

# AE 6009 VISCOUS FLOWS 3 Credits

Fall 2026 A/Q

## Instructor information

**Instructor:** Suresh Menon,

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Office Hours: By appointment

## Course description

This is the first in a series of three GRADUATE courses in viscous flows. The second course in Spring 6012 will be on turbulent flows and the third course (which is an elective and is only offered every two years) will discuss advance topics in turbulence. **In this course we will focus primarily on laminar flows and transition to turbulence, with only a brief introduction to turbulence near the end of this course.**

**Prerequisites:** It is assumed that ALL students taking this course have had some courses in fluid dynamics in their undergraduate curriculum. Furthermore, it is hoped that ALL students have seen the Navier-Stokes equations, are aware of the derivation method, and are familiar with typical exact solutions of Navier-Stokes equations (see book by ANDERSON AND/OR you RTT theorem notes regardless of the class taken.) If any of the above assumptions do not apply to you then it is critical that you review your undergraduate material. First assignment will attempt to cover some prerequisites (never enough). Derivation is required and expected in the course.

## Learning outcomes

AS this is a graduate course in general, I am interested in finding out how you can integrate the material discussed in the class to demonstrate your knowledge BEYOND just memorizing or remembering the class notes. Some parts of the exams will be open notes and open book, and some parts will be closed book/notes. **During the course, some sections in the book or syllabus may be deliberately skipped and will be assigned as a reading assignment. READING and derivation are required.**

Finally, **NOTE this is a graduate course with quals relevance. So, work on it.**

## Required course material

**Required text:** Viscous Flows by F. White (McGraw Hill).

**Strongly recommended:** Boundary Layer Theory by H. Schlichting (McGraw Hill) v

## Attendance policy

Attendance is required and participation in class is expected. TA if assigned will be noted later.

## Grading policy

Mid Term I will be before drop deadline. **Mid-term II will be a computer project.** Assignments are for self-review and if collaborated must be submitted in your own handwriting. **Delayed submission will not be graded for all unless medical options is valid and justified.**

<b>4 Assignments of unequal length</b>	<b>20%</b>
<b>1 Project (TBD)</b>	<b>25%</b>
<b>Mid Terms I (TBD)</b>	<b>20%</b>
<b>Final (GT academic calendar)</b>	<b>35%</b>

## Syllabus

Material will also cover examples when relevant. Number in parenthesis is approximate number of weeks to be used to cover this material

- 1. Introduction [2]**
  - 1.1 The Navier Stokes equations
  - 1.2 Viscous Stresses
  - 1.3 Non-dimensional Parameters and Dynamic Similarity
  - 1.4 The Vorticity transport
  - 1.5 Low Re FlowsHW1 (TBD)
- 2. Exact Solutions of the Navier-Stokes Equations [2-3]**
  - 2.1 Parallel Flows
  - 2.2 Unsteady Flows
  - 2.3 Stagnation Point Flows
- 3. Incompressible Laminar Boundary Layer [2-3]**
  - 3.1 Boundary Layer Approximations
  - 3.2 Similarity Solutions – General and Particular Solutions
  - 3.3 Thermal Boundary LayersHW 2 (TBD)
  
- MIDTERM I (TBD)
  
- 4. Compressible Boundary Layers [1]**
  - 4.1 Compressible Transformations
  - 4.2 Similarity Solutions
  - 4.3 Applications
- 5. Transition to Turbulence [2]**
  - 5.1 Survey of Methods

- 5.2 Linear-Stability Analysis
- 5.3 Orr-Sommerfeld equation and temporal stability analysis
- 5.4 Prediction of transition and relevance to turbulence
- 5.5 Non-Linear Stability analysis
- HW 3 (TBD)

PROJECT I (TBD)

- 6. **Boundary Layer Separation [1]**
  - 6.1 Singularities in 2D and 3D boundary layers
  - 6.2 Criteria and analytical representation
- 7. **Free Shear Layers [2-3]**
  - 7.1 General Similarity Solutions
  - 7.2 Jets, Wakes and Mixing Layers
- HW 4 (TBD)
- 8. **Introduction to Turbulent Flows [1]**
  - 8.1 Time averaging
  - 8.2 Closure issues for the turbulent Navier-Stokes equations
- FINALS (TBD)
- 9. **Special Topic (if time permits – not included in course grading) [?]**
  - 9.1 Scalar transport and mixing in boundary and free shear layers
  - 9.2 Acoustic modes in compressible flows
  - 9.3 Characteristic Boundary Conditions

***All assigned material (except 9) is considered part of this course. Project format must be strictly followed and will be assigned in advance and delayed submission will not be graded.***

## **Academic Integrity**

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review Georgia Tech's Honor Code and the student Code of Conduct. Any student suspected of cheating or plagiarism on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations.

## **Accommodations for Students with Disabilities**

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible to set up a time to discuss your learning needs.

## **Student-Faculty Expectations Agreement**

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.