Term Information

Effective Term	Autumn 2026

General Information

Course Bulletin Listing/Subject Area	Physics
Fiscal Unit/Academic Org	Physics - D0684
College/Academic Group	Arts and Sciences
Level/Career	Undergraduate
Course Number/Catalog	2110
Course Title	The Physics of Computer Games and Simulations
Transcript Abbreviation	Phys Comp Games
Course Description	Students will learn about the physics underlying many computer games and simulations. They will learn about idealized, approximated situations and ways to describe the situation more realistically using numerical methods, as well as data analysis and visualization. This is a GE themes course on “Number, Nature, Mind” as well as a research-based course.
Semester Credit Hours/Units	Fixed: 4

Offering Information

Length Of Course	14 Week, 12 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus, Lima, Mansfield, Marion, Newark, Wooster

Prerequisites and Exclusions

Prerequisites/Corequisites	Completion of the GE foundation requirements in “Natural Science” and “Mathematical and Quantitative Reasoning/Data Analysis.”
Exclusions	
Electronically Enforced	Yes

Cross-Listings

Cross-Listings	

Subject/CIP Code

Subject/CIP Code	40.0801
Subsidy Level	General Studies Course
Intended Rank	Freshman, Sophomore, Junior, Senior

Requirement/Elective Designation

Number, Nature, Mind; Research Seminar

Course Details

Course goals or learning objectives/outcomes

- Conceptually and mathematically describe physical laws of motion and sound, and apply them to game and simulation contexts.
- Understand and apply the approximations made in modeling various physical processes involving kinematics, dynamics, or waves, and discuss their range of validity.
- Implement numerical approaches to use physical laws of motion and sound to calculate quantities of interest for computer games, simulations, and science investigations.
- Analyze and visually represent the data generated by a game engine or simulation.
- Identify and explain the effects of different physical assumptions about a physical process on the observed and simulated outcome.
- Plan, execute and report on a research project investigating different settings and physics assumptions.

Content Topic List

- Kinematics, Graphical interpretation of kinematics quantities. Vectors, Motion in two or three dimensions, Projectile motion
- Forces, Newton’s Laws, Friction and Air Resistance, Circular motion, Universal Gravitation, orbital motion, Momentum and Impulse, Collisions
- Sound: Types of waves, Standing waves, Amplitude & frequency, volume & pitch, Quality of sound
- Computational Physics: Algorithms and how to implement them, Simple methods for integrating differential equations: Euler’s method, Numerical issues, in particular for systems with periodic motion
- Scientific practices: Defining a research question/goal of game or simulation, Investigating the effects of changes in quantities or parameters on the outcome, Visualizing and analyzing data, Planning, organizing, executing and communicating

Sought Concurrence

Yes

Attachments

- submission-number-nature-mind.pdf: GE Themes form

  (Other Supporting Documentation. Owner: Heckler,Andrew Frank)
- ConcurrenceCSE.pdf: CSE concurrence

  (Concurrence. Owner: Heckler,Andrew Frank)
- P2110SyllabusPhysVideoGamesSim.docx: Physics 2110 Syllabus

  (Syllabus. Owner: Heckler,Andrew Frank)
- Physics2110Research_Creative_InquiryForm.pdf: Physics2110Research_Creative_InquiryForm

  (Other Supporting Documentation. Owner: Heckler,Andrew Frank)
- Physics 2110 New Course Request cover letter.pdf: Cover Letter

  (Cover Letter. Owner: Heckler,Andrew Frank)

Comments

- Please see Subcommittee feedback email sent 9/18/25 *(by Neff,Jennifer on 09/18/2025 06:50 PM)*
- We edited the prereq in this form. We added the GE High Impact Practices Form: Research and Creative Inquiry. *(by Heckler,Andrew Frank on 08/18/2025 03:21 PM)*
- - The prereqs on the form in curriculum.osu.edu do not match the prereqs on the syllabus.
  - I gather this is a 4-credit High Impact Practice Theme course. Correct? If so please fill out and upload the appropriate HIP form and check off the HIP category on the form in curriculum.osu.edu. All the forms are here (scroll down to the bottom of that page) https://ugeducation.osu.edu/academics/general-education-ge/ge-course-submission *(by Vankeerbergen,Bernadette Chantal on 08/18/2025 02:03 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Heckler,Andrew Frank	08/14/2025 10:15 AM	Submitted for Approval
Approved	Bundschuh,Ralf Andreas	08/14/2025 10:19 AM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	08/18/2025 02:03 PM	College Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	08/18/2025 02:03 PM	ASCCAO Approval
Submitted	Heckler,Andrew Frank	08/18/2025 02:13 PM	Submitted for Approval
Approved	Heckler,Andrew Frank	08/18/2025 02:13 PM	Unit Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	08/18/2025 02:14 PM	College Approval
Submitted	Heckler,Andrew Frank	08/18/2025 03:22 PM	Submitted for Approval
Approved	Heckler,Andrew Frank	08/18/2025 03:22 PM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	08/18/2025 04:10 PM	College Approval
Revision Requested	Neff,Jennifer	09/18/2025 06:50 PM	ASCCAO Approval
Submitted	Heckler,Andrew Frank	11/11/2025 09:55 AM	Submitted for Approval
Approved	Heckler,Andrew Frank	11/11/2025 09:59 AM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	11/21/2025 04:30 PM	College Approval
Pending Approval	Jenkins,Mary Ellen Bigler Neff,Jennifer Vankeerbergen,Bernadette Chantal Steele,Rachel Lea	11/21/2025 04:30 PM	ASCCAO Approval

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November 11, 2025

Dear Curriculum committee chairs and members:

We respectfully resubmit a new course request for Physics 2110, The Physics of Computer Games and Simulations. This is a GE Themes Nature, Number, Mind course. The committee reviewed the original request in September and sent back feedback to be addressed before it could be considered for approval.

We detail below how we addressed the points brought up by the committee.

1. Clarification of contact hours being commensurate with 4 credit hours: We have more appropriately labelled the contact hours as lecture-recitation. Therefore, there are two 110-minute sessions each comprised of a "lecture" portion, which involves more traditional didactic methods and "recitation" portion, which involves engagement of students in activities (in groups or alone) such as coding, discussing questions, and problem solving. This was originally mislabeled because the course's active engagement can sometimes resemble computer lab activities. In all, there are 220 minutes of in-class contact per week. Adding that to the expected 440 minutes out of class per week for assignments, this totals 9240 minutes, which is above the threshold of 9000 minutes for 4 credit hours.
2. Consideration of timeslots for offering on Columbus campus: The current schedule is two 110-minute sessions. This course schedule could be easily adapted to four 55 minute sessions, which fits with the registrar's approved weekly schedule, and this schedule would likely work better on the Columbus campus.
3. Automatic failure policy: we have removed the clause about automatic failure (for not completing final oral presentation or report) and instead increased the weight of these assignments to 10% each. This underlines the importance of these two assignments for the course.
4. We have also addressed the issues brought up by the subcommittee in the syllabus:
    a. We have removed references to an "OSU standard grading scale".
    b. We have removed the old, required syllabus language and replaced it with the link to Office of Undergraduate Education's Syllabus Policies & Statements webpage.
    c. We have removed the language about land acknowledgment, in accordance with recent changes to University rules.
5. We recently received the concurrence from CSE with no major concerns, and the document indicating this is included in the submission. They "recommend suggesting that students take CSE 1224: Introduction to Computer Programming in Python to help mitigate any challenges related to understanding Python while learning Physics." While we can recommend this course to students, we feel that such a course is not necessary for

two reasons. First, the course does not assume prior knowledge of programming, and second, the course is not dependent on any particular software language, and the instructor may choose the programming language used in the course. Further, CSE 1224 is not offered at most regional campuses.

Please don't hesitate to let me know if there are any issues or concerns

Sincerely,

Andrew Heckler
Professor
Department of Physics
Ohio State University
Email id: heckler.6@osu.edu

Syllabus

Physics 2110

The Physics of Computer Games and Simulations

Autumn 2026, 4 Credit Hours

Monday, Wednesday: 2:35pm - 4:25pm, Galvin 305 Lecture-Recitation

Delivery Mode: In Person, Galvin 305, Lecture and Recitation; meets twice per week for ~55 minutes of lecture followed by ~55 minutes of recitation.

Course overview

Instructor

Dr. Sabine Jeschonnek, jeschonnek.1@osu.edu, phone 567 242 7165

Office: Science 310A

Office Hours: Friday 10 – 11am, TBA, and by appointment.

My preferred method of contact for questions is email: Jeschonnek.1@osu.edu I will use Carmen for general announcements to the class, please check your Announcements in Carmen.

