

Quantitative Methods

James Taylor

Course

This is the syllabus for Quantitative Methods, 420.301.81. It is jointly offered to students of Environmental Science & Policy (ESP), Energy Policy & Climate (EPC), and Geographic Information Systems (GIS). This course is offered as part of Johns Hopkins's Krieger School of Arts and Science (KSAS), Advanced Academic Programs (AAP).

Objectives

Quantitative skills are fundamental to understanding the science core of your program. Many of these skills are also essential in understanding the scope and impact of policy measures. The primary goal of this course is to provide mathematical training in precalculus topics, probability, statistics, and calculus. You will need to demonstrate computational mastery of the early topics and conceptual mastery of the latter topics. The assignments and exams will assess your skills.

Practical mathematics is greatly facilitated by computer-based tools. There will be a variety of assignments that will focus on using technology to explore mathematics and solve problems. Spreadsheets, the free program GeoGebra, and graphing calculators are our main tools.

In addition to some basic computational skills, the intention of this course is to make mathematics a readily available tool for you in gaining quick insight into many questions. It can be very hard to do perfectly accurate computations; in most circumstances, it is both impossible and unnecessary. Guesstimation is a technique that approaches problems very roughly to get a sense of the size of an answer. By doing a rough estimate, one can get a feeling for where attention is needed. Guesstimation skills will be honed by writing blog posts in the course.

The final objective is to be able to converse in mathematics. The most important part of that is understanding what someone is saying. The discussions portion of this course develops both the writing and reading skills of mathematics. In addition to writing clearly and correctly for others, you need to be able to read and critique other people's mathematical writings.

Your assignments should be written to be read, typed, and filled with clear explanations. Strings of equations are NOT desired.

Format

This course is a fully online course. All content is delivered from within Blackboard.

Start each week with the lessons. On average, there are 6 sections per week, consisting of a screencast, notes, practice problems, and other support files. You should watch one to two sections a day, reflect on it, and do the practice problems.

Throughout the week, you should participate in the discussions, post blog entries, and submit the required assignments. See below for details.

Materials

Required

- *Guesstimation*, Lawrence Weinstein and John Adams.
ISBN-13: 978-0-691-12949-5

This is absolutely required. You will be going through this entire book. This is a skill/art of the utmost importance.

In a pinch, you can use the online version at JHU: https://catalyst.library.jhu.edu/catalog/bib_5724360

- Internet

Internet-enabled computer able to access the course website and watch online videos.

- Geogebra.org

There is no software that you need to buy. However you will need to use Geogebra. It is free and available at [geogebra.org](http://www.geogebra.org) It is easy to use for graphical explorations of functions. It can even do some basic statistics. It is what I use for graphing and exploring 2D functions. It will appear throughout the course. Mastering this early in the course will make the assignments much easier for you.

- Office program with a word processor and a spreadsheet, such as Word and Excel.

The canonical choice is Microsoft Office. You can also use Open Office (free), Google Docs (free with Google account), or iWork (on a Mac). I have access to all of them and thus may be able to help you troubleshoot them as needed. The final output for a Wordesque document should be a PDF so that it is rendered the same to me as you see it.

The free statistics software R <http://www.r-project.org/> can also be used instead of a spreadsheet. Ask me for help if you are interested in learning and using this powerful tool.

L^AT_EX is a powerful alternative to word processors. It is what I use. If you have an interest, I would be happy to help you learn it. Check out <http://www.tug.org/begin.html> It is free and used by professional mathematicians and scientists. An easy to use online version can be found at <https://www.sharelatex.com/>

- Scanner

Any handwritten work should be uploaded as PDFs when submitting assignments. Handwritten work is fine for support materials such as lengthy computations or if you just want to upload your scratch work to help me identify any mistakes that may have been made. Handwritten work is NOT acceptable as the assignment.

Try to make the file size small while maintaining readability (90 to 150dpi is generally fine).

