MATH S118E:
Introduction to Functions of Several Variables
Course Syllabus, Summer Session A, 2024

Last updated: February 19, 2024

Instructor:	E-mail:	Class Meetings:	Location:	Office Hours:
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Course Information

Course Format

This class will be online. We will meet over Zoom for all activities including lectures, exams, etc. We will meet 15 times in total. There will be a 5-minute break in the middle of each of the lectures. In-class worksheets will be available for download on Canvas before each lecture. Hand-written lecture notes will be posted after each class.

Course schedule

Here is a schedule of the course, including class meetings, homework due dates and exam dates. Please keep the important dates and times in mind. I will add office hours to this table when they are determined.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 1	05/27 Class @1pm	05/28	05/29 Class @1pm	05/30	05/31 Pset1 due @12pm Class @1pm	06/01	06/02
Week 2	06/03 Class @1pm	06/04	06/05 Pset2 due @12pm Class @1pm	06/06	06/07 Class @1pm	06/08	06/09
Week 3	06/10 Pset3 due @12pm Class @1pm	06/11	06/12 Class @1pm	06/13	06/14 **Midterm @1pm**	06/15	06/16
Week 4	06/17 Pset4 due @12pm Class @1pm	06/18	06/19 Class @1pm	06/20	06/21 Pset5 due @12pm Class @1pm	06/22	06/23
Week 5	06/24 Class @1pm	06/25	06/26 Pset6 due @12pm Class @1pm	06/27	06/28 **Final @1pm**	06/29	06/30

Course Description

MATH 118 is a combination of linear algebra and differential calculus of functions of several variables. This course is primarily intended for students majoring in Economics and other social sciences.
One of the goals of the course is to prepare students for the mathematics of ECON 121. Note that MATH 118 is a prerequisite for STAT 238, but it cannot be used as a prerequisite for upper division mathematics courses.

Prerequisites

A solid understanding of differential single-variable calculus at the level of MATH 111 or MATH 112.

Key Topics

- 3D spaces and vectors, dot product, cross product, projections.

- Functions of multivaraibles variables, graphs, partial derivatives, tangent planes, linear approximations, the chain rule, directional derivatives, gradient vector, level surfaces.

- Linear algebra in $\mathbb{R}^2$ and $\mathbb{R}^3$: matrix operations, determinant, inverse matrices, column space, null space, linearly independence, basis, least squares method, solving system of linear equations.

- Optimization: multivariable optimization, second-derivative test, Lagrange multiplier, Bordered Hessian, OLS via vector projection.

Textbooks

There is no required textbook for this course—the lecture materials and class worksheets will be the basis for the assessments. However, if you would like to have a textbook to consult for more examples and exercises, I recommend the following books:

- For the calculus portion of this class: *Calculus: Multivariable*, 7th Edition by McCallum et. al. (This is the one in the Bookstore)

- For the linear algebra portion of the class: *Linear Algebra With Applications*, Open Edition by: W. Keith Nicholson (available online `here`)

Assessment

Quizzes

After most of the classes, there will be a short quiz on Canvas to test if you have mastered the contents. There is no specific due time for the quiz; however, it will be beneficial to finish it before the next class.

These quizzes will be available throughout the duration of the course. You are able to access them until 11:59pm on Friday, June 28. These quizzes are graded for correctness, though you will have three submission attempts for each quiz.

Participation

Attendance is mandatory in Yale Summer Session. Your participation grade will be based on your in-class performance such as group discussions, asking and answering questions, doing short exercises, etc.

Problem Sets

There will be six written problem sets, which are assigned roughly after every other class and is due by **noon, 12pm, EST** on the day of the next class. The respective due dates of the six problem sets are 05/31, 06/05, 06/10, 06/17, 06/21, 06/26. Each problem set accounts for 5% of your final grade.

These assignments assess your ability to use the material that we learned in class to solve problems. You are expected to write in complete sentences and to justify all of the work that you do. You will be graded on the mathematical correctness of your work and on the coherence of your explanations. Please do start on each homework early, otherwise, it is very easy to fall behind during summer courses. You are encouraged to work on the problems together with your peers, so long as you write up your solutions independently.

You will submit your written problem sets online via Gradescope as PDF files. Please scan your homework properly. We will be using Gradescope for homework grading, and when you follow the assignment link from Canvas to Gradescope you will be prompted to indicate which problems are on which pages. The graders will not be able to grade your work unless you do this step!

A Dean's Extension is required for any late submission.

Exams

There will be one midterm and one final exam. Both of the exams will take place during regular class times. The tentative dates for these are:

- Midterm, June 14, 1-3:15pm, over zoom.

