Preface

The following notes supplement the three lectures:

1. Aerodynamic Sound in Unbounded Flows,

2. Compact Green's Functions, and

3. Vortex Sound in Bounded Flows

to be given during the five day seminar entitled *Advances in Aeroacoustics* at the von Karman Institute for Fluid Dynamics. These three topics in their classical sense have actually remained unchanged for many years. The real advances have come in the area of computational aeroacoustics. However, a solid background in the fundamentals of classical aeroacoustics enables one to critically examine computational results and, often, to validate them.

Thus these notes describe classical analytical approaches to calculating aerodynamic sound in unbounded and bounded flows. The Lighthill and Powell-Howe forms of the acoustic analogy may have already been presented in previous lectures, but they are rederived here for completeness. The focus of these lectures then is the integral solution to these wave equations. The first lecture commences with the derivation of Lighthill's acoustic analogy followed by a brief discussion of the acoustic source types and the causal free-space Green's function solution to Lighthill's wave equation. The Ffowcs-Williams-Hawkings equation is derived and its usefulness as a general solution to the Lighthill equation in unbounded and bounded fluids will be described.

The second lecture focuses on the important problem of sound radiation from a source region considered to be compact. A solution method that relies on the formulation of a relevant compact Green's function will be discussed at length.

The third lecture focuses on the Powell/Howe acoustic analogy. The lecture notes contain a derivation of their wave equation and examples of how this analogy can be applied in practice.

It is my intention that these lectures prepare the reader/participant to open books or articles which refer to integral forms of aeroacoustic solutions and to understand the basic methodology discussed. I have relied on three main sources when developing these notes:

- Modern Methods in Analytical Acoustics, by D. G. Crighton et. al. [1]
- Acoustics of Fluid-structure Interactions, by M. S. Howe [2]
- Course notes for Boston University's graduate course AM762, Fall 2000, written by M. S. Howe (to be published in the future)

I extend my gratitude to Michael Howe for providing me a copy of his lecture notes.