Lecture 1: Sets, Functions, Limits, Derivatives

Note that the suggested readings will cover a lot more than what I cover in lecture and it's probably not feasible to read all of them. Check out the table of contents and pick out the sections that are most relevant to you (e.g. were the most confusing in lecture, or seem the most interesting)

Basic:

* *Calculus Early Transcendentals (8th ed.)*, James Stewart.
  + Chapters 1, 2 - Functions, Limits (also see Chap 4.4 for l'Hopital's rule), Derivatives
  + Chapters 3, 4 - How, when, and why to compute derivatives. (Not discussed in lecture)
* (Almost identical content can be found in *Calculus, Early Transcendentals*, C. Henry Edwards, David E. Penney)

Advanced:

* *Mathematical Analysis*, Tom M. Apostol
  + Chapter 2 - Sets, Functions

# Lecture 2: e, Integrals, Fundamental Theorem

Basic:

* *Calculus Early Transcendentals (8th ed.)*, James Stewart.
  + Section 1.2, 3.8 - e^x
  + Chapter 5 - Integrals, FTC
  + Chapter 6, 7, 8 - How, when, and why to compute integrals (Not discussed in lecture)
* *Calculus, Early Transcendentals*, C. Henry Edwards, David E. Penney
  + Chapter 5 - presents the material somewhat differently, starting with antiderivatives and then moving to integrals
  + Chapters 6, 7 (Not discussed)

Advanced:

* A note by Prof. Gilbert Strang about how to introduce the number e: [http://www-math.mit.edu/~gs/papers/Paper1\_ver10.pdf (Links to an external site.)](http://www-math.mit.edu/~gs/papers/Paper1_ver10.pdf)
* Way more than you ever wanted to know about the characterizations of the exponential function: <https://en.wikipedia.org/wiki/Characterizations_of_the_exponential_function>

# Lectures 3,4: Complex numbers, ODEs

Basic:

* Complex numbers:
  + *Calculus of One Variable*, Robert T. Seeley
    - Chapter XI
  + Absurdly good notes by Prof. Paul Dawkins on Complex Numbers (also check out his other calculus notes, you might prefer them over the textbooks)
    - [http://tutorial.math.lamar.edu/Extras/ComplexPrimer/ComplexNumbers.aspx (Links to an external site.)](http://tutorial.math.lamar.edu/Extras/ComplexPrimer/ComplexNumbers.aspx)
* ODEs
  + *Calculus Early Transcendentals (8th ed.)*, James Stewart.
    - Chapter 9
    - (Almost identical content can be found in *Calculus, Early Transcendentals*, C. Henry Edwards, David E. Penney)
  + *Differential Equations, Dynamical Systems, and an Introduction to Chaos*, Morris Hirsch, Stephen Smale, Robert Devaney
    - Chapter 1

Advanced:

* *Mathematical Analysis*, Tom M. Apostol
  + Chapter 1 - A first-principles definition of real and complex numbers.

# Lecture 5: Taylor series

Basic:

* *Calculus Early Transcendentals (8th ed.)*, James Stewart.
  + Ch 11.2, 11.8-11.11 - Series, power series, Taylor series
* The Wikipedia page on Taylor series is actually quite good. Take a look at the figures, especially.
  + [https://en.wikipedia.org/wiki/Taylor%27s\_theorem (Links to an external site.)](https://en.wikipedia.org/wiki/Taylor%27s_theorem)
  + [https://en.wikipedia.org/wiki/Taylor\_series (Links to an external site.)](https://en.wikipedia.org/wiki/Taylor_series)

Advanced:

* *Mathematical Analysis*, Tom M. Apostol
  + Ch 5.12 - Taylor's formula with remainder

# Lecture 6: Vectors, matrices, operations

Basic:

* Notes by our own Prof. Ken Miller: [https://ctn.zuckermaninstitute.columbia.edu/KenLinks to an external site.](https://ctn.zuckermaninstitute.columbia.edu/Ken)
  + Go to "Links of Interest" -> "Math Notes" -> Part 1 (read section 1)
* Notes by Prof. Eero Simoncelli from NYU: [https://www.cns.nyu.edu/~eero/math-tools/Handouts/geomLinAlg.pdf (Links to an external site.)](https://www.cns.nyu.edu/~eero/math-tools/Handouts/geomLinAlg.pdf)
* Pick one\* (ignore Gauss-Jordan elimination)
  + *Introduction to Linear Algebra (4th Ed.),* Gilbert Strang
    - Ch 1-2
    - (This is the text that was used in my undergraduate linear algebra class)
  + *Linear Algebra and its Applications (4th Ed.)*, Gilbert Strang
    - Ch 1
  + *Linear Algebra with Applications (4th Ed.)*, Otto Brescher
    - Ch 1-2
    - (This is the text used in Columbia's undergraduate linear algebra class)

Advanced:

* *Linear Algebra Done Right (3rd Ed.)*, Sheldon Axler\*\*
  + Ch 1-3

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\*other editions will also work, these are just the ones I'm using. Chapters might be different in other editions

\*\*this is actually my favorite reference, but it is somewhat abstract and oriented towards "pure math"

# Lectures 7-9: Vector spaces, span, independence, basis, orthogonality, linear transformations

Basic:

* Section 2 of Ken's notes: [https://ctn.zuckermaninstitute.columbia.edu/KenLinks to an external site.](https://ctn.zuckermaninstitute.columbia.edu/Ken)
  + Go to "Links of Interest" -> "Math Notes" -> Part 1 (section 2)
* Pick one:
  + *Introduction to Linear Algebra (4th Ed.),* Gilbert Strang
    - Ch 3, 4, 7
  + *Linear Algebra and its Applications (4th Ed.)*, Gilbert Strang
    - Ch 2, 3
  + *Linear Algebra with Applications (4th Ed.)*, Otto Brescher
    - Ch 2, 4

Advanced:

* *Linear Algebra Done Right (3rd Ed.)*, Sheldon Axler
  + Ch 1-3 (again!)

