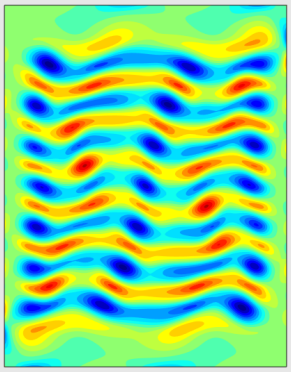

Computational Heat Transfer

ME 5351

Course Info

Mon & Wed 2:30 pm - 4:25 pm

Online: Zoom

Prereq:
ME 3332 (Fluid Mechanics)
ME 3333 (Heat Transfer)
Working knowledge of computer programming

Course materials: Canvas

Instructor Info

Prof. Jeff Tithof

Office Hrs: Wed 9:30 - 10:30 am

Office: Zoom

tithof@umn.edu

TA Info

Mahsa Mirzaee

Office Hrs: Thur 10 - 11 am

Office: Zoom

mirza039@umn.edu

Overview

This course is intended for senior undergraduates and beginning graduate students interested in computer–based analysis of engineering problems in fluid mechanics and heat transfer. Traditionally, our ability to solve problems of engineering and scientific interest has been limited to a handful of analytical techniques – separation of variables, Green's functions, Fourier analysis, etc. Numerical simulation has rendered much of these restrictions obsolete. The coupling of numerical methods, physics, and modern computing hardware has facilitated numerical solutions as a new form of science. ME 5351 will take you beyond the trivial problems you encountered in your junior-level fluid mechanics and heat transfer courses.

You will be responsible for writing computer programs to solve problems involving steady and unsteady conduction, fully-developed flows, and unsteady, quasi-turbulent flows. Introduction to use of state-of-the-art computer tools for analysis and graphical representation of results will give you a broad view of computational transport phenomena in the fluid/thermal sciences. Successful completion of this course will equip you with the knowledge and skills needed to solve a wide variety of problems related to thermal science and transport phenomena.

Material

No Required Text

- Class notes will be adequate

Recommended Text

- Hoffman, K. A. and Chiang, S., "Computational Fluid Dynamics Volume I", 4th ed.
- Pletcher, R. H., Tannehill, J. C., and Anderson, D. A., "Computational Fluid Mechanics and Heat Transfer", 3rd ed.

Grading Scheme

70% Homework (Approximately 5 Coding Assignments)

30% Final Project

Course topics

- Introduction to numerical methods
- Finite differences (major emphasis)
- Implementation of numerical methods
- Ordinary differential equations
- Partial differential equations
- Specification of boundary conditions
- Stability, convergence, and accuracy
- Conductive heat transfer
- Solutions of the Navier-Stokes equations
- Convective heat transfer
- Nonlinear transport phenomena
- Introduction to turbulent flow (if time permits)

Completing Assignments

You will be asked to develop numerical solutions to physical problems, each based on a problem statement containing mathematical equations. Each assignment may require a variety of numerical approaches, and you will make use of your computer programming knowledge and skills. Although you may be “rusty" at the start of the course, you will be a strong coder by the end of the semester. You are welcome to use any coding language you like (such as Matlab, python, C++, Fortran, etc.). Note that examples throughout the duration of the course will be presented using Matlab. For each assignment, you will need to obtain the numerical solutions and generate plots/videos that convey the results. Each assignment must be submitted in the form of a presentation (PDF or Powerpoint formats are acceptable) which contains your interpretation of results and answers to specific assigned questions.

Academic Integrity

General statement. The University of Minnesota Student Conduct Code is central to the ideals of this course. Students are expected to be independently familiar with the Code and to recognize that their work in the course is to be their own original work that truthfully represents the time and effort applied. Violations of the Code are most serious and will be handled in a manner that fully represents the extent of the Code and that befits the seriousness of its violation. It is emphasized that students should beware of websites that advertise themselves as being “tutoring websites." It is not permissible to upload *any* course materials to these sites or copy material from such sites for your own assignments.

Specific guidelines. Collaboration with other students can be immensely beneficial for learning and is encouraged. However, each student must independently develop his/her own simulation codes, interpret those results, and compile those results into a presentation which is submitted. Discussing particular algorithms or expected trends in data is acceptable. Any action involving copy-and-paste or explicit duplication of another student’s work, even if proceeded by revision, constitutes academic dishonesty.

Policies Around Zoom Recordings

This course will include video and audio recordings of class lectures and classroom activities. These recordings will be used for educational purposes, and Professor Tithof will make these available to students currently enrolled in this course. Students must seek instructor permission in order to share either course recordings or course content/materials. Similarly, instructors who wish to share zoom recordings with other sections or classes must seek and document permission from students whose image or voice are in these recordings.

Make-up Policy

If you are facing challenging or unexpected circumstances, especially as outlined by the University of Minnesota’s Policy for Make-up Work, that prevent you from submitting an assignment on time, please contact Professor Tithof to discuss the possibility of an extension. The likelihood of obtaining an extension is much higher if you contact Professor Tithof *in advance of the due date*. Sending an email without confirmation does not guarantee an extension.

Diversity and Inclusivity Statement

Professor Tithof is committed to fostering an inclusive teaching and learning environment for everyone, regardless of identity. This is in alignment with the University’s Board of Regents Policy that provides equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, veteran status, sexual orientation, gender identity, or gender expression.

Accommodations for Students with Disabilities

The University of Minnesota views disability as an important aspect of diversity and is committed to providing equitable access to learning opportunities for all students. The Disability Resource Center is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations. If you have a disability that could impact your learning in this class, please bring this to Professor Tithof’s attention as soon as possible, so that he can make sure your accommodation(s) is (are) in place as soon as possible. Feel free to reach out to Professor Tithof to discuss modifying accommodations at any time during the semester. Further information is available from the Disability Resource Center website or by calling 612-626-1333.