Electronics for Technicians

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Electronics for Technicians

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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 which 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 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 covers the Electronics content of the TEC Certificate programme in **Electronics (A2)** and the Certificate programme in **Telecommunications (A2)**. In 1980 a revision of the Certificate programmes in electronics and telecommunications was carried out by the Technician Education Council and the Electronics content originally contained within Electronics II(U76/010) and Electronics III(U76/009) was restructured into two new units

Electrical and Electronic Principles II(U81/747), sections G and H, and

Electronics III(U81/743).

During this process the material on thermionic valves and cathode ray tubes was deleted, together with large amounts of transistor circuit design theory which was thought by the Technician Education Council to be unnecessary for the modern Electronics or Telecommunications Technician.

Chapters 1 and sections 2.1 to 2.5 of chapter 2 cover the Level II material which then extends to the *h*-parameter and FET material of Level III. The remaining chapters cover the objectives of the Level III Unit with expansion to supplementary topics where it is thought necessary. Examples are in chapter 4 where many typical circuits are included and chapter 7 where full details of multivibrator circuit operation are given. Chapter 8 includes a brief history of integrated circuit development, details of modern IC manufacture and a number of typical linear ICs and their working circuits. Chapter 10 has been included as a supplementary chapter which links the electronics content of this book with that of Microelectronics II and Digital Techniques II.

It is essential that the principles covered in the prerequisite Physical Science I Unit are understood before reading this book, since basic electrical theory and a full appreciation of electric currents and voltages are assumed to be fully understood prior to the reading of this book. An electronics or telecommunications technician must obtain a **feel** for the circuits being investigated so that fault diagnosis can be logically carried out rather than the time-consuming hit-and-miss methods.

This Unit follows a TEC syllabus written in **objective** form, starting with, for example, '**the expected learning outcome is that the student** compares the properties of a field-effect transistor with

valves and bipolar transistors'. For this reason many assessment questions will be of objective form such as multiple-choice-type or short-answer form. A selection of these questions is inserted into this book together with a few longer-type questions which test the various objectives of the Unit syllabus. Answers and comments may be found at the end of the book.

All symbols and diagrams conform to the latest British Standards specification although these do vary from time to time. **Practical exercises** such as structured laboratory work or investigatory work are essential while following this book since many of the concepts that are introduced are of a practical nature and should be tested along with the theoretical knowledge. Project work greatly assists a full understanding of electronic principles, and for this reason several practical circuits are included in the book which take the reader a little further than the syllabus being followed. Readers are advised to experiment with the circuits given and obtain access to the necessary test equipment wherever possible.

Despite the fact that this book covers the objectives of the relevant TEC Units, it also serves as a self-contained text for anyone wishing to study the basic principles of modern electronic circuits.

G.D. Bishop