Math 118 Introduction to Functions of Several Variables

Summer II 2020—June 29 to July 31, 2019

<table>
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<tr>
<th>Instructor:</th>
<th>Dr. Ning Jia</th>
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<tbody>
<tr>
<td>Email:</td>
<td><a href="mailto:ning.jia@yale.edu">ning.jia@yale.edu</a></td>
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<tr>
<td>Class Meetings:</td>
<td>MW 1:00-4:15pm</td>
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<tr>
<td>Office:</td>
<td>Virtual</td>
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<tr>
<td>Phone:</td>
<td>(617) 710-6857</td>
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<td>Location:</td>
<td>Virtual</td>
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**Course Pages:** Our class will be online, with live sessions held during class meeting times through Zoom. Please check our Canvas page regularly for all announcements, assignments, supplementary materials and schedule.

**Office Hours:**

- There will be virtual office hours each week, schedule will be announced by the end of first week.
- By appointment. Please feel free to email me to request a meeting outside of my regular office hours.

**Textbooks:**

- Kuttler, A First Course in Linear Algebra  
- McCallum, et. al., Calculus: Multivariable, Wiley, 7th Edition (please wait for announcement on purchase options for this textbook)

**Course Description:** A combination of linear algebra and differential calculus of several variables. Matrix representation of linear equations, Gauss elimination, vector spaces, independence, basis and dimension, projections, least squares approximation, and orthogonality. Three-dimensional geometry, functions of two and three variables, level curves and surfaces, partial derivatives, maxima and minima, and optimization. Intended for students in the social sciences, especially Economics.

**Prerequisites:** Math 112 or equivalent. Please seek instructor consent if you have not taken Math 112 at Yale University before.

**Grading Policy:**

- In-Class Quizzes .............................................. 20%
- In-Class Participation ...................................... 10%
- Homework ....................................................... 40%
- Final Exam ..................................................... 30%

**Important Date:**

- Final Exam . . . . . . . . . . . . . . . July 29th, 1:00-4:15pm

**In-Class Quizzes:** We will have 10 meeting times, and will have a 20-25 minute quiz at the beginning of each of the fist 9 classes. The first quiz is for information purpose only and will
not count toward your grade. Each of the other quizzes is worth 3.75% of your total grade, for the total of 30%.

You will receive a code at the beginning of class to access the quiz in Canvas, and then you will be required to submit your quiz through Canvas after you are done. You will need to provide documentation to support your absence to class, if you want to make up the quiz.

**In-Class Participation:** You are expected to attend each class, leave video on during the entire duration of the class, and participate in all class activities such as discussions and short exercises. Your performance for each in-class participation is worth 1% of your total grade, for the total of 10%.

**Homework:** There will be 9 homework assignments, due either Thursday or Sunday nights at 11:59pm in Canvas. Homework must be submitted through Canvas following instructions. No late submissions accepted without proper supportive documentation. Each homework is worth 4.44% of your total grade, for the total of 40%.

**Final Exam:** Final exam will take place on July 29th during regular class time: 1:00-4:15pm with proctoring service.

**Detailed Class outline:**

| Week 1 Lecture 1 | Part 1: Introduction, logistics  
Part 2: 1.1 Systems of Equations, Geometry, algebraic procedures  
Part 3: 1.2.1 Elementary Operations, 1.2.4 Rank and Homogeneous Systems |
|------------------|--------------------------------------------------------------------------------|
| Week 1 Lecture 2 | Part 1: 2.1.1-2.1.5 Adding and multiplying matrices  
Part 2: 2.1.6-2.1.7 Transpose, Identity and inverse matrices  
Part 3: Markov Chain |
| Week 2 Lecture 1 | Part 1: 2.1.9-2.2.3 Elementary matrices, LU factorization  
Part 2: 4.1-4.6 Vectors in R^n, algebra in R^n geometric meaning, length of vector, parametric lines |
| Week 2 Lecture 2 | Part 1: 4.7-4.9. Dot product, planes in R^n, cross product  
Part 2: 4.10 Spanning, linear independence and basis in R^n |
| Week 3 Lecture 1 | Part 1: 4.11.1-4.11.3 Orthogonality and the Gram Schmidt process  
Part 2: 4.11.4-4.11.5 Orthogonal projections and least squares |
| Week 3 Lecture 2 | Part 1: 12.1-12.2 Functions of two variables, graphs and surfaces  
Part 2: 12.3 Contour diagrams  
Part 3: 12.4 Linear functions |
| Week 4 Lecture 1 | Part 1: 12.5-12.6 Functions of 3 variables, limits and continuity  
Part 2: 14.1. Partial derivatives  
Part 3: 14.2: Computing partial derivatives |
| Week 4 Lecture 2 | Part 1: 14.5 Gradients and Directional Derivatives in Space  
Part 2: 14.6 The Chain Rule  
Part 3: 14.7 Second-Order Partial Derivatives |
| Week 5 Lecture 1 | Part 1: 15.1 Critical Points: Local Extrema and Saddle Points  
Part 2: 15.2 Optimization  
Part 3: 15.3 Constrained Optimization: Lagrange Multipliers  
If time allows: application in econometrics |
| Week 5 Lecture 2 | Final Exam |