

Physics of Music/ QU PHY 105/105L

Fairfield Ludlowe High School - Fairfield Warde High School



Insert Teacher Name

Insert Room Number

Insert Full Year/Semester

Insert Period

Insert Email Address

COURSE DESCRIPTION

This course explores the science behind sound and music, from wave generation, to acoustics, to harmonies and instrumentations. Students study the principles of wave mechanics and emphasize applications associated with sound, music and instruments. Topics cover the anatomy of waves and sound, the structure and physics of instruments (guitar, trumpet, drums, piano, etc), human voice, singing and speech, musical harmony and scales, architecture acoustics and electronic communication and sound digitization.

This course is articulated with the Quinnipiac University (QU) ECE/Dual Enrollment Program. Students can apply for 4 college credits for PHY*105: Physics of Music (3 credits) and PHY*105L: Physics of Music Lab (1 credit), through the QU ECE/Dual Enrollment Program.

COURSE OBJECTIVES

By the end of PHY105 and PHY105L, students will have demonstrated the ability to:

- Evaluate the quality of the experimental methods and data.
- Communicate the process and outcomes of an experiment.
- Use appropriate tools to measure physical quantities accurately and precisely.
- Create plots on excel/spreadsheet software.
- Organize data tables, create, and analyze plots, and execute formulas within spreadsheet software.
- Recognize the connection between experimental results and scientific concepts.
- Generate scientific arguments based on observations.
- Evaluate simulated phenomena and connect between mathematical relationships.
- Understand the basic models and characteristics of generalized waves. Sound is a mechanical wave that occurs due to energy passing through mediums as vibrations.
- Distinguish between different types of waves and how sound waves are modeled
- Interpret sound waves and identify their frequency and pitch as it relates to high/low and loud/soft sound waves. Understanding hearing ranges of people as well as animals.
- Understand how our brains identify different loudness and how we model the decibel system, intensity and discuss how different frequencies need different loudness to interpret correctly.
- Understand that waves can interfere or complement one another to create dissonance and harmony, and the acoustics of a space can cause waves to dissipate or reflect.
- Describe what happens when two waves meet under the concept of interference. Describe different applications of interference in industry and musical settings
- Describe standing waves in instruments such as guitar, flutes, trumpets, drums, piano and clarinet. Introduce the various instruments in their instrument families and how their shape/materials affect their sounds.
- Model the concept of resonance in pipes, strings and solids. Identify their harmonics/overtone and how it related to the timbre of an instrument
- Explain the concept of a musical scale, how it was developed and listen/model different types of scales such as major, minor, chromatic, blues, pentatonic.
- Describe how human speech works along with pronunciation of vowels and constants as it relates to a closed pipe instrument.

- Understand the basic mechanics of singing/vocal training.
- Describe how to use air, diaphragm and mouth to generate specific resonate tones.
- Describe how the shape and material of the room, known as acoustics, effect the way sound travels and is heard
- Describe the basic functions of microphones and speakers.
- Interpret speaker information such as wattage/frequency range.
- Distinguish the difference between a dynamic microphone and condenser microphone.
- Understand the basics of digitizing and recording music.
- Use programs such as logic pro to edit/create a song

UNITS OF STUDY

Unit 1: Wave Properties: *Introduction to Mechanical Waves & Sound*

Unit 2: Resonance: *Instrumental Structure*

Unit 3: Musical Applications: *Musical Scales, Voice, Hearing, and Acoustics*

Unit 4: Music Production: *Final Project*

LAB INVESTIGATIONS

Lab 1	Intro to Lab & Types of Waves*- What do different sounds/noises/songs look like in wave form?
Lab 2	Mechanical Wave Speed- Which is faster – Longitudinal Waves or Transverse waves?
Lab 3	Sound Wave Analysis* Pure, Rich, Noise
Lab 4	Intensity of Light Waves*- Modeling Intensity in darkness
Lab 5	Interference Mapping & Beats - Modeling nodes/anti nodal Mapping and Beats
Lab 6	Resonance in Pipes – Harmonics Lab
Lab 7	Standing Waves on String - Modeling waves on strings
Lab 8	FFT Harmonics/Dial Tones - Understanding Harmonics, Timber and FFT
Lab 9	Mathematics of Music *- Mathematics behind major and chromatic scale
Lab 10	Vowels, Singing, Speech * - Waveforms of speech and singing
Lab 11	Reflection & Refraction - Modeling how waves reflect and bend
Lab 12	Acoustics Lab - What accounts for the best acoustics?
Lab 13	Synthesizer Lab -Making a song
Final Project	Electromagnets & Guitars - Making a guitar pick up and electromagnet

COURSE POLICIES AND REQUIREMENTS

GRADING

Cumulative/In-Progress Grade:

- 10% of the grade will be based on formative assessments, classwork, homework completion, or behavior (see FPS BOE [Policy 6154AR](#))
- 90% will be based on summative assessments (see FPS BOE Policy 6146AR).

