# CD Grant Application

**Name(s):** Lisa Nelson

**Department(s) or School(s):** School of Music

**Type of Grant Sought:** ☑ Individual ☐ Group*

*Please list additional member(s) here: _____

**Course(s):** new course: MUS 163 The Hidden Mathematics of Music

A) Have any of the applicants received funding from the Thorpe Center to develop the course? ☐ Yes ☑ No

B) Will the course use human beings as experimental subjects? ☐ Yes* ☑ No

**If yes, please explain in narrative.*

If you have questions about whether IRB approval or exemption is required for your project, please visit on "Policies and Procedures" at https://www.iwu.edu/institutional-review-board/irb-policy-procedure.pdf.

C) Will the course use animals as experimental subjects? ☐ Yes* ☑ No

**If yes, please explain in narrative.*

(See the IACUC link for protocol forms at https://www.iwu.edu/associate-provost/)

D) If your proposal is funded, would you be willing for the Thorpe Center to use it as an exemplary submission in the online Handbook? ☑ Yes ☐ No

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*Please complete the following checklist by placing a check mark against each item to ensure that your application is complete. Please note that incomplete applications will be returned to the applicant without further consideration.*

- ☑ 1. Summary of Prior CD Grants (if applicable)
- ☑ 2. Narrative (formatted as requested)
- ☑ 3. CD Budget Page
- ☑ 4. CD Grant Supervisor's Endorsement(s)

Lisa Nelson
Signature of applicant

Feb. 6, 2026
Date

Signature of Dept. Chair/Director
*(if different than applicant)*

Feb. 13, 2026
Date

**CD Grant Application for new course, *The Hidden Mathematics in Music***
**Spring 2026**
**Lisa Nelson, School of Music**

**Summary of Previous CD Grants:**

1. a. MUS 372 *Vienna, Budapest, Prague: Music, Arts, and Culture in Imperial Capitals of Central Europe*
   b. Spring 2024 through the UISFL CD grant application process: $2,000
   c. May Term 2025
   d. Part of the May Term/Summer Term courses, offered every 4 years

2. a. MUS 321 *String Pedagogy*
   b. Fall 2022: $2,000
   c. Spring 2023 and Spring 2026
   d. A requirement for BM music performance majors, offered every other spring or as needed

**Narrative**

**A. Description**

The purpose of this grant is to support the development of course materials for a new course MUS 163: *The Hidden Mathematics in Music*. This will be an interdisciplinary course exploring the connections between math and music, as well as musical expressions of specific mathematical concepts. The relationship between these two fields has been recognized since the days of Pythagoras, Plato, and Aristotle. Their similarities in sharing structure, creative thought, and beauty, and for being useful tools for each other's disciplines (music creation and analysis inspired by math, and mathematical learning promoted through music) have been widely recognized. Scale patterns, key signatures, intervals, rhythm, time signatures, tuning systems, and musical forms all have a mathematical basis, as well as using symbolic notation similar to mathematics.

The School of Music has been asked to offer a larger range of general education courses, including a class in the Formal Reasoning category. Currently, we do not offer any courses for non-majors with the kind of focus that this course would provide, i.e., one that affords students to delve into the mathematical background of a fine arts discipline. This course aims to study a number of these mathematical concepts in comparable depth and rigor to Finite Math and other Formal Reasoning course offerings. This course would be open to all IWU students, with only high school math prerequisites. It would be an additional option for students with an interest or background in music, who are looking to fulfill their Formal Reasoning requirement. A number of universities offer a class with content similar to this proposal, either in a general education course or in a more rigorous course for mathematics majors.

Note: CC has reviewed the course proposal, and it is on the consent agenda for the February full faculty meeting.

**Proposed Course Content**

Course topics will include musical structure and notation (rhythm, form, patterns) and how we experience musical sound (pitch, harmony, timbre, tuning) from a mathematical perspective.

Background and introduction (1 week)

The course will begin with a historical and cultural look at the relationship between music and math, followed by an introduction to basic musical notation (e.g., notes names and values) and a review of the mathematical concepts assumed from high school math that will be used throughout the course (e.g., sets, functions, and graphs). Much of the introduction will be discussion, based on personal experience and select short reading(s). The music and math fundamentals will be explored with a combination of traditional mini-lectures and small group work.

Pitch, melody, and harmony (3 weeks)

Pitches will be introduced as frequencies and musical intervals as associated ratios. We will use fractions, basic arithmetic operations (multiplication and division), modular arithmetic, and logarithms to represent the relationships between notes, intervals, the forming of chords, musical key signatures, and the circle of fifths.

