

Instructor:

Dr. Siddharth Thakur
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Phone: (352) 846-3555

Class Time: MWF Period 7 (1:55–2:45 PM) - online
Office Hours: Monday and Wednesday: 10:30 AM – 12:00 PM

Teaching Assistant:

Please contact through the Canvas website

- Name: Songqi Li
- Email address: : songzi32@ufl.edu
- Office location: online
- Office hours: Tuesday and Thursday, 1-2 pm

Course Description

Fundamentals of computational fluid dynamics: Spatial discretizations, semi-discretizations, time-integration methods, full discretizations

Course Pre-Requisites / Co-Requisites

EGM6812, EGM6813 or equivalent for fluid mechanics knowledge; EGM6341 or equivalent for basic knowledge in numerical methods. Basic knowledge in ordinary differential equations, partial differential equations (PDEs), matrix analysis, and basic numerical methods is required. Also, you are expected to be reasonably proficient in computer programming (in a language of your choice). Some of the homeworks and projects will require actual implementation of numerical methods.

Course Objectives

By the end of the course, you should be able to do the following:

- Analyze the accuracy of semi-discretizations based on finite-difference and finite-volume methods.
- Analyze the stability of time-integration methods and select a suitable time-integration method for a given spatial discretization.
- Analyze the accuracy and stability of full discretizations.
- Create a CFD code to solve the Euler and Navier-Stokes equations in a simple geometry and determine whether the solutions produced with it are accurate.

Required Software and Computer Support

Access to a computer is required. MATLAB is recommended as a primary tool for the projects and some of the homework problems. However, any programming language can be used: FORTRAN, C, C++, Java, Python, etc.

Recommended Materials

- **The primary source of reference will be the lecture notes.**
- The following book is recommended:
An Introduction to Computational Fluid Dynamics: The Finite Volume Method, H.K. Versteeg and W. Malalasekera, Second Edition, Pearson Education Limited, 2007.

Additionally, the following books are useful references:

1. *Computational Fluid Mechanics and Heat Transfer*, J.C. Tannehill, D.A. Anderson & R.H. Pletcher, Taylor & Francis, 1997
2. *Computational Methods for Fluid Dynamics*, J.H. Ferziger & M. Peric, Springer, 2002
3. *Finite Volume Methods for Hyperbolic Equations*, R.J. Leveque, Cambridge, 2002

Grading Policy

- Your course grade is a weighted average: 20% homework, 50% projects, 30% mid-term exam
- Should your weighted average be just below the lower boundary of a letter grade range (e.g., 89.2), you may receive the higher letter grade depending on your attendance record, whether you handed in all homeworks, and your level of participation in class.
- The course letter grade will be determined from the weighted average as shown below:

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
80.0 - 83.9	B	3.00
77.0 - 79.9	B-	2.67
74.0 - 76.9	C+	2.33
70.0 - 73.9	C	2.00
67.0 - 69.9	C-	1.67
64.0 - 66.9	D+	1.33
60.0 - 63.9	D	1.00
57.0 - 59.9	D-	0.67
00.0 - 56.9	E	0.00

- More information on UF grading policy may be found at:
<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

Course Syllabus:

1. Governing and model equations: Brief review of governing equations, motivation for and derivation of model equations
2. Overview of basic concepts: discretization process, discussion of consequences of discretization process
3. Overview of numerical methods: Discussion of finite-difference and finite-volume methods, introduction to finite-element, spectral, and spectral-element methods
4. Analysis of spatially discrete equations: consistency, accuracy, stability, and convergence of spatially discrete equations
5. Time-integration methods: methods for integration of spatially discrete equations with focus on linear multistep and Runge-Kutta methods; analysis of accuracy, stability, and convergence of time-integration methods
6. Analysis of fully discrete equations: consistency, accuracy, stability, and convergence of fully discrete equations
7. Advection equation: solution of the one-dimensional advection equation, systems of one-dimensional advection equations, and the two-dimensional advection equation, motivation for upwinding, TVD methods, multidimensional methods
8. Burgers equation: exact solution and properties, non-linear stability, conservation, shock capturing, ENO and WENO methods.
9. Numerical methods for incompressible Navier-Stokes equations: Incompressibility constraint and implications, fractional-step methods, pressure-correction methods, artificial-compressibility method

Homework Policy

Homework assignments are due at the beginning of the period on the due date. All assignments should be neat and legible. Points will be taken off for sloppy work. You may discuss the assignments with other students, but you are expected to put in individual effort. Copying and plagiarizing assignments will not be accepted. You are expected to uphold academic honesty and failure to comply will result in disciplinary action. It is in your best interest to put in the time and effort to understand the homework problems and projects – emphasis will be on grading the process and just the final answer.

Online Course Recording

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Attendance Policy and Make-Up Policy

Excused absences must be in compliance with university policies in the Graduate Catalog (<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>) and require appropriate documentation.

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.