Course Prerequisites

Completion of the GE foundation requirements in "Natural Science" and "Mathematical and Quantitative Reasoning/Data Analysis." It is recommended, but not required, that students take CSE 1224: Introduction to Computer Programming in Python.

Course description

Students will learn about the physics underlying many computer games and simulations, including kinematics in three dimensions, Newton's Laws, circular motion, universal gravitation, momentum, collisions, and sound.

Students will explore and actively pursue the process of doing science: asking questions and defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating and communicating information.

Students will learn about idealized, approximated situations and ways to describe the situation more realistically using numerical methods eg projectile motion without air resistance, projectile motion with air resistance, and projectile motion with air resistance with changing air density. Students will learn which situation requires which level of realistic description, how to achieve this in practice, and what the consequences of non-physical choices are.

Students will learn how to turn physical laws into algorithms for the computation of simulated events. Students will use provided Jupyter notebooks and learn how to modify these notebooks or write their own, simple Python code, how to analyze and visualize data and how to create simple physics animations. Students will learn to use and edit Jupyter notebooks to run physics engines for games and simulations. Students will learn that many science applications require approaches very similar to the ones used in video games and simulations, and how their skills and knowledge gained in this class can be transferred to conduct scientific research.

Please note: students will not play any video games during class. Students will also not develop complete video games, rather relevant components of games or simulations that involve the physical principles of interest.

Course expected learning outcomes

By the end of this course, students should successfully be able to:

1. Describe physical laws and analyze them mathematically.
2. Understand the approximations made in describing various physical processes, and discuss their range of validity.
3. Implement numerical approaches to use physical laws to calculate quantities for video games, simulations, and science investigations.
4. Visualize and analyze the data generated by a game engine or simulation.
5. Discuss the effect of different physical assumptions about a process on the observed and simulated outcome.
6. Plan, execute and report on a research project investigating different settings and physics assumptions.

Course Materials

Software: We will use Anaconda to run Jupyter notebooks and the Spyder Integrated Development Environment (IDE) using the Python programming language for our course. This software is free. It is installed on the computers in our class room, Galvin 305. You can download and install it on your own machine, too. You can find Anaconda at https://www.anaconda.com/download#Links

Note: when this class is offered on other campuses, a different software platform or coding language may be employed. The course contents will be the same, they are independent of the particular platform and language.

There is no required textbook for this class. Optional and supplemental reading assignments and reference materials will be posted or linked on Carmen. All of them are freely and legally available.

General education goals and expected learning outcomes

As part of the Number, Nature, Mind category of the General Education curriculum, this course is designed to prepare students to be able to do the following:

1. Successful students will analyze an important topic or idea at a more advanced and in-depth level than in the Foundations component. [Note: In this context, “advanced” refers to courses that are e.g., synthetic, rely on research or cutting-edge findings, or deeply engage with the subject matter, among other possibilities.]

2. Successful students will integrate approaches to the theme by making connections to out-of classroom experiences with academic knowledge or across disciplines and/or to work they have done in previous classes and that they anticipate doing in future.

3. Successful students will experience and examine mathematics as an abstract formal system accessible to mental manipulation and/or mathematics as a tool for describing and understanding the natural world.

Expected Learning Outcomes of the GEN Theme: Number, Nature, Mind

Successful students are able to:

1.1 Engage in critical and logical thinking about the topic or idea of the theme.

1.2 Engage in an advanced, in-depth, scholarly exploration of the topic or idea of the theme.

2.1 Identify, describe, and synthesize approaches or experiences as they apply to the theme.

2.2 Demonstrate a developing sense of self as a learner through reflection, self-assessment, and creative work, building on prior experiences to respond to new and challenging contexts.

3.1 Analyze and describe how mathematics functions as an idealized system that enables logical proof and/or as a tool for describing and understanding the natural world.

How Physics 2110 meets the above Goals and Expected Learning Outcomes of the GEN Theme: Number, Nature, Mind

Physics describes the natural world with physical laws that are phrased as mathematical equations. In some, relatively simple, cases, these equations can be solved analytically, with paper and pencil, e.g. the calculation of a path of a projectile without air resistance. This is a standard subject in introductory physics courses. However, the actual path of a projectile needs to be computed including the effects of air resistance, and of the changing density of air with height. This problem cannot be solved with paper and pencil, but requires a numerical solution. This is beyond the scope of the typical introductory physics class, but extremely relevant, and also very interesting. In computer games as well as in simulations for scientific investigations and technical applications, including the actual situation, not just the idealized version of nature, is crucial to obtain reliable results and a realistic gaming experience. In this course, students learn how to set up an appropriate model and simulation of various common process in Nature. Successful students learn to identify the important features of the situation, cast them in abstract form (equations, parameter values etc), and then run, analyze, and critically interpret the results. In this process, mathematical equations and algorithms play a crucial role. In this course, the students will thus explore several physics topics in-depth, and at an advanced level.

Students will be exposed to several standard approaches to modeling and simulating natural processes. They will learn how to turn physical laws into algorithms, and how to implement these algorithms numerically. Students will modify provided Jupyter notebooks to simulate a variety of natural phenomena. This requires logical and critical thinking about the phenomenon under investigation.

A central component of the course is the research project. Students will learn the necessary physics knowledge, numerical methods and coding skills from the start of the course, and will then pick a topic for their own game or simulation research project by week 6. In a series of scaffolding assignments, the students will build up to their final project presentation and report. In this research project, they will

- Define a situation in a game or simulation that stems from a real-world physics process, and a goal for the game or specific question to be answered by the simulation.

-Formulate a model, with appropriate physical laws and parameters for the situation, that they will implement in code.

- Discuss why they chose the specific numerical methods and physics description, and how well it works, or doesn't work for the given situation.

- Analyze and critically interpret the results.

- Discuss potential further steps and challenges.

- Present their results both in a 10 – 15 minute oral presentation and in a written report.

ELO 1.1 Engage in critical and logical thinking about the topic or idea of the theme.

During the lecture portion, students will learn important physics concepts and laws, and their applications to scientific and technological investigations. Students will learn how to implement physical laws numerically, when an idealized version of the situation is not appropriate - i.e. in the vast majority of practical cases. Students will study numerical methods and algorithms that allow us to model, simulate and describe natural phenomena. An important part of this discussion is a consideration of why these methods work or do not work, what the advantages and disadvantages of these methods are, and to which situations they are well suited. Students will have the opportunity to deepen their understanding during group activities in lecture and during the recitations, where they will develop their own physics engine implementations.

During the recitation, students will perform their own investigations with various models and into simulations of natural phenomena. They will modify provided codes and write their own. Computer code embodies the topic "Number, Nature, Mind" as the code is a construct of the mind, and it describes nature in a numerical, quantitative way.

ELO 1.2 Engage in an advanced, in-depth, scholarly exploration of the topic or idea of the theme.

Students will apply their new knowledge to the analysis of a variety of situations in the recitations throughout the course, every class day. They will use the implementation of physics in their game engines to thoroughly explore the data and outcomes of the simulated process.

A central component of the course is the research project. Students will learn the necessary physics knowledge, numerical methods and coding skills from the start of the course, and will then pick a topic for their own game or simulation research project by week 6. In a series of scaffolding assignments, the students will build up to their final project presentation and report. In this research project, they will

- Define a situation in a game or simulation that stems from a real-world physics process, and a goal for the game or specific question to be answered by the simulation.

-Formulate a model, with appropriate physical laws and parameters for the situation, that they will implement in code.

- Discuss why they chose the specific numerical methods and physics description, and how well it works, or doesn't work for the given situation.

- Analyze and critically interpret the results.

- Discuss potential further steps and challenges.

- Present their results both in a 10 – 15 minute oral presentation and in a written report.

Carrying out this research project clearly requires an advanced, in-depth, scholarly exploration of the chosen research problem.

ELO 2.1. Identify, describe, and synthesize approaches or experiences as they apply to the theme.

In this course, students will learn about physics and will be exposed to several standard approaches to modeling and simulating natural phenomena. They will learn how to turn physical laws into algorithms. In several of the Jupyter notebooks, they will need to identify the relevant aspects of a problem, and find an appropriate way to build their game or simulation, using one or more methods discussed and demonstrated in the course. This will allow them to synthesize the material, and apply it to new questions.

ELO 2.2. Demonstrate a developing sense of self as a learner through reflection, self-assessment, and creative work, building on prior experiences to respond to new and challenging contexts.

Students will carry out a research project in this course. The students will be guided to a successful completion of this project through a series of scaffolding assignments. In this process, they have several opportunities to set goals (First Game/Simulation Design Assignment, Week 6), evaluate their progress towards these goals, and identify remaining problems (Game/Simulation Progress Report, Week 9, and First Game/Simulation Submission, Week 10). During this process, they will be working with clearly formulated questions and rubrics. In order to further develop their skills as researchers, they will serve as peer reviewers for the First Game/Simulation Design Assignment and the First Game/Simulation Submission. With this role change from researcher to reviewer, they will learn how to give constructive feedback, and will broaden their perspective by engaging with the projects of their classmates.

