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## Appendix D Computational Aerodynamics Programs

Several programs are used to provide insight into aerodynamics. This appendix provides the input instructions.

### D.1 PANEL\*

Two dimensional incompressible, inviscid (potential) flow over NACA airfoils using the Smith-Hess low order panel method. From Moran's book, with modifications.

### D.2 Panelv2\*

An extension of PANEL to prediction of pressure distributions over arbitrary airfoils, modification of the airfoil shape, and production of an output file for plotting or use as input to a boundary layer analysis program.

### D.3 LIDRAG

Computation of the induced drag of a single planar surface given the spanload distribution. The coefficients of the assumed Fourier Series are computed using a Fast Fourier Transform. The program was written by Dave Ives, and used in numerous programs developed for the government by Grumman.

### D.4 LAMDES

John Lamar's design program, modified to find the span  $e$  for multiple and non-planar lifting surfaces given the spanload on each surface. This is a more capable version of LIDRAG. This code also finds the wing camber and twist required to obtain this spanload at subsonic speeds. The code will also do an optimization analysis, finding the minimum trimmed drag and spanload required to achieve it.

### D.5 FRICTION

Computation of skin friction and form drag using turbulent flat plate skin friction estimates, and empirical form factors. Provides a basis for zero lift drag estimates. Includes compressibility effects and the 1977 standard atmosphere.

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\* This program is a modified form of a code in Moran's book.

### D.6 VLMpc

John Lamar's two surface vortex lattice program, developed at NASA Langley. The program treats two lifting surfaces using up to 200 panels. Vortex flows are estimated using the leading edge suction analogy.

### D.7 DESCAM

The camber line required to produce a specified chord load distribution is computed using the quasi-vortex lattice method. The method is valid for two dimensional incompressible flow, and is an original program.

These codes are subject to significant revision, with the objective of becoming entirely independent of codes obtained from copyrighted sources, so the students won't have to own the books to be able to use them.