

CS107e: Computer Systems from the Ground Up

Pat Hanrahan, Dawson Engler, Phil Levis

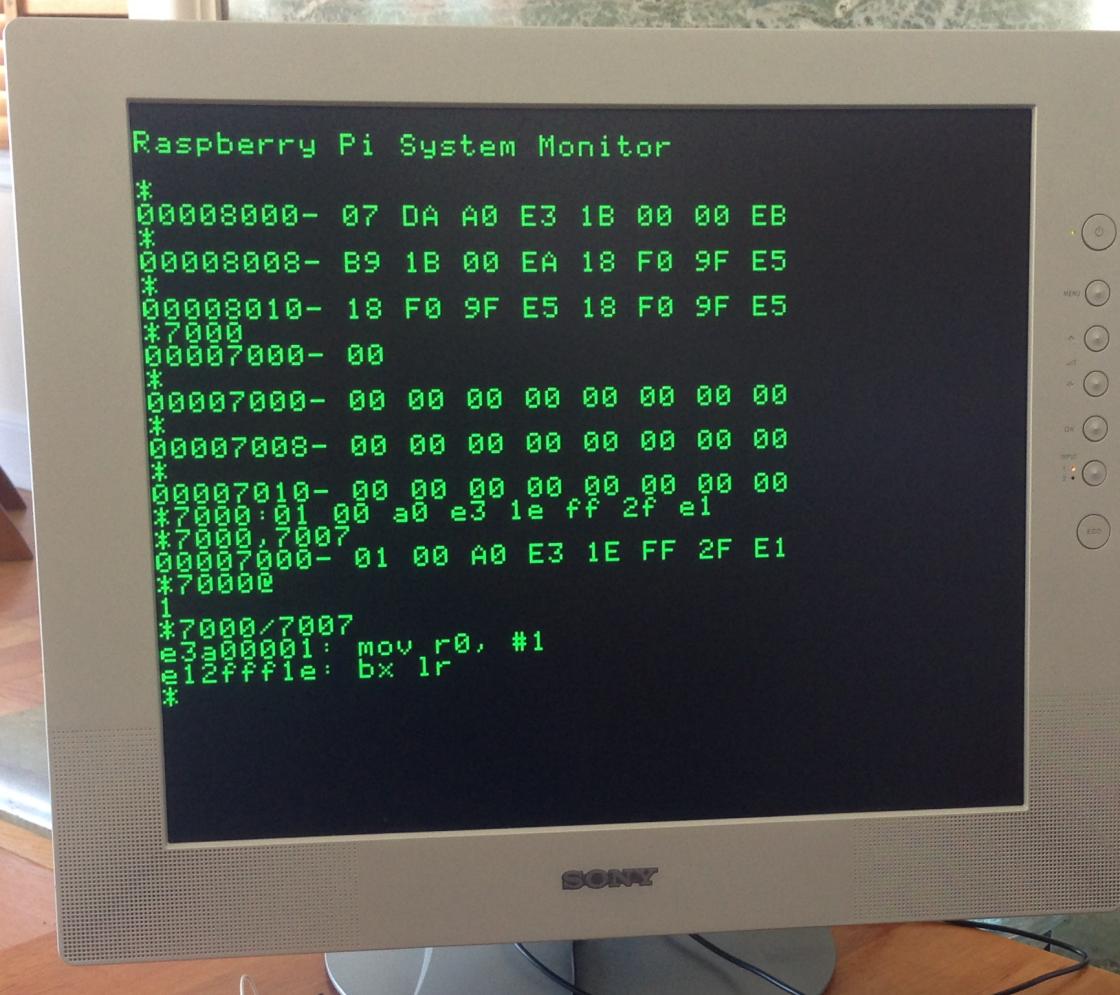
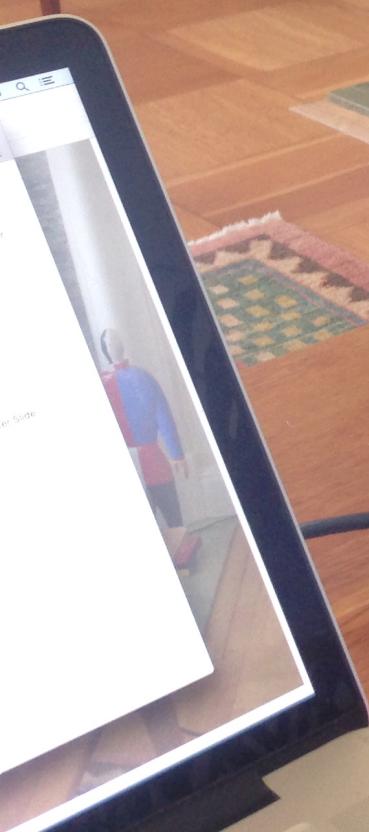
**Isabel Bush, Jane E,
Omar Rizwan, Anna Zeng**