- Final Exam, June 28, 1-3:15pm, over zoom.

A Dean's Extension is required for any missed exam.

Grading Scheme

Your final numerical grade will be the greater of the following two schemes:

- 10% Quizzes + 5% Participation + 30% Problem Sets + 25% Midterm + 30% Final Exam

- 10% Quizzes + 5% Participation + 30% Problem Sets + 20% Midterm + 35% Final Exam

Final course (letter) grades will then be determined by your numerical grade via the following scale:
$100 \geq A, A- \geq 90 > B+, B, B- \geq 80 > C+, C, C- \geq 70 > D \geq 60 > F$.

Resources

Office Hours

I will hold office hours twice a week. Detailed schedules are to be determined closer to the date. If you cannot make any of the times for whatever reason, send me an email and we can find another time to talk.

Please come to my office hours! Do you want to say hello? Do you have a question about the course—even the tiniest thing? If there is anything that you are struggling with in our class or on the homework, that's what I'm here for. I'd love for you to come by, and I will try my best to help you!

Canvas

All of the course information and materials (homework, supplemental materials, quizzes, office hour, exam info, etc.) will be posted on the course Canvas page.

Calculator Policy

Using a calculator or a computer to check or investigate problems for homework is encouraged, but be sure that you can solve the problems without one. **Calculators will not be allowed on midterm and final exam.** Having said that, the problems on the exams will require only a moderate amount of calculation.

How to Succeed in MATH 118

Come to Class Ready to Work

Mathematics is best learned by actively working through problem. Coming to class ready to engage with the material will ensure that you get the most out of it. Turn your video on, take notes, and go through the examples in class with me instead of just watching me solving the problems. Trust me, you will learn much more if you do it on your own.

Don't be Afraid to Make Mistakes

Making mistakes is the most important part of doing mathematics! It is an integral part of the learning process. Never hesitate to share your reasoning (even if you think it's incorrect)—we cannot arrive at a correct answer if we don't understand why the incorrect ones don't work.

Don't be Afraid to Ask Questions

All questions are encouraged. I highly appreciate any questions you may have. **There are no dumb or bad questions.** Actually, when you are having a question, you are probably not the only one in the classroom having the same question. If you ask it out, you are not only helping yourself, but also doing a good thing for the whole class.

Work Together and Come To Office Hours

Working with your peers in class and on homework assignments can be very helpful. Two brains are better than one and having multiple perspectives when tackling a problem provides additional insight for it. Also, **come to office hours**—if I understand what you are having difficulties with, I can help make the course better.

Detailed Class Outlines

- May 27, Lecture 1: Review of single-variable optimization. 3D space, vectors, equations of lines. (Stewart: 12.1, 12.2 / McCallum 13.1, 13.2)

- May 29, Lecture 2: Equations of Lines, planes. Dot product, projections, cross product. (Stewart: 12.3-12.5 / McCallum 13.3, 13.4)

- May 31, Lecture 3: Functions of two and three variables, graphs, contour diagrams, linear functions. (Stewart 14.1 / McCallum 12.1-12.5)

- June 3, Lecture 4: Partial derivatives, second-order partials, tangent plane, linear approximations. (Stewart 14.3, 14.4 / McCallum 14.1-14.3, 14.7)

- June 5, Lecture 5: The chain rule, directional derivatives and the gradient vector in the plane. (Stewart 14.5 / McCallum 14.4, 14.6)

- June 7, Lecture 6: Gradient vector in space, tangent planes to level surfaces. (Stewart 14.6 / McCallum 14.5)

- June 10, Lecture 7: Solve system of linear equations. Span, independence, dimension, basis. (Nicholson 1.3, 2.2)

- June 12, Lecture 8: Matrix, matrix multiplication, inverse matrix, column space, null space. (Nicholson 2.1, 2.3, 2.4)

- June 14, Midterm.

- June 17, Lecture 9: Linear transformation, kernel and image, change of basis, determinant. (Nicholson 2.6, 3.2)

- June 19, Lecture 10: Eigenvalue, eigenvector, least squares. (Nicholson 5.5, 5.6)

- June 21, Lecture 11: Multivariable optimization and the second-derivatives tests. (Stewart 14.7 / McCallum 14.7, 15.1)

- June 24, Lecture 12: Lagrange multipliers. (Stewart 14.8 / McMacllum 15.3)

- June 26, Lecture 13: The Lagrangian and the bordered Hessian. (McMacllum 15.3)

- June 28, Final Exam.