CHEE 5379/6379
Safety and Reliability

Catalog Data: Topics Course. Credit Hours: 3. **Prerequisites**: ENGI 3363 or CHEE 3363, CHEE 3369 and CHEE 3367. **Content**: An overview of risks, hazards and safeguards associated with chemical process engineering.

Textbook:

Daniel A. Crowl and Joseph F. Louvar, Chemical Process Safety: Fundamentals with Applications, Prentice Hall, 2nd Edition, 2002.

Prerequisites by Topic:

1. Basic knowledge of the principles of fluid flow.
2. Basic knowledge of the principles of heat and mass transfer.
3. Basic knowledge of the principles of process control systems.

Topics: (each class is 1 hour 50 minutes, two classes per week)

1. Course Introduction and Overview (3 classes)
    a. Understanding risk
    b. Perception of risk and acceptable risks
    c. Layers of protection
    d. Management systems
    e. "Designed for safety" concept
    f. Toxicology
    g. Industrial hygiene
    h. Nature of chemical process accidents and case histories
2. Source Models (2 classes)
    a. Discharge of Liquids
    b. Discharge of Vapors
    c. Discharge of Flashing Liquids
    d. Pool Boiling
3. Toxic Release and Dispersion Models (2 classes)
    a. Design basis
    b. Dispersion modeling
    c. Weather effects
    d. Terrain effects
    e. Release mitigation
4. Fires and Explosions (2 classes)
    a. The fire triangle
    b. Flammability characteristics of liquids and vapors
    c. Flammability diagram

   d. Ignition energy
   e. Explosions – vapor clouds and boiling-liquid expanding-vapor explosions
5. Design to Prevent Fires and Explosions (2 classes)
   a. Inerting
   b. Controlling static electricity
   c. Ventilation
   d. Fire protection
6. Relief and Relief Sizing (4 classes)
   a. Concepts
   b. Types of relief
   c. Sizing relief systems for liquid and vapor services
7. Hazards Identification and Risk Analysis (1 class)
   a. Normal operation and deviation from normal operation
   b. Consequences of deviation
   c. Process Hazard Analysis and Operability Studies
   d. Fault tree analysis
   e. Consequence analysis
   f. Safety reviews

Expected Course Outcomes and Performance Criteria:

1. Demonstrate ability to participate actively as a member of a Process Hazard Analysis team (**a, d, e, g**)[1].
2. Demonstrate ability to identify and evaluate hazards associated with a process facility (**a, e**).
3. Demonstrate ability to understand the risks associated with a process, and the consequences of deviation from normal operation (**a, c, e, k**).
4. Demonstrate appreciation of the importance of safety, both on-the-job and at home (**h, j**).

Evaluation:

1. Six homeworks (5% each). Late homeworks will not be accepted.
2. Two exams (15% each). All exams are mandatory. No make-ups. Failure to attend an exam will result in a zero for that exam.
3. Case review (10%).
4. Two projects (15% each).

[1]Lowercase letters in parentheses refer to ABET outcomes under Criterion 3 (see Appendix).

Appendix

ABET Outcome, Criterion 3	Program-Specific Outcomes
(a) an ability to apply knowledge of mathematics, science and engineering.	• Use chemistry and physics concepts to set up and solve chemical engineering problems • Use mathematical tools to solve chemical engineering problems
(b) an ability to design and conduct experiments as well as to analyze and interpret data.	• Select appropriate experimental equipment and techniques necessary to solve a given problem • Evaluate and interpret experimental results using statistical tools and chemical engineering concepts
(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 & safety, manufacturability, and sustainability.	• Apply material and energy balance concepts to design a unit operation • Define objectives and perform the design of an integrated chemical process under realistic constraints
(d) an ability to function on multi-disciplinary teams.	• Define roles and responsibilities to align with capabilities of team members and fulfill project requirements • Develop and carry out a project plan through team work
(e) an ability to identify, formulate and solve engineering problems.	• Translate an engineering problem into a mathematical model or other suitable abstraction • Use mathematical model or other suitable abstraction to solve an engineering problem and interpret results
(f) an understanding of professional and ethical responsibility.	• Demonstrate knowledge of professional code of ethics. • Identify ethical issues and make decisions for a chemical engineering problem.
(g) an ability to communicate effectively.	• Make presentations that are factual and tailored to the audience • Can communicate in writing to non-technical and technical audiences
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.	• Understand the impact of chemical engineering solutions in a global, economic, environmental, and societal context.
(i) a recognition of the need for and an ability to engage in life-long learning.	• Recognize the importance of advanced education and development opportunities • Identify, retrieve, and organize information necessary to solve open-ended problems
(j) a knowledge of contemporary issues.	• Know the interplay between current technical and societal issues • Know the recent history, current status, and future trends of chemical engineering
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	• Use modern software to solve chemical engineering problems • Understand how to operate equipment relevant to chemical engineering systems