

Chemical Process Safety
ECH 4714 Section 11805 (4997)
Class Periods: M, W, F Period 8 (3:00 PM - 3:50 PM)
Location: WEIM 1084
Academic Term: Fall 2023

Instructor

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Office Hours: F 10:30 AM-12:30 PM (ChE 327, in person)

Supervised Teaching Student

Please contact through the Canvas website

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Office Hours: W 10:30-11:30 AM (by Zoom) and R 1:00 PM-2:00 PM (by Zoom)

Course Description

Laboratory and process safety analysis which emphasizes prevention and mitigation. Application of chemical engineering principles to assessing hazards and risk.

Course Pre-Requisites / Co-Requisites

Prerequisite: ECH 3101, ECH 3203, and ECH 3223.

Course Objectives

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

1. Work safely in a laboratory setting.
2. Be familiar with proper methods for disposing of chemical waste.
3. Be familiar with personal protection equipment and the reasons for use.
4. Be familiar with known hazards such as dust and vapor explosions.
5. Understand the fire triangle and the methods used to avoid explosions.
6. Be aware of methods used for incident investigation.
7. Be aware of the factors that can lead to an accident.
8. Be aware of societal issues concerning technology and the impact of the practice of chemical engineering on the surrounding and larger community.
9. Be aware of ethical issues and principles in chemical engineering practice.
10. Understand risk assessment.
11. Understand Process Safety Management (PSM).

Specific topics covered will include:

- Lab safety, gas cylinder safety, personal protection equipment.
- Hazardous materials, waste disposal
- Factors leading to major accidents
- Dust explosions
- Lifting hazards
- Current topics: recent incidents
- Incident investigation
- Engineering ethics, examples of significant disasters
- Inherent safety, accident and loss statistics, acceptable risk, public perceptions, the nature of the accident process
- Toxicology, TLV, dose response curves
- Industrial Hygiene. Government regulations (OSHA: PSM; EPA: RMP)
- Ventilation calculations, control of worker exposure

- Source Models (liquids, vapors, liquid pools, realistic and worst case releases)
- Toxic Release and Dispersion Models, Pasquill-Gifford model, Dense gas dispersions
- Fires and Explosions, Fire triangle, flammability diagram, Characteristics of explosions
- Designs to Prevent Fires and Explosions. Static electricity, chemical reactivity
- Hazard identification
- Chemical reactivity, reactive hazard index
- Risk Assessment, revealed and unrevealed faults, event trees, QRA, LOPA

Materials and Supply Fees

None.

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.	High
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.	Medium
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	High
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	
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	High

*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

Textbook

Daniel A. Crowl and Joseph F. Louvar, *Chemical Process Safety: Fundamentals with Applications*, 4th edition, Prentice-Hall, Upper Saddle River, NJ, 2019. ISBN-13: 9780134857770

Note: Exams will be open-book, and use of computers, photocopies, and phones will be prohibited. Thus, a paper copy of the book will be required. Other materials will be made available on the course website. The required textbook for this course is the fourth edition. The third and earlier editions are not suitable replacements.

Software

We will make use of free programs (ALOHA, MARPLOT, CAMEO Chemicals) from the National Oceanic and Atmospheric Administration (NOAA).

<https://response.restoration.noaa.gov/oil-and-chemical-spills/chemical-spills/response-tools/cameo-software-suite.html>

and CRW4 downloadable from the AIChE.

<https://www.aiche.org/ccps/resources/downloadinstall>

Recommended Materials

Other materials will be made available on the course website.

Course Schedule

The tentative schedule for exams and materials covered is appended.

Attendance Policy, Class Expectations, and Make-Up Policy

Attendance is required. Attendance records will be used to guide determination of final grades. Cell phones and other distractions may not be used in 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.

Evaluation of Grades

Grades are based on exams, completion of homework assignments, attendance, and participation in the class.

Homework and quizzes	10%
Mid-term exams (2)	50%
Final exam	40%

Students are encouraged to attend office hours. Students will receive 1% extra credit for the first office hour attended with Prof. Orazem.

All students are required to complete the [SACHE Chemical Reactivity Hazard](#) certificate. Extra credit is given for completion of [Level Two](#) and [Level Three](#) SACHE certification as follows:

1-2 certificates	1/3 letter grade
3-4 certificates	2/3 letter grade
5 or more certificate	1 letter grade

The [SACHE Chemical Reactivity Hazard](#) certificate is counted as one of the five certificates used to award extra credit. Maximum extra credit for completion of SACHE certificates is one letter grade. To be eligible for extra credit, the student must have achieved a C or better through homework, quizzes, and exams. The SACHE certification is free to AIChE student members. For undergraduate students, your membership is free. If you are a graduate student, AIChE membership is \$50 a year. <https://www.aiche.org/students/membership> Please confirm your membership as soon as possible to avoid unforeseen problems later in the semester.

Grading Policy

Grades for this class are curved at the discretion of the instructor. Attendance and class participation will be considered.

Please note: A score of C or better required before continuing in the Chemical Engineering program. By University of Florida policy, a C- will not be a qualifying grade for critical tracking courses. 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>

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.bluer.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 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 Program Coordinator
- HWC OE Human Resources, 352-392-0904, student-support-hr@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: <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 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>.

