Course Change Request

Date Submitted: 01/17/18 1:55 pm

Viewing: SENG 430: Risk Analysis in Safety Engineering

Also Known As: CHEN 430

Last edit: 03/02/18 2:48 pm

Changes proposed by: kmabray

Programs referencing this course
- CERT-CU51: Safety Engineering - Certificate
- MINOR-ENPM: Engineering Project Management - Minor

Other Courses referencing this course
- As A Banner Equivalent: CHEN 430: Risk Analysis in Safety Engineering

Faculty Senate Number

Contact(s)

<table>
<thead>
<tr>
<th>Name</th>
<th>E-mail</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley Stokes</td>
<td><a href="mailto:stokes992@tamu.edu">stokes992@tamu.edu</a></td>
<td>9798453364</td>
</tr>
</tbody>
</table>

Rationale for Course

The proposed changes are part of a routine curriculum review.

Course prefix: SENG

Course number: 430

Department: Chemical Engineering

College/School: College of Engineering

Academic Level: Undergraduate

Undergraduate course level justification (Select One)

Academic Level (alternate)

Effective term: 2018-2019

Complete Course Title: Risk Analysis in Safety Engineering

Abbreviated Course Title: RISK ANALYSIS SAFETY ENG

Catalog course description:

Concepts of risk and risk assessment, which uses all available information to provide a foundation for risk-informed and cost-effective engineering practices; examples and exercises are drawn from a variety of engineering areas.

Prerequisites and Restrictions:

Junior or senior classification.

Concurrent Enrollment: No

Should catalog prerequisites / concurrent enrollment be enforced?

Crosslistings: Yes

Crosslisted With: CHEN 430

In Workflow

1. CHEN Department Head
2. Curricular Services Review
3. EN Committee Preparer UG
4. EN Committee Chair UG
5. EN College Dean UG
6. UCC Preparer
7. UCC Chair
8. Faculty Senate Preparer
9. Faculty Senate
10. Provost II
11. President
12. Curricular Services
13. Banner

Approval Path

1. 01/17/18 1:58 pm
   Yossef Elabd (elabd):
   Approved for CHEN Department Head
2. 01/18/18 7:59 am
   Sandra Williams (sandra-williams):
   Approved for Curricular Services Review
3. 01/25/18 7:25 am
   Eileen Hoy (ehoy):
   Approved for EN Committee Preparer UG
4. 01/25/18 8:30 am
   Prasad Enjeti (enjeti):
   Approved for EN Committee Chair UG
5. 02/21/18 1:53 pm
   Prasad Enjeti (enjeti):
   Approved for EN College Dean UG
6. 02/21/18 1:57 pm
   Sandra Williams (sandra-williams):
   Approved for UCC Preparer
7. 03/05/18 8:41 am
   Sandra Williams (sandra-williams):
   Approved for UCC Chair

https://nextcatalog.tamu.edu/courseleaf/approve/
<table>
<thead>
<tr>
<th>Semester Credit Hour(s)</th>
<th>Contact Hour(s) (per week):</th>
<th>Lecture:</th>
<th>Lab:</th>
<th>Other:</th>
<th>Total</th>
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<tbody>
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<td></td>
<td>3</td>
<td>0</td>
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Repeatable for credit? No

Three-peat? No

CIP/Fund Code 1401010006

Default Grade Mode Letter Grade (G)

Alternate Grade Modes Satisfactory/Unsatisfactory

Method of instruction Lecture

Will sections of this course be taught as non-traditional? (i.e., parts of term, distance education) Yes

Learning Outcomes

Meets traditional face-to-face learning outcomes.

Describe how learning outcomes are met or provide justification why they are not met.

The learning outcomes are the same for on campus and distance learning student. All are provided through Ecampus for all students.

Hours

Meets traditional face-to-face hours.

Describe how hours are met or provide justification why they are not met.

Courses are required and uploaded to Ecampus. The students are able to view as required.

Will this course be taught as a distance education course? No

Is 100% of this course going to be taught in Texas? Yes

Will classroom space be needed for this course? Yes

This will be a required course or an elective course for the following programs:

Required (select program)

Elective (select program)

Has/will this course be(ren) submitted for core curriculum consideration? No

Has/will this course be(ren) submitted for Writing or Communication consideration? No

Has/will this course be(ren) submitted for ICD consideration? No
## Course Syllabus

