**CEE 5970 – Risk Analysis and Management**

Spring 2019

3 Credits

For more information, see CEE 5970 canvas.cornell.edu

Our Canvas account is a new effort and there will be some confusion. Good by Blackboard.

**Instructor:**  Jery R. Stedinger, e-mail: jrs5@cornell.edu;

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 Office Hours: After class MWF 11:30, or by appointment.

**TAs:** Matthew Zalesak, Hollister 309, mdz32@cornell.edu

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 Proposed Office Hrs: Tu 2:00-3:45; Th 2:00-4:30; Location Hol 208

**Text:** T.S. Glickman, and M. Gough (eds.), *Readings in Risk,*

 Resources for the Future, Washington, D.C., 1990. (Optional; in store+ reserve)

CEE 5970Course Packet-Required Readings *Risk Analysis and Management 2019*

 *– Prof. J. Stedinger*, availableCampus Store [printed upon demand] Print+Digital

 (A compilation of *classic* papers, references and reading material for course.

 Packet for 2019 is a subset of 2016-18 Packet. Recent material mostly on-line.

 220 Hollister has extra handouts for CEE 5970 lectures.

 Handout are also available on-line, as are PPTs and lectures.

Summary

Course develops a working knowledge of risk terminology, analytic tools used for quantitative analysis of environmental and technological risks, terrorist threats, and social and psychological risk issues. Technical analysis methods include event trees, fault trees, network reliability, reliability engineering, Poisson models for accident/failure arrivals, Gaussian plume models of air pollutants, non-parametric statistical analyses of accident data, sensitivity analysis, and Monte Carlo simulation. Case studies illustrate choice among alternative models, and analytical analyses for environmental risk assessment requiring transport, exposure, and dose-response modeling. Discussions consider risk in modern life, model limitations, statistical analyses and data presentation, Benefit-cost analysis, psychological and community perceptions of risk, environmental risk communication, presentation of environmental and health risk issues in the media, and risk management. Discussions address appropriate regulatory policy for risk exposure, EPA’s priorities, applications of risk methodologies in natural hazards and threat assessment, manufacturing and transportation of hazardous materials, toxic emissions from waste incineration and hazardous waste sites, food safety and other health risks, dose-response models for carcinogens, public health risks such as AIDS, and historic accidents including Three Mile Island, Fukushima-Reactors, Bhopal, Challenger / Columbia shuttles and Katrina/New Orleans.

Prerequisite

Students need a course in probability and statistics, plus two semesters of calculus. Course for seniors and graduate students, or permission of instructor. Students should be prepared to address the mathematical computation of risk, and consideration of associated policy, health, and economic issues.

The target audience is seniors and first-year graduate students in engineering and other technical fields, or permission of instructor. Why the focus on seniors and graduate students in this 500-level course?We kept the prerequisite low so that graduate students in environmental toxicology and fields outside of engineering can take the course as a required or an elective course in risk analysis. They generally have experience and strength in biology that compensates for less engineering background. Course asks students to work across many fields of knowledge.

The course is intended to be a capstone on top of a full BS program: it tries to look at how to pull together the models that one is likely to have seen in other courses. Thus we hope students can look back on a set of courses they have completed, including liberal electives, as well as a range of life experiences (summer jobs and internships), and think about how the world works, and how risk might be understood and managed.

Course Requirements

There will be one prelim at 7:30 on the evening of Tuesday 12 March 2019 in Thurston Hall (THR) 203 & 205 and a comprehensive final exam Thursday May 16 from 7-9:30 pm, plus regular homework assignments requiring analytic problem solving and short essays. Grades are based on the final exam (45%), the evening prelim (35%), homework (20%), and class participation (±5%). If you learn the material well by doing the homework, you should do well on the tests and thus receive the grade that you earned and you deserve. However, real test comes after you graduate.

Homework Policy

This year we are going to employ electronic submission and return of homework in CEE 5970. Given the confusion experienced in the past, and the challenge of returning homework, this promises a great improvement in your 5970 experience.

1. Homework will be submitted via Canvas as a single document (pdf or word, under Assignments in the folder for the corresponding homework).
2. Written responses are to be typed; quantitative answers may be scanned or typed. Scanned material must be clear. Graphics need appropriate labels.
3. Late homework will not be accepted without prior approval by instructor or TA.
4. Graded homework will be returned directly to you via Canvas.
5. Turnitin software will be used to analyze homework submissions. “Turnitin is a plagiarism detection software that scans student work for matched text by comparing the work to a large database of student work, publications, and materials on the Internet”.
6. If you really feel an error has been made in grading your homework, you may raise that issue with the TAs. This is best done first in office hours to resolve the issue. Official electronic homework regrade requests should be submitted via email to the TA’s asa273 with subject line: “CEE 5970 regrade request” within

1 week of week when Homeworks were returned. Please return the graded assignment with a list of problem parts and why you think a change of score is appropriate.

