Syllabus for **STAT 7020** (#) Surrogates: Gaussian Process Modeling, Design and Optimization. Fall 2025

Wednesdays/Fridays, 9:30 pm – 10:50 pm, FRENCH-W 4211

Instructor: Bledar Alex Konomi
Department of Mathematical Sciences, French Hall West 5043
Phone (513) 556-4050 (6-4050 from on campus phones)

Office Hours: Wednesday 11:00 am – 11:50 am or online by request, 5043 French Hall

Course Description: This course is concerned with Surrogate Models, which are the backbone of the Uncertainty Quantification (UQ) in the natural sciences, biological sciences, and engineering. The course will cover : Introduction to Response Surface and UQ problems, Steepest Ascent and Ridge Analysis, Space Filling Design, Gaussian Processes (GP), Model based Design for GP, Optimization, Multifidelity and Calibration Models, Sensitivity Analysis, GP Fidelity and Scale, Heteroskedasticity, etc..

Objective: This course will introduce students to the Surrogate Models for data analysis. Students will learn how to quantify uncertainty regarding response surface and parameters. The course will emphasize modeling and computations under the Bayesian paradigm. We will use and build statistical software in R (time premised we may also introduce Matlab tools).

Topics: Response Surface, Computer Experiments, Motivating Datasets, Path of Steepest Assent, Second order Response Surface, Latin Hyperqube Design, Maximum Design, GP prior, GP hyperparameters, GP by convolution, Model based Design, Sequential Design, Bayesian Optimization, Optimization Under Constrains, Multifidelity, Calibration, Sensitivity Analysis, Compact Support Kernel, Partition Model and Regression Trees, GP approximations, Stochastic Kriging, Laten Variable Process, Sequential Design.

Prerequisites: Students are assumed to have background knowledge of concepts of probability, mathematical statistics, applied statistics and advance calculus. Bayesian statistics background is preferable.

Textbook: Detailed lecture notes will be posted on canvas. However a good reference for the class is:

> Robert Gramacy, "Surrogates: Gaussian Process Modeling, Design and Optimization" CRC Press, Taylor & Frances 2020.
>
> For the book website: https://bobby.gramacy.com/surrogates/

and complementary textbooks will be:

> C. E. Rasmussen & C. K. I. Williams, "Gaussian Processes for Machine Learning", the MIT Press, 2006. Online Access: https://gaussianprocess.org/gpml/chapters/RW.pdf
>
> Thomas J. Santner, Brian J. Williams, & William I. Notz, "The Design and Analysis of Computer Experiments" 2018. Online Access: https://www.asc.ohio-state.edu/santner.1/TJS-BJW-WIN/master-driver.pdf & https://link.springer.com/content/pdf/10.1007/978-1-4939-8847-1.pdf?pdf=button%20sticky

Course Webpage: All course related information are posted on UC canvas, including course syllabus, reading assignments, lecture notes, handouts, homework assignments, codes, announcements, etc. Visit Canvas frequently.

Table 1: Grade weighting

Attendance-Participation	Homework	In Class Exam (Topic Presentation)	Take Home Exam	Project
10%	25%	20%	20%	25%

Grade: Your final course grade will be based on the following weighting of assessment components: Your final course letter grade will be assigned according to the following grading scale: A 93–100, A- 90 – 92, B+ 87–89, B 83–86, B- 80 – 82
C+ 77–79, C 73 – 76, C- 70 – 72, D+ 67– 69, D 63 – 66, D- 60 – 62
F below 60

Homework: Homework will generally be assigned on canvas (tentatively) every two week throughout the semester (Tentatively 5-6 HWs). Preferably, homework will be submitted in a pdf, Microsoft world or equivalent – Using Latex or equivalent program is encouraged. Handwritten homework will be also accepted in non computer based problems if they are clearly written. The due date of the homework will be announced in the HW and/or class room. Homework will be collected at the start of the class on the due date, and this is the only acceptable way to turn in homework. **No late assignments will be accepted unless there are extreme and document-able circumstances that are approved by the instructor.** .

Project: There will be a major individual project for this class which will account for the 25% of your grade. For this you have to submit a proposal, give a class presentation and a final manuscript.
You have to submit one project proposal to me by email and must contain the following information.

1. Your name.
2. Project Title.
3. Project Description - What is the goal of the project, what problem are you solving or what experiment will you be performing, and what do you hope to accomplish by the end of the semester?
4. Project Deliverables - What results and analysis will you have by the time of the presentation of your project to the class?
5. Work Plan - What work needs to be done to accomplish your objectives?
6. Datasets - What dataset will you be using? Do you already have experience in using it? How large is it?

A project presentation will be required at the end of the semester. Please include project goal, what you were trying to accomplish, technical approach, what method you were using to achieve your goal and the outcome and results, what were the results of your efforts.
A final report in the form of a paper should be also submitted by the last day of class. The code used should be also included in a separate file.

Communication Devices Personal communication devices such as cell phones and PDAs must be either turned off or put on vibrate during class. Additionally, please refrain from texting during class.

Academic Integrity Please help maintain an academic environment of mutual respect and fair treatment. You are expected to produce original and independent work on the exams. For homework, group work is encouraged. However, it is plagiarism to copy someone else's work and call it your own. All students must submit their own written work in their own words. Academic misconduct will not be tolerated (http://www.uc.edu/conduct/Academic_Integrity.html).

Issues of Differing Abilities: Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of those available accommodations, students must contact the Disability Services Office at 210 University Pavilion (513-556-6823).
http://www.uc.edu/aess/disability.html.
(This syllabus is subject to changes.)