

ME 702 Introduction to Computational Fluid Dynamics

UNLV Department of Mechanical Engineering

Days and Time: Tuesday-Thursday, 4:00 PM – 5:15 PM, TBE B153

Text: Essential Computational Fluid Dynamics, O.Zikanov, Wiley & Sons, 2010.

Course Description:

This course is intended for the graduate engineer or scientist who is interested in the numerical solution of fluid dynamics problems. Solutions to the equations of motion that describe fluid flow do not exist except for idealized conditions. In this course, the governing equations will be transformed to algorithmic statements that can be solved using computational techniques. Numerical schemes illustrating finite difference, finite volume, and finite element techniques to solve both the incompressible and compressible equations of motion will be covered. Problems of engineering interest will be examined. A class CFD project will be given requiring use of a computational code (MATLAB, FORTRAN or C/C++). FLUENT, COMSOL and ANSWER, commercial CFD codes, will be introduced. The course will consist of Midterm (35%), Final (45%), project (20%)

Course Learning Outcomes:

By the end of this course, students will be able to:

1. Transform governing equations into algorithmic statements that can be solved using computational techniques.
2. Use finite difference methods to solve fluid dynamics problems.
3. Use finite volume methods to solve fluid dynamics problems.
4. Use finite element techniques to solve fluid dynamics problems.
5. Solve incompressible and compressible equations of motion using numerical techniques.
6. Use a commercial software code for a class project.

References:

Reference Books:

Computational Fluid Dynamics, J. D. Anderson, McGraw-Hill, 1995

Computational Fluid Dynamics for Engineers, Hoffmann & Chang, Engr. Edu. Sys., 1993

Computational Fluid Mechanics and Heat Transfer, Anderson, et al, 2nd Ed., Taylor & Francis, 1997

Computational Heat Transfer, Jaluria & Torrance, Hemisphere, 1986

Fundamentals of Computational Fluid Dynamics, Roache, Hermosa, 1998

Handbook of Numerical Heat Transfer, Minkowycz, et al, Wiley, 1988

The Finite Element Method: Basic Concepts & Appl., Pepper & Heinrich, Hemisphere, 2nd ed., 2006

Turbulence Modeling for CFD, D. Wilcox, DCW Industries, 1993

Summary Course Outline

WK	MTG	DAY	DATE	TOPIC	CHPT	HW
1	1	Tu	8/25	Introduction and Review	1	
	2	Thrs	8/27			
2	3	Tu	9/1	PDE's, Transport Eqs	2	2.6
	4	Thrs	9/3	Eqs of Motion	3	
3	5	Tu	9/8	Finite Difference Methods (FDM)	4	3.1,3.3,3.4
	6	Thrs	9/10			
4	7	Tu	9/15	FDM Applications		4.1,4.5,4.7
	8	Thrs	9/17			
5	9	Tu	9/22	FDM Applications con't		4.11
	10	Thrs	9/24			
6	11	Tu	9/29	Control Volume Method (CVM)	5	5.1,5.2,5.3
	12	Thrs	10/1			
7	13	Tu	10/6	CVM Applications	6	6.3,6.5
	14	Thrs	10/8	Stability Analysis		
8	15	Tu	10/13	Review	7,8	7.3,7.6
	16	Thrs	10/15	MID-TERM QUIZ		
9	17	Tu	10/20	Finite Element Technique (FEM)	9	notes
	18	Thrs	10/22			
10	19	Tu	10/27	Fluid Flow with Heat Transfer	10	notes
	20	Thrs	10/29			
11	21	Tu	11/3	Incompressible Flow Methods	11	notes
	22	Thrs	11/5			
12	23	Tu	11/10	Turbulence Modeling	9	notes
	24	Thrs	11/12			
13	25	Tu	11/17	Compressible Flow	12	notes
	26	Thrs	11/19			
14	27	Tu	11/24	Grids		
	28	Thrs	11/26	Thanksgiving		
15	29	Tu	12/1	CFD Project Presentations		
	30	Thrs	12/3	CFD Project Presentations, Review		
16	31	Tu	12/8	FINAL		

Library Resources

- Students may consult with a librarian on research needs. For this class, the subject librarian is Sue Wainscott. (https://www.library.unlv.edu/contact/librarians_by_subject). UNLV Libraries provides resources to support students' access to information. Discovery, access, and use of information are vital skills for academic work and for successful post-college life. Access library resources and ask questions at <https://www.library.unlv.edu>.

