MAT309 – Transport Phenomena in Materials Processing
3 credits (3 hr lecture +1 hr recitation)

Objective

This course intends to introduce materials science and engineering students to the transport phenomena in materials processing. Transport phenomena is concerned with the subjects of momentum transport (fluid mechanics), energy transport (heat transfer with conduction, convection, and radiation), and mass transport (molecular and convective diffusion in fluids, and solid state diffusion in solids). The course is composed of two parts. Part I will provides introduction to fluid flow, heat transfer, and mass transfer. It includes governing equations and boundary conditions for studying materials processing. Part II covers the several specific applications to materials processing with a brief description of various materials processing technologies such as solidification, crystal growth, phase change, polymer processing, and rheology, and bulk and surface heat treating. Students will also be exposed very briefly to the numerical simulation of transport equations through finite difference formulations and coding with MATLAB. By the end of the course, students will gain mathematical modeling skill that is fundamentally important to have a better understanding of engineering problems involving momentum, heat and mass transport.

Teaching Staff

	Instructor	Teaching Assistant
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Course Schedule

Lectures:

- Monday 1.40 pm – 2.30 am @Room: FENS L029
- Thursday 3.40 am – 5.30 am @Room: FENS L056

Recitation:

- Monday 5.40 pm – 6.30 pm @Room: FENS L065

Textbook and Reference Materials

I will use my own lecture notes complied from different resources.
Textbook:

- R. Byron Bird, Warren E. Stewart, Edwin N. Lightfoot, Transport Phenomena, 2nd Edition, Wiley

Reference Materials:

- James Welty, Charles E. Wicks, Robert E. Wilson, Gregory L. Rorrer, Fundamentals of Momentum, Heat, and Mass Transfer, Wiley; 4 edition (November 2, 2000)
- Anthony F. Mills, Mass Transfer, Prentice Hall
- Sindo Kou, Transport Phenomena and Materials Processing, Wiley

Exams

- Exams will be classical paper-and-pencil type.
- You are allowed to use calculator. Please make sure you have one during the exams. Sharing calculators will not be allowed during the exams.
- Date is announced at the tentative outline section
- Make-up exams will be given only to students with valid excuses. To take a make-up exam you need to present a document about your excuse such as a

medical report or a letter taken from the department/university administration.

Assignments

- There will be 5 homework assignments. This is up to change.
- Assignments should be written clearly. Diagrams or graphs should be given when necessary. They should be clearly labeled and contain enough information so that they can stand alone.

Project

- You will be assigned a project on finite-difference formulations and coding to numerically solve heat transfer equations.
- MATLAB is suggested as the coding platform but you can use any platform for coding after talking to the instructor.
- You will submit your source code and a report to state your formulations, discrete form of equations, knowns, unknowns, etc.

Quiz

- You will have pop-up quizzes during the class hour on the topics. Quizzes will be open notes unless otherwise stated.

Grading

Following is the list of items that will contribute to your final grade. Percentages are up to change and will be finalized at the end of the semester.

- Midterm 30 %
- Final 40 %
- Assignment 15 %
- Quiz 5%
- Project 10 %

Course Policies

- Class attendance is required for your own benefit. It is imperative that you review the coverage of previous weeks prior to coming to class to increase your understanding of the materials to be covered in the class.
- Working with others to learn the material is strongly encouraged. However, it is strictly forbidden to copy answers from one another without putting your efforts to solve them. All graded materials (assignments and project) are intended to be solved or prepared individually. Any instance of giving or receiving aid on these issues will be viewed as a serious offence, which may result in a failing grade for the course and/or referral to the University disciplinary system
- Plagiarism
    - Definition: the practice of taking someone else's work or ideas and passing them off as one's own.
    - Proper citing is suggested to avoid plagiarism
- Latecomers
    - You are allowed to join the class after the class starts.

Tentative Outline

Week 1 – Oct. 3rd, Oct. 6th

A brief introduction to Transport Phenomena
Brief summary of vector mechanics and matrix algebra

Week 2 – Oct. 10th, Oct. 13th

Suffix notation, Summation convention (Einstein notation)
Gradient of a scalar, divergence and curl of a vector
HW1

Week 3 – Oct. 17th, Oct. 20th

Gradient of a vector, divergence and curl of a tensor
Integral theorems for vectors and tensors: Divergence and stokes theorems

Week 4&5 – *Oct. 24th**, Oct. 27th, Oct. 31st, Nov. 3rd

Introduction to Fluid Flow
Boundary and Interfaces Conditions
Emphasizing the similarities among transport equations
HW2
**This class will be rescheduled according to the common free hours*

Week 6&7 – Nov. 7th, Nov. 10th, Nov. 14th, Nov. 17th

Introduction to Heat Transfer
Boundary and Interfaces Conditions
HW3

Week 8 – Nov. 21st, Nov. 24th

Midterm Exam (Nov. 24th)

Week 9&10 – Nov. 28th, Dec. 1st, Dec. 5th, Dec. 8th

Introduction to Mass Transfer
Boundary and Interfaces Conditions
HW4

Week 11&12 – Dec. 12th, Dec. 15th, Dec. 19th, Dec. 22nd

Introduction to numerical simulation of transport equations using finite difference
Project (week 11)

Week 13&14 – Dec 26th, Dec 29th, Jan 2nd, Jan 5th

Applications of Transport Phenomena in Materials Processing
Selected Materials Processing Technologies: injection molding; compression molding; prepreg curing; flow through porous media with a support of a software
HW5