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Learning Goal 1

**Understand how computers
represent data,
execute programs,
and control peripherals**

```
Raspberry Pi System Monitor  
*  
00008000- 07 DA A0 E3 1B 00 00 EB  
*  
00008008- B9 1B 00 EA 18 F0 9F E5  
*  
00008010- 18 F0 9F E5 18 F0 9F E5  
*7000  
00007000- 00  
*  
00007000- 00 00 00 00 00 00 00 00  
*  
00007008- 00 00 00 00 00 00 00 00  
*  
00007010- 00 00 00 00 00 00 00 00  
*7000:01 00 a0 e3 1e ff 2f e1  
*7000,7007  
00007000- 01 00 A0 E3 1E FF 2F E1  
*70000  
1  
*7000/7007  
e3a00001: mov r0, #1  
e12ffff1e: bx lr  
**
```





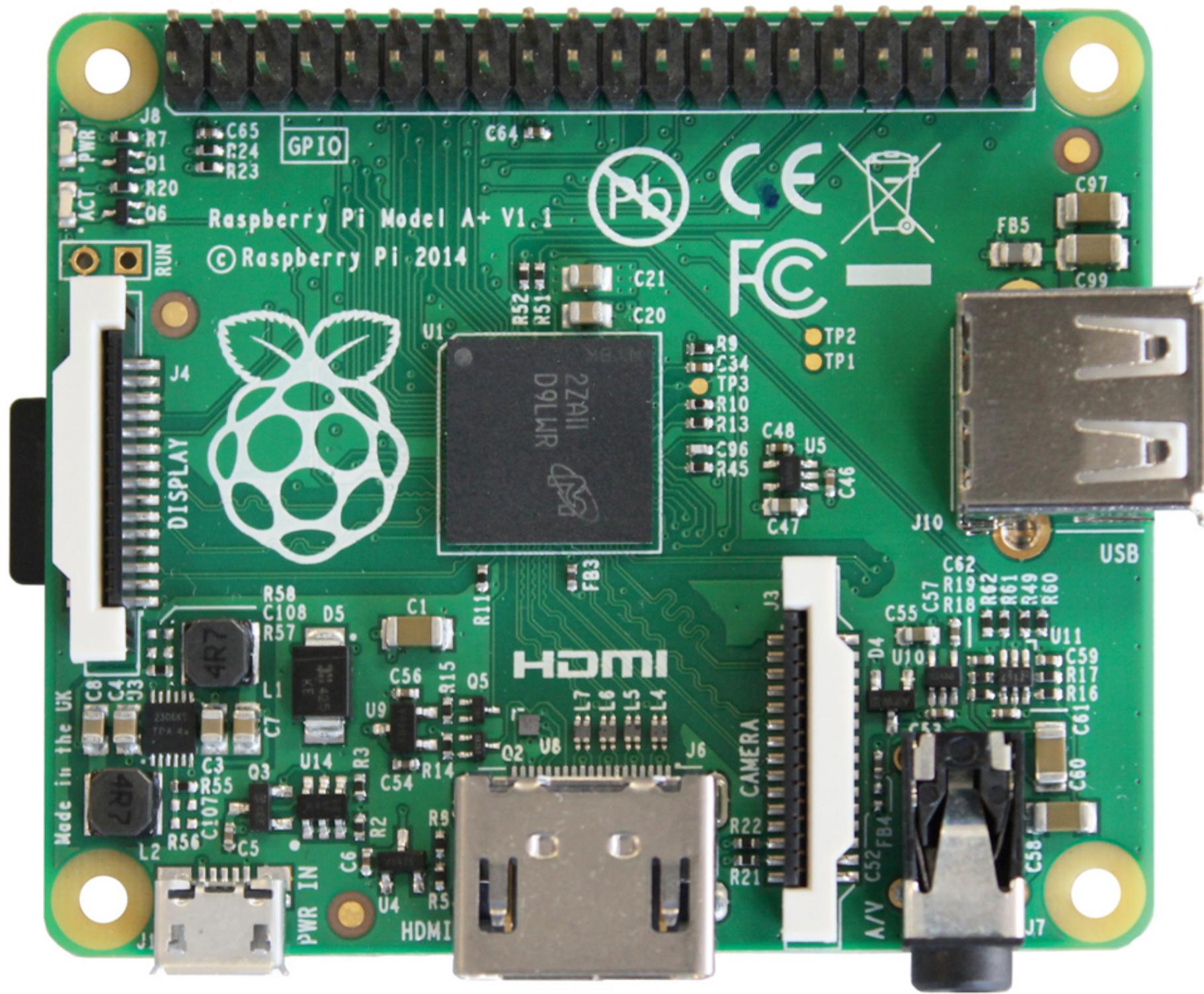
Bare Metal on the Raspberry Pi

Definition: Bare metal programming involves no operating system and minimal use of libraries.

Bare metal programs boot and startup on their own, and directly control peripherals.

