University of Toronto Mississauga

MAT392H5S: Ideas of Mathematics, Winter 2019

Second essay

Due dates.

- Your essay topic is due by Tuesday February 26th.
- Be ready to write one paragraph about the topic of your essay as an in-class assignment on Thursday February 28th.
- Oral presentations will take place in the second half of March.
- Submit a complete draft in good shape on Thursday March 7. Prepare 9–12 pages (counting references, not counting diagrams and graphics). Use LaTeX. Submit three hard copies (of only the PDF, preferably double-sided) in class, and submit the LaTeX and PDF files on UTORsubmit.
- Submit the final version on Monday April 1st. Submit one hard copy (preferably double-sided) in the tutorial, and submit the LaTeX and PDF files on UTORsubmit.

Topic/partner.

- You can write the essay on your own or with a partner, but not with the same partner as for the first essay. Partners receive the same mark.
- A list of suggested topics is linked from the course website. With your partner, register in one slot on the doodle poll that is linked from the course website.
- Authors with the same topic will coordinate or combine their presentations. At most two essays can be on the same topic.

Bibliography.

- Choose sources that contain enough mathematical content at a reasonably accessible level.
- Use at least two and no more than eight sources that have been published in print – books or articles, no theses.
- At most two of your sources can be Wikipedia pages, of your choice. You may not use other online courses. (Wikipedia can be useful for finding published sources.)
- Exceptions are allowed only with the instructor's permission.
- Record every source; see the examples on the LaTeX samplefile on the course website. If you use graphics from the web, cite the source in a footnote.

The essay.

- Your audience is your fellow students.
- Use your own voice. Make several iterations of thinking, rewriting in your own words, reorganizing. Stand behind what you write.
- These topics are wide. Try to grasp some of the big picture. Include some important aspects of the topic. Include a helpful example.
- Explain (some of) the mathematics, don't just tell about it. Include some rigorous math content: a bit of logical reasoning; a precise definition/statement/example that is relevant. Also include some informal discussion of background/context/history/importance.
- You will encounter vocabulary that you don't understand. When you do, identify it, and use it cautiously. You must stand behind what you write.
- Your mathematics will be marked according to the following criteria: clarity; correctness; depth; logic.
- Your writing will be marked according to the following criteria: clarity; voice; overall structure; grammar; sources and documentation; typesetting and LaTeX.

MAT392, Winter 2019
Essay 2 – suggested topics and references

Note: you do not have to choose one of the topics listed below, and if you do, you do not have to cover the particular material suggested by the references.

- Mathematics in the Animal World
  - S. M. Henson and J. L. Hayward, "The Mathematics of Animal Behaviour: an Interdisciplinary Dialogue", Notices of the Amer. Math. Soc. 57 no. 10 (2010), p. 1248–1258, and works cited.
  - The above is only one of many possible themes. See also: symmetries in nature (honeycombs, seashells...), modeling flocks of birds and other collective behaviours, etc.
- Mathematics in Art
  - Hermann Weyl, "Symmetry", in "The World of Mathematics" (Ed.: J. R. Newman).
  - "Math and Art", chapter in "The Princeton Companion to Mathematics" (Ed.: Gowers), and works cited.
  - Huntley, "The Divine Proportion".
  - "Artful Mathematics: The Heritage of M. C. Escher", Notices of the Amer. Math. Soc. 50 no. 4 (2003), p. 446-451, and works cited.
- Classical Mechanics
  - Goldstein, "Classical Mechanics".
  - The Feynman Lectures on Physics, Volume 1. Available online.
- Two Dimensional Crystallography ("Wallpaper Groups")
  - Coxeter, "Introduction to Geometry" (2nd edition).
  - Branko Grunbaum, "Tilings and patterns".
  - Conway, Burgiel, and Goodman-Strauss, "The Symmetries of Things".
  - Coxeter and Moser, "Generators and relations for discrete groups", 1957.
- Mathematical Finance
  - Robert Almgren, "Financial derivatives and partial differential equations", Amer. Math. Monthly 109 no. 1 (2002), p. 1–12.
  - Martin Baxter and Andrew Rennie, "Financial Calculus: An Introduction to Derivative Pricing".
  - Samuel A. Broverman, "Mathematics of investment and credit".
- Knot Theory
  - Colin Adams, "The Knot Book".
  - De Witt Sumners, "Lifting the Curtain: using topology to probe the hidden action of enzymes", Notices Amer. Math. Soc. 42 no. 5 (1995), p. 528–537, and works cited.

