OUTLINE for AE 514, Boundary Layer Theory, Spring 2013; Jackson

1. Governing Equations
   (a) Derivation of Reynold's Transport Theorem
   (b) Derivation of Governing Equations
   (c) Scalings
   (d) Role of Reynolds Number in Boundary Layer Theory and the Concept of a Boundary Layer
2. Mathematical Theory of Boundary Layers
   (a) Theory of Matched Asymptotic Expansions
   (b) Inner and Outer Solutions, Matching
   (c) Higher-order Matching
3. Potential Flow Theory - Outer Region
   (a) Complex Variables
   (b) Complex Velocity
   (c) Ideal Fluid Flow - uniform flow, stagnation-point flow; point source; vortex; doublet; flow past a cylinder
4. Incompressible Theory
   (a) Two-dimensional theory
   (b) Derivation of the Blasius Boundary Layer
   (c) Derivation of the Falkner-Skan profile
   (d) Shear layers and Wakes
   (e) 2-D Jet
   (f) Boundary layers with suction/blowing; asymptotic suction profile
   (g) Numerical methods - shooting methods, finite difference methods
   (h) Keller Box Method for non-self similar boundary layers
   (i) Three-dimensional boundary layers
5. Stability Theory
   (a) Origin of Turbulence
   (b) Introduction to Stability Theory
   (c) Derivation of the Orr-Sommerfeld and Rayleigh Equations
   (d) Absolute/Convective Stability
   (e) Kelvin-Helmholtz theory
   (f) Temporal Stability of Continuous Profiles

i. Rayleigh Inflection Point Theorem
ii. Fjortoft's Theorem
iii. Plane Poiseuille Flow
iv. Plane Couette Flow
v. Shear Layers
vi. Boundary Layers
vii. Discrete and Continuous Spectra

(g) Spatial Stability of Continuous Profiles
i. Shear Layers
ii. Boundary Layers
iii. Discrete and Continuous Spectra

6. Turbulence for Incompressible Flows
(a) Fluctuations and Correlations
(b) Prandtl Mixing Length Theory
(c) Reynolds Shear Stress and Scaling
(d) Rough Wall Turbulent Boundary Layers

7. Compressible Theory
(a) Introduction to Compressible Flows
(b) 2-D Boundary Layers
(c) Hypersonic Theory
(d) Boundary Layer Interactions
(e) Mangler Transformation
(f) Unsteady Boundary Layer Behind Moving Shock
(g) Stability
i. Compressible Shear Layer
ii. Compressible Boundary Layer