Department of
MECHANICAL ENGINEERING
THE UNIVERSITY OF UTAH

Course Syllabus

ME EN 7110—System Safety

Sections 001 & 030

University of Utah
Department of Mechanical Engineering

Lecture Time: Monday at 6:00-9:00 PM

Three (3) Credit Hours

Instructor: Prof. Kenneth L. d'Entremont
k.dentremont@utah.edu or Canvas message
Office: MEK 2467
Office Hours: Monday 4-6 PM (via ZOOM), after lecture, by appointment, and drop in (subject to health restrictions)
Office Phone: +1-801-581-6766
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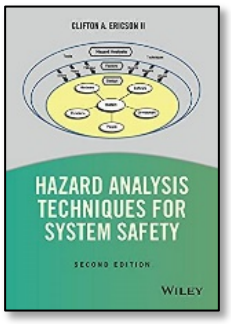
Required Textbook: Clifton A. Ericson II. ***Hazard Analysis Techniques for System Safety*** *(Second Edition).* John Wiley & Sons, Inc., Hoboken, NJ, USA 2016.



Course Description: This course covers system safety techniques for accident prevention and for quantification of hazards inherent in machines and human/machine systems. This course includes the techniques and methods most commonly used, including Preliminary Hazard Analysis (PHA), Fault-Tree Analysis (FTA), and Failure Modes & Effects Analysis (FMEA). The purpose of this course is to introduce the student to the major principles of risk evaluation in systems so that they can be employed in different situations and under varying conditions during the working career of the student.

Course Philosophy: It is the Instructor's hope that this classroom will be an open forum for both learning and discussion. He encourages student participation in questioning and answering. The intent is to make this classroom a ***fault-tolerant*** environment (in keeping with the theme of the course subject). All will be treated with respect. There are very few wrong answers in the field of safety. Some answers are just better than others—and *no one will make more mistakes than the Instructor*. Therefore, be willing to express your ideas and conclusions in a free and open manner. We are not here to judge, but to learn. This will be a relatively small class and it will be on Monday nights. Please, become involved and speak up to break up the sound of the Instructor's voice.

Course Objectives:

Upon completion of this course, students will:

1. Understand the principles of system safety and be able to apply them in varying situations.

2. Understand the limitations inherent in each type of system safety technique and when each method is most appropriate to use.

3. Appreciate the significance of understanding the complete system and the interactions between system components.

4. Understand the difference between single and multiple point failures and the importance of redundant and fail-safe systems.

5. Be able to compute path and cut sets for fault tree analysis, simplify the fault tree. Know how to use cut set and path set information to cost effectively reduce system hazards, and to prioritize the hazard abatement and minimization alternatives.

6. Be prepared to apply techniques learned in this class in occupational settings.

7. Be able to perform a variety of system safety analyses on real-world systems and present recommendations in a coherent, structured report.

8. Be able to prepare presentation materials and clearly and succinctly present systems safety analyses and recommendations to an audience.

Communication Plan: The Instructor will do all that is possible to clearly make important announcements in class, to reiterate them on lecture slides (to be posted after each lecture), and to use Canvas announcements when necessary.

Structure of Course:

1. The synchronous section (001) will be held via Zoom. The distance-learning section (030) will have available videos of the lecture.
2. Lectures will be up to three (3) hours long. Sometimes they will be shorter.
3. Breaks will be taken during the course of the lectures. I will try to take two short breaks during each lecture.
4. A lecture format will be used with PowerPoint slides taken from the textbook material.
5. The evening's slides will be posted—usually by Noon the following Tuesday—on Canvas.
6. Students are expected to be familiar with the lecture material (as outlined in the syllabus schedule) before coming to class.
7. This is a graduate-level course and will be conducted as such. There are fewer assignments than in an undergraduate-level course. It is your responsibility to keep up on material throughout the course. The Instructor is readily available to help anyone who has questions. Please set up an appointment with if there is a need to speak.
8. Please notify the Instructor if he ever fails to post or supply information or documents that were promised.
9. The textbook will be closely followed.
10. Additional content, including videos, will be used to supplement the textbook. These will reflect recent events or current topics related to System Safety which are not covered in the textbook.
11. There will be reading or viewing assigned that is not from the textbook. These documents will be from publicly available sources and will be at no expense to the student.

