

# Digital Signal Processing Detailed Course Outline

## Lesson 1 - DSP 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.

### 4 Videos - topics include

1. A little background
2. Why Process
3. Digital Signal Processing
4. The Signal Chain
5. Principles
6. Introduction
7. A loudspeaker processor
8. Routing
9. Input Chain
10. Output Chain
11. Filter Generatio Utility
12. Dynamics Control
13. Conclusion

## 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.

### 3 Videos - topics include:

1. DSP Inputs
2. Source Characteristics
3. Signal Characteristics
4. Analog-to-Digital Conversion
5. Garbage In, Garbage Out
6. "Line Level"
7. Microphone Preamps
8. Levels Through the DSP Blocks
9. Unity Gain
10. Output Levels
11. Digital Outputs
12. Overview
13. The Equipment Rack
14. DSP Architecture
15. 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."

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## 2 Videos - topics include:

1. Introduction
2. Signal Summing
3. Summers
4. The Matrix
5. Multi-bus Mixers
6. Conclusion
7. Introduction
8. Gating Auto Mixers
9. Gain-sharing Auto Mixers
10. 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.

## 2 Videos - topics include:

1. Introduction
2. Analog Filters
3. A Little Background...
4. The Transfer Function
5. A High Pass Filter Example
6. The Band Pass Filter
7. Equalizers
8. The Shelf Filter
9. Notch Filters
10. 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.

## 2 Videos - topics include:

1. Introduction
2. The Impulse Response (IR)
3. The Transfer Function (TF)
4. Phase and Phase Shift
5. Phase Signatures
6. Phase Shift Significance

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7. Minimum Phase
8. Excess Phase
9. Linear Phase
10. Infinite Impulse Response (IIR) Filters
11. 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.

### 3 Videos - topics include:

#### Video 1 - Sound and Hearing

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

#### Video 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 3 - Other DRC Processes

1. Gating
2. Expansion
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.

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## 6 Videos - topics include:

### Video 1

1. Overview

### Video 2 - Pass Band Equalization

1. Corrective EQ
2. The Anechoic Response
3. IIR Filter Equalization
4. FIR Filter Equalization
5. Level Matching

### Video 3 - Crossover Networks

1. Overview
2. Relative Phase

### Video 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 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 6 - Coarse Signal Delay

1. Introduction
2. Sound Speed
3. Arrival Time Differentials
4. Coarse Signal Delay

## Lesson - 8 Special Processing

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.

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## 2 Videos - topics include:

### Video 1 - Acoustic Echo Cancellation - AEC

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

### Video 2 - AEC Continued

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