ISTANBUL TECHNICAL UNIVERSITY
DEPARTMENT OF MECHANICAL ENGINEERING

ADVANCED FLUID DYNAMICS - MIA 503E

Spring 2017-2018

Instructor : Dr. Hakan Öksüzoğlu, **Office No:** 435
Phone & e-mail : (0212) 293 13 00 / 2464 & hoksuzoglu@itu.edu.tr
Lecture hours : Tuesday 13:00-16:30 **Class Room:** Aselsan DERSLİK 10

Office hours : See http://web.itu.edu.tr/hoksuzoglu/ for up to date hours
Prerequisities : Undergraduate Fluid Mechanics

Course Description :

Basic concepts. Flow kinematics. Classification of fluid motion. Conservation equations of viscous flows. Vorticity transport equation. Low-Reynolds number flows. Exact solution of viscous flow problems: Laminar boundary layers, Similarity solutions. Momentum Integral formulation. Boundary layer separation, Laminar jets, Free shear layers. Introduction to flow instability and turbulence.

Textbook : White, F.M., 2006. *Viscous Fluid Flow, 3rd Int Ed*, McGraw-Hill.

Other References :

(1) Currie, I.G., 2013. *Fundamental Mechanics of Fluids,* 3rd Ed*,* CRC Press.
(2) Schlichting, H. and Gersten, K. 2017. *Boundary Layer Theory,* 9th Ed, Springer.
(3) Panton, R. 2013. *Incompressible flow,* 4th Ed., Wiley.
(4) Kundu, P.K., Cohen, I.M., Dowling D.R., 2016. *Fluid Mechanics*, 6th ed, Elsevier
(5) Graebel, W. P.,2007. *Advanced Fluid Mechanics*, Elsevier
(6) Kirkkopru, K. 1997. *Viscous Flows* " Compiled Lecture Notes"

Objectives :

- provide graduate students with knowledge in the key areas of advanced fluid dynamics.
- use this knowledge in the solution of engineering problems of interest.

Outcomes :

1. A sound understanding of the governing equations in viscous fluid flows and their physical aspects.
2. Ability to formulate and solve low-Reynolds number flows
3. Ability to simplify Navier-Stokes equations and obtain exact solutions to some simple viscous flow problems, e.g, Couette flow, Poiseuelle flow etc.
4. Ability to derive boundary layer equations in differential and integral forms.
5. Ability to solve integral and differential boundary layer equations.
6. A basic understanding of flow instability and turbulent flows.

COURSE PLAN

Week	Topics
1	Basic concepts, definitions, continuum assumption, viscosity, some examples of viscous flows. Flow kinematics, material derivative. Classification of fluid motion. Vorticity.
2	Review of fundamental equations of viscous flows: Continuity Equation, Navier-Stokes equations. Energy Equation.
3	Mathematical characteristics of the basic equations. Dimensionless form of governing equations. Dimensionless parameters in viscous flows. Vorticity transport equation. Vorticity-Stream function formulation
4	Exact solution of viscous flow problems: Couette Flow, Poiseuille flow , Flow between concentric rotating cylinders
5	Stokes' first and second problems, Flow over a porous wall
6	Low-Reynolds number Flows (Creeping Flow): Stokes' solution past a sphere
7	Laminar boundary layers, Origin of similarity transformation
8	Blasius solution. Falkner-Skan solutions
9	Continues
10	Momentum Integral formulation. Approximate solutions
11	Boundary layer separation, Laminar jets, Free shear layers
12	Continues
13	Introduction to flow instability, Introduction to Turbulence
14	Turbulent boundary layers

Assessment Criteria :

Midterm Exams	Quantity: **2**	Percentage **:** **20%+20%**
Homeworks	Quantity: **4**	Percentage : **20%**
Final Exam	Quantity**:** **1**	Percentage **:** **40%**

In order to be able to take the final exam

- You should attend at least 70% of the classes
- You must submit all of the homeworks
- The average of two midterms must be at least 35 out of 100.