Math, Music and Memory

MONT 106Q, MWF 10:00 - 10:50, Brooks Center 454, Fall 2014

Professor Gareth Roberts

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Office Hours: Mon. 2:00 - 3:00, Wed. 2:00 - 3:00, Thurs. 1:00 - 2:30, Fri. 1:00 - 2:00, or by appointment.

Required Texts: *A First Course in Math and Music*, GR (chapters distributed via Moodle); *Musicophilia*, Oliver Sacks; *Unbowed*, Wangari Maathai; *Our Town*, Thornton Wilder; *The Vintage Book of Amnesia*, Jonathan Lethem, ed. You should also purchase some staff paper, e.g., the *Music Tablet*, available at the college bookstore.

Webpage: `http://mathcs.holycross.edu/~groberts/Courses/Mont1/homepage.html`
Homework assignments, handouts, schedule changes, exam materials, useful links and other important information will be posted at this site. Please bookmark it! The course page on Moodle will primarily be used for listening to audio files. It will also have chapters from my upcoming book *A First Course in Math and Music*, which will serve as the primary textbook for the class.

Common Area Designation: Mathematical Science

Cluster Theme: (Core Human Questions) Given that we need to remember, but tend to forget, how then shall we live?

Course Content: This is an interdisciplinary course exploring some of the connections between mathematics and music. This semester will focus on links from a structural perspective. For instance, both fields use a specialized form of notation to communicate their ideas. Each subject has its own logical structure and set of axioms finely tuned over centuries of study. Students in high school geometry learn the axiomatic technique of Euclid to write their first proofs, just as music theory students learn compositional techniques such as avoiding parallel fifths and octaves. Mathematicians use numbers as the invariant building blocks of their theory as musicians use pitch as the common denominator of their creations. While the number three has the same abstract meaning to mathematicians everywhere, the concert pitch A440 used to tune modern orchestras is a global standard.

One goal of the course is to apply mathematical concepts and techniques to gain a deeper insight into how music works. Some of the kinds of questions we will investigate are: Why are there twelve notes in the Western classical octave? How do we tune our instruments? Why do some combination of pitches sound more pleasing to our ears than others? How do we perceive sound and pitch, and what role does our memory play in that process?

We will also investigate the role that music and mathematics has in driving memory. For instance, elder patients suffering from Alzheimer's disease and severe memory loss have demonstrated massive responses to personalized playlists intended to stimulate brain activity. Why is this the case? How does having a good "working memory" make us better problem solvers? We will also consider what effect, if any, working through daily math puzzles or playing a musical instrument has on the brain.

The pertinent mathematical and musical concepts will be developed as the need arises. Musical topics to be considered include basic music theory (notation, rhythm, time signatures, pitch, scales, intervals, circle of fifths, chords, progressions), different tuning systems, and the overtone series. Mathematical topics to be covered include graphing functions, trigonometry, logarithms, equivalence relations, modular arithmetic, rational and irrational numbers, and continued fractions.

A tentative outline of the course is given below. We will cover the first four chapters of *A First Course in Math and Music.* In addition, a few days have been reserved for a course lab using a monochord, as well as some guest lectures.

- Introduction to the course and Montserrat (1 class)
- Book Discussion: *Unbowed* (3 classes)
- Rhythm: time signature, geometric series, polyrhythms, least common multiple (4 classes)
- Introductory Music Theory: notation, scales, circle of fifths, major and minor keys, intervals, tonality, transposition (6 classes)
- Guest Lecturer: Liz Lerman (Math and movement), October 3
- Exam I (in class)
- The Science of Sound: how we hear, the ear-brain system, attributes of sound, sine waves, understanding pitch, a vibrating string, the overtone series, beats, the monochord lab (6 classes)
- Guest Lecturer: Cristina Pato (The sounds of the Galician bagpipe), November 5
- Book Discussion: *The Vintage Book of Amnesia* (3 classes)
- Tuning and Temperament: the Pythagorean scale, just intonation, equal temperament, cents, rational and irrational numbers, alternative tuning systems (5 classes)
- Exam II (in class)
- Book Discussion: *Our Town* (3 classes)
- Memory and the Brain: the music-memory connection; does math improve your memory or does memory improve your math? (2 classes)
- Final Exam (Cumulative)

Course Objectives: 1. Investigate the multiple connections between mathematics and music.

