Software Design of PCBs: Course Info

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EECS UC Berkeley

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Course Description

Software Defined Printed Circuit Boards
"Circuit Board Design for Programmers"

Prof Jonathan Bachrach with Richard Lin @ EECS

Do you want to

make this

on this

```
val led_rows = Vector<Layout>()
for j in 0 to 8 do :
  val led_row = Vector<Layout>()
  for i in 0 to 8 do :
    val name = symbol_join(["led_" i "x" j])
    val led = bool_out(name, PullUpLED)
    append(led_row, Space(V2f(12.0, 12.0), led))
  append(led_rows, HBox(led_row))
val sliders = [slider(0), slider(1)]
val lay = HBox([VBox(join(sliders, Fill())),
                HSpace(2.0), VBox(led_rows)])
val sob = SOB(lay)
```

in code?

Have you ever wanted to design a circuit board but were intimidated?
Have you been frustrated by the tedium of circuit design apps?
Are you a programmer and want circuit board design to be like software design?
Do you want to design boards at the speed of rapid fabrication?

Well this class is for you...

CS194/294-126
upper div / grad / studio / project class

Fall 2016, TuTh 10-11:30a, Jacobs 220
4 Units: 3 hr lecture and 3+ hrs lab time / week.

`http://www-inst.eecs.berkeley.edu/~cs194-126`

"making the easy things easy and the hardware things software"

Course Style

- seminar
- cutting edge
- early stage and kind of rough
- workshop for fab toolkit
- lots of hands on and class discussion

Costs

- $75 Jacobs MakerPass
- > $100 material costs

can work with you if you have financial need

Tools/Parts + Costs

tools

- $75 Jacobs MakerPass and/or
- can use your own tools and/or lab space

parts

- > $100 material costs
- makerpass gives you access to stock parts
- makerpass gives you access to materials store
- otherwise buy from digikey + mouser + etc

can work with you if you have financial need

Goals

- competent with milling + soldering boards
- proficient in algorithmic design
- basic circuit design
- embedded debugging skills
- basic understanding of manufacturing constraints
- research directed – projects seed research ideas
- flush out examples for jitpcb
- push limits of what's possible with pcb design
- raise level of design to be as productive as fab machines
- have fun!

Why This Class?

- Have you ever wanted to design a circuit board but were intimidated?
- Have you been frustrated by the tedium of circuit design apps?
- Are you a programmer and want circuit board design to be like software design?
- Do you want to design boards at the speed of rapid fabrication?

No but really Why This class?

- Want to dig deeper into circuit design specifically?
- Want to build a research platform for your projects?
- Want to learn how to quickly prototype boards?
- Want to participate in a new and powerful design paradigm?

Non Goals

- teach standard tools
- teach programming
- to be a hardcore mechatronics class
- to be a hardcore embedded systems class

Prerequisites

- cs61a
- cs61b
- cs61c
- ee16ab*

- python programming
- algorithms
- computing systems
- electronics

Who Am I?

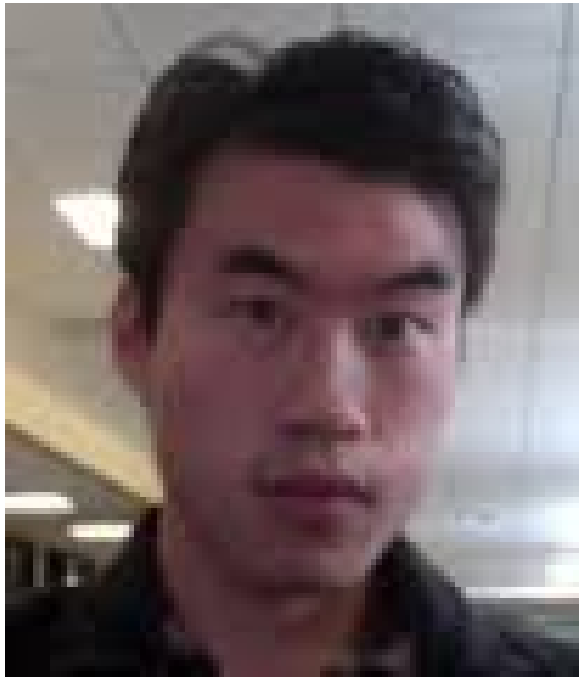
- adjunct assistant professor in eecs
- cofounded otherlab
- advise phd students and taught cs250
- teach cs194-028 on sw defined me
- lead chisel hardware design project

`http://www.jbot.org`

`jackbackrack`

Who Are TA'S?

