Syllabus for ME412: Numerical Thermo-Fluid Mechanics

Spring 2024, Mechanical Science and Engineering, University of Illinois at Urbana-Champaign
Mondays, Wednesdays, and Friday during 1:00 to 1:50pm in Transportation Building 112

Instructor: Prof. Kyle C. Smith LuMEB 3048 kcsmith@illinois.edu

Course TA: Colby Warden cwarden2@illinois.edu

Prerequisites: This course assumes undergraduate knowledge of fluid mechanics (ME 310 or TAM 335) and heat transfer (ME 320).

Office Hours: In-person office hours will be held during 3:30 to 4:30 pm Wednesdays in LuMEB 3048.

Course Description: This dual-level course introduces basic concepts in computational simulation of fluid dynamics and heat transfer (i.e., computational fluid dynamics or CFD) using a project-based format wherein students exercise theory and practice by (1) performing computer-based simulations with commercial software, (2) implementing and testing associated methods in computer code, and (3) deriving and analyzing the formulas that embody the associated methods. Numerical methods for solving the equations governing steady and unsteady incompressible flow and conduction and convection heat transfer in steady and unsteady fluid flows, including the finite-difference and finite-volume methods, basic algorithms, and applications to real-world fluid-flow and heat-transfer problems.

Textbook: While there is no required textbook for the course, students may find readings from the following reference beneficial as a supplement to the material covered during lecture: Anderson, D., Tannehill, J.C., Pletcher, R.H., Munipalli, R., and Shankar V., *Computational Fluid Mechanics and Heat Transfer*, 4th Edition, CRC Press (2020).

Lectures: This course will meet for lecture three times weekly for 50 minutes each. Lecture sessions will be in-person in Transportation Building 112, unless indicated otherwise on the Course Schedule. Lectures 1 through 32 are intended for 3-credit students, while all lectures are intended for 4-credit students. Students are expected to attend in-person lectures, unless enrolled in an online section. While I will post notes and lecture recordings on the ME412 Canvas site after lecture, students are encouraged to take their own notes.

Laboratory: On-campus sections of the course will meet 5 times for laboratory sessions held in Engineering Hall (EH) 406B1 during 1:00 to 2:50 pm bi-weekly on Fridays. Prior to each session, a recorded tutorial of the particular Simulation Project to be completed using Ansys Fluent will be made available on Canvas. During each session the Course TA will be available for tutorial help while students use the session to work on their own Simulation Project individually. Ansys Fluent will be available on computers in EH 406B1, MEL 1001, and MEL 1009, and remotely via FastX (see Canvas).

Graded Assignments: Student grades will be determined as a weighted average of the assignments listed below. The number of assignments to be completed is shown for 4-credit students and for 3-credit students in parentheses. Final grades will be assigned based on separate distributions for graduate and undergraduate students.

- **5 (4) Code Projects** will be completed to exercise and implement concepts from lecture in computer code, while debugging the associated code and verifying, characterizing, analyzing, and communicating the associated results (42% overall).
- **5 (4) Simulation Projects** will be completed to exercise the use of computational fluid dynamics using the established software Ansys Fluent, while verifying, characterizing, analyzing, and communicating the associated results (33% overall).
- **16 (12) Homework Assignments** will be completed to reinforce and exercise theoretical concepts from lecture (25% overall).