ECE 4680

Signal Processing Laboratory

Fall Semester 2025: ENGR 242, Tue. 10:50 AM–1:30 PM

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Office Hrs: Wed. during/after the DSP lab, others by appointment, including *Slack*, *Teams*, or *Zoom*.

Required Labs The lab experiments with readers can be found on the course WebSite. The real-time DSP hardware makes use of the ARM Digital Signal Processing Education Kit on GitHub.

Required Hardware The Infineon FM4 S6E2CC Pioneer Kit, now maybe Bella Gem. The plan was to move to STM32F746g Discovery Kit. For doing lab experiments outside the lab consider Analog Discovery 3, USB oscilloscope, logic/spectrum/network analyzer ($179 with EDU discount). *For a few students* we have FM4 boards.

Software: Python 3.13 via *Jupyter Lab* and ARM Keil MDK Community Edition

Grading:
1.) Laboratory assignments worth 80% total.
2.) Lab quiz 20%.

Topics		Text	Weeks
	Course Overview and Introduction	Lecture +1	0.5
Lab 1:	Python and the Scipy stack for basic signal representation; also Julia if desired.	ECE 2610 background	1
Lab 2:	Speech signal processing using Python and the Scipy stack and sound/audio functions found in scikit-dsp-comm.	ECE 2610 background	2
Lab 3:	Introduction to the Cypress FM4 with ARM Cortex®-M4 processor using the Keil IDE.	1 & 2 + lab reader	2
Lab 4:	Real-time FIR Digital Filters using the CMSIS DSP library and scikit-dsp-comm	3 + lab reader	2
Lab 5:	Real-time IIR Digital Filters using the CMSIS DSP library and scikit-dsp-comm	4 + lab reader	2
Lab 6:	Signal generation using DDS, audio special effects, and FM demodulation	2.6 + lab reader	3
Lab 7:	Using DMA to Improve Performance	2.5 + lab reader	Time permitting

Learning Outcomes

The expected learning outcomes of this course are: An introduction to Python (via the Scipy stack) for digital signal processing modeling and filter design, with emphasis on the Jupyter Notebook interface; audio signal processing simulation; real-time signal processing using the Cortex M4 micro-controller; ANSI C for developing real-time signal processing; the ARM CMSIS-DSP library and the associated application programming interface (API); Hardware interfacing to ADC and DAC as well as GPIO for code timing analysis; implementation of real-time FIR and IIR filters and signal generation using direct digital synthesis (DDS).

Slack

We will be using Slack *Channels* for group discussions and Slack *Direct Messaging* for audio and screen sharing. You will receive an invite to join the *DSP Comm Courses* Slack workspace.

Installing Julia and Python, with Jupyter Lab together

Documents linked on the course Web Site provide details on how to install both Python and Julia along various Python packages (Julia_with_Python_-Setup.pdf). Under Jupyter Lab you create notebook documents (.ipynb) for either Python of Julia.

Note: Jupyter notebook is the perfect place to write code, document code, write text using markdown, import figures, and typeset math equations using LaTeX syntax. Julia makes a significant step in solving the *two language problem* (Python for rapid prototyping and C/C++ for execution speed). I want you to experience this. You will also see the *reactive* Julia Pluto notebook in action.

Optionally Install vs code

Microsoft Visual Studio Code (vs code): https://code.visualstudio.com/ is great for writing and debugging Python and Julia code source code files or Jupyter Lab notebooks. *Extensions* are available for Python, Julia, and Jupyter Lab.

Typst

Typst is a new writing tool, similar to LaTeX, but it has a very nice cloud-based interface with real-time preview and one click PDF export. Why? To allow you to create documents that are a hybrid of scanned hand written solutions, typed out problems with text and math, and code with plots. For ECE 4650/5650 I have supplied a homework template and examples and you can decide if you want to try it. The example template is design for homework sets but may be adaptable to lab reports. In particular content from Jupyter notebooks can be imported cell-by-cell into a Typst document. See the ECE 4650/5650 Web Site for details.

Bella Gem

The future hardware may lie with the Bella Gem which will become available in November 2025.

Important: If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to register with Disability Services and provide them with documentation of your disability. They will work with you to determine what accommodations are appropriate for your situation. To avoid any delay, you should contact Disability Services as soon as possible. Please note that accommodations are not retroactive and disability accommodations cannot be provided until a Faculty Accommodation Letter has been given to me. Please contact Disability Services for more information at Main Hall, 3rd floor, Room 324, (719) 255-3354, or dservice@uccs.edu.