ME 608: Numerical Methods in Heat, Mass, and Momentum Transfer

Spring 2018 (Schedule: MWF 3:30 – 4:20 pm, Venue: WANG 2555)

Version 1.0 (12/18/2017)

INSTRUCTOR **Dr. Partha P. Mukherjee**

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OFFICE HOURS **Monday & Wednesday: 4:30 PM – 6:00 PM** or by appointment.*
**Note that I try to be really prompt in responding via email. If you have a quick question, send me an email.*

GRADING POLICY

Homework/Quiz	40%
Final Examination	20%
Project	40%

Grade	Point
A+	96 – 100
A	91 – 95
A-	86 – 90
B+	81 – 85
B	76 – 80
B-	71 – 75
C+	66 – 70
C	61 – 65
C-	56 – 60
D	<= 55
F	<= 45

Your cumulative score will be calculated up to two decimal places. Scores falling in the "gray" areas will be assigned the grade corresponding to the score rounded off to one decimal.

RESOURCE Lectures will be developed based on multiple resources including research papers, and chapters from relevant textbooks. The following can be referred to additionally.

1. "Numerical Heat Transfer and Fluid Flow," Patankar (CRC Press)
2. "An Introduction to Computational Fluid Dynamics: The Finite Volume Method," Versteeg and Malalasekera (Pearson)

PREREQUISITES Strong analytical background; engineering mathematics (partial differential equations); programming skills; discussion with and approval from the instructor.

LEARNING OUTCOMES ***The focus of the course will be on learning the fundamental concepts of numerical solution of transport phenomena (heat, mass, momentum) problems with a goal to develop the ability for sound analysis*.** After finishing this course, the students should have the following ability.

1. Understand the mathematical description of advection-diffusion-reaction system;
2. Comprehensive grasp on the basics of finite volume method;
3. Gain knowledge on numerical solution of transport phenomena, involving species, charge, thermal, and fluid flow characteristics.

PROJECT The project, based on numerical analysis and simulation of multi-physics phenomena, is an integral part of this course. You can choose your own group members (group size limited to 4). Each course project will be designed based on discussion with the instructor. The formal written report and presentation will constitute a significant part of your grade.

Project Milestone (tentative schedule)

Milestone	Breakdown	Due Date
Team List (email to instructor)	-	2nd week
Topic Selection (title and brief description of the project objective)	5	3rd week
Progress Report (4-page report including the problem statement, objective, task list with tentative schedule per task and preliminary results)	10	7th week
Draft Report	15	11th week
Final Report and Group Presentation	70	Last day of class
Total points	100	

SUBMITTED WORK	All submitted work should be presented in a clear, professional manner and must follow given format; should include a restatement of the problem, appropriate diagrams with all variables defined, a detailed, step-by-step solution, and all final answers clearly identified.
IMPORTANT DATES	FINAL EXAM: As per final-exam schedule or TBA
FERPA	Grades cannot be discussed via email or phone. All discussions will require to be held in the office of the instructor and in person. Your grades can be viewed through the Blackboard Learn portal.
ONLINE STUDENTS	The course project teaming arrangement will be discussed and appropriate adjustments may be made as needed.

Table of Content

1. Introduction
    a. Mathematical description of physical phenomena
    b. Overview of numerical methods
2. Finite Volume Method (FVM)
    a. Control volume constructs for advection-diffusion-reaction systems
    b. Discretization and schemes
    c. Solution algorithm
3. Diffusion
    a. Species transport
    b. Charge transport
    c. Thermal transport
4. Advection
    a. Fluid flow and momentum transport
    b. Convective heat transfer
    c. Solute transport
5. Transport in porous media
    a. Effective medium approximation
    b. Effective transport property estimation
6. Coupled transport phenomena (example problems and course projects)
    a. Coupled species and charge transport
    b. Thermal and fluids analysis