

Final Exam Exercises and Practice Problems

Lecture 21: Non-dimensionalization and Scale Analysis

Page 3: Non-dimensional Energy Equation (Text 4.11)

Solution here

Lecture 23: Buckingham Pi Theorem

Page 1: Detailed BPT (Sec. 1.11)

Lecture 25: Boundary Layer Analysis

Page 1: Momentum Thickness Proof

Lecture 27: Von-Karman Momentum Integral Equation

Page 3: Example 2, Non-constant U_e w/ 4th order polynomial

Lecture 30: Vorticity Introduction

Page 1: Study Sec 10.8

Page 3: Vorticity in NS (Sec 4.9)

Page 5: Rigid Body Rotation (L8, Sec 3.5)

Page 5: Idealized Vortex (Sec 3.5)

Lecture 31: Kelvin's Circulation Theorem

Page 1: Kelvin Proof (Sec 5.2)

Page 1: Note 3: Take curl of NS to verify total acceleration vector

Lecture 32: Vorticity Transport Equation

Page 1: x,y,z components of Vorticity equation

Page 2: Rotational reference vorticity derivation (Sec 5.5)

Lecture 33: Vorticity Equation Interpretations

Page 2: Prove no stretching/tilting in 2D

Lecture 34: Turbulence Introduction

Page 2: Derive Re-dependent equations for other Kolmogorov Scales

Page 3: Show statistical properties

Lecture 35: RANS

Page 2: Closure. Write 3x3 Reynolds stress tensor and identify normal and shear components

Page 3: Energy Equation derivation (Sec 12.5)

Lecture 36: Turbulence Modeling

Page 3: TKE derivation with Reynolds stress (Sec 12.16)

Lecture 37: Turbulent BL

Page 2: Proof that given velocity terms in WSS as above, $U^+ = y^+$