Book Reviews

Introduction to Aircraft Aeroelasticity and Loads – Second edition

J. R. Wright and J. E. Cooper

John Wiley and Sons, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK. 2015. 543pp. Illustrated. £81.50. ISBN 978-1-118-48801-0.

For many years the subject of aeroelasticity seemed somewhat neglected in undergraduate teaching with limited references available in the field. Fortunately, this situation has improved and several textbooks reflecting more modern practices are available eg: Hodges and Pierce *Introduction to Structural Dynamics and Aeroelasticity* (Cambridge University Press. 2011 – Second edition), Dowell et al. A *Modern Course in Aeroelasticity* (Kluwer Academic Publishers. 2004 – Fourth edition), Rodden *Theoretical and Computational Aeroelasticity* (Crest Publishing. 2011) and of course Wright and Cooper. Whereas the contribution by Hodges and Pierce provides an excellent introductory reference, the volume by Dowell *et al*. clearly covers a much more broader and advanced spectrum. This book fills the gap between these two references quite successfully.

As the title suggests, the book is dedicated to aircraft and focuses on the challenges loads and aeroelastic engineers face in aeronautical engineering. The book is split into three Parts: Part I provides the theoretical basics required to the study of aeroelasticity; Part II is the main body of the book, exploring in detail aeroelastic phenomena and the prediction of aircraft loads; the book finishes with Part III describing modern industrial practices.

The introductory material in Part I provides an ample review of vibration and structural dynamics analysis, but also includes a brief revision of aerodynamics and control theory with the necessary techniques for the following chapters. There is a strong aeronautical emphasis from the onset, which assists the reader in relating these general concepts to aircraft.

Following the theoretical foundations, Part II of the book progresses onto its main theme of aeroelasticity and aircraft loads. It starts with the 'compulsory' chapters on static aeroelasticity and flutter. The equations are derived from the principles introduced in Part I, with an adequate level of detail for the typical undergraduate student to follow. I particularly welcomed the introduction of the impact of manoeuvres on divergence speed and control surface effectiveness. The aeroelastic equations for flutter are described from first principles for a typical bending-torsion system, this is complemented by a thorough qualitative description of this type of instability. The remaining chapters further set this book aside, first by introducing a control system into the equations of motion and demonstrating how a control system, even a simple one, can influence the aircraft dynamics.

This is followed by two chapters on manoeuvre loads, where the flight dynamics equations of motion are derived for rigid and flexible aircraft and a range of typical manoeuvres are considered. Chapter 14 looks at the impact of gusts on aircraft loads, considering both discrete and continuous gusts with examples for wings and fully flexible aircraft model strategies. There is considerable detail on flexibility effects and tail/fuselage models, more complex examples are included in the companion MatLab software. From gust loads, the book then introduces ground loads exploiting the same methodologies used up to this point.

Finally, Part III of the book describes modern practices used in industry. The proximity of the authors with industry allows the book to include several representative examples of modern aircraft models used in loads and aeroelastic analysis. This section also details procedures used in design, certification, testing and validation required for the development of modern aircraft.

Seven years have elapsed since the First edition, this new edition provides some additional consistency between chapters and further examples. Despite the book's reach by integrating control systems, manoeuvres and loads, this is still a self-contained manual presented in a very logical and accessible format, using simple enough and tractable examples.

I strongly recommend this textbook to undergraduates and researchers, not only due to how principles and concepts are explained, but also because it clearly shows the multidisciplinary nature of modern engineering techniques.

Simão Pinheiro Marques, Lecturer in Aerospace Engineering, School of Mechanical and Aerospace Engineering, Queen's University Belfast

General Aviation Aircraft Design: Applied Methods and Procedures

S. Gudmundsson

Elsevier Butterworth-Heinemann, The Boulevard, Langford Lane, Kidlington, Oxford, OX5 1GB, UK. 2014. 1034pp. Illustrated. £95. ISBN 978-0-12-397308-5.

This is a splendid book. It's a 'why wasn't this available when I started my studies ...?' kind of book. For anyone involved in the design of general aviation (GA) aircraft and those deeply interested in the subject, this book is highly recommended.

