Parsons School of Design
MFA Design + Technology
Physical Computing 1
PGTE 5585; CRN 1945
FALL 2019
Wednesdays, 19:00-21:40 @ 6 East 16th St. room 1204A

Professor

Phillip David Stearns
Contact: TBD
Office Hours: by Appointment
Course Materials Online: http://github.com/phillipdavidstearns/PGTE_5585_F2019 Slack Workspace: https://pgte5585f2019.slack.com

Physical Computing 1

Course Description

The physical and the digital are often thought of as distinct and disparate. This class will be an investigation into notions of physicality and interface with respect to the computer, and an exploration of related analog and digital technology. Students will complete a series of exercises that will encourage inquiry into these various technologies and the implications of a connection between or joining of physical and digital worlds. Basic electronics and various sensor mechanisms will be used in conjunction with toolkits such as Arduino. Students joining this class should be comfortable with code in general, have experience with one programming language or another, and be prepared to solder.

PLEASE NOTE: ***You should bring your tools, materials, and components to EVERY class.***

Goals

We are physical creatures that interact with the physical world using all our senses. This class will prepares you to move beyond the default modes of human computer interaction---keyboard, mouse, touchpad, touchscreen---and empower you to design and build customized experiences. The study of physical computing gives us a chance create interactions that capitalize on our full range of senses to create truly engaging and magical experiences for users.

Learning Outcomes

- The creation of engaging, tactile-rich experiences for users.
- The creation of fully functional and integrated prototypes.
- Detailed documentation of individual projects and lab exercises.
- Learning introductory theories and practices of electronic circuits.
- Becoming proficient in microcontroller programming.
- Learning to identify electronic components, and become literate in circuit schematics.
- Gain the ability to design and produce circuit boards.
- Explore conceptual models which will critique, enhance, and innovate in the space of Human Computer Interaction.

Course Structure

Overview

The course is structured as a combination of in-class learning activities, discussions and lab time in addition to a weekly outside assignment.

- Lectures: Introduction to the material, lab prep talk.
- Labs: Experimenting with a new language and techniques; Hands-on workshops.
- Studio: Think Tanks, Discussions, Critiques, Making.

Group Presentations

The best way to learn is to teach. --Frank Oppenheimer, founder of the Exploratorium

From Weeks 5 to 8, you will work in groups of 3-4 to teach us about a particular physical computing topic. You will choose groups in the second week. Each group will be assigned a topic and will work together to develop a lesson based on that topic. A brief will be provided to contextualize the topic and provide some starting points for your research and planning. You can email/Slack me at any point to get feedback or brainstorm your lesson.

Mid-Term Project

Students will be asked to devise a project that applies the skills and knowledge developed in the preceding weeks in the form of a conceptual prototype. A creative design prompt will be given in order to help seed ideas, get creative juices flowing, and provide a range of challenges to solve through physical computing.

Final Project

We will spend the final third of the semester focusing on your final project. Theme TBD based on class

interests. You are encouraged to collaborate and/or align this project with another class (i.e. major studio, thesis, etc). Presentations and projects are due the last day of class. Final documentation is due the following week (no exceptions!).

Communication

Please try to keep all communication to Slack. This is the *PRIMARY* mode of communication we will use for the class. You are *REQUIRED* to signup for a slack account with your Parsons email. You should receive an invitation to the class Slack located at pgte5585f2019.slack.com. I will post *ALL* announcements/updates here, so it is up to you to check it regularly. If you have questions about a circuit, assignment, topic, etc or want feedback from the class, please post it in Slack. Many heads are better than one!

It's *STRONGLY* recommended to download and install the apps for both your desktop and mobile devices.

Grading

Students will be graded upon the quality of work based on concept development, technical execution, and fabrication. Major projects are expected to be fully functional and completed integrated *prototypes*. Weekly assignments should be documented as outlined below and published on Medium. You MUST bring all completed assignments (working or not!) to the next class.

