

# MATH-S

## 21A 2021

This multivariable calculus course extends single variable calculus to higher dimensions. It provides a vocabulary for understanding data appearing in fundamental processes of nature like weather, planetary motion, waves, diffusion, finance, or quantum mechanics. It helps to visualize processes and data. It teaches important background needed for statistics, discrete mathematics, computer graphics, bio medical sciences, bio-informatics or economics. It provides tools for describing curves, surfaces, solids and other geometrical objects in space. It develops methods for solving optimization problems with and without constraints. You learn a powerful computer algebra system. The course will enhance problem solving and visualization skills and prepares you for further study in other fields of mathematics and its applications.

# LECTURES

Online classes

Tue/Thu 8:30-11:30 AM



1. EXAM	2. EXAM	FINAL
JULY 8	JULY 22	AUG 5
8:30 AM	8:30 AM	8:30 AM
ONLINE	ONLINE	ONLINE

PART	GRADE
1. HOURLY	20
2. HOURLY	20
HOMEWORK	25
LAB	5
FINAL	30

# SEMINAR

Choice of Wednesday or Thursday

## ACCESSIBILITY

We are committed to an accessible academic community. For details see the Accessibility Office.

## TEXTBOOK

You do not need a book. If you want to see an other angle, consult any of the textbooks available. The Stewart Calculus text is a popular option.

## ORGANISATION

Oliver Knill, office: Mon 3-5,  
[knill@math.harvard.edu](mailto:knill@math.harvard.edu)

SC 432, Tel: (617) 495 5549

## COURSE ASSISTANTS

Martin Reyes, Elliot Parlin

## ACADEMIC INTEGRITY

We strictly follow the Harvard Summer school policies. Students are responsible to know the rules and guidelines.

# CALENDAR

SU	Mo	TU	WE	TH	FR	SA
22	21	22	23	24	25	26
27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31
1	2	3	4	5	6	7

- First class
- Reviews
- Midterm exams
- Independence day
- Mathematica due
- Final exam

# SYLLABUS

## 1. Week: Geometry / Space

Lect 1-2 6/22 Space, Vectors, Dot Product  
Lect 3-4 6/24 Cross product, Lines/Planes

## 2. Week: Surfaces / Curves

Lect 5-6 6/29 Implicit /Parametric Surface  
Lect 7-8 7/1 Curves, Arc Length

## 3. Week: Linearization / Gradient

Lect 9-10 7/6 Partial Derivatives, Review  
Lect 11-12 7/8 Midterm. Gradient

## 4. Week: Extrema / Double Integrals

Lect 13-14 7/13 Tangents, Extrema  
Lect 15-16 7/15 Lagrange . Double integrals

## 5. Week: Triple Integrals /Line Integrals

Lect 17-18 7/20 Double and triple integrals  
Lect 19-20 7/22 Midterm Line integrals

## 6. Week: Vector fields /Integral Theorem

Lect 21-22 7/27 Curl, Greens theorem, Flux  
Lect 23-24 7/29 Stokes /Divergence theorem

# PREREQUISITES

Arithmetic, Algebra, Geometry  
Trigonometry, Exp and Log,  
Single Variable Calculus

