**LIGHT CURRENT ELECTRICAL
APPLICATIONS III**

Macmillan Technician Series

P. Astley, *Engineering Drawing and Design II*

P. J. Avard and J. Cross, *Workshop Processes and Materials I*

G. D. Bishop, *Electronics II*

G. D. Bishop, *Electronics III*

J. C. Cluley, *Electrical Drawing I*

H. G. Davies and G. A. Hicks, *Mathematics II*

J. Elliott, *Building Science and Materials*

John G. Ellis and Norman J. Riches, *Safety and Laboratory Practice*

D. E. Hewitt, *Engineering Science II*

P. R. Lancaster and D. Mitchell, *Mechanical Science III*

R. Lewis, *Physical Science I*

Noel M. Morris, *Digital Techniques*

Noel M. Morris, *Electrical Principles II*

Noel M. Morris, *Electrical Principles III*

Owen Perry and Joyce Perry, *Mathematics I*

LIGHT CURRENT ELECTRICAL APPLICATIONS III

A. Simpson, C.Eng., M.I.E.R.E.

*Department of Electrical and Electronic
Engineering,
Worthing College of Technology*

M

© A. Simpson 1981

All rights reserved. No part of this publication may be reproduced or transmitted, in any form or by any means, without permission.

First published 1981 by
THE MACMILLAN PRESS LTD
London and Basingstoke
Associated companies in Delhi Dublin
Hong Kong Johannesburg Lagos Melbourne
New York Singapore and Tokyo

ISBN 978-1-349-03752-0 ISBN 978-1-349-03750-6 (eBook)
DOI 10.1007/978-1-349-03750-6

Typeset in 10/12 Times

This book is sold subject to the standard conditions of the Net Book Agreement.

The paperback edition of this book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, resold, hired out, or otherwise circulated without the publisher's prior consent in any form of binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

Contents

<i>Foreword</i>	vii	4. Digital Electronics	50
<i>Preface</i>	ix	4.1 Logical Functions	51
1. Regulated Power Supplies	1	4.2 Digital Devices	53
1.1 Shunt Regulators	2	4.3 Logic Circuits	54
1.2 Multi-stage Voltage Reference Sources	6	4.4 Examples of Simple Logic Applications	55
1.3 The Transistor as a Shunt Regulating Element	6	4.5 NAND and NOR Gates Only	56
1.4 Simple Series Regulator Circuit	7	4.6 NAND and NOR Gates Only Logic Diagrams	58
1.5 Series Regulators Incorporating Amplifiers	7	4.7 Rules of Logic	62
1.6 Protection Circuits for Series Regulated Supplies	9	4.8 Simple Memory Circuit	63
1.7 Integrated-circuit Voltage Regulators	11	4.9 Digital Integrated Circuits Problems	64
1.8 Switched-mode Power Supplies	12		67
1.9 Specifications for Regulated Power Supplies Problems	13	5. High-power Electronics	72
	14	5.1 The Reverse-blocking Thyristor (Thyristor)	72
2. Transistor Amplifiers	16	5.2 The Bidirectional Thyristor (Triac)	81
2.1 The Common-emitter Amplifier	16	5.3 Protection of Thyristors and Triacs against Excess Current and Voltage Problems	82
2.2 The Use of Negative Feedback to Stabilise the Gain of an Amplifier	22		83
2.3 Effect of Feedback on the Bandwidth of an Amplifier	24	6. Monolithic Integrated Circuits	85
2.4 Effect of Feedback on Noise and Distortion	25	6.1 Production of the Silicon Slice	85
2.5 Effect of Feedback on the Input and Output Impedance of the Amplifier	25	6.2 Planar Process	86
2.6 Practical Feedback Amplifier Circuits	27	6.3 Integrated Circuits	88
2.7 The Emitter Follower	28		
2.8 Classes of Amplifier Operation	29		
2.9 Power Amplifier Circuits	29		
2.10 Linear Integrated Circuits Problems	31		
	33		
3. Sinewave Oscillators and Pulse Generators	35		
3.1 Sinewave Oscillators	36		
3.2 Relaxation Oscillators	41		
3.3 Waveform Shaping Problems	45		
	48		

Foreword

This book is written for one of the many technician courses now being run at technical colleges in accordance with the requirements of the **Technician Education Council** (TEC). This Council was established in March 1973 as a result of the recommendation of the Government's Haslegrave Committee on Technical Courses and Examinations, which reported in 1969. TEC's functions were to rationalise existing technician courses, including the City and Guilds of London Institute (C.G.L.I.) Technician courses and the Ordinary and Higher National Certificate courses (O.N.C. and H.N.C.), and provide a system of technical education which satisfied the requirements of 'industry' and 'students' but that could be operated economically and efficiently.