Please note the percentage breakdown:

- Attendance and Participation: 25%
- Assignments (and documentation) + Group Presentation: 25%
- Mid Term Project: 25%
- Final Project: 25%

Submitting Work

Assignments are submitted by sending a DM to me on slack with the following items (where applicable):

- A link to your Documentation (see below)
- A link to your code base (if not included in your documentation)
- A link to any cad, schematic, or other relevant media files

You should synchronize the google drive account associated with your Parsons email to your devices. Keep all your projects organized and files clearly labeled. When submitting work, you will be able to link to those files. Generate and submit a shareable link to files where applicable. Alternatively, you may host video on YouTube and link/embed in your documentation.

Documentation

You are REQUIRED to sign up for an account on Medium using your Parsons email. All assignments (unless otherwise noted) should be documented and posted to your Medium account by the due date. Proper documentation includes the following:

- Short video of project in action (link to Youtube, Vimeo, etc)
- Text description of project including:
  - Goal of project/interaction
  - Quick description of assembly and list of core components
  - How it works

- Arduino Code (link to GitHub, text, or as a link to your.ino file)
  - Code must be WELL documented with comments the include:
    - Short summary of what the code does
    - A list of dependencies, libraries used
    - Short descriptions of your custom functions
    - Credits and links to code someone else wrote

Attendance and Participation

This class will conform to New School attendance policy. Only three absences are allowed without special permission from the instructor; any more and you will be dropped from the class with a failing grade. Two late arrivals or two early departures will count as one absence. You will also find this a very difficult class to miss even once; extra effort will be required to catch up. When in doubt, communicate with me as early as possible about any special circumstances. You should come ready to make. Much of class time will be spent workshopping in small groups or individually. When we are having a discussion or demo, your active participation is expected. Everyone should engage actively in class discussions and complete in-class activities. Working on any work outside of this course will not be tolerated. Laptops should be closed when not needed and phones should be on silent. Specifically, I have no tolerance for inattention during student project presentations. A core principle of this program is peer feedback and I expect all of you to respect this.

Please help keep the lab clean and tidy! Consider this a key role of participating in this class!

Schedule

This schedule is subject to change at any time. Check back regularly!

Week	Date	Class	Assignments
1	8/28	• Welcome & Syllabus Overview • Introductions • Overview of Concepts	**Assignment #1 start** • Buy all required components and tools

		• Download Arduino & Fritzing • Pseudocode • Order Kits • Making Center : Scheduling & Orientation Sessions	• Find a cool interactive project example and create a Medium post about it. Describe the project, identify the tools techniques, software involved. Write about what you find inspiring. Reflect on what you want to make this semester.
2	9/4	**Electricity** • Basic Electronics & Ohm's Law • Power Supplies • Schematics • Block Diagrams • Parallel vs. Serial circuits • Identifying electrical components **In-class Activity:** Creating a simple circuits by using Arduino, resistors and LEDs.	**Assignment #1 due** **Assignment. #2 start** • Build a series circuit + Build a parallel circuit • Create a custom switch built from novel materials • Draw the circuit diagrams of your projects • Publish Documentation to Medium
3	9/11	**Microcontrollers & Sensors** • Programming concepts • Digital I/O • Analog Input • Introduction to Arduino **In-class Activity:** Creating simple circuits by using a switch (digital input) and LED (digital output) and Arduino.	**Assignment #2 due** **Assignment #3 start** Create a simple application using one button and two leds: • If button is pressed for 3 seconds, one LED should light up. • If button is pressed for 6 seconds, another LED should light up. (Hint: Use INPUT_PULLUP for the pin mode) Draw the circuit diagram of your project.
4	9/18	**Inputs: Analog vs Digital** • Variable resistors, accelerometer, capacitive sensors • Libraries in Arduino - capacitive	**Assignment #3 due** **Assignment #4 start** Experiment with different forms of analog inputs to control LED

