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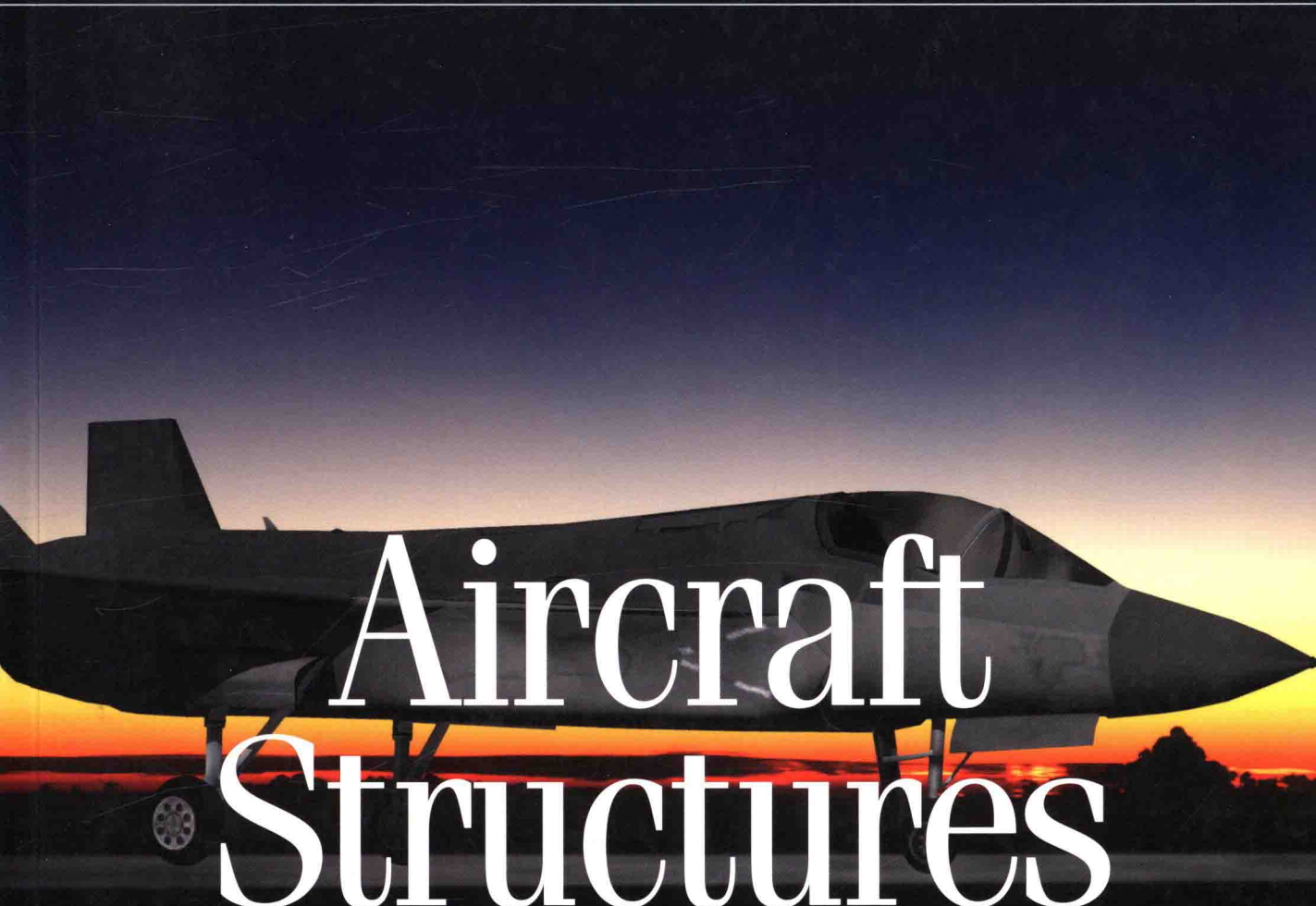

Aircraft Structures for Engineering Students

Sixth Edition

T.H.G. Megson

B/H

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Sixth Edition

To the memory of my darling wife, Margaret.

Preface to the Sixth Edition of Aircraft Structures

The publication of a sixth edition has enabled me to review some of the topics included in the fifth edition and to provide additional worked-out examples and end-of-chapter exercises of a more practical nature than previously. It has also given me the opportunity to carefully examine the text and correct the printing errors which had, unfortunately, crept into the fifth edition.