- TI-84 Plus Silver Edition

The recommended calculator is the TI-84 Plus Silver Edition though any TI-83, TI-84 should be fine. Other graphing calculators are permitted, but it is unlikely that I will be able to support you in their use. Smart Phone Graphing Calculator Apps could be a good alternative as well. For iPhones and iPads, I highly recommend [GraphNCalc83](#). It is possible to do this course without a graphing calculator, but the feedback that I have received is that many students appreciate having one.

Recommended

You should obtain and read these books. They are for reading, not reference. We will not use them directly in the course, but if you read these books while taking this course, your understanding and abilities will be greatly enhanced.

- *How Not to Be Wrong: The Power of Mathematical Thinking* Jordan Ellenberg.
ISBN-13: 978-1594205224

This gives a call and perspective for, well, the power of mathematical thinking. It contains entertaining uses of mathematics from recent times. Much of it is focussed on statistics. I found it quite entertaining and I hope you will find it illuminating.

- *Introduction to Applied Mathematics for Environmental Science* David Parkhurst.
ISBN-13 978-0387342276

This is an advanced book, but the first three chapters, some of the ninth, and the appendix A should be helpful for this course. Think of it as another voice on the proper perspective to have in mathematics. It will be a nice companion for more advanced uses of the material we touch on here. It is also available online through JHU at https://catalyst.library.jhu.edu/catalog/bib_6578588

- *Primer of Ecological Statistics* Nicholas Gotelli and Aaron Ellison.
ISBN 13: 978-1605350646

This is a very readable text which covers statistics with the examples drawn from ecological questions. It explains the reasons and concerns about statistical procedures. We cover the first four chapters, but the rest are very worth reading as well.

The book pointed to here is the second edition. For our purposes, the first edition is fine too, but correction in errors and a bit of new content/focus reflective of current trends makes the second edition worth getting.

- *Everyday Calculus* Oscar Fernandez
ISBN: 978-0-691-15755-9

This is an enjoyable text that follows the author for a day and applies the ideas of mathematics to understanding the various experiences. This book will extend the basic point of Guesstimation beyond arithmetic. It should be readable after Unit 4 and will be a good mental preparation for the last third of the course.

Optional

Some more standard, textbookish reference materials.

- *Introduction to the Practice of Statistics* David Moore and George McCabe.

This is a good, classic textbook on statistics. Any edition should be fine. I have the fifth.

- *College Mathematics* (Schaum's Outlines), Philip Schmidt.

Practice is essential to mathematics and this book provides a variety of problems related to what we cover in this course.

- *Technical Mathematics with Calculus* Paul Calter, Michael Calter

This is a textbook of sorts that covers most (maybe all) of the topics we discuss. JHU has an online version that you can use: https://catalyst.library.jhu.edu/catalog/bib_5722601

- *Attacking Probability and Statistics Problems* David S. Kahn

This is a good, cheap, short reference for the material of the middle third of the course.
ISBN-13 978-0486801445

- *Attacking Problems in Logarithms and Exponential Functions* David S. Kahn

This covers some of the more challenging material of the first and third weeks of the course. He has a similar book on Trigonometry, but we don't delve into that material sufficiently enough to merit getting it unless you wish to pursue it on your own. ISBN-13 978-0486793467

Internet

Good materials that you can access for free online.

