Fluid and Solid Operations

ECH 3203 Section 4009/OL04

Class Periods: MWF, period 7, 01:55PM – 02:45PM

Physical Location: Psychology Building 0151

Virtual Location: https://ufl.zoom.us/j/93526690519?pwd=YXV5UE9FSTZCZk9WT3NXMFlOWDF1dz09

(Due to pandemic, for students enrolled in 4009, you may attend the class in person or via Zoom; for students enrolled in OL04, you may only attend via Zoom.)

Academic Term: Spring 2021

Instructor:

Henry Chu, h.chu@ufl.edu, (607) 319-6298

Office Hours: M, 04:00PM – 05:00PM (Time and Zoom link to be confirmed)

Teaching Assistant/Peer Mentor/Supervised Teaching Student (ST):

Minghan Xian, mxian@ufl.edu, (302) 268-4180, WF, 04:00PM – 05:00PM (Time and Zoom link to be confirmed)

Course Description

3 credits; Characteristics of laminar and turbulent flow, mechanical energy balance, flow through packed beds and fluidization of solids, design of pumping systems and piping networks and metering of fluids

Course Pre-Requisites / Co-Requisites

COT 3502 and ECH 3264

Course Objectives

Upon completion of this course, a student is expected to be able to:

- Identify key fluid properties and list the corresponding units in analyzing fluid behavior
- Determine the hydrostatic pressure and buoyancy force on a submerged body; calculate pressure readings in various manometers
- Apply conservation of mass and energy as well as Newton's second law of motion to the contents of a finite control volume in analyzing behavior of fluids in motion
- Identify and determine flow kinematic quantities such as the acceleration field given a velocity field
- Analyze and design flows in pipe(s); calculate exact solutions for laminar, viscous, incompressible flows
- Use constitutive relations to model simple non-Newtonian fluid flows
- Apply stream functions and velocity potentials to model inviscid flows
- Determine the flow characteristics of a boundary layer, including laminar, transitional, to turbulent regimes
- Apply knowledge in above objectives in designing turbomachines
- Characterize a porous medium and compute the fluid flows
- Characterize and determine the mixing and dispersion in a static and/or dynamic fluid medium

Specific topics covered will include:

- Common fluid properties, e.g. density, viscosity, compressibility; dimensions and units
- Fluid statics pressure and force, manometry, and buoyancy
- Newtonian's second law, conservation of mass and energy (Bernoulli equation with/without shaft work and head loss), and finite control volume analysis
- Eulerian and Lagrangian descriptions; steamlines, streaklines, and pathlines; Reynolds transport theorem
- Navier-Stokes equation; exaction solutions to plate-driven and pressure-driven flows
- Generalized non-Newtonian constitutive relations such as the power-law and Casson fluid models
- Euler equation of motion, velocity potential and stream function, and superposition of plane potential flows
- Boundary layer structure and thickness, momentum integral boundary layer equation, lift and drag force
- Flow, energy, and momentum in pumps, fans, and turbines
- Porosity, partition coefficient, Darcy and Brinkman flows in packed and fluidized beds
- Mixing time and length scales; Taylor hydrodynamic dispersion

Materials and Supply Fees
None.

Professional Component (ABET)

Outcome	Coverage*
(a) An ability to apply knowledge of mathematics, science, and engineering	High
(b) An ability to design and conduct experiments, as well as to analyze and interpret data	Medium
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	High
(d) An ability to function on multi-disciplinary teams	Medium
(e) An ability to identify, formulate, and solve engineering problems	High
(f) An understanding of professional and ethical responsibility	High
(g) An ability to communicate effectively	High
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	Medium
(i) A recognition of the need for, and an ability to engage in life-long learning	Medium
(j) A knowledge of contemporary issues	Medium
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	Medium
(l) A recognition of industrial health and safety issues, and an ability to engage in fostering and exercising health and safety rules and regulations	Medium

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Textbooks and Software

- Fundamentals of Fluid Mechanics; Munson, Young, and Okiishi; 8th Edition; ISBN 978-1-119-08070-1

The majority of the course notes are developed by the instructor based on this textbook and will be given to students via Canvas.

