First Year Foundations Seminars

This will be an evolving document at least until January 13, 2019. Suggestions/comments to ugchair@math.toronto.edu.

The (nearly-) latest version is always at http://drorbn.net/uc/UG_Committee_Agenda_181017.pdf. This version: 2018-12-16 7:25 PM.

Proposed Action.

Starting on January 14, 2019, Dror will act to get four First Year Foundations Seminars (FYFs) approved by the FAS Curriculum Committee. The current list of ideas is down below. The deadline for submission of FYF proposals to the FAS is January 18, 2019.

Dror's Email of December 4, 2018.

Subject: PMU -> FYF

Dear All,

As you may already know, the faculty of arts and science is re-organizing the first year seminars. We used to offer 4 such seminars each year, carrying random titles yet all under the designation "PMU 199". As of next year, the system is changing a bit: these seminars will be given an MAT designation (MAT199, MAT198, etc.) so they will appear to be much more like "normal" math courses, yet they remain "first year seminars" with up to 30 students in each, they remain outside of our normal specialist/major/minor programs (some exceptions allowed), and the expectation remains that they will be open to the general arts and science population rather than only to math nerds. It is expected that they will be given by a "continuing faculty member" (not a GS or a PDF) and that each one will be given for a number of years, hence they should not be tailored to just a single individual instructor.

The new name is "First Year Foundations Seminars", and you can read more at http://www.artsci.utoronto.ca/faculty-staff/cpad-info/2018-2019-memos/pdfs/35.pdf and way more at http://www.artsci.utoronto.ca/faculty-staff/committees-reports/pdfs/First-Year-Academic-Offerings-Working-Group-Recommendations.pdf.

There is some administrative burden involved: by January 18, we need to propose at least 4 such courses for approval by the faculty-wide curriculum committee. For this we need to decide which would these 4 courses be and we need to build a little proposal around each one. I expect the faculty will show some flexibility, yet we shouldn't count on it at this stage.

PMU seminars that were given in the past include "Exploring Math Around Us!", "Magic and Mathematics", "Mathematical Explorations", "Mathematics in the News for Social Sciences Students", "Aha! Mathematical Discovery and Creative Problem Solving", "Math: Here, There and Everywhere", "The Universe in Zero Words", "Mathematics in Current Events", "Mathematics at Work, Home & Play", and "Discovery & Creative Problem Solving". I also heard the ideas "Geometry and the Imagination", "Mathematics for Poets", and "Mathematics and Sustainability".

If you are the person who gave any of those seminars, or if you are interested in giving any of these seminars, or if you have any other ideas, it will be immensely useful if you will write me back with a 1-2 paragraph "course description" and perhaps also a 12-week non-binding list of topics, with a sentence or two about each. I will decide how to move forward depending on your responses.

Please reply within 168:27 hours, by Tuesday December 11 at 3PM. Feel free to forward to other interested parties.

Truly,

Dror.

PMU Seminars given since 2012:

Course	2018-2019	2017-18	2016-2017	2015-2016	2014-2015	2013-2014	2012-2013
Exploring Math Around Us!	Y. Qing	Y. Qing					
Magic and Mathematics	B. Galvao-Sousa	B. Galvao-Sousa	B. Galvao-Sousa				
Exploring Math Around Us!	Y. Qing	Y. Qing					
Mathematical Explorations						M. Gualtieri	
Mathematical Explorations	D. Burbulla	D. Burbulla	S. Rayan	S. Rayan	S. Rayan		
Mathematics in the News for Social Science Students			N. Derzko				
Aha! Mathematical Discovery and Creative Problem Solving			R. McCann		R. McCann		R. McCann
Math: Here, There and Everywhere					S. Tanny		
The Universe in Zero Words				D. Burbulla	D. Burbulla		
Mathematics in Current Events				N. Derzko		N. Derzko	N. Derzko
Mathematics At Work, Home & Play						S. Tanny	S. Tanny
Discovery & Creative Problem Solving						R. McCann	

Two Proposals by Dietrich Burbulla.

