

# USC Viterbi

School of Engineering  
*Information  
Technology Program*

## ITP 348 – Introduction to Physical Computing

Units: 4

Fall 2019—TBD—TBD

**Location:** TBD

**Instructor:** Rob Parke

**Office:** OHE 412

**Office Hours:** TBD

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**Teaching Assistant:** TBD

**Office:** TBD

**Office Hours:** TBD

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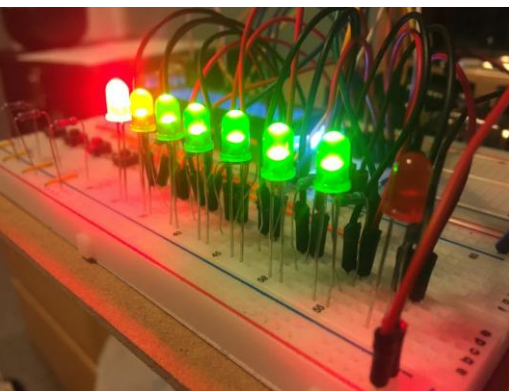
**IT Help:** Provided by Viterbi IT

**Hours of Service:** 8am–5pm M-F

**Walk-in:** DRB 205

**Contact Info:** (213) 740-0517

**Email:** [engrhelp@usc.edu](mailto:engrhelp@usc.edu)



## Course Description

This course introduces students to the fundamental concepts of physical computing systems through hands-on, real-life applications. Physical computing forms the basis of **smart devices**, **wearables** like smart watches, **e-textiles / fashion**, **IoT (Internet of Things) devices**, and hardware start-up

This course is designed specifically for a **general audience** and **all majors**. You will learn to design electronic devices that interact with the physical world. Assignments will use **motion detectors**, **robotic arms**, and **electronic music generation**.

This course teaches students to design electronic devices that interact with the physical world by building circuits and developing software algorithms that run on a microcontroller. Students are expected to be familiar with object-oriented programming, but **no prior experience with electronics or microcontrollers is necessary**.

## Learning Objectives

- Understand fundamental circuit and electronics theory principles
- Apply programming knowledge to C / microcontroller (Arduino-compatible) environment
- Write firmware algorithms for a microcontroller
- Understand analog-to-digital and digital-to-analog conversion on a microcontroller
- Understand communication protocols for interacting with a connected device

## Learning Outcomes

- Design a simple device that reads sensor data and communicates with an internet-based storage platform
- Determine the appropriate electronic component for specific operations
- Use a microcontroller to communicate with sensors and motors

**Prerequisite(s):** ITP 109 or ITP 165 or ITP 115 (equivalent courses or knowledge will be considered)

## Format

This course will make use of Blackboard for content and assignments. Lecture slides and any supplemental course content will be posted to Blackboard for use by all students. Any and all announcements for the course will be posted to Blackboard. All assignments will be posted to Blackboard and will be submitted through Blackboard. **Students must familiarize themselves with Blackboard before the course begins.**

## Course Materials

Students will be expected to have access to a Particle Argon as well as basic electronic components and tools. Our ITP 348-specific kit can be purchased at <https://www.sparkfun.com/products/14684> **(PLEASE NOTE THAT THIS IS VERSION ISN'T CUSTOMIZED. DON'T PURCHASE BEFORE SPEAKING WITH INSTRUCTOR)**



## Required Readings



Scherz, Paul, et. al. *Practical Electronics for Inventors (3rd Edition)*. McGraw-Hill Education, 2013. ISBN: 978-0071771337  
[Amazon](#)

Additional readings will be posted on Blackboard occasionally during the semester

## Supplementary Books



Hughes, John M. *Arduino in a Nutshell: A Handbook for Technicians, Engineers, and Makers*. 2015. ISBN: 978-1491921760  
Amazon: <http://a.co/dkklYgg>



Purdum, Jack. *Beginning C for Arduino, Second Edition: Learn C Programming for the Arduino*. Apress, 2015. ISBN: 978-1484209417  
Amazon: <http://a.co/9NcBY1V>

## Hardware Assignments

There will be approximately 13 hardware assignments that are due 1 week after being assigned. These assignments require building a hardware device with the Arduino. They will be assigned in class and are due in class one week later. Code from external sources may be used as a reference, as long as it is properly cited. These are to be completed individually unless otherwise noted.

