Aircraft Dynamics: From Modeling to Simulation

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This is a very comprehensive aircraft dynamics textbook for undergraduate level students and lecturers alike. The book has A4 size pages that permit the clear presentation of large complicated flow charts, block diagrams, figures and equations. Each chapter is concluded with well-presented worked examples and student problems. Appendices covering mathematical concepts such as Laplace Transforms and matrix manipulation together with databases and geometrical information for a number of aircraft are also provided for use in the solution of student problems and research.

The first chapter covers the derivation of the basic equations of motion used to provide a simple simulation of aircraft dynamics with respect to body and earth axes systems. This is followed in Chapter 2 by a review of the basic aerodynamic concepts used in determining the characteristics required to estimate the aerodynamic forces and moments acting on an aircraft in flight and the various options for capture of this data.

Chapters 3 and 4 cover the evaluation of the longitudinal, lateral and directional stability and control derivatives required to obtain the aerodynamic forces and moments acting on an aircraft at any flight condition. Chapter 5 is a review of basic aircraft performance and the modelling of thrust forces and moments at particular flight conditions as required for the solution of the equations of motion. Chapter 6 covers the concept of static stability and the analysis of longitudinal lateral and directional trim conditions.

Chapter 7 covers dynamic stability and the solution of the longitudinal and lateral and directional equations of motion to study the short period pitching oscillation, phugoid, roll, spiral and Dutch roll modes. This is accomplished with the application of Laplace Transforms to the small perturbation equations and presented in great detail. Coding for a MATLAB software based solution to the equations of motion is presented here together with illustrative worked examples.

Chapter 8 introduces the concept of state variables solutions for the dynamic stability equations of a multi-input – multi-output system as an alternative to the transfer function method of the previous chapter. Again examples of the use of MATLAB coding are provided with worked examples. Chapter 9 presents more modern flight simulation codes, namely Flight Dynamics and Control (FDC) Toolbox, Mathworks Aerospace Blockset and AIRLIB with examples of how they are used to solve the full nonlinear and coupled equations of motion. Finally, Chapter 10 is devoted to a review of handling quality requirements for both civil and military aircraft against which the results of the simulation using the preceding methods should be judged.

Undergraduate and postgraduate Students would be well advised to consider acquiring this helpful textbook to understand this difficult area of aeronautical engineering.

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Aircraft Structures

G. L. Narasaiah


In common with other CPC publications, this book has a long-life binding, an attractive come-and-buy-me cover and looks the part. The blurb markets the content as a concise, comprehensive presentation of basic aircraft design and analysis and goes on to claim that: ‘This textbook on aircraft structures is an essential source of information for both students and engineering professionals’. That this marketing ploy is a gross misrepresentation of fact will be clear from this review.

The first hint that all is not what it seems comes with the Preface, where the author writes (confesses) that: ‘The material for this book was compiled from my class notes as a student at IIT.’ The author (formerly a Professor of Aeronautical Engineering at the Institute of Aeronautical Engineering, Hyderabad, India) divides his text into three parts: basics of structural analysis, Chapters 1-7; design and analysis, Chapters 8-17 and other relevant topics, Chapters 18-20.

The bulk of Chapters 1, 2, 3, 4 and 6 amount to little more than remedial studies in ‘A’ Level applied mathematics – energy methods, Chapter 5 being the sole exception. The reviewer grants that second moments of area are relevant but not when laboured to such extent. One has to ask: How many undergraduates (worthy of the name) need to be told how to resolve forces, or be reminded of the Parallelogram Law?

The text proper begins at Chapter 7 with the analysis of continuum structures, meaning: elasticity, theories of material failure, dynamic analysis, natural frequencies and modes. Then comes design aspects of aeroplane structures, Chapter 8, a topic which many might say lies at the heart of the subject, but which in this study is dispatched in a few summary pages. The first eight pages are informative. The last five pages sub-titled: types of frames, designing a tie, designing a strut, designing a beam, designing a panel, are rock-bottom basic. The author should have taken time out to read M. C. Y. Niu Airframe Structural Design Practical Design Information and Data on Aircraft Structures (Granada Hills, CA: Adaso/Adastra Engineering Center. 1999 – Second edition) and Niu’s companion text on Composite Airframe Structures (Granada Hills, CA: Adaso/Adastra Engineering Center. 2000 – Third edition) before embarking on Chapters 8 and 18.

