SEMICONDUCTOR DEVICE FUNDAMENTALS

TESTBOOK

assembled and edited
by

Robert F. Pierret
ECE Emeritus Professor
Purdue University, W. Lafayette IN 47907

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PREFACE

Collected herein are 54 mostly hour tests that were utilized over the years in a junior/senior-level course entitled "Semiconductor Devices" offered by the School of Electrical and Computer Engineering at the West Lafayette campus of Purdue University. Although the material probed on the tests is closely correlated with the coverage in the "SDF" text (R. F. Pierret, *Semiconductor Device Fundamentals*, Addison-Wesley, Reading, MA © 1996) and its forerunner, Volumes 1–4 in the Modular Series on Solid State Devices, the scope of the coverage is very similar to that found in a number of undergraduate texts on the subject.

It is hoped that this collection of tests dealing with Semiconductor Device Fundaments will be useful to both instructors and students. For instructors, the tests at a minimum provide a wealth of possible problem ideas. In addition, there are examples of open-book and closed-book tests, with a range of test problem types including fill-in-the-blank, draw a picture, work out a numerical problem, and provide an explanation. Specific test formatting may also be of interest. For example, in the vast majority of tests, space is left to complete the problem beneath the question statement, or there is a blocked area where the answer is to occur. For students, the collected tests provide an excellent tool for course-related or individual study. It has been the author's experience that students are always seeking practice problems. Answers to the test questions have not been included herein to encourage student self-determination of the problem solutions.

Although the majority of tests were created and assembled by the author, interaction with Purdue ECE faculty colleagues is gratefully acknowledged. Moreover, some problems and a limited number of the reproduced tests associated with a given semester were created by Purdue ECE Professors Alam, Cooper, Furgason, Gray, Melloch, Neudeck, or Woodall. Again, their contributions are gratefully acknowledged.

Robert F. Pierret
Professor Emeritus
School of Electrical and Computer Engineering
Purdue University

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– B13	B13-1 → B13-7
– B14	B14-1 → B14-7
– B15	B15-1 → B15-4
– B16	B16-1 → B16-6
– B17	B17-1 → B17-6
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INTRODUCTION

Testbook Organization

The book is divided into three parts containing tests associated with the roughly five week modules of the semiconductor device course taught at Purdue University. Tests treating material covered in course modules labeled A, B, and C herein generally probed student understanding of semiconductor, diode, and transistor basics respectively. The tests, given over a number of years, are arranged in reverse time order, with the latest tests appearing first. Sheets containing key equations and numerical information were typically provided during closed book tests. A set of info/equation sheets is included before the first test in each of the three book parts and are identified with page numbers beginning with A0, B0, and C0 respectively. Test page numbers are similarly of the form...(module)(test number)-N...to provide ready access to a given test. A title sheet precedes each test noting the module designation (A, B, or C), the test number (A2, B5, etc.), whether the test is open or closed book, a reminder that info/equation sheets are available for use with closed book tests, and problem weighting information. Finally, providing an indication as to difficulty, the following page contains the median of student scores on the tests.

General Information

Tests A and B 1-6 contain special take-home problems found before or at the beginning of the test proper. The take-home problems were either for extra credit or an integral component of the test weighting. All but one of the take-home problems required use of the Matlab software program. The reader is of course free to use a computational program of his/her choosing. The extra credit problem associated with test A1 makes use of the Purdue University nanoHUB found online at http://nanoHUB.org.

The vast majority of tests were formatted in such a way as to provide sufficient space for answers on the test booklet below the questions or within a boxed-in area. A few of the tests have multiple-choice answers, but most questions require a computation, a fill-in the blank, draw something, and/or an explanation. Given the limited scope of the material coverage within a course module, there is understandably groups of very similar (i.e., slightly changed) questions and even a few totally repeated questions. Similarity of some questions to homework problems, review problems, or exercises in the author's text books should also be understandable.

It should be noted that there was some variability of the material coverage associated with modules B and C. For one, coverage of the Bipolar Junction Transistor (BJT) was transferred from Module B to Module C in semesters 1-5. In the cited semesters, Modules B was exclusively devoted to diodes and included the Schottky diode and occasionally Light Emitting Diodes (LEDs). The *pn* junction diode transient response, the Junction Field Effect Transistor (JFET), and modern FET structures were supplemental topics in some Module B and C semesters.

Although students were permitted to utilize the entire two-hour testing period, the lower-numbered finals (module C1-C9 tests) were designed to be completed in our hour and were

weighted equally with the module A and B tests. The C1-C9 tests per se are not comprehensive in the usual sense; i.e., containing questions explicitly spanning the semester material content. However, in order to answer the module C questions often requires a working knowledge of module A and B material. By way of contrast, the higher-numbered finals (Module C10-C18 tests) are comprehensive and were designed to be two hour tests.

Median Test Scores

Test	Median	Test	Median	Test	Median
A1	51	B1	66.5	C1	58
A2	76	B2	52	C2	65
A3	71	B3	51.5	C3	58
A4	80	B4	59.5	C4	68
A5	85	B5	71	C5	77 (part A)
A6	76	B6	55	C6	66.5
A7	64	B7	68	C7	72
A8	78	B8	61.5	C8	90
A9	85	B9	64	C9	60.5
A10	79	B10	64	C10	59
A11	69.5	B11	55	C11	70
A12	76.5	B12	70	C12	66
A13	81	B13	58	C13	68
A14	78	B14	62	C14	63
A15	68	B15	66.5	C15	65
A16	69.5	B16	70	C16	67
A17	84	B17	56	C17	65
A18	77	B18	54	C18	76