This is a substantial text, of nearly 700 pages, which attempts to cover a broader than usual range of topics in flight dynamics. At the level of detail of the content, the coverage is, arguably, too much for a single volume. Although the target audience is not stated, the style and mathematical complexity of the content suggest that it is intended as a teaching text aimed at third year undergraduate level courses in aerospace engineering and, possibly, at postgraduate level courses. The presentation quality of this hardback volume is generally of a good standard. However, it is unfortunate that the content has many significant shortcomings leaving a lot to be desired in the quality of its technical discussion.

The material content of the book is contained in 10 chapters and each chapter concludes with a useful selection of examples for students. Chapter 1 introduces the book with a description of an aeroplane and the basic functional properties of its principal components. It concludes with a brief summary of the mathematical aerofoil theory and the aerodynamic properties of a 3D wing. Chapter 2 describes the ‘Basic Principles Governing Aerodynamic Flows’ and covers the generation of lift, drag and pitching moment on an aerofoil. This includes an overview of the well rehearsed theory found in most books on aerodynamics and would seem a little out of context in a book on flight dynamics. Chapter 3 delivers the standard textbook theories of static stability and manouevrability. The material is very descriptive and unfortunately some explanation is ambiguous and, or misleading. For example, the author does not distinguish adequately between lateral stability and directional stability, which is confusing. It is also misleading, for example, to define manouevrability as ‘…the pilots ability to deploy the control surfaces…’ implying that it is a property of the pilot rather than of the aeroplane.

Chapter 4 describes the standard development of the equations of motion and to attempt this without first setting out the reference axes systems is quite unsatisfactory. Chapter 5 concludes the preparation of the ‘foundation’ material by describing the further development of the linearised equations of motion. This chapter is difficult to follow for two reasons: First, the poor descriptive precision supporting the maths and second, the introduction of ‘body axes’, ‘wind axes’ and ‘stability axes’ without first defining these axes systems.

From Chapter 6 onward the author gives greater emphasis to the application of the theoretical material and the later chapters include numerous application examples. Chapter 6 is concerned with the solution of the linear equations of motion, a review of dynamic stability and concludes with the estimation of the stability and control derivatives. The chapter includes several case studies illustrating the solution of the equations of motion and the numerical characteristics of the stability modes. Unfortunately, the case studies have little or no explanatory discussion of the results and there is evidence that some of the studies contain errors.

Chapter 7 is supposed to discuss the methods used to obtain the dynamic response of an
aeroplane from the equations of motion. The methods of solution are simply stated as the Laplace transform, numerical integration and Matlab/Simulink, with no examples of their application. Surprisingly, nowhere in this chapter are time history response plots given to illustrate the dynamic behaviour of aircraft. Then follows some very detailed material covering atmospheric turbulence modelling, again with no example of its application. The chapter concludes with a lengthy ‘analysis’ of the effects of nonlinearity on aircraft dynamics. However, it is not an analysis it is simply a descriptive overview.

Chapter 8 is a very large chapter dealing with aircraft flight control. The first part of the chapter contains a large number of typical flight control system block diagrams each of which is described briefly. This is followed by a very large section on flight control system design which covers both ‘classical’ and ‘modern’ methods with application to autostabilisation and autopilot systems. A summary of the essential mathematical background is given together with numerous worked examples. In this material the author introduces the ideas of flying qualities rating and of pilot handling qualities rating, but in this context does not distinguish between piloted flight control and automatic flight control. Unfortunately, the rating requirements are not referred to in the worked examples. An especially poor example of this is given under the heading ‘Performance assessment of a command or control augmentation system’. The C” handling qualities metric is introduced, but from the information provided no assessment could be made and no reference is given to guide the reader to the source material.

Chapter 9 is a short descriptive chapter covering, at an accessible introductory level, the piloted flight simulator, pilot modelling, pilot induced oscillation and motion and visual cueing. Chapter 10, the final chapter, is concerned with the extension of the equations of motion to represent the flexible airframe. The entire chapter is used to set out the mathematical theory and the effects of flexibility on aircraft dynamics. No worked examples are included in this chapter.