<table>
<thead>
<tr>
<th>Syllabus:</th>
<th>Upload syllabus</th>
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<tbody>
<tr>
<td></td>
<td><strong>seng430_v2.pdf</strong></td>
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<table>
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<tr>
<th>Letters of support or other documentation</th>
<th>No</th>
</tr>
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<table>
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<tr>
<th>Additional information</th>
<th>Reviewer Comments</th>
</tr>
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</table>
|                        | **Sandra Williams (sandra-williams)** (01/16/18 8:57 am): Rollback: You will need to attach a traditional syllabus and a non-traditional syllabus (if applicable) to this request.  
**Jim Herman (jherman)** (03/01/18 9:31 pm): ADA and Honor Code need updating  
**Sandra Williams (sandra-williams)** (03/02/18 2:48 pm): Update received. Concerns addressed.  
**Sandra Williams (sandra-williams)** (03/05/18 8:41 am): UCC approved March 2018. |

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<tr>
<th>Reported to state?</th>
<th>No</th>
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CHEN/SENG 430, Risk Analysis in Safety Engineering

Syllabus

**Instructor:** William J. Rogers, CHEN, JEB-426, <wjrogers@tamu.edu>

**Class Sessions:** JEB –104; Tue, Thu, 12:45 – 2:00 pm

**Office Hours:** Wed, Fri, 1:30 – 2:30 pm or by arrangement in JEB-426

**Teaching Assist:** TBA

**Office Hours:** TBA

**Required Text:** Norman Fenton and Martin Neil, *Risk Assessment and Decision Analysis with Bayesian Networks*, CRC Press, 2012 (RDBN)


**Resources:** Materials from M. Modarres, *Risk Analysis in Engineering*, Taylor & Francis, 2006, and from other sources will be placed on the course website. Class PowerPoint presentations, solutions to exercises, quizzes, and tests, tables, figures, articles on the course website. Risk in the News articles with current applications of risk analysis Risk Reminder messages sent via Howdy each weekend

**Prerequisite:** Senior or Junior UG status in engineering or science

**Exams:**

I Tuesday, September 30, 12:45-2:00 pm, JEB-104  
II Thursday, October 30, 12:45-2:00 pm, JEB-104  
Final Wednesday, Dec 17, 8:00 – 10:00 am JEB-104

**Project dates:** Project papers due date: November 11, 2014, JEB-104  
Project presentations: November 17 –19, 5:30-8:30 pm, JEB-104

**Grading:**

Exam 1 15%  
Exam II 17.5%  
Final 22.5%  
Quizzes 10%  
Homework 15%  
Project 20%  

Increasing weight

**Objectives:** Learn the fundamentals of risk analysis and risk-informed decision making with an emphasis on engineering applications.
**Materials:** Exams will be based on all materials covered in class and practiced on assigned homework and quizzes. The course exams are weighted based on the concepts covered up to each exam.

**Exams** will test knowledge and ability to use methods practiced on homework to analyze industrial risk applications. Complex expressions and statistical tables will be provided on handout sheets to be used during exams.

**Homework:** Problems for work in teams and submitted as a team product with a team self evaluation will be assigned each week and will be due in class the following week for full credit. Solutions to problems will be posted on the course website.

**Project:** All students on each team will perform a term project based on applications of risk analysis as discussed and practiced in this course.

**Class sessions:** Attendance for each class session is expected except for excused absences for which makeup quizzes will be given.

**Quizzes** are given about 1/week, often on the homework due date, to help students keep up to date with the class materials and to be better prepared for the exams. Solutions to quiz problems will be posted on the course website. Quiz credit is also given for occasional questions and comments based on material discussed in class.

**Success** in this course is achieved through consistent work to keep up with the class materials and discussion, assigned homework problems, and assigned reading. This approach is designed to help each student and each team understand the concepts and apply to class discussion and applications. Class and homework exercises are especially important for learning and reinforcing probability models used to represent uncertainty in real systems and to support engineering decision-making under uncertainty and risk management involving uncertain events in real-life engineering applications.

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**Course Outline**

<table>
<thead>
<tr>
<th>Topic</th>
<th>*Discussed and used throughout the course</th>
<th>Classes</th>
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<tbody>
<tr>
<td>Introduction</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Hazards, risk, risk analysis, decisions, probability, reliability</td>
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<td></td>
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<tr>
<td>Risk Assessment (RA) structure and methods</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>*Decision analysis, value of information, value of control, pre-posterior analysis</td>
<td></td>
<td></td>
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<tr>
<td>*Probabilistic modeling of uncertain events for optimum decision-making</td>
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<tr>
<td>*Bayes discrete models and Bayesian networks (BNs), for probability updating and identifying causal effects</td>
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<tr>
<td>Statistical correlations and cause/effect analysis</td>
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<tr>
<td>*Data engineering: confidence interval analysis and amount of data</td>
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</tbody>
</table>
*Traditional statistics compared with Bayesian statistics
Near misses, unusual occurrences, precursor events
Logic modeling, fault trees, event trees
Bayesian network construction, software calculation, analysis
Diagnostic, predictive, inter-causal, and abductive reasoning
Dependent failures: $\beta$-model of common cause failure

