Physical Computing and Alternative Interfaces

IGME.470.01: Mon/Wed, 5pm-6:15pm, room: MSS-3110
School of Interactive Games & Media, Rochester Institute of Technology
Spring 2023

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Syllabus: Spring 2023

Course Description

This course introduces students to techniques for creating experimental digital media artifacts, systems and interfaces using electronics, sensors and actuators. This is known as physical computing, a way of designing and building physical systems that use a mix hardware and software to sense and respond to the surrounding world. Human-machine interaction research such as motion-sensing, gesture recognition, wearable technology and tangible computing interfaces offer a rich set of techniques and technologies for making computers more “natural” and “human”. Similarly, new paradigms of ubiquitous computing are exploring the possibilities of activated spaces in which objects are endowed with intelligence, communication, and responsiveness. The rich variety of these interface technologies demonstrates the potential for systems and devices that seamlessly integrate people and environments. This course surveys some of the scientific and artistic work in these areas while also providing a rapid technical introduction to basic electronics (components, circuits, microcontrollers, etc.).

This course trains students from computing and engineering disciplines to approach physical computing from an art and design perspective. The goal is to help students develop culturally expansive, inclusive and critical perspectives to projects, products and technologies that bring computation into the physical world. As such, it provides complementary experiences that are characteristic of training in the arts, design and architecture: self-directed learning, critical making, independent research, discussion and critique.

Prerequisites: IGME-102 or IGME-106 or IGME-206 or equivalent course and at least 3rd year standing

Course Content & Organization

This is a lecture-lab course organized around regular readings, discussions and hands-on lab activities, exercises and projects. Topics are presented by the instructor, examples are shown and lab exercises are assigned that coincide with the topics covered. These are to be completed by students both during and outside of class.

The course focuses on developing conceptual and technical strategies for creating human-machine interaction-based systems, interfaces and media that connects computers to the physical world. To build physical computing devices, you will learn how a computer converts the changes in energy from the environment and our bodies (in the form of motion, light, touch, sound, temperature and other forms) into variable electronic signals that it can read and interpret. You will learn via a series of practical hands-on exercises which introduce the fundamentals of circuits, embedded programming, sensor signal processing, simple mechanisms, actuation, and time-based behavior. You will spend time building circuits, writing programs and figuring out how best to make all of these things relate to human computer interaction.

In addition to technical matters, this course delves into philosophical, theoretical and conceptual aspects of human-technology relations. Subjects addressed include: human cognition and machine interaction, human embodiment in the digital age, critical and reflective design, conceptual strategies for creative meaning and expression (not just accomplishing tasks) with physical computing devices.

The course will make considerable use of the Arduino microcontroller platform (http://arduino.cc). The Arduino is an open source, cross platform, inexpensive hardware platform supported around the world by artists and makers interested in experimental media and interfaces. Each student is expected to acquire an Arduino board to use during the semester. We will also be using the Processing programming environment to interface Arduino with standard desktop/laptop computers. Processing is a Java-based language used in many media/graphics applications (http://processing.org). Although Processing will be the primary media development environment taught in this course students may use any other media development environment or programming language they are comfortable with (e.g., Unity, Python, etc.).

Objectives

This course aims to provide students with skills to prototype interactive computing systems and experimental interfaces. Upon completion of this course, the student should be able to:

- design and build interactive objects and systems using sensor and actuator circuits for microcontrollers

- make effective use of standard hardware and software tools for physical computing
- intuitively understand how information and energy move between the physical, electronic, and computational domains to create a desired behavior
- understand and apply basic theoretical principles of analog and digital electronics
- comprehend and adapt programming and digital electronics concepts and technology to media arts and technological design
- identify, describe and analyze the work of researchers, artists and designers working with sensors and experimental interfaces
- apply and extend research skills and incorporate them into the design and development of interactive systems and alternative interfaces
- articulate theoretical perspectives relevant to scientific and cultural experimentation with embodiment, physical computing, ubiquitous computing, tangible interfaces, motion detection, gesture recognition, activated objects and alternative interfaces
- develop and apply critical, analytical and conceptual thinking skills to the creation of socially and culturally engaged interactive systems and alternative interfaces
- gain sensitivity to aesthetic concerns within physical computing