- Mathematics in Linguistics
  - Frederic Mosteller and David L. Wallace, "Deciding authorship", in "Mathematics: People, Problems, Results" Volume III (Ed.: D. M. Campbell and J. C. Higgins), p. 164–172.
  - Barbra Partee, Alice ter Meulen, an Robert E. Wall, "Mathematics methods in linguistics".
  - Keith Devlin, "Patterns of Language" in "Mathematics, the Science of Patterns: the search for order in life, mind, and the universe", 1994, p.65–71.
- Mathematics in Medicine
  - J.W. Cain, "Taking Math to Heart: Mathematical Challenges in Cardiac Electrophysiology", Notices Amer. Math. Soc. 58 no. 4 (2011), p. 542–549.
  - J.P. Keener and J. Sneyd, "Mathematical Physiology", Springer-Verlag, New York, 1998.
- Mathematics in Music
  - Article by Henri Matin in "Mathematics: People, Problems, Results" (Ed.: D. M. Campbell and J. C. Higgins), 1984.
  - Catherine Nolan, "Mathematics in Music", in "The Princeton Companion to Mathematics", (Ed.: Gowers), 2008.
  - Article by Sir James Jeans in of "The World of Mathematics" Volume IV (Ed.: J. R. Newman).
- Origami
  - David Auckly and John Cleveland, "Totally real origami and impossible paper folding", American Mathematical Monthly, 102 no. 3 (1995), p. 215–226.
  - Thomas Hull, "A note on impossible paper folding", American Mathematical Monthly, 103 no. 3 (1996), p. 240–241.
  - E. Demaine and J. O'Rourke, "Geometric Folding Algorithms: Linkages, Origami, Polyhedra", Cambridge, 2007.
- Population Dynamics
  - Britton, "Essential Mathematical Biology".
  - Textbooks on Ordinary Differential Equations, and mathematical modeling in Biology or Ecology.
- Rainbows
  - Tricker, "Introduction to Meteorolical Optics", Elsevier, 1970.
  - Nussenzveig, "The theory of the rainbow", Scientific American, 1977.
- Rubik's Cube
  - David Joyner, "Adventures in Group theory".
  - Donald E. Knuth, "Efficient representation of permutation groups", "Combinatorica" 11 no. 1 (1991), p. 33–43. (This is a more abstract description of the relevant algorithm, and might not address individual puzzles.)

- Mathematics in Sports
  - Rob Eastaway and John Haigh, "How to take a penalty" – see the appendix.
  - Sadovskii and Sadovskii, "Mathematics and sports".
  - Gallian (Ed.), "Mathematics and Sports", Mathematical Association of America.
  - Gould, "Mathematics in games, sports, and gambling".
  - Townend, "Mathematics in Sports".
  - Winston, "Mathletics", Princeton University Press, 2009.

  Warning: this is not as easy a topic as it might appear! It is not enough to present calculations. You need to include mathematical content above the level of arithmetic.

- Traffic flow
  - Barbara Keyfitz, "Hold that light! Modeling of traffic flow by differential equations". Available online.

- Wavelets
  - Ingrid Daubechies, "Ten Lectures on Wavelets".

- Other (Option 1, with instructor permission). Consider applications of mathematics in another field of study. For example:
  - Chemistry (spectroscopy, molecular structure, ...)
  - Computer Science (algorithm design and optimization, cryptography, ...)
  - Economics (game theory and decision-making, modeling the financial market, ...)
  - Physics (electrodynamics, quantum mechanics, statistical mechanics, ...)
  - Something else?

- Other (Option 2, with instructor permission). Choose another mathematical object, theorem, or field of study, and describe some of its applications. For example:
  - Analytic Geometry
  - Functions of a Complex Variable
  - Ordinary Differential Equations
  - Vector Calculus
  - You can choose a topic from the list of "What is..." topics, so long as it is not the same one you used for the first essay.