It is a large book, available both in print and electronic forms. In addition to over a thousand pages, a further 264 pages of companion materials are available on the publisher's website. The book is profusely illustrated, principally with very high quality diagrams and charts. In the e-book these are in colour, but in the printed book are black, white and half-tone which leaves some of the charts difficult to read. The most outstanding characteristic of this book is that it has obviously been written by someone who has been fully involved with the design of production GA aircraft; it is not just an academic view from outside. Professor Snorri Gudmundsson, who now teaches at Embry-Riddle University, spent fifteen years at Cirrus Aircraft in a range of roles including chief aerodynamicist of the SF50 single engine business jet seen on the cover photograph.

The author clearly has an enquiring mind and one feels that he must have kept many notes during his time at Cirrus – as he says in the text, the designer should always write comprehensive design reports. He has been very generous in the extent to which he has shared them. The writing is clear and direct. Diagrams are used most effectively to support the text and, while those responsible for the artwork have done an excellent job, one feels they must be to the author's design.

Who is the book written for? The author expects it to be read and used by both experienced and 'novice' engineers; the 'experienced, as well as the aspiring, designer'. The novice will find a helpful and comprehensive introduction to terminology and discourses on a wide range of aircraft configurations as well as the many issues to be addressed by the designer. The experienced engineer will find an unusually

comprehensive range of analytical tools for all aspects of the early stages of the design process. As the author says, it aims to be a compilation of information and methods ('practical and industry proven') helpful to the designer. The scope of the book is, as announced on the cover, limited to general aviation. This ranges from Piper Cub to Learjet; the Cirrus SR22 is used extensively through the book in examples. The book is aimed at conceptual and preliminary design stages, rather than detail design, but does so with remarkable completeness and depth.

Set out in 23 chapters, the book opens with material on the design process, costing analysis (including the Eastlake model) and initial sizing. Qualitative chapters follow on the conceptual layout and structural considerations such as choice of material and the manufacturing implications. In a chapter on weight, statistical formulae (from Raymer and Nicolai) have been quoted, followed by a section on direct weight estimation. A chapter on powerplant selection is followed later in the book by a chapter on propellers with material supplied by Hartzell. A set of chapters covers aerofoils, the wing, lift enhancement and tail surfaces. Two chapters cover the fuselage and the undercarriage. Then one of the longest chapters covers drag analysis, the importance of which the author regards as paramount. This looks not only at achieving minimum drag at cruise but also the management of drag for descent and landing. Not many books show a graph of aircraft drag for alpha between zero and ninety degrees. Next are seven chapters on performance addressed through the various stages of a typical flight. Finally a chapter of notes sweeps up remaining issues.

At first glance, judging from the contents list, there seems to be bias towards aerodynamics rather than structures with only notes on materials and manufacturing in Chapter 5. However there is an excellent introduction to the flight envelope in Chapter 16 (Performance -Introduction) and there are numerous qualitative references to structural considerations elsewhere in the text. There is not much on structural analysis, which the author considers mostly belongs in the detail design phase.

The author is very practical and pragmatic and always draws attention to the limitations of any particular piece of analysis. There are copious worked examples. Frequent use is made of spreadsheet techniques and a few pieces of code written in Visual Basic for Applications (VBA) are for use with Excel. The author has helpfully inserted numerous panels giving the derivations of key equations. All sections are well supported by pertinent references.

As well as serving as an introductory textbook, this will continue to be a valuable source of reference for the designer. Others have already expressed the view that this will become a classic. I agree.

John M. Robertson CEng MIMechE MRAeS

Introduction to Aeronautics: a Design Perspective – Third edition

S. A. Brandt

American Institute of Aeronautics and Astronautics, Reston, VA. 2015. Distributed by Transatlantic Publishers Group, 97 Greenham Road London N10 1LN, UK. xxiii; 634pp. Illustrated. £88. (20% discount available to RAeS members on request; e-mail:- mark.chaloner@tpgltd.co.uk Tel: 020-8815 5994). ISBN 978-1-62410-327-8.