Philosophy

This course operates under the following principles:

- **Experiential Learning**. We learn by doing. The course emphasizes immediate application of theory into practical demonstrations. Success — and especially failures — of an experiment help create understanding of underlying principles.
- **Collaboration & Cooperative Learning**. We teach each other. Knowledge sharing and creative dialogue are critical to success in this course and in the new media technology field in general. Success in this field requires an ability to collaborate within diverse cohorts of technology, arts and design experts. Collaborative skill requires excellence in one's own areas of expertise and an ability to translate ideas across disciplinary boundaries.
- **Self-motivation**. Students are responsible for their own progress. Wherever possible, the driving motivation will be a self-chosen goal, divided into manageable subproblems. The desire for the goal prompts autonomous exploration. If you ever find the course dull, that is an opportunity to reflect on what you are trying to achieve and choose a new objective.
- **Critical Thinking, Reflection and Writing**. 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.

Course Website

MyCourses is the most important resource of information for this course. In addition, the course web site provides additional resources related to the course (in addition to mirroring the content here).

There is also a GitHub repository for the course. You will need to refer to it for many of the lab exercises. I suggesting cloning or downloading it.

Required Textbook

There is no required textbook, but the optional recommend books below (along with the course web site) are valuable supplemental materials

Optional: (but recommended):

Interactive Electronics for Artists & Inventors (excellent and free online book)

Getting Started With Arduino, 2nd edition (Massimo Banzi, O'Reilly, 2011)

Physical Computing: Sensing and Controlling the Physical World with Computers (Dan O'Sullivan & Tom Igoe, Course Technology Publishers, 2004)

Making Things Talk: Using Sensors, Networks, and Arduino to see, hear, and feel your world (Tom Igoe, Maker Media, 2nd edition, 2011)

Make: Electronics, (*Charles Platt*, Maker Media Inc, 2009). (Great intro to electronics!)

Fashioning Technology: a DIY Intro to Smart Crafting (Syuzi Pakhchyan. Make books, 2008)

Practical Electronics for Inventors (Paul Scherz, McGraw-Hill Education TAB, 3rd edition, 2013)

Processing: A Programming Handbook for Visual Designers and Artists, Second Edition (Casey Reas and Ben Fry, O'Reilly, 2014)

Required Supplies

- *Arduino Nano 33 IoT **with Headers*** from a reputable source (e.g. Sparkfun.com). This is a fully assembled board.
- The course parts list, available here, contains parts and equipment you will need to purchase.
- USB flash drive or External Hard-drive (32+ GB) to save all you work (or use your own laptop).

Optional: (but recommended) supplies:

- 9V batteries and/or 9-12V "wall wart" DC power supply
- Multimeter
- DC power jack – female (2.1mm, center positive, preferably with screw terminals)
- Wire strippers
- Wire cutters

You may also want to purchase specific items for your projects.

In addition, the course will offer access to shared tools and components (including some of the ones listed above). These supplies can easily be lost and/or mistreated. All students will be expected to help maintain the viability of these supplies. For example, cleaning up after lab sessions, putting things back in their place, etc.

Assignments

Homework Assignments:
There are homework assignments (graded) and in-class lab activities to familiarize you with specific techniques and/or hardware. The homework assignments are typically based upon these in-class lab activities.

Research Presentation:
A presentation that outlines your research agenda for the 2nd half of the course. This is essentially a way to frame and contextualize the themes and goals of your final project.

Final Project:
Create a physically interactive system of your choice. For your final projects, you are asked to explore building interactive interfaces/systems as a form of **critical inquiry**.

In addition there are also readings and discussions, quizzes and a research journal/blog. These are discussed below.

Additional details on these assignments can be found in myCourses and on the course web site.

Assignment Reporting Requirements & Deliverables
Each assignment serves both learning and evaluative goals. Fulfilling the assignment is an essential step in the learning process, and the result also demonstrates learning success. Please take careful note of the requirements for each assignment: they represent a contract between student and instructor.