Rhythm and the horizontal structure of music (2 weeks)

This module will focus on rhythmic durations and pitch over time. In a discussion of rhythm students will:

-learn about time signatures and note values (length of notes and rests and how they are notated)
-practice clapping rhythms to a steady beat
-review adding, subtracting, and dividing fractions
-translate note values into fractions and complete sequences with various note lengths using fractional operations
-solve equations to determine the durations of notes
-calculate sub-divisions of notes (dividing fractions)
-identify rhythmic patterns, translations, and transpositions in musical examples

Systems of tuning and the harmonic series (2 weeks)

The class will compare different tuning systems, their mathematical structures (how the pitch frequencies are determined in each tuning system), and the audible differences in their sound. This module could also include a study of overtones and wave motions. The class will produce a proof showing that tuning some Western musical instruments perfectly is impossible.

Timbre and periodic functions (1-2 weeks)
Students will divide into groups to investigate the equations for the timbre of the instrument(s) of their choice: plucked strings, bowed strings, winds, drums, and various percussion instruments. This section could contain the most challenging math, and I will have to carefully prepare the background, project instructions, and expectations to match the skill sets of the students.

Patterns and symmetry (2-3 weeks)
This module will delve into musical form, especially in examples that display symmetry and patterns. Discussion points will include the golden ratio, the Fibonacci sequence, and fractals. I can use some materials from my Gateway course for this topic.

Serialism and the graphing of musical concepts (1-2 week)
In the context of 12-tone music, the class will number the twelve notes of the Western scale; represent the order of a pattern of notes numerically, using a matrix; operate on created matrices (inversion, retrograde, translation, etc.); listen to the changes made to the tone rows; identify and analyze examples in musical compositions; and write a composition using the 12-tone principles.

**Student Learning Outcomes**
Specific student learning goals and outcomes for this course have been identified and align with the category description of Formal Reasoning. A demonstration of understanding will occur both verbally and in writing:
*Formal Reasoning Goal #1: Familiarize students with one or more formal systems.*
*Formal Reasoning Goal #2: Promote the understanding of formal systems and their use in identifying, analyzing, and solving problems.*
At its core, music almost always follows a set of rigid rules. A scientific study of the order and structure of music and sound will focus on examining and defining the concepts and rules used in musical constructs, including pitch, rhythm, timbre, and form. Students will be introduced to the definitions, theorems, and problem-solving methods needed for each topic, as well as the background needed to understand pertinent musical notation. For each of the proposed course topics, students will identify, analyze, and solve problems using mathematical formulas. Then they will use these rules to come up with music-related questions/problems and the methods in which to find solutions.

One formal system students will explore is serialism. Musical set theory provides precepts for categorizing musical concepts (such as pitch, rhythm, dynamics) and describing their relationships. In a study of 12-tone music, the class will use matrices to visualize all permutations or forms of a tone row (ordered set of 12 pitches). Students will be given rules with which to operate on the created matrices to produce inversion, retrograde, translation, and other permutations. They will listen to the changes made to the tone rows and identify and analyze examples in musical compositions. As a culminating project, each student will use the rules of

the 12-tone system to compose their own piece of music.

Another significant activity for the class is constructing a proof that some musical instruments can never be perfectly in tune. There is a serious mathematical problem with the tuning of musical instruments, one that Galileo, Newton, and Euler grappled with. Students will be introduced to the main tuning systems that were proposed to solve this problem, along with their arguments – Pythagorean tuning, just intonation, meantone temperament, and equal temperament. Students will discover why pure intervals don't fit neatly inside an octave, why all these tuning systems exist, and why pianos are slightly out of tune. A mathematical proof demonstrates that it is impossible to have a musical tuning system with both perfect octaves (2:1 ratio) and perfect fifths (3:2 ratio) simultaneously. Circling through twelve perfect fifths, one never lands on an exact octave, a contradiction known as the Pythagorean comma, the difference between twelve perfect fifths and seven octaves. Equal temperament, a tuning system that divides the octave into 12 equal intervals (which are mathematically irrational numbers), is most commonly used today.

3. *Formal Reasoning Goal #3: provide a real-world context for the use of formal reasoning.*
After the necessary musical and mathematical background is introduced for each topic, subsequent problem-solving examples will be common, relevant, and real-world music situations.
Specific examples:

1) Students may wonder why the different instruments that have played or heard in a concert/recording have different sounds (timbre). The same musical pitch sounds different when played on various instruments due to the unique mixture of higher-pitched harmonics (overtones) that create a distinct soundwave. The class will investigate the equations that relate to particular instruments and their resulting soundwaves.
2) Why does the structure of certain musical compositions sound so balanced and pleasing to the ear? The golden ratio (approx 1.618) is used in music to determine the timing of climaxes, create rhythmic patterns that feel naturally balanced, and help structure the proportions of compositions. Similarly, the Fibonacci sequence and elements of symmetry (arch form, inversions/mirroring, and repetition) can be explored in real musical examples, both visually and aurally.