Richard "Ducky" Lin

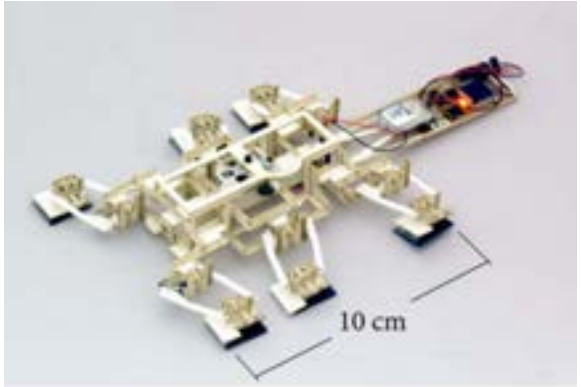


Patrick Li

Austin Buchan

EE192

STANZA



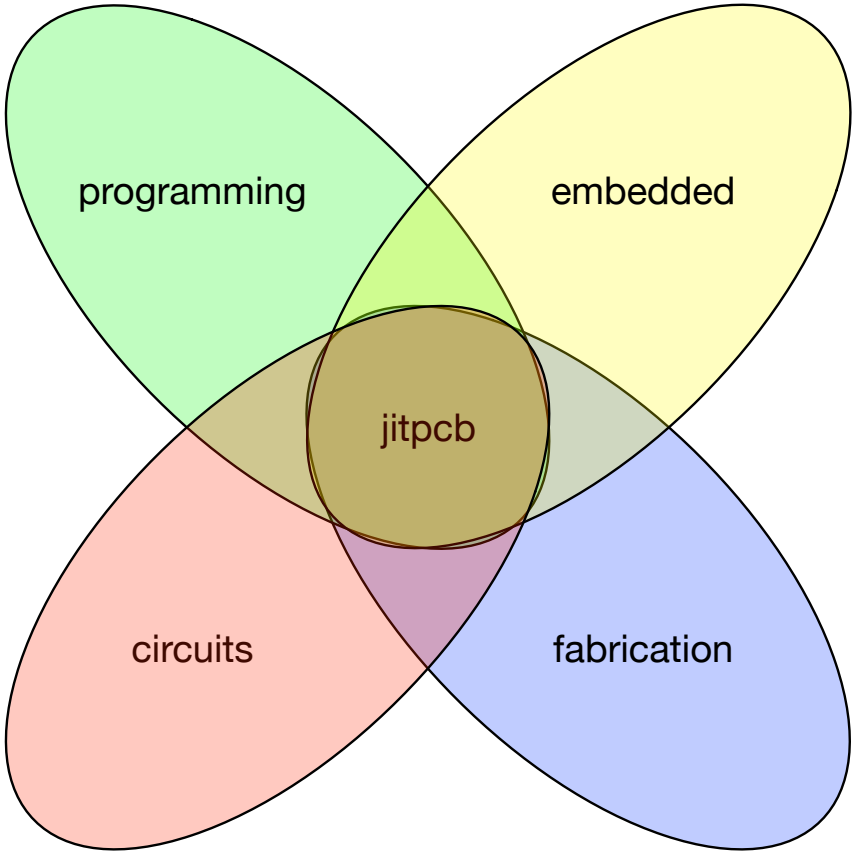
PhD Students in EECS

Who Are You?

- CS
- EE
- ME
- Art
- other?

- power tools
- fabrication
- arduino?
- python programming
- electrical engineering?

Course Material



“circuit boards for programmers”