		library **In-class Activity:** Creating a simple circuit by using capacitive sensing(analog input) and LED (digital output).	behaviors. For Example: 1. Use a potentiometer to change the rate of a blinking LED 2. Use capacitive sensing library to indicate when someone is near. 3. Use touch as an interaction with an object, space etc. You can increase the number of touch inputs and/or you can play around with the number and type of outputs.
5	9/25	**Outputs** • Pulse width modulation vs. frequency modulation • Low current applications • LEDs (different forms) • Piezo/Buzzer • Vibrating motors **In-class Activity:** Potentiometer + Buzzer	**Assignment #4 due** **Assignment #5 start** Apply PWM to LEDs • Use “fading” and “smoothing” code to control a (or two / three) LED with a potentiometer or other combination of digital and analog inputs.
6	10/2	**Datasheets** **High Current Loads** • Transistors • Relays • Servos, DC Motors, H-Bridges • ED Strips • Servo Library **In class activity:** • Reading datasheets • Servo motor control	**Assignment #5 due** **Assignment #6 start** Use a Transistor and aRelay to turn on a higher current load. **Midterm Assigned** • Come up with a creative project idea for midterm---can be based on inspiration you found for Assignment 1 • You are required to use minimum of two inputs and two outputs. • Publish research on the circuits you need to create • Develop bock diagrams, schematics • define potential problems you

			might face.
7	10/16	**Analog Circuits & Soldering** **Debugging: Hardware & Software** • Using multimeter • Power Supply Selection • Tips & Tricks • Q&A	**Assignment #6 due** Work on midterm
8	10/23	**Midterm Presentations (Presentation mandatory)**	**Midterms due by start of class**
9	10/30	**Serial Communication** • Interpreting Serial Data • DIY Protocols **In class activity:** Arduino to Arduino Messages	**Assignment #7 start** Team up with one or two friends to *design* a simple visualization project by using sensor data and processing (or another program you choose like PD, MAX, etc.). • Write a Paragraph Description of the Project • Write a Technical Description of tools, parts, techniques • Create block diagrams, schematics, pseudocode • Publish your progress to Medium
10	11/6	**Serial Communication Continues** **In class activity:** • Processing to/from Arduino • Reading sensor data on processing	**Assignment #7 due** **Assignment #8 start** With your team, implement the design you developed for Assignment 7: • Submit the code you developed for the Processing and Arduino components • Document challenges you encountered and how you overcame them • Create video documentation of the project in action

			• Publish all this on Medium
11	11/13	**Connecting Arduino to internet** • Bluetooth + Wifi • ESP8266 **In class activity:** Connect to the internet by using ESP8266	**Assignment #8 due** **Final Project assigned** Create a project proposal that has the following components: • Narrative Description • Technical Description • Conceptual Description • Block Diagram of Elements and Interactions • Three references for inspiration, research, context. Your project idea is expected to be conceptually and technically strong. Just like your Phys-Comp skillz at this point.
12	11/20	**OPTIONAL:** **Raspberry Pi Workshop** Set up a Pi - connect to the internet - read a sensor through PI, control some output	**Work on Final**
13	12/4	Work Week - Q&A	**Work on Final**
14	12/11	Work Week - Q&A	**Work on Final**
15	12/18	**Final Presentations**	**Finals Due at the Start of Class**

Software and Platforms

- Slack - Communication Platform (required)
- Medium - Publishing Platform (required)
- Arduino - Microcontroller IDE (required)
- Fritzing - Electronics Prototyping Software (required)
- Processing - Creative Coding IDE (required)
- Sublime Text - Developer Friendly Text Editor (strongly recommended)
- GitHub (recommended)
- MacDown (recommended)

- PureData - Graphical Programming Environment for Creative Coding
- MAXMSP - Graphical Programming Environment for Creative Coding
- Rasbian - Debian Linux based OS for Raspberry Pi

Readings

These are suggested Books that you will find helpful:

- Physical Computing by Dan O'Sullivan and Tom Igoe (PDF here)
- Practical Electronics for Inventors: Fourth Edition by Paul Shertz and Thomas Monk (If you are looking to grasp deep theories in an approachable way, this is a great book. Highly recommend/)
- Arduino Cookbook by Michael Margolis
- Code by Charles Petzold (PDF here . Highly recommend.)
- Making Things Talk by Tom Igoe
- Making Things Move by Dustyn Roberts
- Programming Arduino Getting Started with Sketches, 2nd Edition by Simon Monk
- Forrest Mims III books:
    - Electronic Formulas, Symbols, and Circuits
    - Timer, Op Amp, and Optoelectronic Circuits
    - Electronic Sensor Circuits & Projects, Mims

- Handmade Electronic Music by Nicholas Collins (If you are into music and/or instrument creation, I highly recommend this. PDF will be available to the class.)

