

Coding Integration into High School Physics using STEMcoding Project Resources

One week intermediate-level course

Instructor:

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Course Meetings:

Videoconferences on zoom (typically at 1pm EST unless otherwise noted)

Dates: July 22 - July 26, 2024

Final exam: No final exam

Course web page: <http://stemcoding.herokuapp.com>

Intermediate level?

This course occurs after an absolute-beginner-level one-week course July 15 - July 19, 2024. The activities in the absolute-beginner course are simple enough that they could be used (and have been used) in high school physical science classes. The activities in this “intermediate level” course are designed for non-AP physics level courses, and college algebra-based introductory physics courses.

Participating in the absolute beginner level course is **not** a requirement for taking this intermediate level course. Experienced physics teachers with little to no programming experience are welcome to skip the absolute beginner level course and start with this intermediate level course, so long as they have plenty of time during July 22 - July 26 to participate. You will find that your physics knowledge will often be helpful in modifying the codes and noticing problems with the programs.

Teachers who have recently been assigned to teach physics for the first time may struggle with the pace of this course and find the absolute beginner level course to be much more appropriate and comfortable.

Specific Goals/Rationale

The goal of this particular course is to show teachers how computer programming exercises can be integrated into high school physics (AP or non-AP) in a simple, fun and engaging way.

The basis of this course is a set of computer programming exercises that Prof. Orban developed (at least initially) for freshman physics courses on OSU’s Marion campus. Over a thousand college and high school students, many of whom have never written a computer program before, have successfully completed these exercises. As discussed in Orban et al. 2018 (<https://aapt.scitation.org/doi/10.1119/1.5058449>) surveys of students at OSU Marion seem to indicate that the content is at an appropriate difficulty level, even for absolute beginner programmers.

Videoconferencing

We will regularly use videoconferencing on Zoom as part of the course. Please download zoom from <https://zoom.us> If you cannot get zoom working on a computer or laptop, you can use teams on a smartphone or tablet instead. **You should not have to pay anything to use Zoom to participate in this course!**

Zoom sessions **will** be recorded so that people traveling can catch up later.

Strings attached?

There is no specific requirement that you will use these activities in your courses in the coming academic year. Ultimately it is up to you to decide how pervasive you want to make computer programming activities in your own course. There are no “strings attached” to your participation in this course. There is no funded grant that requires you to you participate in an ongoing study.

Relevancy to Science, Computer Science and Math Standards

The Next Generation Science Standards (NGSS), which is the basis of most state science standards in the US, includes “computational thinking” as one of its core practices. For an in-depth discussion of how activities like these align with com-

putational thinking please consult this paper: Orban & Teeling-Smith 2020 <https://doi.org/10.1119/1.5145470> which is published in The Physics Teacher. A free version of this paper is available at this link: <https://arxiv.org/abs/1907.08079>

Regarding the specific statements in the NGSS that outline important science learning objectives, the activities that will be discussed in this course do align with many of these statements. A google document that summarizes the alignment between NGSS and the STEMcoding activities in this course is accessible from this link: <http://go.osu.edu/ngss>

Increasingly, states are adopting or creating K12 computer science (CS) standards. Typically these standards are derived from a national set of standards approved by CSTA. For the most part, these state CS standards can be interpreted as a blanket permission to include computer science and computational thinking oriented activities in K12 science and math classes. We believe our activities line up well against state and national CS standards to the point where one could use these activities as the basis for a computer science course. We are happy to discuss more specifics of CS standards if you are interested.

Regarding math standards, the activities in this course involve algebra 1, algebra 2 and trigonometry level concepts including working with 2D plots with x and y axes. The STEMcoding activities in this course do NOT involve or require any calculus.

Expected Learning Outcomes

1. Teachers will learn how to use a computer code to solve physics problems in an iterative way
2. Teachers will learn about potential pitfalls and common mistakes that students make in completing physics-focused computer programming exercises
3. Teachers will learn some of the limitations of using a computer code to iteratively solve physics problems (e.g. energy conservation, lack of perfect agreement with analytic expectations)
4. Teachers will become familiar with assessment questions designed to probe student conceptual knowledge gains from completing physics-focused computer programming exercises
5. Teachers will become familiar with the <http://stemcoding.herokuapp.com> learning management system

How the Learning Objectives will be met

1. Teachers will complete a set of physics-focused computer programming exercises that solve physics problems in an iterative way, and often in an interactive way
2. After completing each exercise, teachers will read through a set of detailed instructor notes outlining potential pitfalls and common mistakes
3. Many of the exercises include comparisons to analytic expectations. Teachers will learn the limitations of the codes by completing the exercises and in discussions with Prof. Orban
4. Teachers will complete pre and post assessments for each exercise. These assessments are the same that students would complete.
5. After completing the exercises teachers will learn to set up a course in the <http://stemcoding.herokuapp.com> learning management system

Texts and Required Material

There is no required text for this course. All of the exercises are available at <http://stemcoding.herokuapp.com>

STEMcoding Learning Management System (stemcoding.herokuapp.com)

OSU created a custom-built learning management system for Prof. Orban's coding activities which is available at <http://stemcoding.herokuapp.com>. Please register an e-mail address on <http://stemcoding.herokuapp.com> and use the course join key AAPTSummer2024Intermediate You can register any e-mail you want with the system. It does not have to be your school e-mail. At the end of the course you will be given "teacher" status on the learning management system so you can set up your own courses and grade student submissions. The fees you pay for this course provide you with unlimited use of <http://stemcoding.herokuapp.com> for one year. Following that, the rate will be \$50 per teacher per year. Student use of the site is free and teachers can enroll an unlimited number of students on the system.

This learning management system has been used successfully on various operating systems, including chromebooks and iPads.

What programming language is involved?

The activities in this course involve modifying and running javascript programs. For people with experience working with C, C++ or Java code, this language will seem very familiar. We do not currently use python or vpython in our activities. Python uses indentation instead of curly brackets to define the logic of the program, which means that just adding a space to the code in the wrong place could change the behavior of the program and lead to confusion. (However, many people argue that the role of indentation in python helps students avoid writing sloppy looking code.) We may set up a python version of our activities in the future if there is interest.

Participants with Disabilities

Any teacher who feels that they may need an accommodation based on the impact of a disability should contact us to discuss their specific needs.

Grading:

Teachers who complete required exercises will earn an A in the course. The exercises are available on <http://stemcoding.herokuapp.com>

Required exercises:

1. Planetoids
2. Lunar Descent
3. Bellicose Birds
4. Planetoids with momentum
5. Planetoids with torque
6. Particle accelerator

Optional: STEMcoding Slack Channel

In the previous summers that this course has been offered, teachers have often wanted to talk to each other during the course. To facilitate this we have a “slack channel” at <http://stemcoding.slack.com> You can add yourself to this slack channel by clicking this link

Tentative Course Schedule

(all times are Eastern Standard Time)

	Dates	Topic / Item	Assignments due
Week 1	July 22	video chat at 1pm	Planetoids
	July 23	video chat at 1pm	Lunar Descent / Bellicose birds
	July 24	video chat at 1pm	Planetoids with momentum
	July 25	video chat at 1pm	Planetoids with torque & Particle accelerator
	July 26	video chat at 1pm	Discussion about other activities