Four qualifications are awarded by TEC, namely the Certificate, Higher Certificate, Diploma and Higher Diploma. The **Certificate** award is comparable with the O.N.C. or with the third year of the C.G.L.I. Technician course, whereas the **Higher Certificate** is comparable with the H.N.C. or the C.G.L.I. Part III Certificate. The **Diploma** is comparable with the O.N.D. in Engineering or Technology, the **Higher Technician Diploma** with the H.N.D. Students study on a part-time or block-release basis for the Certificate and Higher Certificate, whereas the Diploma courses are intended for full-time study. Evening study is possible but not recommended by TEC. The Certificate course consists of fifteen Units and is intended to be studied over a period of three years by students, mainly straight from school, who have three or more C.S.E. Grade III passes or equivalent in appropriate subjects such as mathematics, English and science. The Higher Certificate course consists of a further ten Units, for two years of part-time study, the total time allocation being 900 hours of study for the Certificate and 600 hours for the Higher Certificate. The Diploma requires about 2000 hours of study over two years, the Higher Diploma a further 1500 hours of study for a further two years.

Each student is entered on to a **Programme** of study on entry to the course; this programme leads to the award of a Technician Certificate, the title of which reflects the area of engineering or science chosen by the student, such as the Telecommunications Certificate or the Mechanical Engineering Certificate. TEC have created three main **Sectors** of responsibility

Sector A responsible for General, Electrical and Mechanical Engineering

Sector B responsible for Building, Mining and Construction Engineering

Sector C responsible for the Sciences, Agriculture, Catering, Graphics and Textiles.

Each Sector is divided into Programme committees, which are responsible for the specialist subjects or programmes, such as A1 for General Engineering, A2 for Electronics and Telecommunications Engineering, A3 for Electrical Engineering, etc. Colleges have considerable control over the content of their intended programmes, since they can choose the Units for their programmes to suit the requirements of local industry, college resources or student needs. These Units can be written entirely by the college, thereafter called a college-devised Unit, or can be supplied as a Standard Unit by one of the Programme committees of TEC. **Assessment** of every Unit is carried out by the college and a pass in one Unit depends on the attainment gained by the student in his coursework, laboratory work and an end-of-Unit test. TEC moderate college assessment plans and their validation; external assessment by TEC will be introduced at a later stage.

The three-year Certificate course consists of fifteen Units at three Levels: I, II and III, with five Units normally studied per year. A typical programme might be as follows.

Year I	Mathematics I	Standard Unit	} six Level I Units
	Science I	Standard Unit	
	Workshop Processes I	Standard Unit	
	Drawing I	Standard Unit	
	General and Communications I	College Unit	
Year II	Engineering Systems I	College Unit	} six Level II Units
	Mathematics II	Standard Unit	
	Science II	Standard Unit	
	Technology II	Standard Unit	

Year III	General and Communications II	College Unit	} six Level II Units
	Industrial Studies II	College Unit	
	Engineering Systems II	College Unit	
	Mathematics III	Standard Unit	} three Level III Units
	Science III	Standard Unit	
	Technology III	College Unit	

Entry to each Level I or Level II Unit will carry a prerequisite qualification such as C.S.E. Grade III for Level I or O-level for Level II; certain Craft qualifications will allow students to enter Level II direct, one or two Level I Units being studied as 'trailing' Units in the first year. The study of five Units in one college year results in the allocation of about two hours per week per Unit, and since more subjects are often to be studied than for the comparable City and Guilds course, the treatment of many subjects is more general, with greater emphasis on an **understanding** of subject topics rather than their application. Every syllabus to every Unit is far more detailed than the comparable O.N.C. or C.G.L.I. syllabus, presentation in **Learning Objective** form being requested by TEC. For this reason a syllabus, such as that followed by this book, might at first sight seem very long, but analysis of the syllabus will show that 'in-depth' treatment is not necessary—objectives such as '... **states** Ohm's law ...' or '... **lists** the different types of telephone receiver ...' clearly do **not** require an understanding of the derivation of the Ohm's law equation or the operation of several telephone receivers.

This book satisfies the learning objectives for one of the many TEC Standard Units, as adopted by many technical colleges for inclusion into their Technician programmes. The treatment of each topic is carried to the depth suggested by TEC and in a similar way the **length** of the Unit (sixty hours of study for a full Unit), **prerequisite qualifications**, **credits for alternative qualifications** and **aims of the Unit** have been taken into account by the author.

Preface

This book has been written primarily for electrical technicians studying for awards with the Technician Education Council (TEC) and covers the syllabus for Light Current Electrical Applications, a subject at third-year level in the A3 Electrical Engineering Council programme.

The unit as originally conceived was considered by the Council to contain too much work for a 60 hour unit and colleges were free to select the areas they considered most suitable for their needs, eliminating some 20 per cent of the material. This book, however, covers the whole of the published unit in the five main sections: regulated power supplies, transistor amplifiers, sinewave oscillators and pulse generators, digital electronics, high power electronics. It includes worked examples in the sections together with exercises, with answers where applicable, at the end of each section. The book finishes with a short chapter about integrated circuit manufacture.

It would be appropriate at this time to record my thanks to my wife for her help in preparing the manuscript and for her encouragement throughout this time-consuming task.

A. SIMPSON