Materials and Supplies

I recommend the Adafruit ARDX Kit (you can get this from Adafruit or at Tinkersphere) or the Arduino Starter Kit to get started, though you will need to purchase additional materials and tools.

The Adaruit Parts Pal($20) has many of the smaller passive components and transistors you'll need.

I highly recommend starting your kit with a assortment packs. Tinkersphere has them available for:

- resistors ($8)
- ceramic capacitors ($23)
- electrolytic capacitors ($17)
- transistors ($17)
- diodes ($14)

Below is the full list. Also be sure to find a sturdy carrying case!

Required

- Arduino UNO Board
- Half or Full Size Breadboard
- Jumper Wires OR 22 gauge solid-core wire and wire strippers
- Arduino USB Cable
- Arduino 9V Battery Clip
- 9V batteries
- Set of Alligator clips
- 20-40 Assorted LEDs. Choose different colors, sizes (3mm, 5mm, 10mm), diffusions, and viewing angles.
- 2-5 5mm diffused tri-color (RGB) LED
- Toy DC Motor
- Mini Servo Motor
- Vibration motor
- 8 Bit Shift Register (74HC595)
- 1 H-bridge motor driver [L293D]
- 8 Ohm speaker or piezo
- 4-6 switches/pushbuttons. Try to choose different sizes, colors, etc to test different affordances.
- 3-4 10K potentiometers. Try to choose different sizes, colors, etc to test different affordances.
- Photoresistor assortment (get about ~6)
- 2-3 other analog sensors based on your interest (NOTE: you do NOT need to get all of these):
    - SEE: PIR Motion Sensor, Infrared Proximity Sensor, Ultrasonic Range Finder, Color sensor
    - LISTEN + SENSE: Tiny Microphone, Piezo Vibration Sensor
    - TOUCH: Capacitance sensing, Pressure sensors, Flex sensors, Stretch sensors
    - WEATHER: Humidity sensors, Temperature sensors, Barometric Pressure sensor
    - POSITION: Accelerometer/Gyroscope, Tilt switch

- Resistors:
    - 25 x 220 Ohm
    - 10 x 470 Ohm Resistors
    - 10 x 1K Ohm Resistors
    - 15 x 10K Ohm Resistors

- 2 1N4001 Diodes
- 5V Voltage regulator
- 2-3 Perfboards
- Wireless communication device (TBD)
- Sturdy carrying case Useful, but not required
- Resistor pack (optional but *highly* recommended)
- Extra Arduinos on hand. Arduino Pro Minis are cheap and do the trick, Floras are great for wearables, and Teensys are powerful for prototyping.
- Enclosures
- Fabrication materials

- Craft materials

Tools

- Soldering Iron (30watt recommended)
- Solder (small gauge)
- Solder wick (this helps you remove solder)
- Digital multimeter (Make sure you can measure resistance, amperage, and voltage. Here's a good one from Adafruit and you can find some good ones on Amazon for $15-20 - no need to spend more than that)
- Tweezers
- Wire strippers
- Wire cutters/snips
- Needle nose pliers (I recommend jewelry tools for pliers and snips)
- Soldering iron (This is optional, but I *highly* recommend picking up a cheap soldering iron that you can carry back and forth with you. While we have ordered new soldering irons for D12, public use usually means they don't end up in the best condition)
- Tinner (this cleans your soldering iron tip - this is optional, but very, very useful especially if you plan to only use the D12 irons)

Local Stores

- Tinkersphere
- Home depot*
- Dollar Stores*
- The Container Store*

*For miscellaneous materials

Online Distributors

- Adafruit
- SparkFun
- Mouser
- Digikey
- Jameco
- Amazon

Resources

The university provides many resources to help students achieve academic and artistic excellence. These resources include:

- The University (and associated) Libraries: http://library.newschool.edu
- The University Learning Center: http://www.newschool.edu/learning-center
- University Disabilities Service: www.newschool.edu/student-disability-services/

In keeping with the university's policy of providing equal access for students with disabilities, any student with a disability who needs academic accommodations is welcome to meet with me privately. All conversations will be kept confidential. Students requesting any accommodations will also need to contact Student Disability Service (SDS). SDS will conduct an intake and, if appropriate, the Director will provide an academic accommodation notification letter for you to bring to me. At that point, I will review the letter with you and discuss these accommodations in relation to this course.

