Course: M 118 Sec. 01 (CRN 75091) 3 cr., Autumn 2016
Mathematics for Music Enthusiasts
T, Th 11:00am–12:20pm in MATH 306

Instructor: Mark Kayll

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Office: MATH 209
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Hours: M 2:00–2:50pm, Th 12:20–1:10pm & by appointment
(*tentative*) (open for all course matters, including DSS accomm.)

Prerequisites: either: M 090 (MAT 005, Introductory Algebra) with a minimum B− grade;
or: M 095 (MAT 100, Intermediate Algebra); or: ALEKS placement score ≥ 3;
and: elementary music background, plus an open mind.

Text: *The Math Behind the Music*, L. Harkleroad, Cambridge Univ. Press, 2006 [978-0-521-00935-5]

Material: Three separate units, based on: Numbers & Music; Mathematics & Music; Logarithms & Music. We'll use portions of the text together with handouts.

Important Dates:

Labor Day Holiday	Monday, 5 September;
last day to add by Cyberbear	Wednesday, 7 September (5pm);
last day to drop by Cyberbear,	
or select Audit grade option	Monday, 19 September (5pm);
last day to add/drop by paper form	Monday, 31 October (5pm);
Election Day (no classes)	Tuesday, 8 November;
Thanksgiving vacation	23–25 November;
last day to add/drop by petition	Monday, 12 December (5pm);
Last class meeting (during finals)	Wednesday, 14 December 10:10am–12:10pm.

Description: Course topics revolve around the interplay and connections between mathematics and music. Here are some example questions to be considered: Why are there circles of fifths and fourths but not thirds or tritones?; What is equal temperament?; How is the chromatic scale related to modular arithmetic?; How is the musical staff like a logarithmic scale for pitch?; How are overtones related to the integers?; How does harmony derive from the overtone series?; What are the mathematical relationships between pitches in consonant intervals and chords?; What are the historical obstacles (going back to the Greeks) to tuning a musical scale that gives a mathematically precise harmony in all keys?

If any of these questions intrigue you, and you are looking to satisfy your general education mathematical literacy requirement, then this is the course for you.

Key musical and mathematical concepts will be introduced/reviewed as they are encountered.

Abbreviated learning outcomes: The 'official' outcomes below are reflected in the description above; see the instructor for the full (unabbreviated) list.

1. Understand the elementary number theory governing the possibilities for musical circles (of fourths, fifths, etc.).
2. Learn the relationship between the overtone series in music and the set of positive integers; understand how this impacts the mathematical relationships between pitches in consonant intervals and chords.
3. Understand mathematics underlying musical tuning systems, particularly Pythagorean tuning and equal temperament (but not necessarily limited to these two systems). Gain facility in computing frequency ratios between musical intervals in different tuning systems; be able to compare and contrast tuning systems mathematically. Become familiar, mathematically, with the Pythagorean comma, and gain awareness of other musical commas.
4. Learn the mathematics behind the placement of frets on a fretted instrument. Apply this knowledge toward the solution of problems in luthier design.
5. Gain an elementary understanding of the mathematics governing the music compositional transformations of transposition (T), inversion (I), and regression (retrograde) (R).
6. Learn how to convert between frequency ratios (of musical intervals) and semitones or cents (as two common measures of musical differences). Learn the three basic laws of logarithms. Apply these laws to solve equations involving exponentials and logarithms. Express the reason why musical intervals are additive in terms of the addition law of logarithms.

Class attendance & activities: Attendance is taken and contributes to the "in-class work" portion of the grade. Class activities include: discussion, group work, and lectures. Often group work consists of worksheets which also contribute to the "in-class work". Participation is necessary; learning mathematics is similar to learning to play a musical instrument or a new sport: one learns by *doing*, not by watching.

Readings: *Reading the text and handouts is essential for this course.* Short, <u>possibly unannounced</u>, quizzes based on the readings will be given.

Homework: Problems are assigned based on the in-class work. Solution keys are distributed after homework is due. Homework problems are discussed regularly in class. Assignments are collected and checked, but individual problems are not normally graded. *Keep in mind that the only way to learn mathematics is to do mathematics.* This means that students should be prepared to spend some quality time outside of class on this course.

I urge you to acquire the habit of staying on schedule with your reading and homework. This helps to maximize the material you're able to absorb in class, meaning less effort preparing for tests.

Assessment: Course grades are based on homework assignments, in-class work, and three term tests. Traditional letter grades will be assigned using the $+/-$ system (see *UM catalog* at `www.umt.edu/catalog/academics/academic-policy-procedure2.php`). UM's policy on Incomplete grades will be followed (see *UM catalog*).

***Tentative* grading schedule:**

Item	Date(s)	Weight
Homework	30 August — 8 December	20%
In-class work	30 August — 8 December	20%
Test # 1	Thursday, 29 September	20%
Test # 2	Thursday, 3 November	20%
Test # 3	Wednesday, 14 December	20%

Accommodation: The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you think you may have a disability adversely affecting your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or 406.243.2243. The instructor will work with you and Disability Services to provide an appropriate modification.

General Remarks

On credit: If you're taking this course as a general education requirement, you must choose 'traditional letter grade', not cr/ncr. The 'D−' grade is considered passing and earns course credit, but it does *not* fulfill the Gen Ed requirement. A minimum grade of 'C−' is needed to fulfill the Gen Ed math literacy requirement.

On homework: You may work with others on homework problems, and you are encouraged to do so; however,

Solutions should be written down privately in your own words.

On tests: Each test is based on the material from the corresponding unit (i.e. no cumulative tests).

On make-ups: Make-ups for tests will *not* be given unless there is a valid excuse cleared with the instructor *prior* to the test. At least one of your most detrimental homework/in-class work scores will be dropped; thus, there are no make-ups for quizzes, homework, or class work.

On deadlines: Any stated deadlines are firm; please do not ask for extensions.

On electronic devices: Cell phones must be silenced during class meetings and visits to my office. Use of a cell phone during a test for any purpose other than as a calculator is grounds for earning a zero score on that test.

On conduct: All students need to be familiar with the Student Conduct Code; it can be found in the 'A to Z Index' on the UM home page. All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the university.