Exercise

Inspect Raspberry Pi



AKCE MC1
V-OF3
1439 1-6

PP35
PP22
PP23
PP27

R12 C40 C17
C36 C95 F82 C69
C94 C51 C49 C18 C37
C50 C9 F51 C14 R25
C45 C29 C13 C12 C35
C30

MICRO SD CARD



PP10
PP13

27/10

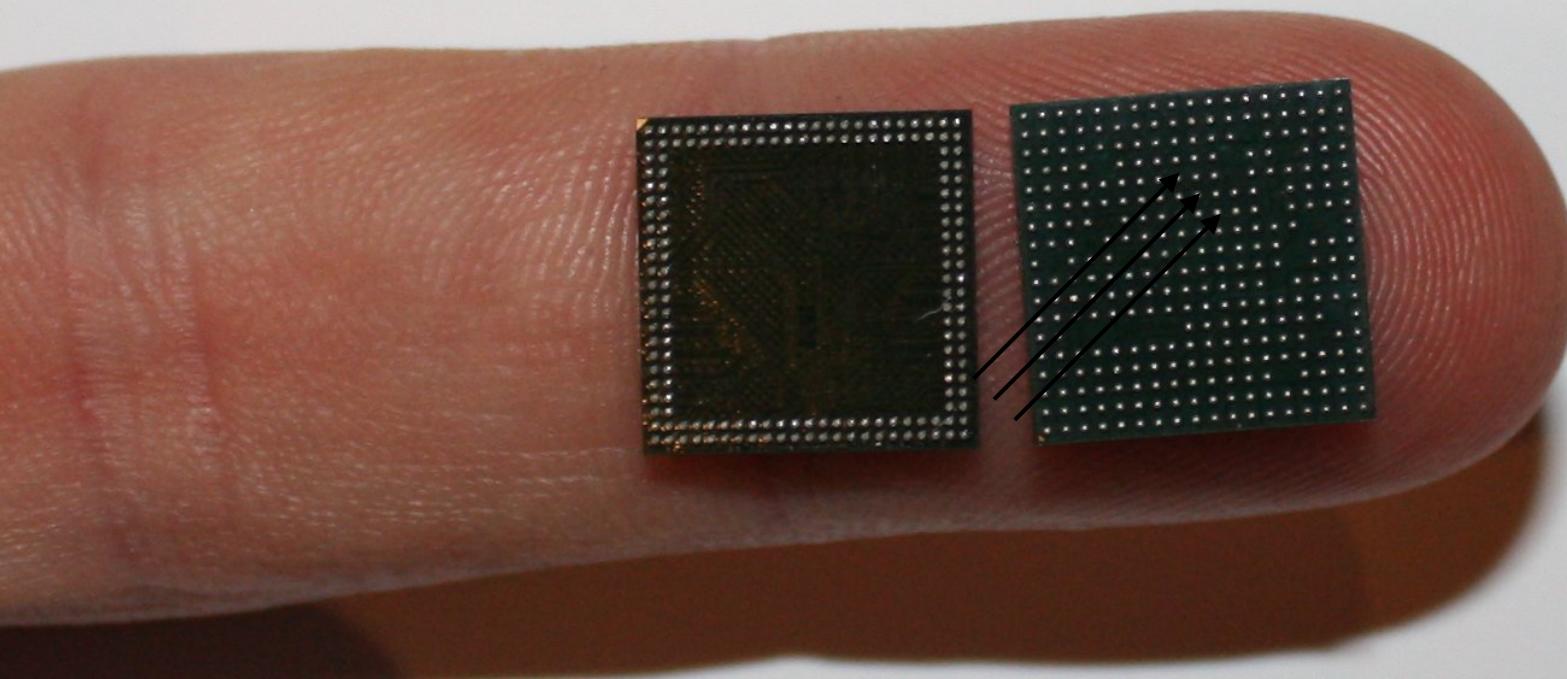
1

J9

A close-up photograph of a green printed circuit board (PCB). Several surface-mount components are visible, each labeled with a code. At the top left is a capacitor labeled 'C2'. To its right is a resistor labeled 'R1'. Below 'C2' are two pads labeled 'PP8' and 'PP4'. To the right of 'R1' is a pad labeled 'PP9'. In the center, there is a larger component with four pads around it, labeled 'PP7' at the top, 'PP1' below it, and 'PP2' to the right. At the bottom left is a component labeled 'PP3'. The PCB has a standard green color with white solder mask.

