This standard multivariable calculus course extends single variable calculus to higher dimensions. It provides a vocabulary for understanding fundamental processes like weather, planetary motion, waves, heat and analysis in finance, life and social sciences. It teaches important background needed for statistics, computer graphics, bioinformatics, etc. It provides valuable tools for visualization as we study curves, surfaces, solids and other geometrical objects in two and three dimensions. It develops methods for solving optimization problems with and without constraints. You learn a powerful computer algebra system. The course will enhance problem solving skills and prepares you for further study in any other fields of mathematics and its applications.

**TEXTBOOK**

We do not require a textbook. James Stewart, Multivariable Calculus is a popular side reading. Any edition.

**ORGANISATION**

Course head: Oliver Knill
knill@math.harvard.edu
SC 432, Tel: (617) 495 5549

**MATHEMATICA**

We have a computer algebra project in this course. Harvard has a site license for Mathematica. It is a professional and powerful software.

**SECTIONS**

The course lectures (except reviews and intro meeting) are taught in sections. This assures you can discuss the material in class. Additional problem sessions are offered too. Lecture sections meet at:

MWF 9, MWF 10, MWF 11, MWF 12, TTh 10-11:50, TTh 11:50-13:00. Please section for one.

**MQC**

Sun to Thu in 309, 8:30-10:30PM

**EXAM DATES**

<table>
<thead>
<tr>
<th>Part</th>
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<tr>
<td>1. Hourly</td>
<td>15</td>
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<td>2. Hourly</td>
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<tr>
<td>Homework</td>
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<td>Mathematica</td>
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<td>Final</td>
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**Grades**

**Exam Dates**

<table>
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<tr>
<th>Exam</th>
<th>Date</th>
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<tr>
<td>1. Exam</td>
<td>Sept 27</td>
<td>7 PM</td>
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<tr>
<td>2. Exam</td>
<td>Nov 1</td>
<td>7 PM</td>
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<tr>
<td>Final</td>
<td>December</td>
<td>TBA</td>
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### SYLLABUS

#### 1. Vector geometry

- September 4: labour day, September 6 first classes
- 1. coordinates and distance
- 2. vectors and dot product

#### 2. Functions

- 1. cross product lines/planes
- 2. level surfaces quadrics
- 3. curves, velocity acceleration

#### 3. Curves

- 1. arc length, curvature
- 2. other coordinates
- 3. parametric surfaces

#### 4. Partial derivatives

- 1. review for first hourly
- first midterm (week 1-3) Sep 27

#### 5. Linear approximation

- 1. partial differential equations
- 2. linear approximation
- 3. chain rule implicit differentiation

#### 6. Gradient

- 1. Columbus day (no class)
- 2. tangent spaces
- 3. directional derivative

#### 7. Extrema

- 1. maxima, minima, saddle points
- 2. Lagrange multipliers
- 3. more problems, global extrema

#### 8. Double integrals

- 1. double integrals
- 2. polar integration
- 3. surface area

#### 9. Triple integrals

- 1. review for second midterm
- second midterm (week 5-8) Nov 1
- 2. triple integrals
- 3. spherical integrals

#### 10. Line integrals

- 1. vector fields
- 2. line integrals
- 3. line integral theorem

#### 11. Stokes theorem

- 1. Greens theorem
- 2. Curl, Divergence and flux
- 3. Stokes theorem

#### 12. Divergence theorem

- 1. Stokes theorem II
- 2. Thanksgiving (no class)
- 3. Thanksgiving (no class)

#### 13. Overview

- 1. Divergence theorem
- 2. Green-Stokes-Gauss
- 3. Overview, Outlook

Reading period (2-8) and Exam period (9-20)