Here's some info on "Mathematical Explorations:"

Description: This course is meant to develop an appreciation for, and an understanding of, the subject of mathematics. The course will feature a variety of mathematical topics accessible to those who are interested in mathematics and who did well in it in secondary school, but who are otherwise not pursuing it further at the University level. The topics may include infinity, the ``fourth dimension'', Moebius strips, golden rectangles, secret codes, puzzles, fractals, and so on. The history of mathematics, the ways in which mathematicians communicate ideas, and the perception of mathematics in the public-at-large and in the media may also be explored. Apart from problem-solving and experimenting with mathematical ideas, students will be expected to write brief non-technical papers and/or make a presentation on some aspects of mathematics.

Outline: the following topics are very broad. How much time we spend on them will be determined by the level of interest in class.

Week 1: What is mathematics?

Week 2: Types of numbers

Week 3: Types of geometry

Week 4: Types of symmetry

Week 5: Types of infinity

Week 6: Mathematics in the sciences

Week 7: Mathematics in the arts

Week 8: Golden ratio and the Fibonacci numbers

Week 9: Time and the 4th dimension

Week 10: Modular Arithmetic

Week 11: Pascal's Triangle

For "The Universe in Zero Words," the whole course was based on the book of the same title by Dana Mackenzie, 2012.

Description: this course examines some equations that are important in the history of mathematics. These will range from the simple $1 + 1 = 2$ to the famous $E = mc^2$, including among others the Pythagorean Theorem and the Black-Scholes equation for financial derivatives.

For each equation, or as many as we have time for, we will discuss the notation, the concepts involved, its historical context, and its practical or theoretical significance. Where suitable, we will illustrate the equation with some sample calculations. Only grade 12 math will be assumed.

Dror's Comments. Both were given before as PMU seminars.

A Proposal by Robert McCann.

Course title: 199H Aha! Mathematical Discovery and Creative Problem Solving
Previous version: http://www.math.toronto.edu/mccann/199

Text: Burger & Starbird "The Heart of Mathematics. 4th Ed." Wiley 2013
Handouts from "In process" by Peter D Taylor (Queen's University)

This course is an exploration into the creative process and use of imagination as they arise in the context of mathematical problem solving. The problems, which are all at a pre-calculus level, are chosen primarily by the criterion of aesthetic appeal, and emphasize reasoning rather than technique. Still, many of them are quite challenging, and substantial independent thinking will be required. The course is therefore appropriate for students from a variety of backgrounds and disciplines. Its goal will be to hone each participant's creativity and mathematical problem-solving skills while guiding them towards the `Aha!' experience which accompanies independent discovery.

In addition to weekly problem sets, the course will require students to make regular journal entries and complete an independent written project of 6-8 pages.

2017 SYLLABUS
PMU 199H1S LEC 0291 Aha! Mathematical Discovery and Creative Problem Solving

Week; topics from Burger and Starbird's "The Heart of Mathematics" 4th Ed.

COUNTING

1 S2.1 The pigeonhole principle, estimation, and quantitative reasoning:
``Are two non-bald people alive with the same number of body hairs''

2 S2.3, 2.6-2.7 Primes, rationals, irrationals and real numbers

INFINITY

3 S3.1-3.3 `The buddy system:' uncountability of the the irrationals

GEOMETRY AND TOPOLOGY

4 S5.1-5.2 Topological equivaluence; Mobius strips; classifying surfaces

5 S4.5, 6.2 Platonic solids and the Euler characteristic proof
that there are only five. (S5.4 in 3rd Ed.)

ENUMERATIVE GEOMETRY AND COMBINATORICS

6 Cut Plane: "Space can be divided into two regions by a single plane,

four regions by a pair of planes, and eight regions by using three planes. What is the maximum number of regions that space can be divided into by using k planes?"