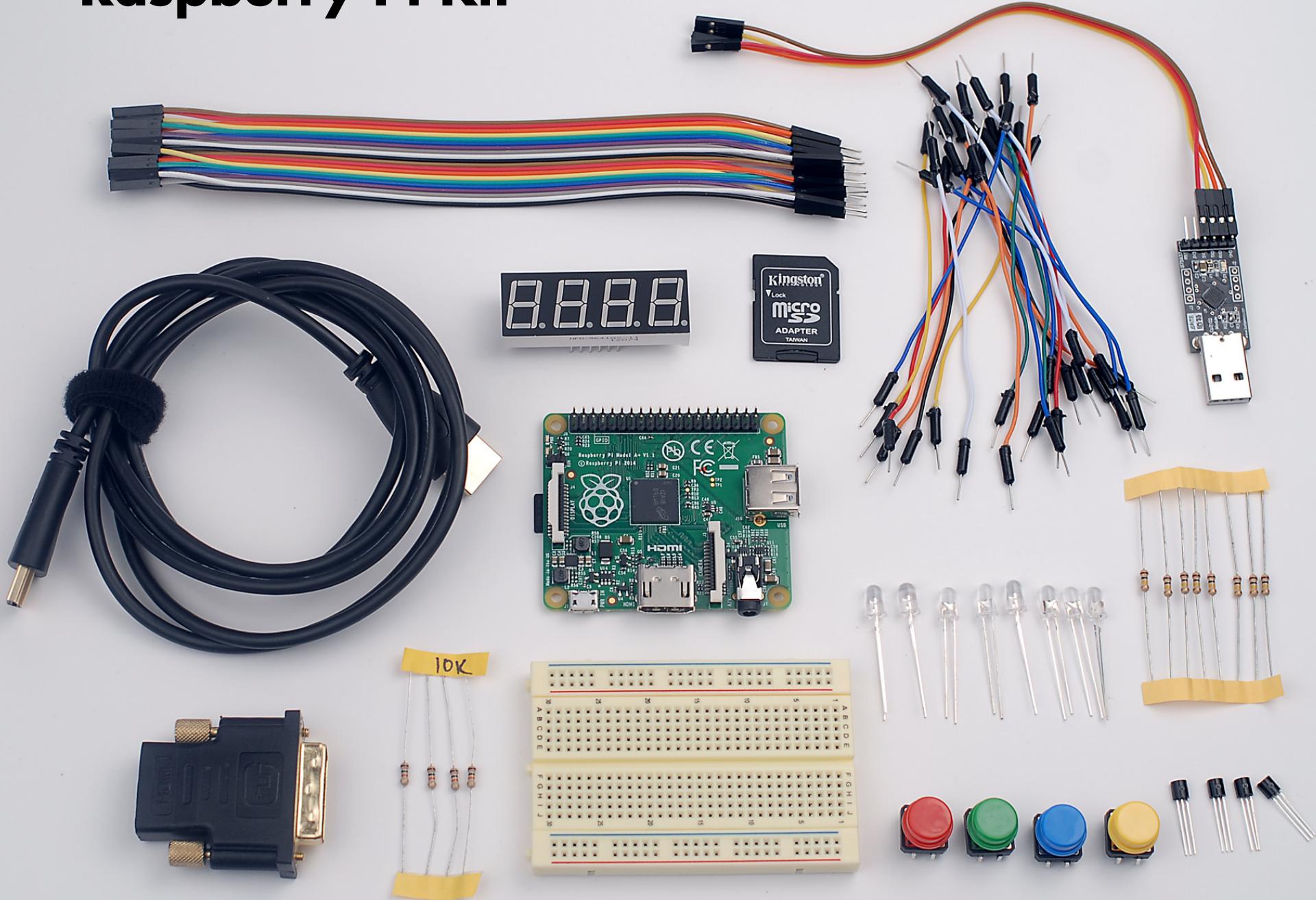
Package on Package

**Broadcom 2865 ARM Processor
ARM1176JZF-S 700 MHz
ARMv6 Architecture**



Samsung 512MB SDRAM

Raspberry Pi Kit





Learning Goal 2

Master your tools

Different Tools for Different Jobs



<http://dans-woodshop.blogspot.com/>

Organized Development Environment



<http://amhistory.si.edu/juliachild/>

A close-up photograph showing a person's hands working on a piece of wood. The person is using a chisel to shape a dark, rectangular block of wood that is resting on a larger, light-colored wooden board. The background shows a workshop environment with various tools and equipment.

Master the Craft

<https://paulsellars.com/tag/gouge/>

Debugging and Troubleshooting



Course Topics

cs107e.github.io

§1 Bare Metal Programming

- 1. ARM processor and memory architecture**
- 2. ARM assembly language and machine code**
- 3. C**
- 4. Functions**
- 5. Serial communication**
- 6. Linking and loading**
- 7. Memory allocation**

§2 Personal Computer

1. Keyboard

2. Graphics

3. Interrupts

End goal: Your *own* running Raspberry Pi System Monitor

§3 Additional Topics

- 1. Sensors**
- 2. Signed and unsigned arithmetic**
- 3. Towards Linux and beyond**

And a special guest lecture!

Administration

Weekly Cadence

Each week has a focus topic

Pair of coordinated lectures on Fri and Mon

Mandatory lab on Tue/Wed evening from 7-9 pm in Gates 325

