Course Overview & Purpose

Physical Computing refers to a creative framework involving the use of hardware and software to build interactive systems that can sense and respond to the real world. It is an emerging and rapidly-growing area that seeks to understand and modulate human beings' relationship to the digital world.

This course in Physical Computing incorporates the use of microcontrollers, sensors, and actuators to read input signals measuring the state of the world and produce output that controls electromechanical devices such as motors, servos, and lights. The course is organized around a series of practical hands-on exercises that introduce the fundamentals of circuits, embedded programming, sensor input processing, simple mechanisms, actuation, and time-
In this course, we seek to extend our idea of a computer from a black box, operating in isolation of its environment, with an interface limited to mouse, keyboard, and monitor, to one that plays a central role in actions and reactions to external physical phenomena, especially those that relate to the expressive capabilities of the human being. We will explore how physical objects create experiences, seeking to gain a deeper understanding of how physical interactions and collaboration can enrich information in devices and enhance creativity in people.

**COURSE MATERIALS**

There is no required textbook for this course. Readings of online articles and texts will be assigned occasionally.

Students are **required** to purchase an Arduino-based starter kit. The recommended kit is the **Elegoo UNO Project Super Starter Kit** available from Amazon or directly from [http://www.elegoo.com](http://www.elegoo.com). Depending on your selection of projects for this course, you may need to purchase additional hardware components.

We will be using the **Arduino software** environment extensively for this course. You may download the software (free) from [arduino.cc](http://arduino.cc) and install it on your own computer. We will also use **Processing**, available from [processing.org](http://processing.org).

**REQUIREMENTS / EVALUATION COMPONENTS**

**Participation and Attendance**

- Showing up on time, engaging in class discussion, and offering advice and critique on other projects in the class is a major part of your grade. Please be present and prompt. Late attendance and excessive absence affects your grade adversely. If you’re going to be late or absent, please email me in advance. If you have an emergency, please let me know.

**Lab Assignments**

- There will be one or more lab activities most weeks of the semester. These will be short, simple activities that exercise basic steps you need to go through to understand the principles demonstrated in lecture each week. They are designed to help you not only understand the technical details, but also get a feel for what the technologies we are discussing can do, so that you can incorporate them into actual applications. There will be application suggestions in many of them as well.

I expect that each of you will complete the steps outlined in the lab activities each week, so that you understand practically what we've been talking about. After completing each activity or assignment, you are to document in your blog (see below) any discoveries you make, pitfalls you hit, and key details not covered in class or the

**STUDENT LEARNING OUTCOMES**

By the end of this course you will be able to build systems that use digital and analog inputs and outputs, sensors, actuators, motors, and serial communication to create engaging interactions with purposes ranging from practical to whimsical. You will be able to use the Arduino prototyping platform and its programming language (basic C) to realize these interactive physical systems. You will also be expected to explain and present your ideas and developments in written and oral form.
lab writeup that you think would be useful for your fellow students or future students in the class.

**Activities and Projects** • There will be several homework “activities” and more substantial projects assigned during the semester, including a final project. You will be expected to spend a substantial amount of time (up to 8 hours/week) **outside of class** working on projects. You will present your final projects during the last week of the course and/or the final exam period.

**Journal (Blog)** • You are required to keep an online course journal, in the form of a regularly-updated blog hosted at [http://berryphyscomp20.wordpress.com](http://berryphyscomp20.wordpress.com)

The purpose of the journal is three-fold. First, it is a valuable way for you to communicate to me that you are keeping up with the work in the class. I will read your journal to see how you are doing and to help me assess your completion of projects and assignments. Second, the journal is a place for you to showcase your efforts and build a portfolio of your work. Well-kept journals may function as a helpful resource for you (e.g. when job hunting) and for other students. Finally, understanding develops through reflection, and the best discipline for reflection is writing and drawing. Mere repetition of the examples does not build skill; it is the process of reflection which integrates experience into knowledge which can be applied to novel situations.

Details regarding the journal and an evaluation rubric are linked on the course website.

**ASSESSMENT MEASURES**

The determination of how well each student meets the learning outcomes described in the box on page 2 will be assessed by her/his overall grade in the course, based on the Evaluation

---

**Schedule of Class Sessions**

A detailed schedule for the semester will be maintained on the course website. A brief outline of weekly topics is as follows:

- **Week 1** – Welcome / Prototyping / Electronics
- **Week 2** – Schematics / Arduino
- **Week 3** – Digital Input/Output • Coding
- **Week 4-5** – Fundamental Techniques
- **Week 6** – Integrated Circuits
- **Week 7** – Analog Input
- **Week 8** – PWM • Audio • Motors
- **Week 9** – Interaction & Design • RTC/storage ICs
- **Week 10** – Processing • Serial Communication
- **Week 11** – Protocols • APIs • Network
- **Weeks 12 to 14** – Final project work

---

**GRADING SCALE**

Your overall course grade will be based on a weighted average of:

- 25% - Participation/attendance
- 25% - Projects
- 50% - Journal (blog) and weekly work

The minimum grade to attain an A will be an average of 90%, for a B 80%, for a C 70%, and for a D 60%. Plus and minus grades are assigned at the instructor’s discretion.
Components detailed above. A satisfactory level of competency will be demonstrated by earning a grade of 75% (C) or higher in the course.

Assignments and projects will be done in groups of two or three. Journal (blog) write-ups will be completed and assessed individually.

METHODS OF INSTRUCTION

We will meet twice a week this semester. We will use that time for a mixture of lecture, discussion, brainstorming, design, lab work, and presentation of assignments/projects.

