ME571 Reliability Based Design

Spring 2016

Instructor: Ganesh Subbarayan
Professor
School of Mechanical Engineering, Purdue University
585 Purdue Mall, West Lafayette, IN 47907-2088

Phone: 765-494-9770 (only during office hours please)
Email: ganeshs@purdue.edu

Instructor's personal webpage:
https://engineering.purdue.edu/ME/People/ptProfile?id=11244

Class Hours: Tue/Th 1:30-2:45 PM, WNG 2599

Teaching Assistants: Tao Song, Yuvraj Singh and Chun-Pei Chen

Course Webpage: http://www.itap.purdue.edu/tlt/blackboard/
You need a Purdue login (also called Purdue Career account) to access the course webpage. The instructions for creating your Purdue login are at https://engineering.purdue.edu/ProEd/current_student/create_career_account. If you have difficulty with your userid/password, please contact Engineering Professional Education office to ensure that your registration is complete.

Help and Office Hours: The most efficient way to have your question answered (one that will help other students also) is to post your questions on the discussion board at the course website. Either the TA or I will attempt to answer your questions within one business day. Please note that we may not be able to answer your questions over the weekends and when other extraordinary circumstances delay us.

The TAs and I will also be available to answer your questions by phone individually during:

GS:	Mon:	3:00-5:00 PM,	Room: ME 3172,	Phone: 765-494-9770
TAs:	Wed:	11:30 AM-1:30 PM,	Room: ME 2170,	Phone: 765-494-1357
	Fri:	9:30-11:30 AM,	Room: ME 2160,	Phone: 765-494-0866

All times are Eastern. No calls outside of office hours please.

Course Objective: Enables students to understand the importance of reliability in the design and manufacture of engineered products, components and systems. The methods of reliability analysis and reliability-based design of mechanical and electronic systems are presented with illustrative examples.

Course Description: The course is aimed at providing an engineering view (as opposed to a purely statistical view or a management view) of reliability analysis as well as reliable product design. The goal is to make the student familiar with both the statistical tools as well as the failure physics that enable one to model time to failure of products and to use such models during design phase to ensure reliable product designs.

Course Outline by Topical Areas: Introduction; probability rules; probability examples; conditional probability; algebra of expectations and variance; normal, lognormal, exponential and weibull distributions; load strength interference; binomial and poisson distributions; failure rate modeling; reliabilty block diagrams; monte carlo simulation; uncertainty in load and in geometry; first-order reliability methods; time to failure modeling for selected failure mechanisms in mechanical and electrical systems.

Prerequisites: Undergraduate machine design course or consent of instructor. You should understand (or be willing to learn) the concepts of shear force, bending moment, stress, and principal stress.

Lecture Notes: Powerpoint notes posted on blackboard site. In class hand written derivations and notes will also be posted electronically on the blackboard site.

Course Textbook: J.W. McPherson, Reliability Physics and Engineering: Time to Failure Modeling, 2nd Edition, Springer, 2013.

Note: Please don't purchase the text before the first week of classes.

Reference: P.D.T. O'Connor and A. Kleyner, Practical Reliability Engineering, fifth edition, Wiley, 2012.

Homeworks: Weekly assignments, not all will be graded. When the homework is assigned, I will inform you whether the homework will be graded.

Exams: Two mid-term tests and a comprehensive final exam.

Evaluation Criteria

Homeworks (not all graded)	40%
Three tests (equally weighted)	60%

Late Homework/Project Policy: Late work will be accepted, however, a penalty will be assessed for lateness. Late homeworks will not be accepted after the solution

has been posted on the course webpage. The penalty will be 15% for each day the assignment is late. This late penalty will not be assessed if you have a special situation such as illness.

Computer Requirements: You need access to MATLAB and Microsoft Excel for homeworks. You will need MATLAB Statistics Tool Box, which may not come standard with the student version of MATLAB. Off-campus access to full version of MATLAB is available through a web interface via Purdue ITaP's Software Remote service site (https://goremote.itap.purdue.edu/Citrix/XenApp/auth/login.aspx). As with the course webpage, you will need a Purdue login to access the software server. **A high-speed Internet connection is critical if you plan to use Purdue University computing servers to complete your projects.** If you have difficulty with remote software server, please contact or Purdue's IT department itap@purdue.edu (phone help options are also available at http://www.itap.purdue.edu/help/).

Miscellaneous: Exams will test your ability to synthesize the material learned in class and practiced in the homeworks. The exams may not be identical in form to the homeworks.

Schedule of Topics					
			Spring 2016		
Week #	**Class #**	**Date**	**Topic**	**References* (in addition to ppt notes)**	**Assignment**
1	1	1/12/16	Introduction	OC:1.1-1.5	
	2	1/14/16	Rules of probability	OC: 2.1-2.4	H1
2	3	1/19/16	Probability examples		
	4	1/21/16	Conditional probability	OC: 2.1-2.4	H2
3	5	1/26/16	Expectation and variance		
	6	1/28/16	Expectation and variance		H3
4	7	2/2/16	Normal distribution, PDF and CDF	OC: 2.5-2.6, MP: 5	
	8	2/4/16	Load strength interference	OC: 5.1-5.3	H4
5	9	2/9/16	Load strength interference	OC: 5.1-5.3	
	10	2/11/16	Material degradation and time to failure	MP: 2-4	
6	11	2/16/16	Lognormal distribution	MP: 6.1	
	12	2/18/16	**Test 1**		H5
7	13	2/23/16	Lognormal distribution	MP: 6.1	
	14	2/25/16	Exponential distribution, hazard rate and reliability	MP: 7	H6
8	15	3/1/16	Weibull distribution	MP: 6.2	
	16	3/3/16	Multimodal distributions and mixed multiple failure mechanisms	MP: 6.3	H7
9	17	3/8/16	Data fits and failure rate modeling	MP: 7, OC: 3	
	18	3/10/16	Data fits and failure rate modeling	MP: 7, OC: 3	H8
10		3/15/16	**Spring break, no class**		
		3/17/16	**Spring break, no class**		
11	19	3/22/16	Binomial and Poisson distributions		
	20	3/24/16	Binomial and Poisson distributions		H9
12	21	3/29/16	Reliability block diagrams		
	22	3/31/16	Monte Carlo simulation	OC: 4	H10
13	23	4/5/16	Uncertainty in geometry, load and strength		
	24	4/7/16	**Test 2**		
14	25	4/12/16	First order reliability methods		
	26	4/14/16	First order reliability methods		H11
15	27	4/19/16	Accelerated testing and acceleration factors	MP: 8 and 9	
	28	4/21/16	Accelerated testing and acceleration factors	MP: 8 and 9	H12
16	29	4/26/16	Failure models for mechanical systems	MP: 12	
	30	4/28/16	Failure models for electronic systems	MP: 11	
17		5/3/16	**Exam Week**		
			* MP= J.W. McPherson, Reliability Physics and Engineering		
			OC=P.D.T. O'Connor, Practical Reliability Engineering		