## Programming Assignments

There will be approximately 8 programming assignments (no hardware) which will focus on a further understanding of problem-solving, algorithms, and logical thinking using C, and are due 1 week after being assigned. Programming assignments will be posted on Blackboard on Sunday night and are due the following Sunday at 11:59pm. Assignments are to be completed individually and submitted on Blackboard.

## Grading Breakdown

Item	% of Grade
Participation	10
Hardware Assignments	30
Programming Assignments	10
Midterm Exam	25
Final Exam	25
Total	100

## Grading Timeline

Assignments will receive feedback within one week.

## Policies and Expectations

Students are expected to:

- Attend and participate in lecture discussions
- Attend and complete weekly assignments

**Late Work**

It is the student's responsibility to submit assignments on or before the due date. Assignments may be turned in with a late penalty of 25% per day. This will apply to assignments immediately after the deadline. It is the responsibility of the student to contact the grader when posting late work. After four days, submissions will not be accepted and will result in a score of 0 (zero).

Students who register for the class after assignments are due must turn in any missed work within three days from the day student has registered. For example, if a student registered on a Friday, then all missed work needs to be submitted by the end of day on Monday.

## Course Schedule: A Weekly Breakdown

	Topics/Daily Activities	Readings	Assignment Deliverable
<b>Week 1</b>	Intro to Physical Computing / C++ Review <ul style="list-style-type: none"> <li>• Hardware overview</li> <li>• C++ Syntax</li> <li>• C++ Data types</li> <li>• C++ Functions</li> <li>• Software installation</li> </ul>	Supplemental readings online	HA 1 – Arduino setup PA 1 – Four function calculator with display and memory
<b>Week 2</b>	Circuits <ul style="list-style-type: none"> <li>• Components</li> <li>• Power / ground</li> <li>• Breadboards</li> <li>• Circuit diagrams</li> <li>• Current and voltage relationships</li> <li>• Ohm's Law</li> <li>• Kirchoff's Law</li> </ul>	Ch. 2 (Scherz)	HA 2 – Lights! PA 2 – Finance and Tax Calculator
<b>Week 3</b>	I/O and Microcontrollers <ul style="list-style-type: none"> <li>• Communicating with devices</li> <li>• Interacting with the world</li> </ul>	Ch. 13 (Scherz)	HA 3 – Microcontroller I/O
<b>Week 4</b>	Analog to Digital <ul style="list-style-type: none"> <li>• Analog to digital inputs</li> <li>• Voltage and impedance</li> <li>• Advanced inputs / multiple inputs</li> </ul>	Ch. 12 (Scherz)	HA 4 – Ambient Light Compensation
<b>Week 5</b>	Circuit Configurations <ul style="list-style-type: none"> <li>• Series vs. parallel</li> <li>• Advanced iteration</li> <li>• Storage containers in C</li> </ul>	Ch. 2-3 (Scherz) Supplemental readings online	HA 5 – Binary clock PA 3 – Decimal / Binary / Hexadecimal Conversion
<b>Week 6</b>	Sensor Components <ul style="list-style-type: none"> <li>• Photoresistors</li> <li>• Thermistors</li> <li>• Bitwise operations</li> </ul> Audio <ul style="list-style-type: none"> <li>• Generating audio</li> <li>• Pure / mixed tones</li> <li>• Harmonics</li> <li>• Piezo speakers</li> </ul>	Ch. 12 (Scherz) Supplemental readings online	HA 6 – Motion-activated camera
<b>Week 7</b>	Midterm	-	-
<b>Week 8</b>	Pointers and Memory <ul style="list-style-type: none"> <li>• Pointers</li> <li>• Memory management</li> <li>• Device considerations</li> <li>• Standard library functions</li> </ul>	Supplemental readings online	HA 7 – Smart thermometer PA 4 – Histogram

