ME 597/AAE 590: INTRODUCTION TO
UNCERTAINTY QUANTIFICATION
Profs. Alina Alexeenko (AAE), Jayathi Murthy (ME)
1 credit hour
Fridays 3:00 – 3:50 pm BRK 1001
Lecture notes online: http://memshub.org/resources/40

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Hours: by appointment  by appointment

Course Outline: The focus of the course is on the quantification of uncertainty in simulations for engineering analysis. Though engineering simulation has become the mainstay of academic and industrial analysis in recent years, there has been little emphasis in understanding and quantifying the source of uncertainty in predictions. These uncertainties may arise for a variety of reasons: lack of mesh-independence, inadequate physical models, uncertainties in geometry, operating conditions and material properties, among others. The course introduces the student to the concepts of verification and validation, sensitivity analysis, and uncertainty propagation using sampling methods, polynomial chaos and reliability based methods. An introduction to uncertainty quantification software is also given. Emerging topics in uncertainty quantification of microsystem simulations are presented. The course is taught as a set of lectures given by Purdue Faculty from the schools of Science and Engineering.

Required Text: None  Prerequisites: None.

Grading: Grading will be based on attendance (50%), homework assignments (25%) and a project (25%).

Tentative Schedule:
Week  Topic
1  Intro to Verification & Validation; Basic Probability and Statistics
2  Linear Sensitivity Analysis; finite difference, sensitivity equation, code differentiation
3  Uncertainty propagation – variance propagation eqn, non-deterministic sampling (Monte Carlo, LHS)
4,5  Polynomial Chaos – Galerkin and collocation
6,7  UQ in computational research examples (guest lectures)
8  Verification and validation of computational models
9  UQ in experiments
10  Using MEMOSA UQ software
11  Introduction to DAKOTA UQ software
12  Reliability methods for uncertainty quantification and validation of models
13  No lecture (Thanksgiving)
14  Uncertainty quantification across scales
15  Epistemic uncertainties and errors; closure