This is the Third edition of the book by S. A. Brandt. The two previous editions were very successful in introducing aeronautics from a design perspective. Apart from providing an excellent update to the previous edition, new features have been incorporated, for instance, methods for stealth design or sizing techniques for solar aircraft. Being initially directed to cadets in U.S. Air Force Academy, it is very relevant indeed for year-one undergraduate students at Universities and Colleges, or anyone with little or no background on the subject as it is a notable introduction to the subject.

The book is structured in self-contained chapters including problems and design-oriented exercises. References are provided at the end of each chapter. A particularly useful feature for students is the summary at the end of chapters or sections. These summaries are very schematic, graphical and emphasise equations or data of special interest.

Chapter 1 is a good introduction to aeroplane design, its phases and provides a brief history of aircraft design. Chapter 2 deals with the operating environment, addressing basic concepts as units, pressure measurement, pressure and the standard atmosphere. This second chapter is interesting for someone that lacks essential background. Chapter 3 presents aerodynamics concepts. Again, this is started in a basic level to build up gradually to more advanced concepts for the design of the aircraft. Chapter 4 presents wing design and aerofoil selection procedures. Whole aircraft lift curves and drag polar are presented. The chapter progresses into interesting design topics such as strakes and leading-edge extensions for military aircraft. Comprehensive introduction to supersonic flight regime is also introduced.

Chapter 5 is about performance. It starts with the aircraft motion equations followed by a description of propulsion systems (piston, turbofan, turboprops, ramjet, etc.) with details of the selection process based on power curves and curve shifts. Range and endurance equations are explained and the altitude varying effects are described. Chapter 6 on stability and control introduces aircraft trim, longitudinal stability, neutral point and lateral stability amongst others. The chapter is an excellent introduction to stability and control concepts. These are explained carefully. This is especially relevant for undergraduates looking at the topic for the first time. The different cases are supported by pertinent illustrations.

Chapter 7 does not assume anything on aerospace structures and starts introducing the basic concepts in solid mechanics such as stress, failure, plasticity or fatigue. The determination of loads and planning of the aircraft layout are well explained as is the materials selection section. The chapter continues with V-n diagrams and type of loading to account for the actions of gust, turbulence, etc. Chapter 9 is dedicated to sizing providing the equations for weight calculation of the different aircraft components. Chapter 10 presents a number of study cases very valuable to review and understand the design process.

The book is an excellent asset for any newly arrived student to the subject of aerospace design and may be really useful as an initial textbook for Introduction to Aeronautics on Year One of Aerospace Engineering University degrees.

Dr Jose Curiel-Sosa
Lecturer in Aircraft Design and
Aeroelasticity, University of Sheffield

Design and Analysis of Structural Joints with Composite Materials

R. B. Heslehurst

DEStech Publications, Inc., 439 North Duke Street, Lancaster PA 17602-4967, USA. 2013. 459pp. Illustrated. $195. ISBN 978-1-60595-034-1.

The author promotes his book as: the first to provide complete coverage of issues related to the design and analysis of structural joints using composite materials. A composite material is here defined as: 'Any combination of filaments and/or particulates in a common matrix', at which point a truism (not mentioned in the text) comes to mind. A chain is only as strong as its weakest link. The author does, however, state in Chapter 6 that the joint efficiency of a bolted/riveted, metal to metal joint rarely exceeds 70%, whilst that of a comparable joint in a composite material may be as low as 40%; and therein lies the importance of designing proper structural joints.

The Introduction – Chapter 1 – is basically a summary of various well established joint configurations, joining methods and procedures. The chapter also outlines the most basic of stress/strain principles and an array of eighteen 'mini-pics' of Aerospace, Civil and Marine applications, well supported by lengthy informative anecdotal captions.

