Spring 2-1-2022

M 118.01: Mathematics for Music Enthusiasts

Mark Kayll

University of Montana, Missoula, mark.kayll@umontana.edu

Course: M 118 Sec. 01 (CRN 34149) 3 cr., Spring 2022
Mathematics for Music Enthusiasts
T,Th 11:00am–12:20pm in MATH 211

Instructor: Mark Kayll   **Econtact:** mark.kayll@umontana.edu
                            umontana.zoom.us/j/6948539958 (in case of remote OH)
                            hs.umt.edu/math/people/default.php?s=Kayll

Office: MATH 209   **Hours:**   T,Th 1:00–1:50pm & by appointment
           406.243.2403   (*tentative*)   (open for all course matters, including ODE accomm.)

Prerequisites: either: M 090 (Introductory Algebra) with a minimum B− grade;
           or: M 095 (Intermediate Algebra); or: ALEKS placement score ≥ 3,
              M01-Maplesoft Arithmetic score ≥ 18, ACT score ≥ 22, or SAT score of ≥ 520;
           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 as well as posted readings.

Important Dates:
last day to add w/o instructor consent	Wednesday, 26 January (5pm);
last day to drop or change to Audit	Monday, 7 February (5pm);
Presidents' Day holiday	Monday, 21 February;
spring break	21–25 March;
last day to drop via Add/Change/Drop link and avoid 'WP' or 'WF'	Tuesday, 29 March (5pm);
last day to add/drop with higher approval	Friday, 6 May (5pm);
last class meeting (during finals)	Friday, 13 May ☯ 8:00–10:00am.

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?; How does a luthier decide where to place the frets?; 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?

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

Learning outcomes: (i) Gen Ed math literacy: Upon completion of the math literacy requirement, a student will be able to apply effectively mathematical or statistical reasoning to a variety of applied or theoretical problems.
(ii) Abbreviated course 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 and apply the mathematics behind the placement of frets on a fretted instrument.
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: *Completing assigned readings 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, and homework problems are discussed regularly in class. Assignments are collected and checked, but individual problems are not normally graded. Submission is electronic via `gradescope.com`, either in PDF or JPG format from your device. The course number is **354803**, with Entry Code **N8B2ZE**. You'll receive an email invite at your official UM address; follow the instructions to link to `Gradescope` and get started. Solution keys are distributed after homework is due. *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 students to acquire the habit of staying on schedule with reading and homework. This helps to maximize the material absorbed in class, meaning less effort preparing for tests.

Assessment: Grades are based on homework assignments, in-class work, and three term tests. Traditional letter grades are assigned using the $\pm$ system (see *UM catalog* @ `catalog.umt.edu/academics/policies-procedures`). UM's policy on Incomplete grades is followed (see *UM catalog*).

Tentative **grading schedule:**

Item	Date(s)	Weight
Homework	18 January — 5 May	20%
In-class work	18 January — 5 May	20%
Unit test # 1	Tuesday, 22 February	20%
Unit test # 2	Thursday, 14 April	20%
Unit test # 3	Friday, 13 May	20%

Accommodation: UM assures equal access to instruction through collaboration between students with disabilities, instructors, and the Office for Disability Equity (ODE). If you anticipate or experience barriers based on disability, please contact the ODE at 406.243.2243, `ode@umontana.edu`, or visit `www.umt.edu/disability` for more information. Retroactive accommodation requests will not be honored, so please do not delay. The instructor will work with you and the ODE to implement an effective accommodation, and you're welcome to contact the instructor privately if you wish.

Teaching modality: This course is face-to-face. The instructor is prepared to shift to Zoom should the need arise, as dictated by the pandemic status.

Moodle pages: These are located at `moodle.umt.edu/course/view.php?id=49826`. Students should check the Moodle site regularly to stay in tune with the course flow (announcements, homework, grade book, etc.).

General Remarks

On credit: If you're taking this course as a general education requirement, you must choose 'traditional letter grade', not CR/NCR. A 'D−' grade is considered passing, will earn course credit, but will *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 are *not* 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 don't ask for extensions.

On electronic devices: Cell phones must be silenced during class meetings and office visits. 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 coronavirus: Masks are required in all UM's indoor spaces (e.g. classrooms & offices); students feeling sick or exhibiting COVID-19 symptoms shouldn't attend class and instead contact Curry (CHC: 406.243.4330). UM recommends obtaining a vaccine; please visit the CHC. Students required to isolate or quarantine will receive support for continued academic progress. Specific seating arrangements may go into place; attendance/seating may be recorded photographically to support contact tracing. Consuming food or beverages in the classroom is discouraged.

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.