Digital Signal Processing Detailed Course Outline

Lesson 1 - Overview

Many digital signal processing algorithms emulate analog processes that have been around for decades. Other signal processes are only possible in the digital domain. This clip provides a fly-over of signal processing in general, and where it fits into the signal chain.

Video Clip 1
1. A little backdrop
2. Why Process
3. Digital Signal Processing
4. The Signal Chain
5. Principles

Lesson 2 - DSP Gain Structure

The first step in deploying DSP is to make sure the processor has an appropriate drive signal - not too much and not too little. This will assure a maximum signal-to-noise ratio in the processed signal.

Video Clip 1
1. DSP Inputs
2. Source Characteristics
3. Signal Characteristics
4. Analog-to-Digital Conversion

Video Clip 2
1. Garbage In, Garbage Out
2. "Line Level"
3. Microphone Preamps
4. Levels Through the DSP Blocks
5. Unity Gain
6. Output Levels
7. Digital Outputs

Video Clip 3
1. Overview
2. The Equipment Rack
3. DSP Architecture
4. Meters

Lesson 3 - Mixing and Routing

DSP is naturally suited to mix signals, and various types of mixer blocks are provided. Using them effectively requires a little technical background on how multiple electrical signals sum to produce a composite signal, or "mix."

Video Clip 1 - Inputs vs. Outputs
1. Introduction
2. Signal Summing
3. Summers
4. The Matrix
5. Multi-bus Mixers
6. Conclusion

Video Clip 2 - Auto Mixers
1. Introduction
2. Gating Auto Mixers
3. Gain-sharing Auto Mixers
4. Auto Mixer Advantages

Lesson - 4 Digital Filters Part 1

Filtering is perhaps the most important signal process. We rely on it to improve the response of the loudspeaker, shape the spectrum of the audio signal, and precondition the acoustic signal that drives the room. "Digital" filters may behave like analog filters, or they may have characteristics not achievable with analog technology.

This is Part 1 of 2 on this important topic.

Video Clip 1 - Filter Characteristics Part 1
1. Introduction
2. Analog Filters
3. A Little Background...

Video Clip 2 - Filter Characteristics Part 2
1. The Transfer Function
2. A High Pass Filter Example
3. The Band Pass Filter
4. Equalizers
5. The Shelf Filter
6. Notch Filters
7. In Review

Lesson - 5 Digital Filters Part 2

A thorough presentation of audio filters requires the discussion of phase response. In fact, filters are classified in terms of the nature of the phase shift that they produce as they modify the magnitude response of the audio signal.

The concepts presented in this lesson have universal application and are brand agnostic.

Video Clip 1 - Signal Analysis
1. Introduction
2. The Impulse Response (IR)
3. The Transfer Function (TF)

4. Phase and Phase Shift
5. Phase Signatures
6. Phase Shift vs. Group Delay

Video Clip 2 - Filter Classifications

1. Minimum Phase
2. Excess Phase
3. Linear Phase
4. Infinite Impulse Response (IIR) Filters
5. Finite Impulse Response (FIR) Filters

Lesson 6 - Dynamic Range Control

Next to filters, DRC may be the most important signal process. It gives us a way to automate the control of both peak and RMS signal levels. This is necessary to achieve a pleasing mix of various talkers, and to protect the loudspeaker from thermal damage and excessive excursion.

Video Clip 1 - Sound and Hearing

1. Introduction
2. Audio Levels
3. SPL and Loudness
4. Loudness Protection
5. Audio Meters
6. In Review

Video Clip 2 - Compressors and Limiters

1. Dynamic Range Control (DRC) Overview
2. The I/O Line
3. Gain or Loss
4. Peak Limiting
5. Attack and Release Time
6. RMS Limiting
7. Compression
8. DRC Visualized

Video Clip 3 - Other DRC Processes

1. Gating
2. Expanders
3. AGC
4. Ducking
5. ANC
6. Universal DRC Principles

Lesson 7 - Loudspeaker Processing

A modern DSP can provide all of the processes necessary to optimize the response of a loudspeaker. A lifetime is required to learn all of the nuances, which is why loudspeaker optimization is often done by the manufacturer.

Even if you don't "tune" loudspeakers for a living, you will have to do it sooner or later. This lesson will serve as an excellent review of nearly everything discussed in the course.

Video Clip 1
1. Loudspeaker Processing Overview

Video Clip 2 - Pass Band Equalization
1. Corrective EQ
2. Anechoic Response
3. IIR Filter Equalization
4. FIR Filter Equalization
5. Level Matching

Video Clip 3 - Crossover Networks
1. Overview
2. Relative Phase

Video Clip 4 - Crossover Networks (cont.)
1. Overview
2. 1st Order Network
3. 2nd Order Network
4. 3rd Order Network
5. 4th Order Network
6. FIR Crossover Networks

Video Clip 5 - Final Tweaks
1. Overview
2. LR24 Crossover
3. All Pass Filters
4. Precision Signal Delay
5. FIR Crossover
6. Mixed Phase Tunings
7. Conclusion

Video Clip 6 - Coarse Signal Delay
1. Introduction
2. Sound Speed
3. Arrival Time Differentials
4. Coarse Signal Delay

Lesson 8 Special Processes

This lesson covers some signal processes that are a bit less mainstream. We will add new clips here from time to time.

The first topic covered is Acoustic Echo Cancellation or AEC. AEC is essential for teleconferencing systems. Even if you don't do conference rooms, mastering an understanding

of AEC opens the door to understanding many other DSP topics, such as FIR filters, the impulse response, and adaptive filters.

Video Clip 1 - Acoustic Echo Cancellation - AEC

1. Introduction
2. The Problem
3. Direct and Reflected Signals
4. Echo Removal

Video Clip 2 - AEC Continued

1. A Simple AEC Example
2. AEC Convergence
3. Echo Return Loss (ERL)
4. Echo Return Loss Enhancement (ERLE)
5. Challenges