

## **Managing Safety in the Chemical Industry**

ECH6937 Class Number 29535

**Class Periods:** M,W,F | Period 5 (11:45 AM - 12:35 PM)

**Location:** Weil 234

**Academic Term:** Spring 2022

### **Instructor:**

Mark E. Orazem

[meo@che.ufl.edu](mailto:meo@che.ufl.edu)

[www.che.ufl.edu/orazem](http://www.che.ufl.edu/orazem)

392-6207

Office Hours: W,F 3:00-4:00 PM (by Zoom)

### **Teaching Assistant/Peer Mentor/Supervised Teaching Student:**

N/A

### **Course Description**

3 credit hours. Separations processes, reactor design, applied molecular and kinetic theory, thermodynamics, particulate systems. Properties of chemical substances, transport phenomena, non-Newtonian fluid dynamics, turbulence, applied mathematics, computer science, biochemical and electrochemical engineering.

### **Course Pre-Requisites / Co-Requisites**

Chemical Engineering graduate student standing.

### **Course Objectives**

The objective of this course is to build an understanding of how chemical engineering science and principles may be used to recognize and mitigate hazards in the chemical process industry. The lectures are based partly on a textbook that is a standard for chemical process safety education. Other material will be drawn from incident investigations published by the Chemical Safety Board (CSB) and the National Transportation and Safety Board (NTSB). The class will also draw on computer program resources provided by the National Oceanic and Atmospheric Administration (NOAA). Guest speakers will provide valuable perspective on safety in industry. The course will also encourage completion of safety certification administered by Safety and Chemical Engineering Education (SACHE). These certificates serve to complement the content of the course and to enhance the students' resumes.

### **Materials and Supply Fees**

AICHe membership (\$50/year for graduate students) is required to allow free access to the required certification courses.

### **Required Textbooks and Software**

Daniel A. Crowl and Joseph F. Louvar, *Chemical Process Safety: Fundamentals with Applications*, 3rd edition, Prentice-Hall, Upper Saddle River, NJ, 2011. ISBN-13: 9780131382268.

Note: Exams will be open-book, and use of computers 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.

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**

As the course represents the synthesis of chemical engineering courses taken to date, e.g., material and energy balances, transport phenomena, fluid and solids operations, and thermodynamics, students are advised to refer to textbooks used in those classes as needed.

### **Course Schedule**

The schedule for topics covered is given below. The tentative detailed schedule is given on page 7.

<b>Week</b>	<b>Topics Covered</b>
1	Introduction: Explosion at T2 Laboratories, Jacksonville Chapter 1: Inherent safety, accident and loss statistics, acceptable risk, public perceptions, the nature of the accident process Chapter 2: Toxicology
2	Chapter 2: Dose and response curves, threshold limit values Chapter 3: Industrial hygiene, OSHA, PSM
3	Chapter 3: EPA, RMP, TLV calculations, ventilation calculations, safety data sheets
4	Chapter 3: Ventilation, laboratory safety
5	Chapter 4: Source models, liquids, gases, release of gases, choked flow, compressible flow
6	Chapter 4: Compressible flow, flashing, liquid pool evaporation, realistic and worst-case releases, graphical methods
7	Chapter 5: Toxic release and dispersion models, fundamental approach, turbulence in neutrally buoyant dispersion models
8	Chapter 5: Pasquill-Gifford model, examples 5.1 and 5.2, dense gas dispersions
9	Chapter 5: Toxic effect criteria Chapter 6: Fire triangle, Intro to flammability diagrams
10	Video: Piper Alpha Using Flammability diagrams Fire and Explosions 1
11	Fire and Explosions 2 Dust explosions
12	Dust explosions, use of NOAA emergency response programs Chapter 11: Hazard identification
13	Chapter 12: Risk assessment, revealed and unrevealed faults, event trees, QRA, LOPA, incident investigation
14	Chapter 9: Lifting Hazards, pressure reliefs
15	Chapter 13: Safety procedures and best practices Review
	<b>Final Exam</b>

### **Attendance Policy, Class Expectations, and Make-Up Policy**

Attendance is expected and will be recorded. 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.

## ***Evaluation of Grades***

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

Homework and quizzes	10%
SACHE certification (5)	25%
Mid-term exam	25%
Final exam	40%

All students are required to complete the [SACHE Chemical Reactivity Hazard](#) certificate. Credit is given for completion of 4 additional [Level Two](#) and [Level Three](#) SACHE certification.

The SACHE certification is free to AIChE student members. For graduate students, the cost of membership is \$50/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.

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/>.

