EML6934: Prognostics and Health Management of Engineering Systems (Spring 2021)

Catalog information: Credit 3, Prerequisite: EGM6341 or equivalent

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Class time and location: Online, MWF 8th period (3:00 – 3:50 PM)
Office hours: MWF 9th period (4:05 - 4:55 PM)

Textbooks:
– "Prognostics and Health Management of Engineering Systems" by N. H. Kim, D. An, and J. H. Choi (Required). Springer, 2017, ISBN: 978-3-319-44740-7

Course Objectives and Outcomes
Catalog description: Advanced topics in diagnostics and prognostics of engineering system's health state, Bayesian statistics, physics-based methods, data-driven methods, and applications

The objective of this course is to introduce methods of predicting the future behavior of a system's health and the remaining useful life to determine an appropriate maintenance schedule. This course not only introduce various prognostics algorithms, but also explain their attributes and pros and cons in terms of model definition, model parameter estimation, and ability to handle noise and bias in data. Students will also be exposed in MATLAB programming. The main topics covered in the course, in general, are outlined below.

1. Introduction to prognostics: the basic ideas of PHM are introduced along with historical backgrounds, industrial applications, reviews of algorithms, and benefits and challenges of PHM.

2. Tutorials for prognostics: Before discussing individual prognostics algorithms in detail, prognostics tutorials with Matlab codes using simple examples are presented. Using simple polynomial models with the least-squares method, most important attributes of various prognostics algorithms will be learned.

3. Bayesian statistics: Many prognostics algorithms utilize Bayes' theorem to update information on unknown model parameters using measured data. For the purpose of prognostics, this course focuses on how to utilize prior information and likelihood functions from measured data in order to update the posterior probability density function (PDF) of model parameters.

4. Physics-based prognostics methods: We will learn several algorithms, such as nonlinear least squares, Bayesian method, and particle filter. The major step in physics-based prognostics is to identify model parameters using measured data and to predict the remaining useful life using them.

5. Data-driven prognostics methods: Data-driven approaches use information from observed data to identify the patterns of the degradation progress and predict the future state without using a physical model. As representative algorithms, the Gaussian process regression and neural network models are explained.

6. Applications: Various applications of prognostics will be discussed, including fatigue crack growth, wear in a revolute joint, prognostics using accelerated life test data, and fatigue damage in bearings.

Other Information

Homework is an essential part of this course. Various programming and formulation problems will be assigned on Canvas. Late homework will not be accepted.

Exams: There will be two in-term exams but no final exam. Exams will be open-book and engineering calculator is allowed. Exam questions are mostly problem solving questions.

Class participation: Students can get extra points if s/he finds an error in the textbook and report to the instructor first time. The errors that were already found were posted in class website.

Projects: There will be two term projects. One project is related to computer implementation of hyperelasticity, and the other is solving nonlinear structural problems using Abaqus. Here the students are encouraged to learn certain aspects of the software on their own as an exercise in self-education and life long learning. Projects must be submitted by noon on Canvas. Late projects submitted by the next day will receive 90% credit. Projects received later than that will not be accepted without medical or other valid reasons.

Grading: Exams: 40%, Projects: 40%, Homeworks: 20%

(A=93~100, A-=90~92.9, B+=87~89.9, B=83~86.9, B-=80~82.9, C+=77~79.9, C=73~76.9, C-=70~72.9, D+=67~69.9, D=63~66.9, D-=60~62.9, E=0~59.9).

Software: All students are required to use MATLAB. Homework and project assignments require heavy MATLAB programming.

Academic honesty: All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is reminder to uphold your obligation as a student at the University of Florida and to be honest in all work submitted and exams taken in this class and all others.

UF Graduate School Policy: Letter grades of C-, D+, D, D- or E are not considered passing at the graduate level. Although the grade points associated with these letter grades are included in grade point average calculations, courses with these grades will not be credited towards graduation. Also, grades of B-, C+ or C count toward a graduate degree if an equal number of credits in courses numbered 5000 or higher have been earned with grades of B+, A- and A, respectively. Further explanation of graduate grading policies can be found at http://gradcatalog.ufl.edu/content.php?catoid=12&navoid=2750#grades.

Course Schedule:

Week	Content	Lecture Videos	Comment
1/11 – 1/15			
1/18 – 1/22			
1/25 – 1/29			
2/1 – 2/5			
2/8 – 2/12			
2/15 – 2/19			
2/22 – 2/26			
3/1 – 3/5			
3/8 – 3/12			
3/15 – 3/19			
3/22 – 3/26			
3/29 – 4/2			
4/5 – 4/9			
4/12 – 4/16			
4/19 – 4/21			