ME498CF1/CA1/CA3 · Tools of Computational Mechanics · Fall 2016

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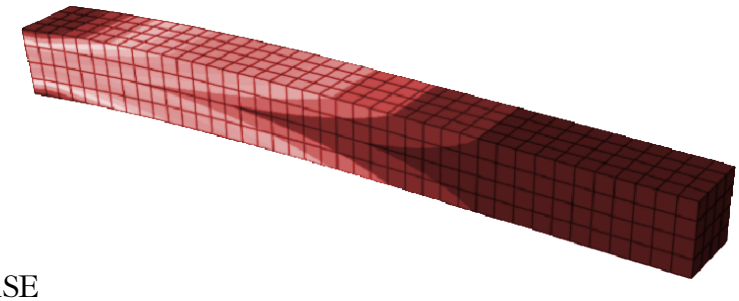
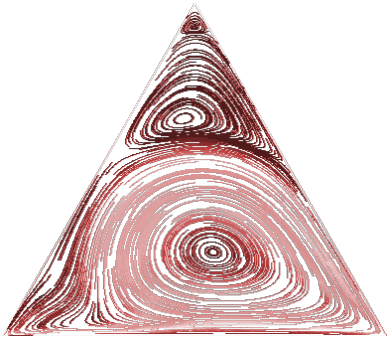


URL go.illinois.edu/me498cf

Lecture/Lab MEL 1001 · 2:00–3:20 · Tue/Thu

Office Hours MEL 1001 · 3:30–4:30 · Tue/Thu

Online Forum *Piazza*



Summary

This course will provide an opportunity for students who have been introduced to principles of finite element analysis and computational fluid dynamics (by taking ME 412, ATMS 502, ME 554, etc.) to learn the basic and intermediate functionality of widely used commercial mechanics packages. The course will cover the finite element analysis package *3DS Abaqus FEA* and the computational fluid dynamics package *ANSYS Fluent CFD*.

The course will be taught Tuesdays and Thursdays in 1h20m applied lecture sections, with lab hours and an online forum available for consulting and exercise help. Applied lectures will introduce modeling methods and software capabilities as well as feature the hands-on demonstration of fundamental principles and techniques. Students will apply the principles to short exercises and projects for each package.

The course will be broken into three discrete units, one credit hour being available for each software package and another for the term projects. The class will be taught in two nonconsecutive five-week units devoted to each package (see *Course Outline & Schedule* for more details).

Fluent	Aug 22–Sep 23	(10 lectures)
Abaqus	Oct 17–Nov 18	(10 lectures)
Projects	Sep 26–Oct 13	Fluent
	Nov 28–Dec 15	Abaqus

Prerequisites

Familiarity with computational methods; exposure to underlying principles of fluid dynamics and structural mechanics. Essentially, the standard set of 300-level courses in fluid flow, heat transfer, and continuum mechanics offered within AE, CEE, MatSE, MechSE, and NPRE.

Required Text

Fluent ANSYS Fluent CFD documentation

Abaqus 3DS Simulia Abaqus 6 FEA documentation (requires account)

Auxiliary Texts & Resources

Abaqus 3DS Academy learning materials (requires account)

A. Khennane (2013) *Introduction to Finite Element Analysis Using MATLAB and Abaqus*. Boca Raton, Florida: CRC Press.

F. Moukalled *et al.* (2016) *The Finite Volume Method in Computational Fluid Dynamics*. Berlin: Springer-Verlag.

P. J. Roache (1998) *Fundamentals of Computational Fluid Dynamics*. Albuquerque, New Mexico: Hermosa.

CFD-Online wiki and forums

Illinois Compass 2g will be used for students to privately monitor grades and course progress.

Attendance

Laboratory The primary class meetings will consist of applied laboratory exercises, in which the instructor will introduce software features, discuss algorithmic underpinnings as appropriate, and guide students through exercises designed to illustrate features and applications in engineering modeling.

Office Hours The EWS lab will be reserved for students to work on their projects using the required software. Teaching assistants will be present to answer questions. The lab block may occasionally be used to make up lectures missed due to instructor travel or class cancellation. The instructor will be available for consultation as well.

Software

The software products required for this course are available in Engineering WorkStation (EWS) computer laboratories, and no purchase is required to complete any element of this class. EWS also supports remote access via the command line or Citrix.

ANSYS (Webstore)—includes the Workbench and Fluent.
Abaqus (Webstore) (Student Edition)

Assessment

Labs Attendance and participation will be assessed via in-class labs, which may be instructor-guided or self-guided as appropriate. Labs collectively constitute 40% of the grade. Labs should be completed during class and handed in at the end of class or the beginning of the next class.

Exercises Student understanding will be assessed through four exercise sets for each software package, intended to elicit insight into the application's design and operation. Exercises collectively constitute 60% of the grade. Homework should be submitted in soft or hard copy prior to 5:00 p.m. on the due date. Late submissions will be penalized 10% of total project score per day.

Examinations None.

Grading Letter grades will be assigned based on student performance within each credit hour of the course; each credit hour will be graded independently of the others. Grade cutoffs may be adjusted based on clusters in aggregate student performance; however, students with a percentage score above 90% are guaranteed an A or A–, those above 80% guaranteed a B+, B, or B–, etc.

Citation Policy

Students are responsible for their own work, although collaboration is encouraged. Each student must carry out all calculations him- or herself and write and compose his or her own report. Plagiarism will not be tolerated, and may result in academic sanctions and in all parties receiving no credit on the exercise. Although you may share work or utilize online resources, *citations are required* for any outside resources with a strong influence on your work, and you *may not copy* work. If you have any questions, review the University policy on academic integrity or ask the instructor.

Course Outline & Schedule

The course is decomposed into three logical units, one for each software package and another spanning two three-week projects. (This outline and schedule are subject to revision.)

ANSYS Fluent CFD for Computational Fluid Dynamics [CF1]

1	Finite volume method workflow	Tue, Aug 23		
2	Preprocessing I	Thu, Aug 25		
3	Preprocessing II/Coupling physics	Tue, Aug 30		
4	Boundary conditions	Thu, Sep 1	Homework 1	Fri, Sep 2
5	Transient simulation/V&V	Tue, Sep 6		
6	Turbulent flow	Thu, Sep 8	Homework 2	Fri, Sep 9
7	Compressible flow	Tue, Sep 13		
8	Scripting/HPC	Thu, Sep 15	Homework 3	Fri, Sep 16
9	Chemical reactivity	Tue, Sep 20		
10	Applications	Thu, Sep 22	Homework 4	Fri, Sep 23

Fluent Project [CA3]

Mon, Sep 26–Fri, Oct 14

3DS Simulia Abaqus FEA for Structural Analysis [CA1]

1	Finite element analysis workflow	Tue, Oct 18		
2	Meshing & elements	Thu, Oct 20		
3	Loading & analysis	Tue, Oct 25		
4	Coupling physics	Thu, Oct 27	Homework 1	Fri, Oct 28
5	Material & yield models	Tue, Nov 1		
6	Contact analysis	Thu, Nov 3	Homework 2	Fri, Nov 4
7	Transient simulation	Tue, Nov 8		
8	Applications	Thu, Nov 10	Homework 3	Fri, Nov 11
9	Batch programming & scripting	Tue, Nov 15		
10	Applications	Thu, Nov 17	Homework 4	Fri, Nov 18

Abaqus Project [CA3]

Mon, Nov 28–Fri, Dec 16 (negotiable)