The style of writing is not very concise and lacks precision. It is evident that material has been imported from numerous sources but the reference sources are not always given. It is irritating that some material is repeated unnecessarily and that explanatory material occasionally lacks clarity and is misleading or factually incorrect. A particular problem in this respect is that the author has not used figures to help explain the more demanding topics. In fact, the lack of suitable figures to illustrate the material is a problem that pervades the whole book. A notable omission in the book is a comprehensive list of notation defining the many math symbols used throughout and a consequence of this is the inconsistent use of symbols. Unfortunately, the foundation material defining the axes systems, notation and sign convention required for the development of the equations of motion is inadequate and lacks the usual explanatory figures, the written explanation is not given the appropriate degree of attention and this leads to various difficulties of interpretation later in the book.

A large part of the book is intensively mathematical and the math theory is generally sound. However, the inconsistent notation and the failure to use the equation numbering for cross referencing in the mathematical development leads to occasional difficulties of assimilation. An additional shortcoming in this context is the cursory and frequently weak link between the defining mathematics and correct interpretation of the flight physics.
A welcome feature of the book is that it contains a good number of worked examples and case studies. However, the examples tend to be prescriptive rather than analytical. In general, the examples do not state clearly the objective of the calculation - the solution steps are then set out and the numerical solution given. Typically, no discussion or interpretation of the result follows to complete the exercise. The flight control system design examples in Chapter 8 are especially poor, and this is in part due to inadequate definition of the systems of axes and sign convention earlier in the book. The many root locus plots given are of little use because they do not show the closed loop gain calibration. Some also fail since it is not recognised that the open loop transfer function is negative and the interpretation is incorrect. Most of the examples have little real world relevance since they lack analytical discussion to explain the process and its solution.

This book is very disappointing, it is difficult to see who might benefit from it and, given its shortcomings, is very costly. All of the content is available elsewhere and a number of excellent texts on flight dynamics are currently available at more affordable prices.

_M. V. Cook, CEng, FRAeS_

The aim of the book is to provide a complete text covering both the basic and applied aspects of aerodynamic theory. The book gives a detailed coverage of classical inviscid aerodynamic theory with little coverage of viscous flow. The author provides an extensive description of the subject with a full derivation of all the equations, many worked examples and exercises for the reader. It is a suitable introduction to students for these classical topics and provides a good grounding for any aerodynamicist.

The book is divided into ten chapters with a useful summary at the end of each chapter. The first two chapters introduce some basic aerodynamic nomenclature and the essence of fluid mechanics by stating the Navier-Stokes equations and concentrating on both incompressible and compressible potential flow. Elementary solutions of the potential flow equation, in the form of source, sink, doublet and vortex, are introduced and are used extensively throughout the book to develop solutions for two and three dimensional shapes.

Chapters 3 and 4 cover conformal transformations of the complex plane and their application for calculating the potential flow about Joukowski aerofoil sections. Methods for calculating the potential flow about general aerofoil shapes are described in Chapter 6, with thin aerofoil theory, which assumes the airfoils are thin to allow the solution to be developed and Chapter 7 ‘Panel Method’ using numerical techniques. The chapter on panel methods only covers two-dimensional panel methods, with no description of three-dimensional methods which have been used extensively in the aircraft industry. However three-dimensional flows are covered in Chapter 8 with a description of the classic theory developed by Lanchester and Prandtl. Chapter 9 covers modifications introduced to the theory to account for compressible flow about aerofoils and finite wings and relationships for shock waves. The last Chapter applies some of the ideas covered in the book to simple flights of aircraft.
The main objective of the book is to cover the classical theory for inviscid flow using exact solutions of the linear equations or approximations to the equations with, for example, panel methods and thin aerofoil theory. This provides a good grounding for the student in the basic properties of the fluid flow and results can be achieved by simple calculation. However it should be noted that since the 1970s the calculation of aerodynamic flows for subsonic and transonic inviscid and viscous flows about aerofoils and complete aircraft has been achieved by the application of methods of Computational Fluid Dynamics (CFD) to the Navier-Stokes and Euler equations. For a complete coverage of theoretical aerodynamics the reader will also have to consult books on viscous flow and CFD.

