Fall 2019

ME 618-103: Turbulent Flows

Simone Marras

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MECHANICAL ENGINEERING
NEW JERSEY INSTITUTE OF TECHNOLOGY

Course Syllabus and Guidelines
ME 618: Turbulent flows
Prof. Simone Marras
smarras@njit.edu
Office: MEC 315 Fall 2019

(Updated: September 5, 2019)

It is the responsibility of the student to read and understand this course syllabus.

Introduction
This course is meant for graduate students at the Master and Doctoral level in mechanical engineering, civil engineering, biomedical engineering, mathematics, and physics. It is an advanced introduction to the theory of turbulence with a part dedicated to the numerics of turbulence modeling.

Class Times

<table>
<thead>
<tr>
<th>Section</th>
<th>Lecture room</th>
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<tbody>
<tr>
<td>M 06:00-8:55pm</td>
<td>CKB 106</td>
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Office Hours
By appointment only. Send an email with the subject: "Booking office hour".
Prerequisites

For Mech/Civil students:
ME 304/320: Fluid mechanics

For Biomed. students:
BME 351 Introduction to Biofluid Mechanics

For MATH students: MATH 331. Introduction to Partial Differential Equations or MATH 335. Vector Analysis or MATH 440. Advanced Applied Numerical Methods

For PHYSICS students:
PHYS 444. Fluid and Plasma Dynamics

Main topics

• Part I: fundamentals of turbulence
  – Tensor analysis for fluid dynamics.
  – Introduction to the basic principles of conservation of mass and momentum of incompressible flows.
  – Statistical description of turbulence
  – Scales of turbulent motion
  – Free shear flow and wall bounded flows

• Part II: modeling and simulation
  – Introduction to Direct Numerical Simulation
  – Introduction to Reynolds Averaged Navier-Stokes equations
  – Large Eddy Simulation

Course outcome

Students will learn how to identify and analyze a turbulent flow by means of statistical interpretation first and numerical models then. The course is taught at a graduate level.

Suggested literature

The main book for this class is:
Turbulence in the atmosphere by J. Wyngaard, Cambridge University Press (Approx. $62)

However, parts from the following two references will be also considered (it is not required to purchase either one of the two book below): Turbulent flows by Pope S., Cambridge University Press (Approx. $40)
A first course in turbulence by Tennekes H. and Lumley J.L. MIT Press (Approx. $40)

Practice problems

Practice problems will be assigned along the semester.

Grading

Projects will be evaluated throughout the course and a final exam will be given.
A Superior: only given if all of the exams average to an A.
B+ Excellent
B Very Good
C+ Good
C Minimum
D Inadequate

The following conditions will cause loss of points during any exams:

- Wrong units.
- Wrong numerical results.
- Lack of explicit formula and solution procedure (i.e. I will not give credits/points if you do not show what formula you are using.
- Ambiguous sentences and explanations.

Allowed and not allowed material during testing:

One US-letter sheet of paper written on one side only and containing only the formulas that you think are necessary to solve the problems. Programmable calculators are NOT allowed. Cellular phones, computers of any type, tablet, etc. are NOT allowed during exams and class.

Personal matters and health issues

The instructor should not be exposed to family matters, health, hospitalization, or other serious personal matters. Should a serious event happen, please, communicate the issue directly and solely to the Dean of Students who will advise on how to proceed.

NJIT honor code

The NJIT honor code will be upheld and any violations will be brought to the attention of the dean of students. Mobile phones and similar electronic devices are expected to remain silent and not in use — the sight of a mobile phone during an exam will result in a final grade of F for the class.

Communication

This course will make use of Moodle and/or official NJIT e-mail for dissemination of various materials. You will be regularly contacted via email at your NJIT email address. I will respond to questions sent by e-mail if and only if the answer cannot be found on this syllabus. I do not communicate by telephone.

Problem Sets

Homework will be often assigned but will not be graded. It is the student’s responsibility to come see me during office hours if having trouble with the solution of homework problems. If you come requiring help, it is your responsibility to have solved the problem by yourself first because I will not solve it for you at office hours; I will explain how to do it to get you going.
Requirements for students

For best understanding of the material, the student is advised to attend all classes. As soon as possible after missing a lecture, it is the responsibility of the student to study the missed material from the book(s) or from the notes of a fellow student.

A personalized exam will NOT be granted at a different date unless the request comes directly from the Dean of Students.

Reports placed under doorways and not submitted during the class period are not the responsibility of the instructor if lost. If you feel you are not going to pass this course, please reach out to your instructor with adequate time before the drop date.