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978-0-521-47879-3 - A Practical Introduction to Electronic Circuits, Third Edition

Martin Hartley Jones

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*A practical introduction to
electronic circuits*

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A practical introduction to electronic circuits

Third edition

MARTIN HARTLEY JONES

Managing Director, Engineering

Industrial Group

Smiths Industries plc



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TO CHRISTOPHER, TIMOTHY AND ELIZABETH

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PREFACE TO THE THIRD EDITION

The popularity of the first and second editions has been very gratifying. This third edition uses the same practical approach to provide an update relevant to today's exciting electronics scene whilst retaining the character of the basic text.

It is a sign of the relentless advance of electronics that key applications today such as the CD player, cellular telephone and fax machine were nowhere on the scene at the original publication date of 1977. The second edition in 1985 then recognised the burgeoning microcomputer industry, though some home computers popular at that time have now disappeared without trace.

Today, a decade later, the industry has seen remarkable progress, especially in computer processing speed, memory capacity and component packing density. Surface-mount technology is the norm and more and more signal processing and recording is carried out digitally. Fortunately for the student and the experimenter, the basic component and circuit elements explained in the book continue to be just as relevant as ever. Components are still widely manufactured in the wire-ended packages best suited to experimental work; the favourite BC107 transistor remains commonplace. In those circuits where components have become obsolete, suitable updates have been introduced.

In some areas, developing technology has changed the relative importance of particular topics. For example switch-mode power supplies are now deserving of greater coverage, as is the whole theme of analogue to digital conversion. Some other topics no longer as relevant have been quietly dropped. The ubiquitous PC now features in some characteristically practical interfacing experiments in addition to the programming examples using the Acorn computers popular in education.

Thank you to my colleagues at Kelvin Hughes for their advice and assist-

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Preface to the third edition

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ance, to Maureen Brown for her typing and to my wife Sylvia for her continuing secretarial help and motivation. I am also grateful to my sons, Chris and Tim, for their useful suggestions on the updates.

Martin Hartley Jones

July 1994

PREFACE TO THE SECOND EDITION

There have of course been many advances in electronics since the preparation of the first edition and this has been a welcome opportunity to bring the text up to date. The decade leap is reflected particularly in the two new chapters (13 and 14) on digital techniques and computers. Here I have aimed to present the important relationship of the microcomputer chip to other circuits, both digital and analogue, in a digestible form with plenty of experiments.

In the remainder of the book, many detailed changes have updated it without destroying the logical structure which has by now become familiar to students on many college and university courses. The approach throughout remains a practical one and is still based on my experience of teaching electronics in the Department of Pure and Applied Physics at UMIST. In recent years my work has been in industrial electronic design, further experience which has helped me to keep the text relevant to real applications.

In acknowledging gratefully the help I have received in preparing this second edition, I must first thank those readers of the first edition who wrote in with encouraging suggestions and amendments. Thank you too to my eldest son Christopher for his help in devising and testing the computer-based experiments. Alan Jubb was a great help in checking the manuscript of the new material.

Finally thank you again to my wife Sylvia not only for her typing skill but also for her encouragement and patience.

Martin Hartley Jones
February 1985

PREFACE TO THE FIRST EDITION

Anyone who is interested in technology is aware of the importance of electronics. Despite its all-pervading influence, however, electronics retains a strong element of mystery for many people who are otherwise well informed on technical matters. In this book, I aim to provide a practically-based explanation of the subject to try to dispel the mystery.

In the study of electronics, I have always found practical experience to be an invaluable stimulant and confidence-builder. There is enormous satisfaction in ‘lashing up’ a new circuit on the test bench and seeing it work for the first time. As an experimental physicist, I have never regarded electronic design as an end in itself, but rather as a valuable tool in research and development. The practical approach is therefore of primary importance in the electronics content of the UMIST Pure and Applied Physics degree course. Experience of teaching electronics to people of various backgrounds has encouraged me in the belief that a book based on a practical viewpoint can be valuable at all levels from school, through college or university, to the industrial laboratory.

This book aims to cover a wide range of circuit building bricks, analogue and digital, discrete and integrated. It is from these bricks that an elaborate system is constructed, whether it be a colour television set or a computer. Sufficient practical information is given to enable the reader to construct the circuits and test them in the laboratory. There are no formal exercises: I hope that the reader will be stimulated to test for himself whether the circuits work as I describe.

Very few of the circuits are critical regarding component layout. Most can be quickly soldered together on a tagboard or printed-circuit stripboard. A 6 V or 9 V radio battery makes a perfectly adequate power supply in most instances. A simple audio generator, an oscilloscope and a multimeter will facilitate testing.

The only mathematics required for a satisfactory understanding of most circuits is Ohm's law:

$$\text{current} = \frac{\text{voltage}}{\text{resistance}}.$$

Differential calculus is occasionally used as a convenient way to measure the slope at a particular point on a curve. For the sections of the book which deal with frequency or phase response, some knowledge of reactive circuits, using *j*-notation, will be helpful.

The bibliography at the end of the book lists some introductory texts which will fill in the background for the reader with little experience of electrical circuits. The bibliography also lists books which discuss detailed topics to a level which is inappropriate here.

I would commend every reader to make maximum use of the many data sheets and application notes published by all semiconductor manufacturers. The various monthly electronics magazines, readily available from newsagents, are also invaluable sources of practical information. Electronics is a rapidly-developing subject. Whilst this book aims to provide a foundation of knowledge and experience that will be relevant for many years, it is only by familiarity with the latest literature that the electronic engineer can remain abreast of the current state of the art.

It is impossible in a reasonable space to identify and thank individually all those who have contributed to this book. I must thank all my staff colleagues and students, both past and present, whose astute questions have so often initiated a broadening of my own understanding. My special thanks must go to my wife, Sylvia. Not only has she skilfully typed the manuscript, but she has also been a constant source of encouragement, and has accepted with equanimity the domestic disorder inevitable in this type of enterprise.

Martin Hartley Jones
November 1975