4. *Formal Reasoning Goal #4: convey an appreciation of formal systems.*
Students will demonstrate an understanding of the multiple connections between mathematics and music. They will examine elegance, symmetry, and beauty both visually (in written music) and aurally (in the resulting musical compositions and instrumental sounds). For example, members of the class will attend musical performances to observe connections to the course material, to enhance their musical appreciation, and to reflect on how formal systems yield musical results that transcend mathematical rules. In class students will listen to recordings,

along with the written score, that demonstrate a mathematical principle being discussed. They will be able to observe the shapes and patterns in the written notation while hearing their acoustic manifestations.

**Assignments**

I anticipate that the following types of assignments will be included in this course: short readings, in-class group assignments, homework consisting of problem sets and word problems, in-class quizzes, a student-chosen creative project, and attendance of musical performances.

In-class group assignments will typically be given at the end of each module. They will be designed to further develop understanding of the topics and connect newly-learned math concepts with musical applications -- designed to stretch them just beyond the examples given in class or in their texts. Students will work together, and I will answer questions and probe them in thinking through the assignment.

Homework consisting of problem sets and word problems will be mostly traditionally-based math homework. If I can find textbooks with sample problems for some of the course topics, these will likely be part of the selection. However, my investigation into usable books for this course have come up with few great options so far; many good texts simply describe the concepts and give examples without giving further exercises. Most books that are formatted for a course setting are too difficult for the level of the class proposed. I may end up having to write most of the homework questions myself.

Regular in-class quizzes and tests (2-3 during the semester) will likely be traditional problem-based assessment that will help me gauge the students' understanding. I will also need to create these from scratch.

Students will be required to attend a minimum of two live musical performances and to report on the mathematical connections they observe. Additionally, they will complete a creative project(s), either individually or in groups. It will take more investigation to come up with the guidelines, but I plan to have students write a musical composition using mathematical principles learned in class and perhaps construct a musical instrument.

**Teaching Approaches**

Because I do not teach a full course-load of traditional in-class courses (much of my load is one-on-one and small group teaching) and have not delivered a course that is mathematically-based, some of my preparation for this course will be preparing my explanations and demonstrations of math formulas in a clear and concise manner. By recommendation of other faculty in math/sciences and from my experience teaching general education students in Gateway and the

Gourmet Listener, I plan to use a mixture of lecture, group discussion, and in-class group work and projects. I will actively promote discussion and sharing between members of the class.

Students in the class may not have used their math skills recently or enjoyed their previous math experiences in the past. One of my goals will be to engage them in applications that show them the relevance of math in other areas and get them excited to see math as a tool in a variety of real-life experiences.

I do not think I am to the point of giving more specific teaching method details, as spending time to develop these is a reason for applying for the CD grant.

**Curricular Contribution to the Program and University**

The School of Music has been asked to offer a larger range of general education courses, including a class in the Formal Reasoning category. Currently, we do not offer any courses for non-majors with the kind of focus that this course would provide, i.e., one that affords students to delve into the mathematical background of a fine arts discipline. This course would be open to all IWU students, with only high school math prerequisites. It would be an additional option for students with an interest or background in music, who are looking to fulfill their Formal Reasoning requirement. This course also promotes stronger cross-disciplinary connections and collaboration between departments.

**Work Plan**

January 2026: Finalize CC proposal, and submit to CC
Spring 2026: Search for potential references and course texts
Summer 2026: Practice my dormant math "muscles" and develop course materials

**B. Rationale for Grant Request**

**How the grant will assist with course development**

The goals of this grant project are:
1) to identify solid materials for my reference and review mathematical concepts I have not worked with for a number of years;
2) to find course texts, articles, and/or book chapters for student use in the course;
3) to solidify the proposed course topics and the level of depth for each;
4) to write homework problem sets and quizzes/tests;
5) to develop class projects and group assignments

This work will take time, as most of the material and the teaching style of mathematical explanation is new to me. The creation of homework sets, examples, and word problems will also take a considerable amount of work. The stipend provided by the grant will provide compensation for the needed time.

