MTSE 3040- Transport Phenomena in Materials  
(Required) Fall Semester

Catalogue data: Principles of transport phenomena in materials processes including momentum, heat and mass transport.

Prerequisites: Math 3310 and MFET 3450.

Time distribution: 2-1.5 hr classes per week.

Objectives: To provide students with the concepts related to fluid flow, heat and mass transfer and their common applications to specific systems in materials engineering. ABET criterion 3 outcomes 1, 2, 3, 5, 6, 7

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Lectures: T/Th 11:30a.m.-12:50p.m.
Room: NTDP D215
[Makeup lectures will be scheduled for missed class sessions.]

Textbook:

Reference Book

Topics:

I. Fluid Flow (3 weeks)
   Fluxes, Phenomenological laws, and Conservation laws
   Momentum transfer and viscosity
   Convective and diffusive momentum transport

II. Heat Transfer (3 weeks)
   Modes of heat transfer (Conduction, Convection, and Radiation)
   Steady and unsteady state heat conduction
   Heat transfer coefficients
III. Mass Transport (3 weeks)
   Fick's law and diffusivity of materials
   Mass transfer in fluid systems, mass transfer coefficient
   Diffusion as random thermal jumps of atoms (1 d random walk)
   Self-diffusion coefficients
   Vacancy and interstitial mechanisms of self-diffusion
   Diffusion in presence of driving force and mobility
   Interdiffusion and Darken’s equation
   Simple solution of diffusion equation
   Grain boundary and surface diffusion

IV. Similarities, Coupling and Boundary Conditions (2 weeks)
   Coefficients of transfer
   Balance equations
   Coupling of different types of transport
   Solid/Liquid/Gas interfaces

III. Applications in Materials Processing (1 week)
   Liquid-Solid processing
   Solid-Solid processing
   Gas-Solid processing

Grading plan:

(1) Homework 30%
(2) Mid-term examination 30%
(3) Final 40%

Relationship to program Objectives:
The course is integral to program objectives 1 and 2. It provides students opportunities (1) to learn basic science and engineering concepts of transport phenomena (heat, mass and momentum transfer) and apply them to materials processing and (2) to understand the effect of materials processing on properties or quality of material produced.

Prepared by: Zhenhai Xia         Date: August 20, 2019