Instructions for the Prandtl Lifting Line Program

Introduction

The Prandtl Lifting Line program is a Windows-based application that allows the user to compute the inviscid aerodynamic properties of straight tapered wings. The user is free to vary

- Wing Aspect Ratio
- Wing Taper Ratio
- Wing Twist
- Variation of Section 2D $dCl/d\alpha$
- Variation of Section α_{L0}

The user is then given the wing properties of CL, CD, and span efficiency factor. In addition, the user is given a general formula for CL as a function of root chord geometric angle of attack.

How to Use the Program

As seen in Figure 1, the program consists of a user interface where the user enters data into appropriate boxes and then selects one of three actions in the form of buttons. In general, the user only enters data in boxes with white backgrounds. These can change as will be described below. All inputs and outputs are grouped in boxes (called frames). Descriptions by frame follow:

Geometry – Here the geometric features of the wing along with the number of Fourier coefficients in the Lifting Line theory are selected. These are described in Table I.

Table I. Inputs in the Geometry Frame

Input	Purpose	Min	Max
No. of Fourier Coeffs	Set the number of coeffs in Lifting Line theory	1	21
Aspect Ratio	Wing Aspect Ratio = b^2/S	0	100
Taper Ratio	Wing Taper Ratio = Tip Chord / Root Chord	0	2
Root Chord Alpha	Root chord absolute angle of attack	-15	15
Tip Chord Alpha	Tip chord absolute angle of attack	-15	15

Section Lift Curve Slope – In this frame the user sets the section lift curve slopes ($\partial Cl/\partial\alpha$) by choosing one of the three options. The options are described in Table II.

Table II. Section Lift Curve Slope Options

Option	Description	Min	Max
Constant on Span = 2π	$\partial Cl/\partial\alpha$ set to 2π for the entire span	--	--
Constant on Span =	User sets value of $\partial Cl/\partial\alpha$ for the	0	10

____	entire span		
Linear variation on Span	User sets root and tip $\partial Cl/\partial\alpha$	0	10

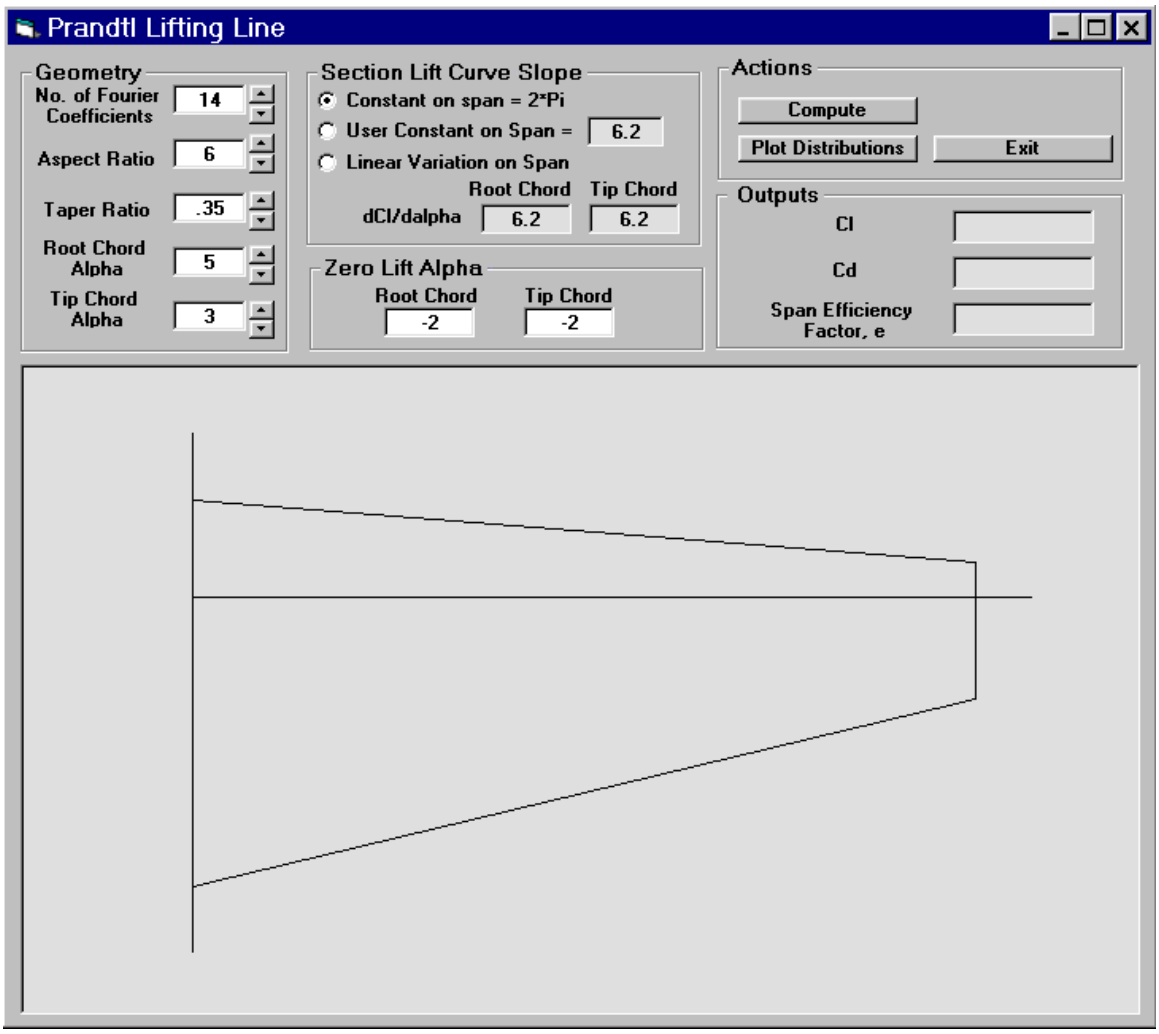

Figure 1. User Interface for the Prandtl Lifting Line Program.

Zero Lift Alpha – The user sets the Cl at zero angle of attack for the root and tip chords. The program assumes a linear variation along the span between these two values.

Actions – This frame has three buttons, Compute, Plot Distributions, and Exit.

Compute button – Pressing this button activates the computation of the Fourier coefficients in the Lifting Line theory and the subsequent computation of the performance results. The program will display the computed wing CL, wing Cdi, and Span Efficiency Factor in the Outputs frame. In addition, a formula for the wing lift coefficient as a function of root chord angle of attack is shown on the graphic picture.

Plot Distributions button – Pressing this button results in the graphic picture changing from the wing planform to six graphs of the spanwise variation of the following quantities:
When the Distributions button is selected, the user is given six graphs of the spanwise variation of:

- absolute angle of attack
- induced angle off attack
- effective angle of attack
- section lift coefficient
- section drag coefficient
- downwash velocity