Curriculum

- first chunk lectures / readings / labs and
- last 1/3 project

Week	Date	Subject	Assignments
01	Thu Aug 25	Lecture 01: Intro	
02	Tue Aug 30	Lecture 02: Stanza Programming Language	Stanza Tutorial
	Thu Sep 01	Lecture 03: Basic Embedded Systems	
03	Tue Sep 06	Lecture 04: mbed and Nucleo	Breadboarding
	Thu Sep 08	Lecture 05: Basic PCBs and Soldering	
04	Tue Sep 13	Lecture 06: PCB milling, assembly and soldering	Milling
	Thu Sep 15	Lecture 07: Basic JITPCB	
05	Tue Sep 22	Lecture 08: Basic Circuit Design Part I	Soldering
	Thu Sep 22	Lecture 09: Basic Circuit Design Part II	
06	Tue Sep 27	Lecture 10: Expert JITPCB Part I	JITPCB Basic Design
	Thu Sep 29	Lecture 11: Expert JITPCB Part II	
07	Tue Oct 04	Lecture 12: Sensors	JITPCB Physical Design
	Thu Oct 06	Lecture 13: Actuators	
08	Tue Oct 11	Lecture 14: Advanced Debugging I	JITPCB Peripheral Design
	Thu Oct 13	Lecture 15: Advanced Debugging II	
09	Tue Oct 18	Lecture 16: Project Ideas	
	Thu Oct 20	Lecture 17: Advanced Stanza	
10	Tue Oct 25	Proposal Presentations	
	Thu Oct 27	Proposal Presentations	
11	Tue Nov 01	Project 1-1s	
	Thu Nov 03	Project 1-1s	
12	Tue Nov 08	Project Critiques.	
	Thu Nov 10	Project Critiques.	
13	Tue Nov 15	Project 1-1s	
	Thu Nov 17	Project 1-1s	
14	Tue Nov 22	Project Critiques	
	Thu Nov 24	Thanksgiving	
15	Tue Nov 29	Project 1-1s.	
	Thu Nov 31	Project 1-1s.	
16 R+R	Tue Dec 06	Final Show	
17 Finals	Tue Dec 13	Final Project Writeups due	

SW to HW to SW Progression

- start from stanza
- work through old skool ways
- build out sw defined hw defined sw approach

Sections

- tools
- stanza programming
- jitpcb toolkit
- lab questions
- monday 4-5p in jacobs 210

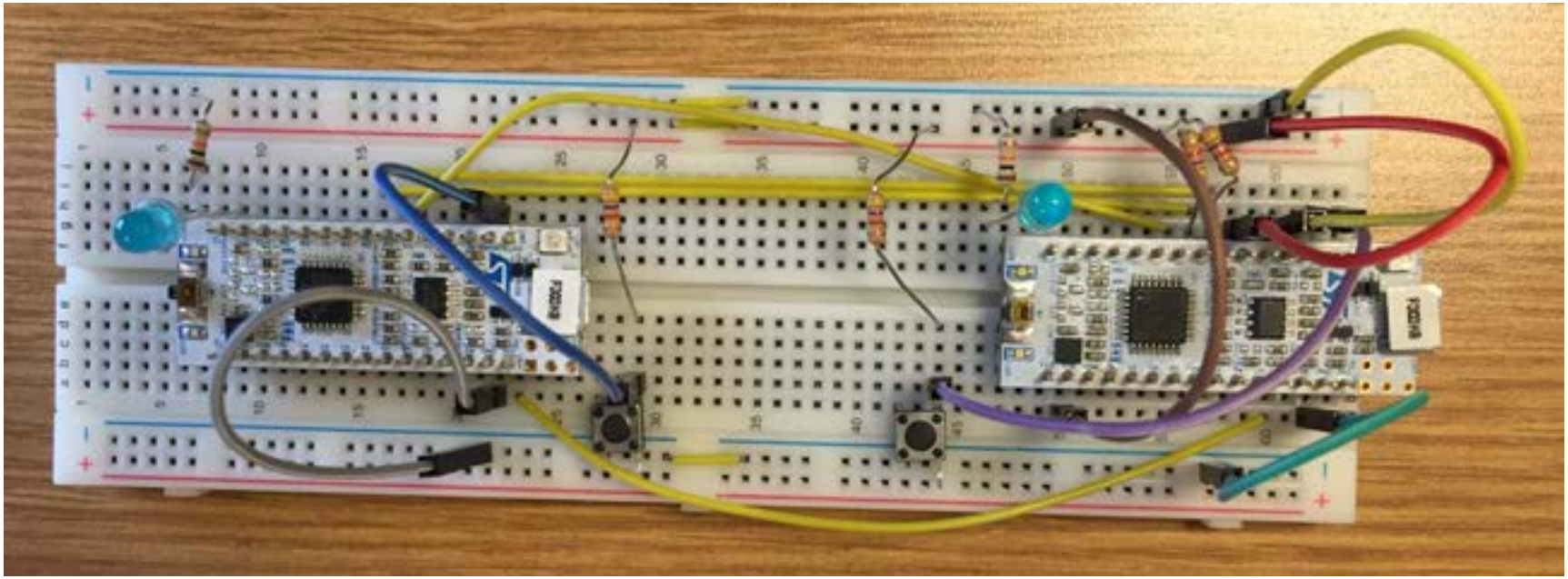
Labs

- series of tasks to learn fabrication and algorithmic design
- assigned at end of each tuesday's class
- due by start of next tuesday's class
- 5 late days total

