UNIVERSITY OF ARIZONA
DEPARTMENT OF CHEMICAL AND ENVIRONMENTAL ENGINEERING
CHEE 305 – TRANSPORT PHENOMENA
SPRING 2017

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Office hours: Posted on D2L, or by email appointment

Textbook: Class notes, posted on D2L

Objectives

1. To develop a fundamental knowledge of the physical principles that govern the transport of momentum, energy and mass, with emphasis on the mathematical formulation of the conservation principles.

2. To apply the knowledge obtained to the solution of chemical engineering problems involving transport phenomena.

Outline

Part I - Momentum Transport (Fluid Mechanics)

1. The momentum and mass conservation principles. Derivation of velocity distributions from mass and momentum balances.
Previous knowledge on basic concepts of fluid mechanics will be used to solve relatively simple steady-state, one-dimensional flow problems.

2. The principles of conservation of mass and momentum. Mass conservation: the continuity equation. Momentum conservation: the equations of motion. Stresses in a moving fluid. The constitutive equation for a Newtonian fluid. The Navier-Stokes equations.
The conservation principles of mass and momentum will be used to develop general equations that can be used to predict motion and forces for Newtonian fluids.

3. Velocity distributions.
The Navier-Stokes equations will be used to solve momentum transport problems with applications to chemical engineering.

Part II - Energy Transport (Heat Transfer)

1. The principle of conservation of energy. The energy equation. Fourier's law. The thermal energy equation.
The general equations that represent the principle of conservation of energy will be developed.

2. Heat conduction. The energy equation for solids and static fluids. Temperature distributions in one-dimensional heat conduction. Unsteady heat conduction. Two-dimensional heat conduction.
The thermal energy equation will be used to solve problems dealing with static materials (heat conduction).

3. Temperature distributions in moving fluids. Convection.
The thermal energy equation will be used to solve heat transfer problems in moving fluids (heat convection).

Part III - Mass Transport

1. Introduction. Mechanisms of mass transport of a chemical species in a mixture. Diffusion.
The basic mechanisms for transport of a chemical species in a multicomponent mixture will be explored and quantified.

2. The principle of conservation of mass applied to a chemical species in a mixture. The species continuity equation. Fick's law. The convective-diffusion equation.
General equations will be developed for the modeling of mass transfer processes.

3. Diffusion. One-dimensional diffusion. Unsteady diffusion. Diffusion in systems with chemical reactions.
The mass transfer equations will be applied to static materials (diffusion).

4. Concentration distributions in moving fluids.
The mass transfer equations will be applied to model problems in moving fluids (convection).

REFERENCES

1. Bird, R.B., W.E. Stewart, E.N. Lightfoot D.J. Klingenberg, Introduction to Transport Phenomena, Wiley, 2015. An expanded version of this book is the classic work by Bird, Stewart and Lightfoot, Transport Phenomena, 2nd edition, Wiley, 2002.

2. Middleman, S., An Introduction to Fluid Dynamics. Principles of Analysis and Design, John Wiley, 1998.

3. Middleman, S., An Introduction to Mass and Heat Transfer. Principles of Analysis and Design, John Wiley, 1998.

4. Sáez, A.E., J.C. Baygents, Environmental Transport Phenomena, Taylor and Francis, 2014.

5. Welty, J.R., C.E. Wicks, R.E. Wilson and G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 5th edition, Wiley, 2008.

COURSE EVALUATION

Homeworks
There will be homework assignments approximately every week. The final homework average will correspond to 12% of the final grade. Homeworks may be submitted as hard copies or electronically in the corresponding folder on D2L. **Homeworks will not be accepted after class time on the due date.**

Tests
There will be four tests. Each test will correspond to 22% of the final grade. **All tests will be open book and notes.**

Test 1 – Friday, February 17
Test 2 – Friday, March 10
Test 3 – Friday, April 14
Test 4 (final) – Wednesday, May 10 (8-10 am)