12. There will be one guest lecturer who will speak on her work on applying the techniques shown in the textbook and discussed in lecture. A change in her availability may result in a change in the syllabus scheduling. I will let you know of any changes as soon as possible.

Use of Canvas:

1. Be sure that Canvas (through the U of U CIS system) has your correct email address so that you will receive announcements and other information.
2. The Instructor must presume that you receive all notifications issued through Canvas.
3. All scores for assignments will be posted via Canvas.
4. Please regularly check Canvas grades and notify the Instructor of any problems as soon as possible.
5. Folders have been set up in Canvas for ME EN 7110 for course materials including lecture slides, the syllabus (and supporting documents), Homework assignment, and other documents as needed.

Academic Integrity: Students enrolled in this course will be required to successfully complete the Canvas module on Academic Integrity by January 22, 2019. Failure to complete this module within the allotted time window will initially result in an inability to access some Canvas features and ultimately result in a failing overall grade for the course.

Final Exam: The course Final Exam will be held on Monday, April 29, 2019, at 6:00-8:00 PM in the Lecture Classroom.

Course Points: There will be three (3) Homework assignments, two (2) examinations, and one (1) semester project. The points available for each of the above are shown below.

Homework 1	20 Points
Homework 2	40
Homework 3	40
Exam 1	100
Exam 2	100
Project In-Classroom Presentation	50
Project Written Report	100
Total	450 Points

Final Grades: Grades for the course will be based on the percentage of total available points for the course. See the table below.

Grade	%
A	93+
A-	90+
B+	87+
B	83+
B-	80+
C+	77+
C	73+

C-	70+
D+	67+
D	63+
D-	60+
F	<60

The professor reserves the right to grade "on a curve" (to the benefit of students).

Homework: The three Homework assignments will be due on the dates provided by the Instructor.

Please follow the guidelines below when turning in homework assignments:

1. Only turn in a PDF-format file of your homework—unless there is a need for something else.
2. Put your **name** on **every** sheet.
3. **Number** your pages (even if only by hand).

Homework Re-Submission Policy: Homework is due at date/time specified. Students may correct and re-submit homework assignments within one week after the HW has been returned. Eighty percent (80%) credit of the new score will be used for HW grade. Of course, resubmission of a homework assignment does not guarantee that the student will receive 80% credit for an assignment. Student may only re-submit HW once.

Exams: There will be two exams given. Exam 1 will be the equivalent of a Mid-Term exam and Exam 2 will be the Final Exam.

- Exams will be "take home" using open-materials, notes, computer—to access Canvas only.
- No Google-type searches or electronic communications are permitted to complete your exam. Exams will be approximately 90 minutes in length and will be due that long after downloading the exam with an allowance of time for scanning your work to a PDF-format file.

Violations of these rules may be viewed as a violation of Academic Integrity (see above).

- Exam 1 one will cover all material covered up to the end of the prior lecture. This includes Homework material due by the time of Exam 1.
- Exam 2 will be non-comprehensive (*you're welcome!*) and will cover all material presented since Exam 1.

Again, both exams will be taken by students at a time of their choosing and all work must represent the work of that student alone.

Semester Project: All students in the course are required to work in groups of 3-5 students and submit a Semester Project using techniques, methods, analyses, and other tools and skills learned during the semester. There are two parts to the semester project: an oral presentation given to the other students and a written report submitted to the Instructor.

The semester project is intended to connect the course material to a topic of professional or personal interest to the student team and to show the complementary nature of different system-safety techniques.