The objective of assigning reports is to encourage evaluative thinking throughout the process of development. Writing and sketching is much faster than physically building something, and writing the core of the report *first* is a great way to clarify a concept. It is highly recommended to consider the report requirements throughout your process, e.g., by taking in-process notes, photos, and fully sketching out designs.

All assignments require an accompanying report as a post to your journal/blog. We will use myCourses to distribute assignments, collect deliverables, and assign grades. An outline of specific requirements will be provided for each assignment through myCourses, with a denotation of specific required and optional elements. The following specifies the detailed requirements for **all** reports:

1. All report documents must be submitted as a post to your journal/blog; a clickable link to this post must be submitted to myCourses for assessment.
2. Reports must include a statement of objectives, general descriptive text, narrative, results, photos/videos, technical documentation and citations of related work. All assignments (Homework and Final Project) should include a system diagram that shows what the major components of the system are and how they relate to each other as well as

breadboard layout and circuit schematic that shows how the electronic components (sensors, resistors, etc) are connected

3. For group work: each group must submit **one** joint report. If a group member fails to fulfill their documentation role, the other group members should submit what they can on time.
4. For group work: each report should clearly attribute the contribution of each group member. Individual grades may be adjusted from group grades if it becomes apparent that contribution is not equitable. A separate confidential peer evaluation may be requested individually from each group member at the instructor's discretion.
5. Project images should be embedded within the blog post.
6. Project videos must be uploaded to a hosting service of your choice and embedded in the blog post.
7. Project videos must be a minimum of 1 minute and maximum of 3 minutes in duration.
8. Project videos are encouraged to include a title and credits.
9. **In general, enough technical documentation must be provided that a person of equal skill could replicate the construction of the project.**
10. All program source code, electronic schematics and breadboard diagrams must be provided within a single zip file uploaded to myCourses and linked within the blog post (optionally the blog post may also contain a link to a GitHub or other code repository site where the code, electronic schematics and breadboard diagrams live). Electronic schematics and breadboard diagrams may also be embedded within the blog post (as images). Hand-drawn or illustrated schematics are acceptable, but the use of schematic capture software such as Fritzing, EAGLE or KiCad is recommended as it will help reduce errors.
11. Any drawings or sketches can also be provided within the single zip file uploaded to myCourses. They may also be embedded into the blog post or uploaded to the code repository.
12. Any original CAD files are required. Multi-file designs (typical for SolidWorks) must be provided as links in the blog post (or uploaded or the code repository site).

Group Work

This course relies on some amount of group work and collaborative learning. Throughout the course, students will work in groups, either self-selecting and/or instructor-assigned. Instructor-assigned groups are intended to give students practice with team-work among unfamiliar collaborators, a common setting in the real world. Self-selecting groups are intended to allow students complete freedom in shaping their team, dividing tasks and choosing roles. Experimentation with roles and the rigidity/flexibility/overlap of those roles is encouraged. Below is an example of group roles for a 3-person group.

- **Integrator:** Student who will lead the overall development of the project and communicate its overall vision. Responsibilities include researching existing relevant work that can push the project to new levels of sophistication and relevance in the world, setting and maintaining timelines for project execution, negotiating assigned roles and expectations for other group members, and facilitating communication among group members.

- **Designer:** Student who will lead the design and fabrication of the project. Responsibilities include researching relevant existing references that can help the group plan how to make the necessary things, producing system diagrams for the project, and conceiving and implementing and overall strategy for how to make things and how to delegate various making activities to different group members.
- **Tutor:** Student with advanced knowledge or experience with the activity who will gain the most by teaching and helping others, instead of breezing through familiar territory. Responsibilities include assuring that all group members gain the necessary essential skills covered by the activity.