The 90% will be comprised of the following summative assessments:

Three unit exams and a final reflection. These count for 50% of the summative assessment grade.

- **Exam 1: Wave Properties**

- **Exam 2: Resonance**

- **Exam 3: Musical Applications**

- **The Final Reflection:** The Final Reflection is a personal reflective assessment of the learning goals and connections as seen below (subject to change by instructor discretion). Pick three learning goals that resonated best with you and demonstrate your understanding. Word total: 800 Words

Part 1: Three Learning Goals: Evaluate your understanding of three goals. Provide evidence to support your evaluation such as homework examples, diagrams, calculations, in-class demonstrations lab examples, etc. 200 words per objective.

Part 2: Make Connections – How has this class changed your perspective of waves/sound? Make one connection to the content presented so far and share your interaction. For example, have you experienced beats? Have you seen a standing wave in another scenario other than class, etc? 200 words

Labs count for 50% of the summative assessment grade.

Lab grading criteria: Each lab will be graded out of a total of **10 points** using the following criteria:

(4pts) Lab Presentation- Grade will focus on presentation of information, demonstrating knowledge of equations and units, and generating graphs/tables.

Criteria	Assessment	Points
Format	Lab is Formatted & presented professionally. No awkward spaces/changes of font/formatting issues.	1
Calculations	All calculations are present and are correct.	1
Measurements/ Units	Recorded values are labeled and reasonable. All units are present and correct	1
Data Presentation	Data Tables/Graphs are labeled appropriately and present relevant information.	1

(6pts) Lab Understanding – Grade will focus on your ability to connect the physics to the lab by applying concepts, going beyond the lab questions to make connections and think of limitations to your experiments.

Criteria	Assessment	Points
Analysis Questions	Questions are answered and elaborated with scientific concepts and/or connected to lab data. Sophisticated interpretation of data and correct usage of scientific concepts.	2
Lab Understanding	Wholistically graded. Demonstrates thorough understanding of the main objective of the experiment and makes connections to physics content.	4

End-of-the-Year Grade:

- 90% of the overall course grade will reflect the student’s mastery of course content and laboratory investigations during the school year through the Cumulative/In-Progress Grade.
- 10% of the End-of-the-Year course grade will be based on the Presentation. Students will research and give an oral presentation on the physics of an instrument, build an instrument or research the history of an instrument/physicists using 21st century learning skills. They must use references and resources for support and use presentation software (PowerPoint, Keynote, a Website or Prezi). Students will be assessed on their content and presentation skills. In addition, students will self-assess their performance as well. This presentation will take place during the final exam period.

Grade Reporting

- All grades will be communicated through Infinite Campus
- Summative assessment results will be reported back to the student within ten school days from the date of submission or the due date.

Guidelines for Late Work (see FPS BOE Policy 6146AR):

- Late work will be accepted for both summative and formative tasks within a defined timeline agreed upon between the student and the teacher
- The total points may be reduced as a penalty for late work

Reassessments:

- Any extenuating circumstances may be discussed with administration to allow alternative reassessment opportunities with administrative approval.
- Reassessment opportunities are defined as twice per year (with a maximum of one per quarter) for assignments that students met the original required deadlines and do not violate the academic integrity policy. Reassessment does not apply to midyear assessments or final assessments.
- Gradebook impact of Reassessment: original and reassessment scores will be averaged in the gradebook.

MATERIALS:

- Calculator, Pen/Pencil for recording data, Chromebooks
- No textbook is needed for the course. All notes/readings will be provided by the instructor in Google Classroom

EXPECTATIONS OF STUDENTS:

- You are expected to turn in the lab at the end of the lab session, unless specified by your instructor.
- Lab instructor will sign off or check your lab data before you leave the lab.
- Clean up your lab station after you complete the lab so that the next class can find the equipment and work efficiently