Course Offerings

Accessible

Projective Planes

Martin Strauss
We explore theory and applications of real and finite projective planes, including the following, which are all connected!

- **Linear perspective in art.** What does it mean to say that parallel lines meet at infinity?
- **Finite Fields.** How can we make a *field* of eight elements, in which we can add and multiply?
- **Error-correcting codes.** Seven patients, of whom one is sick, spit into some of three cups. We test the cups--only three!--for evidence of disease and learn who is sick.
- **The game Spot It!.** How to design cards and images so that any two cards have exactly one image in common? What symmetries result?

See more at Projective Planes.

Introduction to Number Theory

Burton Newman
The natural numbers 1, 2, 3, ... are some of the simplest mathematical objects one can imagine, yet simple questions about them have remained unanswered for millennia, and attempts to answer these questions have given birth to whole new fields of mathematics. In this course we will explore these questions and seek out our own!

The Metallic Ratios

Rolfe Schmidt
Starting with a famous counting problem from 13th-century Italy, we will explore recurrences that arise in combinatorics, geometry, algebra, and number theory. It will all start with the famous Fibonacci numbers and the Golden Ratio, but we will see that the theory goes far beyond this. Along the way we will learn about continued fractions, continuants, difference equations, and even some 3D geometry. *No prerequisites, but students with solid algebra or computing experience will be able to use it to take some of our topics farther.*

Indo-European Linguistics

Todd Krause
Did you know English is related to German? Look at some common words to check: *Vater* 'father', *Mutter* 'mother', *zwei* 'two', *Hand* 'hand'. But it's also related to Italian, Greek, Russian, and even Hindi. How does that work? What does it mean for languages to be "related"?

We will study how Historical Linguistics establishes these relationships. We will mine English for clues as to how languages evolve over time. We will compare Old English to other ancient languages looking for similar patterns in both grammar and vocabulary: maybe Latin? Ancient Greek? Gothic? (I thought that's just a way of dressing…) Sanskrit? Old Church Slavonic? Tocharian? (OK, now you're just making things up…) Are you ready to climb the family tree and learn a few languages? *Open to students of all backgrounds and ages.*

Mayan Hieroglyphs

Todd Krause
Completely independent writing systems have only arisen a handful of times across the globe. One such development of writing occurred in Mesoamerica, where a rich system of hieroglyphs arose. This system perhaps reached its zenith among the ancient Maya, who adorned their temples and pottery with ornate art that also served to record their language. In this class you will learn how to read and write these hieroglyphs. We will also learn about the unique Mayan calendar, the contexts of hieroglyphic inscriptions, and some basics of how the Classic Mayan language worked. Let's dive into the ancient jungles of the Americas and read the temple inscriptions! *Open to students of all backgrounds and ages.*

Intermediate

Math Video Party

Burton Newman
Who makes your favorite math videos? In this course we'll scour the internet for the best math videos out there. During the week, you'll watch videos centered around a theme and then we'll discuss them in class. We'll aim to

- Expose you to the best teachers in the world.
- Support you in finding answers to all your questions about the videos.
- Use interactive tools (e.g. Desmos, Python, etc.) so you can experience the ideas first-hand and explore them on your own.
- Describe connections between the videos and other fields both inside and outside of mathematics.

Prerequisites: Algebra 1

Zero Knowledge Proofs

Rolfe Schmidt
We will explore the world of Zero Knowledge Proofs, seeing concrete and practical examples in graph theory and cryptography but also building up the theoretical machinery to make the concepts precise. We'll use simple examples to introduce the core concepts - interactive protocols, soundness, completeness, zero-knowledge, simulations, and extractors - then use this to explore protocols in practical use today. *Prerequisites: Algebra, Modular arithmetic. Experience with computer science or programming helps but not required.*

Advanced

The Prime Number Theorem

Yo'av Rieck
In this challenging class you will learn how to prove one of the triumphs of Mathematics, the Prime Number Theorem. Surprisingly, the proof uses techniques from complex analysis, a field which appear to be completely unrelated. We will discuss the basics of complex analysis, including topics such as the maximum principle, the cauchy integral formula, zeta functions and more as we dive deeply into analytic number theory. The subject was covered last year, but since it is very rich and touches many different directions, students are encouraged to consider taking the class again. *Prerequisites: Calculus, Mathematical maturity.*

Course description and pre-camp worksheet available here.

Entropy!

Yo'av Rieck
You probably heard that the Second Law of Thermodynamics states that *entropy always increases*, but have you ever wondered what entropy *really* is? In this class we will discuss various aspects of entropy: from its emergence in the 18th century, through its development in 19th century physics (including a variety of paradoxes!), and ending with its relation to information theory. We will also discuss topics in physics that are sometimes featured in books and movies: Heat Death and Poincaré Recurrence.

A Peek into Topology

Christian Geske
In this course Campersandians will be introduced to a cherry-picked selection of concepts from the mathematical field of topology in an intuitive and visual way. We'll discuss deformations of spaces, study the theory of surfaces, learn how to multiply curves, and more. At the university-level topology is buried in technicalities that we'll shed much of so that we can explore the topological world unhindered!

Clubs

Polyhedron Club

Rolfe Schmidt
Come build with us! Check out our flyer here!

We will have activities every week that only require a printer, regular paper, and scissors! But if you want the full range of activities, you'll make good use of the supplies below:

- Heavy paper or cardstock
- A printer
- Scissors
- Craft glue - Aleene's Tacky Glue is highly recommended or iCraft supertape (1/4" or 1/8" recommended)
- A ball point pen or a geometry compass with sharp tip for scoring fold lines.
- A ruler

Watch this video to see how we'll use it.

Python Club

Burton Newman
Got a project you want to build? Not sure how to get started? Curious to learn more about how Python can help? Python has a large ecosystem of free packages just waiting to be used - all you have to do is ask! In this club we'll survey some of the more fun packages out there and support one another in building the projects we've been dreaming about! *Prerequisites: Successful installation of Anaconda on your machine (it's free and commonly used in industry). MacOS preferred.*

Desmos Art Club

Burton Newman
In this club we'll explore Desmos artwork as well as make our own. Along the way, we'll deepen our understanding of the mathematical tools in Desmos by answering the question 'How did they do that?'