CLASS CLUSTERS FOR MATHCAMP 2018

0. ABOUT CLUSTERS

The Mathcamp schedule provides a plethora of options, and we give you the freedom to choose among them as you will.[1] However, you may find the academics this summer more rewarding if you're able to look back in five weeks and reflect that you've learned *a lot* about something. To this end, we've constructed *clusters*: sets of classes with a common theme.

It is completely fine to only take part of a cluster. Note that fewer than half of the classes this summer are in a cluster; just because a class doesn't live in a cluster doesn't mean that it's not awesome!

1. ANALYSIS

Analysis is the study of limits— the process of understanding the solution to a mathematical problem by taking successively closer approximations. These ideas are the core components of differential and integral calculus. This cluster uses these methods by developing fundamentals of analysis, as well as applying techniques from calculus to build strange new functions and study mathematical systems.

	Week 1	Week 2	Week 3	Week 4
9:00			Signals Analysis ♪♪ (Jeff)	
10:00	Complex Dynamics ♪♪ (*Scott Kaschner*)		Monsters in Real Analysis ♪♪♪ (Ben)	
11:00		Metric Space Topology ♪♪ (Jeff)		
1:00		Chaotic? Good! ♪♪♪ (Ben)		

2. RINGS AND FIELDS

Rings generalize our notion of numbers: their elements can be added, subtracted, multiplied and sometimes divided. Courses in this cluster build new number systems out of old, classify and understand the structures of rings, and tie the geometry of equations with algebra.

	Week 1	Week 2	Week 3	Week 4
9:00	Algebraic Number Theory ♪♪♪ (Shiyue)	Intro Ring Theory ♪♪♪ (Lara)		Representation Theory ♪♪♪♪ (Aaron)
10:00			Commutative Algebra ♪♪♪ (Mark)	
11:00			Representation Theory ♪♪♪♪ (Aaron)	Algebraic Geometry ♪♪♪ (Mark)
1:00			Galois Theory ♪♪♪♪ (Viv)	

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[1]Unfortunately, our reality only allows us to perceive one class at a time.

3. Topology

What do the letters a, o, d, p have in common but h, j, x and z lack? Topology is the study of spaces which can be modified under continuous deformations. These courses will involve many pictures, visualizations and construction of new mathematical spaces. Classes in this cluster will also look at how topology connects to analysis, geometry and algebra.

	Week 1	Week 2	Week 3	Week 4
9:00				Differential Topology ♪♪♪ (Kevin)
10:00			Low-Dimensional Zoology ♪♪♪ (Larsen)	The Fundamental Group ♪♪♪ (Larsen)
11:00		Metric Space Topology ♪♪ (Jeff)		
1:00				Cohomology via Sheaves ♪♪♪→♪♪♪♪ (Apurva)

4. Logic

Logic is the study of reasoning. Sometimes this means learning to reason carefully in strange situations to arrive at surprising conclusions; sometimes this means using "reasonable" axioms to build weird, fascinating objects that shouldn't exist; and sometimes it means studying the way we reason mathematically itself. The classes in this cluster take what you already know about proofs in mathematics and do weird things with it.

	Week 1	Week 2	Week 3	Week 4
9:00				
10:00	Infinitesimal Calculus ♪♪♪ (Tim!)		The Continuum Hypothesis ♪♪♪♪ (Susan)	
11:00	Stupid Games on Uncountable Sets ♪♪♪♪ (Susan)			The Continuum Hypothesis ♪♪♪♪ (Susan)
1:00				

5. Math in the real world

Math is all around us if you know where to look for it! These classes both explore how to create mathematical tools which can be used to attack the real world problems you encounter, and look at the elegant mathematics which naturally occur as real world phenomena.

	Week 1	Week 2	Week 3	Week 4
9:00	Statistical Modeling ♪♪ (Sam)		Signals Analysis ♪♪ (Jeff)	Public-Key Cryptography ♪♪→♪♪♪ (J-Lo)
10:00		MCMC ♪♪→♪♪♪ (Mira)		Mathematics of Democracy ♪ (Mira)
11:00	Game Theory ♪ (Ben)			
1:00				Modeling of Biological Systems ♪♪→♪♪♪ (*Angela & Kamila*)

6. Number Theory

Which are rarer, prime numbers or perfect squares? Which numbers can be written as the sum of four cubes? Is there a prime number which yields a remainder of 4 when divided by 7, 9, and 11? Questions like these, about the *arithmetic properties* of natural numbers, fall under the umbrella of "number theory." Despite its specific focus, number theory interacts with practically every area of mathematics, and ranges from the concrete to the incredibly abstract. Classes in this cluster will teach both number theory on its own, and its interactions with other fields.

	Week 1	Week 2	Week 3	Week 4
9:00	Algebraic Number Theory ♪♪♪ (Shiyue & J-Lo)			Public-Key Cryptography ♪♪ → ♪♪♪ (J-Lo)
10:00				
11:00		Intro Number Theory ♪♪ (Mark) The Class Number ♪♪♪ (Kevin)	Riemann's Explicit Formula ♪♪♪ (Kevin)	
1:00	Intro Number Theory ♪♪ (Mark)	Modular Forms ♪♪♪♪ (Shiyue)		Rational Points on Elliptic Curves ♪♪♪ (Shiyue)

7. Problem Solving

Classes in this cluster will teach you problem-solving techniques used in math competitions. Expect to solve many math problems along the way!

	Week 1	Week 2	Week 3	Week 4
9:00	Street Fighting Mathematics ♪♪ (*Sanjoy Mahajan*)			ARML Power Rounds ♪ (Misha)
10:00	Machine Geometry ♪♪♪ (Misha)			
11:00		PS: Inequalities ♪♪♪♪ (Pesto)		
1:00				

8. Networks and Graphs

A graph, or network, is a collection of nodes with edges that connect nodes together. Graphs are wonderful mathematical objects and these courses look at graphs for their own right, as well as applications of graph theory to optimization and scheduling problems.

	Week 1	Week 2	Week 3	Week 4
9:00				
10:00	Calculus on Graphs ♪♪ (J-Lo)	Flag Algebras ♪♪♪♪ (Misha)		
11:00			Conflict-Free Graph Coloring ♪♪♪ (Pesto)	
1:00	Intro Graph Theory ♪♪ (Mia)		Spectral Graph Theory ♪♪ (Laura) Max Flow Min Cut ♪♪ (Tim!)	