

MAE 633 – Computational Fluid Dynamics
Mechanical and Aerospace Engineering Department – West Virginia University
Spring 2022, MWF 1:00 – 1:50 PM, 756 ESB

Instructor: Dr. Christopher Griffin, Teaching Assistant Professor, MAE Dept.
Office Hours: Mondays 11 – 12 PM, Wednesdays 2 – 3 PM, or by appointment (open door policy)
Office Hours Zoom Link: <https://wvu.zoom.us/j/97377393687>
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Course Description

This course is an intermediate-level graduate course on computational fluid dynamics (CFD) primarily based upon finite difference and finite volume methods applied to fluid flow and heat transfer problems in engineering. The students will have access to the commercial code ANSYS Fluent. They will also develop their own programs for solving heat transfer and fluid flow problems. The course will introduce methods for discretization, review numerical methods for solving systems of equations, techniques for grid development, and solution analysis. Techniques for modeling turbulence will also be discussed.

Course Prerequisites: MAE 532: Dynamics of Viscous Fluids or equivalent
Knowledge of computer programming (Fortran, Matlab, Python, etc...)

Course Textbook: An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd Edition by H. K. Versteeg and W. Malalasekera

References: Computational Fluid Dynamics: The Basics with Applications, JD Anderson, McGraw-Hill
Computational Fluid Dynamics: A Practical Approach, Jiyuan Tu, Guan-Heng Yeoh, and Chaoqun Liu, Elsevier

General Course Outline

- Review of the Governing Equations of Fluid Flow
- Classification of Partial Differential Equations
- Finite Difference Method
- Finite Volume Method
- Mesh Generation and Boundary Conditions
- Numerical Solutions to Algebraic Equations
- CFD Solution Analysis
- Turbulence Modeling

Grading

The final grade in the course will be assigned on the following basis:

Homework/Quizzes	10%
Semester Project	15%
Exam 1	25%
Exam 2	25%
Final Exam	25%

Final course grade will be submitted as: A (≥89.5%), B (≥79.5%), C (≥69.5%), D (≥59.5%), F (<59.5%)

NOTE: A final course score of 59.4% and below is a letter grade of “F”, whether you are graduating or not, have a job lined up or not. No exceptions.

Key Course Objectives

It is the intent of this course that:

1. Students will develop the skills necessary to apply the governing equations of fluid flow to specific applications and transform those equations for numerical analysis.
2. Students will have the ability to develop meshes for computational analysis.
3. Students will gain hands-on experience with the commercial solver ANSYS Fluent.

Key Course Learning Outcomes

Through satisfactory completion of homework, quiz and exam problems, as well as through classroom discussion, successful students will be able to:

1. Discretize the governing equations of fluid flow using finite difference and finite volume methods.
2. Develop meshes for specific fluid flow applications.
3. Solve a system of equations using numerical methods.
4. Appreciate the importance of solution validation.
5. Post-process solution data for presentation.

Spring 2022 General Academic Calendar Key Dates

JAN 10	First Day of Classes	APR 14	Last Day to Drop/Withdraw
JAN 14	Last Day to Modify Courses	APR 15	Spring Holiday (No Classes)
JAN 17	Martin Luther King, Jr. Day (No Classes)	APR 29	Last Day of Classes
MAR 4	Mid-Check Grades Due	MAY 5, 2PM	Final Exam
MAR 12-20	Spring Recess (No Classes)		

Engagement Policy

There is no doubt we are in very unusual times. I appreciate all of you continuing your education despite the obstacles that we all are facing. I hope none of us gets sick, I also hope no one close to us gets sick, but I am prepared to work with anyone that may need to miss lectures or assignments due to COVID-19 or any other serious issue. I encourage you to reach out to me as soon as an issue arises so we can work out a plan to keep you up to speed and allow you to finish the course.