ELO 3.1. Analyze and describe how mathematics functions as an idealized system that enables logical proof and/or as a tool for describing and understanding the natural world.

This whole course is about ELO 3.1 – we use mathematics to state physical laws, and to develop algorithms, and then implement them, generate numerical results, and discuss how these results help us understand the natural world. Please refer to the Course Description on page 2.

How this course works

Mode of delivery

This course is delivered in person.

Attendance Policy

It is extremely important that you attend all class meetings. While I will not give points for attendance, you will be most successful in this class if you attend all the time. The only way to learn how to understand physics, create simulations, debug code and analyze results is by doing. The best and most efficient way to do this is by interacting in person with your classmates and instructor. If you are not in class, you will lose points from the worksheets and notebooks from that day.

Credit hours and work expectations

This is a **4-credit-hour course**. According to Ohio State policy (go.osu.edu/credithours), students should expect around 12 hours of engagement with the class each week to receive a grade of (C) average. Actual hours spent will vary by student learning habits and the assignments each week.

AI Use

In general, you will learn all necessary information in class, and you will have time to work on your research project in class, and ask your instructor for help with any questions. You will learn in class where to get information online about coding (e.g. where to find documentation for creating graphs in Python). If you use information or code snippets you found online, you will need to cite your source in the code. **You also need to be able to explain how your code works to the instructor upon request. If you are not able to explain your code, you will receive zero credit for the assignment in question.** You are not allowed to simply use AI to generate your code, notebook or any other part of the assignment, unless explicitly directed to do so in a specific assignment.

Course materials and technologies

Textbooks

Required

No textbook required. Links to relevant articles, book chapters etc will be posted on Carmen. All these materials are free and legally available for download/reading.

Optional/Reference

Students may wish to consult the following textbooks for reference, or for work on their research project. Any sources used for your research project need to be cited, with the relevant page numbers!

OpenStax Algebra-based Physics, 2nd edition
https://openstax.org/details/books/college-physics-2e

Hiroki Sayama, (SUNY Open Textbooks): Introduction to the Modeling and Analysis of Complex Systems

https://staging.open.umn.edu/opentextbooks/textbooks/introduction-to-the-modeling-and-analysis-of-complex-systems

There are many good books on games, simulations, and coding available. I list some here that you might find helpful. Also please realize that I am well aware of these books and their content, and simply copying projects from them is not acceptable, and will be detected.

Allen Downey, Modeling and Simulation in Python
https://allendowney.github.io/ModSimPy/

Al Sweigart: Invent Your Own Computer Games with Python, 4th edition,
https://inventwithpython.com/invent4thed/

Al Sweigart, Making Games with Python & Pygame,
https://inventwithpython.com/pygame/

Course technology

Technology support

For help with your password, university email, Carmen, or any other technology issues, questions, or requests, contact the Ohio State IT Service Desk. Standard support hours are available at it.osu.edu/help, and support for urgent issues is available 24/7.

- Self-Service and Chat support: it.osu.edu/help
- Phone: 614-688-4357(HELP)
- Email: 8help@osu.edu
- TDD: 614-688-8743

Technology skills needed for this course

- Basic computer and web-browsing skills
- Navigating Carmen (go.osu.edu/canvasstudent)

Grading

How your grade is calculated

Assignment Category	Points and/or Percentage
In-Class Work on Notebooks and Handouts	18%
Quizzes	20%
Midterm	15%
First Game/Simulation Design Assignment	5%
Game/Simulation Building Progress Report	5%
First Game/Simulation Submission	9%
Peer Reviews	8%
Oral Presentation	10%
Final Report	10%

Assignment Category	Points and/or Percentage
Total	**100%**

There is no curve in this class. I would be extremely happy for all students to earn a high grade. The final score is converted to a letter grade using this grade scale:

Letter Grade	Final Percentage
A	more than 93
A-	92 - 90
B+	89 - 87
B	86 - 83
B-	82 - 80
C+	79 - 77
C	76 - 73
C-	72 - 70
D+	69 - 67
D	66 - 60
E	less than 60

Description of major course assignments

Jupyter Notebooks and In-Class Handouts

- **Description**

You will work in class on handouts with physics problems and provided notebooks, and perform calculations and write code along the way. You will upload your completed notebook to Carmen, and hand in your completed handouts by the end of the class period.

- **Academic integrity and collaboration guidelines**

Collaboration and discussion with your classmates is actively encouraged, but simply copying and pasting work is not allowed. An equation sheet and coding cheat sheet will be provided.

Quizzes

- **Description**

Once per week during the first twelve weeks (apart from the first week and the midterm week), there will be an in-class quiz given. Quizzes consist of at most four or five multiple choice or short answer questions. You should be able to answer them easily if you solved the physics questions and coding and analysis tasks from class.

- **Academic integrity and collaboration guidelines**

You will be allowed to run code during these quizzes, but getting help from your classmates or the internet is not allowed.
An equation sheet and coding cheat sheet will be provided.

Midterm Exam

- **Description**

The midterm exam will consist of a number of multiple choice and/or short answer questions, and one or two show work questions requiring you to analyze a physics problem and write some code for it.

- **Academic integrity and collaboration guidelines**

You will be allowed to run code during these quizzes, but getting help from your classmates or the internet is not allowed. An equation sheet and coding cheat sheet will be provided.

Research Project

In this course, you will learn how to formulate a research question, build or modify a simulation/game in Jupyter notebooks, test the simulation/game and analyze the obtained data, give a presentation on your results, and write a final report. You will also give constructive feedback to your classmates through peer review. The details for these assignments will be posted on Carmen, including a rubric of expected elements.

Students may choose their own research project from a variety of provided examples, or create their own game or simulation from scratch. Starting in week 6, there will be a series of assignments to scaffold the research project you will do, see below. If you have doubts about your choice of research project, please discuss this with the instructor. If the First Design Assignment you submit seems not to be feasible, your instructor will discuss ways to modify your project or alternative projects.

Specifically, these scaffolding assignments are:

- **First Design Assignment**

Give a brief description of what kind of game or simulation you would like to build. Keep it focused on a very specific task or process. Which process/situation do you wish to model? Which quantities do you need to include? Which laws of physics do you need to implement? Which quantities will you observe? Which parameters will your game or simulation have? A list of specific questions will be provided on Carmen. (Week 6, 5% of your grade)

- **Peer Review of the First Design Assignment**

Is it specific? Is it clear? Feasible? You will review three submissions from your peers for the First Design Assignment. There will be detailed instructions and rubrics available on Carmen. These peer review assignments will help everyone by providing constructive feedback. If you feel that the peer review scores given were not fair, you may appeal to the instructor. (Week 7, 2.5% of your grade)

- **Game/Simulation Building Progress Report**

Is the physics content clear? Is your scope realistic? Are there any coding issues you need help with? Which documentation do you still need to write? How did you/will you test your game/simulation? A list of specific questions will be provided on Carmen. (Week 9, 5% of your grade)

- **First Game/Simulation Submission**

Notebook including code and documentation needs to be submitted. You will be able to work on your game or simulation until the end of the semester to work out the last issues, but it should be running right now. (Week 10, 9% of your grade)

- **Peer Review of the First Game/Simulation Submission**

You will review two submissions from your peers for the First Game/Simulation Submission assignment. Does the game/simulation run without crashing? Is the physics implemented correctly? Is it clearly documented? A rubric will be provided on Carmen. (Week 11, 2.5% of your grade)

- **Peer Review of the Oral Presentation**

You will give constructive feedback on the oral presentation, and note open questions. A feedback sheet will be handed out in class for each presentation. (Week 14 & 15, 3% of your grade)

- **Oral Presentation**

You will present your game/simulation in a 10 - 15 minute oral presentation, with an additional 10 minutes for questions from your peers. You will address the game/simulation you wanted to build, the physics it is based on, and the expected behavior. You will provide an analysis of the data/outcome, including a visualization. You will also discuss how your game/simulation relates to the real world. (Week 14 and 15, 10% of your grade).

- **Final Report**

The written report on your research project will build on all your previous submissions regarding your project, see above. It will address all the questions discussed in the oral presentation, and may contain more detail regarding the implementation and testing of your game/simulation and analysis of your data. Your final report should be between 5 – 10 pages long, including figures. (due on the last day of classes, 10% of your grade)

Late assignments

I realize that sometimes, students may experience difficult life situations (eg severe illness of self or family member, family emergencies) outside their control that influence their performance and ability to participate in class and submit assignments on time. If you are experiencing any such situation, please notify me right away, and we will work out an appropriate plan for dealing with this.

