Instructor: Logan Axon
Email: axon@gonzaga.edu
Office: Herak 307A
Office hours: 1:30-2:30 MW, 9:30-10:30 TTh, and 1-2 F in the Math Lab (Herak 224), and by appointment
Textbook: **The Book of Proof** by Richard Hammack (available for free online)
Web site: `http://web02.gonzaga.edu/faculty/axon/301`

Description: Fundamentals of Mathematics covers standard proof techniques through the examination of logic, set theory, properties of numbers, and the basic theory of functions. Additional topics may be chosen from analysis, algebra, number theory, or combinatorics.

Goals: In contrast to prior math classes, Fundamentals of Mathematics does not aim to teach a specific branch of mathematics (like calculus or geometry), but instead focuses on the logical skills fundamental to all mathematics. The primary goal of the class is for you to learn to write and read mathematical proofs. This entails understanding basic propositional and predicate logic, the ability to formulate mathematical arguments, the clear expression of such arguments, and the analysis and critique of mathematical arguments. Most of these skills are fundamental to all arguments, not just those in mathematics, and you will occasionally be asked to apply these skills to non-mathematical situations.

A subsidiary goal for the class is building familiarity with the fundamental objects of formal mathematics: sets, relations, functions, numbers, etc. Proofs need to be about something, and in this class these objects are that thing.

Learning Outcomes: On completion of the course students will be able to:

- Translate between informal mathematical statements and formal mathematics;
- Determine the truth or falsehood of formal mathematical statements;
- Formulate and write mathematical proofs;
- Read and evaluate mathematical proofs.

Writing-enriched Learning Outcomes: This course carries the writing-enriched designation. Consequently, at the completion of the course, students will be able to:

- Demonstrate competency in formal and informal writing specific to Mathematics;
- Integrate appropriate primary and secondary research in their writing by the means customarily used in Mathematics;
- Incorporate feedback received during and intensive revision process.

Course work: New material will be introduced in class (either in lectures or worksheets) or in assigned readings of the textbook (yes, you are expected to actually read some of the book). Reading mathematics is usually hard–if it's not, then you might be doing it wrong. Take your time, think about what has already been covered, recall relevant examples, think about how the new ideas apply to those examples, read any provided examples carefully, re-evaluate your own thinking, then go on to the next sentence and repeat.

As always, "doing math" requires practice and homework sets are how I make sure you practice. Working with other students is encouraged, but submitted work should reflect your understanding. It's okay to have someone explain their solution to you, but you should make sure you understand the solution and express it in your own words. Homework will be collected approximately weekly and late work will not be accepted unless permission is obtained in advance. Every effort will be made to grade and return homework in a timely manner and you are expected to review graded homework carefully; comments and suggestions on specific problems will be an

important way for you to learn from your mistakes.

Exams are a way to measure your progress in the class, but they also encourage you to review material and understand it in the context of later topics. The word "review" may be misleading: studies on learning have shown that merely re-reading the book and notes does not help most students learn (specifically, it does not on average lead to better exam scores). On the other hand, research has shown that trying to figure out what kinds of problems are most likely to appear on the exam and then practicing those kinds of problems can be very helpful. At minimum you should identify the central idea of each section and think about how the homework problems reflect that idea. Exam questions will require you to write proofs, so be sure to practice writing proofs.

Please only turn in work that you think is correct. There is no point in telling you that a proof doesn't work if you already know that to be the case. This means that you might turn in an incomplete argument or add a note saying that you know that something is wrong and where you think that might be. Knowing what you really think helps guide the lessons (and will only ever help your scores).

Assignments, deadlines, worksheets, solutions, past exams, and links to resources will all be posted on the course web site: `http://web02.gonzaga.edu/faculty/axon/301/`. Keep track of this page (and remember that none of the class material will be on Blackboard).

PORTFOLIO: Over the course of the semester you will create a portfolio of mathematical writing. The portfolio will consist of 9 entries: 6 formal mathematical proofs and 3 other less-formal entries. Proofs will come from a list of portfolio problems. One of the other entries will be based on reading a part of Euclid's Elements (or another selection of historical mathematics). Another entry will be based on reading a modern math publication (a list will be provided). The other informal entry will be about current research: you may either attend a math talk (a list will be provided) or interview a math professor about his/her research.

Proofs for the portfolio must be written using LaTeX. This is free, open source software, so you can download it onto your personal computers (which I recommend and which I can help you with). You can also make use of the computers in certain labs. Examples, links to software sources, and templates are posted on the course web site.

The class after a portfolio proof is due will be a peer-review day. You will read portfolio proofs and make suggestions for how they could be improved. This may mean correcting math or grammar errors, but it might also entail suggestions about mathematical style. Comments and suggestions will be returned to the authors, who will then be able to revise their proofs before turning in a final draft for grading. I will be evaluating the final proofs using the rubric at the end of the syllabus. At the end of the semester you will compile the portfolio entries into one document (again using LaTeX). This gives you one last chance to revise your proofs and other portfolio entries before they get a final grade.

PROOFS: Always strive for clarity and brevity when writing proofs. Start with a clear statement of the problem and, for complex solutions, a brief statement of the main idea or technique of the solution (e.g. "proof by contradiction"). Avoid introducing superfluous variables and be sure to specify what each variable is when it is introduced. Unless directed to do otherwise, **use actual English words (not just math) to make actual English sentences.** More suggestions are in section 5.3 of the textbook.

