

Spring 2-1-2018

# GEO 585.01: Topics: Hydrologic Modleing

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GEO585: Hydrologic Modeling  
Spring 2018  
University of Montana  
Instructor: Marco Maneta  
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Office: CHCB 348  
Phone: 406-243-2454  
Class meetings: Monday-Wednesday 10:00pm-11:20pm

Note: This Course has a Moodle Site. Additional reading material, problems sets and other information will be posted there with frequent updates, so check the site often.

Overarching goals:

- System identification and parameter estimation using inverse modeling and Bayesian inference techniques
- Advanced topics in forward computer modeling and model analysis.

Ancillary goals: Along with the overarching goals, in this course we will revisit some linear algebra, probability, and optimization concepts necessary to understand the contents of the course and to understand the scientific literature. We will also run computer models and get familiar with data pre- and post-processing tools.

Prerequisites: Interest in quantitative modeling of environmental processes and comfort with computers, calculus, physics and algebra.

Office hours: Office hours will be the next hour after class.

Grades: 60% Individual project; 40% class activities

Text books:

- Bayesian inference:
  - Martin, O. Bayesian Analysis with Python. Packt. 2016.
  - Gelman, A, Carlin, J, Stern, H, Dunson, D, Vehtari, A, Rubin, D. Bayesian Data Analysis, 3rd edition. CRC Press, 2013
- Kalman filters:
  - Labbe Jr, R. Kalman and Bayesian Filters in Python. 2018. Jupyter Notebook accessible at: [http://nbviewer.jupyter.org/github/rlabbe/Kalman-and-Bayesian-Filters-in-Python/blob/master/table\\_of\\_contents.ipynb](http://nbviewer.jupyter.org/github/rlabbe/Kalman-and-Bayesian-Filters-in-Python/blob/master/table_of_contents.ipynb)
- Least squares estimation and inverse modeling:
  - Aster, RC, Brochers, B, Thurber, CH. Parameter estimation and inverse problems. Elsevier, 2nd ed, 2012
- Linear Algebra:
  - Noble and Daniel. Applied linear algebra. 2nd edition

Date	Topic	Activity
01/22/18	Intro to environmental models	
01/24/18	Motivation and objectives	Numpy and matplotlib exercises
01/29/18	Python practice	Python practice
01/31/18	Python practice	Python practice
02/05/18	Least squares. Probabilistic interpretation	
02/07/18	Least squares as a minimum variance estimators	Assignment: Problem set on normal distributions
02/12/18	Least squares. Normal equations	
02/14/18	Least squares. Variance propagation	Assignment: Problem set on least square estimation
02/19/18	No Class	
02/21/18	No Class	
02/26/18	Bayes theorem and statistical inference	Assignment: Problem set on probability
02/28/18	Introduction to Monte Carlo methods	
03/05/18	No Class	
03/07/18	No Class	
03/12/18	MCMC: Metropolis Hastings.	Assignment: Implementation of MH algorithm
03/14/18	Static estimation: Bayesian inference with MH algorithm	
03/19/18	Static estimation: linear regression	Assignment MCMC with pyMC3
03/21/18	Static estimation: predictive checks	
03/26/18	Spring break	
03/28/18	Spring break	
04/02/18	Dynamic estimation	
04/04/18	Error model and B + G filter	Assignment: Implementation of the B
04/09/18	1D discrete Kalman filter	
04/11/18	Multivariate Kalman filter	Assignment: linear Kalman filter
04/16/18	Extended Kalman filter	
04/18/18	Unscented Kalman filter	Assignment: UKF
04/23/18	Extended Kalman filter	
04/25/18	No Class	
04/30/18	Class presentations	
05/02/18	Class presentations	

## POLICIES

**Emailing** We may occasionally conduct email correspondence with class members and we will use official UM email addresses. All email sent to us must originate from your official UM email address (email originating from non-UM addresses will not be read or responded to). Sorry, but this is the law we are required to follow.

**Attendance** No formal attendance will be taken. However, the format of this course requires class attendance for success. Substantial course content (i.e., graded in-class exercises and discussions) and information transfer will only occur in class. We cannot accommodate individual make-ups for missed classes. This is not a good course for you if it is not possible for you to always attend class sessions.

**Due dates** All assignments are due at the start of class on designated due date.

**Disabilities** The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you think you may have a disability adversely affecting your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or 406.243.2243. I will work with you and Disability Services to provide an appropriate modification.

**Conduct Code** All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the University. All students need to be familiar with the Student Conduct Code. The Code is available for review online at:  
[http://www.umt.edu/vpsa/policies/student\\_conduct.php](http://www.umt.edu/vpsa/policies/student_conduct.php)