For this reason, considerable flexibility will be given for the projects selected by student groups. Students are encouraged to make the project meaningful and not just a grading exercise for the instructor.

Teams may wish to perform system-safety analyses relating to an issue involving work, home, personal interest, or graduate design/research project in which you are already involved. It is projected that the text of the resulting document will be approximately fifteen (15) double spaced-pages (not including appendices, etc.). One single report shall be submitted for all students in a particular group. Project reports will be evaluated by the Instructor.

A term-project proposal (two or three paragraphs) shall be submitted by 03/01/21 for Section 001 (or 03/03/21 for Section 030) and include the names of the students in that group. The proposal has not points attached to it; the Instructor wants to be sure that groups are formed and are pursuing suitable subjects.

Proposals will be reviewed and returned. Contact the Instructor if you have questions about the appropriateness of a particular project topic. ALL project presentations will be given to the class on 04/26/21. Written term-project reports are due on 05/03/21 for Section 001 (and on 05/05/21 for Section 030).

Examples of previous semester projects include the following:

Fault Tree Analysis of a Chemical Release
Failure Modes and Effects Analysis of an Industrial Hygiene Sampling Operation
Risk Assessment of Inventory Handling Procedures
Risk Assessment of Underground Storage Tank Removal
Performance of a PHA and FMEA on a Belt Section in an Underground Mine
FMEA of Glo-Germ Dye Aided Avalanche Victim Detection Device
Fault Tree Analysis of Downloading ICM Submissions
Systems Safety Analysis of Rail Car Loading/unloading of Sulfuric Acid in a Petrochemical Plant
OSHA for the Main Control Operator - Plasma-Fired Cupola Iron Making Facility at Geneva Steel
Systems Safety Eval of The Kiln Loading/Unloading Process at The University Art Department
System Safety Approach to the Hazards and Waste Management for Hard Chromium
Electroplating Failure Modes and Effects Analysis of Toilet Seat Lift System
OSHA: Various External Lodge Operations for an Alaskan Fishing Lodge
System Safety Analysis for the Self-Balancing Wheelchair
Systems Hazard Analysis of Jetway Passenger Bridge
PHA and FMEA of the UU College of Engineering Machine Shop
FMEA Analysis of Catheter Design
FMEA and FTA of a Left Ventricular Assist System
Automotive Air Bag Fault Tree Analysis
Using System Safety Tools to Evaluate Mountain Biking
KC-135 Nose Landing Gear Steering FTA
Multiple Failure Mode and Effects Analysis- Application on a CNC Machine
System Safety Analysis of a ScubaPro MK25/S600 Regulator/Demand Valve System
Preliminary Hazard Report University of Utah Moonbuggy
Safety Analysis of Machine Shop in The Merrill Engineering Building
RSRM Water Deluge System
Hazard Analysis, FMECA/CIL, and Fault Tree Analysis of Pressure Vessel Stiffener Rings
FMEA and FTA Report for Monorail Crane
System Safety Analysis of a SCUBA System

