ME/AE 435 Turbulent Flows – Theory, Measurements & Modeling - Fall 2011
Mechanical & Aerospace Engineering Department, Missouri S&T

Instructor: Prof. Arindam Banerjee (E-mail: banerjeea@mst.edu, ☏ 573-341-4494)
184 Toomey Hall, Missouri S&T, Rolla, MO 65409.

Class schedule: Tuesday-Thursday: 8.00 a.m. - 9.15 a.m.
Office hours: Tuesday-Wednesday: 2.00 p.m.– 3.00 p.m.
(other time by prior appointment only)

Class Location: Toomey 250

Grading Outline: Homework: 20%, Mid-term Exams (2): 40%,
Final Exam: 20%, CFD/Lab Assignment: 20%.

Prerequisites: ME/AE 331 or ME/AE339 + co-enrollment in MATH 325


Supplemental Reading: Pope, S.B. Turbulent Flows – Cambridge University Press

Notes/handouts by instructor

Programming Skills: Knowledge of Fortran/Matlab and CFD packages (Fluent, CFX, etc).

Course objectives: This course is designed to give the students an overview of various aspects of
turbulent flows – the course is highly mathematical and will involve rigorous
derivations using PDEs. The course is divided into 3 parts and will cover:
(a) Turbulence theory (i.e. where does turbulence come from and what are
its universal features, to what extent is it deterministic?)
(b) Turbulence modeling (i.e. derive semi-empirical models to parameterize
the influence of turbulence on various flows)
(c) Turbulence measurements (discuss state of the art techniques to measure
and quantify various parameters discussed in (a) and (b) above)
The topics are meant to provide graduate students a sound theoretical
foundation regarding analyzing turbulent flows.

Topics to be covered

Part 1: Fundamentals & Turbulence Theory
(Introduction to Tensors, Statistical Properties, Equations of Fluid Mechanics – mean flow equations,
Origin and nature of turbulence, Statistical description of turbulent flows, Phenomenology of Taylor,
Richardson and Kolmogorov, Understanding some simple flows)

Part 2: Modeling of Turbulent Flows
(RANS averaging, RANS models – algebraic models, one and two equations models, effects of
compressibility – FAVRE averaging, basics of LES and DNS techniques)

Part 3: Turbulence Measurements
(Data acquisition and analysis, signal processing techniques, hot-wire/hot-film anemometry, Laser
Velocimetry including PIV)

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Equilibrium (Award No. 0967672)