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Engineering Science II

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Contents

<i>Foreword</i>	ix
<i>Preface</i>	xi
1. Statics—Materials	1
1.1 Stress	1
1.2 Strain	2
1.3 Hooke's Law and the Modulus of Elasticity	3
1.4 Elasticity and Plasticity	5
1.5 The Tensile Test	6
1.6 Properties of Materials and Stress–Strain Curves	11
1.7 Introduction to Plastics Materials	12
1.8 Shear Stress and Shear Strain—Modulus of Rigidity	13
1.9 Factor of Safety and Working Stresses	14
Exercises	16
2. Statics—Structures	18
2.1 Force as a Vector	18
2.2 Equilibrium—The Triangle and Polygon of Forces	20
2.3 Bow's Notation	21
2.4 Conditions of Equilibrium	22
2.5 The Turning Effect of a Force	24
2.6 Beam Reactions	25
2.7 Resultant Forces in Frameworks	26
2.8 Graphical Determination of Forces in Simply Supported Frameworks Subject to Vertical Loads	27
2.9 Graphical Determination of Forces in Simply Supported Frameworks Subject to Vertical and Non-vertical Loads	28
2.10 Graphical Determination of Forces in Cantilever Frameworks	30
Exercises	31
3. Dry Sliding Friction	39
3.1 The Nature of Dry Sliding Friction	39

U75/036	U76/053	U76/061	U76/062	U76/063
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3.2 Angle of Friction (Angle of Repose)	42	✓	✓	✓		
3.3 Full-film and Boundary Lubrication	43			✓		
3.4 Friction Losses in Bearings	44	✓	✓	✓		
Exercises	46					
4. Simple Machines	48					
4.1 Simple Machines and Levers	48	✓	✓	✓		
4.2 Mechanical Advantage and Velocity or Distance Ratio	49	✓	✓	✓		
4.3 Velocity Ratio or Distance Ratio of Simple Machines	50	✓	✓	✓		
4.4 Mechanical Efficiency of Simple Machines	55	✓	✓	✓		
4.5 Limiting Efficiency—the Law of a Simple Machine	57	✓	✓	✓		
4.6 Overhauling in a Simple Machine—Ideal Machines	59			✓		
Exercises	61					
5. Velocity	62					
5.1 Constant-velocity and Uniformly Accelerated Motion	62			✓	✓	
5.2 Distance–Time, Velocity–Time and Acceleration–Time Graphs for Uniformly Accelerated Motion	64			✓	✓	
5.3 Uniformly Accelerated Motion Due to Gravity	66			✓	✓	
5.4 Velocity as a Vector	67	✓	✓			
5.5 Relative Velocity Applied to Mechanisms	69	✓	✓			
5.6 Circular Motion and Angular Velocity	70	✓	✓	✓	✓	
Exercises	73					
6. Dynamics—Newton’s Laws of Motion	76					
6.1 Newton’s First Law of Motion	76	✓	✓	✓	✓	✓
6.2 Newton’s Second Law of Motion	77	✓	✓			
6.3 Newton’s Third Law of Motion	79	✓	✓			
6.4 Forces Required to Produce and Maintain Motion	79	✓			✓	
Exercises	83					
7. Dynamics—Work and Energy	84					
7.1 Work and Energy	84	✓			✓	

		U75/036	U76/053	U76/061	U76/062	U76/063
7.2 Work done by a Constant Force	85	✓			✓	
7.3 Work done by a Varying Force	85	✓				
7.4 Work done by an Inclined Force	86	✓			✓	
7.5 Mechanical Energy	87	✓		✓	✓	
7.6 Potential Energy	87	✓		✓	✓	
7.7 Kinetic Energy	87	✓		✓	✓	
7.8 Conservation of Energy	89	✓		✓	✓	✓
7.9 Power—the Rate of Doing Work	91	✓			✓	✓
Exercises	94					
8. Heat and Its Applications	95					
8.1 Heat and Energy	95			✓	✓	✓
8.2 Effects of Heat	95	✓	✓	✓	✓	✓
8.3 Sources of Heat	95			✓		
8.4 Heat Transfer	95	✓	✓			
8.5 Temperature	97	✓	✓		✓	✓
8.6 Calorimetry	98	✓	✓		✓	✓
8.7 Change of State	100	✓	✓		✓	✓
8.8 Change of Size	102	✓	✓	✓	✓	✓
8.9 Properties of Gases	104				✓	
Exercises	107					
9. Electricity and Electrical Measurement	109					
9.1 The Nature of Electric Charge	109	✓	✓		✓	✓
9.2 The Electric Current	110	✓	✓	✓	✓	✓
9.3 The Electrical Circuit	111	✓	✓	✓	✓	✓
9.4 Factors Determining Resistance	118			✓		
9.5 Electric Power	121					✓
9.6 Electrical Measurements	122	✓	✓	✓		✓
9.7 Measurement in A.C. Systems	128	✓	✓		✓	✓
9.8 Electrostatics	130				✓	
9.9 Electrochemistry	134					✓
9.10 Safety Precautions for Electrical Equipment	140	✓	✓	✓	✓	✓
Exercises	142					
10. Magnetism and Electromagnetism	144					
10.1 Evidence of a Magnetic Effect	144	✓	✓	✓		

