THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

Advanced Biological Transport

BIOMEDE 5210

Credit Hours:
3.00 - 3.00

Course Levels:
Undergraduate (1000-5000 level)
Graduate (5000-8000 level)

Course Components:
Lecture

Course Description:
Theoretical and phenomenological derivation and applications of transport (momentum, mass and energy) concepts important for biological systems and motivated by biomedical problems.

Prerequisites and Co-requisites:
Prereq: 4210 or equiv, and Sr standing; or Grad standing; or permission of instructor.

Course Goals / Objectives:
- Define each term in the overall equation of continuity, the equation of continuity for a species, the laws of diffusion, and the Navier-Stokes equation of motion
- Apply momentum and mass balances to describe standard transport problems, and when possible, solve them analytically
- Utilize (and, in certain cases, solve analytically) the same conservation equations to describe biotransport problems

Course Topics:

- Definition of transport processes. Derivation of species mass balance equation and equation of continuity. Fick’s laws of diffusion. Review conservation equations: continuity, momentum, energy, species mass balances. Important dimensionless groups.
- Applications of mass balances: Unsteady diffusion with a heterogeneous reaction (reaction on a surface). Importance of boundary conditions. Multicomponent diffusion: Stefan-Maxwell equations.
- Constitutive relations (Newton’s law of viscosity, non-Newtonian rheology). Applications of momentum balances (Pressure-driven flow; Flow through cylindrical tube; Pulsatile flow through cylindrical tube with rigid walls).
- Modeling the blood oxygenator (Unsteady 1-D diffusion of oxygen in a semi-infinite medium). Modeling the dialysis machine (Artificial kidney; Convective mass transfer with reaction at the boundary).
- Example of convective mass transport. Boundary layer theory.
- Diffusion- vs. reaction-limited mass transfer (Blood platelet transfer to the vessel wall). Unsteady mass transfer with diffusion and reaction (A mutagen bioassay).
- Whole-cell kinetic models (Ligand-receptor kinetics on the cell surface and molecular transport within cells). Mass transport in tissues and organs (Pharmacokinetic models). Biochemical reaction kinetics. Mass transfer through a porous media.
- Presentation of paper projects by student teams.

Designation:

Elective