Instructor Information:
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Course Information:
Lectures: MWF, 2:10-3:00PM, EN 2102
Office Hours: T 10-11:30AM, F 10:00-10:50AM and by appointment

Prerequisites: Grade of C or better in MATH 2310.

Course Description:
This course is one of the core courses for the Interdisciplinary Computational Science Minor. The objective of this course is to develop the capacity for algorithmic thinking in a scientific context. The course is intended to be suitable for students in a variety of disciplines who want to use computing to explore scientific problems. The focus will be on basic numerical methods for scientific and engineering problems, and MATLAB will be used as the primary environment for numerical computations. Topics include: overview of MATLAB's syntax, code structure and algorithms, basic numerical methods for linear systems and eigenvalue problems, interpolation and data fitting, Newton's method for nonlinear systems, numerical differentiation and integration, basic numerical methods for solving differential equations and applications.

Objectives/Outcomes/Standards: This course aims at getting you acquainted with using computers to solve commonly encountered problems in science and engineering. After the class, you may expect to: a) have proficiency in basic skills related to using MATLAB; b) be able to apply these skills to solving challenging problems that are either purely mathematical or arise from other disciplines.

Disability Statement: If you have a physical, learning, sensory or psychological disability and require accommodations, please let me know as soon as possible. You will need to register with, and provide documentation of your disability to University Disability Support Services (UDSS) in SEO, room 330 Knight Hall.

Text(s) and Readings: This semester we’ll use my own class notes.

Course Requirements/Assignments: You are expected to work on your homework alone. If there are any questions, I'll be happy to address them during my office hours or, if major clarification is necessary, in class.
Grading Standards:

**Homework/Computational Projects: 65%**. Several homework problems/computational projects will be assigned during the semester - expect there will be at least six and at most eight of these projects altogether. They will be designed such that students have an opportunity to engage the skills acquired on various topics. The focus in all these projects will not be only on doing them anyway; rather, it will be on finding a computationally efficient alternative. This may mean coming up with good data structures and storage, a good algorithmic strategy or nice algorithm design etc. depending on the problem. These projects should not take too long if the material in class is properly understood, although it is a good rule to think that you should be able to devote about the same amount of time for individual work as the time you spend in class.

**Final project: 35%**. The final project will count separately. We'll work on it together, from formulating the problem to putting it in a computer program, and I expect the work to be completed by the end of the exam week.

Your letter grade is determined as follows: A=not below 90; B=not below 80, C=not below 70, D=not below 60, F=below 60.

**Attendance/Participation Policy:**

Class attendance and participation are strongly recommended, especially because of my using notes instead of a textbook. University sponsored absences are cleared through the Office of Student Life.

**Academic Honesty:**

The University of Wyoming is built upon a strong foundation of integrity, respect and trust. All members of the university community have a responsibility to be honest and the right to expect honesty from others. Any form of academic dishonesty is unacceptable to our community and will not be tolerated [from the University Catalog]. Teachers and students should report suspected violations of standards of academic honesty to the instructor, department head, or dean. Other University regulations can be found at: [http://www.uwyo.edu/generalcounsel/new-regulatory-structure/index.html](http://www.uwyo.edu/generalcounsel/new-regulatory-structure/index.html)

**Course Outline:**

Here is a tentative schedule for the semester:

**Week 1:** Description of course goals and objectives. Introduction to computational science by means of examples from engineering, biology, meteorology, genetics. Different views of computation as transformation and reaction to events. Introduction to Matlab: how to invoke a computation. Also, at the end of each session, succinct presentation of the objectives and type of work involved in the final project.

**Week 2:** Matlab immersion: simple data types, numbers, Booleans, collections and indexing. At end of each session, focus will shift to the mathematics required for the final project: review of vector calculus, scalar product, vector product, how to handle three dimensional vectors on computers. First homework assignment: simple programming skills.
**Week 3:** Matlab immersion: files and scripts, importing and exporting data, functions. At the end of each session, focus on mathematical aspects: graphs and grids, how they can be used to discretize space and time in scientific computing.


**Week 5:** Matlab: scope of functions and variables; detecting and responding to events. Mathematics: in-depth description of the grid construction and manipulation for the final project.

**Week 6:** Matlab: short introduction to data searching and databases. Mathematics: introduction of the partial differential equations for the final project. Third assignment: building and viewing a triangular finite element grid on a rectangle.

**Week 7:** Matlab: in-depth discussion of trees and recursion. Mathematics: grid refinement using recursive procedures.

**Week 8:** Matlab: processing of sounds, images and signals. Mathematics: viewing data defined on the grid as contour lines or as three-dimensional surfaces. Fourth assignment: plotting contour lines of grid-defined data.

**Week 9:** Matlab: discussion of numbers and precision. Start exploring mathematical relationships in one unknown, solving for roots of equations, minimization/optimization.

**Week 10:** Matlab: internal procedures to view functions of several variables. Mathematics: starting the mathematical foundations of the finite element method. Fifth assignment focusing on minimization, root finding, optimization.

**Week 11:** Matlab: geometry of functions, the gradient, optimization using the gradient. Mathematics: focus on the necessary tools for the finite element method, the important theorems in vector calculus.

**Week 12:** Matlab: least squares solutions of systems. Mathematics: using the integral theorems and the grid-defined functions the students are familiar with by now, construct the finite element discretization for a simple two-dimensional boundary value problem. Sixth assignment (analytical): developing the equations by hand for a very simple grid involving a couple of unknowns. The final project also assigned.

**Week 13:** Mathematics: discussion of methodologies for solving the large systems of equations arising in the finite element method in an efficient manner. Linear algebra review; iterative (conjugate gradients) methods versus exact methods.

**Week 14/15:** Mathematics: putting it all together, from the diffusion partial differential equation problem to the finite element discretization and the solution method. How to use the tools developed in previous assignments (grid construction, visualization, etc) for the final project. Last session will be used exclusively to discuss problems arising from the final project. Final project due at the end of the exam week.

All handwritten homework due within one week from the date it was assigned.

**The instructor may make changes to the syllabus as the course proceeds. If necessary, these changes will be announced in class. Substantive changes made to the syllabus shall be communicated in writing to the students.