

Rheology Fundamentals & Practice

ECH 6937

Class Periods: Tuesdays 10:40 am – 11:30 am and Thursdays 10:40 am - 12:35 pm

Location: Weimer Hall (WEIM) 1076

Academic Term: Fall 2024

Instructor:

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Office Hours: Mondays and Wednesdays 1 pm – 2pm, or by appointment

Course Description

Theoretical and practical introduction to the measurement and characterization of fluid deformation and flow properties (i.e., *rheology*).

Course Pre-Requisites / Co-Requisites

Previous completion of a basic course in transport theory or fluid mechanics is highly suggested.

Course Objectives

At the completion of this course, students will have a working knowledge of quantitative and qualitative fundamentals of rheology sufficient for reading rheological literature as well as designing and implementing their own rheological studies.

Required Textbooks and Software

Understanding Rheology

Faith A. Morrison

2001, New York : Oxford University Press

ISBN 9781628708554

Note that this text is available online, free of charge, through the UF libraries.

Recommended Materials

- The Structure and Rheology of Complex Fluids, RG Larson, Oxford University Press.
- Rheology: Principles, Measurements, and Applications, C.W. Macosko, Wiley.
- Rheology and Non-Newtonian Fluids, F. Irgens, Springer.

Course Schedule

- Introduction and motivation for course of study
 - Rheology applications in industry and academia
 - Fluid deformation and associated material properties
 - Measurement methods
 - Summary of required expertise
- Vector/tensor review
 - Vector and tensor definition
 - Vector/tensor algebra review (addition/subtraction, and inner, cross, and dyadic products)
 - Review of torque and its calculation
- Equations of fluid mechanics (review)
 - Conservation of mass
 - Euler equations (conservation of momentum)
 - Strain and strain rates
 - Constitutive laws: constraints

- Newtonian fluid and Navier-Stokes equations
- Practical Measurement Strategies
 - Viscometry: capillary flows
 - Shear rheology: shearing flows and torsional flows (cone and plate, Couette, etc.)
 - Extensional rheology: planar and axial
- Material Properties and Example Measurements
- Steady and unsteady shear measurements and definitions
- Elongational flow measurements
- Experimental data for polymers
- Constitutive models
- Generalized Newtonian fluids
- Generalized linear viscoelastic fluids
- Presentations on rheology of classes of fluids, including
 - Gels and gelation
 - Brownian and non-Brownian suspensions
 - Active suspensions

Attendance Policy, Class Expectations, and Make-Up Policy

- Students should attend all lectures.
- Exams/quizzes will be rescheduled only for those students who missed due to an acceptable reason (illness, serious family emergencies, military obligation, religious holidays, etc.).
- Students arriving late for a quiz/exam will be given only the balance of time remaining to complete their work unless an acceptable reason (see above) is provided.
- Excused absences must be consistent with university policies in the Graduate Catalog (<https://catalog.ufl.edu/graduate/regulations>) and require appropriate documentation. Additional information can be found here: <https://gradcatalog.ufl.edu/graduate/regulations/>

Evaluation of Grades

Assignment	Percentage of Final Grade
Homework	25%
Project	25%
Midterm Exam	25%
Final Exam	25%

Grading Policy

Percent	Grade	Grade Points
90 - 100	A	4.00
80 - 89	A-	3.67
70 - 79	B+	3.33
60 - 69	B	3.00
55 - 59	B-	2.67
50 - 54	C+	2.33
45 - 49	C	2.00
<45	C-	1.67

Meeting the percentages listed above guarantees the specified letter grade at least. However, the instructor may employ a curve to lower the threshold for attaining the letter grades specified above. More information on UF grading policy may be found at: [UF Graduate Catalog](#) and [Grades and Grading Policies](#).

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.a.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.a.ufl.edu/public-results/>.

In-Class Recording

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

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/process/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 varied perspectives and lived experiences within our community and is committed to supporting the University’s core values, including the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect

regardless of race, creed, color, religion, age, disability, sex, sexual orientation, gender identity and expression, marital status, national origin, political opinions or affiliations, genetic information, and veteran status.

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 Coordinator
- HWCHE Human Resources, 352-392-0904, student-support-hr@eng.ufl.edu
- Pam Dickrell, Associate Dean of Student Affairs, 352-392-2177, pld@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: <https://counseling.ufl.edu>, 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://elearning.ufl.edu/>.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; <https://career.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://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

On-Line Students Complaints: <https://distance.ufl.edu/getting-help/>; <https://distance.ufl.edu/state-authorization-status/#student-complaint>.