

The University of Arizona

College of Engineering

Course Title: Reliability Engineering Spring 2017

- Course:** SIE 408/508
Class room: AME S 212
Class time: T, Th 12:30 – 1:45
- Instructor:** Mr. Merrill Jackson, Adjunct Lecturer
Systems and Industrial Engineering Department
University of Arizona
Office: 265 Engineering Building
Office hour: Tuesdays, 11:00-12:00 and 2:00 pm – 4:00 pm
Phone Number: (520) 609-2353 E-mail: merrilljackson@email.arizona.edu
- GTA:** Jen Wu
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Office hour: 2:00-3:00 on Fridays
E-mail: j1ngw@email.arizona.edu
- Text:** Ebeling, C. E., *An Introduction to Reliability and Maintainability Engineering*, Waveland Press, Inc., 2009 (ISBN 1-57766-625-9) second edition.
- Software:** Synthesis (Weibull, XFMEA, and BlockSim) from ReliaSoft
(Licenses are available, free to use for class); MS Excel

Course Description and Goals:

This is a three-credit course configured for well-qualified seniors, graduate students, and engineering professionals and practitioners. It is concerned with determining the probability that a component or system, whether simple or complex, will function as intended. The scope of this course includes: (1) Root cause analysis of critical failures, (2) reliability models of components and systems, (3) development of statistical methods for estimating the reliability of a product, (4) use of software tools to perform model development and analysis, and (5) methodologies to influence system designs. After successful completion of the course the students will be able to analyze data related to reliability questions and use the analytical results to predict the reliability of simple and complex systems. This course will provide an introduction to probability calculus for continuous and discrete random variables, statistical failure time models, estimation of model parameters, model comparison and prediction of future failures. Reliability for simple and complex systems and the relationship to component reliability will be discussed. Students will practice application of the theoretical techniques with data sets from different engineering disciplines using the commercial software provided in this class.

Graduate-level requirements include a term project that focuses on real-world implementations of the course material and/or original theoretical developments in the form of a technical paper. Project topics (e.g., system reliability optimization, physics-based reliability models, warranty data analysis) must be approved by the instructor.

Prerequisite:

For undergraduate students: SIE 305 or equivalent; For graduate students: SIE 430/530.

Topics to be covered:

- Basic concepts in Reliability Engineering
- Root cause analysis
- Statistical reliability models
- System reliability analysis & optimization
- Life time data analysis & model parameter estimation

Contribution to Professional Component/Learning Outcomes:

1. Understand and gain the ability to apply concepts and methods of reliability analysis to failure data from different engineering disciplines.
2. Understand and be able to develop probability distribution models (exponential, Weibull, etc.) for failure time analysis.
3. Understand various statistical methods used in reliability analysis.
4. Acquire ability to appropriately apply statistical methods to the prediction/allocation of reliability and failure rates for technological systems and their components.
5. Acquire ability to model system reliability.
6. Acquire ability to root cause, correct, and document system failures.

Proctor Information:

This course will have proctored exams for distance students. It is the student's responsibility to locate a proctor and report this information to the distance education department.

Grading (different criteria will be used for Under Grad and Grad students):

SIE 408	
Quiz	5%
Homework	15%
Midterm Test	15%
Final Exam	30%
Design Project	30%
Total	100%

SIE 508	
Quiz	5%
Homework	10%
Midterm Test	15%
Final Exam	25%
Design Project	25%
Research Project	20%
Total	100%

It is expected that grading will be based on a percentage of the total points possible with the following minimums required for each grade: **A = 90%**, **B = 80%**, **C = 70%**, and **D = 60%**.

Homework will be assigned approximately one week before it is due. **NO LATE HOMEWORK WILL BE ACCEPTED.** If you cannot attend class, make sure your homework is e-mailed to the GTA or delivered to my office (265 Engineering Building) before class on the day it is due.

Homework not turned in on time will be graded as zero, so please turn in what you have completed even if you have not fully completed an assignment.

Design Projects (DP) – Team Project (408 & 508)

Case Studies:

- Oil industry: e.g. Deepwater Horizon accident or Exxon Valdez
- Automotive: e.g. Toyota uncommanded acceleration, Firestone tires, Pinto gas tank, Tesla or Google autopilot
- Nuclear industry: e.g. Three Mile Island, or Chernobyl
- Space industry: e.g. Space X, Space shuttle Challenger or Columbia
- Aerospace: Aircraft failures –many to choose from (many are well investigated and documented) e.g. US Airways Flight 1549 (Sully)
- Consumer Product Recalls: e.g. food, toys, Lithium ion (Note 7, Dell, Boeing 787 etc.)
- Civil Engineering: e.g. bridge collapse, Dam failure
- **Other: You propose it!**

Case Study Deliverables:

- DP1: Design project proposal (and presentation)
- DP2: Reliability measures and reliability block diagrams
- DP3: List of potential failures, risks from published databases
- DP4: FMEA results
- DP5: FTA & ETA results
- DP6: FRACAS reports
- DP7: Summary report for case study putting all the results together (presentation)

Research Projects (RP) – Individual Project (508)

Research Topics: Some Suggestions

- Reliability for early engineering design
- Robust design
- Reliability optimization as applied to various industries
- Reliability as a function of organizational maturity
- Reliability as a function of product maturity
- Reliability and Risk Management (business and product)
- Bayesian approaches to sample size requirements
- **Other: You propose it!**

Deliverables:

- RP1: Topic proposal
- RP2: Initial list and summary of literature search
- RP3: Continuation of literature search
- RP4: Refinement of literature search
- RP5: Future work
- RP6: Final report

Suggested References

Websites:

1. www.reliasoft.com
2. www.maintenancetechnology.com
3. www.reliabilityweb.com
4. www.barringer1.com/

Books:

1. E.A. Elsayed, *Reliability Engineering*, Addison Wesley, 1996 (ISBN 0-201-63481-3).
2. Meeker, W.Q., and L.A. Escobar, *Statistical Methods for Reliability Data*, John Wiley & Sons, 1998.
3. J. Moubray, *Reliability-centered Maintenance, second edition*, Industrial Press, 1997 (ISBN 0—8311-3078-4).
4. A. Smith and G. Hinchcliffe, *RCM Gateway to World Class Maintenance*, Elsevier Butterworth-Heinemann, 2004, ISBN 0-7506-7461-X.
5. *Design for Reliability* (eds D. Raheja and L. J. Gullo), John Wiley & Sons, Inc., Hoboken, NJ, 2012.
6. O'Connor, Patrick, and Andre Kleyner. *Practical Reliability Engineering*, John Wiley & Sons, 2011
7. Blischke, Wallace R., and DN Prabhakar Murthy. *Reliability: Modeling, Prediction, and Optimization*. Vol. 767. John Wiley & Sons, 2011
8. Reliability Toolkit: Commercial Practices Edition. Reliability Analysis Center, 1995.