includes a number of examples of spacecraft and instruments and the radiators designed for them. Cryogenic and thermoelectric cooling, and refrigeration systems, are also discussed in some detail, again with real-world equipment examples and details of the thermal requirements for selected instruments.

The 'hardware' part of the book also includes a discussion of the applications, design and performances of louvers and phase change materials. Again, tables of material properties are provided. Spacecraft heaters and heater control is also covered, including some mention of the use of radioisotope systems. Finally, thermal protection for atmospheric entry is presented, with examples given of both radiative and ablative systems.

The final part of the book places thermal control subsystem design, analysis and test in the context of the overall space project. It gives the philosophy of the design process, showing how all the elements in the preceding chapters are considered, in order to produce a complete functioning thermal control subsystem that meets the mission requirements. Thermal testing approaches are described, with discussion of test levels and test model philosophy and the facilities required. Useful references are given to the relevant ECSS standards documents.

Overall, this is a very readable book, which does not assume much in the way of prior knowledge and provides numerous useful examples. All the key areas are covered, with a level of technical detail that is comprehensive without being overwhelming. It would be appropriate for a junior systems engineer conducting preliminary thermal analysis and thermal control subsystem design in a mission concept study, but also gives enough depth and useful references to be an appropriate resource for a more experienced thermal engineer.

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Theoretical and Computational Aerodynamics

T. K. Sengupta

John Wiley and Sons, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK. 2014. 505pp. Illustrated. £63.50. ISBN 978-1-118-78759-5.

It is a major undertaking to write a book covering such a wide area of aerodynamics, so the author should be commended for his efforts. The book is generally well-written, with enough background and historical text to keep the reader's interest and is split into two main sections: the first comprising general theoretical background and methods for fluid mechanics and aerodynamics; the second focussed on computational studies. However, it is important to stress that, as the author states in the background text, the computational part considers 'recent applications made possible by computational aerodynamics'. Hence, the book is not aimed at presenting detailed numerics of computational methods used in aerodynamics.

The book comprises almost 500 pages, split into 13 chapters, the first seven covering theoretical aspects. It begins with three introductory chapters, covering basic fluid mechanics, derivation of Navier-Stokes equations, stream function and vorticity, potential flow solutions and introducing thin aerofoil theory. This is followed by chapters presenting finite wing theory, a brief introduction to panel methods, slender wing theory, slender body theory and a section on vortex breakdown and finally

a chapter on boundary layer theory. This is all standard content, but is thorough, well-written and interesting.

The computational part starts with a chapter presenting very brief details of temporal and spatial scales and stability for a simple wave equation, then brief details of a specific high-order finite-difference solver. This is slightly confusing as there is little background to numerical methods, and insufficient details of the solver to be able to understand it. There is then a detailed section on an orthogonal mesh generation scheme for aerofoils, followed by simulation results for aerofoil flows.

Chapter 9 presents detailed theoretical analyses of instability and transition for two- and three-dimensional aerodynamic flows. This is interesting and thorough, although it is not clear why it is in the computational part of the book. Chapter 10 considers drag reduction strategies. Theoretical and computational methods are applied to various geometries.

Chapter 11 considers transonic aerofoil flows simulated with a DNS code, very brief details of which are presented first. Chapter 12 then considers simulation of low Reynolds number aerofoil flows and very brief details of a pressure-based solver are presented. Some interesting unsteady results are shown.

Finally high lift and flow control devices are considered. Computational and experimental results are presented for various applications, including the effect of flap location and the effectiveness of vortex generators, winglets, and plasma actuators used as flow control devices is considered. Again, interesting results are presented.

Overall, the book is a good read, presenting results for some interesting applications, covering a significant number of relevant aerodynamic areas. The theoretical content is well-presented and thorough, although it is all fairly standard. Some of the computational parts are slightly frustrating as there is little fundamental numerical methods background, then very specific methods are presented with insufficient detail to be able to follow. However, numerous results are presented for some interesting applications, particularly in the last two chapters.

The book 'is aimed to be a comprehensive textbook': the classical subject matter, including the transition and stability theory in Chapter 9, would be a useful addition to the literature of any undergraduate or graduate student; the computational sections contain little in terms of fundamentals of numerics but, accepting that useful computational results are the focus, results are presented for several applications that would be of interest to many aerodynamicists.

Professor C. B. Allen MRAeS

Flight Dynamics and System Identification for Modern Feedback Control: Avian-inspired Robots

J. A. Grauer and J. E. Hubbard

Woodhead Publishing Limited, 80 High Street, Sawston, Cambridge, CB22 3HJ, UK. 2013. 138pp. Illustrated. £120. ISBN 978-0-85709-466-7.

This research monograph deals with the challenging problem of modelling the flight dynamics of flapping robots. The book is set out in six chapters, which cover 102 pages. In addition, it contains 25 pages of appendices.

The first chapter discusses background and motivation on flapping robots, along with their biological inspiration and it provides a review of previous work on the subject of ornithopter robots, as they are also called. Chapter 2 characterises the specific platform chosen by the authors which serves as a case study throughout the book: a small commercial flapping robot with a total mass of 0·45 kg. Chapter 3 describes the representation of the dynamics of ornithopter aircraft using a