peter R. Rony, David G. Larsen,
and Jonathan A. Titus

BLACKSBURG CONTINUING EDUCATION SERIES™
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Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing—Book 1.

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Preface

Welcome to the new electronics revolution. In ten years, integrated-circuit technology has transformed the digital integrated-circuit chip from an expensive electronic component containing only simple logic functions and few transistors into a highly complex component containing up to ten thousand transistors. The computer-on-a-chip is here! It contains everything—central processing unit, read/write memory, read-only memory, and interface circuitry—required of a digital computer. Within several years, you will be able to purchase a handful of such chips for $10 to $20. There are now only 250,000 minicomputers and large computers in the United States. By 1982, there may be one billion microcomputers in existence. A computer revolution? Certainly.

In education, we believe that the new electronics revolution will create important opportunities and changes:

- More students, including engineers, chemists, biologists, physicists, agricultural scientists, biochemists, and experimental psychologists, will need to learn about digital technology and microcomputers.
- Theoretical courses on Boolean algebra, Karnaugh mapping, and the like will become less important for the majority of students who are interested in digital technology.
- Students of computer science will be exposed to more digital hardware, e.g., in laboratory courses on digital electronics and microcomputers. Many students will have their own microcomputers.
- Hundreds of microcomputers will be present on the typical community college or university campus. Perhaps thousands.

- Courses in digital telecommunications and digital controls will grow in importance.

This series of books on digital electronics, microcomputer interfacing, and microcomputer programming is an attempt to integrate these subjects into a single unified course. This course is oriented toward laboratory experiments, for we believe that this is the best way to convey the excitement and importance of the new electronics revolution. The three subjects will be given approximately equal weight. You will learn how to program a microcomputer, how to interface a microcomputer to external digital devices, and how the external devices operate from a digital point of view. Important digital concepts will be illustrated both with integrated-circuit chips and with microcomputer programs, usually side by side in the same or adjacent units.

For the reader of these books, little or no background in digital electronics or microcomputers is assumed. You will first treat microcomputers and integrated-circuit chips as *functional modules.* With exposure to the modules, you will gradually learn their basic operational characteristics. We will not discuss how they are manufactured, since the technology is sophisticated and changes every several years.

This book is a laboratory-oriented text in a series of books that approach the field of electronics in a somewhat different manner. Rather than start you, as is customarily done in introductory electronics courses, with experiments on electronic *components,* such as *resistors, capacitors, diodes,* and *transistors,* we instead introduce you immediately to *integrated-circuit chips.* We also introduce you immediately to the concepts of *logic switches, lamp monitors, pulsers,* and *displays,* and show you how to use such auxiliary functions; and provide you with many experiments that are based upon connections between integrated-circuit chips and such devices. All this done in *Logic & Memory Experiments Using TTL Integrated Circuits, Books 1 and 2,* in this Blacksburg Continuing Education Series™.

Once you have mastered the basic concepts of digital electronics and are knowledgeable about the techniques of wiring digital circuits using integrated-circuit chips, you are exposed to more complicated digital chips and digital systems. *Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing* (*Books 1 and 2*) is an experiment in digital electronics education. As mentioned earlier, we are attempting to integrate the subjects of digital electronics, microcomputer interfacing, and microcomputer programming into a single unified course. In effect, we are consolidating the material found in other books of the series into a single laboratory textbook. The concepts and techniques of microcomputer programming and interfacing are discussed at the same time that you learn basic digital concepts and perform experiments on TTL inte-

grated-circuit chips. Some material in the earlier books has been omitted, and much new material added, especially in the microcomputer sections.

We believe that the pendulum of digital electronics will now move steadily toward the use of microcomputers. Such being the case, there will be considerable incentive in educational institutions to introduce microcomputers at an early stage in a student's curriculum. What is true for the college student should also be true for the professional scientist or engineer who desires to update his knowledge of digital electronics. Books 1 and 2 of *Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing* are directed toward such individuals.

Books 1 and 2 of *Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing* are self-instructional texts. Answers to all experimental and review questions will be found in the texts. When you perform an experiment, we shall tell you what you should observe. Who can use these books successfully? They are directed toward the same audience as the earlier books in the series. You need no initial background in digital electronics or microcomputers. If you have the ability to organize and grasp new concepts, to extrapolate knowledge to new situations, and to perform experiments in wiring digital circuits carefully, you should enjoy these books. Book 1 and 2 of *Introductory Experiments in Digital Electronics and 8080A Microcomputer Programming and Interfacing* lend themselves very nicely to a self-study program for professionals who desire to update their skills in digital electronics and microcomputers.

We have found wide acceptance of our books in formal classes as well as by individual users in the United States and abroad. Selected books are being translated into German, Japanese, French, Italian, Chinese, and Malaysian. If you are interested in further details concerning such translations, or in translating the books to other languages, please contact us.

We have also observed a need for additional educational material in the field of electronics that is experiment-based but is directed toward more specific topics. This need is being filled by additional books in this series. The *555 Timer Applications Sourcebook, With Experiments, Design of Active Filters, With Experiments, Design of Op-Amp Circuits, With Experiments* and *Design of Phase-Locked Loop Circuits, With Experiments,* all written by Howard Berlin, fall in this category. We expect this series to grow rapidly as we identify authors who can fill in the needed areas in electronics with experimental-based books along the style lines characteristic of these books.

Short courses on digital electronics and microcomputer interfacing are available in conjunction with the Continuing Education Center

and Extension Division at Virginia Polytechnic Institute & State University. For further information, please write or call Dr. Norris H. Bell, Continuing Education Center, Blacksburg, Virginia 24061, telephone (703) 951-6328. The speakers at such short courses include Peter Rony, David Larsen, Paul Field, and Frank Settle (Virginia Military Institute; Dr. Settle is editor of *Digital Directions,* which describes teaching techniques, applications, and useful products in the digital electronics and microcomputer areas). Short courses on microcomputers are also given by Mr. Jonathan A. Titus and Dr. Christopher A. Titus; contact them at Tychon, Inc., Blacksburg, Virginia 24060. Jon designed the Mark 80 and Dyna-Micro® (or MMD-1) microcomputers, and Chris has extensive experience in microcomputer programming and system design.

We wish to again thank those individuals who continue to back our educational efforts. Mr. Murray Gallant and E&L Instruments, Inc. have supported the development of the MMD-1 microcomputer by Jon Titus at Tychon, Inc. Mr. Bob Veltri has provided us with excellent photographs of the hardware. Our wives are no longer quite so patient. After hearing about the glories of microcomputers and reading about the "smart home," they now expect us to interface our households. Mañana.

PETER R. RONY, DAVID G. LARSEN, AND JONATHAN A. TITUS

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