

**TO:** The Engineering Faculty

**FROM:** The Faculty of the School of Mechanical Engineering

**RE:** New Course - ME 53900 Introduction to Scientific Machine Learning

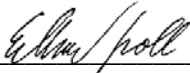
The Faculty of the School of Mechanical Engineering has approved the following new course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

**ME 53900 Introduction to Scientific Machine Learning**, Sem. 1, alternate years, Class 3, cr. 3.

Prerequisites: None

Introduction to the fundamentals of predictive modeling for advanced undergraduates and graduate science and engineering students that work in the intersection of data and theory. Students who complete this course will be able to 1) represent mathematically the uncertainty in parameters of physical models; 2) propagate parametric uncertainty through physical models to quantify the induced uncertainty in quantities of interest; 3) calibrate the uncertain parameters of physical models using experimental data; 4) combine multiple sources of information to enhance the predictive capability of models; 5) pose and solve design optimization problems under uncertainty involving expensive simulations or experiments; 6) improve scientific writing and visualization skills.

**Reason:** This course has been taught two times on an experimental basis under the title “Introduction to Uncertainty Quantification” with the following enrollments: spring 2016 – 25 students, and spring 2018 – 40 students. The enrolled student population covered many engineering fields (mechanical, civil, aero, chemical, electrical, agricultural) along with some scientific fields (mathematics, statistics, atmospheric sciences). The course serves as a foundational course on data analytics and uncertainty quantification for engineering and science students. The intention is to co-list the course with Mathematics since it typically gets about 10 students from mathematics and statistics and it could also serve as a mathematics equivalent for engineering students. Video lectures of this course have been posted on NanoHUB.org and the intention is to create a digital version that is available to professionals. Note that the new title is compatible with the content of the course. The change in name is requested to make the course more attractive to professionals.



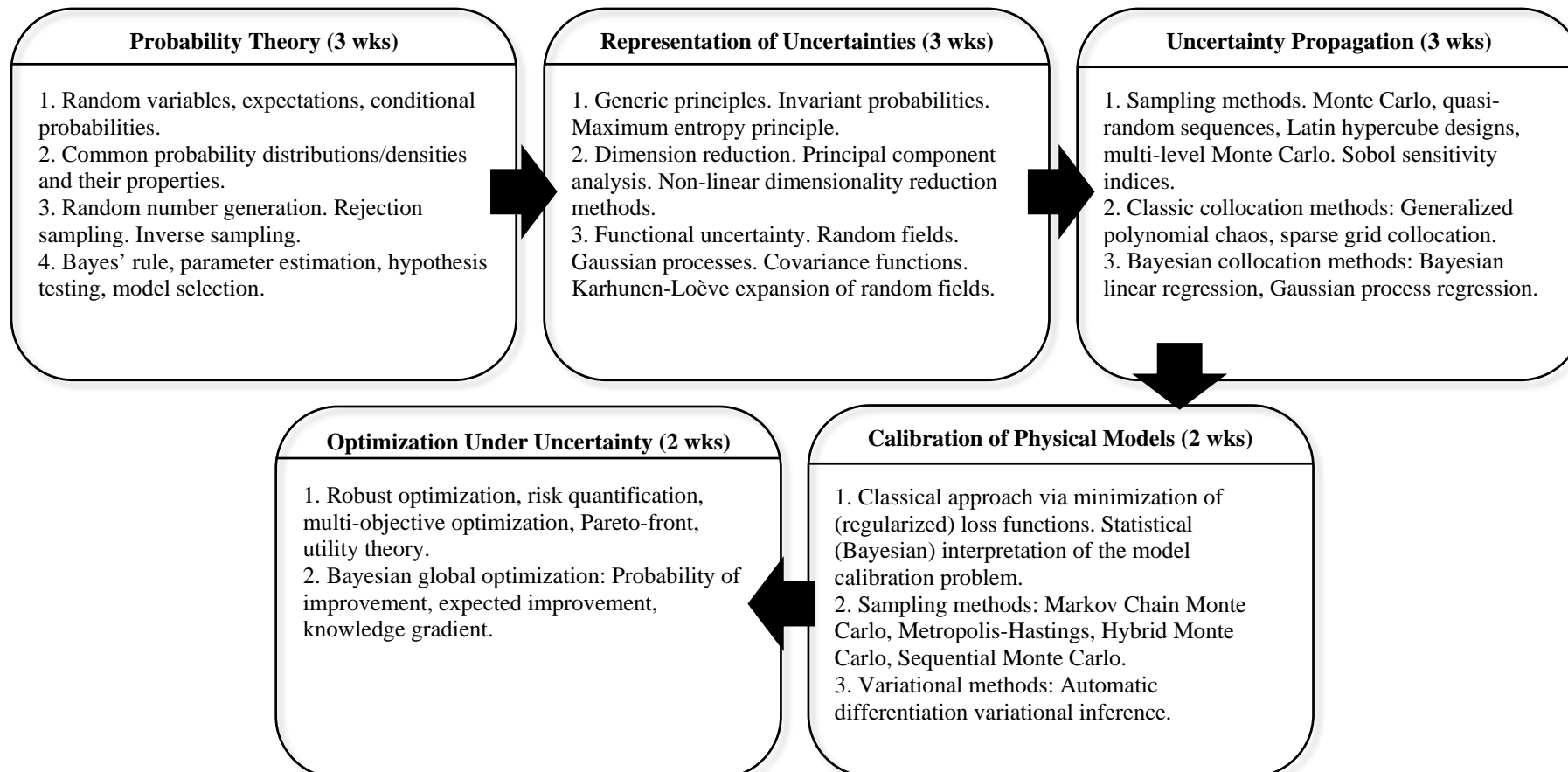
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ME School Head