Making Center

The Making Center is a constellation of shops, labs, and open workspaces that are situated across the New School to help students express their ideas in a variety of materials and methods. We have resources to help support woodworking, metalworking, ceramics and pottery work, photography and film, textiles, printmaking, 3D printing, manual and CNC machining, and more. A staff of technicians and student workers provide expertise and maintain the different shops and labs. Safety is a primary concern, so each area has policies for access, training, and etiquette with which students and faculty should be familiar. Many areas require specific orientations or trainings before access is granted. Detailed information about the resources available, as well as schedules, trainings, and policies can be found at resources.parsons.edu

Grading Standards

- **A** Work of exceptional quality
- A- Work of high quality
- B+ Very good work
- B Good work; satisfies course requirements (Satisfactory completion of a course is considered to be a grade of B or higher.)
- B- Below-average work
- C+ Less than adequate work
- C Well below average work
- C- Poor work; lowest possible passing grade
- F Failure
- GM Grade missing for an individual

Grades of D are not used in graduate level courses.

Grade of W

The grade of W may be issued by the Office of the Registrar to a student who officially withdraws from a course within the applicable deadline. There is no academic penalty, but the grade will appear on the student transcript. A grade of W may also be issued by an instructor to a graduate student (except at Parsons and Mannes) who has not completed course requirements nor arranged for an Incomplete.

Grade of Z

The grade of Z is issued by an instructor to a student who has not attended or not completed all required work in a course but did not officially withdraw before the withdrawal deadline. It differs from an “F,” which would indicate that the student technically completed requirements but that the level of work did not qualify for a passing grade.

Grades of Incomplete

The grade of I, or temporary incomplete, may be granted to a student under unusual and extenuating circumstances, such as when the student’s academic life is interrupted by a medical or personal emergency. This mark is not given automatically but only upon the student’s request and at the discretion of the instructor. A Request for Incomplete form must be completed and signed by student and instructor. The time allowed for completion of the work and removal of the “I” mark will be set by the instructor with the following limitations: [You should include one the following standards, depending on the level of your course].

- **Graduate students:** Work must be completed no later than one year following the end of the class. Grades of “I” not revised in the prescribed time will be recorded as a final grade of “WF” (for Parsons and Mannes graduate students) or “N” (for all other graduate students) by the Office of the Registrar. The grade of “N” does not affect the GPA but does indicate a permanent incomplete.

College, School, Program and Class Policies

A comprehensive overview of policy may be found under Policies: A to Z. You are also encouraged to consult the Academic Catalog for Parsons.

Code of Conduct

There is a clear and documented history of discrimination across technology-related fields related to gender, race, ethnicity, and ability, including electronics and programming. Classrooms can all too often reinforce these stereotypes (silently or not) if they do not actively create an open and inclusive culture. Learning spaces mirror the societies in which they exist and positive action is essential to counteract the many forms of inequality and abuses of power that exist in society. The goal of this class is to create a safe, curiosity-driven environment in which we can all learn from and with each other, one that actively and thoughtfully discusses these issues as they arise.

We are creating this space together and are all accountable. Any form of bullying or harassment will not be tolerated. If you feel unwelcome, uncomfortable, or unsafe at any point in this course or you witness this behavior as a part of this class, please speak to Liza. We will address the issue to ensure your safety and privacy, and make sure all reports are handled as respectfully as possible according to The New School Student Conduct and Community Standards.

Canvas

The Syllabus will be posted here. Otherwise this resource will not be used except by majority request.

GitHub

All the course materials will be available to review and download from the class Github repository. The temporary location is http://github.com/phillipdavidstearns/PGTE_5585_F2019

Slack

This is the PRIMARY mode of communication we will use for the class. You are REQUIRED to signup for a slack account with your Parsons email. You should receive an invitation to the class Slack located at pgte5585f2019.slack.com. **It's HIGHLY recommended to download and install the apps for both your desktop and mobile devices**

Medium

Students are REQUIRED to register for an account with their Parsons email and keep a weekly journal of their process, progress, and projects.