OPTIMIZATION

7 The spider and the ant: "A spider and an ant occupy a 12 x 12 x 24 room. If the spider is in one corner of the room, where should the ant position himself to maximize his crawling distance from the spider? The opposite corner is a an obvious guess, and is the farthest point away as the crow flies. But a spider is not a crow..."

FRACTALS

8 S7.1-7.5 Iterated maps; Cantor middle thirds set; fractal dimension Complex numbers; complex dynamics; Julia and Mandelbrot sets

PROBABILITY AND STATISTICS

9 S8.1-8.2 The Monte Haul problem: Let's make a deal

10 S8.4-8.5 Coin tossing experiments, probability and risk, Bayesian inference

11 S2.2 Patterns and proofs

DECISION THEORY AND SOCIAL CHOICE

12 S10.5 Fair-allocation of scarce resources: envy-free divisions

Dror's Comments. Was given before as a PMU seminar, got excellent reviews.

Two Proposals by Nick Derzko.

Dror's Comments. Both were given before as PMU seminars. Find them at http://drorbn.net/AcademicPensieve/Projects/UChair/FYF/Derzko-MathematicsInCurrentEvents.pdf and at http://drorbn.net/AcademicPensieve/Projects/UChair/FYF/Derzko-MathematicsInTheNewsForScoialScienceStudents.pdf.

A Proposal by Sarah Mayes-Tang.

I have a complete syllabus for the course, so I could give more information if needed. Since I target my course materials to students, I based the description on the cryptological systems rather than the mathematical tools that underlie them. The textbook for the course was The Mathematics of Encryption by Margaret B. Cozzens and Steven J. Miller with some additional supplemental readings.

Title: Cryptology: The Mathematics of Secrecy and Security (subtitle optional, but I think it attracted students).

Description:

How do we send our own confidential information through secure channels, and how can we break codes to uncover the secret information of our adversaries? The mathematical field of cryptology is dedicated to answering such questions. In this course we will study breakthroughs in cryptology, from secret messages in the ancient world and the Enigma cipher in World War II, to modern cryptosystems that facilitate online commerce. Along the way, you will develop a sophisticated understanding of how numbers interact and develop the ability to communicate messages secretly and mathematics clearly.

Big Topics:

For each system, you will work to understand how the system is used to communicate secret messages, evaluate the security of the system, and find ways of breaking the system. The development of course topics is approximately chronological, beginning with ancient systems and culminating in the systems that are currently used to keep our data safe. The systems that we study will fall into the following categories:

* Monoalphabetic substitution ciphers (e.g. Caesar shift, affine, keyphrase substitution) • Polyalphabetic substitution ciphers (e.g. Vigenere, Enigma)

• Polygraphic substitution ciphers (e.g. Polybius, Hall)
• Advanced encryption standard

• Public key cryptography (e.g. RSA, Diffie-Hellman key exchange)

Big Learning Goals:

1. understand the value of having different methods of encryption, including both private key and public key methods
2. identify multiple methods for encrypting and decrypting messages
3. understand how tools from mathematics are used to make and break cryptographic systems
4. analyze and evaluate the strengths and weaknesses of a given cryptographic system
5. construct and communicate rigorous mathematical arguments
6. connect the study of cryptology to significant events in history and the modern world
7. identify how cryptology is used in contemporary daily life
8. come to see yourself as a capable user of mathematics
9. value understanding why mathematical and quantitative concepts make sense
10. be able to read mathematical and quantitative texts independently for learning
11. understand the necessity of solving a variety of problems to gain understanding

Dror's Comments. Not given before at UofT.

An Idea by Bernardo Galvao-Souza.

Hi Dror,

A friend of mine teaches a course called "Mathematics through interesting problems".

Here is the first problem in her class:
Each class the students work in groups of 4.
Create a schedule so a student never works with the same person twice.