The mechanical properties of in-service aluminium alloys, stainless steels, titanium alloys, glass/epoxy and carbon/epoxy fibre composites are tabulated and adequately discussed in 'Material and Properties', Chapter 2. Noteworthy features include: Fibre volume ratio; adhesive selection, storage, joint preparation, assembly and cure. There is also a short section on thermoplastic weldments. The remainder of the chapter is then given over to commercially available mechanical fastenings such as 'HI-LOK' and 'Huck COMP Tension Head' bolts – full data for which is included. Less sophisticated items such as: dowels, rivets, pins (cylindrical, tapered and split) plus ten different nut/bolt/washer assemblies are also tabulated and specific uses discussed.

As elsewhere in the book, the chapter ends with an informative Question and Answer session.

'Fundamentals of Composite Mechanics' – Chapter 3 – provides a first rate introduction to the geometrical/mathematical aspects of fibre composite structural design. Starting from square one the author explains how the inherent strength and stiffness of individual glass/carbon/aramid/boron fibres may be exploited by embedding them in a far less strong and more flexible supportive polymer resin matrix to produce a highly efficient multi-layered plate-like structure. The freedom to align fibres in the required load bearing direction is paramount and based on the following way of thinking. A component in which all fibres are orientated in the 0° direction would lack transverse strength and so a fair proportion of fibres need to be arranged at 90°, with others at plus and minus 45° to resist inplane shear, albeit the through thickness strength is not so good. The mathematical/practical consequences of off axis fibres and non-symmetrical layups are important issues clearly explained in the text. See Fig 3.10, for example. The reader should also observe that: global laminate strain is different from average laminate strains as shown in Fig 3.5. Numerous failure modes based on maximum stress and strain, developed by Tsai-Hill, Hoffman and Yamada-Sun are also discussed.

The concept of Quality Functional Development (QFD) is introduced in 'Structural

Joint Design Requirements', Chapter 4. This, we learn, is an eight step procedure aimed at producing functional excellence combined with customer satisfaction. Just how this goal is achieved is demonstrated by a case study based around the progressive development of decision making tables.

'Adhesively Bonded Joints', Chapter 5, is spread over 135 pages and owes much to the author's very liberal use of graphical data, developed by L .J. Hart-Smith of NASA. It is, of course, common knowledge that adhesive bonded joints are either single or double lap, both of which transmit direct tensile or compressive load, via face to face shear within a thin layer of adhesive. The process of load transfer and the distribution of stress and strain within a joint is quite complex and as shown by the author requires a fair amount of relatively complex mathematics to explain and resolve. One very important point that needs to be understood is that increasing the area of bonded surface by increasing the length of overlap increases the load capability only up to a point – beyond which the load capability of the joint is not, repeat not, increased. Conclusion: a very informative and useful chapter to read.

The author's approach to 'Mechanically Fastened Joints' – Chapter 6 – follows the standard strength of materials procedure for designing riveted/bolted metal to metal joints. Having obtained a baseline design by calculating net tension/compression, pin shear, shear out and bearing failure modes based on geometry and material properties alone, only then does the author move on to consider refinements, such as stress concentrations and fibre crushing effects. Figure 6.7 is particularly instructive as it shows how the joint efficiency of a composite joint lies lower and well within the bound of a triangle representative of the transition from bearing to net tension failures of a metal to metal joint; both composite and metal joints being at their best when d/w u 0.35. As with Chapter 5 the author has reproduced many diagrams from NASA reports by L. J. Hart-Smith. NB: A grand total of 82 separate references to Hart-Smith's work appear in the Index.

'Welded Joints' – Chapter 7 – identifies load cases, defines terminology and covers conventional methods quite thoroughly, its defining feature being the inclusion of numerous multi-term equations, which will undoubtedly be unknown to many.

'Other Joining Methods' – Chapter 8 – promotes the use of torqued-up friction clamping as a means of improving bearing load capacity and fatigue life of a bolted joint. Another section on lightly loaded snap fastenings addresses material selection, whilst load sharing and stressing of a bolted-bonded plate/stiffener assembly is explained as a final example.

An extensive Bibliography and a Glossary of terms concludes the presentation.

