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Further Engineering Dynamics

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To Kirsten, Peter and Christian

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Preface

The rapid developments in engineering and science mean that today's engineering and science students meet new and more challenging situations in dynamics. To deal with these problems, further developments in dynamics beyond the usual courses in elementary to intermediate dynamics are increasingly necessary. It is hoped that this book will be of help on such courses for second and third-year students in any branch of engineering and physics, both at universities and polytechnics.

The book has been arranged in self-contained chapters so that they may be studied in any combination and order.

Chapter 1 deals with the dynamics of a system of particles; several examples of fluid motion are included, although the necessarily brief discussion of this subject is only intended to give a broader view of a subject which is usually treated in depth in specialised courses in fluid mechanics. Chapter 2 gives a short introduction to systems where the total mass of the system is increasing or decreasing.

In chapter 3 Lagrange's equations of motion are introduced in a general form, including constraints depending on time. Previous experience in these equations is useful but is not essential since the equations are developed from fundamental ideas. Lagrange's equations are probably the most powerful method known in engineering dynamics for the determination of the equations of motion of a dynamic system and they allow for the solution of very complex dynamic systems. The equations have been generalised to include the problems of impact and impulsive motion.

Chapter 4 introduces vibrations with two degrees of freedom and includes examples on both linear and torsional systems with and without damping.

Chapter 5 gives a general discussion of rotation about a fixed point and general gyroscopic motion. It introduces the Euler angles as generalised coordinates and the equations of motion are developed both by the Lagrangian method and by the more common Euler method; various types of special cases are considered in detail. Chapter 6 deals with gyroscopic effects in machinery and chapter 7 with the applications of gyroscopes in the fields of direction indication and stabilisation.

In chapter 8 the subject of dimensional analysis and its applications are discussed, including Buckingham's pi-theorem. The chapter ends with a discussion of the theory of models.

The final chapter gives a short introduction to the subject of automatic control, a subject that is intimately linked with the basic subject of dynamics. Included is a discussion of transfer functions and Routh's and Nyquist's stability criteria.

The necessary background in dynamics is that which is provided in most cases in elementary to intermediate dynamics in universities and polytechnics. This part of the subject has been given extensive treatment in the author's earlier book *Essential Engineering Dynamics* (published by Crosby Lockwood).

The author takes the opportunity to thank his wife Kathleen for typing the original manuscript, and to express his appreciation and thanks to the publishers, especially to Malcolm Stewart, for suggestions for improvements and encouragement during the writing of the book.

Exeter

J. C. MALTBAEK