- JHU's library has access to several amazing online resources. You can look up a book and see if it has an online access. When you click on the link, it will ask you to login using your JHU identity. And then you can read the book. As an example, the Master Math series is online and may be a helpful set of alternate resources: https://catalyst.library.jhu.edu/catalog?utf8=%E2%9C%93&search_field=title&q=Master+math
- WolframAlpha <http://www.wolframalpha.com/> This site is very good at not only doing mathematics, but also having great statistics on real world data. After doing a guesstimation, you might use this site to check some of your guesstimates. They also have an app for smartphones which I highly recommend as it has a very convenient keyboard setup associated with it.
- Desmos <https://www.desmos.com/> This an alternative to GeoGebra. It works without Java so if Java is an issue for you, this might be your solution, at least for some of the course's needs.
- Linear Algebra Toolkit <http://www.math.odu.edu/~bogacki/lat/> This can help with exploring the linear algebra portion of the course.
- *Paul's Online Notes* <http://tutorial.math.lamar.edu/>
These are freely available notes on Algebra and Calculus. They should form a nice supplement.
- *Elementary Calculus* <http://www.math.wisc.edu/~keisler/calc.html>
A freely available calculus textbook from the 70's or so.
- *Khan Academy* <http://www.khanacademy.org/>
A site of highly regarded videos covering all of the topics here. It also has practice problems, but mainly it is the videos.

- *Just Math Tutorials* <http://patrickjmt.com/>
More videos on mathematics.
- <http://stattrek.com/>
This is a website devoted to learning basic statistics.
- MathBits on Calculators <http://mathbits.com/MathBits/TISection/Openpage.htm>
Some help on using the TI-84 Calculator
- Dr. Math Forums <http://mathforum.org/dr.math/index.html>
An ancient forum of mathematics questions.
- Arithmetic Game <http://arithmetic.zetamac.com/>
This is a simple game to sharpen your arithmetic skills. It is like a typing test, but for arithmetic. Why? Because quick two digit computations can greatly help in making sense of the scope of a problem, as guesstimation shows. By getting fast with these skills, you gain a fluency in the basic vocabulary of mathematics.

Consider These

- *Why Don't Students Like School*, Daniel Willingham.
ISBN-13: 978-0470591963
If you feel that you don't have the talent for math, then a quick read of this book should help put that falsehood to rest. The book's main thesis is that much of what we think as brilliant thinking comes from an extensive background knowledge. The purpose of this course is to lay down sufficient knowledge so that the more in-depth background knowledge needed in whatever specialty you end up in will be easy to acquire. I have seen repeatedly how "bad math students" are quite capable of doing brilliant mathematics.
- *Statistics in a Nutshell*, Sarah Boslaugh and Dr. Paul Andrew Watters.
ISBN-13: 978-0596510497
Here is an alternative to the Moore&McCabe textbook. It is more conversationally written and more of a reference rather than a textbook.
- *Beyond Numeracy*, John Allen Paulos.
ISBN-13: 978-0679738077
This is for delving deeper into the mathematics in everyday life.

- *Secrets of Mental Math*, Arthur Benjamin.
ISBN-13: 978-0307338402

Read this if you want to be good with numbers.

Imagine reading a book and having to look up every word in a dictionary. This would make reading for comprehension difficult and probably impossible. This is exactly the way most people deal with mathematics; they pause to do arithmetic. Learn to do arithmetic as smoothly as recalling a definition of a word.

JHU also has access to a video series related to this book: <https://jhu-kanopystreaming-com.proxy1.library.jhu.edu/video/art-guesstimation>

- *Physics for Future Presidents*, Richard A. Muller.
ISBN-13: 978-0393337112

If you like *Guesstimation*, then you should like this “physics” book. It delves into a variety of energy issues facing this country, using guesstimation throughout. A large portion of this is related to climate change though there is some fascinating material on nuclear explosions.

- *Guesstimation 2.0*, Lawrence Weinstein and Patricia Edwards.
ISBN-13: 978-0691150802

This is the followup volume to the required *Guesstimation* book. If you enjoy the first, you should enjoy the second. Browse the table of contents of this book. If you prefer to go through some of this book’s chapters instead of the first one, feel free. Just make it clear in your blog entry.

- *Elements of Mathematics: From Euclid to Gödel* John Stillwell.

This is a gentle road into having a more solid foundation on the theoretical side of mathematics. For most who take this course, this book will not be of interest or help, but for a few that get curious about being more solid in the foundation of the mathematics being used here, this book could fill that need.

