Course Number: 28056

Course Name: Boundary Layer Theory

Course Type:	Type & Max Unit: 3
Prerequisite:	Corequisite:
Level: Graduate	First Presentation:
Group: Energy Conversion	Last Edition:

Objectives:

Topics:

1. Outline of Boundary Layer Theory
1.1. The Concept of Boundary Layer
1.2. Separation and Vortex Formation
1.3. Flow regimes in a Boundary Layer and Ducts

2. The Concept of Viscosity
1.1. Definition and Measurements of Viscosity
1.2. Factors Affecting Viscosity
1.2.1. Estimation of Gas Viscosities
1.2.2. Estimation of Liquid Viscosities

3. Classification of Fluid Behavior
3.1. Definition of a Newtonian Fluid
3.2. Non-Newtonian Fluid Behaviour
3.3. Time-Independent Fluid Behaviour
3.4. Shear-Thinning Fluids
3.4.1. Power Law or Ostwald de Waele Equation
3.4.2. The Cross Viscosity Equation
3.4.3. The Ellis Fluid Model
3.4.4. Visco-plastic Fluid Behavior
3.5. Shear-Thickening or Dilatant Behaviour
3.6. Time Dependent Behaviour
3.7. Thixotropic Behaviour
3.8. Rheopectic Behaviour
3.9. Visco-elastic behavior
3.10. Oscillatory shear motion
3.11. Elongational flow
3.12. Origins of Non-Newtonian Behaviour
3.13. Implications in Engineering Applications
3.14. Concluding Remarks

4. Viscous Incompressible Flows
4.1. Navier-Strokes Equation
4.1.1. Nine Scalar Quantities of Stress System - Stress Tensor

4.2. Vector Notation & derivation in Cylindrical Coordinates - Navier-Stokes equation
4.3. A general way of deriving the Navier-Stokes equations from the basic laws of physics.
4.4. Exact Solutions Of Navier-Stokes Equations
4.4.1. Parallel Flow in a Straight Channel
4.4.2. Couette Flow
4.4.3. Hagen Poiseuille Flow
4.5. Applications-
4.5.1. Losses and Friction Factors
4.5.2. Flow between Two Concentric Rotating Cylinders
4.5.3. Calculation of Stress and Torque Transmitted
4.5.4. Low Reynolds Number Flow Around a Sphere
4.5.6. Theory of Hydrodynamic Lubrication

5. Laminar Boundary Layer
5.1. Introduction
5.2. Boundary Layer Equations
5.2.1 About the boundary layer
5.3. Boundary Layer Coordinates
5.3.1. Application of Boundary Layer Theory
5.4. Blasius Flow Over A Flat Plate
5.4.1. Law of Similarity for Boundary Layer Flows
5.4.2. Wall Shear Stress
5.4.3. Boundary Layer Thickness
5.5. Momentum-Integral Equations for The Boundary Layer
5.5. Seperation of Boundary Layer
5.5.1. The mathematical explanation of flow-separation
5.6. Karman-Pohlhausen Approximate Method For Solution Of Momentum Integral Equation Over A Flat Plate
5.7. Integral Method For Non-Zero Pressure Gradient Flows
5.7.1. Point of separation
5.8. Entry Flow In A Duct
5.8.1. At the entrance region,
5.9. Control of Boundary Layer Separation
5.10. Mechanisms of Boundary Layer Transition
5.11. Summary of this chapter

6. Turbulent Boundary Layer
6.1. Introduction
6.2. Characteristics of Turbulent Flow
6.3. Frictional forces at the confining solid walls
6.4. Laminar-Turbulent Transition
6.5. Reynolds decomposition of turbulent flow
6.5.1. Rules of mean time – averages
6.6. Turbulent Boundary Layer Equations
6.7. Turbulent Shear Stress Models
6.8. Structure of a Turbulent Boundary Layer
6.8.1. Shear stress and friction velocity

9.3.2. Maintaining a laminar boundary layer
9.3.3. Control of Boundary Layer Separation

References: