Computation in the geosciences

COURSE INFORMATION

Instructor: Dr. Dylan Mikesell
Email: dylanmikesell@boisestate.edu
Phone: (208) 426-1404
Office Hours: Tu/Thurs 10:30 – 11:30 am and by appt. (ERB 3153)
Course Website: http://blackboard.boisestate.edu

Course Dates: Lecture – MoWe
Lecture Time and Location:
MoWe: 12:00 - 01:15PM (ERB 1100)
Teaching Assistant: Zongbo Xu
TA email: zongboxu@boisestate.edu

RESOURCES

Course Github: http://github.com/dylan_mikesell/GEOS397
Book: An Introduction to MATLAB for Geoscientists

COURSE DESCRIPTION

Computation is broadly defined as using computers in scientific work to understand and solve problems, or formulating problems in ways that can be computed. Processing data and developing quantitative models are critical skills for scientists and engineers. We need to be able to perform calculations, analyze and visualize data, and create numerical models to more deeply understand complex systems. These skills require students to have comfort and skill with coding languages and tools such as MATLAB. This course introduces students to scientific programming and computation as a tool to solve Geoscience-related problems. Students will learn the MATLAB language, including syntax, logic and vectorization, along with MATLAB's built in matrix computation and manipulation capabilities. We will cover the process of writing and debugging programs, learn basic algorithm development, and become familiar with basic MATLAB capabilities and tools, e.g., parallelization and code analyzer. Students will become familiar with data processing and visualization techniques and develop their ability to solve their own problems in a computational framework.

LEARNING is the act of seeking new knowledge, or modifying, improving or reinforcing existing knowledge. Learning is active it requires the learner to construct, personalize and pursue knowledge in a way that works best for them. You are entering a learning-centered environment, where both the learner and the instructor have important responsibilities:

Student Responsibilities	**Instructor Responsibilities**
Take control of your learning	Provide opportunities for active learning
Participate in collaborative learning	Effectively manage class time
Spend time learning outside of the classroom	Provide structure, but with flexibility
Learn new how-to-learn strategies	Make sure the course is relevant to the learners
Engage in reflection exercises (early and often)	Assess and evaluate learning
Participate in class	Facilitate shared decision making
Solve problems using (and developing) critical thinking skills	Interact with learners inside and outside of the classroom
Evaluate your peers writing and your own writing	Provide prompt and useful feedback
Provide constructive and thorough peer review for your classmates	Clearly communicate expectations and respect learners
Complete required reading and assignments	Provide tools and opportunities for critical thinking
Provide critical feedback to the instructor on the methods that facilitate your learning throughout the course	Provide feedback and direction to facilitate learning, but largely allow learners to be responsible for their own learning

Adapted from Doyle, T. (2008). Helping Students Learn in a Learner-Centered Environment. Sterling, VA, Stylus Publishing, LLC. p. 15.

INTENDED LEARNING OUTCOMES

GEOS 397/597: Computing in the geosciences is designed to teach students the basic syntax of MATLAB and enable students to use MATLAB libraries and toolboxes for their data processing needs. This course achieves this goal by focusing on the following course learning outcomes. After successful completion of this course, you will be able to:

- read/write ASCII and binary formatted data files
- use MATLAB to plot graphics in 2D and 3D
- optimize and debug MATLAB code
- implement MATLAB code for data processing (on a single and parallel processor workstations)
- apply basic linear algebra computations to matrices and vectors
- develop functions and write *fast vectorized* algorithms
- use MATLAB toolboxes for curve fitting and optimization problems
- apply frequency filters to time series and analyze those time series in the Fourier domain
- use MATLAB as a tool to solve Geoscience related problems

A complete list of learning outcomes can be found in the Survey of Knowledge questions. **You will take this survey the first week of class and 2 more times during the semester.** This survey helps you and identify the knowledge you have gained.

HOMEWORK SETS

You will receive a homework problem set every one to two weeks. Homework will be completed in pairs. You **must** have a new partner for each homework. An *electronic write-up* is due, along with the code created to solve the given homework problems. Write-ups should be done in Markdown and an HTML file should be submitted to the TA. The code should be published to HTML using the MATLAB *publish* tool and submitted to the TA. Homework is due at 5:00pm on the following Fridays.

Homework #1:	Due: 09/02/16	GIT and Markdown
Homework #2:	Due: 09/09/16	Algebra, loops and branching
Homework #3:	Due: 09/16/16	Hill-slope evolution and plotting
Homework #4:	Due: 10/03/16	Sea-level rise and mapping
Homework #5:	Due: 10/10/16	Sea-floor spreading and function/subroutines
Homework #6:	Due: 10/17/16	Tracking ground water pollution and ODEs
Homework #7:	Due: 10/28/16	Seismograms and digital signals
Homework #8:	Due: 11/11/16	River discharge correlation and statistics
Homework #9:	Due: 11/25/16	Crustal strain rates derived from GPS observations

NOTE: THE CONTENTS OF THIS HOMEWORK SCHEDULE MAY CHANGE

FINAL PROJECTS

Using the tools and techniques covered in this class, your term project will involve processing and displaying a data set of your choice. You must give detailed descriptions of the data and steps involved in the processing. You will write a short report (max 5 pages written text) that contains relevant figures and tables showing results. Possibilities include problems related to your other courses or an extension of a problem from class. If you need help finding/choosing a project, please make an appointment to discuss possibilities with me. The final project will also involve a 10 to 15 minute oral presentation at the end of the semester. Final projects will be in groups of 2 or 3 for undergraduates. Graduate students will each give their own presentation and report, and the topic should be related to their graduate research.

MUD ISSUES AND POP QUIZZES

"Mud cards" are a simple tool for allowing students to get additional information on topics that they did not understand in the lecture. Because this a computing course, we will not use the traditional *cards*; instead we will use *issues* on our course Github site. Traditionally student are asked to write on actual cards and describe the muddiest part of the lecture. In our case, each student will need to submit at least two MUD *issues* over the course of the semester. I expect that you will use this mechanism to post questions related to lecture and course material. Each person subscribed to our GIT repository will immediately receive an email from Github when a new issue is posted. Other students may answer the MUD *issues*. Although students are not required to answer MUD questions, I think it is great and I encourage you to do so.

Throughout the semester I will give pop quizzes. These will only be graded based on participation, not actual correct answers. These quizzes will be used by me to asses your learning and adjust the lecture and homework schedule as needed. Please keep in mind that this is the first time I have taught this course, so we may need to make modifications along the way.

COURSE ORGANIZATION AND GRADING CRITERIA

Your final grade will be based on points that you have earned through course participation, homework, and the final project. The weight of each of these assessments in your final grade is as follows:

Assessment Category	Percent of Grade
Participation (at least 2 MUD issues posted to github over semester and quizzes)	10%
Homework (9 homework assignments)	70%
Final Project (5 page max report and 10-15 minute presentation)	20%

At the end of the semester, your final letter grade will be determined based on the total percentage you have earned on the assessments above as follows:

A	92 - 100%	B	82 - 87%	C	72 - 77%	D	62 - 67%
A-	90 - 91%	B-	80 - 81%	C-	70 - 71%	D-	60 - 61%
B+	88 - 89%	C+	78 - 79%	D+	68 - 69%	F	$< 60\%$

Your grade is determined based on how you perform on the assessments in the course, not how you perform relative to your peers. **There will be no extra-credit opportunities, so please do not ask.**

COURSE SCHEDULE

Lecture #1:	08/22/16	Introductions, Syllabus, GIT and Markdown
Lecture #2:	08/24/16	Intro to MATLAB, language types, variable types
Lecture #3:	08/29/16	Algebra with scalars, vectors and matrices and conditional branching (IF ELSE and CASE)
Lecture #4:	08/31/16	Iterating with loops (FOR and WHILE), logical indexing, debugging
No Class:	09/05/16	Labor Day
Lecture #5:	09/07/16	GUEST LECTURE: Hill-slope evolution
Lecture #6:	09/12/16	File I/O, user I/O (command line and GUI), TRY-CATCH
Lecture #7:	09/14/16	Figures, handles, plotting and mapping toolbox
Lecture #8:	09/19/16	Functions, subroutines and building your documentation/help
Lecture #9:	09/21/16	Algorithm design, pseudo-code, flow charts
Lecture #10:	09/26/16	Numerical integration, ODE toolbox
Lecture #11:	09/28/16	Numerical differentiation, Taylor series, finite differences
Lecture #12:	10/03/16	Curve fitting and optimization toolbox
Lecture #13:	10/05/16	Surface fitting and optimization toolbox
Lecture #14:	10/10/16	Interpolation (1D times series and 2D surfaces)
Lecture #15:	10/12/16	Fourier transform (1D frequency domain)
Lecture #16:	10/17/16	Convolution, filtering and signal processing toolbox
Lecture #17:	10/19/16	Signal processing toolbox
Lecture #18:	10/24/16	Number representation, errors, floating point vs. integer arithmetic
Lecture #19:	10/26/16	Significant digits, statistics toolbox and plotting
Lecture #20:	10/31/16	Statistics toolbox
Lecture #21:	11/02/16	Correlation
Lecture #22:	11/07/16	Landsat 8 toolbox
Lecture #23:	11/09/16	Stereonets
Lecture #24:	11/14/16	Rose plots, spider plots, ternary plots
Lecture #25:	11/16/16	Vectorization and parallelization (multi-threading)
Lecture #26:	11/21/16	GPUs
Lecture #27:	11/23/16	Introduction to R (R-Studio)
Lecture #28:	11/28/16	Introduction to Python (Spyder and Notebooks)
Lecture #29:	11/30/16	Python, MATLAB and Scilab
Lecture #30:	12/05/16	Final project presentations
Lecture #31:	12/07/16	Final project presentations