There will be several in-class activities with worksheets and Jupyter notebooks every week. If a student misses a class meeting or does not hand anything in/does not submit a worked notebook, the score for that activity is zero if this happens three or more times. The first two times this happens will be excused.

Students get to drop the lowest quiz score. If a student misses a quiz, that quiz is automatically the dropped score. If a student misses a further quiz or the midterm and has a reasonable, documented excuse, the student will get the opportunity to take a make-up quiz or midterm at a later date.

It is important that students work on their research project throughout the semester, on pace with their classmates. Handing in the First Design Assignment or the Game/Simulation Building Progress Report late will lead to a deduction of 10% of the maximum possible score for every day the assignment is late. This means that if the First Design Assignment is submitted three days late, the maximum possible score will be 5% - 1.5% = 3.5% instead of 5%.

Warning: your research project is the heart of your course work. Failure to give the final presentation or to hand in the final report will lead to a loss of all points for that part of the course (10% for each, that is a whole letter grade). If you have a valid reason for missing the deadline for the final presentation and report, you will need to take an incomplete and deliver the material within the deadline determined by the university.

Academic policies

Academic integrity policy

See **Descriptions of major course assignments**, above, for my specific guidelines about collaboration and academic integrity in the context of this class.

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The Ohio State University's Code of Student Conduct (Section 3335-23-04) defines academic misconduct as: Any activity that tends to compromise the academic integrity of the University or subvert the educational process. Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Instructors shall report all instances of alleged academic misconduct to the committee

(Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct: http://studentlife.osu.edu/csc/

If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the university's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university.

If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

Other sources of information on academic misconduct (integrity) to which you can refer include:

- Committee on Academic Misconduct web page (go.osu.edu/coam)
- Ten Suggestions for Preserving Academic Integrity (https://oaa.osu.edu/resources/policies-and-procedures/academic-integrity/students)

Copyright for instructional materials

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Applicable Course Policies

For a list of Ohio State policies that apply to this class, like any other OSU class, please see:

https://ugeducation.osu.edu/academics/standard-syllabus/standard-syllabus-statements

and also

https://ugeducation.osu.edu/academics/standard-syllabus/optional-syllabus-statements

Your mental health

Should you find yourself experiencing personal difficulties, whether related to class or not, please know that you have access to confidential mental health services provided by the OSU Lima Counseling and Consultation Service (LCCS). All current OSU Lima students are eligible for services at no charge. You may contact LCCS by emailing Samantha Haudenschield at haudenschield.11@osu.edu or calling 567-242-7158. You can also reach an on-call counselor when Dr. Haudenschield is not available by calling 614-292-5766. For more information about Lima Campus resources, to request an appointment, or to access options for crisis resources, visit our website: go.osu.edu/LCCS. In addition, students from all campuses may access certain resources offered by Columbus Campus Counseling and Consultation Service. For more information, check their website at ccs.osu.edu If you are experiencing a clinical crisis, are in need of emergency assistance, are have thoughts of harming yourself, you may contact the National Suicide Prevention Hotline by dialing 988; call 9-1-1 for emergency assistance; or go to your nearest hospital emergency room.

Accessibility accommodations for students with disabilities

Requesting accommodations

The Ohio State Lima Office for Disability Services (ODS) is committed to creating an accessible educational experience for students with disabilities. We partner with students, faculty, and staff to design accessible environments and to provide academic accommodations and support services. “Disability” is a broad term that includes, but is not limited to, mental health conditions, chronic health conditions, temporary injuries, physical/learning disabilities, and ADHD. Students register with ODS to be approved for accommodations. Registration is confidential and does not appear on transcripts. Medical documentation and information are kept private. Contact information:

Wendy Hedrick, B.S., M.S. ED, OSU Lima Coordinator for Disability Services: hedrick.39@osu.edu

567-242-6549 Office | 614-500-4445 VR

Lima-DisabilityServices@osu.edu

Our usual hours are: Monday through Friday, 8:00 AM to to 5:00 PM

Course Schedule

Refer to our Carmen course page for up-to-date assignment due dates.

List of Topics by Week

During lectures, there will be peer instruction questions and worksheets (**ELO 1.1, 1.2**) to be completed by the students. Students will discuss the worksheets in small groups. The worksheets will be handed in for grading at the end of lecture.

During recitations, students will work through Jupyter notebooks or code in the Spyder IDE, and implement their own solutions (**ELO 1.2, 2.1,3.1**). They will upload their completed notebooks and codes at the end of the recitation period.

There are several assignments scaffolding the research project. (**all ELOs**)

Week 1: Lecture 1 – what is this course, and what is it not. Why is the physics of computer games and simulations worth studying – connection with science and technology. Course expectations, grading, research project, deadlines. This is a research based course, what does that mean? Rules for AI usage. Sharing Python code and notebooks via OneDrive.

Recitation 1: interactive python shell – numerical calculations, variables. Introduction to Jupyter notebooks, strings and numbers.

Lecture 2: How can we use the laws of physics to describe nature/events? Algorithms and flow charts. Unit conversion. Kinematics: Position, coordinate systems.

Recitation 2: Jupyter notebook: unit conversion, more Python. Notebook: Your First Game – Guess the Number.

Week 2: Lecture 3: WHOOSH – describing motion, aka kinematics. Kinematics – position and velocity: definition, graphical representation, calculating position from velocity information. Euler's method.

Recitation 3: Notebook on coordinate conversions, more Python.

Lecture 4: ***Quiz 1;*** Kinematics – physical meaning of the area under a curve. Acceleration. How to pick a good research question.

Recitation 4: Notebook: making graphs with matplotlib. Simulating growth: initialize, compute, update.

Week 3: Lecture 5: Special cases: constant acceleration, free fall.

Recitation 5: visualizing motion with the pygame package. Reading and writing from/to files. Plotting trajectories.

Lecture 6: ***Quiz 2***; straight line motion with air resistance or friction. Straight line motion games. Variational method versus calculation with equations. Overview of potential research topics.

Recitation 6: sky diver simulation. The effects of choosing a time step. Slide a coin simulation.

Week 4: Lecture 7: Constant acceleration versus changing acceleration: special cases and graphic interpretation of position, velocity, acceleration versus time plots.

Recitation 7: modeling multiple variables: radioactive decay, predator-prey.

Lecture 8: ***Quiz 3***; WHAM! KAPOW! Dynamics: Forces and Newton's First and Second Law, still just in one dimension, ie for straight line motion. How to test a game or simulation.

Recitation 8: lunar lander game.

Week 5: Lecture 9: More Forces: free body diagrams, special forces; expectations for the research project.

Recitation 9: test and document lunar lander game. Work on autopilot.

Lecture 10: ***Quiz 4***; force of gravity, Newton's Third Law. Research project: expectations for the First Design Assignment.

Recitation 10: notebook on user defined functions, vectors and vector addition.

Week 6: Lecture 11: motion in two dimensions. Vectors. How to give a short oral presentation to pitch your project.

Recitation 11: projectile motion without air resistance, analytical and numerical solutions.

Lecture 12: ***Quiz 5***; Kinematics in two dimensions; projectile motion.

Recitation 12: projectile motion with air resistance, numerical solutions.

First Design Assignment: Give a brief description of what kind of game or simulation you would like to build. Keep it focused on a very specific task or process. Which process/situation do you wish to model? Which quantities do you need to include? Which laws of physics do you need to implement? Which quantities will you observe? Which parameters will your game or simulation have? A list of specific questions will be provided on Carmen. (5% of your grade)

Week 7: Lecture 13: projectile motion: range equation; effects of air resistance.

Recitation 13: cannon ball simulation with changing air density.

Lecture 14: ***Quiz 6;*** BLASTOFF! Uniform Circular Motion, Universal Gravitation.

Recitation 14: simulating Earth's orbit around the Sun

Peer Review of the First Design Assignment: Is it specific? Is it clear? Feasible? You will review three submissions from your peers for the First Design Assignment. There will be detailed instructions and rubrics available on Carmen. These peer review assignments will help everyone by providing constructive feedback. If you feel that the peer review scores given were not fair, you may appeal to the instructor. (2.5% of your grade)

Week 8: Lecture 15: Planetary Motion; numerical issues with periodic processes, Euler-Cromer method.

Recitation 15: practice with provided code

Lecture 16 & Recitation 16: ***Midterm Exam*** (takes the entire class time of two hours; 15% of your grade)

Week 9: Lecture 17: three-body problem. Physics counter-factuals: what happens to orbits if gravity worked differently?

