Course Outline: EGRMGMT 590.10/ME 555.04

Introduction to Systems Engineering
Fall 2016

Instructor:

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COURSE DESCRIPTION

Introduction to the theory, principles, and methods used to conceive, design and analyze systems. Focus areas include problem identification, description, modeling and simulation, design, test and evaluation issues, as well as broader lifecycle concerns. Two 1.5 hr classes weekly. Prerequisite: Senior standing in engineering.

LEARNING OUTCOMES

This course intends to introduce you to the fundamentals of systems engineering theory, methods, and tools. We will also focus more broadly on the development of systems thinking, particularly as this relates to complex systems. After taking this class, you should be able to:

- Understand the roles and responsibilities of typical systems engineers, and how these fit into a company's overall organization.
- Understand how fundamental concepts from disciplines such as probability, economics, and cognitive science relate to systems engineering.
- Apply systems engineering tools (e.g., stakeholder identification, requirements development and management, robust design principles) to realistic problems.
- Formulate an effective plan for gathering and using technical and sociotechnical data.
- Identify areas that could be served by modeling and simulation, and identify the associated benefits and limitations.
- Understand how to design for and manage the system lifecycle.
- Develop a systems engineering plan for a realistic project.

- Be able to evaluate a systems engineering plan for soundness and identify areas of strengths and weaknesses.

COURSE WEBSITE

https://sakai.duke.edu/portal/site/f6d9a231-09c1-4fbd-9c82-1f2536a7ea8d

GRADING

- Class participation – 10%
- Case Study presentation (see below) – 10%
- Midterm – 15%
- Requirements project – 15%
- Team project – 35% (25% written, 10% oral presentation)

  Teams of 2 will be assigned a common complex system design problem based on a real-world system. The Midterm will be based on the development of requirements, 'ility' analyses, and software and human systems architecture concerns for this project.

- Team project evaluation – 15%

  Each student will provide a constructive written analysis of one other team's project.

HONOR CODE

Note that students are expected to follow the Duke Honor Code/Community Standard, and more information about this can be found here: http://www.integrity.duke.edu/standard.html. Any form of cheating will not be tolerated and will be reported.

TEXT

Engineering Systems (ES), Olivier L. de Weck, Daniel Roos and Christopher L. Magee, 2011, MIT Press (available for free through the Duke Library IEEE subscription).

Coursepack

Recommended reading:
Barfield, W. 2015. *Cyber-Humans: Our Future with Machines*. New York: Springer, Berlin Heidelberg.

CASE STUDIES

At the beginning of every class, 2 student volunteers will present a case study for 10-15 minutes from the following list (or students are encouraged to suggest different case studies). Each

presentation should include a brief description of the events surrounding the incident as well as a concise analysis of the relevant system engineering issues.

- Delta Airlines computer delays
- WTC collapse
- BMW iDrive
- Denver airport baggage handling opening
- Mars Climate Orbiter
- Therac 25
- Healthcare.gov rollout
- Boeing 787 battery problem
- Boston Big Dig
- Chernobyl
- The Chinese "Great Leap Forward" program
- Malpasset Dam collapse
- Toyota unintended acceleration
- Antibiotic debate
- Union Carbide Bhopal accident
- Columbia Shuttle
- Concorde 203
- Tesla Autopilot Crash
- Deepwater Horizon spill
- Karlino oil eruption
- Piper Alpha
- Amagasaki rail crash vs. Spain Santiago rail-crash
- Fukushima
- Y2K bug
- London Ambulance Service computer aided dispatch problem October 1992
- Pipeline release of hazardous liquid May 23, 1996 Gramercy, LA
- Grounding of the ship Royal Majesty June 10, 1995 Nantucket, Massachusetts
- British Columbia M/V Queen of the North sinking March 22, 2006
- MV Bright Field Accident December 14, 1996 New Orleans, LA

Class Topics

8/30: Introduction and Course Overview

- ES Ch 1
- INCOSE Ch 1 & 2
- MITRE SEG pp 1-10

9/1: System Engineering Frameworks

- Coursepack pp 72-119
- INCOSE Ch 3

9/6: Concept Development & CONOPS

- MITRE SEG pp 269-300

9/8: Requirements I
- Coursepack pp 2-30
- INCOSE Ch 4.1, 4.2, 4.12.2
- http://www.svpg.com/assets/Files/goodprd.pdf

9/13: Requirements II
- Coursepack pp 33-69
- MITRE SEG pp 301-323

9/15: The 'ilities' Part I
- ES Ch 4
- INCOSE Ch 9.1

9/20: On-Demand Mobility – Final Project Introduction (Kenneth Goodrich)

9/22: The 'ilities' Part II
- MITRE SEG 664-669
- **Requirements Project Due**

9/27: The 'ilities' Part III
- SWEBOK CH 1 & 2 (under Box site READINGS)
- MITRE SEG 470-482

9/29: Human Systems Engineering I (Michael Clamann)
- INCOSE 9.9, 9.12
- Human-System Integration (HSI) in System Development Ch 5 (under Box site READINGS)

10/4: Human Systems Engineering II (Michael Clamann)
- HSI Ch 7

10/6: Sociotechnical considerations

10/11: NO CLASS

10/13: MIDTERM

10/18: Modeling and Simulation I
- ES Ch 5
- INCOSE 4.12.1

10/20: Modeling and Simulation II
- Coursepack 190-227
- MITRE SEG pp 461-469

10/25: Design I
- ES Ch 6
- MITRE SEG pp 324-346
- INCOSE 4.3

10/27: Design II (Regis Kopper)
- INCOSE 5.3.2.1
- MITRE SEG pp 347-377

11/1: Design III (Regis Kopper)

11/3: Systems Integration
- MITRE SEG pp 378-401

11/8: Test & Evaluation I
- INCOSE Ch 4.6, 5.7.2.3, 5.7.2.4
- Coursepack 121-189

11/10: Test & Evaluation II
- MITRE SEG pp 402-432

11/15: Systems of the Future I (Woodrow Barfield)

11/17: Systems of the Future II (Woodrow Barfield)

11/22: Final Presentations & Evaluations

11/24: NO CLASS

11/29: Final Presentations & Evaluations

12/1: Final Presentations & Evaluations

12/5: Written Evaluations Due