It should be clear that the reviewer rates the content of this book (copyright date 2013) quite highly, but not so the wayward index. The text proper terminates at page 388, the glossary at 449, the index at 459. Yet the index lists over 400 topics with page numbers ranging from 460 to 513. 'Cure' for example is called 39 times with 16 calls invalid. 'A scan', 'C scan', 'S scan', 'peel and prying load' and countless other bogus calls are made where index and text do not tally. Publisher, author, proof reader and typesetter need to 'lock horns' and fix the index pronto.

The reviewer's last words are this otherwise excellent inch thick book is extortionately expensive.

Peter C. Gasson CEng, MIMechE, FRAeS

Statistical Turbulence Modelling for Fluid Dynamics – Demystified: an Introductory Text for Graduate Engineering Students

M. Leschziner

Imperial College Press 57 Shelton Street, Covent Garden, WC2H 9HE. 2015. Distributed by World Scientific Publishing Co. Pte. Ltd., 5 Toh Tuck Link, Singapore 596224. 407pp. Illustrated. £38. ISBN 978-178326-661-6.

This handy-sized paperback aims to provide for the postgraduate student or researcher in the broad area of Computational Fluid Dynamics (CFD) an introduction to the topic of turbulence modelling. Although not explicitly directed at aerodynamicists, it is perhaps most suitable for those following a career path in aeronautics for the focus is very much on the dynamics of high-Reynolds-number, single-phase flows. As the author, Professor of Computational Aerodynamics at Imperial College, London, states at the outset: 'the book focuses squarely on a route that starts with the general Navier-Stokes equations, and ends in closure approximations for the Reynolds stresses and scalarfluxes that appear as unknowns in the Reynolds-averaged Navier-Stokes (RANS) equations'.

The physics of the subject are by no means neglected, however, the first six chapters providing a gentle lead-in to the modelling chapters that follow. The book thus sits somewhere between the guides to software provided by the various commercial CFD enterprises and the more comprehensive and, arguably, more challenging textbooks on the subject. For those aware of that literature, the volume is closest in its coverage and treatment to *Turbulence Modelling for CFD* (La Canada, CA. DCW Industries Inc. 1993) by the Californian D. C. Wilcox though the writing styles are, understandably, very different.

The book follows a conventional path in which each successive chapter considers a higher level of modelling. Thus, the mixing-length hypothesis of Chapter 7 leads to chapters on 1- and 2-equation eddy-viscosity models (Chapters 8 and 9). Careful explanations are provided for modelling choices, drawing where possible on physical arguments. In Chapter 9, a particularly wide consideration is given to the alternative models discussed. There follows a chapter on simpler strategies – wall functions – for handling the near-wall sublayer which concludes: 'It is only in very complex industrial flows … that wall functions will continue to be of significant interest' (True, but it is precisely such flows for which CFD is needed!).

After a chapter on the weaknesses of eddy-viscosity models (Chapter 11), Chapter 12 examines relatively simple closures based on transport equations for the Reynolds stresses themselves, followed by a brief chapter on modelling the turbulent heat fluxes. The book concludes with two chapters on schemes based on rational simplifications of the Reynolds-stress equations, the so-called v^2-f model (Chapter 14) and algebraic Reynolds-stress and nonlinear eddy-viscosity models (Chapter 15). Overall, the book is a well-conceived and welcome addition to the turbulence-modelling library.

On the negative side, there is – as with most first editions – a sprinkling of typographical errors though none was noticed that would significantly affect the reader's progress. An omission is any consideration of the weaknesses of the models considered in free

shear flows: the so-called plane/round-jet anomaly and the very poor prediction of weak wakes where the models considered give a too slow rate of spread. Of course, these frailties are not at the forefront of practical aeronautical CFD where the ultimate objective is the optimum design of solid surfaces over which a fluid must pass.

Finally, an impediment to a reader's quest for further enlightenment is that cited reference sources are invariably to technical papers (sometimes hard-to-obtain theses or unpublished conference proceedings) rather than to more advanced or comprehensive textbooks which directly discuss the matter in question.

Still, these are minor quibbles when one recognises that, given the prevailing fee structure in English universities, the price of this book is barely that of a single lecture in an MSc course.

