Lab tutorial

**Breadboard**

**Logic probe**

**Light emitting diodes (LEDs)**

**Transistor to transistor logic (TTL)**

- Consumes more power than CMOS
- Generally more difficult to damage than CMOS (ESD)
- Inputs “float high”
- What does this imply?
- Why is it good for prototyping?

- Color code sheet in your orange box
- Colored bands indicate numbers
- Black (0), brown (1), red (2), orange (3), yellow (4), etc.
- What is Orange, Orange, Black?
- What about Orange, Orange, Brown?

- Connect all inputs to some signal, best not to rely on floating
  - Good practice for CMOS, where it’s essential
- Color-code wiring in complicated circuits
  - Learn how to strip wire
  - Don’t cross wire over chips
  - Double-check $V_{DD}$ and $V_{SS}$ wiring
  - Watch for hot chips
  - Use current-limiting resistors on LEDs
**Circuit diagram example**

![Circuit Diagram](image)

**Incomplete circuit diagram example**

![Incomplete Circuit Diagram](image)

**Summary**

- Demo to put prototyping in context
- Breadboarding lecture and demo

**Prototypeing trends**

- Surface mount
- FPGAs
- Virtual prototyping

**Computer geek culture references**

- [http://www.digikey.com](http://www.digikey.com)
- [http://www.mouser.com](http://www.mouser.com)
- [http://www.jameco.com](http://www.jameco.com)