Performance assessment

- Reliability, Maintainability, and Availability analysis
- Time independent and time dependent hazard rates
- Covariate models and physical models
- Markov analysis, State dependent systems
- Reliability testing and model parameters updating

Human reliability modeling, SHARP method with quantitative models and BNs. Human factors

Uncertainty analysis

- Uncertainty propagation methods and comparisons

Consequence analysis on projects

- Aloha, Phast, Probit, Multi-Energy, Baker-Strehlow models

Risk contributors

- Risk metrics
- Risk ranking

Risk values, risk acceptance criteria

- Individual and societal criteria, ethics, citizen engineer

Risk Management

- System approach of continual monitoring and measurement of the engineering system, its organization, and its safety climate by aggregation of indicators (lagging and leading) and BNs to identify trends and actions for support of optimum decisions to manage risk within acceptable limits
- Risk-informed multi-criteria decisions
- Dynamic predictive management with monitoring and testing of earlier forecasts with continual updating of model parameters

Risk communication with personal and stakeholders

- Risk perception; risk conversion factors

Guest Lecture on risk analysis topics

Exams and reviews

- Two exams

Total Class Sessions, 75 minutes each

Classroom Attendance

Students are expected to arrive in the classroom for the class session to begin on time
as is required for professional assignments. Late arrivals or missing class sessions can result in a low quiz grade average. If, due to circumstance, a student is not able to arrive on time, late arrival to class is better than missing the entire class. Students missing class time should consult their team members, other class students, and the course website to obtain current classroom materials. Students who missed class time also are urged to consult the instructor and the teaching assistant to collect missed materials. The university rule regarding class attendance: http://student-rules.tamu.edu/rule07

Classroom Participation

Participation and questions in class discussion are encouraged. We will all learn more effectively from each other if we exercise what we encounter and analyze from different points of view and from a variety of experiences.

Laptops and Cell Phones

The use of cell phones and laptops during class is generally a distraction from class participation and is not acceptable. See your instructor if you have a special need for laptop use during class.

Classroom Decorum

As stated in Section 21 of the TAMU Student Rules, “Texas A&M University supports the principle of freedom of expression for both instructors and students. The university respects the rights of instructors to teach and students to learn. Maintenance of these rights requires classroom conditions that do not impede their exercise. Classroom behavior that seriously interferes with either (1) the instructor’s ability to conduct the class or (2) the ability of other students to profit from the instructional program will not be tolerated. An individual engaging in disruptive classroom behavior may be subject to disciplinary action. See 24.3.12.”

If you experience issues concerning classroom behavior, please discuss with the instructor or with the teaching assistant. Also, you are encouraged to bring concerns about the course to the attention of the instructor or the teaching assistant. Thank you for your consideration and dedication to help make the classroom environment respectful, stimulating, and comfortable for all students.

Americans with Disabilities Act (ADA) Policy Statement

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information visit http://disability.tamu.edu
Academic Integrity Statement and Policy

Aggie Honor Code

“An Aggie does not lie, cheat or steal, or tolerate those who do.”
http://aggiehonor.tamu.edu/
Assigning Specific Tasks to Team Members – Task assignments may include doing calculations, explaining principles, or checking someone else's calculations. Assign responsibilities and tasks for the semester project.

Setting Schedules - The leader must set deadlines and insure that they are met. Schedules include time for every team member to review and check all the work done on every assignment with feedback and corrections prior to submission.

Evaluating Team Activities - The team leader for a given week will evaluate the team performance in completing the homework on an included Team Evaluation form that will be the basis for 20% of the homework grade.

Obtaining Signatures - Each student will sign the teamwork evaluation form to confirm that each problem has been understood and performed or reviewed.

Team Members – will perform a variety of tasks relative to the assignments and term projects including researching a topic, setting up or solving a problem, checking calculations, or looking up references or data. Every member of the team must contribute in some way to every assignment and every major component of the term project, even if it involves only checking the work that others have done. Every student is expected to understand every problem on every assignment, and will demonstrate that understanding individually on quizzes and exams.

Communication and persistence are the keys to effective teamwork!

Course Goals and Learning Outcomes

Learn a system approach methods to perform risk assessment, make more accurate predictions of system and component behavior, reduce risk cost effectively within acceptable ranges, manage risk, and improve system performance and reliability, make risk/gain-informed decisions to benefit the organization and the community, and communicate decisions that affect the organization personnel and the public, which benefits from and supports the products of your company.

