Math, Music and Identity

MONT 107Q, MWF 10:00 - 10:50, Brooks Center 454, Spring 2015

Professor Gareth Roberts

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Office Hours: Mon., Wed., Fri. 11:00 - 12:00, Tues. 10:00 - 11:30, or by appointment.

Required Texts: *A First Course in Math and Music*, Gareth Roberts (Chapters 5–8 distributed via Moodle); *One Hundred Years of Solitude*, Gabriel García Márquez; *Musicophilia*, Oliver Sacks; *The Penguin Book of First World War Poetry*, ed. by George Walter.

Webpage: `http://mathcs.holycross.edu/~groberts/Courses/Mont2/homepage.html`
Homework assignments, handouts, lecture notes, exam materials, paper information, 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: At first glance, mathematics is often considered a "hard" science while music is deemed a staple of the humanities. However, in addition to the many structural connections between the two disciplines (discussed last semester), there are also many aesthetic and artistic links. For example, both fields have produced great child prodigies (for example, Mozart and Gauss). Parents play Mozart and Bach to their children, even in the womb, to help foster their brain development and analytic skills. Many mathematicians are outstanding musicians, while many musicians, in particular composers, possess sharp mathematical minds. Scholars often speak of the "beauty" and "purity" of mathematics, although the same lofty descriptions could equally apply to music. While music has the obvious capacity to move the spirit, great mathematical discoveries and insights are often accompanied with an overwhelming sense of elation. The mathematician Andrew Wiles wept on camera while speaking about his incredible proof of Fermat's Last Theorem.

Many composers use mathematical concepts in their music, and in the process, reveal a good deal about their identity and beliefs. For instance, Bach frequently used mathematical operations such as translations and reflections in his fugues to create wonderfully rich counterpoint. His *Musical Offering* to the King of Prussia was basically a math-music puzzle, one that had many hidden messages (some not so hidden, some possibly theological) that poked fun at the King. Another example, quite controversial, is the purported use of the Fibonacci numbers and the golden ratio by Hungarian composer Béla Bartók in some of his pieces. Bartók had an avid interest in nature and folk music, and knew of the connection between the Fibonacci numbers and nature (a connection we will explore). Other examples where mathematics arises in a revealing musical context include

change (bell) ringing, where symmetry and group theory play a prominent role, and the stochastic music of Xenakis, featuring probability theory and calculus.

This course will explore the myriad of ways composers have used mathematical thinking to create meaningful music, and the implications of these choices. We will consider many examples, learning and utilizing the mathematical concepts involved in order to gain a deeper understanding of the music as well as the composer.

A **tentative** outline of the course is given below. We will cover Chapters 5 through 8 of *A First Course in Math and Music*.

- Introduction: course overview (1 class)
- Book Discussion: *One Hundred Years of Solitude* (3 classes)
- Musical Group Theory: symmetry, group theory, symmetries of the square, examples (5 classes)
- The Golden Section: Fibonacci numbers, nature, the Bartók controversy, Mozart (6 classes)
- Change (Bell) Ringing: basic rules and terminology, examples of extents, more group theory (4 classes)
- Book Discussion: *Musicophilia* (3 classes)
- Midterm Exam (in class)
- Modern Mathematical Music: Schoenberg (twelve-tone method), Davies (magic squares), Reich (phase shifting), Xenakis (stochastic music) (6 classes)
- Britten's *War Requiem* and WWI Poetry (3 classes)
- Final Project preparation (3 classes)
- Final Project presentations (3 classes)
- Final Class: Math & Music in the Movies

Course Objectives:

1. Investigate the multiple connections between mathematics and music.
2. Develop skills in critical thinking and abstract reasoning.
3. Develop 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.

Homework: Homework will be assigned on a regular basis, although there will be fewer assignments this semester due to the importance of the final project. Assignments will be posted on the course web page. 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. 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. **Note:** These reviews will be due within two weeks of the 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 current or past (last semester) course material. A schedule of upcoming concerts is linked from the course homepage.

Midterm Exam: There will be one midterm exam given during class, tentatively scheduled for Wednesday, March 25. We will review for the 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.

Research Paper: There will be a substantial research paper assigned due just after Easter break. The paper will focus on one composer and a particular piece (or set of pieces) written by that composer demonstrating some mathematical concept or technique. Your paper will feature an historical element as well as an investigative component analyzing the work(s) in question.

Final Project: You will be expected to complete a final project consisting of a musical composition and performance demonstrating some of the mathematical concepts learned in the course. A brief, typed report should accompany your composition explaining the mathematical connections and rationale in your work. You will also give a brief presentation describing the work immediately before its performance. The performances will take place during the last full week of the semester. A few class periods will be allocated for feedback and constructive criticism before the final performances.

Important Dates: The following are **required** events – other events to be announced shortly:

- *The Camino Experience: Making the Way*, featuring Cristina Pato: Wednesday, February 4, 7:00 pm, Mary Chapel
- Montserrat Debate Night: Thursday, March 19, 6:30 - 8:30 pm, Hogan
- *Boston Music Viva*, featuring the world premiere of Shirish Korde's *Kala-Chakra* (Cycles of Time): Monday, April 13, 8:00 pm, Brooks Concert Hall

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 written assignments) 25%
- research paper 15%
- midterm exam 20%
- final project 30%

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 Preservation and Memory*
- Peter Fritz – *The End of Art and the Death of God*
- Robert Garvey – *Community and/or Me?*
- Edward Isser – *Staging Identity*
- Ellen Perry – *Stolen History: Looting, Nationalism, War and the Archaeological Record*

> *Mathematics and music, the most sharply contrasted fields of scientific activity which can be found, and yet related, supporting each other, as if to show forth the secret connection which ties together all the activities of our mind, and which leads us to surmise that the manifestations of the artist's genius are but the unconscious expressions of a mysteriously acting rationality.*
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> — Hermann von Helmholtz, 1884