MATLAB for Signal Processing

Course Description

This two-day course shows attendees how to analyze signals and design signal processing systems using MATLAB® and Signal Processing Toolbox™. Parts of the course will also use Filter Design Toolbox™.

Topics include:

- Creating and analyzing signals
- Using different spectral analysis tools
- Designing and analyzing filters
- Introduction to advanced filter design
- Filter implementation issues (e.g. fixed-point, converting between architectures, etc.)

Prerequisites

MATLAB Fundamentals or equivalent experience using MATLAB, and a good understanding of signal processing theory, including linear systems, spectral analysis, and filter design.

Course Outline

1. Signals in MATLAB

Objective: Learn how to create and manipulate signals from the command line and using SPTool, a Graphical User Interface (GUI) in the Signal Processing Toolbox. Explore different ways to visualize a signal in time domain. Learn to create a noise signal as per a given specification.

- Creating and importing signals
- Sampling and resampling
- Visualizing signals
- Modeling noise
- Signal statistics and correlation

2. Spectral Analysis

Objective: Gain an understanding of different spectral analysis techniques. Understand the use of windowing and zero padding. Become familiar with the spectral analysis tools in MATLAB. Explore nonparametric (direct) and parametric (model based) techniques of spectral analysis.

- What is Spectral Analysis
- Discrete Fourier transform
- Windowing and zero padding
- Power spectral density estimation
- Spectrum objects
- Time-varying spectra

3. LTI Systems

Objective: Learn to represent Linear Time Invariant (LTI) systems in MATLAB. Learn to compute and visualize different characterizations of LTI systems. Get introduced to filters and filtering.

- LTI system representations
- The z-Transform
- Frequency and impulse response
- Introduction to filtering
- DFILT objects

4. IIR Filter Design

Objective: Apply LTI system analysis to filter design and discuss the use of IIR filters from initial performance specifications to digital design. Learn to use the Filter Design and Analysis Tool (FDATool) GUI. Learn a step by step procedure for designing filters using filter specification objects.

- Filter specifications
- Filter design with graphical interfaces
- Filter design with filter specification objects

5. FIR Filter Design

Objective: Continue the application of LTI system analysis to filter design, and discuss the use of FIR filters from specification to digital design. Explore a variety of specialized filters.

- FIR design methods
- Standard band filters
- Arbitrary response filters
- Multiband filters
- Raised cosine filters
- Reducing filter delay
- Frequency domain filtering

6. Advanced Filter Design

Objective: Discuss additional techniques for designing IIR and FIR filters, as well as adaptive and multirate filters. Explore a variety of practical applications.

- Median filtering
- Filter design with Filterbuilder
- Advanced IIR designs
- Advanced FIR designs
- Adaptive filters
- Multirate filters

7. Filter Implementation

Objective: Discuss the process of moving from filter design to hardware implementation and consider various architectures for filter realization and the effects of various quantization schemes. Explore how to generate hardware description language (HDL) code based on a final design.

- Filter architectures
- Filter realization
- Filter quantization
- HDL code generation

8. Summary