SELECTED TOPICS

In Aerospace Engineering

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CHAPTER SIXTEEN

FORMULATION OF KERNEL FUNCTION FOR AERODYNAMIC LOADING ON AIR VEHICLE

16.1. Introduction

This chapter describes the evaluation of the kernel function used to determine aerodynamic loading on lifting surfaces of air vehicle. Various formulations of the kernel function will be presented. Some of these formulations contain cylindrical functions and incomplete cylindrical functions that require rather careful treatments. The cylindrical functions such as modified Bessel and Struve functions will be treated in the second section. The third section will address some numerical approximation and exact solutions to the incomplete cylindrical functions.

16.2. Formulations of the Kernel Function

The unsteady lifting surface problems may be formulated in several different ways [34]. Table 16.1 summaries the formulations given in Reference 35. The widely used version is the integral formulation relating the pressure distribution Δp to the induced normal wash w_n as follow

$$w_n(x,y,z) = \frac{1}{8\pi} \iint_S \Delta \bar{p}(\xi,\eta,\zeta)\, K(x_o, y_o, z_0, k, M)\, d\xi\, d\eta \qquad (16.1)$$

In terms of velocity components in a Cartesian coordinate, Equation (16.1) may be rewritten as

$$\begin{Bmatrix} u \\ v \\ w \end{Bmatrix}(x,y,z) = \frac{1}{8\pi} \iint_S \Delta \bar{p}(\xi,\eta,\zeta) \begin{Bmatrix} K_u \\ K_v \\ K_w \end{Bmatrix}(x_o, y_o, z_0, k, M)\, d\xi\, d\eta \qquad (16.2)$$