Recitation 17: practice with provided code; work on your own game/simulation

Lecture 18: ***Quiz 7***; CRASH! BANG! Momentum and collisions; explosions. Best practices in data visualization.

Recitation 18: practice with provided code; work on your own game/simulation

Game/Simulation Building Progress Report: Is the physics content clear? Is your scope realistic? Are there any coding issues you need help with? Which documentation do you still need to write? How did you/will you test your game/simulation? A list of specific questions will be provided on Carmen. (5% of your grade)

Week 10: Lecture 19: collisions in two dimensions.

Recitation 19: practice with provided code; work on your own game/simulation

Lecture 20: ***Quiz 8***; realistic bouncing balls; impulse-momentum theorem. Coding with AI.

Recitation 20: practice with provided code; work on your own game/simulation

First Game/Simulation Submission: Notebook including code and documentation needs to be submitted. You will be able to work on your game or simulation until the end of the semester to work out the last issues and do data visualization and analysis, but the code should be working right now. (9% of your grade)

Week 11: Lecture 21: BEEP! Sound and Waves: wave speed, wave length, frequency; standing waves

Recitation 21: practice with provided code; work on your own game/simulation

Lecture 22: ***Quiz 9***; sound: volume and pitch; higher harmonics, quality of sound. Software tools for presentations, how to deliver a presentation.

Recitation 22: practice with provided code; work on your own game/simulation

Peer Review of the First Game/Simulation Submission: You will review two submissions from your peers for the First Game/Simulation Submission assignment. Does the game/simulation run without crashing? Is the physics implemented correctly? Is it clearly documented? Is the code following good design practices? A rubric will be provided on Carmen. (2.5% of your grade)

Week 12: Lecture 23: Random processes – random number generators, Monte Carlo integration. Finding pi. [or part 1 of an alternate advanced topic, see list below] How to present results: oral and written communication.

Recitation 23: practice with provided code; work on your own game/simulation

Lecture 24: ***Quiz 10***; Random walks, diffusion. [or part 2 of an alternate advanced topic, see list below]

Recitation 24: practice with provided code; work on your own game/simulation

Week 13: Lecture 25: Basic network characteristics, diffusion on networks. [or part 3 of an alternate advanced topic, see list below]

Recitation 25: practice with provided code; work on your own game/simulation

Lecture 26: ***Quiz 11;*** Susceptible – Infected – Recovered (SIR) Models on Networks

Recitation 26: practice with provided code; work on your own game/simulation

Week 14: Lecture 27 & Recitation 27: Student Project Presentations

Lecture 28 & Recitation 28: Student Project Presentations

Peer Review of the Oral Presentation: You will give constructive feedback on the oral presentation, and note open questions. A feedback sheet will be handed out in class for each presentation. (Week 14 & 15, 3% of your grade)

Week 15: Lecture 29 & Recitation 29: Student Project Presentations

Lecture 30 & Recitation 30: Final Reflection on Course. What have we learned? ***Final written report on your game/simulation due.***

Peer Review of the Oral Presentation: You will give constructive feedback on the oral presentation, and note open questions. A feedback sheet will be handed out in class for each presentation. (Week 14 & 15, 3% of your grade)

Advanced Topics: these topics are more advanced, but will be accessible to the students towards the end of the course. I intend to pick a topic or two according to the majors and interests of the enrolled students each time the course is scheduled. As there may be some variation in the number of enrolled students, additional advanced topics can be discussed if the number of students is small, as the student presentations will take up less time then.

- Orbital mechanics
- Diffusion and percolation eg spreading of a virus on a network, forest fires
- Rag doll physics: rigid bodies
- Systems of objects

- Spring Forces and Earth quake simulations
- Chaos: damped and driven pendulum

GE Theme course submission worksheet: Number, Nature, Mind

Overview

Courses in the GE Themes aim to provide students with opportunities to explore big picture ideas and problems within the specific practice and expertise of a discipline or department. Although many Theme courses serve within disciplinary majors or minors, by requesting inclusion in the General Education, programs are committing to the incorporation of the goals of the focal theme and the success and participation of students from outside of their program.

Each category of the GE has specific learning goals and Expected Learning Outcomes (ELOs) that connect to the big picture goals of the program. ELOs describe the knowledge or skills students should have by the end of the course. Courses in the GE Themes must meet the ELOs common for **all** GE Themes and those specific to the Theme, in addition to any ELOs the instructor has developed specific to that course. All courses in the GE must indicate that they are part of the GE and include the Goals and ELOs of their GE category on their syllabus.

The prompts in this form elicit information about how this course meets the expectations of the GE Themes. The form will be reviewed by a group of content experts (the Theme Advisory) and by a group of curriculum experts (the Theme Panel), with the latter having responsibility for the ELOs and Goals common to all themes (those things that make a course appropriate for the GE Themes) and the former having responsibility for the ELOs and Goals specific to the topic of **this** Theme.

Briefly describe how this course connects to or exemplifies the concept of this Theme (Number, Nature, Mind)

In a sentence or two, explain how this class "fits' within the focal Theme. This will help reviewers understand the intended frame of reference for the course-specific activities described below.

(enter text here)

Students will learn how to model a physical situation in a game or simulation by identifying relevant physical laws, adopting and adapting algorithms to apply the laws, running and modifying computer code to generate data, analyzing and interpreting these data, and evaluating and iterating the models and approximations used. They will do this for a variety of physical situations that are encountered in science and technology applications, and in computer games inspired by them.

Connect this course to the Goals and ELOs shared by *all* Themes

Below are the Goals and ELOs common to all Themes. In the accompanying table, for each ELO, describe the activities (discussions, readings, lectures, assignments) that provide opportunities for students to achieve those outcomes. The answer should be concise and use language accessible to colleagues outside of the submitting department or discipline. The specifics of the activities matter—listing "readings" without a reference to the topic of those readings will not allow the reviewers to understand how the ELO will be met. However, the panel evaluating the fit of the course to the Theme will review this form in conjunction with the syllabus, so if readings, lecture/discussion topics, or other specifics are provided on the syllabus, it is not necessary to reiterate them within this form. The ELOs are expected to vary in their "coverage" in terms of number of activities or emphasis within the course. Examples from successful courses are shared on the next page.

Goal 1: Successful students will analyze an important topic or idea at a more advanced and in-depth level than the foundations. In this context, "advanced" refers to courses that are e.g., synthetic, rely on research or cutting-edge findings, or deeply engage with the subject matter, among other possibilities.

Goal 2: Successful students will integrate approaches to the theme by making connections to out-of-classroom experiences with academic knowledge or across disciplines and/or to work they have done in previous classes and that they anticipate doing in future.

	Course activities and assignments to meet these ELOs
ELO 1.1 Engage in critical and logical thinking about the topic or idea of the theme.	During the lecture portion, students will learn how to apply important physics concepts and laws involving motion and waves, and their applications to computational investigations of scientific and technological questions. Students will learn how to implement physical laws numerically, when an idealized version of the situation is not appropriate - i.e. in the vast majority of practical cases. Students will study numerical methods and algorithms that allow us to model, simulate and describe natural phenomena. An important part of this discussion is a consideration of why these methods work or do not work, what the advantages and disadvantages of these methods are, and to which situations they are well suited. Students will have the opportunity to deepen their understanding during group activities in lecture and during the computer labs, where they will develop their own physics engine implementations. During the computer lab portion, students will perform their own investigations with various models and into simulations of natural phenomena. They will adopt and iteratively evaluate and modify existing algorithms and codes. Students will demonstrate their knowledge and skills in weekly quizzes, a midterm, and by completing the activities in the Jupyter notebooks every class day.
ELO 1.2 Engage in an advanced, in-depth, scholarly exploration of the topic or idea of the theme.	Students will apply their new knowledge to the analysis of a variety of situations in the computer labs throughout the course, every class day. They will use the implementation of physics in their game engines to thoroughly explore the data and outcomes of the simulated process. A central component of the course is the research project. Students will learn the necessary physics knowledge, numerical methods and coding skills from the start of the course, and will then pick a topic for their own game or simulation research project by week 6. In a series of scaffolding assignments, the students will build up to their final project presentation and report. In this research project, they will - Define a situation in a game or simulation that stems from a real-world physics process, and a goal for the game or specific question to be answered by the simulation. -Formulate a model, with appropriate physical laws and parameters for the situation, that they will implement in code. - Discuss why they chose the specific numerical methods and physics description, and how well it works, or doesn't work for the given situation. - Analyze and critically interpret the results. - Discuss potential further steps and challenges. - Present their results both in a 10 – 15 minute oral presentation and in a written report. Carrying out this research project clearly requires an advanced, in-depth, scholarly exploration of the chosen research problem.

