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Electronic and Electrical Engineering

Principles and Practice

L. A. A. Warnes

*Department of Electronic and Electrical Engineering
Loughborough University of Technology*

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MACMILLAN

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Preface

AN UNDERSTANDING of the basic principles and many of the important practical applications of electronic and electrical engineering is now essential to many practitioners of other disciplines. Through teaching electrical engineering subjects to electrical, civil, mechanical and production engineering students over a number of years, I have been aware that there is an urgent need for a book which goes into sufficient depth to be useful, without being over-complicated or cluttered with too-rigorous and exhaustive a mathematical treatment. In this book, the level of mathematical difficulty is approximately that of A-level, though in most chapters there is nothing so advanced. The aim here has been to establish the foundations thoroughly and then build onto them at least the ground floor of the edifice that this vast subject has evolved into today. While the requirements of the non-specialist are given due priority, the intention is also to provide a useful first course for HNC/HND and undergraduate engineering students. I hope that the practical side of the subject has not been lost to sight; and it has been my intention throughout to illustrate the theory with applications, wherever possible.

The book starts with two chapters on the fundamental subject of circuit analysis, or circuit theory. These are succeeded by chapters devoted to operational amplifiers and the steady-state and transient responses of circuits. Semiconductor theory is briefly reviewed in chapter 6, following which discrete devices and circuits are discussed in chapters 7, 8 and 9. Chapter 10 deals with integrated circuits and the more common analogue circuits. Machines and power make up an important central section of the work in Chapters 11 to 18. Digital electronics, computers and microprocessors are discussed in Chapters 19 to 22. There are four chapters given to communications, including analogue, digital and fibre-optic communications and telephony. Two concluding chapters deal with less central subjects of considerable importance to a wide public: electromagnetic compatibility (EMC) and instruments and measurements. EMC has become far more important since wide-ranging EC regulations became law and now affects every single piece of electrical equipment made and used in the Community. A working knowledge of electrical measurements, their accuracy and achievement is essential to engineers and technicians in every field, and a chapter on these topics rounds off the book.

Many people have helped in writing this book, especially the reviewers, of which there have been a score or more, known and unknown. I am also grateful to my students who have from time to time taken the trouble to read parts of the work and have offered useful suggestions for improvement: Wayne Lyons in particular was very helpful with microcontrollers. My thanks to all of these, but a special word of gratitude to my publisher, Malcolm Stewart, who has maintained a keen interest in the genesis and sometimes difficult birth of this offspring and has never been less than encouraging. To my wife, Irene, I offer my apologies for taking up the pen so very soon after I had said I would not, with all the consequent sacrifices of time and attention; and my thanks too for her unflinching support and encouragement.

Loughborough, 1993

L.A.A.W.

Constants

The speed of light in a vacuum, c	3×10^8 m/s
The permeability of free space or the magnetic constant, μ_0	$4\pi \times 10^{-7}$ H/m
The permittivity of free space or the electric constant, ϵ_0	8.85×10^{-12} F/m
Planck's constant, h	6.626×10^{-34} Js
Boltzmann's constant, k	1.38×10^{-23} J/K
The electronic charge, q	1.6×10^{-19} C

Notes: $c = 1/\sqrt{(\mu_0\epsilon_0)}$. Impedance of free space, $Z_0 = \sqrt{(\mu_0/\epsilon_0)} = 377 \ \Omega$. The above, where approximated, are accurate to $\pm 0.14\%$.

Units

Base units

<i>Quantity</i>	<i>Unit</i>	<i>Symbol</i>	<i>Dimension</i>
Mass	kilogram	kg	M
Length	metre	m	L
Time	second	s	T
Current	ampere	A	I
Temperature	kelvin	K	θ

Derived units

<i>Quantity</i>	<i>Unit</i>	<i>Symbol</i>	<i>Dimensions</i>
frequency	hertz	Hz	T^{-1}
speed	metre/second	m/s	LT^{-1}
acceleration	metre/sec/sec	m/s^2	LT^{-2}
force	newton	N	MLT^{-2}
work, energy	joule	J	ML^2T^{-2}
power	watt	W	ML^2T^{-3}
charge	coulomb	C	TI
potential	volt	V	$ML^2T^{-3}I^{-1}$
resistance	ohm	Ω	$ML^2T^{-3}I^{-2}$
conductance	siemens	S	$M^{-1}L^{-2}T^3I^2$
capacitance	farad	F	$M^{-1}L^{-2}T^4I^2$
inductance	henry	H	$ML^2T^{-2}I^{-2}$
magnetic field	ampere/metre	A/m	$L^{-1}I$
flux density	tesla	T	$MT^{-2}I^{-1}$
magnetic flux	weber	Wb	$ML^2T^{-2}I^{-1}$