

Course Syllabus for ECH 3264, Spring 2022

- Course Title:** Elementary Transport Phenomena
- Course Content:** Flux laws and conservation equations of mass, energy and momentum; steady and unsteady states as applied to physical and chemical processing; macroscopic and microscopic analysis.
- Prerequisites:** ECH 3023, MAP 2302, and MAC 2313.
- Class Meetings:** MWF period 4 (10:40 am - 11:30 am) in CSE E121
The class website on e-learning will be used to share and update any information regarding the impact of COVID-19 on our class meetings and/or activities.
- Instructor:** Jason E. Butler
Professor of Chemical Engineering
431 Chemical Engineering Bldg. (CHE)
e-mail: butler@che.ufl.edu
Office hours TR 1-2 pm, or by appointment
Note that office hours will be hosted simultaneously in person and on zoom. The link for office hours can be found on the class website.
- Supervised Teacher:** Liang Yu
Doctoral Candidate, Chemical Engineering
e-mail: liang.yu@ufl.edu
Office Hours WF 1-2 pm, or by appointment
Office hours in person and on zoom, links provided on website
- Textbook:** *Fundamentals of Transport Phenomena* by Ray W. Fahien
McGraw-Hill Book Company, 1983.
This book is available on the class website as a pdf document.
- Other Texts:** · Bird, Stewart, and Lightfoot
Transport Phenomena
McGraw-Hill, 1960
· Welty, Wicks, and Wilson
Fundamentals of Momentum, Heat, and Mass Transfer
Wiley, 1984
- Class Website:** · <https://elearning.ufl.edu>
· posting of HW assignments, solutions, etc.

- Grading Criteria** 10% Math Review Assessment
25% Early Progress Assessment
30% Midterm Assessment
35% Final Evaluation
- Exam dates** · Math Review Assessment will be in class, date TBD.
· Early and Midterm Assessments will occur in the evening, dates TBD.
· Final Assessment, Wednesday, April 28th, 3:00 PM - 5:00 PM
- Grading Scale** These percentages will earn you a letter grade of *at least*
 $\geq 90\%$ - A
 $\geq 75\%$ - B
 $\geq 60\%$ - C
 Note that a score of C or better required before continuing in the ChE program: A C- will not be a qualifying grade for critical tracking courses. In order to graduate, students must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. More information on UF grading policy may be found at: <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>
- Homework** · *Homework will not be graded.* Suggested homework problems will be assigned on a 1-2 week basis with a completion date. On the completion date, solutions will be posted on the class website.
- Grading:** · Award of partial credit on individual questions will be made on a basis specified by the instructor and will be consistently applied.
· Graders will attempt to assess the value of all work accurately; however, you should present solutions that are neat and well thought-out to maximize your grade.
· Meeting the percentages listed above guarantees the specified letter grade at least.
· Instructor may employ a curve only to lower the threshold for attaining the letter grades specified above.
· The percentages for obtaining grades not listed (A, B+, etc.) above will be set by a curve.
- Attendance** Students are strongly encouraged to attend all lectures, though attendance is not required. Exams/quizzes will be rescheduled only for those students who missed due to an acceptable reason (illness, serious family emergencies, military obligation, religious holidays, and participation in official university activities) as listed in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>). 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.

Teaching Objectives for ECH 3264, Fall 2022

At the completion of this course, you will be able to

- Derive differential equations from basic conservation principles describing heat, mass, and momentum transport in multiple dimensions for Cartesian, cylindrical, and spherical coordinate systems.
- Define and utilize Fourier's Law and Fick's Law, the constitutive equations for heat and mass transfer.
- Recite the characteristics of a Newtonian fluid and a non-Newtonian (Bingham) fluid and use the corresponding constitutive relationships to solve problems of fluid flow.
- Use the equations of change to formulate problem statements along with the proper boundary conditions for real, physical systems involving transport phenomena.
- Solve steady, one-dimensional transport problems involving composite systems and systems with source terms.
- Solve some types of multi-dimensional and unsteady transport problems.

Along the way, you will review (and perhaps develop) skills relating to:

- Problem solving and mathematical modeling.
- Solution of ordinary differential equations.
- Solution of (a small class) of partial differential equations.
- Vector calculus (using Gibbs notation, definition of divergence, Gauss divergence theory, etc.).
- Dimensional analysis.

Reading Guide for ECH 3264, Spring 2022

One dimensional transport

Heat transport, 1-D, steady

heat conduction	pg. 3-32
internal heat generation	pg. 95-98
heat transfer coefficient	pg. 128-131
composite systems	pg. 145-151

Momentum transport, 1-D, steady

basic equations	pg. 32-58
non-Newtonian fluids	pg. 92-94
with body forces	pg. 98-113
dimensional analysis/ friction factor	pg. 120-127
multiphase systems	pg. 157-161

Mass transport, 1-D, steady

basic equations	pg. 58-69
with reaction	pg. 114-116
transfer coefficient and multiphase transfer	pg. 131-145, 151-157

Unsteady transport processes pg. 251-285

Turbulent transport pg. 193-246

Multi-dimensional heat/mass transport pg. 317-384

Multi-dimensional momentum transport pg. 388-467

Advanced topics not assigned yet

Relation to Program Outcomes (ABET):

OUTCOME	COVERAGE
1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	-
3. An ability to communicate effectively with a range of audiences	-
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	-
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	Low
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	-
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	Medium

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.ua.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.ua.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 Conduct 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. 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 · Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@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: <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://lss.at.ufl.edu/help.shtml>.

Career Resource 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: <http://www.distance.ufl.edu/student-complaint-process>.