In this scenario all group members are responsible for some technical development (e.g. code and electronics). Roles may overlap somewhat and a person may naturally flow from one role to another as projects are subdivided into sub-goals. As long as an individual clearly takes responsibility for each element there should be no problems. Also note that documentation is often best universally shared so that each person is continually documenting their own process, and then collaborating on final documentation at the end. Each group member documents their portion of the project with sketches, photos, videos and written reports. All members then come together to craft a single coherent final report that details the design and development process as well as the final outcome (significant time online/outside of class will be needed). This includes creating a well formatted blog post with images, video and text describing the project's goals, methodologies and results.

Grading

Homework Assignments	30%
Research Presentation	10%
Final Project	30%
Mid-term Quiz	10%
Journal/Documentation	10%
Participation: contributing to discussions,	10%

Letter grades can be summarized as follows:

- A is a grade of distinction and excellence. Outstanding achievement against all learning objectives You have far exceeded expectations.
- B represents excellent work, above average. Superior achievement against most learning objectives
- C indicates average/mediocre work. Meets most objectives at a basic level
- D represents minimally acceptable work. Below average work: noticeably weak, fails to meet most learning objectives
- F indicates non-acceptable work. Clearly deficient against all learning objectives

Any appeal for grades must be brought to the instructor during office hours or at a scheduled time convenient to both parties. Incomplete grades ("I") will only be granted for unusual circumstances (e.g., a note from a doctor documenting a hospitalization representing a significant period of time.). Only if given the final grade of "I" (incomplete) will additional work after the conclusion of a semester be accepted.

Everyone is assumed to start with an A in the course. If you do the work you will keep it, but failing to fulfill the expectations will cause your grade to drift downward**.** Generally speaking, grades are based on:

- Completion of all assignments on time.
- Participation in all class discussions, lectures and demos
- Class attendance
- Maintaining a constant and growing journal (discussed below) of source and process materials.
- **Creative risk taking in projects and ideas, pushing yourself past what you already know (and think you know or should know), discovering new territories.**
- A Mastery learning approach. All students are expected to learn the skills taught in the course at a high competence level. They are expected to complete research and assignments with enthusiasm and engagement, and on deadline. Students who need extra assistance to reach this level have the responsibility to arrange for these resources. A grade of A will require excellence in a majority of projects and completion of work beyond the requirements of the course (for example an extra project, reading of an extra book or article related to course topics and discussing it in your journal, attendance at extra community events such as academic talks, gallery openings, maker events, etc.)

Grading Rubrics:

Final projects are graded on the following criteria:

- **concept**: clarity of the key idea, articulation of key principles, applicability (to human, non-human, design or artistic needs), selection of appropriate aspects for proof-of-concept.
- **execution**: translation of the concept into design, quality of the technical implementation; perseverance and work ethic
- **documentation**: quality of the reflection, detail of the technical documentation as it is evident in the project report posted on your blog, quality and clarity of the presentation.

Homework assignments will be a simple 0, 50%, 100% rubric (not including bonus points):

- 0: exercise was not attempted or very little work done
- 50: exercise completed with one or more missing elements
- 100: all requirements of the exercise were completed

Please keep in mind that grades provide only a rough metric for student feedback. The more nuanced and useful feedback comes from in-class verbal critiques, discussions and written comments.

There are no make-ups and no specific extra credit assignments are given. However, if you wish to get bonus points on your assignments you may avail yourself of the following opportunities:

- Take advantage of the “bonus” options in some of the lab activities OR extended the assignment to challenge yourself on a particular electronics, design or programming problem. You may also choose a topic from your own research to investigate further (discuss with instructor first).
- Bug fixes in the lab activities: find a good bug from the GitHub repo for the course, pull the repo, fix the bug, submit a pull request.

In-class Project Reviews

Class time will be devoted to demonstration, critique and discussion of homework assignments and the final project. This will include commentary from peers, instructors and perhaps, guest experts. In order to have enough time for discussion of each project, we must keep a rigid schedule during these reviews. Each individual (or group) will be expected to make a brief 1-2 minute verbal presentation of their goals and results, followed by an open question and critique period. Successful presentation in such a concise form depends on planning. Students are expected to prepare and rehearse their explanations.