Assignment Policy

All assignments are due at the beginning of the assigned period, including electronically submitted material. Make-up exams and late assignments will **NOT** be accepted without **prior approval granted at least 2 days before the due date** from the instructor, consistent with WVU policies. Neat work is expected on all material submitted for grading (i.e. have to be able to read it to grade it). **Multiple sheets must be stapled, problems in the order assigned, and name and mailbox number must be on top of first page.** You may use engineering problem paper or standard notebook paper, but NOT scratch paper or paper torn from a spiral notebook and write on only one side of each page. All assignments turned in for grading must be your own individual work; copying homework is unethical.

Academic Integrity

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, instructors will enforce rigorous standards of academic integrity in all aspects and assignments of their courses. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the [West Virginia University Academic Integrity Policy \(https://provost.wvu.edu/governance/academic-standards-resources/academic-integrity-policy\)](https://provost.wvu.edu/governance/academic-standards-resources/academic-integrity-policy). Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see your instructor before the assignment is due to discuss the matter.

Statler College Policy of Academic Integrity

(Approved by the Statler College Academic Standards Committee, 28 March 2019)

Case	Violation	Penalty
1	Cheating or plagiarism on minor course element (e.g., quiz, weekly lab report, homework as specified in the syllabus)	Report of academic dishonesty Grade of zero on the entire minor course element Possible one-letter reduction in final grade
2	Cheating or plagiarism on a major course element (e.g., exam, project)	Report of academic dishonesty Grade of zero on the entire major course element Possible additional one-letter reduction in final grade Possible UF† recommendation Possible exclusion from further participation in class
3	Collusion on major course element	Report of academic dishonesty Exclusion from further participation in class Failure in the course Recommendation for UF†
4	Other (document alteration, tampering with records, etc.)	Report of academic dishonesty Grade of zero on the entire major course element Possible additional one-letter reduction in final grade Possible failure in the course Possible exclusion from further participation in class Possible UF† recommendation
* Dismissal from Statler College is permanent for Academic Integrity violations. Student conduct violations can be considered in dismissal.		
† UF - Unforgivable F Grade; cannot be replaced under D-F repeat policy.		
‡ Separable sanctions (e.g., dismissal from Statler College, suspension, or expulsion from WVU) will be recommended for aggravated or second AI offenses.		
§ Warning letters may be issued from the Statler College or the WVU Office of Student Conduct.		
Sanctions will be assessed at the instructor and at the college/university levels. Additional sanctions may be assigned at the level of the instructor, college, and/or university.		
FORBIDDEN on Exams and Quizzes: The use of programmable calculators or smart devices (including smart-phones, smart watches, tablets, cameras, wearable devices, etc.) is prohibited unless specifically indicated by the instructor.		

Adverse Weather Statement

In the event of inclement or threatening weather, everyone should use his or her best judgment regarding travel to and from campus. Safety should be the main concern. If you cannot get to class because of adverse weather conditions, you should contact your instructor as soon as possible. Similarly, if your instructor(s) are unable to reach the class location, they will notify you of any cancellation or change as soon as possible, using WVU MIX email to prevent students from embarking on any unnecessary travel. If you cannot get to class because of weather conditions, instructors will make allowances relative to required attendance policies, as well as any scheduled tests, quizzes, or other assessments.

Appropriate Use of Technology Statement

Use of technology in the classroom should always be directly related to class activities and/or course learning outcomes. Inappropriate technology use can be an impediment to learning and a distraction to all members of the class. As such, inappropriate use of technology in the classroom may be considered a disruption of the class and constitute a violation of the [WVU Student Conduct Code](#) and could potentially result in a referral to the Office of Student Conduct. Use of technology in the classroom when specifically prohibited by the instructor may also constitute a violation of [WVU's Academic Integrity](#) policy.