Although there is a further reading list at the end of the book, it would have been helpful to have some references in the text for students to explore the ideas more fully. It would also have been helpful to the reader to have a list of symbols at the beginning of the book.

**Professor B.R. Williams, FIMA, FRAeS**

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**Structural Engineering: a Very Short Introduction**

**D. Blockley**


This book is a recent addition to the publishers’ multi-disciplinary A-Z series, prepared for the general reader. We learn from the Preface that the author regards the Shard in London, the Golden Gate Bridge in San Francisco, jumbo jets and the *Queen Elizabeth II* cruise liner as examples of iconic/high quality structural engineering design.

In Chapter 1, ‘Everything Has Structure’, the author discusses how architecture and engineering have (over the centuries) become separate professions. In building works, architects provide the style and aesthetic appeal, while engineers ensure the optimal structural form is used. And, as the author points out, the aims today are much the same as they were when Vitruvius (15 BC) defined them: *‘firma, utilitas, venustas’*. Durability, utility and beauty. Later in the chapter the author asks: ‘*How do forces flow?*’ His answer: by pulling (tension), pushing (compression), sliding (shear). The duality between active/reactive forces and equilibrium is explained well enough, but if one can rely on the Index, the word stress is used without definition on pages 27, 47, 52, 68, 77 and 78 and one has to read almost 50 pages before a definition of stress (caused by these forces) pops up (8th line down, page 84).

The title of Chapter 2, ‘Does Form Follow Function?’ is a question the author promptly answers (first line of text) without discussion, before Lewis Sullivan’s dictum: ‘*Form ever follows function and this is the law*’, settles the issue. Next up: ‘Structures are natural lazy’, which is the author’s convoluted way of saying: the energy stored in a structure is a minimum for the shape and form devised. The equilibrium of quasi-static forces is demonstrated graphically, using space and force diagrams, but centre stage is 1) The Eden Project and 2) The Cape Town Stadium, both of which are spherical geodesic domes. NB the outstanding pioneering work of ‘the master’, Buckminster Fuller, should have been acknowledged. It isn’t, albeit Fuller is credited with coining the word ‘*tensegrity*’, which is not the same thing. The relatively advanced theoretical concept of six degrees of
freedom and more so direct and shear forces acting on six faces of an infinitesimal cube, Fig. 10, page 37, have nothing to do with form follows function, as Lewis Sullivan defined it. Both these topics might have been better placed in ‘Understanding Structures’, Chapter 4.

Chapter 3, ‘From Stonehenge to Skyscrapers’, is divided into four periods of time: 1) Ancients to late Middle Ages; 2) Renaissance to c1700; 3) c1700 to c1900; 4) c1900 to the present day. Stonehenge c3100 BC, Pyramid technology c2600 BC and the Cathedrals of Europe are presented as extraordinary examples of ‘What we humans can achieve’. The role of the craft trades is mentioned on page 6, Chapter 1, but pages 40-46 are given over to accolades which go to the truly great names of history ranging from Archimedes (287-212 BC) to Frank Lloyd Wright (1867-1959). Other topics include: The artist engineer, The separation of the professions, which culminate in the statement: ‘they [architects and engineers] must and do work together to build buildings: But sometimes they work in a state of tension born of mutual incomprehension’.

‘Understanding Structure’ (singular) Chapter 4, begins ‘Most of us, I suspect, have tried our hands at structural engineering by building a tower of children’s play bricks’ and serves well as an introduction to how non-perpendicular forces acting on a block built tower may cause it to collapse or topple. Why statically indeterminate beams are more complex than their statically determinate counterparts is clearly explained, but the author’s Treatment of Materials page 68, lacks substance and is arguably the least informative part of the book. Seemingly not worth a sub-heading, the three scale-less load/extension diagrams, typical of unclassified: High Tensile Steel, Mild Steel, aluminium and plastic, is hardly enough. There is no mention of concrete (used for buildings), no mention of CFRP (used for aircraft). There is no mention of specific strength or stiffness, modulus or density, all facts on which the selections of the best material depends. Knowing about virtual work and the wonders of the finite element age is fine, but a sound grounding in material properties is more important. A good start to the chapter but a ‘way out’ finish.