**Why the employed pedagogy is appropriate for the course**
Due to the nature of a formal reasoning course, working through mathematical problems during class is a given. I believe that the combination of lecture, group discussion, in-class group work, and projects will provide a strong mix of learning styles for a student body that may have a variety of interests and come from diverse math and music backgrounds.

**Impact on My Development as a Teacher**
I feel that I am uniquely positioned to develop this interdisciplinary course, as I have a degree in mathematics in addition to my degrees in music. The relationship between these disciplines has long intrigued me, and I am excited to be able to combine my strongest academic interests in developing this course. While I tried to incorporate my math interest into my Gateway topic, this course will be a better outlet for the math-music connections I would like to probe.

Since, it has been a number of years since I have exercised my math mind, and I will need some time to read up on these topics and practice the mathematics involved. This will also position me to incorporate tidbits of mathematical findings into my applied lessons when appropriate, as well as potentially teach another mathematically-based course in the future. While the content may be marginally transferable unless I am teaching future math courses, the development of group projects and thinking about interdisciplinary areas creatively may be infused into other shared curriculum courses (Gateway, Life Soundtracks, and/or Gourmet Listener). I will not be certain of the long-term impacts until I get further along in the course-development process.

I will be happy to pass along the developed course materials to anyone else who might teach this course in the future, so this grant will benefit others in this position.

**Sources of funding for this project:** None beyond this grant.

**Budget page explanation:** While the DVD, "How Music and Mathematics Relate," is accessible by inter-library loan, I believe that it is a strong resource that would be beneficial to own.

**IRB/IACUC review**: Not applicable

# CD Grant Budget Page

1. **Estimated expenses** (make sure to include a description of each of the expenses in the narrative). If you are requesting books or DVDs, please provide titles and approximate costs.

| ITEM | AMOUNT |
|---|---|
| DVD:" How Music and Mathematics Relate" by David Kung | $13 |
| | $ |
| | $ |
| | $ |
| | $ |
| | $ |
| | $ |
| **TOTAL** | $13 |

2. **Stipend(s) requested** (see grant description for specific requirements):

| NAME | AMOUNT |
|---|---|
| | $ |
| Lisa Nelson | $1987 |
| | $ |
| | $ |
| **TOTAL** | $1987 |

3. **Total amount requested: (Stipends Requested + Estimated Expenses):** $2000

*Please note:* Materials purchased with CD and ID grant funds, including, for example, software, CDs, and DVDs, are subject to all applicable copyright laws. Faculty members are responsible for upholding these laws. Materials for use in the library collection should be purchased through The Ames Library with allotted departmental funds. For details about copyright issues, please go to http://libguides.iwu.edu/copyright, or contact the University Librarian or your department's liaison librarian.

# CD Grant Supervisor Endorsement

Name(s) of applicant(s): Lisa Nelson

Please provide the information below and return this form to the applicant(s).

1. Is/are the course(s) proposed:

☑ new to the IWU curriculum? ☐ substantial revision of existing course(s)?

2. What part of the curriculum is served by the proposed course? (check all that apply)

☐ major/minor
☐ interdisciplinary program(s)
☑ Shared Curriculum
☐ elective

3. How frequently will the course be offered?

Once every academic year.

4. By checking the boxes below, I acknowledge that I have reviewed the narrative with the applicant and **affirm it addresses the following:**

☑ the new course or course revision's **contribution to the program/curriculum**

☑ **the student learning outcomes** that the course will address

☑ **the anticipated contribution to the applicant's teaching repertoire, whether that be an expansion of teaching content or pedagogical approaches**

Signature of supervisor Lynn Campbell Date Feb. 13, 2026

# Statement of Endorsement

New Course: MUS 163 - The Hidden Mathematics of Music
Submitted by Dr. Lisa Nelson

As Interim Director of the School of Music I wish to provide this statement as an endorsement of the creation of MUS 163 and integration into the shared curriculum. As prompted by the Provost, the School of Music has thought creatively and strategically about our offerings to non-majors to showcase the multi-faceted approaches to understanding music. Through this, our faculty has discussed a variety of angles to implement changes, but the creation of a new Formal Reasoning course was generously designed and proposed by Lisa Nelson. Her experience in music and background in mathematics made this course a natural fit into her teaching responsibilities and does not detract from her other courses. Its addition to our course offerings encourages students who might not otherwise interact with music or our program to consider this course in satisfying their FR requirement.

I hope that both the Curriculum Council and the entire faculty body will see this course as a valuable new offering and support its presence in the upcoming 2026-2027 academic course catalog.

Sincerely,

Logan Campbell
Interim Director of the School of Music
Director of Large Instrumental Ensembles