

## Course Description

This course provides a foundation for Digital Signal Processing theory to serve as either a refresher or as an introductory course. The course begins with a foundation in signal processing concepts and terminology and evolves to explore filtering concepts and techniques, convolutions, and transforms. Although the course is theoretical in nature, the underlying focus is on factors relevant to efficient implementation in hardware. Concepts that are introduced are complemented by several hands-on exercises.

**Level** – Beginner

**Course Duration** – 3 days

**Price** – \$2100 or 21 Hardent Training Credits

**Course Part Number** – HDT-DSPPRI-100-ILT

**Who Should Attend?** – Engineers and designers who have an interest in Digital Signal Processing Theory and are seeking to refresh their knowledge or explore the concepts of DSP through an introductory theory course.

**Prerequisites**

- None

**Software Tools**

- MATLAB® 2010b

**Hardware**

- None

- **Exercise 3** – Filters and z-Transforms.
- **Digital Filters** – Discusses the design specification, advantages, and requirements of digital filters. The FIR filter is introduced and discussed in detail.
- **Exercise 4** – Digital Filter design and analysis.
- **Advanced Digital Filters** – Introduces IIR filters and design considerations. Compares FIR and IIR filter techniques. Discusses comb filters, integrators, differentiators, fractional delay, and adaptive filters.

## Day 3

- **Discrete Fourier Transforms** – Discusses periodic signals, properties of the Continuous Time Fourier Transform, and concepts and applications of the DFT, and practical considerations.
- **Fast Fourier Transforms** – Introduces the FFT mechanics and operation. Examines Decimation in Time and Decimation in Frequency structures for implementation. Discusses FFT limitations compared to DFT.
- **Exercise 5** – Fourier Transform analysis and implementation.
- **Continuous Signal Processing** – Discusses limitations and challenges of continuous signal processing compared to discrete time signal processing.
- **Hardware Design Considerations** – Discusses the advantages and disadvantages of various hardware implementation architectures and strategies. Relates hardware architectural features to mathematical theory of operation. Discussion of Filter implementation and Fourier Transform operation. Examines performance vs. precision and resource tradeoffs. Explores memory usage and limitations in practical hardware applications.
- **Exercise 6** – Hardware architecture implementation.

## Course Outline

### Day 1

- **Back to Basics** – Introduces basic concepts and origins of signal processing, quantization, sampling theory and methods, fixed point and floating point numbers.
- **Linear Systems** – Discusses the requirements and special properties of linear systems. Comparison of linear systems and non-linear systems.
- **Exercise 1** – MATLAB refresher, Linear Time Invariant systems and properties.
- **Correlation and Convolution** – Introduces concepts and properties of correlation and convolution. Introduces the Delta function and impulse response. Discusses common impulse responses and mathematical properties.
- **Exercise 2** – Correlation, convolution, impulse response, and autocorrelation.

### Day 2

- **Filter Basics** – Introduces basic concepts of filtering, filter classification, properties, and types, including Butterworth, Chebyshev, Elliptic, and Bessel filters.
- **Z-Transform** – Discusses the z-Transform and applications to filter design. Examines Region of Convergence and stability.

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**Contact:** Chris Green  
**Email:** [training@hardent.com](mailto:training@hardent.com)  
**Telephone:** 514-999-3880