‘Movers and Shakers’, Chapter 5, is the author’s trendy way of inviting readers to join him in the study of the dynamic behaviour of Jumbo Jets, cruise liners, long span (suspension) bridges and skyscrapers. What have these (vastly different) structures in common? The author asks. Answer: ‘They are all gigantic tubes’. This observation prompts a brief discussion on how various elements of structure are arranged to carry the loads imposed. A definition of P/A stress, material yield stress and rupture follows, then its dynamic loading effects, largely produced by cyclic accelerations and retardations, which produce inertia and damping forces, added to the quasi-static conditions previously considered. There follows a section on structural hierarchies, Euler buckling being one of them. The interesting case of pile hammer driving is also explained. There are, as the author points out, many complexities to be predicted and resolved, so much so that everything that might happen has to be assessed.

‘Resilience’, Chapter 6, is largely about assessing: risk, safety and structural integrity. ‘What are the risks?’ ‘How big are they?’ ‘How safe is safe enough?’ the author asks, before getting down to the nitty-gritty. Force flows (load paths) in trusses, force flows in beams (otherwise known as shear force and bending moment diagrams) are demonstrated graphically. Various ‘Limit States’, both technical and regulatory are discussed. Lloyds Register rules and regulations for the classification for ships, FAR (Federal Aviation Regulations) and other official documents are quoted by name.
Risk [we are told] is in the future and risk has to be recognised and managed. The author’s last words on the subject are: ‘good structural engineering design can save orders of magnitude in cost and protect the lives of both the living and the yet to be born’.

The modular presentation may (or may not) appeal to the younger reader, but in scholastic terms the sequence of Chapters 1 to 4 is muddled and disruptive, whilst the text is fragmented and over the top in places. This said it is right to inform prospective buyers that an earlier review (commissioned by The Independent) described the book as: ‘Expert, concise and far from bland’ (see flyleaf). Nevertheless, two small books Strong Materials (1968) and Structures (1978) both by J. E. Gordon and published by Penguin Books are bestsellers and remain this reviewer’s first choice.

Peter C. Gasson, CEng, MIMechE, FRAeS

Aircraft Propulsion – Second edition

S. Farokhi

This book provides excellent and comprehensive description and physical treatment of the operation of the core elements of the gas turbine aero engine. The book includes some good introductory chapters with broad coverage of the background material including compressible flow physics, engine performance parameters and basic gas turbine cycle analysis.

The book also provides a good overview of various forms of aircraft propulsion and includes sections on propeller theory, IC (internal combustion) engine operation and electric propulsion. However the sections on propeller theory and electric propulsion are limited to a basic introduction and not dealt with in the same level of detail as the gas turbine components. It would be fair to say the principal emphasis of the book is gas turbines with introduction to other propulsion systems.

Included in the book is a chapter on chemical rocket and hypersonic propulsion. In this chapter the sections on rocket propulsion including sections on in-space applications seem somewhat out of place given the title Aircraft Propulsion. While these are only minor sections the chapter on chemical rocket propulsion reads more as an introduction to this topic in a broader sense rather than any specific relation to propulsion for aircraft. While this may be the intention it could seem somewhat out of place for some readers.

The book also includes a comprehensive set of relevant example questions with clear solutions for each topic that is covered and links to online instructor material including copies of the pictures included in the book and comprehensive solutions to the end-of-chapter problems.

This is an excellent resource for anyone intending to use this as a teaching text. In summary an excellent and extremely comprehensive teaching text for gas turbine propulsion systems with introductions to other forms of aircraft propulsion.