- Overview
- Types
- Functions
- Standard Library

Lab Two – Breadboarding

- Breadboard simple Hello World with Nucleo
- Learn basic embedded programming
- Get console running
- Pipe cleaning your tools etc

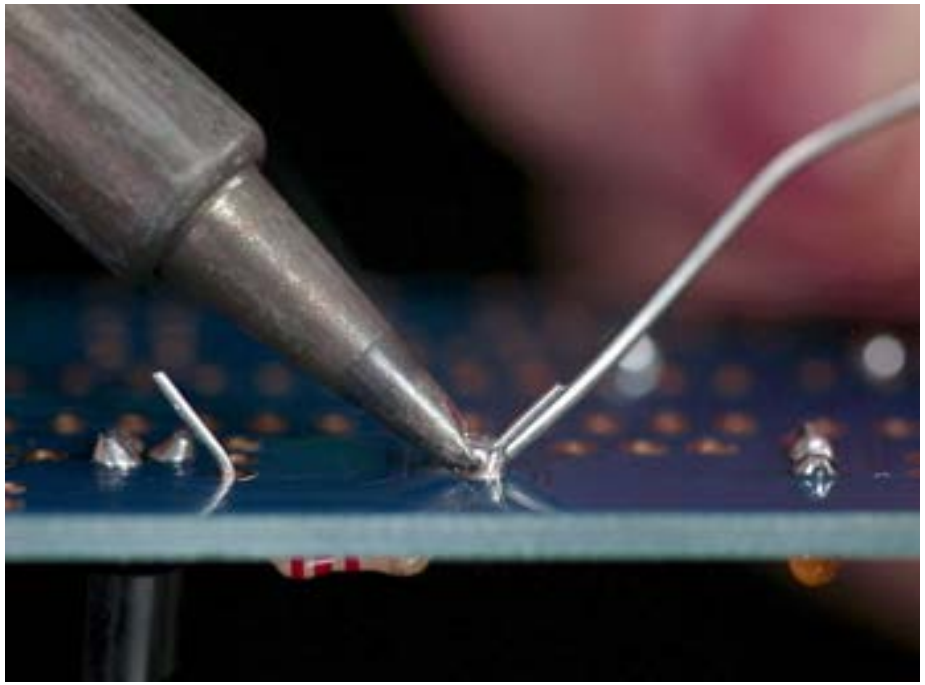


Lab Three – Milling

- Get Otherplan software installed
- Get tooling
- Mill hello world board

Lab Four – Solder

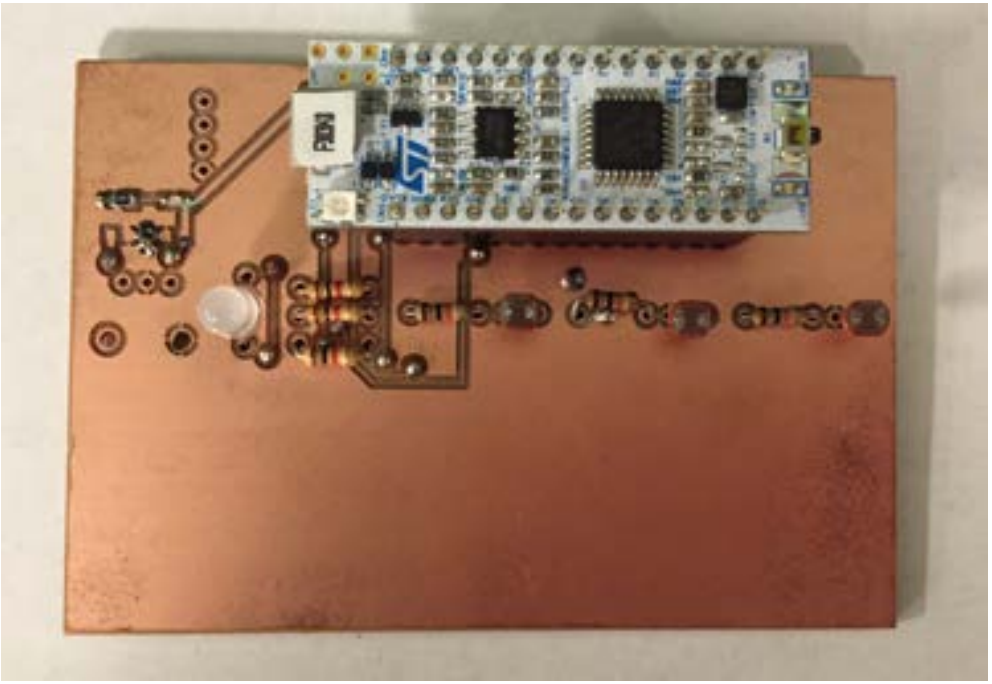
- Solder hello world board
- Learn basic soldering techniques with milled boards
- Solder vias
- Bring up hello world board



