

Course Syllabus

EML 6577 Verification, Validation and Uncertainty Quantification and Reduction (Spring 2024)

Class time and location:
MWF Period 7, MAE-B 211

Instructors:
Nam-Ho Kim, 210 MAE-A, nkim@ufl.edu. **Office hours:** MWF Period 9.

Teaching assistant: None

Course description:

Catalog Information: Uncertainty, Bayesian statistics and surrogates. Reliability and optimization under uncertainty. Verification and validation. *Prerequisite: Graduate standing in Science or Engineering.*

Topics:

- Review of uncertainty, random variables, and Bayesian statistics.
- Sampling methods.
- Surrogates, regression and Kriging.
- Fundamentals of verification and validation.
- Calibration and model accuracy assessment.

Course objective: Introduce students to uncertainty quantification and reduction and its use for reliability based design, verification and validation.

Textbooks (Recommended)

Choi, Grandhi, and Canfield, Reliability-based Structural Design, Springer, 2007 (electronic book available from UF library).

Oberkampf and Roy, Verification and Validation in Scientific Computing, Cambridge University Press, 2010.

Gelman, Carlin, Stern, and Rubin, Bayesian Data Analysis, Chapman and Hall/CRC, 1995.

Software: The course requires the substantial use of Matlab.

Course schedule:

Bayesian techniques

Date	Lect	Content	Note
1/8	1	Introduction to uncertainty	

1/10	2	Random variables and probability distributions
1/12	3	Aleatory vs. epistemic uncertainty
1/17	4	Set theory, conditional probability and Bayes rule
1/19	5	Bayesian posterior
1/22	6	Bayesian estimation of binomial distribution
1/24	7	Single parameter normal estimation
1/26	8	Two parameter normal estimation
1/29	9	Bayesian classification
1/31	10	Gaussian process model
2/2	11	Simulation technique
2/5	12	Markov chain Monte Carlo
2/7	13	Matlab implementation of MCMC
2/9		Exam

Surrogate module

Date	Lect	Content	Note
2/12	1	Local approximations and local-global approximations	
2/14	2	Surrogate construction	
2/16	3	Linear regression accuracy	
2/19	4	Kriging	
2/21	5	Complete Kriging	
2/23	6	Surrogate based global optimization - EGO	
2/26	7	Sampling plans	
2/28	8	Complete sampling plans	
3/1	9	Nonlinear regression	
3/4	10	Multifidelity surrogate	
3/6	11	Monte Carlo simulation	
3/8	12	Surrogate based RBDO	
3/18	13	Complete surrogate based RBDO	
3/20		Exam	

Verification, validation and uncertainty quantification module

Date	Lect	Content	Note
3/22	1	Fundamental concepts and terminology of V&V, Project 1	
3/25	2	Fundamental concepts and terminology of V&V	
3/27	3	Validation fundamentals	
3/29	4	Accuracy assessment	

4/1	5	Epistemic-vs-aleaotry uncertainty assessment
4/3	6	Pbox-validation metric
4/5	7	Calibration without discrepancy
4/8	8	Calibration with discrepancy
4/10	9	Code verification
4/12	10	Exact solutions including MMS
4/15	11	Paper Helicopter Project 2
4/17	12	Design and execution of validation experiments
4/19	13	Project presentation
4/22		Exam

Course Assignments and Evaluation of grades

Homework: Assignments and reading materials are posted on the class Canvas website. Late homework will not be accepted without medical reasons.

Examinations: There will be one exam per module. The exams are closed book, with one 8.5"x11" formula page (two sided) permitted.

Project: The last module will have a project.

Grading: Examination 70% Homework 30% for Bayesian techniques module and Surrogate modeling module. Examination; 35%, Homework 30%; Project 35% for VVUQ module.

Grading Scale: 93.4-100 = A, 90-93.3 = A-, 86.7-89.9 = B+, 83.4-86.6 = B, 80-83.3 = B-, 76.7-79.9=C+, 73.4-76.6=C, 70-73.3 = C-, 66.7-69.9=D+, 63.4-66.6 = D, 60-63.3 = D-, <60 = E.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://www.dso.ufl.edu/sccr/process/student-conduct-honor-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Campus Resources:

Health and Wellness

U Matter, We Care:

If you or a friend is in distress, please contact umatter@ufl.edu or 352 392-1575 so that a team member can reach out to the student.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc> (Links to an external site.), and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/> (Links to an external site.).

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml> (Links to an external site.).

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/> (Links to an external site.).

Library Support, <http://cms.uflib.ufl.edu/ask> (Links to an external site.). Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/> (Links to an external site.).

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/> (Links to an external site.).

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process> (Links to an external site.).

COVID-19 related issues:

1. For face to face courses a statement informing students of COVID related practices such as:

We will have face-to-face instructional sessions to accomplish the student learning objectives of this course. In response to COVID-19, the following policies and requirements are in place to maintain your learning environment and to enhance the safety of our in-classroom interactions.

- You are required to wear approved face coverings at all times during class and within buildings. Following and enforcing these policies and requirements are all of our responsibility. Failure to do so will lead to a report to the Office of Student Conduct and Conflict Resolution.

- This course has been assigned a physical classroom with enough capacity to maintain physical distancing (6 feet between individuals) requirements. Please utilize designated seats and maintain appropriate spacing between students. Please do not move desks or stations.
 - Sanitizing supplies are available in the classroom if you wish to wipe down your desks prior to sitting down and at the end of the class.
 - Follow your instructor's guidance on how to enter and exit the classroom. Practice physical distancing to the extent possible when entering and exiting the classroom.
 - If you are experiencing COVID-19 symptoms ([Click here for guidance from the CDC on symptoms of coronavirus](#)), please use the UF Health screening system and follow the instructions on whether you are able to attend class. [Click here for UF Health guidance on what to do if you have been exposed to or are experiencing Covid-19 symptoms](#).
1. Course materials will be provided to you with an excused absence, and you will be given a reasonable amount of time to make up work. [Find more information in the university attendance policies](#).

 2. For online course with recorded materials a statement informing students of privacy related issues such as:

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.