Professor Brian Launder FRS, FREng, FRAeS

Polymer Composites in the Aerospace Industry

Edited by P. E. Irving and C. Soutis

Woodhead Publishing, 80 High Street, Sawston, Cambridge, CB22 3HJ, UK. 2015. 520pp. Illustrated. £160. ISBN 978-0-85709-523-7.

The use of polymer composites in the aerospace industry is a vast topic fully warranting the 520 pages and 16 self-contained chapters the authors devote to it. The book is split into two parts; Part One deals with 'Design and manufacture of composite components for aerospace structures' and Part Two with 'Composite performance in aerospace structure design'. Individual chapters are written by prominent researchers specialising in the area of aerospace composite structures they address. As such each chapter forms an excellent introduction into the specific topic being covered. The book is generally accessible to all levels of research and industry professional and, although not necessarily a textbook, would benefit both undergraduate and postgraduate students looking to broaden their knowledge of composite structures. The significant number of references for technical papers accompanying each chapter may particularly benefit the latter.

The book opens with an introductory chapter which gives an interesting overview of the historic development of polymer composites, associated analytical techniques and their gradual but increasing integration into aircraft structures. Part One proper of the book begins with Chapter 2 which deals with woven polymer composites and the modelling challenges they present. Various weave topologies are presented together with use of represent volume elements as a method to capture their stiffness. The second half of the chapter presents schemes for dealing with strength degradation. Chapter 3 provides an overview of manufacturing methods for composite components. It touches on both automated pre-preg manufactured and out-of-autoclave techniques discussing the (dis-) advantages of both. Chapter 4 addresses buckling and compressive strength. Focus is placed on controlling fibre orientation in terms of both stacking sequence and fibre steering within a ply. The importance of strength reductions resulting from steering and also from impact damage are addressed. Chapter 5 considers the effect of manufacturing defects on performance. Fibre waviness and

voids are described and related to delamination formation.

Part Two of the book begins with Chapter 6. This chapter is concerned with the stiffness of structural elements. A useful overview is given of classical lamination theory together with a comparison of first ply failure modelling techniques. Simple analytical models for reduction of strength through macro mechanisms such as open holes are also detailed. Chapter 7 provides both extensive experimental data for the multi-axis fatigue life of composite laminates and analytical criteria for prediction of the same. Chapter 8 focuses on experimental fracture mechanics. It addresses fracture mode mixity and touches on the effect of non-unidirectional materials, loading rate and environmental conditions. Chapter 9 presents an overview of one of the most heavily researched areas in composite structures – impact damage and post-impact strength. Chapter 10 is particularly well-illustrated and uses a number of examples from design of helicopter structural elements to provide insight into the design of crashworthy components. Chapter 11 explores failure from bolted joints. Typical failure mechanisms are identified and finite element modelling approaches illustrated.

In Chapter 12 the effects of temperature and humidity are discussed. Models are offered for moisture absorption and compressive and tensile strength following environmentally induced property degradation. Chapter 13 covers a topic which has received little research until recently – blast response. Various methods and materials for containing the enclosed blasts likely to occur in aircraft are discussed. Chapter 14 contains an overview of the increasingly important topic of the repair of aerospace composites structures. Methods for repair and inspection are presented together with analytical analyses of stiffness and strength of repaired areas. In Chapter 15 an overview is provided of damage types seen in aerospace structures and the appropriate non-destructive evaluation techniques for their assessment. A particularly useful table indicating various techniques effectiveness and detecting different types of defects is provided. The final chapter is dedicated to discussion of structural health monitoring (SHM). Various techniques and sensor types for SHM are discussed together with relevant data processing techniques.

Overall the book is well-written and provides a useful entry point into a large majority of the topics that currently effect design of aerospace structures. As such the book is thoroughly recommended.

Dr Andrew T. Rhead
University of Bath

Advances in Ceramic Matrix Composites

Edited by I. M. Low

Woodhead Publishing, 80 High Street, Sawston, Cambridge, CB22 3HJ, UK. 2014. 709pp. Illustrated. £195. ISBN 978-0-85709-120-8.