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Numerical Computation of Compressible and Viscous Flow

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American Institute of Aeronautics and Astronautics, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344, USA. 2014. Distributed by Transatlantic Publishers Group, 97 Greenham Road, London, N10 1LN, UK (Tel: 020-8815 5994; e-mail: mark.chaloner@tpgltd.co.uk). 521pp. Illustrated. £84 (20% discount available to RAeS members on request). ISBN 978-1-62410-264-6.

This book is based on the author’s extensive lectures over the past half century at Stanford University and, earlier, at NASA Ames Research Center and the University of Washington. As a CFD (computational fluid dynamics) practitioner, I read the book with some strong resonance, reflecting on many key developments for computing high speed aerodynamic flows. Professor MacCormack is an eminent researcher well-known for his significant contribution in the early development of numerical methods for solving aerodynamic problems. The MacCormack Method predictor-corrector numerical scheme, named after him, is one of the earliest to address the solution of Euler and Navier-Stokes equations for aerodynamic problems.

Written for senior undergraduate and post-graduate level aerospace/mechanical engineering students, the presentation assumes basic knowledge of aerodynamics or fluid mechanics. It focuses on the various numerical issues for somebody who is interested themselves in programming to solve aerodynamic problems.

The first five chapters cover the equations to be solved (without derivation), basic numerical issues such as numerical approximation and stability and some algorithms for simple model equations. The rest of the book (Chapters 6-18) may be viewed in some sense as a brief history of computational aerodynamics development, from the solution of the transonic small disturbance equation in the early 1970s to that for three-dimensional Navier-Stokes equations. Of course, it is not a history book. The coverage on the numerical algorithm side is rather detailed, including numerical treatments for various boundary conditions, implicit solutions to speed up computation with associated matrix solvers and the curvilinear form of the equations for body fitted structured meshes. The examples reflect also the historical development of computational aerodynamics e.g. solution for shock boundary layer interaction, compression ramp and blunt nose problems.

All the chapters include original references, many being landmark works in CFD development over the period. In my view, the exercises incorporated in the book are extremely useful for the students/readers to get their hands dirty and to appreciate the practical problems when they undertake programming themselves to solve aerodynamic flows. On the other hand, those who are interested in unstructured meshing, unsteady flow dynamics and turbulent separated flow simulations will be disappointed due to the limited scope of the book.

In the modern age of CFD, using commercial or well-validated research/industrial software has now in many cases become common for engineering students and design engineers. Undesirably, this often leads to the ‘black-box’ approach to CFD. If your interest is to work at the forefront development of computational aerodynamics by ‘programming-it-yourself’ or to be a more intelligent user, this is definitely an excellent book to recommend.

Professor Ning Qin, CEng, FRAeS, University of Sheffield
This is a good introduction to the current status of design and optimisation of aircraft geometries and reading this book would allow the non-specialist engineer to understand the topic.

The book is logically laid out, and after some introductory comments starts with a chapter on geometry parameterisation. This chapter ends with an overview of a propulsion integration study, which provides a good illustration of why the optimisation process is potentially useful. The following two chapters on generating curves and surfaces would be enough to make the eyes of many engineers glaze over, but it is here that the strength of the book is introduced – computer codes in either MATLAB or Python. The codes, which can be downloaded from the publisher’s website, allow the reader to understand the theory by ‘playing around’ with input values to see how the generated curves and surfaces change.

Codes are an integral part of the following chapters as the reader is led through aerofoil and wing planform parameterisation to the design of a realistic three-dimensional wing.

The book finishes with two case studies. The first is a worked example on aerofoil analysis and the second considers the aerodynamic shape optimisation of a human-powered aircraft. Example computer codes are included with these case studies.

Prior to the discussion of aerofoil parameterisation, there is a reminder of some fundamental ideas relating to aerofoils, along with a review of the use of legacy aerofoils such as the NACA 4 digit series. A similar section on fundamental ideas relating to wing planform precedes the discussion on planform parameterisation. These sections allow the authors to identify possible parameters for use in optimisation studies, whilst at the same time indicating practical limits to the values of these parameters.

The book is generally well written and easy to read, with a pleasing use of aircraft photographs to illustrate the text.