MATH 672-600 Spring 2019

Hydrodynamic Stability: Theory and Computation
(Description below will change shortly)

homepage: http://www.math.tamu.edu/∼daripa/courses/m672/spring19/math672.pdf

Instructor: Prabir Daripa **Email:** daripa@math.tamu.edu
Office: Blocker 629D
Class Room & Time: Blocker 628; TR 9:35 am - 10:50 am
Office Hour: MW 9:00 am - 11:00 am and/or by appointment

Textbook:

1. "Introduction to Hydrodynamic Stability" by P. G. Drazin, Cambridge Univ. Press.

Other references:

1. "Stability and Transition in Shear Flows" by Schmidt and Henningson, Springer.
2. "Hydrodynamic Stability" by Drazin and Reid.
3. "Theory and Computation in Hydrodynamic Stability" by Criminale, Jackson and Joslin, Cambridge Univ. Press.

Audience: Graduate students from any discipline with an interest in the following topics can take this course. This course is concerned with the following topics: (i) basics of stability and bifurcation theory from dynamical systems view point; (ii) linear and nonlinear stability of fluid flows; and (iii) a very brief introduction to transition to turbulence and turbulence. Lectures will be based on various sources including the textbooks listed above. The course will be conducted in part in seminar format.

Grading (tentative): Grading in the course will be based on projects and/or homework assignment.

Prerequisites: Basic knowledge of fluid dynamics (MATH605/AERO601,602/MEEN621 or equivalent) or Approval of the Instructor.

Note to the Students from the Faculty Senate (January 8, 1997): The handouts used in this course are copyrighted. By "handouts," I mean all the materials generated for this class, which include but are not limited to syllabi, quizzes, exams, in-class materials, review sheets, and problem sets. Because these materials are copyrighted, you do not have the right to copy the handouts, unless I expressly grant permission.

As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writing, etc. which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn in as your own, even if you have permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

If you have any questions regarding plagiarism, please contact the latest issue of the Texas A&M University Student Rules, under the section "Scholastic Dishonesty."

GO TO NEXT PAGE →

Broad Course Outline:

Only some of the following topics will be covered.

1. Part I: Introduction to Fundamental Equations of Fluid Dynamics
   - Navier-Stokes equations for Newtonian, generalized non-Newtonian, and viscoelastic fluids
   - Flow equations in porous media
2. Part II: Basic Theory of Linear Stability Analysis
   - Bifurcation theory through ODEs
   - Stability and instability
   - Linearized problems and normal mode analysis
   - Weakly nonlinear dynamics
3. Part III: Application of Linear Stability Analysis
   - Kelvin-Helmholtz and Rayleigh-Taylor instabilities
   - Instability of jets
   - Rayleigh-Benard convection (thermal instability)
   - Swirling flows and centrifugal instability (Taylor-Couette Flow, Taylor-Dean problem, Gortler problem)
   - Saffman-Taylor instability
4. Part IV: Stability in Parallel/Shear Flows
   - Basics: definition of stability, disturbance equation, critical Reynolds numbers, temporal/spatial growth of disturbances etc.
   - Linear inviscid analysis
   - Linear viscous analysis
   - Nonlinear stability/Secondary instability
5. Part V: Assorted Topics (tentative)
   - linear stability theory for multi-layer flows
   - linear stability analysis with diffusion
   - linear stability theory for visco-elastic flows
6. VI: Transition to Turbulence (This in itself is half a semester course)
   - Model equations
   - Lorentz equations:derivation, dynamics and chaos
   - Various discrete maps
   - Various transition scenarios
7. VII: A Brief Introduction to Turbulence
   - What is turbulence? What is chaos?
   - Some probabilistic tools
   - N.S. equations and turbulence
   - Eddy viscosity, multiple scales, cascade of energy, and renormalization
   - Kolmogoroff's (now) famous 1941 theory
   - Intermittency, etc.