Composites are heterogeneous material systems in which the individual constituents, called matrix and reinforcement, retain their specific characteristics but are so incorporated into a single structure as to give a new material with superior properties to those of individual constituents. We may think of composites as thoroughly modern materials but in fact the concept is not new. It was Ancient Egyptians who discovered that addition of straw makes mud bricks more crack resistant, thus producing the first example

of a composite material. By letting the bricks dry out in the sun, they were also the first to use the concept of 'cold ceramics', which is of much interest nowadays due to increasing demands to reduce processing temperature of ceramics, save energy and reduce harmful emissions and impact on the environment.

This 692-page volume edited by I. M. Low focuses on the most recent advances in the area of ceramic matrix composites. The book consists of 28 chapters written by material scientists from all over the world with significant expertise in the field. Part I of the book (Chapters 1-11) focuses on processing methods, while Part II (Chapters 12-17) covers mechanical properties such as strength and toughness, wear and tribological properties, thermal properties and self-healing behaviour. In Part III (Chapters 18-28) diverse applications of ceramic matrix composites are considered ranging from thermal barrier coatings for turbine parts and energy applications to cutting tools and dental applications.

In the introductory chapter (Chapter 1) the most promising novel material systems and processing methods that have emerged during the last decade are highlighted. Several chapters provide insightful introductions to their subject and identify future trends, which is particularly useful for readers who are not experts in the field.

This book would be useful for senior undergraduate and postgraduate students as well as researchers in materials science, solid mechanics, computational materials modelling and engineering. It would be suitable for those who want to extend their knowledge of ceramic matrix composites and improve their understanding of these materials.

Professor Maria Kashtalyan
University of Aberdeen

An Introduction to Fluid Mechanics

F. A. Morrison

Cambridge University Press, The Edinburgh Building, Cambridge, CB2 8RU, UK. 2013. 927pp. Illustrated. £75. ISBN 978-1-107-00353-8.

Fluid mechanics is fundamental to solving many important engineering and societal problems ranging from designing artificial blood vessels to predicting impact of global climate change. On the other hand, students when they first encounter the subject generally perceive it to be challenging mostly because of its heavily mathematical nature. Making the subject more approachable often implies rendering it less rigorous and finding the right balance is a difficult task.

Now Professor Morrison shows that we do not have to sacrifice mathematics to teach fluid mechanics in a way more attractive and easier to understand. As mentioned in the first chapter, the book aims to show how to analyse flows using the laws of physics and the language of mathematics. This language of mathematics is a serious one and molecular stress is expressed in terms of stress tensor. This is already very brave for an introductory textbook, but in fact being brave is what makes this book truly outstanding.

The author is not afraid of throwing difficult problems and concepts to readers from the beginning. Starting from the first chapter, the mechanical energy balance equation or Bernoulli equation is introduced without much explanation to demonstrate what an equation can do in many different engineering applications. Each time a new problem is introduced, the same equation and the associated assumptions are stated over and over again in the text. Indeed, the author is not afraid of repetition at the cost of loosing terseness or mathematical elegance,

but this is how the mathematical rigorousness could be maintained at the highest level in this introductory textbook.

Let's see the quest of one of the protagonists in this book, namely the problem of flow down a slope. This problem is first introduced in Example 3.3. While an analogous problem of sliding solid block could be easily solved using Newton's Second Law, its fluid counterpart is challenging, and Example 3.3 is not fully worked out and the discussion stops with a list of requirements for the full solution. The problem comes back later in the text whenever a new piece of information is acquired. For example, once the concept of control volume and the Reynolds transport theorem have been introduced, the problem is discussed again in Example 3.9 with a mostly repeated but more detailed figure. Again the discussion is not complete and ends with identifying the need to mathematically express molecular stresses. It appears again in Example 4.22 and the use of stress tensor results in three partial differential equations. Only after the constitutive equation has been constructed, the complete solution for the problem is shown in Example 5.8. The same problem of flow down a slope is solved once again in Example 6.2 taking microscopic approach, now with the Navier-Stokes equation.