ELO 2.1 Identify, describe, and synthesize approaches or experiences as they apply to the theme.	In this course, students will learn about physics and will be exposed to several standard approaches to modeling and simulating natural phenomena. They will learn how to turn physical laws into algorithms. In several of the Jupyter notebooks, they will need to identify the relevant aspects of a problem, and find an appropriate way to build their game or simulation, using one or more methods discussed and demonstrated in the course. This will allow them to synthesize the material, and apply it to new questions. For example, in the first simulation notebook, a skydiver's fall with an open parachute is simulated. In this computer lab activity, students first have to formulate an expectation for the terminal velocity that is reached, and then compare this to numerical results from the simulation. Then, they have to investigate the effects of the chosen time step for the simulation on the results (too large timesteps result in un-physical behavior), and identify the reason for this dependence – the algorithm used incorporates an approximation valid for small time steps only, and the process analyzed here happens very quickly. Students will then reason about how to fix the time step, and try this out. They will be able to observe that results for the terminal velocity will be independent of the time step once the time step is small enough. From this computer lab activity, they will be able to apply their new knowledge on numerical validity of approximations to all following course activities, and their final project.
ELO 2.2 Demonstrate a developing sense of self as a learner through reflection, self-assessment, and creative work, building on prior experiences to respond to new and challenging contexts.	Students will carry out a research project in this course. The students will be guided to a successful completion of this project through a series of scaffolding assignments. In this process, they have several opportunities to set goals (First Game/Simulation Design Assignment, Week 6), evaluate their progress towards these goals, and identify remaining problems (Game/Simulation Progress Report, Week 9, and First Game/Simulation Submission, Week 10). During this process, they will be working with clearly formulated questions and rubrics, and they will receive continual feedback to help them with their own reflections and progress. In order to further develop their skills as researchers, they will serve as peer reviewers for the First Game/Simulation Design Assignment and the First Game/Simulation Submission. With this role change from researcher to reviewer, they will learn how to give constructive feedback, and will broaden their perspective by engaging with the projects of their class mates.

Example responses for proposals within "Citizenship" (from Sociology 3200, Comm 2850, French 2803):

ELO 1.1 *Engage in critical and logical thinking.*	*This course will build skills needed to engage in critical and logical thinking about immigration and immigration related policy through:* *Weekly reading response papers which require the students to synthesize and critically evaluate cutting-edge scholarship on immigration;* *Engagement in class-based discussion and debates on immigration-related topics using evidence-based logical reasoning to evaluate policy positions;* *Completion of an assignment which build skills in analyzing empirical data on immigration (Assignment #1)* *Completion 3 assignments which build skills in connecting individual experiences with broader population-based patterns (Assignments #1, #2, #3)* *Completion of 3 quizzes in which students demonstrate comprehension of the course readings and materials.*
ELO 2.1 *Identify, describe, and synthesize approaches or experiences.*	*Students engage in advanced exploration of each module topic through a combination of lectures, readings, and discussions.* *<u>Lecture</u>* *Course materials come from a variety of sources to help students engage in the relationship between media and citizenship at an advanced level. Each of the 12 modules has 3-4 lectures that contain information from both peer-reviewed and popular sources. Additionally, each module has at least one guest lecture from an expert in that topic to increase students' access to people with expertise in a variety of areas.* *<u>Reading</u>*

	The textbook for this course provides background information on each topic and corresponds to the lectures. Students also take some control over their own learning by choosing at least one peer-reviewed article and at least one newspaper article from outside the class materials to read and include in their weekly discussion posts. *<u>Discussions</u>* *Students do weekly discussions and are given flexibility in their topic choices in order to allow them to take some control over their education. They are also asked to provide* *information from sources they've found outside the lecture materials. In this way, they are able to* *explore areas of particular interest to them and practice the skills they will need to gather information* *about current events, analyze this information, and communicate it with others.* *Activity Example: Civility impacts citizenship behaviors in many ways. Students are asked to choose a TED talk from a provided list (or choose another speech of their interest) and summarize and evaluate what it says about the relationship between civility and citizenship. Examples of Ted Talks on the list include Steven Petrow on the difference between being polite and being civil, Chimamanda Ngozi Adichie's talk on how a single story can perpetuate stereotypes, and Claire Wardle's talk on how diversity can enhance citizenship.*
ELO 2.2 *Demonstrate a developing sense of self as a learner through reflection, self-assessment, and creative work, building on prior experiences to respond to new and challenging contexts.*	*Students will conduct research on a specific event or site in Paris not already discussed in depth in class. Students will submit a 300-word abstract of their topic and a bibliography of at least five reputable academic and mainstream sources. At the end of the semester they will submit a 5-page research paper and present their findings in a 10-minute oral and visual presentation in a small-group setting in Zoom.* *Some examples of events and sites:* *The Paris Commune, an 1871 socialist uprising violently squelched by conservative forces* *Jazz-Age Montmartre, where a small community of African-Americans–including actress and singer Josephine Baker, who was just inducted into the French Pantheon–settled and worked after World War I.* *The Vélodrome d'hiver Roundup, 16-17 July 1942, when 13,000 Jews were rounded up by Paris police before being sent to concentration camps* *The Marais, a vibrant Paris neighborhood inhabited over the centuries by aristocrats, then Jews, then the LGBTQ+ community, among other groups.*

Goals and ELOs unique to Number, Nature, Mind

Below are the Goals and ELOs specific to this Theme. As above, in the accompanying Table, for each ELO, describe the activities (discussions, readings, lectures, assignments) that provide opportunities for students to achieve those outcomes. The answer should be concise and use language accessible to colleagues outside of the submitting department or discipline. The ELOs are expected to vary in their "coverage" in terms of number of activities or emphasis within the course. Examples from successful courses are shared on the next page.

GOAL 3: Successful students will experience and examine mathematics as an abstract formal system accessible to mental manipulation and/or mathematics as a tool for describing and understanding the natural world.

	Course activities and assignments to meet these ELOs
ELO 3.1 Analyze and describe how mathematics functions as an idealized system that enables logical proof and/or as a tool for describing and understanding the natural world.	This whole course is centered around ELO 3.1 – we use mathematics to represent physical laws, develop and implement algorithms, generate numerical results, and evaluate discuss how these results help us understand the natural world. Students will learn about the physics underlying many computer games and simulations, including kinematics in three dimensions, Newton's Laws, circular motion, universal gravitation, momentum, collisions, and sound. Students will explore and actively pursue the process of doing science: asking questions and defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating and communicating information. Students will learn about idealized, approximated situations and ways to describe the situation more realistically using numerical methods eg projectile motion without air resistance, projectile motion with air resistance, and projectile motion with air resistance with changing air density. Students will learn which situation requires which level of realistic description, how to achieve this in practice, and what the consequences of non-physical choices are. Students will learn how to turn physical laws into algorithms for the computation of simulated events. Students will use provided Jupyter notebooks and learn how to modify these notebooks or write their own, simple Python code, how to analyze and visualize data and how to create simple physics animations. Students will learn to use and edit Jupyter notebooks to run physics engines for games and simulations. Students will learn that many science applications require approaches very similar to the ones used in video games and simulations, and how their skills and knowledge gained in this class can be transferred to conduct scientific research.

Example responses for proposals within "Citizenship" (Hist/Relig. Studies 3680, Music 3364; Soc 3200):

ELO 3.1 *Describe and analyze a range of perspectives on what constitutes citizenship <u>and</u> how it differs across political, cultural, national, global, and/or historical communities.*	*Citizenship could not be more central to a topic such as immigration/migration. As such, the course content, goals, and expected learning outcomes are all, almost by definition, engaged with a range of perspectives on local, national, and global citizenship. Throughout the class students will be required to engage with questions about what constitutes citizenship and how it differs across contexts.* *The course content addresses citizenship questions at the global (see weeks #3 and #15 on refugees and open border debates), national (see weeks #5, 7-#14 on the U.S. case), and the local level (see week #6 on Columbus). Specific activities addressing different perspectives on citizenship include Assignment #1, where students produce a demographic profile of a U.S-based immigrant group, including a profile of their citizenship statuses using U.S.-based regulatory definitions. In addition, Assignment #3, which has students connect their family origins to broader population-level immigration patterns, necessitates a discussion of citizenship. Finally, the critical reading responses have the students engage the literature on different perspectives of citizenship and reflect on what constitutes citizenship and how it varies across communities.*
ELO 3.2 *Identify, reflect on, and apply the knowledge, skills and dispositions required for intercultural competence as a global citizen.*	*This course supports the cultivation of "intercultural competence as a global citizen" through rigorous and sustained study of multiple forms of musical-political agency worldwide, from the grass-roots to the state-sponsored. Students identify varied cultural expressions of "musical citizenship" each week, through their reading and listening assignments, and reflect on them via online and in-class discussion. It is common for us to ask probing and programmatic questions about the musical-political subjects and cultures we study. What are the possibilities and constraints of this particular version of musical citizenship? What might we carry forward in our own lives and labors as musical citizens Further, students are encouraged to apply their emergent intercultural competencies as global, musical citizens in*

