# DSP: Digital Signal Processing

## Course No. 199

**FOR WHOM INTENDED** Digital signal processing (DSP) is one of the fastest-changing fields in modern electronics. Individuals who obtained their education and training just a few years ago, need their skills updated to prepare for the continuing explosion of DSP technology. The course is applicable to technicians and engineers employed in a wide range of industries.

**BRIEF DESCRIPTION OF COURSE** This course is an introduction to DSP concepts and implementation. It starts by explaining the need for digital signal processing and DSP systems. A complete model of a DSP system is examined from the input transducer, through all the stages including: signal conditioning, anti-aliasing filter, analog-to-digital and digital-to-analog conversion, output smoothing filter, and output transducers. Real life examples will be used to illustrate the use and need for each part of a DSP system. DSP in telecommunications will be highlighted.

Understanding how numbers are processed in a DSP application is key in their use and application. All the key areas needed to understand number processing are covered in this course.

Correct acquisition of the signal is absolutely necessary for proper use of digital signal processing. Sampling theory, sample resolution and anti-aliasing filters are explored with real examples to illustrate this important area of DSP.

Application examples are examined to give the student a good understanding of what's needed to apply DSP techniques to new areas. DSP tools are demonstrated to illustrate the tools available to apply DSP techniques.

The instructor covers the how, where, why and when of DSP applications. Electronics are rapidly changing the way DSP is applied and the techniques used to solve problems. Successful completion of this course will assist the participants to apply the latest techniques to their everyday projects.

**CERTIFICATE PROGRAMS** This course is required for TTi's Data Acquisition & Analysis Specialist (DAS), Electronic Telecommunications Specialist (ETS) and Instrumentation Test Specialist (ITS) Diploma Programs. It may be used as an optional course for any other TTi specialist certificate program.

**PREREQUISITES** There are no definite prerequisites for this course, but TTi's Course 163 "Instrumentation for Test and Measurement" or Course 164 "Instrumentation for Electrical Test and Measurement" would be helpful.

**TEXT** Each student will receive 180 days access to the on-line electronic course workbook. Renewals and printed textbooks are available for an additional fee.

**INTERNET COMPLETE COURSE** 199 features almost seven hours of video as well as more in-depth reading material. All chapters of course 199 are also available as OnDemand Internet Short Topics. See the on-line course outline for details.

**COURSE HOURS, CERTIFICATE AND CEUs** Class hours/days for on-site courses can vary from 14–35 hours over 2–5 days as requested by our clients. Upon successful course completion, each participant receives a certificate of completion and one Continuing Education Unit (CEU) for every ten class hours.

## Course Outline

**Digital Signal Processing and DSP Systems**
- Need for DSP • Advantages of DSP
- Characteristics of DSP Systems

**A Model of a DSP System**
- Input • Signal Conditioning • Anti-Aliasing Filters
- Analog-to-Digital Converter • Processor
- Digital-to-Analog Converter • Output Smoothing Filter
- Output Transducer • DSP Processors • DSP Format Types
- Alternative Formats for Commercial DSP Processors

**DSP in Telecommunications**
- Typical Applications RFIC • DSP & ASIC Chips • Cell Phones
- DSP Design Process: Hardware Resource Estimation
  - Algorithm Development • Hardware Selection
- Digitization / ADC • Direct Digital Synthesis
- Moving Average Filter • Analog vs Digital Filters
- IIR and FIR Filter Pros and Cons • Use of FFTs

**How Numbers are processed in a DSP**
- Polynomials • Transcendental Functions • Series Expansions
- Limits • Integration • Oscillatory Motion • Complex Numbers

**Acquisition of the Signal**
- Sampling Theory • Sampling Resolution
- Aliasing • Reconstruction

**Application Examples—Anti-Alias Filters**
- Filtering • Sample Filter
- Types of Filters: Bessel, Butterworth, Elliptical

**Fourier Series**
- Insights to be gained from Fourier Series
- Nyquist Frequency

**Orthogonality and Quadrature**
- Orthogonality—Basic Building Blocks of DSP
- Quadrature—Signals 90 degrees out of phase with each other

**Transforms**
- The Z-Transform • DFT—Discrete Fourier Transform
- Laplace Transform

**Finite Impulse Response Filter—FIR**
- What is it? • Stability • Cost
- Design Methodology • Design Examples • Convolution

**Infinite Impulse Response Filter—IIR**
- What is it? • Stability • Cost
- Design Methodology • Design Examples

**DSP Tools**
- Programming Languages • Mathematical Tools
- Special Purpose Tools • Development Packages

**Summary, Final Quiz**

**Award of Certificates for Successful Completion**


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