A Fault Tree Analysis of Autoclave Operation in the MAB Directorate at Hill AFB
Systems Safety Analysis for the Unit Load and Perfect Binder Systems
PHA and HHA Report for Snowboarding and Snow Skiing
System Safety Analysis of Installation of a 1995 Jeep Wrangler Lift Kit
FMEA & FTA Analysis of Cell Phone Ignition Interlock
X-Ray Tube Safety Analysis
System Safety Analysis of the Exoskeleton
Fall Biomechanics During Truck Ingress & Egress
System Safety Analysis of a Natural Gas Pipeline
Hardware FMEA and O&SHA: Arm-Propelled Wheelchair
FMEA and Health Hazard Assessment of Burette Assembly Machine
System Safety Analysis: Acupuncture
System Safety Analysis of Jackleg Drill
FMEA and O&SHA of an Air Knife Blow-Down System-MK 90 Coning Operations
Fault Tree Analysis and Common Cause Failure Analysis of I-35W Bridge Collapse
System Safety Analysis of RSRM Aft Skirt Hydrazine Loading Operation
Hazard Analysis of a Ski Lift
ATK System Safety: Past, Present and Future
Development and Testing of a Paragliding System for People with Lower Extremity Disabilities
Convertible Car Seat - A Safety Analysis
Preliminary Safety Analysis of a Railroad Car Dismount System
Safety Analysis of PDI Micro Sinker EDM System
System Safety Analysis of a K11 Dual-Caliber Air-Burst Weapon
System Safety Analysis of Bicycling
Using SS Tools to Evaluate the Eliminating a Manufacturing Inspection of a Medical Device
Automatic Sphygmomanometer System Safety Analysis
System Safety Assessment of Routine Car Maintenance
System Safety Analysis: Mold Cleaning & Prep
Use of Effective Root Cause Analysis to Identify System Risks
System Safety Analysis: Sodium Separation System
System Safety Analysis of DIY Window Well Covers
Ultra Arm Assisted Robotic Movement

For Section 030 (Distance-Learning) Students only:

1. The points, grading, and other criteria will be identical to in-classroom students in Section 001 with some exceptions.
2. Homework assignments will be due two days later than shown in the syllabus schedule because of the delay in posting the videos of the lectures.
3. Homework and other written assignments **will be** accepted electronically through Canvas.
4. The Section 030 students will be expected to present their semester projects **in person** on April 26, 2021.
5. Section 030 students are always welcome to view in real-time any lecture or guest-speaker presentation.

Notes:

1. This syllabus is meant to serve as an outline and guide for the course. Please note that the Instructor may modify it at any time with reasonable notice to students. The Instructor may also modify the Schedule at any time to accommodate the needs of the class. Should you have any questions or concerns about the syllabus, it is your responsibility to contact the Instructor for clarification.
2. Students are responsible for acquainting themselves with and satisfying the entire range of academic objectives and requirements as defined by the instructor.

Dates & Procedures: Students are referred to the College of Engineering's (CoE) Guidelines for important dates and procedures related to this course at:

https://www.coe.utah.edu/students/current/semester-guidelines/

STUDENT SUPPORT

The University of Utah provides support to numerous student populations, such as those listed below. Please contact the Instructor if you need anything to make the learning process and environment better.

ADA Statement: The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services (CDS), 162 Olpin Union Building, 801-581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations. All information in this course can be made available in alternative format with prior notification to the Center for Disability Services. (www.hr.utah.edu/oeo/ada/guide/faculty/)

Wellness: Personal concerns such as stress, anxiety, relationship difficulties, depression, cross-cultural differences, etc., can interfere with a student's ability to succeed and thrive at the University of Utah. For helpful resources, contact the Center for Student Wellness, www.wellness.utah.edu, 801-581-7776.

Student Veterans: The University of Utah has a Veterans Support Center on campus. They are located in Room 161 in the Olpin Union Building. Hours: M-F 8 AM-5 PM. Please visit their website for more information about what support they offer, a list of ongoing events, and links to outside resources: http://veteranscenter.utah.edu/. Please also let me know if you need any additional support in this class for any reason.

Members of the LGBTQ Community: Please know that the University of Utah has an LGBT Resource Center on campus. They are located in Room 409 in the Olpin Union Building. Hours: M-F 8 AM-5 PM. You can visit their website to find more information about the support they can offer, a list of events through the center, and links to additional resources: http://lgbt.utah.edu.

Students for Whom English is a Second Language: Please be aware of several resources on campus that will support you with your language development and writing. These resources include: the Department of Linguistics ESL Program (http://linguistics.utah.edu/esl-program/), the Writing Center (http://writingcenter.utah.edu/), the Writing Program (http://writing-program.utah.edu/), and the English Language Institute (http://continue.utah.edu/eli/).