Chapter 9, basics of aerodynamics, is also brief: lift, drag and moment coefficients are explained, but not enough said to prepare the reader for the moderately mathematical study of aeroelasticity, Chapter 20.

Chapter 10, structural loads, outlines the elementary essentials of: gusts, load factors and flight envelopes, but completely neglects ground loads which generally speaking produce vastly different shear force and bending moment distributions of opposite sign, to those produced by normal and accelerated flight. Ground load cases which the author might have considered include: 1) Aircraft static, fully laden. 2) Aircraft rolling, nose wheel lifted. 3) Approach with fuel tanks near empty. 4) Crash loads. 5) Longitudinal balance conditions (a ‘beam’ problem) which determines main and nose wheel-loads and positions (to comply with airworthiness requirements). Had the author addressed a few of these load cases, Chapter 10 could have been more applicable and interesting.

Chapters 11, 12 and 13 on beams shafts and columns follow a common course taken by 1st and 2nd year Aero, Civil and Mechanical Engineering students. Joists and rafter beams are covered in Chapter 11 to the point of tedium, there being not a single aeronautical
example. The closest the author gets to a wing beam/span is Fig 11c, page 139 and in this case the shear force and bending moments shown are both incorrect. Had the author a dash of imagination he might have enlivened the Chapter, by including the ubiquitous elliptical lift distribution or that shown, Fig 9.2, Chapter 9 as SF and BM examples. Moreover, given the author excludes Power plants from his study of airframes, Chapter 12 on power transmitting shafts is irrelevant and warping has no place in a chapter dealing exclusively with circular shafts. Euler strut, beam column and torsional buckling are topics explained in Chapter 13, followed by bending and buckling of thin plates in Chapter 14 stiffened panels and tension field beams are included.

Shear flow, shear centre and shear lag, Chapter 15 and the analysis of aeroplane fuselage and wings, both contain a motley of lengthy, line-by-line worked examples, relating to single and multicell tubes. Window cut-outs (without stress concentrations) are also considered. NB: It is easy to spot that several quite extensive worked examples (and figures) have been (all but) directly plucked from well-known texts. It is also odd that the author (who claims 25 years’ experience in the pressure vessel field) does not discuss fuselage pressurisation. Hence, no mention of the 2:1 stress field in a circular fuselage, which should be added to the direct and bending stresses which the author has calculated.

Although the ETB analysis expanded in Chapters 15 and 16 is valid for conventional Passenger/Transport Types is sound and worth reading, it is not directly applicable to thin section/thick skin delta type wings, or to blended wings with integral pressurised passenger cabins.

Chapter 17 on fatigue analysis is but seven pages long, mainly Goodman, Soderberg, Minor and von Mises, without a single word on fracture mechanics and only a few stray words on stress concentration. Materials of aircraft construction, Chapter 18 fares no better. Sections on: wood, steel, aluminium/titanium/lithium alloys reveal no more than one might pick up from a household encyclopaedia. The brief section on composites starts well but peters out. Nothing useful is said about lay-ups (essential for turning a grossly anisotropic material into an acceptable structure), the only important snip being how to estimate elastic modulii, using the Law of Mixtures.

Chapter 19 on finite element analysis (one of the authors declared specialities) is somewhat better, but FEA does not a structure make. The final Chapter 20, aeroelasticity, covers: wing torsion divergence, aileron reversal, flutter, natural modes of lumped and distributed mass systems. Suffice to say the subject matter in Chapter 20 is a significant step-up from the scant introduction given in basic aerodynamics, Chapter 8.

At the end of this lengthy review it is fair to say: the author has produced a text of highly variable quality, pitched at two, if not three, different academic levels. A book in which composite structures are not discussed and fracture mechanics ignored. As for the author’s treatment of materials in general, how is it possible for the author to write in Chapter 2, page 5, ‘He (the engineer) must have intimate knowledge of properties and behavioural characteristics of the material he proposes to use’, and then go on to write an account headed materials of aeroplane construction (Chapter 18), which is trite, lacks specifics and is of no practical or academic value whatsoever.

At a time when 3rd/4th year students at British universities and elsewhere spend much time grappling with state-of-the-art group design projects, this text is (for the most part) well below par.

Not a book to inspire high flyers. Nor a wholly basic book fit for freshers.

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