adafruit soldering

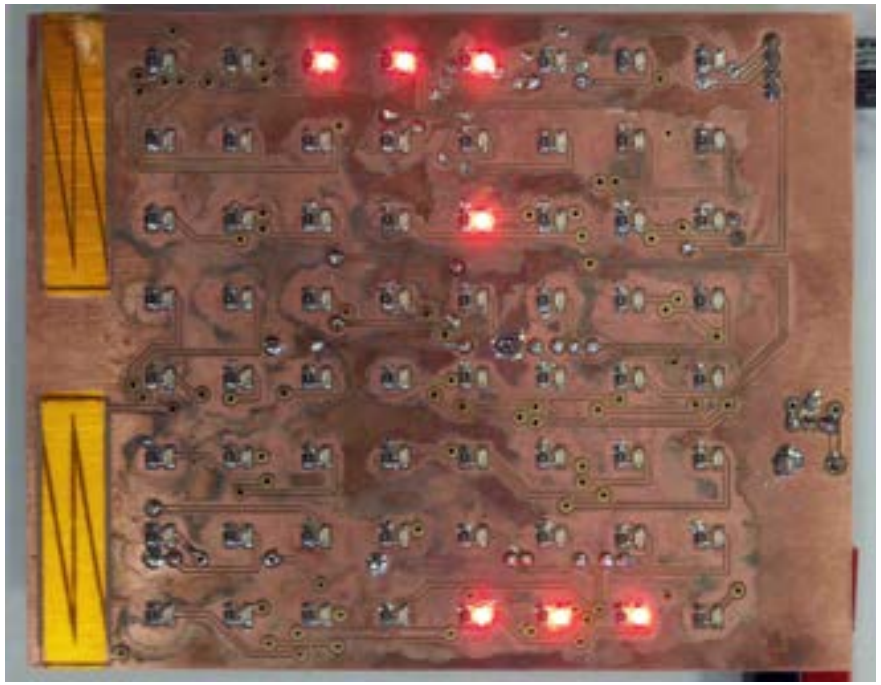
Lab Five – Basic JITPCB

- Write simple JITPCB design with couple peripherals
- Write PCB generator with parameters
- Mill, solder and bring up board