The in-class presentation and critique/discussion of projects serves several purposes:

- provides a live performance or demonstration for evaluation
- demonstrates your ability to speak succinctly about your ideas
- provides the primary opportunity for your peers to see and comment on your work

Please prepare for the critique/discussion as follows:

1. Please be prepared to give a brief (typically 2 minute) verbal overview of your idea and execution. Please rehearse this explanation ahead of time.
2. Please be prepared to demonstrate or perform at your designated time. Please rehearse your performance ahead of time.
3. For the project artifacts and performance, the overall emphasis is on proof-of-concept rather than fit and finish. Please be prepared to designate what issues were deliberately set aside and which were explored to guide the critique. You should be able to justify your choices with respect to the overall concept.
4. In-class critiques may still consider all features in relation to their support of the concept. When this happens, please consider this an exploration of your idea that goes beyond the graded evaluation.

Participation

Attendance and involvement in the discussions, feedback, class collaborations and presentations are critical for each student’s success and for the success of the course as a whole. Class time will be devoted to this and it will make up a significant part of your grade.

Suggestions for commenting on fellow students’ work: Supporting your classmates through feedback on their work is an important part of this course (and an important part of your participation grade). When watching your classmates present their work in class, there will be time for verbal comments but you should also take written notes on their presentations and on their project/circuits/subject matter, etc. Offer suggestions on what they do well, what they could do differently, useful conceptual strategies and anything they could do to make their work better.

Presenters themselves should also take notes during or immediately after their presentations. Share notes, schematics, code, ideas, etc; both during and outside of class. The atmosphere in the course should be one of creative collaboration and continual sharing of ideas and practical know-how.

Journal & Documentation

You will be expected to keep an online journal/blog of your work in this class - **updated weekly** (at minimum). Your instructor will read your journal regularly to see how you are progressing, so you should update often throughout the semester (at least once a week). Project updates, research process, readings, interesting links - all of these go on your blog. Specific requirements will be provided for each assignment but at a minimum, **a journal entry is required part of each assignment you do (including the readings)**. Feel free to do more entries as you see fit.

This journal/blog is a reflection of yourself as a professional and should demonstrate that. Therefore, **even if you do have a website/blog already, this course requires that you create a new one**. This will be a website that you will continue to use throughout this course and perhaps your duration in the program.

Good documentation habits:

Document your projects thoroughly as you go, do not put it off until the end. Plan in advance, perhaps as a group, to have what you need to document. Photos, video, sketches, schematics, code and notes are all valuable forms of documentation.

You may document group projects in a separate individual or group site if you choose, but you must to link this site from your own journal.

For the final projects, you will need to include a description and illustration of the project. Tell us the goal(s) of the project, a general description (what it is, does) the ideas/inspirations and results/experience (i.e. a narrative). Your explanation should give enough information that someone who's never seen the project can understand it. In addition, you should document any ideas, analysis and reactions to the readings, interesting links you discover from your research, etc. Anything that details the evolution of your work in the course is worth documenting.

You should also include a section describing how the project works, aimed at a more informed reader (your instructor, fellow classmates, potential employer, graduate admissions committee). Details provided above (in "Assignment Reporting Requirements & Deliverables" section). This includes, technical documentation (schematics, code, etc.) and theoretical and conceptual foundations of the project (that you obtained from the readings, lectures, discussions and your own research)

Make sure the code is well-commented, so you and others can understand what it does. You may post your code (and other relevant files) to a code repository site like GitHub and simply link to it from your blog.

Make sure to cite sources from which you get your ideas, code, circuits, and construction techniques. When you base your work on someone else's, cite the original author and link to their work, just as you would when quoting another author in a paper. Very few ideas come out of the nowhere, and your readers can learn a lot from the sources from which you learned and by which you were inspired. This is how knowledge and innovation work. So please be generous in sharing your sources.

The following is a selection of several top rated free website services that you may use. You are not limited to these services, but they are recommended.

