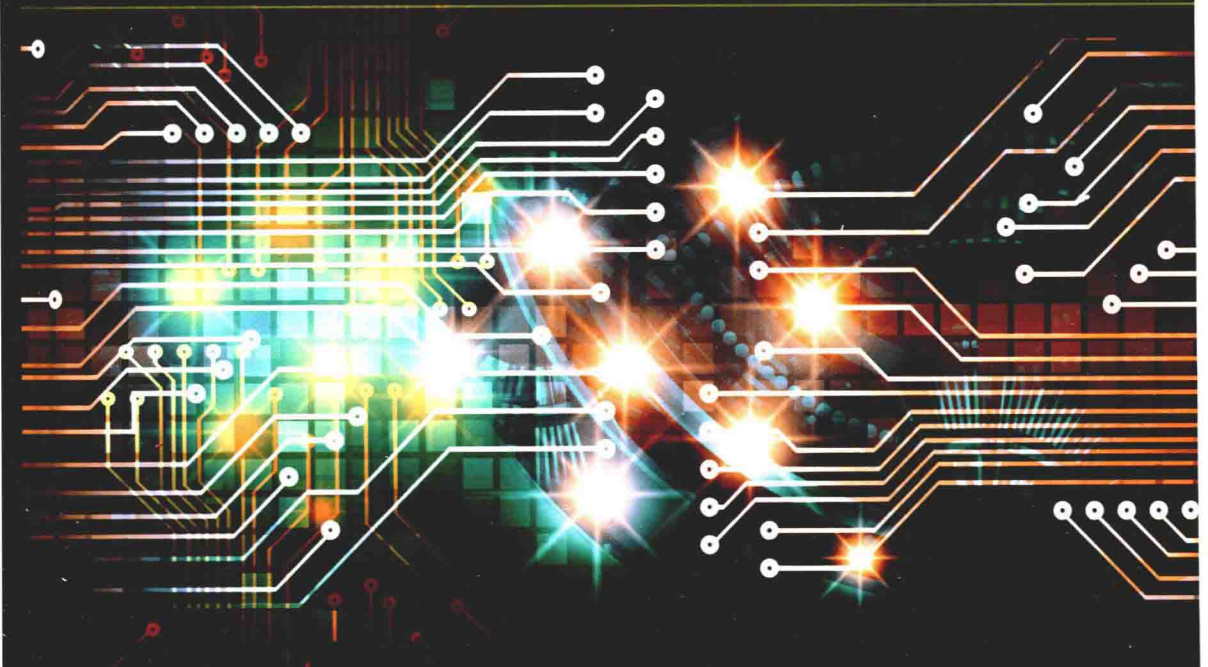


Analog Electronics Applications

FUNDAMENTALS OF DESIGN
AND ANALYSIS



Hernando Lautaro Fernandez-Canque



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*To my wife Vicky
and our children Lalo, Bruni, Lia, and Mandela*

Preface

I have organized the material presented in this book in a way that can be readily used and effortlessly understood. The material presented is based on topics taught over a number of years. As a result, it has been tried and tested.

The book has a hierarchical and mixed method of presenting the learning material combining top-down and bottom-up approaches.

The book starts by examining an electronic system as a top-down approach to provide opportunity for the learner to acquire an understanding of what is globally required from electronics systems. Students may not be asked to achieve complete design projects in their early years of study, but it is worthwhile to encourage an understanding of the nature of global tasks required in analyzing a complete electronic system. This book includes in Chapter 1, a top-down approach to look at some methodologies used for electronic system design indicating the usefulness of embracing a methodical, rational method.

The book then switches to a bottom-up approach to include detailed circuit analysis leading students to gain a good understanding of how circuits operate. This will help in comprehending the material presented and will also contribute to a more enjoyable learning experience.

Some students may be familiar with the material provided in the early parts of the book. However, many students will benefit from going through these topics more formally, and the book provides notes and guidance to ensure that students are familiar with the fundamentals of analog electronics material before progressing.

The book is written to cover material for the first 2 years of an electrical and electronic engineering university degree. The book is also beneficial for all the years of a technician grade study and it can be used by students of science related degrees at any level to acquire knowledge in analog electronics. Some courses may, if appropriate, ignore the material on semiconductor physics and concentrate on the external characteristics of semiconductor devices. Students of electronics or electrical engineering will need to study the physics-related material but students of other disciplines may find it more appropriate to omit these sections.

The book goes from a detailed explanation of fundamental to advanced concepts required to perform and design some applications of an analog electronic system.

Once the idea of amplification is clearly explained, the learning moves to electronic amplifiers of various characteristics. The book presents various models for transistors used in analog electronics to investigate the characteristics of electronic amplifiers. This permits a detailed analysis of voltage, current, and power gains to be determined as well as loading effects, input, and output impedance to be investigated. The concepts of frequency response and bandwidth are then discussed in more detail, and material is included to analyze differential amplifiers leading to the concept and realization of an operational amplifier.

Op-amps are important to all students and they will all benefit from lectures and practical work in this area. The book includes an in-depth analysis of negative feedback and deduces the effects of negative feedback on voltage and current gains,

input and output impedances, and frequency response. The material in each chapter is presented with an emphasis on design and possible practical applications. Chapter 21 includes various common basic applications of analog electronics systems. Where students have a particular specialist interest in a specific topic, he or she may choose to perform the applications and laboratory experiments presented in Chapters 21 and 23, thus making the practical work more directly relevant to their course of study.

Once the general principles of feedback have been established, the book explains the derivation of the transfer function of a generalized feedback system. It presents a comprehensive treatment of different types of negative feedback. This is then used to design and analyze a range of electronic circuits that make use of negative feedback. Chapters include examples tailored to illustrate and consolidate the learning material presented in a chapter.

This book is beneficial to electrical and electronics engineering students in year 1 and 2 of their course. For advanced students, the book offers a good source of reference and revision on how detailed deductions of the different expressions used in electronic circuits are deduced. The book is also useful for all years of a degree in engineering where electronics is not the major subject.

The manner in which the material is presented prepares students to grasp the fundamentals of analog electronics and to use the knowledge acquired to perform basic design work as well as realize some basic applications.

A large section of the book is dedicated to details on realization and implementation of practical applications of an analog electronic system. It also includes many practical assignments to be performed using computer-aided packages tailored to the material covered in the book.

The book includes over 300 figures to illustrate the topics covered, examples, and applications. Over 100 specific tailored examples are included enhancing the material covered in this book. Calculations on examples are accurate to two decimal places. Each chapter includes a key point of the material covered.

In general, the book covers the fundamentals of analog electronics with an enhanced projection for design, analysis, and practical applications.

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Hernando L. Fernandez-Canque
Glasgow

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I thank my wife, Vicky Grandon, for her support and assistance with the preparation of this book. Special thanks to my students who, through the years, have allowed me to guide them and observe how they come up with both queries and unexpected wrong results that needed to be corrected. These have helped me produce teaching material that avoids misconceptions in analysis of electronic circuits.

I received great support from the technician team at Glasgow Caledonian University Department of Engineering in setting up laboratory experiments maintaining software packages used in this book. Thanks to Tony Floyd for his help in the photographic material included. Thanks to my colleagues at Glasgow Caledonian University School of Engineering and Computing for their encouragement, discussion, and suggestions. Thanks to Sorin Hintea and colleagues of Cluj-Napoca University for joint work and publications in advanced analog electronic systems.

Finally, I acknowledge with gratitude the unconditional support and patience of my family and friends.

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