Course Syllabus

Design for Reliability

ENME 695
Spring 2020

Course Description

Reliability is a product or system's capacity to perform as intended, without failure and within specified performance limits, for a specified time in its life-cycle conditions. Knowledge of reliability concepts and principles, as well as risk assessment, mitigation, and management strategies prepares engineers to contribute effectively to product development and life-cycle management and product safety.

This course teaches the fundamental knowledge and skills of reliability as it pertains to the design, manufacturing, and use of engineered products and systems. Specifically, students will learn how to:

- Efficiently and cost-effectively design and manufacture reliable products
- Implement derating, uprating, reliability prediction, and reliability allocation
- Plan and implement product testing to assess and achieve reliability
- Assess the suitability of the supply chain members to contribute the development, manufacturing, distribution, and support of reliable products
- Understand process capability and process control
- Apply design and analysis tools such as failure modes, mechanisms, and effects analysis; fault tree analysis; design of experiment; and others
- Analyze degradation, failure, and warranty return data to estimate fundamental reliability parameters
- Conduct root cause analysis
- Design prognostics and health monitoring tools for products and systems
- Address reliability issues associated with warranties, regulatory requirements, and liabilities

Expectations of Students

- **Attendance**: Attending all classes generally leads to good grades. Except for emergencies, late assignments will not be accepted for credit.
- **Communication Style**: Ask questions whenever they occur to you. Email communication through the class web page is also encouraged.
- **Academic Integrity**: The University of Maryland, College Park, has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://shc.umd.edu/SHC/Default.aspx.

Homework

Both individual and group homework will be assigned. Some of the homework assignments will require use of specialized software tools for which semester-long licenses will be provided. The homework submissions are expected to meet the standard of an industry report. All homework submissions will be online using the course website.

Professor Michael Pecht
Tel.: (301) 405-5323
pecht@calce.umd.edu

Class Meets
Monday
09:30AM – 12:10PM (US Eastern)
J.M. Patterson Building
BLD #083, Room 2217

Office Hours
Tuesdays and Thursdays
9:30AM – 11:30AM (US Eastern)
Engineering Lab Building
BLD #089 , Room 1103

Teaching Staff
Rajkumar B. Patil
rbpatil@umd.edu

Prerequisites
N/A
Graduate standing expected

Course Communication

You are welcome to drop by the office anytime. Calling or emailing in advance is suggested to ensure availability. Questions raised due to skipping of class should be avoided.

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Grading Process

- Mid-term exam[1]: 20%
- Final exam[2]: 50%
- Project: 30%
- Homework: 5 points ++

Course Website

All registered students will be given access to the course website. Please visit https://myelms.umd.edu/login instructions on how to obtain a login/password.

Papers and Research Documents

Papers and research documents will be handed out in class and will be considered required reading.

Software

Semester-long licenses are provided for data analysis, system reliability and accelerated test data analysis tools. If you did not receive the necessary information, contact the instructor.

Textbook

- Kailash C. Kapur and Michael Pecht, "Reliability Engineering", Wiley Series in Systems Engineering and Management, John Wiley & Sons, New York, NY, 2014. ISBN: 9781118140673.

Other References

- Patrick P. O'Connor and Andre Kleyner, "Practical Reliability Engineering," 5th Edition, John Wiley & Sons, New York, NY, 2012.
- Charles E. Ebeling, "An Introduction to Reliability and Maintainability Engineering, Waveland Press, Inc., Illinois, IL, Third Edition, 2019, ISBN: 9781478637349.
- Wayne B. Nelson, "Applied Life Data Analysis," John Wiley & Sons New York, NY, 1982.
- E. E. Lewis, "Introduction to Reliability Engineering," 2nd Edition, John Wiley & Sons, New York, NY, 1996.

Journals in Topic Area (not an exhaustive list)

- IEEE Access
- IEEE Transactions on Device and Material Reliability
- IEEE Transactions on Reliability
- International Journal of Quality and Reliability Management
- Journal of Quality Technology
- Microelectronics Reliability
- Quality and Reliability Engineering International
- Reliability Engineering and System Safety
- Engineering Failure Analysis
- Quality and Reliability Engineering International
- Proceedings of Institute of Engineers Part O: Journal of Risk and Reliability

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[1] Students will take the mid-term exam from 9:30 AM to 11:00 AM on March 09, 2020.

[2] The University of Maryland decides the date and time of the two-hour final exam, which is announced on http://testudo.umd.edu by the middle of the semester. The tentative date of the final exam is between May 14, 2020 and May 20, 2020.

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Lecture Schedule

The schedule of lectures is given below and will be posted separately in the course website and updated if needed. For planning purpose, please note that the mid-term examination (90 minutes long) will be on March 09, 2020 and the final examination will be based on the UMD schedule within the date range of May 14 – 20, 2020.

Course Schedule

Class	Class Dates	Lecture Topics	Reading Materials (Textbook Chapters)
1	01/27	• Reliability engineering in the twenty-first century – what is important and what is very important • Reliability and life distributions for reliability analysis	Chapter 1 Chapter 2 Chapter 3
2	02/03	• Confidence interval concepts • System reliability modeling • Software for reliability data analysis – e.g. Weibull++ and BlockSim	Chapter 13 Chapter 17
3	02/10	• Product requirements, constrains, and specifications • How to meet reliability objectives • Reliability capability • Parts selection and management	Chapter 5 Chapter 6 Chapter 8 Chapter 9
4	02/17	• Process control and process capability • Design of experiments	Chapter 14
5	02/24	• Life cycle conditions • Health monitoring and prognostics	Chapter 7 Chapter 18
6	03/02	• Failure modes, mechanisms, and effects analysis • Product screening and burn-in	Chapter 10 Chapter 15
7	03/09	• 90-min mid-term exam (covering lectures 1-6) • Fault tree analysis (FTA) and common mode failures	Chapter 5 Chapter 16
	03/16	• Spring break	
8	03/23	• Physics of failure based reliability assessment	Chapter 5
9	03/30	• Analyzing product failures and root causes	Chapter 16
10	04/06	• Product qualification and accelerated testing • Software for test data analysis	Chapter 13
11	04/13	• Sustainment – logistics, spares, maintenance, and contracts • Concept of availability and maintainability • Life cycle costing based on reliability and maintainability principles	
12	04/20	• Probabilistic design for reliability and factor of safety • Derating and uprating	Chapter 11 Chapter 12
13	04/27	• Change and change notification • Data driven (machine learning) reliability prediction methods	Chapter 18
14	05/04	• Industry Day	Chapter 19
15	05/11	• Warranty planning and analysis	
16	May 14-20	• Final exam: between May 14, 2020 and May 20, 2020 (On the material covered after the mid-term but retention of the information and und erstanding of all chapters are expected)	

Note: This is a tentative schedule, and subject to change as necessary – monitor the course ELMS page for current deadlines. In the unlikely event of a prolonged university closing, or an extended absence from the university, adjustments to the course schedule, deadlines, and assignments will be made based on the duration of the closing and the specific dates missed.