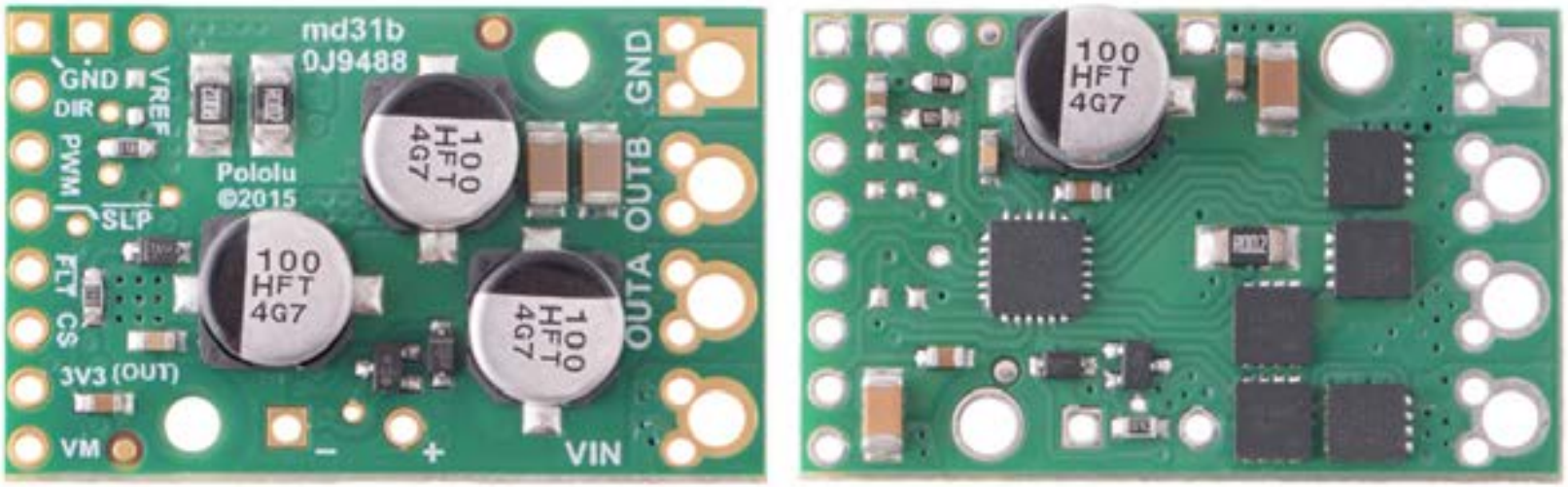
Lab Six – Physical JITPCB

- Write geometry driven design
- Parameterize design
- Learn layout language
- Mill, solder and bring up board



Lab Seven – JITPCB Peripherals

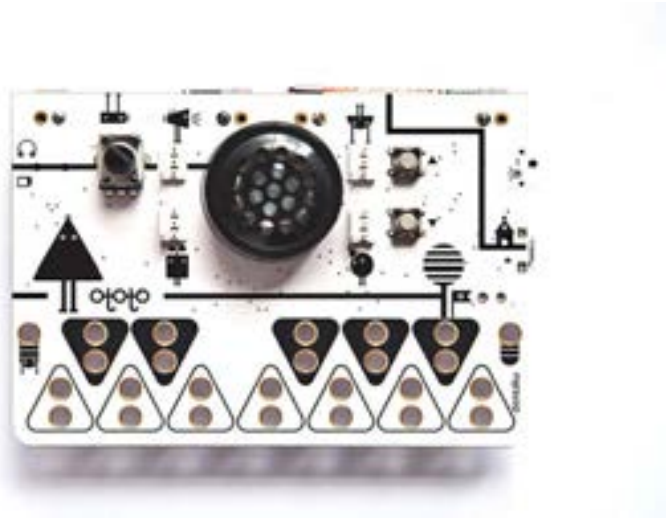
- Write peripheral with package + circuit + driver
- Learn how to design a package
- Learn how to parameterize circuit design
- Write driver
- Write design with new peripherals
- Mill, solder and bring up board



pololu motor board

Project

- eight week project
- JITPCB based projects
- quick pitches
- written project proposals
- live project proposals
- 1-1s
- critiques
- final show



Yuri Suzuki

Project Ideas

- sound – musical instruments
- light – LED sculptures / displays
- sensor – data acquisition and IoT
- actuation – mobile, arm, flying robots
- time – clocks

Project Goals

- parametric – reusable and scalable
- algorithmic – computational design
- declarative – optimize based on goals

Teaming

- ones for lab one
- twos for remaining and sections
- try to get complementary skills

Grading

- from eecs grading guidelines
- 5% participation
- 45% labs
- 50% project

A (excellent); B (good); C (fair); D (barely passed); F (failure); P (passed at a minimum level of C- for undergraduate students); NP (not passed); S (satisfactory, passed at a minimum level of B- for graduate students); U (unsatisfactory); I (work incomplete due to circumstances beyond the student's control, but of passing quality); and IP (work in progress, final grade to be assigned upon completion of entire course sequence).

Piazza

- cs194-126
- sign up
- send message to instructors with
  - availability for wednesday
  - github username
  - teams
- questions posted and answered there

Github

- cs194-126
- homework done here
- each student gets their own repo

app	windows	macos	linux
JITPCB	yes	yes	yes
OtherPlan	yes	yes	no

Website

- http://inst.eecs.berkeley.edu/ cs194-126

Computer Science 194/294-126: Software Defined Printed Circuit Boards

Fall 2016

Prof. Jonathan Bachrach

Lectures: Tuesday and Thursday, 10:00-11:30AM, 220 Jacobs

Course Info and Poster

Course Calendar with Handouts

Subject to Change.

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Training

- get makerpass
- online training
- electronics training
- othermill training

http://jacobsinstitute.berkeley.edu/student-resources/

Materials

- students can purchase materials through jacobs
- `https://store.jacobshall.org`
- also buy through digikey + mouser + sparkfun + adafruit
- examples: nucleo, blank pcbs, sensors, actuators, ...