Recommended Materials

- Transport Phenomena in Biological Systems; Truskey, Yuan, and Katz; 2nd edition (Chapter 8.1-8.3); ISBN 978-0-13-156988-1
- Transport Processes and Unit Operations; Geankoplis, 3rd edition (Chapter 3.1C-3.1D); ISBN 0-13-045253-X

Some course notes are developed by the instructor based on these textbooks and will be given to students via Canvas.

Course Schedule

Week 1 (Jan 11, 13, 15): COVID protocol, Introduction (Munson Chapter 1,2), Fluid statics (Munson Chapter 2) [No office hours]
Week 2 (Jan 20, 22): Fluid statics (Munson Chapter 2)
Week 3 (Jan 25, 27, 29): Fluid statics (Munson Chapter 2), **Quiz 1 on Jan 29**
Week 4 (Feb 1, 3, 5): Fluids in motion (Munson Chapter 3, 5, 8)
Week 5 (Feb 8, 10, 12): Fluids in motion (Munson Chapter 3, 5, 8)
Week 6 (Feb 15, 17, 19): Fluids in motion (Munson Chapter 3, 5, 8), **Quiz 2 on Feb 17**, Fluid kinematics (Munson Chapter 4,6)
Week 7 (Feb 22, 24, 26): Fluid kinematics (Munson Chapter 4,6), Viscous flow (Munson Chapter 6,8)
Week 8 (Mar 1, 3, 5): Viscous flow (Munson Chapter 6,8), non-Newtonian fluid mechanics (notes prepared by instructor)
Week 9 (Mar 8, 10, 12): **Quiz 3 on March 8**, Inviscid flow (Munson Chapter 6)
Week 10 (Mar 15, 17, 19): Inviscid flow (Munson Chapter 6), Boundary layer (Munson Chapter 9)
Week 11 (Mar 22, 26): Boundary layer (Munson Chapter 9)
Week 12 (Mar 29, 31, Apr 2): **Quiz 4 on March 31**, **Student video showcase for turbomachines (Munson Chapter 12) on Apr 2 during lecture hours**
Week 13 (Apr 5, 7, 9): Flow in porous media (Truskey)
Week 14 (Apr 12, 14, 16): Flow in packed and fluidized beds (Geankoplis, lectures given by ST on Apr 12 and 14), Mixing and dispersion (notes prepared by instructor)
Week 15 (Apr 19, 21): Mixing and dispersion (noted prepared by instructor), Recitation by ST on Apr 21 during lecture hours
Final Exams Week: **Final Exam** (Time to be confirmed)

Video showcase for turbomachines : Students will form teams of 4 people (no more than 4 people are allowed). In each team, a representative should email the names of all their members (along with an optional "General Consent and Release Form" signed by each member; to be distributed) to the ST no later than February 15. Students who are not in a team by this date will be assigned into teams randomly. Once a team is formed, members cannot be changed. The instructor/ST will send the finalized list of teams to all students by February 19.

Upon team formation, students will read Chapter 12 of the course textbook (Munson) to learn about Turbomachines by themselves and via discussion. This topic is closely relevant to materials that they have learnt before Quiz 2. Each team will create a 6-8 minutes video (in typical video format, e.g. avi, mp4) to teach the rest of the class what they have learnt from Chapter 12. The video should comprise about 3 minutes for Chapter 12.1-12.3 (the fundamental knowledge of turbomachines) and 3-5 minutes for one of the concepts, applications, or examples in Chapter 12.4-12.8. Students should give proper references to materials used in creating the video. All students, the ST, and the instructor will watch all the videos remotely during the lecture hour on April 2.

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.

F2F Course Policy in Response to COVID-19

We will have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

- You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements are all of our responsibility.
- This course has been assigned a physical classroom with enough capacity to maintain physical distancing (6 feet between individuals) requirements. Please utilize designated seats and maintain appropriate spacing between students. Please do not move desks or stations.
- Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
- Follow your instructor's guidance on how to enter and exit the classroom. Practice physical distancing to the extent possible when entering and exiting the classroom.
- If you are experiencing COVID-19 symptoms (Click here for guidance from the CDC on symptoms of coronavirus), please use the UF Health screening system and follow the instructions on whether you are able to attend class. Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms.
- Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. Find more information in the university attendance policies.