ISBN-13: 978-0691178547

- *Vector Calculus, Linear Algebra, and Differential Forms: A Unified Approach, 5th edition* John H. Hubbard and Barbara Burke Hubbard

If you find yourself needing to delve into multi-variable calculus, this book will give you a perfect foundation though it will be hard to work through. Chapter 1 solidifies much of what we have talked about in calculus and then the fun really begins. Very much focussed on solid mathematical foundations using relevant numerical tools.

ISBN-13: 978-0971576681 <http://matrixeditions.com/5thUnifiedApproach.html>

Grading

Type	Points	Percentage	Notes
Blog	60	10%	Guesstimation
Blog	50	8%	TED video
Discussions	130	22%	3 posts per week
Assignments	120	20%	
Exams	240	40%	

98–100%	A+
94–97%	A
90–93%	A-
88–89%	B+
84–87%	B
80–83%	B-
70–79%	C
<70%	F

Blog (Guesstimation)

Starting with the first unit and going through unit six, you need to post one Guesstimation blog entry. Each entry is worth 10 points.

The Guesstimation blog posts, 6 of them in total, should be inspired by questions and answers from the Guesstimation book. Start with Chapters 1-3, and proceed from there, doing two chapters per week. Try to come up with a question each week which is of a like nature to the questions of that chapter(s). It is acceptable to use the book's questions, but it is much more fun and educational if you create your own questions. In your posting, you should write a fully coherent paragraph concerning how you arrived at your solution. A string of equations alone is not sufficient. If you find your answer to be very different from another source (say you came up with a million when another reference came up with a billion), then explain where the estimates might be off.

Try to do some fact checking after you do your own Guesstimate. The book is also about a decade old at this point. It can be a useful exercise to try and update their numbers, such as the population getting larger, solar panel efficiencies increasing, etc.

Blog (TED)

Starting with the seventh unit and then every unit through unit eleven, you will need to post a blog entry demonstrating some mathematical skepticism from a talk. I recommend the videos from TED.com. There are hundreds of videos given by some amazing speakers on a range of topics related to technology, environment, education, design, and more.

The ideal entry should have a short description of the video's topic, a link to the talk, and some interesting, guesstimational question pertaining to that topic. Do your best to answer your question, exploring the topic in some way or another.

Be skeptical. Not only are many of these talks good to be skeptical of, but one of the reasons

you need to know mathematics is to help investigate suspect claims. Practice that with these videos. Be brutally skeptical of the talk but be just as skeptical of your own skepticism! This is the essence of the scientific method. Question everyone including yourself.

Discussions (3 Posts)

Each week, you need to contribute to the discussions forum. A total of 10 points per week will be assigned based on your discussion posts.

It is expected that you will post at least three times. At least one should be a direct response to one of the week's posted questions. The other two can be responses to other student's postings, new questions that you come up with, or answers to the other official questions for the week.

Your discussion posts should be thoughtful, useful to others, and timely. Please do not wait until the end of the week to post all of your entries. If you post any of the required three posts after the assignment deadline, each of the late posts will have a point deducted.

Note: When grading the blogs and discussion posts, I am mainly looking for decent, reasonable writings. I will not be checking them for accuracy, particularly the discussion posts. This is purposeful. You should read each other's works and ask probing questions of that work. Be skeptical of each other, but be gentle and humble. This is a skill you need to learn well and my validating your work in these areas will not help that skill. If there is something that you want my feedback on, do ask. But otherwise, do your best to figure out whether what you and the others have written is reasonable.

I may speak up if I feel a good learning moment lurks by or if a question has been asked that has not been answered by others, but for the most part I want the blogs and discussions to be your communal space to explore mathematics and the world together without relying on a more knowledgeable guide to take you through. My critical feedback is reserved for the assignments...

Assignments

Each week's content, under Lessons, has an assignment which is worth 10 points.

Please make sure your work is well-organized and typed up. You can use any tool you like. Word, OpenOffice, and GoogleDocs all have the ability to insert equations and pictures. Please convert your document into a PDF to ensure that what you see is what I see. If you have difficulties, please let me know or, better yet, ask it on the discussion forums for the course. If there are graphs, pictures can be embedded.