Academic Standards

Each student in CEE 5970 is expected to abide by the Cornell University Code of Academic Integrity (http://cuinfo.cornell.edu/aic.cfm). Work submitted by CEE 5970 students for academic credit must be a student’s own. For homework assignments, students are encouraged to help one another to understand the material and to develop solution strategies; with that strategy, each student should work out their own solution. *If students work together to develop a spreadsheet model or other tools, their homeworks should explicitly acknowledge such collaborations, and each student should provide their own analysis and interpretation of results generated*. Each student should provide their neat solutions to problems. There is no collaboration during exams – exams allow each student demonstrates what they have learned.

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Mon.~Wed.~Fri. 10:10 – 11:00; Rhodes Hall 253



Professor Jery R. Stedinger

 213 Hollister, jrs5@cornell.edu

 Our society requires a balancing of safeguards and regulation of industrial activities with the risk and benefits from alternative technologies, the use and generation of toxic chemicals, environmental health risks, and threats by terrorists and natural hazards. What are the risks? How can they be described? How does society select the proper balance?

 Course develops knowledge of risk terminology, analytic and systems modeling tools used for quantitative analysis of technological and environmental risks, threat assessment, and social risk management issues. Discussions address risk in modern life, whether it is safer to fly or drive, historic accidents (Three Mile Island, Titanic, Bhopal, Challenger/Columbia shuttles, Hurricane Katrina, train accidents and AIDS), statistical analyses, data presentation, dose-response and pollutant transport models, uncertainty & sensitivity analyses, enterprise resiliency, cost-benefit analysis, psychological and community perceptions of risk, risk communication, and news media coverage of transportation, environmental and health risk issues.

 Intended for seniors and first-year graduate students in engineering and other technical and biological fields who are interested in risk, modeling, and the management of technology. A fun course about serious problems with many real-world and relevant examples reflecting contemporary issues. Students should have completed one course in probability and statistics. Prerequisite: Introduction to Probability and Statistics such as: CEE 3040, Engrd 2700, ILSRT 2100, BTRY 2610 or ARME 2100; and two semesters of calculus. (For OR&IE undergraduates CEE 5970 counts as a field-approved elective from outside OR&IE.) *A distance learning course so CEE 6970 lectures are available ON-LINE.*

This is a guide to topics covered in CEE 5970 and associated readings\*

1. **Risk Definitions & Concepts (People get hurt. People die.)**

 Hoffbuhr, “The Probability of Risk,”

 \*\*Broad, “Analyzing the Dangers” <see CANVAS site>

 Gibbons “Review of Wilson and Crouch, *Risk-Benefit Analysis*”

 Bernstein, *Against the Gods: The remarkable story of risk*

 \*Wilson, "Analyzing the Daily Risks of Life"

 \*Slovic, Fischhoff, Lichtenstein, "Rating the Risks"

 Gorman, “Rethinking Breast Cancer”

 \*Morgan, "Probing the Question of Technology-Induced Risk"

 \*Morgan, "Choosing and Managing Technology-Induced Risk" (SEE footnote below.)

2. **An Example: Fly or drive? (We can model that.)**

Evans, Frick, and Schwing, "Is it Safer to Fly or Drive?" with comment & reply

 Sivak, Weintraub, and Flannagan, "Nonstop Flying is Safer Than Driving"

3. **Failures in Technological Systems and Natural Hazards (Bad things happen.)**

 Bignell and Fortune, “Three Mile Island”

 IEEE Spectrum, “24 Hours at Fukushima” http://spectrum.ieee.org/energy/nuclear/24-hours-at-fukushima/0/

 Bignell and Fortune, First page of Chapter 9 – Titanic Discussion

 Interlandi, “The Titanic’s Last Secret”

 Stix, “Bhopal - a tragedy in waiting”

 Glick, *GENIUS, The Life and Science of Richard Feynman* – Challenger Shuttle

 Feddermann, *Engineering Ethics* – Engineers, Safety and Historical accidents

 ASCE Hurricane Katrina External Review Panel, *What Went Wrong and why*

 Sally Ride, “Cold Comfort”

 Kennedy, “Science, Terrorism and Natural Disasters”

 Cohn, “Risk Management in an Uncertain World”

 Hass, “The Role of Risk Analysis in Understanding Bioterrorism”

 Liebschs, “Its’s a Disaster”

4. **Failure Models,** **Event Trees, and Risk Profiles (Serious modelling and Probability.)**

 Yen and Tung, *Reliability and Uncertainty Analysis in Hydraulic Design*

 CEE 597 Handout on Poisson Processes (Lecture notes)

 Hillier and Lieberman, “Reliability”

 O’Rourke, “Critical Infrastructure, Interdependencies, and Resilience”

 \*Rasmussen, "The Appl. of PRA Tech. to Energy Technologies"

 \*Keeney, Kulkarni and Nair, "Assessing the Risk of an LNG Terminal

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 Raj and Glickman, "Gen. Hazardous Material Risk Profiles on RR Routes"

 Miller, D., “Hell on Rails”

