

Chapter 4 Laminar Boundary Layers

1. Historical Background and Boundary Layer Concepts

2. Boundary Layer Theory

Part 1

- a. Integral Methods: Flat Plate
- b. Boundary Layer Equations

Part 2

- c. Similarity Solutions
 - i. Flat Plate: Blasius Solution
 - ii. Falkner-Skan Wedge Flows
 - iii. Flat Plate with Wall Suction or Blowing

Part 3

- d. Momentum Integral Methods

Part 4

- e. Boundary Layer Separation
 - i. Transition, Pressure Gradient, and Boundary-Layer Separation
 - ii. 3D Separation
 - 1. Definitions and Examples Steady and Unsteady Separation.
 - 2. 3D Separation Patterns
 - iii. Flow Past Cylinders and Spheres
 - iv. Sports Ball Dynamics
 - v. Unsteady Separation

3. Free Shear Flows

a. Mixing Layers

b. Jets

i. 2D

1. Derivation 1

2. Derivation 2

3. Derivation 3

ii. 2D Wall Jet

iii. Axisymmetric (Round) Jet

iv. Axisymmetric (Round) Jet with Swirl

c. Wakes

i. 2D

1. Far Wake Flat Plate

2. Non-Lifting Body

a. Panton

b. White

ii. Axisymmetric (Round) Wake

iii. Simplified Betz Method

1. Clark Y Reference Data

4. Additional Topics

- a. Inlet Duct Flow
- b. Rotationally Symmetrical Boundary Layers
- c. Axisymmetric Boundary Layers
- d. 3D Boundary Layers
- e. Asymptotic Expansions
- f. Unsteady Boundary Layers

Choi, J.-E., Sreedhar, M., and Stern, F., "[Stokes Layers in Horizontal-Wave Outer Flows](#)," ASME J. Fluids Eng., Vol. 118, September 1996, pp. 537 – 545.

Paterson, E.G. and Stern, F., "[Computation of Unsteady Viscous Marine-Propulsor Blade Flows - Part 1: Validation and Analysis](#)," ASME J. Fluids Eng., Vol. 119, March 1997, pp. 145 – 154.

Paterson, E.G. and Stern, F., "[Computation of Unsteady Viscous Marine-Propulsor Blade Flows - Part 2: Parametric Study](#)," ASME J. Fluids Eng., Vol. 121, March 1999, pp. 139 – 147.