	their midterm report and final project, in which weekly course topics inform student-led research and creative projects.
ELO 2.1 *Examine, critique, and evaluate various expressions and implications of diversity, equity, inclusion, and explore a variety of lived experiences.*	*Through the historical and contemporary case studies students examine in HIST/RS 3680, they have numerous opportunities to examine, critique, and evaluate various expressions and implications of diversity, equity, and inclusion, as well as a variety of lived experiences. The cases highlight the challenges of living in religiously diverse societies, examining a range of issues and their implications. They also consider the intersections of religious difference with other categories of difference, including race and gender. For example, during the unit on US religious freedom, students consider how incarcerated Black Americans and Native Americans have experienced questions of freedom and equality in dramatically different ways than white Protestants. In a weekly reflection post, they address this question directly. In the unit on marriage and sexuality, they consider different ways that different social groups have experienced the regulation of marriage in Israel and Malaysia in ways that do not correspond simplistically to gender (e.g. different women's groups with very different perspectives on the issues).* *In their weekly reflection posts and other written assignments, students are invited to analyze the implications of different regulatory models for questions of diversity, equity, and inclusion. They do so not in a simplistic sense of assessing which model is "right" or "best" but in considering how different possible outcomes might shape the concrete lived experience of different social groups in different ways. The goal is not to determine which way of doing things is best, but to understand why different societies manage these questions in different ways and how their various expressions might lead to different outcomes in terms of diversity and inclusion. They also consider how the different social and demographic conditions of different societies shape their approaches (e.g. a historic Catholic majority in France committed to laicite confronting a growing Muslim minority, or how pluralism *within* Israeli Judaism led to a fragile and contested status quo arrangement). Again, these goals are met most directly through weekly reflection posts and students' final projects, including one prompt that invites students to consider Israel's status quo arrangement from the perspective of different social groups, including liberal feminists, Orthodox and Reform religious leaders, LGBTQ communities, interfaith couples, and others.*
ELO 2.2 *Analyze and critique the intersection of concepts of justice, difference, citizenship, and how these interact with cultural traditions, structures of power and/or advocacy for social change.*	*As students analyze specific case studies in HIST/RS 3680, they assess law's role in and capacity for enacting justice, managing difference, and constructing citizenship. This goal is met through lectures, course readings, discussion, and written assignments. For example, the unit on indigenous sovereignty and sacred space invites students to consider why liberal systems of law have rarely accommodated indigenous land claims and what this says about indigenous citizenship and justice. They also study examples of indigenous activism and resistance around these issues. At the conclusion of the unit, the neighborhood exploration assignment specifically asks students to take note of whether and how indigenous land claims are marked or acknowledged in the spaces they explore and what they*

	learn from this about citizenship, difference, belonging, and power. In the unit on legal pluralism, marriage, and the law, students study the personal law systems in Israel and Malaysia. They consider the structures of power that privilege certain kinds of communities and identities and also encounter groups advocating for social change. In their final projects, students apply the insights they've gained to particular case studies. As they analyze their selected case studies, they are required to discuss how the cases reveal the different ways justice, difference, and citizenship intersect and how they are shaped by cultural traditions and structures of power in particular social contexts. They present their conclusions in an oral group presentation and in an individually written final paper. Finally, in their end of semester letter to professor, they reflect on how they issues might shape their own advocacy for social change in the future.

Research and Creative Inquiry Course Inventory

Overview

The GE allows students to take a single, 4+ credit course to satisfy a particular GE Theme requirement if that course includes key practices that are recognized as integrative and high impact. Courses seeking one of these designations need to provide a completed Integrative Practices Inventory at the time of course submission. This will be evaluated with the rest of the course materials (syllabus, Theme Course submission document, etc). Approved Integrative Practices courses will need to participate in assessment both for their Theme category and for their integrative practice.

Please enter text in the boxes below to describe how your class will meet the expectations of Research and Creative Inquiry courses. It may be helpful to consult with the OSU Office of Undergraduate Research and Creative Inquiry. You may also want to consult your Director of Undergraduate Studies or appropriate support staff person as you complete this Inventory and submit your course.

Please use language that is clear and concise and that colleagues outside of your discipline will be able to follow. You are encouraged to refer specifically to the syllabus submitted for the course, since the reviewers will also have that document. Because this document will be used in the course review and approval process, you should be *as specific as possible*, listing concrete activities, specific theories, names of scholars, titles of textbooks etc.

Accessibility

If you have a disability and have trouble accessing this document or need to receive it in another format, please reach out to Meg Daly at daly.66@osu.edu or call 614-247-8412.

Pedagogical Practices for Research and Creative Inquiry Courses

Course subject & number	Physics 2110

Undergraduate research is defined by the Council on Undergraduate Research (CUR) as an inquiry or investigation conducted by an undergraduate student that makes an *original* intellectual or *creative* contribution to the discipline. Undergraduate creative activity is the parallel to research, engaging in a rigorous creative process using (inter)disciplinary methods to produce new work.

In the context of the 4-credit GEN Theme High Impact Practice (which, by definition, is a more robust course than a non-HIP 3-credit Theme course—since student will take one 4-credit course instead of taking two 3-credit courses), research or creative inquiry requires a level of rigor and engagement that goes beyond what is routinely already included in a 3-credit Theme course in that discipline. It will generally mean that students are either (1) instructed in and engage in original research and the production and/or analysis of new understanding or data used in the preparation of a final paper, report, or project characteristic of the discipline, *or* (2) they are instructed in and engage in the primary production and performance or display of new creative work characteristic of the discipline.

Further comments and clarifications:

- The Creative Inquiry or Research component should be integrated throughout a *substantial* portion of the course (not just at the very end, for example).
- The Creative Inquiry or Research component should connect to the Theme and to the subject/content of the course. If the course at hand is requesting two Themes, then the research component or creative work should fully pertain to both Themes.

1. <u>Disciplinary expectations and norms</u>: Different disciplines at the university define original research and creative inquiry differently. Please explain what the expectations/norms of your discipline are for original research or creative inquiry. How is new understanding developed in your field? How does the creative process amplify knowledge in the field? (This information should also be readily visible on the syllabus.)

Physics is a quantitative science that uses mathematics as the language for underlying theories and analysis of problems. In physics research, we typically have a theoretical model that makes predictions. These predictions are obtained using both analytical methods (“paper and pencil” calculations) and numerical methods. For much of (current) physics research, numerical methods are required. The results of calculations and computations are compared to experimental data, and conclusions are drawn, leading to the modification of theoretical models, or to the search for new experiments that may challenge the theory further. In order to fully understand the meaning and implications of a theory, we investigate the predicted behavior for different conditions, and check if e.g., predicted results for different values of a parameter make sense. This is how we develop an understanding of physics, in contrast to just obtaining a numerical result for something.

In this course, students will learn some basic physics knowledge, acquire coding skills, and learn about basic numerical methods. The students will apply all this to the implementation of original game physics engines or simulations. This constitutes an independent, creative research project. Students will also learn how to analyze, interpret andevaluate data from these game engines or simulations, and how to present their findings in a manner expected from a physicist.

While the topic of the course is ``The Physics of Computer Games and Simulations'' a realistic computer game is nothing but a close description of nature, and simulations abound in science and technology, from lattice gauge theories to detector acceptances to forest fires and stadium exit paths and times. Thus, students will be exposed to the methods of cutting-edge science in an environment that will feel attractive and manageable to them, seeing that they are all acquainted with computer games.

2. <u>Teaching methods and practices</u>: Which class activities and materials will be used to <u>teach</u> students the research methodology and/or research practices or the methods and practices of creative inquiry typical or relevant in your discipline? How will the potential ethical implications for research or creative inquiry in the field be addressed in the course? (This information should also be readily visible on the syllabus.)

The students will perform many mini-research projects by working through the provided Jupyter notebooks during the recitations. There, they will engage in all aspects of a computational physics research project: formulate a clear question (what is the condition for winning the game? What do I wish to learn from my simulation? What is the best strategy to apply thrust to the lunar lander?), implement physical laws and numerical methods in Python code, test that this code performs as expected, and analyze the results. While not every recitation activity will include all the aspects mentioned above, every activity will include some of them. In this way, the students can build up all the necessary skills for a research project.

Besides these hands-on learning opportunities, the lectures will deal with not just physics and relevant numerical methods, but also with how to organize research, how to choose a topic, and how to present results in a manner appropriate for the sciences.