<b>Week 9</b>	Digital to Analog <ul style="list-style-type: none"> <li>• Converting digital signals to analog</li> <li>• Control servos</li> <li>• Stepper motors</li> </ul>	Ch. 15 (Scherz)	HA 8 – Robotic arm PA 5 – Tic-Tac-Toe
<b>Week 10</b>	Binary Logic <ul style="list-style-type: none"> <li>• Shift registers extra</li> <li>• Creating "" output pins</li> <li>• Gray codes</li> </ul>	Ch. 12 (Scherz), Supplemental readings online	HA 9 – Binary clock 2.0
<b>Week 11</b>	Communication Protocols <ul style="list-style-type: none"> <li>• I2C</li> <li>• SPI</li> <li>• Communicating with external devices</li> </ul>	Supplemental readings online	HA 10 – WheeeMote Accelerometers PA 6 – War! (random "High Card" card game with structs)
<b>Week 12</b>	Wireless Communications <ul style="list-style-type: none"> <li>• Wireless modules</li> <li>• Bluetooth</li> </ul> Security <ul style="list-style-type: none"> <li>• Case studies</li> <li>• Best practices</li> </ul>	Supplemental readings online	HA 11 – WheeeMote Unplugged
<b>Week 13</b>	The I in IoT <ul style="list-style-type: none"> <li>• Cloud-connected boards</li> <li>• Cloud platforms</li> <li>• Deployment</li> <li>• Webhooks</li> <li>• Publish/subscribe</li> <li>• "Off the shelf" vs. custom systems</li> </ul>	Supplemental readings online	HA 12 – Dorm automation PA 7 – JavaScript APIs (part 1)
<b>Week 14</b>	Roaming Free <ul style="list-style-type: none"> <li>• Wearables</li> <li>• Mobile app considerations</li> <li>• Designing tactile user interface</li> <li>• Enclosures</li> <li>• Batteries</li> </ul>	Supplemental readings online	HA 13 – Tricorder PA 8 – JavaScript APIs (part 2)
<b>Week 15</b>	Advanced Topics <ul style="list-style-type: none"> <li>• Blockchain and IoT</li> <li>• Performance considerations</li> <li>• Hardware startups</li> </ul>	Supplemental readings online	Study
<b>Final</b>			Date: For the date and time of the final for this class, consult the USC <i>Schedule of Classes</i> at <a href="http://www.usc.edu/soc">www.usc.edu/soc</a> .

## Statement on Academic Conduct and Support Systems

### Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” <https://policy.usc.edu/scampus-part-b/>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

### Support Systems

*Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call*

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. <https://engemannshc.usc.edu/counseling/>

*National Suicide Prevention Lifeline - 1-800-273-8255*

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. <http://www.suicidepreventionlifeline.org>

*Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call*

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. <https://engemannshc.usc.edu/rsvp/>

*Sexual Assault Resource Center*

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: <http://sarc.usc.edu/>

*Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086*

Works with faculty, staff, visitors, applicants, and students around issues of protected class. <https://equity.usc.edu/>

*Bias Assessment Response and Support*

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. <https://studentaffairs.usc.edu/bias-assessment-response-support/>

*The Office of Disability Services and Programs*

Provides certification for students with disabilities and helps arrange relevant accommodations. <http://dsp.usc.edu>

*Student Support and Advocacy – (213) 821-4710*

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. <https://studentaffairs.usc.edu/ssa/>

*Diversity at USC*

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. <https://diversity.usc.edu/>

*USC Emergency Information*

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible, <http://emergency.usc.edu>

*USC Department of Public Safety – 213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime.*

Provides overall safety to USC community. <http://dps.usc.edu>