Let me know if you're interested in such a course and what is needed if so.

Best,
Bernardo

An Idea by Matilde Marcoli.

Hi Dror,

As I mentioned I can do one on this book:
http://www.its.caltech.edu/~matilde/LumenNaturaeMITPress.pdf
I would prefer to do it once the book is in print so I can use it as textbook (it will take at least a year before it appears because of clearing the permissions for the images, sigh!)

Best,
Matilde

Ideas by Mary Pugh.

Title: Topics in Mathematics
Description: Offered in the Winter semester, this is a course in mathematics on a topic outside the current undergraduate offerings.
Students must be concurrently enrolled in MAT137Y1 or MAT157Y1. Admission into the course will be based on an application and on Fall marks in linear algebra and Calculus. For information on the specific topic to be studied and possible additional preqrequisites, go to http://www.math.toronto.edu/cms/current-students-ug/
<The course would count towards any of our specialist programs, towards our major, and towards our minor.>

Separately, I'd suggest that we create the following two FYFs

"Strategy, Voting, Power and Proof"
How are the Cuban missile crisis and the opera “Tosca” related? (Who is John Nash and why did he win a Nobel prize in 1994?) How is the process to amend the Canadian constitution similar to the UN Security Council? Would you ever choose to have a dictator? How did eBay choose their method of auction? (Who are Daniel Kahneman and Vernon Smith and why did they win a Nobel prize in 2002?). In this seminar course, we will use mathematics to study topics in political science: escalation, conflict, voting, political power, and social choice. Calculus is not a prerequisite. This course may be of particular interest to students in political science, economics, business, and psychology, but all students are welcome.

"Magic and Mathematics"
In this course we will look at magic tricks! Not just any magic trick, but ones that involve only Mathematics and maybe a flair for the presentation.
Some magic tricks involve only elementary Mathematics, others involve very deep Mathematics. In the discussions, we will talk about the tricks and the Mathematics behind them.

Idea by Mary Pugh.

Convert JUM202, JUM203, and JUM205 into FYFs. These were joint UC (University College) and math courses (taught most recently by Soheil Homayouni), but UC lost interest and now they are orphaned. The calendar descriptions are:

JUM202H1 - Mathematics as an Interdisciplinary Pursuit

Hours: 24L/12T

A study of the interaction of mathematics with other fields of inquiry: how mathematics influences, and is influenced by, the evolution of science and culture. Art, music, and literature, as well as the more traditionally related areas of the natural and social sciences may be considered. (Offered every three years)

JUM202H1 is particularly suited as a Science Distribution Requirement course for Humanities and Social Science students.

Exclusion: JUM102H1

Distribution Requirements: Science

Breadth Requirements: The Physical and Mathematical Universes (5)

JUM203H1 - Mathematics as a Recreation

Hours: 24L/12T

A study of games, puzzles and problems focusing on the deeper principles they illustrate. Concentration is on problems arising out of number theory and geometry, with emphasis on the process of mathematical reasoning. Technical requirements are kept to a minimum. A foundation is provided for a continuing lay interest in mathematics. (Offered every three years)

JUM203H1 is particularly suited as a Science Distribution Requirement course for Humanities and Social Science students.

Exclusion: JUM103H1

Distribution Requirements: Science

Breadth Requirements: The Physical and Mathematical Universes (5)

JUM205H1 - Mathematical Personalities

Hours: 24L/12T

An in-depth study of the life, times and work of several mathematicians who have been particularly influential. Examples may include Newton, Euler, Gauss, Kowalewski, Hilbert, Hardy, Ramanujan, Gödel, Erdös, Coxeter, Grothendieck. (Offered every three years)

JUM205H1 is particularly suited as a Science Distribution Requirement course for Humanities and Social Science students.

Exclusion: JUM105H1

Distribution Requirements: Science

Breadth Requirements: The Physical and Mathematical Universes (5)