MAK691E (14002) Mechanics of Turbulence Fall 2020/2021

Lecturer : Prof. Dr. Bedii Özdemir
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Ofice Hours : Thu: 13:30-17:00, Fri: 13:30-17:00

Lecture Hours : Fri: 8:30 am - 11:29 am (MOB 212) / ONLINE

Contents
Nature of Turbulent Motion, Dimensional Analysis and Length Scales, Vorticity Dynamics, Shear Flows, Statistical Description of Turbulence, Spectral Dynamics, Recent Developments in Turbulence Theory.

Reference Book
- Pope, S 2000 Turbulent Flows, Cambridge Uni. Press.

References
- Tennekes and Lumley 1950 A First Course in Turbulence, Academic Press.
- Hinze, 1945 Turbulence, Academic Press.
- Batchelor, G 1952, Theory of Homogeneous Turbulence, Cambridge Uni. Press.
- Townsend, A. A. 1955 Structure of Turbulent Shear Flows, Cambridge Uni. Press.
- Monin and Yaglom 1971 Statistical Fluid Mechanics, Volumes I and II, MIT Press.
- Özdemir, İ. B. 1995 Turbulence Course Notes

Course Objectives
To introduce;
- onset and development of turbulent flows and their classifications,
- theory and basic concepts of turbulence, and methods of analyses of turbulent flows,
- description of well-established and known approaches and theories and their scope.

Course Outcomes
To develop skills;
- and basic knowledge to model turbulence physics,
- necessary to analyze turbulent flows and solve relevant problems,
- to design flow systems with turbulence.

Course Plan

Week	Topics
1	Onset of turbulence, intermittency and transition.
2	Definitions of turbulent parameters, Reynold's decomposition.
3	Equations of turbulent motion and the closure problem; Homogeneous, isotropic turbulence; Concept of eddy.
4	Dimensional analysis and length scales.
5	Energy cascade; Reynolds number similarity and self-preservation.
6	1st Midterm **27 November 2020**
7	Vorticity equation; Vortex stretching and tilting.
8	Intermittency and entrainment; Free shear flows; Jets, mixing layers, and wakes.
9	Wall-bounded shear flows, Boundary 1ayers and wall jets; Coherent structures in jets and boundary layers.
10	Probability density and joint statistics; Spatially and temporally stationary flows and evolving flows.
11	Ergodicity; Correlation functions; Central limit theorem.
12	2nd Midterm **8 December 2021**
13	Fourier transform and aliasing in one-dimensional spectra.
14	Spectrum of turbulence; Inertial subrange and Kolmogorov's -5/3 law; Some other spectrum functions.
15	Summary of the semester

Exams & Course Work

Midterms	2	30%
Homework Assignments	4	10%
Term Project	1	30%
Final Exam	1	30%

Note: ***Please follow*** **www.akis.itu.edu.tr** ***for any announcement*****.**

TERM PROJECT WILL BE THE SIMULATION OF A TURBULENT FLOW WITH AN OPEN SOURCE CODE OpenFOAM. Meshing will be done with SnappyHexMesh.
A FULL REPORT WILL BE REQIRED (including sections as follows; Abstract, Introduction and Literature Survey, Governing Equations, Numerical Methods and Mesh Details, Discussions, and Conclusions). The geometry and the flow conditions will be defined in the first lecture. If necessary, an oral presentation will be required.