FLUID MECHANICS

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FOUNDATIONS OF ENGINEERING

Series Editor: G. E. Drabble

FLUID MECHANICS

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SERIES EDITOR'S FOREWORD

This series of programmed texts has been written specifically for students meeting a subject for the first time on their engineering degree courses. Each book covers one of the core subjects required by electrical, mechanical, civil or general engineering students, and the contents have been designed to match either the first, or in the case of this volume, the first and second year requirements of most universities, both old and new.

The layout of the texts is based on that of the well-known text *Engineering Mathematics* by K. Stroud (first published by Macmillan in 1970, and now in its third edition). The remarkable success of this book owes much to the skill of its author, but it also shows that students greatly appreciate a book which aims primarily to help them to learn their chosen subjects at their own pace. The authors of this present series acknowledge their debt to Mr Stroud, and hope that by adapting his style and methods to their own subjects they have produced equally helpful and popular texts.

Before publication of each text the comments of a class of students, of some recent engineering graduates, and of some lecturers in the field have been obtained. Those helped to identify any points which were particularly difficult or obscure to the average reader or which were technically inaccurate or misleading. Subsequent revisions have eliminated the difficulties which were highlighted at this stage, but it is likely that, despite these efforts, a few may have passed unnoticed. For this the authors and publishers apologise, and would welcome criticisms and suggestions from readers.

Readers should bear in mind that mastering any engineering subject requires considerable effort. The aim of these texts is to present the material as simply as possible and in a way which enables students to learn at their own pace, to gain confidence and to check their understanding. The responsibility for learning is, however, still very much their own.

G.E. DRABBLE

PREFACE

This book offers an alternative approach to learning in fluid mechanics for those students for whom conventional textbooks and indeed taught courses do not always seem adequate.

The content is structured so as to help students reach a good level of understanding as rapidly as possible, and the programmed approach is designed to ensure that every step can readily be followed and understood.

In my experience, most students like to see practical applications of what they are learning as early on as possible. I have therefore included in the book many examples of the use of fluid mechanics in real engineering situations – examples such as calculating the force on a dam, investigating the stability of a car ferry, or estimating the thrust of a jet engine.

The subject matter is divided into nine areas, each of which is the topic of a separate chapter, or programme. The programmes are intended to be worked through in sequence, but those students who have the appropriate background knowledge can of course start at an intermediate point in the book: the index will suggest where to start.

Two of the programmes, 7 and 8, are about dimensions, similarity and the testing of models. Model tests are used more often in fluid mechanics than in other fields of engineering and science, which is why these topics are usually included in fluid mechanics text books; but exactly the same ideas apply to tests on models in any other field, whether it be a load test on a model structure or an investigation of heat flows in a model building. These two programmes are applicable in many areas besides fluid mechanics, and they should be useful reading for students in many disciplines.

As in any area of engineering, we generally need to measure fluid mechanics quantities in numerical terms, and a certain amount of mathematics is unavoidable. Familiarity with straightforward algebra and trigonometry is sufficient for almost all the work covered in the book. In one or two places there is a proof that goes beyond this fundamental material, but the reader can pass over this and pick up again from the result of the proof without disadvantage.

Early drafts of the book have been read and used by a number of students of Lancaster University, and I am most grateful to them for their helpful comments and corrections. Parts of it have also been read by colleagues in the Engineering Department at Lancaster, and the whole book has received the careful attention of Eddie Drabble, the Series Editor. To all of these my sincere thanks for their constructive suggestions.

MARTIN WIDDEN

HOW TO USE THIS BOOK

This book has nine chapters, or programmes, dealing with nine separate topics in fluid mechanics. Each programme is written as a carefully planned sequence of short sections, called frames, each of which contains a limited quantity of information. Most of the frames end with a short question or problem for you to tackle – this enables you to test your understanding of the material that you have just studied. The correct answer to each problem is given in the following frame.

This structure, which is common to all the books in the *Foundations of Engineering* series, is designed so that you can readily study on your own, and at your own pace. If you find a section easy and straightforward, you can work fast; any parts you find harder you can take more steadily.

When studying independently in this way, you are advised to work systematically through the book from the beginning, attempting all the questions at the ends of the frames. You should make every effort not to look at the next frame until you have answered the given question. A good technique is to have a piece of paper or card to conceal the next frame – you can use it for rough work if necessary.

At intervals throughout the book short sets of problems have been provided. Those placed at intermediate stages in the programmes should encourage you to revise what you have covered so far; at the end of each programme there is a test exercise, so that you can ensure you have mastered the knowledge and techniques you have learned before going on to the next programme.

It is of course possible to start at an intermediate point in the book, if you have the appropriate background knowledge; in this case the index will help you to find the right page to start. The index will also be useful if at a later stage you want to look something up in the book – to brush up on a particular topic, for instance.

Whatever pattern of study you choose, try to make a habit of mastering the content of each small section of the book before you go on to the next, and use the sets of problems to reinforce your new knowledge. If you work in this way, you should learn both efficiently and effectively.