Course Objectives
This course provides the opportunity to learn about risk, learn probability methods needed for a system approach, learn to think in distributions to represent ranges of outcomes of critical variables, and learn the applications of risk involved with industrial activities, and how to practice risk-informed decision-making and risk management. Because engineering is a systems decision-making enterprise, a systems decision-making way of thinking is used throughout the course.

Risk analysis consists of identifying, characterizing, reducing, managing, and informing others about the nature, magnitude, probability, and uncertainty of possible events, which are represented in distributions. Therefore, an understanding of methods and tools to represent and quantify uncertain events is essential. These tools include the models and methods of probability to model uncertain events and statistics to evaluate data, estimate how many data are required, develop cost effective strategies such as how often to test critical components, and calculate model parameters for up-to-date system reliability forecasts. Quantification of risk and forecasts of potential failure occurrences are essential for all risk analysis applications.

Risk assessment and good decision-making for increasingly complex systems is increasingly needed for design, manufacturing, operation, management, and regulations. The risk analysis approach facilitates evaluation of calculations and results so that the benefits and costs of each decision alternative can be weighed and balanced. Open discussion and analysis of decisions can help to improve the organization safety culture based on good risk management and also to increase public confidence in plant leadership.

This course will analyze how uncertainties and risk levels can be reduced and managed at tolerable levels. Zero risk results in no activities, and some risk is always necessary, so a systematic method is needed to provide the basis for controlling risk within acceptable levels. This needed approach is provided by risk assessment. Another approach still used in design and management of systems, however, is to reduce risk through over design and defense in depth using, for example, large ad hoc safety margins that can result in excessive costs or with risk insufficiently reduced or with risk transferred elsewhere in the system or the organization. Risk analysis and optimum engineering decisions result from the fundamentals to analyze and predict overall system behavior under industrial conditions.

The course topics follow those listed on the course syllabus, and homework assignments are based on lecture topics and materials. Applications of class materials are to be consistently practiced and reinforced by class exercises, homework problems, and student projects, which culminate in written reports and class presentations. In addition to applications of engineering principles, concepts of management and individual responsibility are stressed, as well as teamwork and the appreciation for measurement or estimation and the significance of calculated values.
Students in Teams fulfill the homework assignments and perform a major project as a team product. Homework papers and projects are therefore submitted as team products, and the teamwork dynamics of each team are self-evaluated weekly to promote continual and cumulative benefits from team learning. The main purpose of working in teams is to enable each student to learn from the experience, knowledge, and the ideas of the other team members and to learn through the dynamics of team interaction, communication, and leadership.

Course resources

This recent book provides the mathematics needed for Bayesian networks, which are presented clearly with excellent and interesting examples to build motivation for students to learn how to construct Bayesian networks and use them in risk applications.


This is an engaging and up to date book on reliability and maintainability models needed for risk assessment and management.

Modarres, M., M. Kaminskiy, V. Krivtsov, *Reliability Engineering and Risk Analysis, 2nd ed*, Taylor & Francis, 2010 (Modarres, RERA)

This book focuses on practical methods for evaluating and managing systems within acceptable risk levels with emphasis on reliability of system components.


This book provides a clear and coherent approach to engineering decision-making and an intuitive approach for understanding and estimating probability values needed for risk assessment and decision-making.


This book is a comprehensive book on risk analysis to supplement the risk and reliability methods discussed in RERA. Assigned readings will be placed on the course website.


The objective of this excellent book is a unifying scientific platform for evaluating risk assessments with particular focus on the uncertainties on the input information used in the risk calculations.

Provides a good introduction to risk, with emphasis on economic applications, and to decision making.


This book concerning risk decision-making has examples and case studies from the chemical industry.


An excellent, practical source for probability methods and probability distributions with engineering examples


An excellent source for decision analysis and value of information as part of the decision process with many decision-making examples from industry


Uses graphic methods to teach the importance of using distributions instead of only point values, such as mean or median values, for decision-making.


Presents a broad but clear approach to decision making with many examples.


An enjoyable and well-founded discussion of how to make better decisions.


A very clear and readable introduction to decision analysis with interesting examples and applications.


This engaging book dramatizes current weaknesses of risk management and what could and should be done to improve decision-making and manage risk more effectively.


Focuses on the importance of measuring significant factors that benefit a system or help to develop a highly effective risk management program.
Christensen, R., W. Johnson, A. Branscum, and T.E. Hanson, *Bayesian Ideas and Data Analysis, An Introduction for Scientists and Statisticians*, Taylor&Francis, 2011

Provides an incisive discussion of the power and applications of Bayesian reasoning and statistical inference to make accurate predictions and fulfill a crucial objective of engineering and science.


A comprehensive textbook introduction to applications of Bayesian networks for scientists, engineers, and other practitioners of system behavior understanding and management.