What should I do if someone I live with or have frequent contact with tests positive or starts showing symptoms? What should I do if I test positive or start showing symptoms?

1. First and foremost, stay home. Do not come in to the classroom and put others at risk.
2. File a report with UF Screen, Test, and Protect (STP). Arrange to get tested and/or plan to quarantine. This will change your status to "not cleared" to return to campus. **You may not come into the classroom without at least one negative test result after your symptoms are gone or after the full 2-week quarantine period.** Either one of these should change your "not cleared" status back to "cleared". We cannot mandate testing, but you will not be allowed back into the building without "cleared" status.
3. Tell the instructor. You do not need to provide full details (and the instructor legally cannot obligate you to share medical information) but let everyone who needs to know that you will not be in class for at least one week. We will make it work.
4. Finally, make sure that you follow up with UF for the contact tracing / quarantine interview.

*Note: If you are unable to get food/supplies to quarantine properly, let the instructor know and he will help get you what you need. If, for whatever reason, you are unable to afford a test, please let the instructor know and we will figure something out.

Following and enforcing these policies are all our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution, the revocation of classroom/building access, and grade penalties, up to and including failing the course.

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance of all online lectures is highly recommended. Although all lectures will be recorded, it is the student's responsibility to obtain any notes, assignments, etc. that they may have missed during their absence. Repeated absences may lead to a lower grade in the class. Excused absences must be consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.

As a courtesy to the other students and to the instructor, the students should turn off the ringers for all cell phones during lecture and they should not answer incoming calls. If a student is expecting an emergency call, please notify the instructor prior to class.

Makeup exams and quizzes will be given only in case of an emergency – documentation of the emergency has to be provided. It is required that, whenever possible, the student notifies the instructor about the situation prior to the exam, preferably at least two weeks in advance.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Quizzes (4)	100 each	40% (10% for each quiz)
Video showcase	100	10%
Final Exam	100	50%
		100%

Quizzes: There are four 30-minute quizzes. All quizzes will be held during the lecture hours. All quizzes will be closed book and closed notes. Partial credit will be assigned, and no credit will be given for problems that have a solution but all the work leading to this solution is not shown. All students will take their quizzes remotely with their Zoom Camera turned on, streaming their face and their question/answer papers. No talking to any others or via any electronic devices is allowed. Students may use an electronic calculator; no other electronic devices, including their personal phones or computers, are allowed. Questions of the quizzes will be sent to students at the beginning of the quiz-lecture hour. Once the quiz time is up, students should take pictures of their answers and send them to the ST no later than 5 minutes after the end time of the quiz. Late submission will result in a maximum penalty of the total points of the quiz and the instructor solely will determine the penalty. Any form of cheating will result in a penalty of the total points of the quiz.

Video showcase: The instructor and the ST will evaluate the videos based on their content, creativity, proper referencing, and presentation style. Students in the same team will receive the same grade. Late submission of the video after March 26, 2021 and April 2, 2021 will result in 50% and 100% penalty to this part of the course, respectively. To encourage students learning from videos created by other teams, each team will vote for their favorite video. The winners will get a special prize.

Final exam: There is one two-hour final exam. The time for the exam is to be confirmed. The exam will be closed book and closed notes. Partial credit will be assigned, and no credit will be given for problems that have a solution but all the work leading to this solution is not shown. All students will take their exam remotely with their Zoom Camera turned on, streaming their face and their question/answer papers. No talking to any others or via any electronic devices is allowed. Students may use an electronic calculator; no other electronic devices, including their personal phones or computers, are allowed. Questions of the exam will be sent to students at the beginning of the exam session. Once the exam time is up, students should take pictures of their answers and send them to the ST no later than 5 minutes after the end time of the exam. Late submission will result in a maximum penalty of the total points of the exam and the instructor solely will determine the penalty. Any form of cheating will result in a penalty of the total points of the exam.

Grading Policy

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
85 - 89	A-	3.67
80 - 84	B+	3.33
75 – 79	B	3.00
70 - 74	B-	2.67
65 - 69	C+	2.33
60 – 64	C	2.00
55 - 59	C-	1.67
50 - 54	D+	1.33
45 - 49	D	1.00
40 - 44	D-	0.67
0 - 39	E	0.00

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

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 suppor*t*, 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.