The layout of the book remains the same as that in the fifth edition with the first seven chapters remaining unchanged. In Chapter 8 on structural instability of columns, I have included an additional example and an additional end-of-chapter exercise illustrating the application of the reduced modulus theory, while in Chapter 9 the work on the stability of thin-walled columns has been extended to the determination of average failure stresses.

In Chapter 21 on the stress analysis of wing spars and box beams, I have illustrated the effects of sweep in a wing which, of course, is particularly relevant to modern high-speed jet aircraft.

I have revised the theory presented in Chapter 23 for the determination of stresses in fuselage panels containing cut-outs and provided an illustrative practical example together with an end-of-chapter exercise.

The major modification in the sixth edition is the extension of the work on composite materials and structures presented in Chapter 25. In the fifth edition, the theory was restricted to single-ply laminates; this has now been extended to a consideration of multi-ply laminates. In this, the method of specifying different ply lay-ups is presented together with the effects of symmetry and reinforcement orientation. The calculation of the equivalent elastic constants of a laminate is presented for the case of in-plane loading only since this is normally the situation in the thin skins of aircraft structures. The calculation of the distribution of stresses across the thickness of a laminate is illustrated by an example and the strength of laminates investigated using the maximum stress theory. Several additional examples are included as well as end-of-chapter exercises.

Finally, in Chapter 26, I have included a practical example on the effect of shear lag on the loads in a wing panel containing a cut-out for an undercarriage bay.

T.H.G. Megson

Preface

The idea of a textbook on aircraft structures for students of aeronautical engineering was born during the early part of my career teaching the subject. I felt at that time that the books available were either out of date or too specialised to fulfil the requirements of an undergraduate textbook. My aim, therefore, was to fill this gap and provide a self-contained course in aircraft structures which included not only the fundamentals of elasticity and aircraft structural analysis but also the associated topics of airworthiness and aeroelasticity.

Developments in aircraft construction led me, in subsequent years, to re-examine the contents of the book and introduce modifications. In the second edition I reorganised some of the text and expanded the work on composite materials. I also introduced the analysis of more realistic structures such as fuselages and wings containing cut-outs for door openings and undercarriage bays together with the analysis of fuselage frames and wing ribs. The third edition saw the publication of an accompanying solutions manual and a reorganisation of the contents into two parts as opposed, previously, to three. For the fourth edition I decided that a major overhaul would be beneficial in the light of developments in the aircraft industry and the fact that students were wanting more worked examples and end of chapter exercises. I also felt that some of the chapters were too long so I therefore broke them down into shorter, more "digestible", ones. At the same time I rearranged the material to emphasize the application of the fundamentals of structural analysis, contained in Part A, to the analysis of aircraft structures in Part B. I also expanded the application of the powerful principle of virtual work to a complete chapter and extended the work on tension field beams to include post-buckling behaviour. The design of riveted connections was added and the work on crack propagation extended. The study of composite structures was expanded and, finally, the actual design of part of the rear fuselage of a trainer/semi-aerobatic aircraft was presented in an Appendix.

The fifth edition has been produced in response to requests for more worked examples and end of chapter exercises and also for computer based solutions (MATLAB). The organisation of the contents is the same as in the fourth edition. Part A, Fundamentals of Structural Analysis, comprises basic elasticity, virtual work and energy methods, thin plate theory, structural instability and the vibration of structures. Part B, Analysis of Aircraft Structures, includes the principles of stressed skin construction from the points of view of materials and structural components, airworthiness and airframe loads and a detailed study of fatigue including the prediction of aircraft fatigue life. Part B also includes the analysis of thin-walled beams subjected to bending, shear and torsional loads and the method of idealising a structure into one more amenable to analysis. This then leads into the stress analysis of aircraft components such as wing spars, fuselages, wings, fuselage frames and wing ribs. Composite structures are considered and the effects on the analysis of structural and loading discontinuities investigated. An introduction to aeroelasticity is given. Finally the design of a portion of the rear fuselage of a trainer/semi-aerobatic aircraft is presented. I would like to thank Patrick Lewis in the Design Exploration Group at Brigham Young University for providing examples, exercises and solutions using the MATLAB(r) program. I would also like to thank Joe Hayton and Jeff Freeland of Elsevier for their sterling work on the production of the book.

SUPPORTING MATERIAL TO ACCOMPANY THIS BOOK

For instructors using this text in their course, a full set of worked solutions and electronic images of the figures in the text are available by registering at: www.textbooks.elsevier.com

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PART B ANALYSIS OF AIRCRAFT STRUCTURES

PART

Fundamentals of structural analysis

A