Handout #3
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AE 514
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References: AE 514 — Boundary Layer Theory

1. H. Schlichting (& K. Gersten). *Boundary-Layer Theory*. Eighth edition, Springer, 2000.

   This is *the* book on boundary layers, summing up the fundamental understanding that was developed in the first half of the 20th century, plus about a zillion incremental additions since. It covers both fluid dynamics and thermal transport involving boundary layers. Little has fundamentally changed in understanding, at least of laminar boundary layers, since the sixth addition appeared in 1968. The recent editions, now co-authored with Gersten who recognized the declining design role of the analytical tools presented, includes some numerical techniques. However, the presentation is still tied to getting specific answers for specific (and usually similar) cases, which can make for dull reading in portions. This particular edition is available electronically from our library, as is a 2017 edition I have not studied, although it seems superficially the same.

2. G. K. Batchelor. *An Introduction To Fluid Mechanics*. Cambridge University Press, 1967.

   This is an "introduction" in the sense that it is complete and builds from fundamentals. However, the level of presentation is quite advanced. It is difficult to read in places but remains a very important book in the field. Some lectures will draw heavily upon it. The coverage of boundary layers in this book is thoughtful and complete in terms of the fundamentals, but it again only represents part of the book. The book is available electronically from our library.

3. H. Ockendon & J. R. Ockendon. *Viscous Flow*. Cambridge University Press, 1995.

   This wonderful little book (110 pages) assumes a basic understanding of inviscid flow and focuses on the main phenomena that arise due to viscosity: the viscous stress tensor, boundary layer behavior, creeping flow, thin viscous films (lubrication), porous media and turbulence. It does this with remarkable clarity. I find the discussion of boundary layer theory to be insightful and therefore use some of the material from it and include it in this list despite boundary layers being covered in only a fraction of this short book. It is available electronically though our library.

4. M. Van Dyke. *Perturbation Methods In Fluid Mechanics*. Annotated Edition, Parabolic Press, 1975.

   Momentum boundary layers are the quintessential example in which a small parameter, the inverse Reynolds number, is used to simply differential equations. This book introduces pertabative methods in general with a close focus on fluid mechanics including significant emphasis on the viscous boundary layer. We will use it for some of our asymptotic analysis and matching. This book is freely available because Milton van Dyke wanted information to be broadly accessible: (link).

5. M. J. Lighthill. *An Informal Introduction To Theoretical Fluid Mechanics*. Claridon Press.

   As the title says.... Lighthill was well known for developing his own perspective: this book includes one of the most nifty discussions of separations I have seen documented. We will discuss this perspective. He uses very little mathematics in his discussion; studying this book can remind one that the math can be clarifying.

6. F. M. White. *Viscous Fluid Flow*. McGraw-Hill, 2005 (second edition 1991).

   This is a more concise and accessible book than Schlichting, though it is more generally on viscous flow than boundary layer theory. The analysis is relatively easy to follow. I am most familiar with the second edition, but the third edition is not a significant departure from the second. In truth, it is indistinguishable in most places. The presentation of results from stability analysis is particularly complete and informative. This is more of a 400-level than 500-level book.

7. R. L. Panton. *Incompressible Flow*. Wiley-Interscience, 1996.

   This is a fairly modern book on fluid mechanics, which is not as limited in its scope as the title might imply. It has reasonably complete and reasonably well presented material though it far broader than boundary layer theory. This is also more of a 400-level than 500-level book.

8. P. G. Drazin. *An Introduction To Hydrodynamic Stability*. Oxford Press, 2002.

   It is important to understand whether or not any particular flow is unstable to perturbations—its hydrodynamics stability. We cover this topic toward the end of the class, and this book provides a through look at it.

9. W. O. Criminale, T. L. Jackson & R. D. Joslin. *An Introduction To Hydrodynamic Stability*. Oxford Press, 2002.

   A more complete discussion of instability, including numerical techniques.

10. A. D. Pierce. *Acoustics: An Introduction to Its Physical Principles and Applications*. McGraw-Hill, 1981. 1991).

    This comprehensive book on acoustics includes in Chapter 10 a discussion of the fluid mechanics of acoustic boundary layers. It will be a good references for this part of the course. It is available electronically from our library.

11. M. Van Dyke. *An Album Of Fluid Motion*. Parabolic Press, 1982.

    A book of flow visualizations covering many, many areas of fluid mechanics including boundary layers.