NOTE: Please contact the Professor if there are any needs or requests not covered by the above. He is eager to be sure that this semester and this course be a positive and productive experience.

CHANGES MADE TO SYLLABUS (changes shown in RED):

Revision	Date	Change(s)
0	01/18/21	[Original; no changes]
1	01/24/21	Added explicit listing and due date for Academic-Integrity Module

University of Utah -- ME EN 7110 (Sections 001 & 030)							
System Safety							
Spring 2021							
Prof. K.L. d'Entremont							
Week	**Lecture**	**Date**	**Chapter**	**Topics**	**HATs**	**Assignments**	**Notes**
1	--	01/18/21	--	First week courses start on *Tuesday* 01/19/21			[No Class]
2	1	01/25/21	0	Preface & Acknowledgements		ME Academic-Integrity	
			1	System Safety and Hazard Analysis		Module	
			2	Systems		(Due 01/29/21)	
			3	Hazard, Mishap & Risk			
			4	Hazard Analysis Features			
			5	Hazard Recognition and Management			
3	2	02/01/21	N/A	Probability & Statistics		Homework #1	Probability
			N/A	Engineering Design, Development & Testing		(§001: due 02/22/21)	
				Procedure (EDDTP)		(§030: due 02/24/21)	
4	3	02/08/21	6	Functional Hazard Analysis	FHA		
			7	Preliminary Hazards List Analysis	PHL		
5	4	02/15/21	--	Presidents Day		Reading TBD	Holiday; no lecture
6	5	02/22/21	8	Preliminary Hazards Analysis	PHA	Homework #2	
			16	Failure Modes & Effect Analysis	FMEA / FMECA	(§001: due 03/08/21)	
			9	Subsystem Hazard Analysis		(§030: due 03/10/21)	
7	6	03/01/21	10	System Hazard Analysis	SHA	*Sem-Project Proposal*	
			11	Operating & Support Hazard Analysis	O&SHA	(§001: due 03/01/21)	
			12	Health Hazard Analysis	HHA	(§030: due 03/03/21)	
8	7	03/08/21	X	**Exam 1--Mid-Term Exam ("Take Home")**	*Submit Exam by:*	*§001 by 03/12/21*	*§030 by 03/14/21*
			13	Requirements Hazards Analysis	RHA (SRCA)		
			25	Sneak-Circuit Analysis	SCA		
			17	Hazard & Operability Analysis	HAZOP		
9	8	03/15/21	N/A	Review Exam 1		Homework #3	
			15	Fault-Tree Analysis	FTA	(§001: due 03/29/21)	
						(§030: due 03/31/21)	
10	9	03/22/21	18	Event-Tree Analysis	ETA		
			20	Common-Cause Failure Analysis	CCFA		
11	10	03/29/21	28	Barrier Analysis	BA		
			21	Software Hazard Analysis	SwHA		
			30	Management Oversight Risk Tree Analysis	MORT		
12	11	04/05/21	--	Non-Instruction Day		Reading TBD	No Lecture
13	12	04/12/21	23	Test Hazard Analysis	THA		
			33	System of Systems Hazard Analysis	SoS		
			34	Summary			
14	13	04/19/21	GL	Prof. Nancy A. Nickman	Application of SyS		Pharmacy System Safety
15	14	04/26/21	P	Semester-Project Presentations		*Live Zoom Present'n*	***Both §001 & §030***
Final	Exam 2	05/03/21	X	**Exam 2--Final Exam (Non-comprehensive; "take home")**	*Proj. Written Rpt:* *Submit Exam by:*	*§001 on 05/03/21* *§001 on 05/07/21*	*§030 on 05/05/21* *§030 on 05/09/21*
		Color Legend			**Examination**		
					Guest Lecturer		
					Presentations		
					No Lecture		
						Last Revised:	01/24/2021