GRADES: Grades will be based on exams (33%), homework (29%), portfolios (29%), and worksheets/other in-class activities (9%). There will be 2 exams during the semester (with the lower score worth 7% and the higher score worth 10%) as well as a final exam (worth 16%). No extra credit will be given. Each portfolio entry will be worth 3% of the final grade and the final, assembled portfolio will be worth an additional 2%. Final grades will be assigned using the following rough scale (with plus and the top and minus at the bottom of each interval, as appropriate):

	90-100%	80-90%	70-80%	60-70%	0-60%
Grade	A	B	C	D	F

Precise rubric for portfolio proofs:

	3	2	1	0
Argument	The argument is correct	Correct approach with minor errors or omissions	Correct approach with significant errors or omissions	Incorrect approach
Clarity	Argument is clear and variables are well defined	Some part of the argument is unclear or some variables are poorly defined	Argument can be followed but links are often unclear or variables are often poorly defined	Very difficult or impossible to follow argument
Mechanics	All writing is clear and words/symbols are used correctly	Some writing is not clear or some words/symbols are used incorrectly, but the proof is still easily readable	Readable only with effort	Unreadable

Notes: The three areas of evaluation are obviously linked, but they will be evaluated separately to the extent that this is possible. **Argument** involves evaluating the logic behind the proof, i.e. the truth of the assertions made in the proof. **Clarity** involves evaluating the presentation of the argument. Putting aside the truth of the assertions, are the connections between the assertions obvious? Are the variables well defined? Are theorems and defnintions cited appropriately? **Mechanics** involves the use of language, symbols, and diagrams. Issues with using LaTeX will also show up in this area.

Rough rubric for everyday use:

5	4	3	2	1	0
The argument is correct and clear	Correct approach with minor errors or omissions or some lack of clarity	Correct approach with minor errors or omissions and serious lack of clarity	Correct approach but with major errors or omissions	Incorrect approach or very difficult to follow argument	No readable work present

The Dean of the College of Arts and Sciences has suggested that the following be included in all course syllabi. It is important and you should read it at least once.

Harassment, non-discrimination, and sexual misconduct: Consistent with its mission, Gonzaga seeks to assure that all community members learn and work in a welcoming and inclusive environment. Title VII, Title IX and Gonzagas policy prohibit gender-based harassment, discrimination and sexual misconduct. Gonzaga encourages anyone experiencing gender-based harassment, discrimination or sexual misconduct to talk to someone from the Campus and Local Resources list found in the e Harassment and Non-Discrimination Policy.

It may be helpful to talk about what happened in order to get the support needed and for Gonzaga to respond appropriately. There are options for support and resolution, namely confidential support resources, and campus

reporting and support options available. Gonzaga will respond to all reports of sexual misconduct in order to stop the harassment, discrimination, or misconduct, prevent its reoccurrence and address its effects. Responses may vary from support service referrals to formal investigations.

As a faculty member, I want get you connected to the resources here on campus specially trained in and experienced in assisting in such complaints, and therefore I will report all incidents of gender-based harassment, discrimination and sexual misconduct to Title IX (in fact, I am required to report such incidents). A representative from that office will reach out to you via phone and/or email to explore options for support, safety measures and reporting. I will provide our Title IX Director with all relevant details, including names and identifying information, of the information reported. For more information about policies and resources or reporting options, please visit the following websites: Equity and Inclusion and Title IX. If you would like to directly make a report of harassment, discrimination or sexual misconduct directly, you may fill out an online Sexual Misconduct Report Form or contact the Title IX Director by phone, email, or in person:

Stephanie N. Whaley
Title IX Director
509-313-6910
whaleys@gonzaga.edu
Business Services Building 018

Notice to students with disabilities and/or medical conditions: The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability/medical condition requiring an accommodation, please call or visit the Disability Access Office (second floor of Foley Center Library, Room 208.)

Attendance: I follow strictly the universitys standard policy on absences: the maximum allowable absence is two class hours (100 minutes) for each class credit. For a three-credit class meeting three times a week, the maximum number of absences allowed is six. For a three-credit class meeting twice a week, the maximum number of absences allowed is four. The grade for excessive absences is "V," which has the same effect as "F (Fail) and is counted in the GPA. (See also "Class Attendance Policy).

Academic integrity: All members of the Gonzaga community are expected to adhere to principles of honesty and integrity in their academic endeavors, and I will abide strictly by procedures and guidelines of the Universitys Academic Integrity Policy. Students and faculty are governed by this policy, and I encourage you to familiarize yourself with its scope and procedures. Ignorance of the policy will not serve as a defense against any violations.

Course evaluation: At Gonzaga, we take teaching seriously, and we ask our students to evaluate their courses and instructors so that we can provide the best possible learning experience. In that spirit, we ask students to give us feedback on their classroom experience near the end of the semester. I will ask you to take a few minutes then to carry out course/instructor evaluation in class. Please know that I appreciate your participation in this process. This is a vital part of our efforts at Gonzaga to improve continually our teaching, our academic programs, and our entire educational effort.