ATTENDANCE POLICY

Attendance records will be kept. Please see the Berry College Viking Code for "Class Attendance Policies". Missing three (3) or more classes without justifiable reason (and advance notice/appropriate documentation) will be considered excessive absence and may be grounds for being administratively withdrawn from the course.

ACADEMIC INTEGRITY

Students are expected to have read carefully and understood the rules governing breaches of academic integrity that are to be found in the Viking Code and the Course Catalog. All work for this course (including projects, lab activities, and journal/blog entries) must be your own work. Projects and activities will be completed with your partners in your group. Your journal/blog entries are to be written by yourselves, individually. If you include material from other sources in your code or your blog write-up, give credit for it (a link or citation).

LATE WORK

Projects, assignments, and blog postings should be completed on time. For every day (24 hours) an evaluated piece of work is late, the grade will be reduced by 10%. Under no circumstances will work be accepted more than 5 days late.

ELECTRONIC DEVICES

Please do not use cell phones, music players, tablets, etc. in class. Do not use laptops or computers for other than course activities during class time. Working on anything not related to the course, texting, instant messaging, Facebook’ing, tweeting, emailing, and similar activities during class are inappropriate and distracting to everyone (and will result in points deducted from your class participation grade).

ACCOMMODATION STATEMENT

Students with disabilities who believe that they may need accommodation in this course are encouraged to contact the Academic Success Center in Evans Hall, Room 106 (706-233-4080), as soon as possible to ensure that such accommodations are implemented in a timely fashion.

Note: All information, schedules, and policies in this document are subject to change at the instructor’s discretion.
Inspirations

Ideas and material for this course are drawn heavily from several excellent courses taught at some of the best institutions in the country. They include:

**Introduction to Physical Computing** @ the Interactive Telecommunications Program (ITP) at the Tisch School of the Arts at New York University (NYU) • [http://itp.nyu.edu/physcomp/](http://itp.nyu.edu/physcomp/)

The quintessential Physical Computing course. The authors of the Physical Computing text listed below are both based in this program. Tom Igoe maintains a blog of resources for physical computing and networking ([http://www.tigoe.com/pcomp/code/](http://www.tigoe.com/pcomp/code/)).

---

### Instructor’s Bibliography

Listed here are some of the primary guides and references for the material covered in this course. All of these are available for reading in the lab (MAC 128). Please do not remove the books from the lab. Additional recommended texts and online resources will be posted on the course web page.


Includes much material covered in this course and lots of advanced examples as well. This book was developed from the Physical Computing course at NYU. The code examples in the book are not written for Arduino, but the concepts for each exercise apply to Arduino as well as the controllers described in the book. Even without the specific code, the examples can be useful, especially when combined with the labs in this class.


Introduction to communication between computers, including serial communications, wireless, networking, RFID, and more. Though some of the material is beyond the scope of this class, some of it may be useful in understanding computer communications.


A straightforward beginners’ guide to most of the beginning exercises in this class.


The recipes in this book provide solutions for most common problems and questions Arduino users have, including everything from programming fundamentals to working with sensors, motors, lights, and sound, or communicating over wired and wireless networks. You’ll find short, focused examples and advice you need to begin, expand, and enhance your projects.
Fundamentals of Physical Computing by Robert Faludi at the School of Visual Arts in New York City

• https://www.faludi.com/teaching/

SVA is one of the finest art schools in the country and offers an MFA program in Interaction Design (http://interactiondesign.sva.edu/).

The Interaction Design Programme @ the Copenhagen Institute of Interaction Design (in Denmark) • http://ciid.dk/education/

Offers courses in Physical Computing, Tangible User Interfaces, and Introduction to Interaction Design, among others. The portfolio (http://ciid.dk/education/portfolio/) offers presentations of projects from several years’ worth of offerings and can be a rich source of ideas for projects.

Berkeley Center for New Media - Various courses by Eric Paulos at UC, Berkeley

• http://www.paulos.net/teaching.html

Several interdisciplinary courses that span topics in computer science and behavioral and social sciences.

Introduction to Physical Computing @ CMU

• https://courses.ideate.cmu.edu/60-223

A course by the Integrative Design, Arts, and Technology (IDeATe) program - a network of areas that connect “diverse strengths across CMU to advance education, research and creative practice in domains that merge technology and arts expertise.”

The Tangible Media Group @ the MIT Media Lab

• http://tangible.media.mit.edu

Research papers and featured projects at this site provide lots of intriguing and stimulating ideas.

Electronics Suppliers

Most of our electronic components are bought online, so as you work on projects, we’ll have to take shipping time into account if we need to order components. Here are some of our regular sources:

› Adafruit (www.adafruit.com) is based in NYC, delivers fast, and has many components and modules that work well for this class. Their customer service on shipments is excellent, and their tutorials (learn.adafruit.com) are quite good too.

› SparkFun (www.sparkfun.com) has a wide range of components and modules to solve many common physical computing tech challenges. Based in Colorado, they’re also pretty fast on shipping, and good with the customer service.

› Amazon (www.amazon.com) and Ebay (www.ebay.com) can both be good sources for materials and components at competitive prices. Pay attention to shipment times though, especially for international sellers.

› Jameco (www.jameco.com) for all kinds of components and especially ICs.

There are many large distributors of bulk components like resistors, capacitors, transistors, etc. They’re not aimed at the hobbyist market, and their sites can seem a bit daunting at first, but they’re very useful as you get to know how to shop. I use Jameco (above) frequently, but Digikey (www.digikey.com), Mouser (www.mouser.com), and Newark (www.newark.com) are equally good alternatives.