**Syllabus for**

***Multivariable Mathematics for Data Scientists***

**DASC 2594**

**Instructor: TBD**

**Course description**

Multivariable Mathematics for Data Scientists (DASC 2594) provides an in depth look at the multivariate calculus and linear algebra necessary for a successful understanding of modeling for data science. Students will gain an understanding of the mathematical and geometric concepts used in optimization and scientific computation using mathematical and computational techniques. At the end of the course, students will be equipped with the calculus and linear algebra skills and knowledge to be successful in courses in optimization and advanced data science methods.

**Motivation**

* This course provides an introductory overview of the topics from calculus and linear algebra that are most relevant for application in data science, engineering, and other computational sciences.
* This course provides the mathematical and computational knowledge to work with real world data.
* This course emphasizes both how to solve equations mathematically as well as numerically using computational software (e.g., Python, R, MATLAB, etc.).

**Learning objectives**

Students completing DASC 2594 should be able to:

* apply the ideas of multivariate calculus including multivariate derivatives, gradients, and implement the chain rule;
* calculate the Jacobian for change of variables;
* solve linear equations using pseudo-inverse and matrix inversion;
* solve mathematical problems using vector spaces;
* understand and apply Eigen decomposition to solve large systems of linear equations and perform dimension reductions;
* perform matrix decompositions and understand the geometric interpretation of matrix algebra.

**Target audience**

All data science majors as well as students from engineering and computational disciplines interested in a computational implementation of topics from calculus and linear algebra.

**Minimum prerequisites**

Calculus II (MATH 2564) and Programming Languages (DASC 1104).

**Approximate time allocation**

1. Vector Spaces/subspaces 1 week
2. Vectors, dot products, cross products, and projections 1 week
3. Linear combinations: linear independence, bases, coordinates 1 week
4. Planes, surfaces, and lines in space. 1 week
5. Linear transformations, matrix arithmetic, matrix rank 1 week
6. Solving linear equations Ax = b 1 week
7. Inner products and norms 1 week
8. Projections: orthogonal projections, least squares 1 week
9. Matrix decompositions: Eigen, Cholesky 1 week
10. Limits, continuity, and partial derivatives 1 week
11. Gradients 1 week
12. Chain rule, directional derivatives 1 week
13. Tangent planes, linear approximations (Taylor Series) 1 week
14. Linear approximations (Taylor Series) 1 week
15. Double/triple integrals, change of variables (Jacobian) 1 week

**Student work and grading**

* There will be 10 homework assignments. The best 8 will count towards the grade. No late homework will be accepted.
* There will be three tests: two in-class mid-terms and a final.

Weights for grade:

* Homeworks: 30%
* Midterm 1: 20%
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* Final: 30%

**Course materials**

Text to be determined.

**Technology**

R/Python/MATLAB will be used for class notes, in-class demos, homeworks, and labs. Students will have access to a web-based server allowing them to work with notebooks through a web browser.