2. Develop skills in critical thinking, abstract reasoning and argumentative writing.

3. Develop an understanding of music theory and a deeper appreciation for music.

4. Integrate your artistic and analytical skills.

5. Have FUN while learning.

6. Participate in and contribute to the common events, lectures, etc. of the Core Human Questions Cluster.

Important Dates: The following are key events happening on campus that you are expected to attend. Other cluster events will be announced in class.

- Presentation: *Plant a Seed, Change the World: HC Alumni Contributions to the Environment*, Thurs., Sept. 11, 6:30 - 8:00 pm, Hogan Ballroom
- Performance and Panel Discussion: *Time, Memory, Identity*, Cristina Pato & Osvaldo Golijov, Tues., Sept. 23, 7:00 pm, Brooks Concert Hall
- Lecture/demonstration: Mark O'Connor, Mon., Nov. 17, 12 - 1:30 pm, Brooks Concert Hall
- Artists-in-Residence Concert: *Expressions of Time and Timelessness*, Tues., Dec. 2, 7:30 pm, Brooks Concert Hall

Homework/Written Assignments: Homework will be assigned on a regular basis. Assignments will be posted on the course web page or distributed in class. While you are allowed and encouraged to work on homework exercises with your classmates, the solutions you turn in to be graded should be your own. Take care to write up solutions **in your own words**. There will also be a few written assignments related to the cluster common readings. In order to assess the progress of student writing over the course of the year, we will be collecting your first argumentative writing sample from this course, and your last argumentative writing sample next spring. On all assignments, plagiarism will not be tolerated and will be treated as a violation of the Departmental Policy on Academic Integrity.

Concert Reviews: You are required to attend two musical performances during the semester and turn in a typed, 1-2 page review of each concert. The purpose of these reviews is to enhance your musical appreciation, to support your fellow students and the arts, and to notice and describe any possible connections to course material. Your review should include basic information about the concert (location, date, performers, pieces, composers, etc.), your opinion of the concert (strengths and weaknesses) and some connection to course material. A schedule of upcoming concerts is linked from the course homepage.

Exams: There will be 2 in-class midterm exams (tentative dates below) and a comprehensive final at the end of the semester. We will review for each midterm during the class period before the exam. If you have any specific learning disabilities or special needs and require accommodations, please let me know early in the semester so that your learning needs may be appropriately met. You will need to contact the director of Disability Services in Hogan 215 (x3693) to obtain documentation of your disability.

	Exam 1	Fri., Oct. 24	10:00 - 10:50 am
Exam Schedule:	Exam 2	Mon., Nov. 24	10:00 - 10:50 am
	Final	Tues., Dec. 16	8:00 - 10:30 am

Academic Integrity: The Department of Mathematics and Computer Science has drafted a policy on academic integrity to precisely state our expectations of both students and faculty with regards to cheating, plagiarism, academic honesty, etc. You are required to read this policy and sign a pledge agreeing to uphold it. A violation of the Departmental Policy on Academic Integrity will result in a 0 for that assignment (or exam) and a letter describing the occurrence of academic dishonesty will be sent to your Class Dean.

Grade: Your course grade will be based on the following breakdown:

- classroom participation/interest 5%
- concert reviews 5%
- homework (including any labs, worksheets or written assignments) 35%
- midterm exams 30%
- final exam 25%

How to do well in this course:

- Attend class, participate and ask questions. Be an engaged learner.
- Do your homework regularly.
- Work with your classmates.
- Ask for HELP when necessary.

Other Courses in our Cluster:

- Lisa Fluet – *Literatures of Loss, Forgetting and Forgetfulness*
- Peter Fritz – *Art's Birth and the Power of God*
- Robert Garvey – *Farming and/or Food Industry?*
- Edward Isser – *Staging Memory*
- Ellen Perry – *The Ideological Destruction of Art*

May not Music be described as the Mathematic of Sense, Mathematics as the Music of reason? The soul of each the same! Thus the musician feels Mathematic, the mathematician thinks Music, — Music the dream, Mathematic the working life, — each to receive its consummation from the other.

James Joseph Sylvester, 1865