# Lectures 10, 11: Linear systems

Basic:

* *Nonlinear Dynamics and Chaos*, Steven H. Strogatz
  + Chapter 5
* *Differential Equations, Dynamical Systems & An Introduction to Chaos*, Morris W. Hirsch, Stephen Smale, Robert L. Devaney
  + Chapter 2,3

Advanced:

* *Differential Equations, Dynamical Systems & An Introduction to Chaos*, Morris W. Hirsch, Stephen Smale, Robert L. Devaney
  + Chapter 5,6

# Lectures 12, 13: Combinatorics

*Mathematics for Computer Science*, Eric Lehman, F. Thomson Leighton, Albert R. Meyer [[link] (Links to an external site.)](https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-042j-mathematics-for-computer-science-spring-2015/readings/MIT6_042JS15_textbook.pdf)

* Chapter 14 (Combinatorics)
* Also see the corresponding lectures on MIT OpenCourseWare [[link1] (Links to an external site.)](https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-042j-mathematics-for-computer-science-fall-2010/video-lectures/lecture-16-counting-rules-i/), [[link2] (Links to an external site.)](https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-042j-mathematics-for-computer-science-fall-2010/video-lectures/lecture-17-counting-rules-ii/)

*Introduction to Probability 2nd ed.*, Dimitri P. Bertsekas and John N. Tsitsiklis

* Section 1.1 (this should be a review, we covered sets in Lecture 1)
* Section 1.6 (Counting)
* Optionally, see the MIT OCW Lecture [[link]](https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-041-probabilistic-systems-analysis-and-applied-probability-fall-2010/video-lectures/lecture-4-counting/)

# Lectures 14-16: Probability

**Books**

1. A. Poppulis and S. Pillai, Probability, Random Variables and Stochastic Processes, 4th  
   Edition, McGraw Hill, 2002 (Chapters 1 through 8).
2. S. Ross, A First Course in Probability, 5th Edition, Prentice Hall
3. Lecture Notes of Caltech Probability Course by Kim Border:
   * [http://www.math.caltech.edu/~2016-17/2term/ma003/ (Links to an external site.)](http://www.math.caltech.edu/~2016-17/2term/ma003/)

**Topics**

1. **Independence, Conditional, Bayes**
   1. Ross (Chapter 3)
   2. Border  (Lecture 4)
2. **Concept of RVs, Discrete RVs**
   1. Papoulis (Chapter 4)
   2. Border (Lecture 5)
3. **Continuous Rvs, Expectation**
   1. Papoulis (Chapter 4)
   2. Border (Lecture 6, 7)
4. **Functions of RVs**
   1. Papoulis (Chapter 6)
5. **Central Limit Theorem**
   1. Border (Lecture 9, 10)
   2. Papoulis (Chapter 10)
6. **Joint Distributions, Marginals, Conditionals**
   1. Border (Lecture 19)
7. **Multivariate Gaussian**
   1. Border (Lecture 22)
8. **Statistical Inference**
   1. Border (Lecture 15, 16)
9. **Bayes Estimation, Estimator Properties**
   1. Border (Lecture 19, 20)

# Lectures 17-19: Multivariable calculus

Basic:

* *Calculus Early Transcendentals (8th ed.)*, James Stewart.
  + Chapter 14
  + Section 16.1
* Almost identical content can be found in:*Calculus, Early Transcendentals*, C. Henry Edwards, David E. Penney
  + Chapter 12
  + Section 14.1

Advanced:

* *Calculus Volume II, Second Ed.*, Tom M. Apostol
  + Chapter 8
  + Sections 9.9-9.15

# Lecture 20: Fixed points, stability, linearization

* *Nonlinear Dynamics and Chaos*, Steven H. Strogatz
  + Chapter 1 (optional - gives some nice motivation and context)
  + Chapter 2.0-2.4, 6.0-6.3
* *Differential Equations, Dynamical Systems & An Introduction to Chaos*, Morris W. Hirsch, Stephen Smale, Robert L. Devaney
  + Chapter 7.1, 8.1-8.4, 9.1-9.2
  + Chapter 12.5 (a classical example from neuroscience)

# Lecture 24-25: Convolution and Fourier series

Signals and Systems (Second Edition) by Alan Oppenheim and Alan Willsky

* LTI systems and Convolution
  + Chapter 1 (optional background and context), especially:
    - Section 1.2 for a refresher on math (transformation of independent variable)
    - Section 1.5 for background on systems
  + Chapter 2
    - Especially section 2.1 and 2.4
* Fourier series
  + Chapter 3
  + <http://www.falstad.com/fourier/>