## ***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/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](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto: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](mailto: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](mailto: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/>.

**COVID-19**

- You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated.
- If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email [covid@shcc.ufl.edu](mailto:covid@shcc.ufl.edu)) to be evaluated for testing and to receive further instructions about returning to campus.
- If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.
- UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the [UF Health Screen, Test & Protect website](#) for more information.
- Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

## 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>.

## Tentative Schedule (updated January 4, 2022)

Date	Topics Covered
Jan. 5, 2022	Introduction to Course. Explosion at T2 Laboratories, Jacksonville. Expectations.
Jan. 7, 2022	(Chapter 1) Inherent safety, accident and loss statistics, acceptable risk, public perceptions, the nature of the accident process.
Jan. 10, 2022	(Chapter 2) Toxicology.
Jan. 12, 2022	Chapter 2 continued. Dose and Response Curves. Threshold Limit Values.
Jan. 14, 2022	Chapter 3. Industrial Hygiene. OSHA, PSM.
Jan. 17, 2022	UF Holiday. Martin Luther King Day.
Jan. 19, 2022	(Chapter 3 continued. EPA, RMP. TLV calculations.
Jan. 21, 2022	(Chapter 3) Ventilation calculations.
Jan. 24, 2022	(Chapter 3) Safety Data Sheets.
Jan. 26, 2022	Chapter 3. Ventilation.
Jan. 28, 2022	Laboratory Safety
Jan. 31, 2022	(Chapter 4) Source Models. Liquids, gases. Release of gases, choked flow.
Feb. 2, 2022	(Chapter 4) Compressible flow
Feb. 4, 2022	
Feb. 7, 2022	(Chapter 4) Compressible flow.
Feb. 9, 2022	(Chapter 4) Compressible flow. Graphical methods.
Feb. 11, 2022	(Chapter 4) Flashing. Liquid pool evaporation, realistic and worst-case releases.
Feb. 14, 2022	(Chapter 5) Toxic Release and Dispersion Models. Fundamental approach.
Feb. 16, 2022	
Feb. 18, 2022	(Chapter 5) Chapter 5 turbulence in neutrally buoyant dispersion models
Feb. 21, 2022	(Chapter 6) Chapter 5 Pasquill-Gifford model Chapter 5 Examples 5.1 and 5.2
Feb. 23, 2022	
Feb. 25, 2022	Chapter 5 Dense gas dispersions
Feb. 28, 2022	Chapter 5 Toxic effect criteria.
Mar. 2, 2022	Review
Mar. 3, 2022	Mid-Term Exam to be held during Exam Periods (8:20-10:10 PM)
Mar. 4, 2022	Guest speaker: Jeffrey Wanko, OSHA
Mar. 7, 2022	UF Holiday. Spring Break.
Mar. 9, 2022	UF Holiday. Spring Break.
Mar. 11, 2022	UF Holiday. Spring Break.
Mar. 14, 2022	Chapter 6 Fire triangle
Mar. 16, 2022	Chapter 6 Intro to flammability diagrams
Mar. 18, 2022	Video: Piper Alpha
Mar. 21, 2022	Using Flammability diagrams
Mar. 23, 2022	Fire and Explosions 1
Mar. 25, 2022	Fire and Explosions 2
Mar. 28, 2022	Dust explosions.
Mar. 30, 2022	Dust explosions. Use of NOAA emergency response programs.
Apr. 1, 2022	Guest speaker: Kevin Kennelley

Apr. 4, 2022	(Chapter 11) Hazard Identification
Apr. 6, 2022	(Chapter 12) Risk Assessment.
Apr. 8, 2022	Revealed and unrevealed faults, Event trees, QRA, LOPA
Apr. 11, 2022	Incident investigation
Apr. 13, 2022	Lifting Hazards.
Apr. 15, 2022	(Chapter 9) Pressure Reliefs
Apr. 18, 2022	(Chapter 13) Safety Procedures and Best Practices
Apr. 20, 2022	Review
Apr. 28, 2022	<b>Final Exam (10:00 am–12:00 pm)</b>

#### Guest Speakers

Jeffrey Wanko	Director, Office of Chemical Process Safety and Enforcement Initiatives, OSHA, Washington, DC. Jeff previously was an investigator with the Chemical Safety Board.
Kevin Kennelley	CEO, Kennelley & Associates Oil & Gas Consulting. Kevin was Vice President for BP and for Maersk Oil and Gas.

#### Exams

Midterm	Tentatively scheduled for March 3 during evening exam periods.
Final	Apr. 28, 2022, 10:00 am – 12:00 am