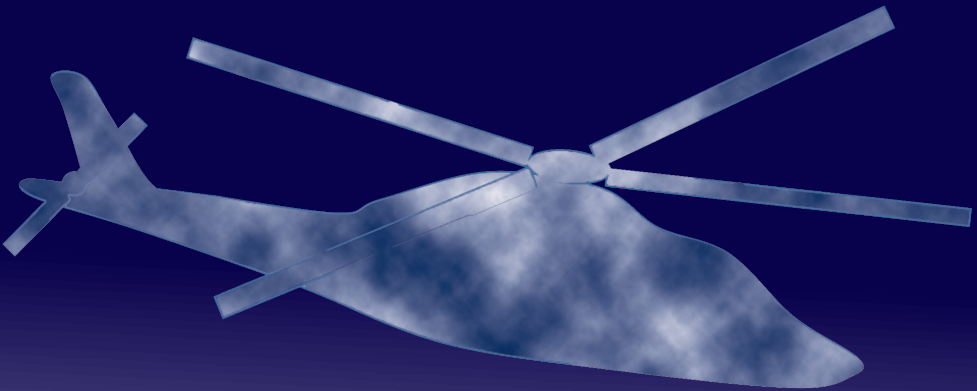


Giovanni Di Giorgio

# THEORY OF HELICOPTER FLIGHT

AERODYNAMICS, FLIGHT MECHANICS



Giovanni Di Giorgio

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Aerodynamics, flight mechanics





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via Vittorio Veneto, 20  
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## Preface

This book provides an introduction to helicopters through the fundamental theories and methods of rotor aerodynamics and flight mechanics. The arguments have been structured in order to provide the reader with the physical aspects of problems, the basic mathematical tools involved, the presentation of theories and methods with solved numerical examples or ready to be implemented on the computer. Therefore, the understanding of both the rotary-wing principles of flight and the approximate magnitude of parameters and variables involved is achieved through a clear and step by step practical presentation.

After Chapter 1, that treats the main helicopter configurations, Chapters 2, 3 and 4 review basic rotor aerodynamics applied to helicopters. They treat the momentum and blade element theories, with an introduction to the fundamentals of vortex theory and the elements of rotor dynamics. The developed methods are applied in the subsequent chapters to generate data for examples and to support the arguments. Chapters 5, 6, and 8 present the conditions of helicopter trim and manoeuvres and the flight performance prediction and evaluation. Chapter 7 develops the fundamental problems of helicopter stability and control by means of the mathematical tools provided by the modern control theory. Chapter 9 completes the treatment of theory of flight with specific elements for tandem and coaxial rotor helicopter configurations.

Therefore, this book may be used as a reference or a complementary textbook for students in aerospace engineering, and the material provides a starting point to prepare a more in depth analysis useful for both practicing engineers and professionals in helicopter technology.

This volume is my English translation with the addition of new arguments of my book *Teoria del volo dell'elicottero* in Italian, published in 2007 and 2009 in Italy by Aracne Editrice. During my translation, I included updates that have occurred over the last years. The Italian book has been used by numerous colleagues and professionals from whom I received positive feedback and appreciation.

In my professional experience I have verified the complexities of a rotary-wing aircraft since the early approach to the problems of vertical flight. Therefore, writing an introduction to this subject is a challenge.

Moreover, this book takes into account the multidisciplinary approach required by rotorcraft. Finally, I hope that the same enthusiasm, which has accompanied me from the beginning of my eighteen year career in rotary-wing, will be transferred to the reader through the pages of this volume.

I would like to thank Professor Gian Battista Garito and Ingegner Giovanni Fittipaldi for the significant discussions about the fundamentals of rotorcraft; moreover, since the first edition of the Italian book, they have given me helpful comments and many suggestions.

I am very grateful to Dottor Gianluca Grimaldi and to Ingegner Andrea Bianchi of Leonardo Helicopters Division (AgustaWestland, when I started to write the book) in Cascina Costa; they have always appreciated my efforts, providing me useful comments.

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I am also very grateful to Professor Carlo de Nicola of University of Naples Federico II for stimulating many constructive discussions, from the aerodynamics to the aircraft pilot's standpoint, and thanks are due to Professor Renato Tognaccini; over the last years, they have invited me to give an interesting series of conferences on helicopter flight performance in Naples.

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Giovanni Di Giorgio  
Roma, February 25, 2018

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The book provides an introduction to helicopters through the fundamental theories and methods of rotor aerodynamics and flight mechanics. The arguments have been structured in order to provide the reader with the physical aspects of problems, the basic mathematical tools involved, the presentation of theories with solved numerical examples or ready to be implemented on the computer. Therefore, the understanding of both the rotary-wing principles of flight and the magnitude of parameters and variables involved is achieved through a clear and step by step practical presentation. The topics include rotor aerodynamics and elements of rotor dynamics, helicopter flight performance, helicopter stability and control. The text can be used as a reference for students in aerospace engineering, and, moreover, the material is useful for both practicing engineers and professionals in helicopter technology.

Giovanni Di Giorgio was born in Italy. He received the Laurea degree, MSc, in Aeronautical Engineering from the University of Naples Federico II, in 2000. In 2001 he joined AgustaWestland, now Leonardo Helicopters Division, where he is currently involved in a large number of significant production programs relating to light, medium and heavy helicopters (single and tandem rotor) and to a tilt rotor aircraft. His areas of interests include helicopter performance calculation and flight mission simulation by Artificial Intelligence methodologies, and flight safety. His extensive experience in rotary-wing technology, as aeronautical engineer and educator, includes sustaining and manufacturing engineering, special processes on rotors and flight controls, structures, transmission system. Dott. Ing. Di Giorgio is also a qualified professional Engineer, registered in Italy.

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