Policies:

Academic Misconduct—Academic integrity is a legitimate concern for every member of the campus community; all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy and are encouraged when faced with choices to always take the ethical path. Students enrolling in UNLV assume the obligation to conduct themselves in a manner compatible with UNLV's function as an educational institution.

An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another, from the Internet or any source, without proper citation of the sources. See the *Student Academic Misconduct Policy* (approved December 9, 2005) located at: <https://www.unlv.edu/studentconduct/student-conduct>.

Copyright—The University requires all members of the University Community to familiarize themselves **with** and to follow copyright and fair use requirements. **You are individually and solely responsible for violations of copyright and fair use laws. The university will neither protect nor defend you nor assume any responsibility for employee or student violations of fair use laws.** Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional information can be found at: <http://www.unlv.edu/provost/copyright>.

Disability Resource Center (DRC)—The UNLV Disability Resource Center (SSC-A 143, <http://drc.unlv.edu/>, 702-895-0866) provides resources for students with disabilities. If you feel that you have a disability, please make an appointment with a Disabilities Specialist at the DRC to discuss what options may be available to you. If you are registered with the UNLV Disability Resource Center, bring your Academic Accommodation Plan from the DRC to the instructor during office hours so that you may work together to develop strategies for implementing the accommodations to meet both your needs and the requirements of the course. Any information you provide is private and will be treated as such. To maintain the confidentiality of your request, please do not approach the instructor in front of others to discuss your accommodation needs.

Religious Holidays Policy—Any student missing class quizzes, examinations, or any other class or lab work because of observance of religious holidays shall be given an opportunity during that semester to make up missed work. The make-up will apply to the religious holiday absence only. It shall be the responsibility of the student to notify the instructor within the first 14 calendar days of the course for fall and spring courses (excepting modular

courses), or within the first 7 calendar days of the course for summer and modular courses, of his or her intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit: <http://catalog.unlv.edu/content.php?catoid=6&navoid=531>.

Transparency in Learning and Teaching—The University encourages application of the transparency method of constructing assignments for student success. Please see these two links for further information:

<https://www.unlv.edu/provost/teachingandlearning>

<https://www.unlv.edu/provost/transparency>

Incomplete Grades—The grade of I—Incomplete—can be granted when a student has satisfactorily completed three-fourths of course work for that semester/session but for reason(s) beyond the student's control, and acceptable to the instructor, cannot complete the last part of the course, and the instructor believes that the student can finish the course without repeating it. The incomplete work must be made up before the end of the following regular semester for undergraduate courses. Graduate students receiving "I" grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the time indicated, a grade of F will be recorded and the GPA will be adjusted accordingly. Students who are fulfilling an Incomplete do not register for the course but make individual arrangements with the instructor who assigned the I grade.

Tutoring and Coaching—The Academic Success Center (ASC) provides tutoring, academic success coaching and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, visit <http://www.unlv.edu/asc> or call [702-895-3177](tel:702-895-3177). The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of the SSC (ASC Coaching Spot). Drop-in tutoring is located on the second floor of the Lied Library and College of Engineering TEB second floor.

UNLV Writing Center—One-on-one or small group assistance with writing is available free of charge to UNLV students at the Writing Center, located in CDC-3-301. Although walk-in consultations are sometimes available, students with appointments will receive priority assistance. Appointments may be made in person or by calling 702-895-3908. The student's Rebel ID Card, a copy of the assignment (if possible), and two copies of any writing to be reviewed are requested for the consultation. More information can be found at: <http://writingcenter.unlv.edu/>.

Rebelmail—By policy, faculty and staff should e-mail students' Rebelmail accounts only. Rebelmail is UNLV's official e-mail system for students. It is one of the primary ways students receive official university communication such as information about deadlines, major campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the university. Students' e-mail prefixes are listed on class rosters. The suffix is always @unlv.nevada.edu. **Emailing within WebCampus is acceptable.**

Final Examinations—The University requires that final exams given at the end of a course occur at the time and on the day specified in the final exam schedule. See the schedule at: <http://www.unlv.edu/registrar/calendars>.