Tentative Class Schedule: updated August 18, 2023

Date	Topics Covered
Aug. 23, 2023	Introduction to Course. Expectations.
Aug. 25, 2023	Laboratory Safety
Aug. 28, 2023	Chapter 1. Inherent safety, accident, and loss statistics.
Aug. 30, 2023	Explosion at T2 Laboratories, Jacksonville. The nature of the accident process.
Sep. 1, 2023 ¹	Chapter 2. Toxicology. Dose and Response Curves.
Sep. 4, 2023	UF Holiday. Labor Day
Sep. 6, 2023	Chapter 2. Toxicology. Dose and Response Curves.
Sep. 8, 2023	Chapter 3. Industrial Hygiene. OSHA, PSM.
Sep. 11, 2023	Chapter 3. OSHA, PSM, continued. Toxicant or air-free basis.
Sep. 13, 2023	Chapter 3. Safety Data Sheets.
Sep. 15, 2023	Guest speaker: Jeff Wanko (by Zoom)
Sep. 18, 2023	Chapter 3. Ventilation calculations.
Sep. 20, 2023	Chapter 3. Ventilation calculations.
Sep. 22, 2023	Chapter 4. Source Models. Mechanical Energy Balances
Sep. 25, 2023	Chapter 4. Flow of liquids (holes and pipes).
Sep. 27, 2023	Chapter 4. Flow of gases in holes
Sep. 29, 2023	Chapter 4. Flow of gases in pipes
Oct. 2, 2023	Chapter 4. Flashing liquids, worst case analysis
Oct. 4, 2023	(Chapter 5) Toxic Release and Dispersion Models. Fundamental approach.
Oct. 6, 2023	UF Holiday. Homecoming
Oct. 9, 2023	Chapter 5 Pasquill-Gifford model
Oct. 11, 2023	
Oct. 13, 2023	Chapter 5 Toxic effect criteria.
Oct. 16, 2023	Review.
Oct. 18, 2023	Exam 1. In class
Oct. 20, 2023	Chapter 6 Fire triangle
Oct. 23, 2023	Chapter 6 Intro to flammability diagrams
Oct. 25, 2023	Video: Piper Alpha
Oct. 27, 2023	
Oct. 30, 2023	
Nov. 1, 2023	Guest speaker: Kevin Kennelley (in person)
Nov. 3, 2023	
Nov. 6, 2023 ²	Using Flammability diagrams
Nov. 8, 2023	
Nov. 10, 2023	UF Holiday. Veteran's Day

1. 74th Annual Meeting of the International Society of Electrochemistry, Lyon, France.
2. 242nd AIChE Annual Meeting, Orlando, Florida.

Date	Topics Covered
Nov. 13, 2023	Dust explosions. Use of NOAA emergency response programs.
Nov. 15, 2023	Review.
Nov. 17, 2023	Exam 2. In class
Nov. 20, 2023	
Nov. 22, 2023	UF Holiday. Thanksgiving
Nov. 24, 2023	UF Holiday. Thanksgiving
Nov. 27, 2023	(Chapter 12) Risk Assessment.
Nov. 29, 2023	(Chapter 8) Chemical Reactivity.
Dec. 1, 2023	Revealed and unrevealed faults, Event trees, QRA, LOPA
Dec. 4, 2023	(Chapter 13) Safety Procedures and Best Practices
Dec. 6, 2023	Review. Closeout.
Dec. 11, 2023	Final Exam (10:00 am – 12:00pm)

Guest Speakers

Frank Tagliarini	Frank Tagliarini is a BS graduate of the University of Florida (Business Administration) and is the Senior EHS & Facilities Manager for Kaman Aerospace Corporation. He served as Environmental Manager at Busch Gardens, as EHS Manager at the Anheuser-Busch Packaging Group, and as EHS Manager at the Bacardi Bottling Corporation. Frank also served for more than 24 years as Chief Petty Officer in the U.S. Navy Reserve. (date to be determined)
Jeffrey Wanko	Jeff Wanko has a BS degree in Chemical Engineering from Syracuse University and a MS degree in Environmental Engineering from the Illinois Institute of Technology. He served as a Process Safety Engineer at DSM Nutritional Products for four years before joining the Chemical Safety Board in 2005 as a Chemical Incident Investigator. After six years, he joined the U.S. Occupational Safety and Health Administration (OSHA) where he is currently the Director of the Office of Chemical Process Safety and Enforcement Initiatives.
Kevin Kennelley	Kevin Kennelley received his BS, MS, and PhD in Metallurgical Engineering and Materials Science from the University of Oklahoma. He has worked largely in the petroleum industry, including Schlumberger, Exxon Production Research Company, ARCO, and BP. For BP, he served as Engineering Manager/Engineering Authority in Azerbaijan, Director of Engineering Excellence in the UK, Project and Engineering Director/Engineering Authority for the Deepwater Gulf of Mexico Business Unit, Vice President of Engineering and Technology for Global Projects, and Vice President of Facilities Technology. In 2015, he joined Maersk Oil as Vice President and Head of Project Excellence, and in 2018, he began consulting for the oil and gas industry. Kevin is the recipient of the 1987 D. Grant Mickle Award (The National Research Council/National Academy of Sciences/National Academy of Engineering) and the 1993 A.B. Campbell award (National Association of Corrosion Engineers). He is a Registered Professional Engineer in the State of Texas and a Fellow of the Institute of Engineering and Technology.

Exams

Midterms	Exams tentatively scheduled for October 18 and November 17
Final	December 16, 2023 (10:00 am – 12:00pm)