Suggested Websites/Blogging Platforms:

- WordPress (my personal recommendation)
- Wix
- Weebly
- Webflow
- Tumblr
- Blogger

Readings

A number of short readings will be assigned to generate discussion about physical interaction, conceptual design strategies, application ideas and other topics. You are expected to write short 1-2 page responses to them on your journal/blog. Along with lectures and discussions, the readings are meant to give you an understanding of the field and provide you with context, background and inspiration for the work you are making. They will also help you in formulating ideas for your projects. **You are required to write a short summary and analytical response for each assigned reading, posted on your blog.** Also, be sure to cite the readings you do (both assigned and those you come across in your own research) on your blog if you are using them as a guide or source of inspiration for your work.

Here is a general guideline for writing your responses:

- What is the focus of the article?
- List 2-3 key points the author article makes
- Write up what impresses you, what confuses you, what you agree or disagree with, and what project ideas come to you while you're reading.
- Compare and contrast with other related work if you can.

A longer list of both technical and conceptual source material can be found on the course web site in the Bibliography page.

Expectations

- Complete all work on time
- Participate fully in all critiques, discussions, demos and exercises
- Arrive to class on time

- Bring any problems, questions, or circumstances that hinder your full participation in the course to the attention of the instructor

Prepare for class in advance. Review the material to be covered that week, and come to class with questions prepared about that week's assigned material. If you have no questions, be prepared to show your work.

Students are responsible for all of the material presented in class. All assignments must be presented on the due date. Late assignments will be accepted no more than 1 week after the due date, but with a 50% grade reduction. Students are expected to meet with the instructor to review progress and discuss individual approaches. Students are expected to perform the necessary background research on topics and techniques appropriate to completion of the assignments and projects.

Criteria for Excellence (i.e., how to get an A in the course)

In addition to the project grading criteria above, the following represents a guide for excelling this course

1. Maintaining a constant and growing journal/blog reflecting a consistent and focused engagement with ideas, research, works, discussions and other related subject matters and class exchanges.
2. Completing all assignments on time.
3. Actively participating in and contributing to all class discussions, critiques, lectures and presentations.
4. Maintaining a consistent and timely presence (i.e. attendance).
5. Taking risks in projects and ideas, pushing past what you already know and discovering new territories, terms, skills, connections. Ideas that fail often teach more than ideas that succeed.

Health & Safety

Electricity and electronics have some dangers associated with them – for example, electrocution, toxic materials. Students will be taught safe procedures. Most of the course will concentrate on low voltage electronics which generally will not do much damage. 110 v AC (wall plug current) on the other hand can be quite dangerous. Students may not work on 110v projects unless they are cleared by the instructor or graduate assistant. Any student working on these kind of projects without clearance or other unsafe processes may be asked to withdraw from the course.

Safety guidelines for working with electronics

Personal safety:

- Keep dry, wipe hands, avoid spills, don't work in wet environments – liquids make for much lower resistance. Wet skin conducts much easier than dry and increases shock danger.
- Avoid contact with soldering irons; they get very hot and burns are possible. Avoid molten solder. Avoid putting soldering irons down in areas where they can melt wires etc.
- Conventional solder contains lead. Although we will try to use lead-free solder, try to work in well ventilated spaces. Avoid direct inhalation of solder fumes.

- Wire cutters and strippers can also cut skin. Exposed wires are sharp and can cut. Use pliers to manipulate wires if possible.
- In this course no one should work on 110/120v AC circuits unless cleared by the instructor. When working on authorized projects, avoid direct contact with 110v sources, watch for frayed wires, disconnected grounds, inadvertent contacts between 110 and low voltages systems – eg wires touching. If working with 110, turn off power while constructing circuits, inspect for open wires. Work with one hand if possible putting the other in pocket (thus avoiding circuit path to ground). Wear shoes. Take off metal jewelry. If someone does get shocked, turn off power supply immediately if possible. Don't touch person directly, try to use insulating material (such as broom handle or rubber material) when moving them to safety.