A 10% penalty will be applied to handwritten assignments. A different 10% penalty will be applied to late assignments.

If you have trouble with uploading, you can email attachments to me directly.

Solutions become available once your work is graded and deemed acceptable.

When typing up your work, use words more than equations. You should write the starting equation and final equation, as applicable, but there is no need to write a chain of equations. But you should be descriptive in your solution to the problem. Why did you set it up the way you did? What methods/tools did you use to solve it? How did you check your answer? Why is it reasonable? These are questions to try and answer. Not all problems need answers to each of the questions, but try your best to be descriptive.

Do keep it brief. I do not want you wasting too much time typing up your answers. And briefness is actually a virtue in mathematical communications. Practice being brief while still being fully descriptive.

Also use the computational tools such as calculators and GeoGebra. They may seem like shortcuts, but you will find that they complement your human insight with machine accuracy.

Exams

These are also found under Lessons. There are three exams and each is graded out of 80 points.

The format is similar to the assigned problems. You download a PDF, type up the solutions, and then upload them. They are open book exams.

The course is divided in to 3 sections of 4 units each. There is an exam after each section is completed.

Topics

Each week contains a variety of topics, but the three sections of the course are: Algebra/Precalculus (4 weeks), Probability/Statistics (4 weeks), and Calculus (4 weeks).

Precalculus and Algebra

How does the equation of a line reflect its placement in the plane? How do we solve a system of linear equations? There will be a variety of word problems. How can we use units to understand a formula? We will also touch on a few points concerning arithmetic, inequalities, and absolute values.

This should largely be a review/refresher and we will use these topics to get some experience with the tools of the course. It is absolutely crucial that you master and understand everything in this part of the course.

What are functions? How do we graph them, solve $f(x) = 0$, find maxima/minima? What is the exponential function? logarithm? trigonometric functions? How do we compute compound interest?

We delve deeper into the electronic tools and provide a broad foundation for what you need to know in order to understand mathematical models of reality.

Probability and Statistics

How do we process and parse data? How many different outcomes are there when choosing something from a pile? What is the likelihood of errors? Does a sample reflect the population?

This is to help understand the basis of claims in scientific findings and understand when to be doubtful of someone else's claims.

Calculus

How do we approach hard problems? By pretending functions are lines! That is the key idea of calculus. How do we compute the area underneath a curve? How do we model population growth?

Here our journey ends with a gambit of approximations. Calculus gives science the power of differential equations. It is hoped that this section will teach you what a differential equation is.

Advice

Think and reflect! In your previous mathematical experiences, you may have seen mathematics as a bunch of rules to learn, master, and forget. If that is the case, then your first assignment is to understand that this course is different. This course's primary goal is to teach you how to think mathematically.

A large part of mathematical mastery is practice and working with the concepts. It is not a spectator subject. Do all the practice problems, consult the texts for more problems, and explore the topics with the tools. You can even post your explorations to the forums for discussion and more learning.

Ask questions. Just the act of asking often leads to better understanding. And answer questions when you can. Teaching is the greatest way to learn. So be active in the discussion groups and the blogs. By doing so, you will become very comfortable with mathematics.

When you master guesstimation, you will find it to be immensely empowering. Please go through each chapter carefully. Do not look at the solution in the book for a problem until you have done your best to solve the problem; your solution will generally be different from the book's, but a successful one should be within a factor of 10. There are no right Guesstimation answers, but there are wrong answers.

University Policies

General

This course adheres to all University policies described in the academic catalog. Please pay close attention to the following policies:

Students with Disabilities

Johns Hopkins University is committed to providing reasonable and appropriate accommodations to students with disabilities. Students with documented disabilities should contact the coordinator listed on the [Disability Accommodations](#) page. Further information and a link to the Student Request for Accommodation form can also be found on the [Disability Accommodations](#) page.