Campus Safety Statement

The WVU Police are committed to creating and maintaining a safe learning environment for all students, faculty, and staff. Part of this mission includes educating the campus community on how to respond to potential campus threats, such as the threat of an active shooter on campus or other suspicious behaviors. Fortunately, WVU Police offer training - both online and in-person - on how to handle a variety of campus safety scenarios. All students are

encouraged to visit the [WVU Police webpage](#), in particular the content under the [Active Shooter](#) training program. Students are also encouraged to report any suspicious behaviors on campus using the [Report a Threat](#) portion of the webpage. Additional materials on campus safety prepared by WVU Police, including special safety tips and training, will also be provided on our eCampus page. [adopted 10-2-17]

Notice of Class Recording Policy

Meetings of a course at West Virginia University (WVU), whether online or in-person, may be recorded. Recordings are not guaranteed, and are intended to supplement the planned class session. Recordings will be made available to class participants, which may include students, assistants, guest lecturers, and co-facilitators. Recordings may be shared by the instructor or institution in accordance with WVU Rules and policies. The Recordings are owned by and contain intellectual property of WVU. The Recordings may not be shared, copied, reproduced, redistributed, transferred, or disseminated in any form or by any means without the prior written consent of authorized officials of WVU.

COVID-19 Statement

WVU is committed to maintaining a safe learning environment for all students, faculty, and staff. Should campus operations change because of health concerns related to the COVID-19 pandemic, it is possible that this course will move to a fully online delivery format. If that occurs, students will be advised of technical and/or equipment requirements, including remote proctoring software.

In a face-to-face environment, our commitment to safety requires students, staff, and instructors to observe the social distancing and personal protective equipment (PPE) guidelines set by the University at all times. While in class, students will sit in assigned seats when applicable and wear the required PPE. Should a student forget to bring the required PPE, PPE will be available in the building for students to acquire. Students who fail to comply will be dismissed from the classroom for the class period and may be referred to the Office of Student Conduct for further sanctions.

If a student becomes sick or is required to quarantine during the semester, they should notify the instructor. The student should work with the instructor to develop a plan to receive the necessary course content, activities, and assessments to complete the course learning outcomes.

Sale of Course Material Statement

All course materials, including lectures, class notes, quizzes, exams, handouts, presentations, and other course materials provided to students for their courses are protected intellectual property. As such, the unauthorized purchase or sale of these materials may result in disciplinary sanctions under the [Student Conduct Code](#). (<https://studentconduct.wvu.edu/campus-student-code>) [adopted 5-11-2015]

Inclusivity Statement

The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion.

If you are a person with a disability and anticipate needing any type of accommodation in order to participate in your classes, please advise your instructors and make appropriate arrangements with [the Office of Accessibility Services](#). (<https://accessibilityservices.wvu.edu/>)

More information is available at the [Division of Diversity, Equity, and Inclusion](#) (<https://diversity.wvu.edu/>) as well.

Sexual Misconduct Statement

West Virginia University does not tolerate sexual misconduct, including harassment, stalking, sexual assault, sexual exploitation, or relationship violence [[BOG Rule 1.6](#)] (<https://policies.wvu.edu/finalized-bog-rules/bog-governance-rule-1-6-rule>). It is important for you to know that there are resources available if you or someone you know needs assistance. You may speak to a member of university administration, faculty, or staff; keep in mind that they have an obligation to report the incident to the [Title IX Coordinator](#). (<https://titleix.wvu.edu/staff>)

If you want to speak to someone who is permitted to keep your disclosure confidential, please seek assistance from the [Carruth Center](#), 304-293-9355 or 304-293-4431 (24-hour hotline), and locally within the community at the [Rape and Domestic Violence Information Center](#) (RDVIC), 304- 292-5100 or 304-292-4431 (24-hour hotline).

For more information, please consult [WVU's Title IX Office](https://titleix.wvu.edu/confidential-resources) (<https://titleix.wvu.edu/confidential-resources>).

Disclaimer

The instructor reserves the right to deviate from the syllabus when a change is in the best interests of the class, as determined by the instructor.