Book Reviews

Tactical and Strategic Missile Guidance – Fifth edition. Progress in Aeronautics and Astronautics series Vol 219

P. Zarchan

American Institute of Aeronautics and Astronautics, 1801 Alexander Bell Drive, Suite 500, Reston, VA 20191-4344, USA. 2007. 888pp. Illustrated. $94.95 (AIAA members), $134.95 (non-members). ISBN 1-56347-874-9.

For a book to remain in print for five editions over seventeen years, it must be both useful and popular. Zarchan is a valuable text for a spectrum of readers from newcomers to the subject, to research students and to experienced engineers for whom it performs as a reference to a multitude of guidance topics.

For most aspects the book utilises a first principles approach and leads the reader through in a logical, progressive manner. There are useful insights included along the way. Essential methods and techniques, particularly adjoints, are described in the opening chapters and these are used extensively later. With the exception of the new final chapter, examples are limited to single plane. This simplification is considered and allows discussion of salient points without unnecessary complication. The emphasis of the text is primarily towards the ballistic threat, but it is not limited to this. Various guidance forms are discussed: PN, CLOS, optimal. There is also useful coverage of target tracking techniques, particularly utilising Kalman filters, and airframe control.

The fifth edition comprises the fourth edition reproduced in its entirety with the suffix of a further three chapters and additional enlightening examples in the Appendix which increase the size of the book by 145 pages. The first new chapter describes alternative methods of developing guidance laws numerically which are shown to be useful with complex flight control systems. The second provides a valuable introduction to multiple model techniques via a filter bank approach to weaving targets. The origin for the technique may be decades ago, but the references show there is plenty of recent work on the topic. The conclusion reached is that you get good results if one of the filters is a match for the target manoeuvre, but the chapter fails to mention methods to ensure that this occurs. However, this topic is a sizeable iceberg for which the new chapter may only describe the tip. It will provide the author with myriad opportunities for extra chapters in subsequent editions. The third new chapter provides methods to expand previous examples into three dimensional space, introducing axis systems and mapping as well as Kepler's problem as a method to intercept a ballistic missile.

The appendix refers to an included CD ROM. However, the publisher has decided instead to provide the information via the internet. Downloading this is trouble-free and removes the risk of misplacing the CD at a later time.

The inclusion of listings within the text appears unnecessary in light of them being available to download. The location of these often obstructs the flow and structure of the text, which would otherwise be readable. This is especially the case for the new chapters for which the examples are increasingly complex; over half the third new chapter is devoted to code listing. Devoid of comments, these listings become indecipherable without assistance from executing the code on a PC. However, the author does acknowledge that the reader may be attuned to a language other than FORTRAN and usefully supplies the code in three formats; although the extra representations are direct translations from the FORTRAN and may not take into account native utilities to speed up the execution and improve efficiency.

Disappointingly, the text maintains its use of dated imperial units. Those of a metric persuasion may require the conversion table provided in the appendices.

Tim Parrish, MA (Cantab), MSc

Fundamentals of Jet Propulsion with Applications

J.D. Flack

Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, UK. 2005. 637pp. Illustrated. £60. ISBN 0-521-81983-0.

This large book, of more than 600 pages, is described by its author as "*an introductory text on air-breathing jet propulsion….directed at upper-level undergraduate students"*…and is also *"well suited to independent study….by practising engineers*" and should therefore be "*a valuable reference text.*" Although the concentration is mainly on aero-engines, gas turbines for land and marine applications also receive some coverage.

An initial historical summary of gas turbine evolution leads into a section on thermodynamic cycle analysis. Subsequent sections deal with the major powerplant components – compressors, turbines, combustion chamber, intake and ducting systems, and propelling nozzles. The main emphasis is on thermodynamics and fluid mechanics, with materials and mechanical design aspects receiving relatively brief treatment. There are numerous illustrations, both in the form of diagrams and photographs of actual hardware. Calculation procedures are well illustrated by worked examples. At the end of each chapter there is a summary, and example problems for the reader to solve. The operation of the whole engine is dealt with in the final chapter, which discusses the matching and interaction of the engine components over the range of operating conditions. A series of Appendices provides reference tables of gas dynamic quantities, supporting theory and other data for use in performance calculations.

The author emphasises the value of comments he has had over many years from students, and says that his book "*has been tailored to be a very user friendly text.*" He also acknowledges the merits of various other gas turbine textbooks, of both US and UK origin, and states that these have "*provided inspiration for this book*". It is therefore surprising, and disappointing, to find a number of significant weaknesses.

First, nowhere does one find any mention of the importance of environmental factors in civil aero-engine design. The merits of the high bypass turbofan are presented purely in terms of fuel economy, and the extensive discussion of combustion system performance says nothing about emissions. There are clearly limits to the detail that can be included, but a work purporting to be a general introductory and reference book on gas turbine propulsion should surely acquaint its readers with the existence of the environmental problem, and the main physical factors involved. This could be achieved with a few succinct paragraphs on the strong dependence of jet noise on jet velocity; the need to balance jet noise with turbomachinery noise; the use of intake duct liners; the need to control the combustion processes to minimise NO_x production etc.

In regard to measures of engine performance, the author does not take the opportunity of introducing his readers to the well-known group of three efficiency parameters relevant to propulsion in a fluid, namely overall efficiency, thermal

efficiency, and propulsive efficiency. Each of these has a clear physical meaning, readily appreciated by students. They are linked by the relation: Overall efficiency = propulsive efficiency × internal efficiency. Instead, the book defines only the propulsive efficiency – correctly, as the ratio of thrust power to rate of increase of kinetic energy in the propulsive stream, but there follows an erroneous theoretical development, which ignores the ½ in the kinetic energy term, leading to an equation giving half the correct value for this efficiency. Having commented that this (incorrect) equation produces an efficiency of 100% when the engine jet velocity is set to zero – ie, when the net thrust is then negative – the author discards the parameter from further use in the book!

