The series presents lecture notes, monographs, edited works and proceedings in the field of Mechanics, Engineering, Computer Science and Applied Mathematics.

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Roberto Camussi
Editor

Noise Sources in Turbulent Shear Flows:
Fundamentals and Applications

Springer
PREFACE

The knowledge of the physical mechanisms underlying the generation of noise in turbulent shear flows remains a challenging task despite over 50 years of intensive research in the field. The interest in this topic is considerable because turbulent shear flows originating noise are encountered in many engineering applications, such as flows in pipes, compressible and incompressible jets, turbulent boundary layers over rigid or elastic surfaces, wakes generated behind streamlined or bluff bodies.

Recent developments in terms of our capacity to both numerically and experimentally analyze the physics of turbulent shear flows have opened up new possibilities to improve our knowledge about noise generation and propagation mechanisms. These understandings lead, for example, to the development of flow/noise manipulation techniques and address the design of noise suppression devices.

The scope of this volume is to present a state-of-the-art review of on-going activities in noise prediction, modeling and measurement and to indicate current research directions. This book is partially based on class notes provided during the course ‘Noise sources in turbulent shear flows’, given at CISM in April 2011.

Introductory chapters on fundamentals topics will be followed by up-to-date reviews of arguments of specific interest for engineering applications.

The first part of the volume is denoted as ‘Fundamentals’ and contains two chapters. The first one covers general concepts of aeroacoustics, from the basic equations of fluid dynamics to the theoretical description of self-sustained oscillations in internal flows including the vortex sound theory. The second chapter illustrates more deeply the acoustic analogies in account also of the presence of solid surfaces. The flow features involved in sound generation are also highlighted by means of suitable dimensional analyses.

In the second part of the volume, denoted as ‘Applications’, particular emphasis is put into arguments of interest for engineers and relevant for aircraft design. An important topic included in this part is jet noise, which is treated from both an experimental and an analytical viewpoint. A comprehensive review of literature results as well
as a description of present understandings of noise generation and its predictions is presented.

A second chapter is devoted to describing airfoil broadband noise and its analytical modeling with emphasis on trailing edge noise and rotating blades.

The boundary layer noise is treated in another chapter that is divided into two parts. In the first one noise generation mechanisms are described. In the second, the problem of the interior noise and some basic approaches used for its control are presented.

As a fundamental completion of the state-of-the-art knowledge, a chapter is devoted to clarifying the concept of noise sources, their theoretical modeling and the techniques used for their identification in turbulent flows.

All these arguments are treated extensively with the inclusion of many practical examples and references to engineering applications.

For the purpose of optimizing the convenience of this book, the chapters are conceived to be self-contained. Readers may concentrate on the topic they are more interested in, with no need of consulting other chapters. The disadvantage of this approach lies in the repetition of some basic notions, such as the Lighthill’s analogy or the Green’s function formalism, which can be found replicated in more than one chapter. Indeed, scientists may use the same mathematical tool in a different but efficient way, depending on the purpose of their analysis.

To my opinion, these reiterations do not represent a shortcoming. On the contrary I consider this approach to be a quite instructive way for young researchers to discover and appreciate the amazing strength and effectiveness of theories, models and mathematical formalisms that provide the foundations of aeroacoustics.

Roberto Camussi
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