**Math 537 - Mathematical Principles of Continuum Mechanics - Fall 2024**
Tu/Th 16:05–17:20 in Ayres 112,

**Instructor:** Dr. Tim Schulze, 224C Ayres Hall, 974-4162, tschulze@utk.edu **Office Hours:** Tu/Th after class.

**Recommended Reading:**

- *A Mathematical Introduction to Fluid Mechanics* by A. J. Chorin & J. E. Marsden.
- *An Introduction to Fluid Dynamics* by G.K. Batchelor.
- *Fluid Mechanics: Volume 6 (Course of Theoretical Physics)* by L.D. Landau & E.M. Lifshitz.
- *Incompressible Flow* by R. L. Panton.
- *Elementary Fluid Dynamics* by D. J. Acheson.
- *Vorticity and Incompressible Flow* by A. J. Majda & A. L. Bertozzi.
- *Album of Fluid Motion* by M. Van Dyke.
- *Perturbation Methods in Fluid Mechanics* by M. Van Dyke.
- *Applied Analysis of the Navier-Stokes Equations* by Charles R. Doering & J. D. Gibbon.

**Course Prerequisites:** Vector calculus, experience solving partial differential equations.

**Course Description:** This course will provide a broad introduction to fluid mechanics and the mathematics associated with it. We will begin by discussing the equations for inviscid fluid flows (the Euler equations) and follow this by a discussion of the case of irrotational flows, where special mathematical techniques can be applied. We will then move on to viscous flows and the Navier-Stokes equations. Emphasis will be placed on exact solutions, asymptotic techniques and an analysis of energy dissipation.

Grading will be based on attendance/participation. There will be some suggested homework, but no exams in this course.

**Dates to note:**

- Sept. 5 - Householder Lecture 4th floor
- Oct. 8 - Fall break, no class
- Nov. 5 - Election Day, no class
- Nov. 28 - Thanksgiving break, no class
- Dec. 3 - Last day of class

## OUTLINE

1. Mathematical description of fluid flow
2. Flows that conserve energy
   (a) The Euler Equations
   (b) Elementary examples
      i. Rotating flows
      ii. Sources and sinks
   (c) General results
      i. Energy conservation
      ii. Kelvin's Circulation Theorem
   (d) Advanced solution techniques
      i. Irrotational flow
      ii. Conformal mapping
3. Flows that dissipate energy
   (a) The Navier-Stokes Equations
   (b) Elementary examples
      i. Parallel flows
      ii. Stagnation point flow
   (c) General results
      i. Energy dissipation
      ii. Vorticity equation
   (d) Advanced solution techniques
      i. Similarity solutions
      ii. Fourier-Laplace transforms
      iii. Asymptotic methods