The research project itself is scaffolded through a series of assignments starting with the First Design Assignment due in week 6.

While the topics of computer games and simulations are in general not related to ethical issues, ethics come into play in two aspects: 1) it is extremely important for scientists to be honest about their results, and to admit if something cannot be fully investigated or understood. Often, scientific investigations or technical simulations have very concrete real-world applications, and problems with badly performed science may lead to severe real-world issues. 2) Just like in the research practice of the field of physics, students will be required to perform peer reviews according to given standards. The students will receive in-class instruction, and rubrics, for performing these reviews. After seeing this process several times, and from both sides, the students will be able to understand and appreciate the responsibility of peer review better.

3. <u>Implementing</u>: Through which class activities and materials will the students be given opportunities to <u>practice</u> disciplinary research or creative inquiry techniques, methods, and skills to create new knowledge or advance praxis? (This information should also be readily visible on the syllabus.)

During lecture, students will work together in small groups on handouts, and in recitation, they will work on Jupyter notebooks. In each of these activities, aspects of research are introduced and practiced. With the knowledge from class activities and the practice from recitation, the students will then tackle a scaffolded research project.

As described in the syllabus, the individual assignments for the research project are:

- First Design Assignment
- Peer Review of the First Design Assignment
- Game/Simulation Building Progress Report
- First Game/Simulation Submission
- Peer Review of the First Game/Simulation Submission
- Oral Presentation
- Peer Review of the Oral Presentation
- Final Report

4. <u>Demonstration of competence</u>: Disciplines develop and share new knowledge or creative work in different ways. Through which activity or activities will students first be taught and then be involved in a demonstration of competence in an appropriate format for the discipline (e.g., a significant public communication of research, display of creative work, or community scholarship celebration)? The form and standard should approximate those used professionally in the field. (**This information should also be readily visible on the syllabus.**)

The research project culminates in an individual oral presentation to the class and a final written report on the project. Communication of physics research mainly happens in two venues: research journals and conferences. The final report will follow the general rules for a journal article, and the presentation will adhere to the standards of presentations for conferences. During lecture, the students will learn about professional standards for communication, including structure, formatting, data visualization and appropriate software tools to create presentations.

5. Scaffolding and mentoring: Explain how the creative inquiry or research project will be scaffolded across multiple assignments or one large project broken up across the course (e.g., specific explanations about reviewing literature, developing methods, collecting data, interpreting or developing a concept or idea into a full-fledged production or artistic work). Each pertinent assignment should help students build and demonstrate skills contributing to the larger project. Meaningful feedback and mentoring should be provided by the instructor at regular intervals to inform next steps in the process. (This information should also be readily visible on the syllabus.)

Information about the expectations for the research project will be discussed in lecture starting in week 1, and in regular intervals, relevant questions and information for the research project will be discussed in lecture, eg how to pick a good research question in week 2, overview of potential research topics in week 3, how to test a game or simulation in week 4, specific expectations for the research project and individual assignments in weeks 5 and 6.
The research project itself consists of a number of scaffolding assignments, with feedback from peers and the instructor built in. In particular, the First Design Assignment, The Game/Simulation Building Progress Report, and The First Game/Simulation Submission assignments provide ample opportunity to check in and discuss the feasibility and appropriate progress towards the completion of the research project.
As described in the syllabus, the individual assignments for the research project are:

- First Design Assignment
- Peer Review of the First Design Assignment
- Game/Simulation Building Progress Report
- First Game/Simulation Submission
- Peer Review of the First Game/Simulation Submission
- Oral Presentation
- Peer Review of the Oral Presentation
- Final Report

6. Reflection: Explain how the course offers students opportunities for reflection on their own developing skills and their status as learners and as researchers or creatives. (This information should also be readily visible on the syllabus.)

An important part of solving any problem in physics, and even more so for completing a research project in physics, is to assess if the results obtained make sense, and how they fit in with the body of knowledge of the field. This will be practiced throughout the course, as students will always be asked to check if their results make sense.
A major opportunity for self reflection will be provided by the peer review assignments. There are three in total, for the First Design Assignment, the First Model Submission, and the oral presentation. Serving as a peer reviewer will allow students to step out of their student role and step into a reviewer role. This will allow them to also see their own work from a different perspective, and to learn and incorporate what others will expect out of their research work.
In both their oral presentation and their final written report, the students will be expected to reflect on the value, questions answered and open questions related to their project.

Outlook

Re: Seeking concurrence for Physics 2110

From Williamson, Donald <williamson.413@osu.edu>
Date Fri 8/29/2025 2:18 PM
To Heckler, Andrew <heckler.6@osu.edu>; Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>; Jeschonnek, Sabine <jeschonnek.1@osu.edu>; Bundschuh, Ralf <bundschuh.2@osu.edu>
Cc Arora, Anish <anish@cse.ohio-state.edu>; Ramnath, Rajiv <ramnath.6@osu.edu>

Hi Andrew,

The CSE curriculum committee has reviewed this course and has no major concerns. However, since it includes a Python component, we recommend suggesting that students take CSE 1224: Introduction to Computer Programming in Python, to help mitigate any challenges related to understanding Python while learning Physics.

Best,

Donald S. Williamson
Associate Professor
Director, The ASPIRE Group
Affiliated faculty, Translational Data Analytics Institute
Computer Science and Engineering
493 Dreese Labs, 2015 Neil Ave, Columbus, OH 43210
williamson.413@osu.edu

THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

From: Heckler, Andrew <heckler.6@osu.edu>
Date: Wednesday, August 13, 2025 at 9:44 AM
To: Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>, Jeschonnek, Sabine <jeschonnek.1@osu.edu>, Bundschuh, Ralf <bundschuh.2@osu.edu>, Williamson, Donald <williamson.413@osu.edu>
Cc: Arora, Anish <anish@cse.ohio-state.edu>, Ramnath, Rajiv <ramnath.6@osu.edu>
Subject: RE: Seeking concurrence for Physics 2110

OK, thanks Eric. As for the deadline, we are submitting the course to ASC this week. I imagine it may take some time to process, so it seems to me that the concurrence review can happen in parallel. I will let Donald Williamson know of imminent deadlines.

Thanks, Andrew

--
Andrew Heckler
Professor
Vice Chair for Administration
Department of Physics
Ohio State University

From: Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>
Sent: Wednesday, August 13, 2025 7:42 AM
To: Heckler, Andrew <heckler.6@osu.edu>; Jeschonnek, Sabine <jeschonnek.1@osu.edu>; Bundschuh, Ralf <bundschuh.2@osu.edu>; Williamson, Donald <williamson.413@osu.edu>
Cc: Arora, Anish <anish@cse.ohio-state.edu>; Ramnath, Rajiv <ramnath.6@osu.edu>
Subject: FW: Seeking concurrence for Physics 2110

Hi Andrew,

I'm on duty as acting chair until tomorrow (and Anish is traveling at the moment), so Anish forwarded this to me.

I'm duly forwarding it to our curriculum committee chair (Donald Williamson), with an FYI to our Associate Chair for Academic Programs (Rajiv Ramnath). Please let Donald know how soon you need it - the timing is a bit awkward since we don't have our committees up and running yet. Donald or Anish will get back to you with the reply.

Best wishes,
-Eric

Eric Fosler-Lussier
John I. Makhoul Professor and Acting Chair, CSE
Professor by Courtesy of Linguistics and Biomedical Informatics
Dept. of Computer Science and Engineering, The Ohio State University
fosler-lussier.1@osu.edu

Nodie Antoine
Interim Assistant to Chair and Associate Chairs
antoine.28@osu.edu

From: Arora, Anish <anish@cse.ohio-state.edu>
Date: Wednesday, August 13, 2025 at 6:07 AM
To: Fosler-Lussier, Eric <fosler@cse.ohio-state.edu>
Subject: Fw: Seeking concurrence for Physics 2110

From: Heckler, Andrew <heckler.6@osu.edu>
Sent: Tuesday, August 12, 2025 3:52:55 PM
To: Arora, Anish <anish@cse.ohio-state.edu>
Cc: Jeschonnek, Sabine <jeschonnek.1@osu.edu>; Bundschuh, Ralf <bundschuh.2@osu.edu>
Subject: Seeking concurrence for Physics 2110

Dear Prof. Arora,

The physics department is submitting for approval a new course entitled: "The Physics of Computer Games and Simulations". This course is a GEN Themes course. The syllabus is attached.

Since this course involves computational modeling, we would like to seek concurrence from the Department of Computer Science and Engineering. Responding to this email with a confirmation of concurrence is sufficient.

Please let us know if you have any questions or concerns or need further information.

Thanks and regards, Andrew

--
Andrew Heckler
Professor
Vice Chair for Administration
Department of Physics
Ohio State University