 Stedinger, J., Risk Profile Examples

5. **Airline Safety (Using non-parametric statistics.)**

 Barnett *et al.*, "Airline Safety: Some Empirical Findings"

 Barnett and Higgins, "Airline Safety: Some Empirical Findings"

 Barnett, and Wang, “Passenger-mortality risk estimates provide perspective …”

 Sivak, Flannagan, "Flying and Driving after the 9/11 Attacks"

 Stedinger, J., “Method of Randomization” + “Randomization Examples”

1. **Highway Safety: Going 55**  **(What it costs to save time.)**

National Research Council, "55: A Decade of Experience," Exec. Summary

 Lave, "Costs of Going 55"

1. **Modelling** **Toxic Emissions and Chronic Risks (It moves around.)**

 Stevens and Swackhamer, "Environ. Pollution: A multimedia approach . . ."

 McKone, "...Exposure .. from Multiple Media and through Multiple Pathways..."

 Davis and Cornwell, “Air Pollution”

 Marshall, et al., “Risk Assessment at a Former Pesticide Production Facility”

 *ATSDR Public Health Assessment Guidance Manual*

8. **Food Safety, Carcinogens, and Health Risk Analyses (Could it kill you?)**

Paustenbach, “Primer on Human Health and Environmental Risk Assessment”

 Molak, "Toxic Chemicals Noncancer Risk Analysis …"

 \*Rodricks and Taylor, "Appl. of Risk Assess. to Food Safety Decision Making"

NRC, "*Risk Assessment in the Federal Govn't: Managing the Process*", 1983

 McClellan, R.O., “A Risk Assessment Primer, ” 1995

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 Anderson et al., "Quantative Approaches in Use to Assess Cancer Risk"

 \*Hattis and Kennedy, "Assessing Risks from Health Haz.: An Imperfect Science"

 Calabrese, “Hormesis: Changing view of the Dose-response”

 Abelson, *Science* Editorial, Risk Assessment of Low-Level Exposures

 \*Ames et al., "Ranking Possible Carcinogenic Hazards"

 \*Epstein/Swartz Comment on Ames et al.; Ames/Gold Response

 Colborn, Dumanoski, and Meyers, *Our Stolen Future*

Wikipedia(Jery Stedinger edited), “Endocrine disruptor”

 Steingraber, *Having Faith: An Ecologists Journey to Motherhood*

9. **Regulatory Policy & Economics (So, what do we do? What does economics tell us?)**

 \*Ruckelshaus, "Risk, Science and Democracy"

 Pinkowski, “Whose Risk Is It Anyway?”

 \*Wildavsky, "No Risk is the Highest Risk of All"

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 \*Kelman, “Cost-Benefit Analysis: An Ethical Critique”

 Kent and Allen, “Overview of Risk-Based Priority Setting...” in *Worst Things First?*

 Morrall, "Review of the Record"

 Graham and Carrothers, “Cost-Benefit Analysis”

 Hammitt, “Valuing Health: …”

 Zeckhauser and Viscusi, “The Risk Management Dilemma”

10. **AIDS and Public Health Policy (A ongoing concern.)**

 Hearst and Hulley, "Preventing the Heterosexual Spread of AIDS"

11. **Decision, Sensitivity and Uncertainty Analysis**

 Stedinger, "Sensitivity and Uncertainty Analysis"”

12. **Perceptions of Risk and Risk Communication (What people think. What to say.)**

 Slovic, "Perceptions of Risk"

 \*Slovic, Fischhoff, Lichtenstein, "Rating the Risks"

 \*Fischhoff, Watson, and Hope, "Defining Risk”"

 Sandman, “Definitions of Risk: Managing Outrage, Not Just the Hazard”

\*Sandman, "Getting to Maybe: Comm. Aspects of Siting Haz. Waste Facilities

 \*Pough and Krimsky, "Emergence of Risk Comm. Studies: Soc. and Pol. Context"

\*Johnson et al., "Informed Choice or Regulated Risk? Lessons from Radon"

1. **Risk in the Media (Did you see the news?)**

 Bean, "Speaking of Risk"

Sandman, "Telling Reporters"

 Greenburg et al., "Network News Coverage"

14. **Risk Management and the Public (Pulling it all together.)**

 Randolph, “What Price Speed?”

 Lave, “Fixing the System”

 \*Starr, “Social Benefit versus Technological Risk,”

 Starr, "Risk Management & Assessement"

 Slovic, “Perceived Risk, Trust, and Democracy”

* Articles with an asterisk are in the textbook by Glickman and Gough (eds.), *Readings in Risk*, Resources for the Future, 1990. Most other articles are in *CEE 5970 Readings*, except for a few discussions distributed with class handouts. In a rare cases homework & lecture notes supply a URL for recent articles available on the web.
* Morgan, p. 25: In expected value calculation for winding 10 more turns, path "does not break" –

 "lose" is omitted. Computation should be: (0.4)\*(-120) + (0.6) [ (.8)\*(70) + (.2)\*(-70) ] = –22.8