

Electronics – what we'll study/do winter 2021

1. Digital Logic Elements/Gates

- a. MOSFET switches and logic gates (NOT, OR, AND, NOR, NAND, XOR)

2. Memory devices

- a. Flip-flops and D-latches with various triggering modes
- b. Memory registers, read/write operations
- c. RAM
- d. Flash

3. Binary numbers and Computer arithmetic

- a. Binary, Hex, Decimal Number Systems
- b. Adders
- c. Counters

4. Communication protocols

- a. [SPI](#)
- b. [I2C](#)
- c. Serial/[UART](#)

5. Sensors/actuators and theory of operation

- a. Servo Motors
- b. Pressure sensors
- c. Accelerometers/IMU
- d. Etc

6. Analog-to-Digital Converter (ADC) and Digital-to-Analog Converter (DAC):

- a. Resolution
- b. Modes
- c. Speed
- d. Nyquist/Shannon sampling theorem

7. Microcontrollers/Integrated Devices

- a. Specs: CPU speed, power consumption, peripherals, ADC, DIO, etc.
- b. Tradeoffs/how to choose a device
 - i. [Arduino](#)
 - ii. [Teensy](#)
 - iii. [Particle](#)
 - iv. [ESP32](#)
 - v. [Raspberry Pi](#)

8. Wireless Devices and Protocols

- a. [Bluetooth](#)

- b. WiFi
 - c. [XBee](#)
 - d. [LoRa](#)
- 9. Practical Stuff**
- a. Eagle schematic and PCB layout
 - b. Mechanical assembly/considerations
- 10. Design Project**
- a. **You will have about 6-8 weeks to work on yours!**
 - b. see project list below

Electronics Project Ideas (compiled winter 2021)

Biomedical:

- EWH projects that matter:
https://docs.google.com/document/d/1rsnvAk_s6G33OCzafoQl1B1DyY39Xp_jhL4gw6Jtnek/edit
- Sports Impact and Injury Assessment: e.g., football pad integrated sensors
- Digital Stethoscope (for GI applications):
 - <https://pubmed.ncbi.nlm.nih.gov/22969233/>
 - <https://pubmed.ncbi.nlm.nih.gov/24156174/>
- Electrical Impedance Tomography (EIT)
 - <https://github.com/OpenEIT>
 - <http://www.chrisharrison.net/index.php/Research/Tomo>

Environmental Monitoring:

- Air Quality Sensor – What’s in the air? Tracking air quality around Lexington (for instance, see: [Hawai’i Island Vog Network](#) on the Particle blog)
- Bee Hive Monitoring: <https://makezine.com/projects/bees-sensors-monitor-hive-health/>
- Water quality sensor for [low-resource setting](#) or ocean monitoring (e.g., see: [SmartFin](#) on Particle blog)

Digital Security:

- Gas pump Skimmer Scanner:
 - <https://makezine.com/projects/gas-pump-skimmer-scanner/>

- https://learn.sparkfun.com/tutorials/gas-pump-skimmers?_ga=2.61900972.1427611620.1609525879-169289951.1604782701

Rocketry:

- Parachute deployment and data logging (e.g., see: <https://hackaday.io/project/7189/logs>)

Imaging and Object Manipulation:

- Reflectance transformation imaging: <https://makezine.com/projects/shoot-super-detailed-macro-photographs-with-an-rti-camera-rig/>
- Acoustic Tractor Beam:
 - <https://www.instructables.com/id/Acoustic-Tractor-Beam/>
 - <https://www.nature.com/articles/ncomms9661>

Fun and Leisure:

- Cold brew coffee drip tower: <https://makezine.com/projects/build-a-behemoth-cold-brew-coffee-drip-tower/>
- Coffee Capsule Detector: <https://www.circuito.io/blog/coffee-capsule-color-detector/>
- Perfect bullseye dart board: <https://www.popularmechanics.com/technology/gadgets/a25784/mark-rober-robot-dartboard/>
- Air hockey table w/ robot opponent: <https://makezine.com/projects/assemble-a-robot-opponent-for-air-hockey/>

Your ideas?!

- Idea 1...
- Idea 2...