10.2	Shape and Distribution of Magnetic Fields	145
10.3	The Concept of Magnetic Flux and Field Strength	147
10.4	The Direct-current Motor	151
10.5	Electromagnetic Induction	155
10.6	Machines for Generating Electric Current	158
10.7	Flux Change as an Alternative to Flux Cutting	160
10.8	Self-inductance and Mutual Inductance	163
10.9	Production of Magnetism in Magnetic Materials	165
	Exercises	168

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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 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 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	}	six Level II Units
Year II Engineering				
Systems I	College Unit			
Mathematics II	Standard Unit			
Science II	Standard Unit			
Technology II	Standard Unit		}	three Level III Units
General and Communi- cations II	College Unit			
Year III Industrial Studies II	College Unit			
Engineering Systems II	College Unit		}	
Mathematics III	Standard Unit			
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.

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

The aim of this book is concisely to cover sufficient engineering science material at Level II to meet the needs of any student following a Technician Education Council programme of studies within the fields of Sector A1—General Engineering and Sector A5—Mechanical and Production Engineering.

The standard Units provided by TEC to meet the needs of the outline programmes in these areas are

TEC U76/053 Engineering Science—aiming to give a basic mechanical and electrical engineering science background for engineering manufacturing technology; taken by *all* students in the mechanical and production engineering field.

TEC U76/061 Engineering Science (1) II—a half Unit aiming to provide a basic background of engineering science for *all* technician students in the general engineering field.

TEC U76/062 Engineering Science (2) A II—an additional half Unit to develop the engineering science background of the more analytical student following a Certificate programme in general engineering.

TEC U76/063 Engineering Science (2)B II—an additional half Unit to complement TEC U76/061 to give the more practical student following a Certificate programme in general engineering an engineering science background to his technology subjects.

The students taking these particular Units will include those just entering their further education studies, having obtained an O-level G.C.E. pass (Grade 3 or better) in physics or a suitable science, or, alternatively, having obtained a C.S.E. Grade 1 pass in similar subjects.

Other students will include those whose school-leaving attainments are less than those outlined above, but who have successfully

studied TEC Units TEC U75/004 Physical Science I or TEC U76/004 Engineering Science I. There will also be students transferring to a technician course having distinguished themselves on a craft course.

The material within the book is presented in logically arranged chapters, each preceded by its own general objective. Each chapter is sub-divided into concise sections, which any student may select to study to fulfil the specific objectives associated with his programme. Each sub-section is cross-referenced to the particular TEC Unit or half Unit to which it is relevant. Each chapter concludes with specific objectives and these, coupled with the student exercises, should help the student to monitor his own progress effectively and ensure that the specific objectives have been achieved.

There are numerous worked examples within the text, carefully graded in complexity, illustrating where possible the application of the principles involved to everyday and common engineering situations.

The text also includes brief biographical details of some of the scientists and engineers to whom we owe much of our current knowledge. Comment has also been included to emphasise the aspects of science and technology which have particular social and environmental implications. It is hoped that this will assist in the integration of general studies by providing introductory material for discussion on topics such as the history of technology, energy sources, pollution, etc., and will broaden the interests of the student and make him aware of the importance of the engineering industry in society and, in particular, the role of the 'technician' within the industry.

I wish to acknowledge the assistance and collaboration of my colleague, C. H. Salsbury, B.Sc., C.Eng., M.I. Gas E., M.Inst.F., in the preparation of the book, in particular for reading through the manuscript and making helpful comments, and for his contribution of chapters 8, 9 and 10 on heat, electricity and magnetism.

D. E. Hewitt