NOTE: THE CONTENTS OF THIS SCHEDULE MAY CHANGE

COURSE POLICIES

1. **Academic Dishonesty:** Academic integrity is essential to a positive teaching and learning environment, and scholastic dishonesty is considered unacceptable in any form in this course. All students enrolled in University courses are expected to complete coursework responsibilities with fairness and honesty. Failure to do so by seeking unfair advantage over others or misrepresenting someone elses work as your own, can result in disciplinary action. As described in Article 4, Section 1 of Boise State Universitys Student Code of Conduct:
   A violation may include cheating, plagiarism, or other forms of academic dishonesty. All assignments submitted by a student must represent her/his own ideas, concepts, and current understanding or must cite the original source. Academic dishonesty includes assisting a student to cheat, plagiarize, or commit any act of academic dishonesty. Attempts to violate academic integrity do not have to be successful to be considered academic dishonesty. Academic dishonesty includes turning in substantial portions of the same academic work to more than one course without the prior permission of the faculty members.

Infraction	**Sanction**
Copying part or all of another student's homework	**First offense:** Student(s) receive zero credit for the homework **Second offense:** All students involved fail the course
Any and all of the above	**Instructor files Academic Dishonesty Report Form with the Office of the Dean of Students**

2. **Behavioral Expectations:** All students have the right to a respectful learning environment and as such, each student is tasked with taking individual responsibility in conducting him or herself in a mature manner. Students will be held accountable for their behavior and may be asked to leave the classroom in the event of inappropriate or disrespectful behavior.

3. **Attendance:** Class attendance is essential. In the vast majority of circumstances, late work is not accepted and class homeworks cannot be made up. Much of the class is based on activities and discussions, which require full attention and participation. Please be prompt and ready to begin at the start times for your lecture section.

4. **Accommodation:** If you have any physical or learning needs that might impact your learning and evaluation in this course, please discuss these needs with your instructor at the beginning of the term. The University has a multitude of resources so dont hesitate to let your instructor help you. To request academic accommodations for a disability, contact the Disability Resource Center, Admin 114, (208) 4261583. Students are required to provide documentation of their disability and meet with a Disability Specialist prior to receiving accommodations. Information about a disability or health condition will be regarded as confidential.

5. **Communication:** If you have something important to tell your instructor (i.e. you'll be late, absent, etc.), send an email reminder. Telling your instructor after class and hoping he/she will remember is not a good option. You must notify your instructor(s) well in advance of any travel plans for university-sponsored events (athletics or other activities) that will interfere with the scheduled course activities. When communicating with your instructor, please include your full name, and the course you are enrolled in. Complete sentences and proper grammar are appreciated.

6. **Electronic devices:** Please show respect for your instructor and fellow students by turning off all phones, personal music players, etc., before coming to class. If your phone rings during class your instructor will answer it for you. This is no joke, but it will be funny.

7. **Course Workload:** You should expect to spend a total of 4 hours per week working to earn 1 credit in this class. This includes lecture, which accounts for 1 of those 4 hours. The remainder should be spent studying your notes, and/or coming to office hours, and homework. I will do my best to make the course content as clear and accessible as possible; you should do your part by reviewing your notes day to day.