ChemE 530
Transport I: Emphasis on Fluids

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Theme
To add interest, we will loosely tie the course examples and problems to issues arising in low-intensity acoustic-driven microfluidic devices (hydrodynamic corrals).

Grading
Grades will be determined from the scores on homework (50 pts), two midterms (50 pts each), and a project (100 pts). Due dates for the mid-terms will be around the 4th and 8th week. The project written and oral presentations will be during the final week of class.

Text
The text is Analysis of Transport Phenomena, by W.M. Deen.

Course Outline
1. Vectors and Tensors: Appendix A
   Mainly covered in Chem E 512; but a brief review will be provided.

2. Fluxes and Material Properties: Chapter 1
   Constitutive Equations, transport coefficients, and their interpretation.

3. Conservation Equations: §2.1–2.8
   Derivation of equations for the conservation of mass, momentum, and energy, including jump boundary conditions.

4. Scaling and Approximation Techniques: Chapter 3
   Using mathematical methods (e.g., singular perturbation) and intuition to determine the essential length and time scaling behavior of transport systems.

5. Solution Methods for Conduction and Diffusion Problems: Mostly avoid Chapter 4.
   Numerical solutions using the Finite Element Method software FEMLab.

6. Fundamentals of Fluids: Chapter 5
   Kinematics, stress, statics and dynamics in fluids.

7. Unidirectional and Lubrication Flows: Chapter 6
   Steady and unsteady unidirectional flows. Lubrication flows.

8. Creeping Flows: §7.1–7.4
   Low Reynolds number flows.

9. Laminar Flow at High Reynolds Numbers: §8.1–8.4
   Inviscid, irrotational, and boundary layer flows.