Assignment due following Tue at 7 pm (before Tue lab)

Laboratories

Gates 325: Attendance is **mandatory**

Doe exercises and complete check-list

Leave ready to do assignment

Philosophy: lots-of-help, hands-on, collaborative

Lab: access to tools and supplies

Lab fee: \$50, collected during first lab (the kit is yours)

Assignments

7 assignments

- **Build on each other**

Two parts for each assignment

- **Basic**
- **Extension**

Final project

NO EXAMS

Grading

Basic - 5 points

Extension - 5 points

**Extra 5 points for completing the last assignment
using all your own code**

**A = 7 fully functional basic assignments + 3
extensions + bonus + outstanding final project**

**B = 7 functional basic assignments + good final
project**

First Week

Questionnaire

Will email "Accepts" by Tue

Assignment 0

Subscribe to cs107e in piazza

Attend cs107 UNIX labs

Assignment 0

- Using git and github**
- Submit your lab preference**

Read and understand basic guides

Basic Electricity

Voltage and current

Ohms Law : $V = I R$

Power : $P = I V$

Driving an LED

Transistor switches

Breadboarding

Guide: [electricity.md](#)

Number Representations

Binary representation

Hexadecimal

Bit operators

Guide: number.md

Unix Command Line

Moving around the file system

Creating, moving, and deleting files

Compiling and running programs

Profiles and paths

Guide: unix.md

Note: Attend cs107 labs this week