IE5995: IoT and Edge AI Programming

Parts and Supplies

In this course, we will build some working knowledge and programming experience on some of the most popular, mainstream microcontroller units (MCUs) and development environment (i.e., development boards, toolchains, libraries and open-source projects). These MCU chips underpin thousands of contemporary IoT innovations, covering industries such as industrial automation, monitoring and diagnostics, smart home, robotics, personal health and fitness, toy making, and more.

To be fully hands-on, you need to buy the following parts and supplies at your own expense. They are needed for in-class activities, homework exercises and projects.

**STM32 NUCLEO-F446RE (or alternatively, F401RE or F411RE) Development Board (~$20)**


Recommended purchase links:

- [https://www.mouser.com/ProductDetail/STMicroelectronics/NUCLEO-F446RE?qs=PRtH0mD6DWYnuBoPSlbRCA%3D%3D](https://www.mouser.com/ProductDetail/STMicroelectronics/NUCLEO-F446RE?qs=PRtH0mD6DWYnuBoPSlbRCA%3D%3D)

We will use STM32 Nucleo F446RE to:

1. Learn the STM32CubeIDE and the development toolchain
2. Learn programming the STM32 MCU products using the STM32 HAL drivers (closer to hardware, compared to Arduino and MicroPython)
3. Deploy Tensorflow Lite models on the board

**ESP8266 Starter Kit (~$15)**


You can also buy it in-store in the MicroCenter Madison Heights store (near I-75 14 Mile exit).

We will use ESP8266 to:

1. Install, learn and exercise MicroPython, including ESP specific features such as deep sleep
2. Provide WIFI capability to other MCUs
3. Try out ESP8266 open-source projects, such as ESP-Link and Web Server

Alternative to the ESP8266 Start Kit, you can buy:

**ESP32 WROOM-32D Core Board (~$10) + some electronic parts kit**

Purchase link:

Compared to the ESP-01 board (in the ESP8266 Starter Kit), ESP32 WROOM Core Board is easier to use (i.e., there are more available pins and there is an onboard USB-to-TTL bridge). ESP32 has all the functions and features that ESP8266 has. The reason why I require the ESP8266 Starter Kit is for the supplies included in the kit (assuming most of you do not otherwise possess jumper cables, bread board, LED, etc. at your disposal).

**Arduino Nano 33 Sense with headers (~$39)**

Official link: [https://store-usa.arduino.cc/products/arduino-nano-33-ble-sense](https://store-usa.arduino.cc/products/arduino-nano-33-ble-sense)

I bought mine in the MicroCenter store in Madison Heights for $32.99.

There are other variants, for example, ones without headers. If you buy those, you’ll have to solder headers on your own (I can provide solder tools). No matter which variant you buy, make sure the chip is Nordic nRF52840 (but not SAMD21 or Arm Cortex M0+, etc.).

We will use the Nano 33 Sense to:

1. Learn the Arduino ecosystem, including the Arduino IDE, C programming and libraries
2. Learn to develop Bluetooth Low Energy (BLE) applications
3. Explore and use its onboard sensors, including the 9-axis inertial sensor, humidity & temperature sensor, barometric sensor, microphone, gesture, proximity, light and color sensors.
4. Deploy TensorFlow Lite models following some book examples

### Optional materials and references

While most programming and debugging activities will happen on MCU boards, the end goal of embedded development is to interact with the physical world, through sensors, actuators and human-computer interaction interfaces. You may have some project ideas that will involve extra parts and supplies and even custom-made (3D printed) parts. If you want to add certain capability to your projects but are unsure what parts to buy, feel free to talk with me and I’d be happy to offer some guidance.

This page has a list of sensors (you may not want to buy from this site, it just provides some inspirations): [https://esphome.io/](https://esphome.io/)

The Adafruit industries also offer lots of maker parts along with tutorials: [https://www.adafruit.com/](https://www.adafruit.com/)

The SparkFun Electronics is also a good source: [https://www.sparkfun.com/](https://www.sparkfun.com/)


### On Raspberry Pi

Recently, System-on-Chip (SoC) computers such as Raspberry Pi and Jetson Nano seem to be out of stock or price doubled everywhere, so I will reduce the course coverage on such systems. However, if you already have such a computer and want to develop a project on it, feel free to do so and I’d be happy to provide guidance as well.