As stated in the preface, the presentation in this book resembles engineering practice. To find the solution for a given problem, information that is thorough but just enough is sought. Each time more understanding is acquired, the same problem is revisited and the solution is applied to new problems. In this discovery process, one is not limited by the scope of methodologies beforehand. If it turns out difficult mathematics such as tensor calculus is desired for the solution, then it will be utilised. The book reads very well and it almost feels like listening to the author's lecture. It is a pleasure to find many practical advices embedded in the text, such as knowing when to use logarithmic scales in plotting data spreading over many orders of magnitude.

This book is truly a remarkable achievement that will significantly contribute in educating future fluid mechanists without sacrificing rigorousness and beauty of the subject. The book will appeal to lecturers who teach introductory fluid mechanics and both undergraduate and graduate students in engineering and science majors. Practicing engineers in the related fields will also find it useful.

Dr Yong Sung Park
Lecturer in Civil Engineering & Royal Society of Edinburgh/Scottish Government Personal Research Fellow co-funded by the Marie-Curie Actions
School of Science & Engineering, University of Dundee

Hypersonic Nonequilibrium Flows: Fundamentals and Recent Advances

Edited by E. Josyula

Progress in Astronautics and Aeronautics series Vol. 247. American Institute of Aeronautics and Astronautics, Reston, VA, US. 2015. 548pp. Illustrated. $129.95. ISBN 978-1-62410-328-5.

At present, there is intensive growth of interest to space access and exploitation. Most work on design and testing of new hypersonic flight demonstrators, prototypes of space shuttles, is carried out in the framework of national programs. The United States, Russia and the United Kingdom are intensively developing the space tourism as a new sphere of business. Involvement of private

companies in the United States and the United Kingdom in this area clearly indicates that new designs of spacecraft systems satisfying different demands should be developed in the foreseeable future.

The design of spacecraft systems is a highly complex multidisciplinary problem that is based essentially on gas flow prediction. In turn, the description of hypersonic flows past spacecraft is based on a very rich physics. In this book, the considered hypersonic flow regimes correspond to the temperatures between 3,000K and 25,000K. In these regimes thermal excitation, radiative emission and absorption, ionisation and surface catalytic effects can be important. Nowadays with the strong growth of computer power, there is an opportunity to significantly improve the accuracy of flow prediction due to not only the construction of more accurate numerical approximations of existing models but also development of novel more sophisticated models. Some advanced models for nonequilibrium hypersonic flows, described in the book, are significantly more computationally expensive than the existing models. However, they appear to be realistic for implementation on modern computers. For example, for the gas-surface interaction it is now possible to set quite complex and accurate boundary conditions based on molecular dynamics.

The book consists of eight chapters written by different authors who are world-recognised experts in the appropriate fields. It covers the fundamental principles of continuum mechanics, radiation, atomic-molecular physics, kinetic theory of gases, numerical methods for the solution of the Navier-Stokes equations, Boltzmann kinetic equation, application of the Monte-Carlo method and methods of molecular dynamics and experimental techniques for high enthalpy flows as well as flow diagnostics. In addition are new approaches to evaluation of transport coefficients and gas surface interaction, which are based on quantum mechanics. Significant attention is paid to the design of thermo-protection systems. Future challenges are addressed in the most of chapters.

Despite the book volume of 548 pages, it is not surprising that some important issues of the general topic are missing. Plasma flows and turbulent flows are not addressed in this book at all. The Maxwell-Stefan equations that are a generalisation of Fick's Law for multicomponent diffusion are not considered. Some advanced numerical methods are not described either. Mesh refinement proves to be very important for hypersonic flows especially around shocks. However, this problem is not addressed in the section devoted to numerical methods. Most computations are only limited by axisymmetric formulations and very low angles of attack. As in any collection of papers, description of different topics is not as smooth as can be achieved in a monograph.

However, all-in-all the primary objective of this book is to provide insight into alternative sophisticated models and a survey of modern facilities and measurement technologies. It is clear that this target has been achieved.

Dr Sergey Utyuzhnikov DSc, FIMA
Professor of Computational Mathematics
University of Manchester