جامعة الملك عبدالله
للعلوم والتقنية
King Abdullah University of
Science and Technology

Course Syllabus: Uncertainty Quantification - AMCS 350

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	AMCS 350
Course Title	Uncertainty Quantification
Academic Semester	Spring
Academic Year	2016/2017
Semester Start Date	01/22/2017
Semester End Date	05/18/2017
Class Schedule (Days & Time)	09:00 AM - 10:30 AM | Mon Thu

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Omar Mohamad Knio	Omar.Knio@kaust.edu.sa	+966128080311		By appointment as needed. Office location: Building 1, Room 0113.

Teaching Assistant(s)

Name	Email

Course Information

Comprehensive Course Description	This course is an advanced introduction to uncertainty propagation and quantification in model-based simulations. Examples are drawn from a variety of engineering and science applications, emphasizing systems governed by ordinary or partial differential equations. The course will emphasize a probabilistic framework, and will survey classical and modern approaches, including sampling methods and techniques based on functional approximations. We will start with an overview of the goals of uncertainty quantification (UQ), and the practical role of UQ in design and decision making. We will review fundamental results from spectral approximation theory, and outline basic concepts from probability theory. Based on these reviews, we will conduct an in-depth exploration of uncertainty propagation methods based on various functional approximations. We will conclude with discussion of several topics pertaining to sensitivity analysis, measure transforms, noisy systems, Bayesian inference, and model calibration.
Course Description from Program Guide	This course is an advanced introduction to uncertainty propagation and quantification in model-based simulations. Examples are drawn from a variety of engineering and science applications, emphasizing systems governed by ordinary or partial differential equations. The course will emphasize a probabilitic framework, and will survey classical and modern approaches, including sampling methods and techniques based on functional approximations.
Goals and Objectives	Students completing this course will be able to: (1) apply classical and modern methods for propagating parametric uncertainties in computational simulations in problems governed by ordinary and differential equations, (2) quantify uncertainties in predicted outputs; (3) identify dominant sources, (4) identify courses for uncertainty reduction, and (5) apply UQ concepts to problems of inference or inverse design.
Required Knowledge	Basic knowledge of ordinary and partial differential equations. Computer programming using MATLAB, C, FORTRAN, and/or PYTHON.

Reference Texts	**Required Text:** -O.P. Le Maître and O. Knio, Spectral Methods for Uncertainty Quantification, Springer, 2010 (available online (http://library.kaust.edu.sa) **Reference Texts:** -Canuto, M.Y. Hussaini, A. Quarteroni, and T.A. Zang, Spectral Methods, Springer, 2006 (available online). -D.S. Sivia, Data Analysis, Oxford, 2006. -J.S. Liu, Monte Carlo Strategies in Scientific Computing, Springer, 2008.
Method of evaluation	**100.00**% - Homework /Assignments
Nature of the assignments	Assignments will involve analytical work, computer programming, and implementation of open source software.
Course Policies	Course materials and homework submission will be communicated via email.
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 01/23/2017 Thu 01/26/2017	Introduction: Role and Goal of UQ Spectral approximation
2	Mon 01/30/2017 Thu 02/02/2017	Spectral approximation
3	Mon 02/06/2017 Thu 02/09/2017	Review of basic concepts from probability theory
4	Mon 02/13/2017 Thu 02/16/2017	Uncertainty propagation based on functional approximation
5	Mon 02/20/2017 Thu 02/23/2017	Uncertainty propagation based on functional approximation
6	Mon 02/27/2017 Thu 03/02/2017	Uncertainty propagation based on functional approximation
7	Mon 03/06/2017 Thu 03/09/2017	Uncertainty propagation based on functional approximation
8	Mon 03/13/2017 Thu 03/16/2017	Uncertainty propagation based on functional approximation
9	Mon 03/20/2017 Thu 03/23/2017	Uncertainty propagation based on functional approximation
10	Mon 03/27/2017 Thu 03/30/2017	Uncertainty propagation based on functional approximation
11	Mon 04/03/2017 Thu 04/06/2017	Break
12	Mon 04/10/2017 Thu 04/13/2017	Sensitivity analysis
13	Mon 04/17/2017 Thu 04/20/2017	Bayesian inference
14	Mon 04/24/2017 Thu 04/27/2017	Bayesian inference
15	Mon 05/01/2017 Thu 05/04/2017	Measure transforms
16	Mon 05/08/2017 Thu 05/11/2017	Noisy systems
17	Mon 05/15/2017 Thu 05/18/2017	Noisy systems
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Note

The instructor reserves the right to make changes to this syllabus as necessary.