Equipment safety:

- Low voltage components are easily damaged by high voltages. Even static electricity can damage components (such as rubbing your hair). Ground your body by touching metal chassis or pipes before working. Try to avoid touching metal leads and pads. Store components in static free bags. Use a grounding wristband if possible.
- Components can be damaged by excessive voltages. Read specification sheets to determine voltage limits. Start out with lower voltages and work up. Test sources with multimeter.
- Components can be damaged by reversed polarities. Make sure you understand what the component is designed for. Test the circuit to check polarities. Learn how to use the power supplies.
- Computer components are especially vulnerable. Be very careful about what voltages you expose the Arduino to.

Statement on Well-Being and Success

Success in this course depends heavily on your personal health and wellbeing. Recognize that stress is an expected part of the college experience, and it often can be compounded by unexpected setbacks or life changes outside the classroom. Moreover, those with marginalized identities may be faced with additional social stressors. Your other instructors and I strongly encourage you to reframe challenges as an unavoidable pathway to success. Reflect on your role in taking care of yourself throughout the term, before the demands of exams and projects reach their peak. Please feel free to reach out to me about any difficulty you may be having that may impact your performance in this course as soon as it occurs and before it becomes unmanageable. In addition to your academic advisor, I strongly encourage you to contact the many other support services on campus that stand ready to assist you.

Weekly Schedule

A week-by-week summary of the course (subject to change)

Week	Theme/ Topic(s)	In-class activities	Assignment Due	Readings Due	Post-class Work

1	Introduction	Lecture: What is Physical Computing Lecture: What is Electricity?			Set up a blog and post link in the myCourses Discussions Buy the parts from the course parts list Get an Arduino microcontroller (Arduino Nano 33 IoT with headers) Look at the Arduino web site Topic: What is Electricity? Topic: Microcontollers Readings
2	Introduction	Discussion Lecture: The Arduino Ecosystem Lab: Hello Microcontroller! Lecture: Tools & Prototyping Workflow Lab: Components		Don Norman, *The Design of Everyday Things*, ch. 1	Homework 1
3	Introduction	Homework 1: discussion and critique Lecture: Schematics & PCBs Intro to Fritzing Lab: Setting up a Breadboard	Homework 1		Readings

4	Sensors and Data Acquisition	Lecture: Sensors Lab: Analog Input (Photocell, Potentiometer) Lab: Switches & Digital I/O			Topic: Sensor Analysis & Filtering Readings Homework 2
5	Sensors and Data Acquisition	Homework 2: discussion and critique Discussion Lecture: Sensor Analysis & Filtering	Homework 2	Jeon et al, "From rituals to magic: Interactive art and HCI of the past, present, and future" Hiroshi Ishii & Brygg Ullmer, "Tangible Bits: Towards Seamless Interfaces Between People, Bits and Atoms"	Topic: Serial Communication
6	Communication protocols	Lecture: Serial Communication Lab: Asynchronous Serial Communication Lab: Serial Output from Arduino to Processing			Homework 3 Arduino Serial Communication Reference

7	Communication protocols	Homework 3: discussion and critique Lecture: Networks and Locative Media Lab: Two-way Serial Communication (handshaking) Lab: Wifi Communication in Arduino	Homework 3		Sparkfun: Motors Review/Prepare for Mid-term
8	Actuators	Lab: Motors & Transistors Lab: Piezo Buzzer	Mid-term Quiz		Research presentation Homework 4
SPRING BREAK: March 12-19					
9	Research Presentations	Research presentations	Research presentation		Homework 4 Readings
10	Advanced Sensors and Data Acquisition	Homework 4: discussion and critique Lecture: Touch, Tactility & Alternative Materials Lab: DIY Touch Sensor	Homework 4		Readings
11	Advanced Sensors and Data Acquisition	Discussion Lecture: Reflective Design & Ambiguity Lab: Distance Sensing		William Gaver, “Ambiguity as a Resource for Design” Critical Engineering Manifesto	Final Project

12	Advanced Sensors and Data Acquisition	[Lab: Accelerometer]			Final Project
13	Designing Alternative Interfaces	Lecture: Designing Alternative Interfaces [Lab: Logic Chips]			Final Project
14	TBD	TBD			Final Project
15	Final Project	Final project: Show project work in progress, get feedback (from fellow students) Free lab time			Final Project
16	Final project		Final Project		