**ME 53900**  
**INTRODUCTION TO SCIENTIFIC MACHINE LEARNING**

**Course Outcomes** [Related ME Program Outcomes in brackets]

1. Represent mathematically the uncertainty in the parameters of physical models. [1]
2. Propagate parametric uncertainty through physical models to quantify the induced uncertainty in quantities of interest. [1]
3. Calibrate the uncertain parameters of physical models using experimental data. [1]
4. Combine multiple sources of information to enhance the predictive capabilities of models. [1]
5. Pose and solve design optimization problems under uncertainty involving expensive simulations or experiments. [1, 2]
6. Improve scientific writing and data visualization skills. [3]



<b>COURSE NUMBER:</b> ME 53900		<b>COURSE TITLE:</b> Introduction to Scientific Machine Learning	
<b>REQUIRED COURSE OR ELECTIVE COURSE:</b> Elective		<b>TERMS OFFERED:</b> Spring, alternate years	
<b>TEXTBOOK/REQUIRED MATERIAL:</b> None		<b>PRE-REQUISITES:</b> None	
<b>COORDINATING FACULTY:</b> I. Bilonis		<b>COURSE OUTCOMES</b> [Related ME Program Outcomes in brackets]: 1. Represent mathematically the uncertainty in the parameters of physical models. [1] 2. Propagate parametric uncertainty through physical models to quantify the induced uncertainty in quantities of interest. [1] 3. Calibrate the uncertain parameters of physical models using experimental data. [1] 4. Combine multiple sources of information to enhance the predictive capabilities of models. [1] 5. Pose and solve design optimization problems under uncertainty involving expensive simulations or experiments. [1, 2] 6. Improve scientific writing and data visualization skills. [3]	
<b>COURSE DESCRIPTION:</b> Introduction to the fundamentals of predictive modeling for advanced undergraduates and graduate science and engineering students that work in the intersection of data and theory.			
<b>ASSESSMENTS TOOLS:</b> 1. In-class activities and quizzes. 2. Bi-weekly homework. 3. Project reports (initial, midterm, and final).			
<b>PROFESSIONAL COMPONENT:</b> None			
<b>NATURE OF DESIGN CONTENT:</b> Design optimization via the formulation of optimization problems under uncertainty. The focus is on the development of methodologies that can solve the design optimization problem with limited computational and experimental resources.			
<b>COMPUTER USAGE:</b> All class activities, quizzes, homework, and the project require students to write Python code in the form of Jupyter notebooks		<b>RELATED ME PROGRAM OUTCOMES:</b> 1. Engineering fundamentals 2. Engineering design 3. Communication skills	
<b>COURSE STRUCTURE/SCHEDULE:</b> 1. Lecture – 2 days per week at 75 minutes.			
<b>PREPARED BY:</b> I. Bilonis		<b>REVISION DATE:</b> 11 / 2020	