Ethics & Plagiarism

JHU Ethics Statement: The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic

devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Report any violations you witness to the instructor.

Read and adhere to JHU's [Notice on Plagiarism](#).

Dropping the Course

You are responsible for understanding the university's policies and procedures regarding withdrawing from courses found in the current catalog. You should be aware of the current deadlines according to the [Academic Calendar](#).

Getting Help

You have a variety of methods to get help on Blackboard. Please consult the resource listed in the "Blackboard Help" link for important information. **If you encounter technical difficulty in completing or submitting any online assessment, please immediately contact the designated help desk listed on the [AAP online support page](#).** Also, contact your instructor at the email address listed in the syllabus.

Copyright

All course material are the property of JHU and are to be used for the student's individual academic purpose only. Any dissemination, copying, reproducing, modification, displaying, or transmitting of any course material content for any other purpose is prohibited, will be considered misconduct under the [JHU Copyright Compliance Policy](#), and may be cause for disciplinary action. In addition, encouraging academic dishonesty or cheating by distributing information about course materials or assignments which would give an unfair advantage to others may violate AAP's [Code of Conduct](#) and the University's [Student Conduct Code](#). Specifically, recordings, course materials, and lecture notes may not be exchanged or distributed for commercial purposes, for compensation, or for any purpose other than use by students enrolled in the class. Other distributions of such materials by students may be deemed to violate the above University policies and be subject to disciplinary action.

Code of Conduct

To better support all students, the Johns Hopkins University non-academic [Student Conduct Code](#) has been integrated and updated to include all divisions of the University. In addition, it is important to note that all AAP students are still accountable for the [Code of Conduct for Advanced Academic Programs](#).

Title IX

Confidentiality and Mandatory Reporting

As an instructor, one of my responsibilities is to help create a safe and inclusive learning environment on our campus. I also have mandatory reporting responsibilities related to my role as a Responsible Employee under the Sexual Misconduct Policy & Procedures (which prohibits sexual harassment, sexual assault, relationship violence and stalking), as well as the General Anti-Harassment Policy (which prohibits all types of protected status based discrimination and harassment). It is my goal that you feel able to share information related to your life experiences in classroom discussions, in your written work, and in our one-on-one meetings. I will seek to keep information you share private to the greatest extent possible. However, I am required to share information that I learn of regarding sexual misconduct, as well as protected status based harassment and discrimination, with the Office of Institutional Equity (OIE). For a list of individuals/offices who can speak with you confidentially, please see Appendix B of the [JHU Sexual Misconduct Policies and Laws](#).

For more information on both policies mentioned above, please see: [JHU Relevant Policies, Codes, Statements and Principles](#). Please also note that certain faculty and other University community members also have a duty as a designated Campus Safety Authority under the Clery Act to notify campus security of certain crimes, as well as a duty under State law and University policy to report suspected child abuse and/or neglect.

Other Policies

Online Posting

If this is your first online course, please remember that discussion posts and other writings submitted to the course should be well-written, professional, courteous, thoughtful, and useful. Under no circumstances will uncivil discussions be tolerated. Should you feel uncomfortable with anything that someone else writes, please let me know privately and I will take appropriate action.

Disclaimer

This syllabus and the course materials are subject to change. These changes will be made to benefit the class and to maintain Johns Hopkins University's high standards of quality and fairness.

Instructor

James Taylor (james.taylor@jhu.edu, 410-790-2441)

Contact

The best method of contact is to email me. Feel free to ask any questions, share your concerns, or voice your thoughts about the course.

Consider using a scanner to email written work that you are having difficulty with. You can also call me at the number listed above, but email will probably reach me faster!

The discussion boards are also there to ask and answer student questions. That is the best place to ask since the resulting understanding, perhaps given by another student, can then be shared by all.

You should expect an answer from me within 24 hours. If you have received no response from me within that time frame, please contact me again (calling is a good option) as I have probably not received your email.