Delays

In rare instances, I may be delayed arriving to class. If I have not arrived by the time class is scheduled to start, you must wait a minimum of thirty minutes for my arrival. In the event that I will miss class entirely, I'll make an announcement on Slack regarding assignment for next class meeting.

Electronic Devices

The use of electronic devices (phones, tablets, laptops, cameras, etc.) is permitted when the device is being used in relation to the course's work. All other uses are prohibited in the classroom and devices should be turned off before class starts.

Responsibility

Students are responsible for all assignments, even if they are absent. Late assignments, failure to complete the assignments for class discussion and/or critique, and lack of preparedness for in-class discussions,

presentations and/or critiques will jeopardize your successful completion of this course.

Active Participation and Attendance

Class participation is an essential part of class and includes: keeping up with reading, assignments, projects, contributing meaningfully to class discussions, active participation in group work, and coming to class regularly and on time.

Parsons' attendance guidelines were developed to encourage students' success in all aspects of their academic programs. Full participation is essential to the successful completion of coursework and enhances the quality of the educational experience for all, particularly in courses where group work is integral; thus, Parsons promotes high levels of attendance. Students are expected to attend classes regularly and promptly and in compliance with the standards stated in this course syllabus.

While attendance is just one aspect of active participation, absence from a significant portion of class time may prevent the successful attainment of course objectives. A significant portion of class time is generally defined as the equivalent of three weeks, or 20%, of class time. Lateness or early departure from class may be recorded as one full absence. Students may be asked to withdraw from a course if habitual absenteeism or tardiness has a negative impact on the class environment.

- Attendance for each day is 1 full point
- On-time, full attendance = 1pt
- 1 Lateness or Early Departure = -0.33pts
- Absence = 0pts
- 3 Latenesses or Early Departures = 1 Absence

I will assess each student's performance against all of the assessment criteria in determining your final grade.

Academic Honesty and Integrity

Compromising your academic integrity may lead to serious consequences, including (but not limited to) one or more of the following: failure of the assignment, failure of the course, academic warning, disciplinary probation, suspension from the university, or dismissal from the university.

Students are responsible for understanding the University's policy on academic honesty and integrity and must make use of proper citations of sources for writing papers, creating, presenting, and performing their work, taking examinations, and doing research. It is the responsibility of students to learn the procedures specific to their discipline for correctly and appropriately differentiating their own work from that of others. The full text of the policy, including adjudication procedures, is found on the university website under Policies: A to Z. Resources regarding what plagiarism is and how to avoid it can be found on the Learning Center's website.

The New School views "academic honesty and integrity" as the duty of every member of an academic

community to claim authorship for his or her own work and only for that work, and to recognize the contributions of others accurately and completely. This obligation is fundamental to the integrity of intellectual debate, and creative and academic pursuits. Academic honesty and integrity includes accurate use of quotations, as well as appropriate and explicit citation of sources in instances of paraphrasing and describing ideas, or reporting on research findings or any aspect of the work of others (including that of faculty members and other students). Academic dishonesty results from infractions of this “accurate use”. The standards of academic honesty and integrity, and citation of sources, apply to all forms of academic work, including submissions of drafts of final papers or projects. All members of the University community are expected to conduct themselves in accord with the standards of academic honesty and integrity. Please see the complete policy in the Parsons Catalog.

Intellectual Property Rights

The New School (the "university") seeks to encourage creativity and invention among its faculty members and students. In doing so, the University affirms its traditional commitment to the personal ownership by its faculty members and students of Intellectual Property Rights in works they create. The complete policy governing Intellectual Property Rights may be seen on the university website, on the Provost’s page.

Open Source Policy

You are encouraged to work in groups, but unless otherwise specified you must turn in your own work. Copying/pasting and reusing code is a key part of the programming process, especially while learning. You often learn best by modifying working examples rather than starting from scratch. We stand on the shoulders of giants; that’s the essence of the open source philosophy. However, there is a very important caveat: any code you borrow and/or modify must be labeled as such. That is, you must include, in your work, the name of the author, the source URL, and you must make clear which lines of code are not yours. If you fail to do this, you will fail the class. It is very, very easy to get this right, though, so if you take a moment’s time to label your work correctly, you will not have a problem. Just be diligent and honest.