There is a further shortcoming regarding the presentation of aircraft drag characteristics in the discussion of matching an engine to an aircraft in the final chapter. Figures 11 and 12 shows 'general drag characteristics for an airframe', as increasing continuously from zero at zero speed – ie. ignoring the existence of lift-dependent drag, which results in an aircraft drag curve having a minimum value at a finite speed. This does not invalidate the principles of engine/aircraft thrust/drag matching which the chapter is explaining, but errors like this can tend to lessen confidence in the authority of the book.

A final specific comment relates to the 'running lines' along which compressors operate over the power range of an engine. The principles of these, and their derivation from matching calculations, are appropriately explained in the text, but clearer diagrams of typical examples, including running lines under transient conditions, would be helpful to the reader who is not yet familiar with the challenge of matching the engine components so as to avoid compressor surge problems.

Overall, this reviewer is forced to the conclusion that this is not one of the best available textbooks on gas turbines and jet propulsion.

F.W. Armstrong, FREng, FIMechE, FRAeS

Selection of Engineering Materials and Adhesives

L.W. Fisher

Taylor & Francis Group, PO Box 6329, Basingstoke RG24 8DR, UK. 2005. 581pp. Illustrated. £44.99. ISBN 0-8247-4047-5.

There is, we are told, a gap between what students currently learn (are taught) at college, and what the design engineer needs to know in practice. The author is unhappy that on graduating, design engineers are left to acquire their knowledge of material specifications and how to select them, from an industrial mentor.

Although this book contains neither worked examples nor set problems to solve, the author hopes that his book (number 186 in a long established series) will be adopted as a college text in the UK and double as an industrial reference source thereafter.

Most current courses already cover all but one section of Chapters 1, 2 and 3, but it is unlikely that college tutors will be afforded the time to cover the content of Chapters 4-7 *in toto*. One solution (not mentioned by the author) would be to offer Chapters 4-7 on Ferrous, Non-Ferrous Metals, Plastics and Adhesives as separate (money spinning) continued professional development courses. It is likely the appropriate professional institutions would welcome CPD courses in this subject.

'Introduction to Materials Selection' – Chapter 1 – is worthy of two undergraduate lectures. Seventeen specific material properties are listed for initial consideration. Availability, Cost and Process issues are, however, only mentioned en passant but reappear briefly on page 412. There, it is belatedly stated that: 'Material cost and availability are most often the primary drivers for final selection of a material'. Under the heading 'Design Methodology' the author presents design phase workflow and related (American) acronyms extracted from ANSI/ASQC documents D1160-1995 (ideal for a lunch time seminar but of only peripheral relevance to material selection). More useful are the specific Indices and Ashby Plots on pages 13, 14, 409, 410, 412, 413 and 414, some of which may be missed as the index only directs the reader to page 11.

For 'Structure of Materials' – Chapter 2 – read Physical Chemistry, meaning atoms and sub-atomic particles. The periodic table quantum numbers, atomic/ionic/covalent/metallic bonding, crystal lattice structures for metals and polymer molecular chains for plastics.

The aspiring design engineer will find 'Material Properties and Behaviours' – Chapter 3 – of direct practical value; highlights include: Castability, Formability, Weldability, Machinability, Hardness, Corrosion and Surface Finish. Thermal, Electrical, Optical and the usual strength considerations are also discussed at undergraduate level.

From this stage on materials are classified by type. 'Ferrous Metals'- Chapter 4; 'Non-Ferrous Metals'- Chapter 5; 'Engineering Plastics'- Chapter 6; 'Adhesives'- Chapter 7. The author does not discuss ceramics or composite materials on the grounds that the nature and application of these materials is unique (see the author's declaration page 67). The materials data for metals is comprehensive, drawn mainly from American sources – American Iron and Steel Institute (AISI) and the Society of Automotive Engineers (SAE). The data given for plastics is 'ball park', rather than authentic. Those who have not used glue before will learn how, when and where adhesives may be used in general terms. Temperature limitations and lap shear strengths are given as typical values, the variability of the latter is there as a warning, but little will be learned about the use of jigs, moulds, autoclaves and presses.

Appendices include: a seventeen page list of General Engineering Conversion Factors (courtesy, the US Government Printing Office); Unit scales from 'yotta' 10^{24} to 'yocto' 10^{-24} and numerous Tables on the Strength and Hardness of Metals; plus two pages of website addresses and an index.

Those who hope to design aircraft, racing cars, golf clubs and tennis rackets will be disappointed to learn that reinforced fibre composites are not considered, but for those who choose to design in metals the book is keenly priced and reflects the author's own experience of teaching the subject at UCL.

Peter C. Gasson, CEng, MIMechE, FRAeS

Undergraduate research projects

A research project is often an important part of many university undergraduate courses. The Royal Aeronautical Society is occasionally approached regarding publication of papers from such projects in *The Aeronautical Journal*.

Our policy is that we welcome papers from any and every source, including papers resulting from undergraduate projects. In this case we would normally expect the papers to be submitted jointly with the supervisor and they would be exposed to exactly the same refereeing process as all the other papers received.

https://doi.org/10.1017/S0001924000087017 Published online by Cambridge University Press