
Digital Signal Processing, Data Acquisition and Analysis

Course No. 197-5

FOR WHOM INTENDED (1) Testing laboratory personnel who want to expand their analysis capabilities, perhaps in the interest of improving their test designs; (2) analysis personnel responsible for the interpretation of data acquired in the laboratory; (3) test requestors/designers who want to know what tools are available and what to expect from them.

BRIEF COURSE DESCRIPTION (See [course outline](#), over.) The objective of the first portion of the course (also available separately as [Course 196, Digital Data Acquisition](#)) is to provide participants with the knowledge required to specify, evaluate and use a wide variety of digital data acquisition systems in laboratory and field applications. Basic principles of sampling and digitizing theory are presented and reinforced with practical examples from everyday testing operations.

Hardware discussions concentrate on performance capabilities and practical problems that arise in laboratory and field applications. Heavy emphasis is placed on new technologies and system concepts that will be available in the near future. The aim is to prepare participants to design and procure state-of-the art systems that will satisfy their technical requirements efficiently and economically.

Literature describing the latest available hardware will be used as examples of good (and bad) practice. Particular emphasis will be placed on critical evaluation of commercially-available hardware and software systems.

The objective of the second part of the course is to provide participants with a working knowledge of the tools available for analysis of data acquired by digital data acquisition systems for a variety of laboratory and field applications. Basic analysis principals and methods are presented and reinforced with practical examples from everyday testing operations. The interaction between test design, data acquisition and analysis is emphasized.

The lectures and discussions are designed to promote understanding of the concepts involved through "mechanical feel" rather than mathematics. Participants are encouraged to offer problems from their own activities for discussion and solution by the class.

The course is presented as a series of highly interactive lecture /discussion sessions. Problems for individual and group solution are interspersed throughout the course to act as training aids and to evaluate class progress. Special-interest discussions are encouraged outside of the regular course sessions.

CERTIFICATE PROGRAMS This course may be used as an elective for any [TTi Specialist Certificate Program](#).

RELATED COURSES The data acquisition portion of Course 197-5 is available separately in [Course 196, Digital Data Acquisition](#), which runs concurrently. Either Course 197-5, or Course 196 may be presented on-site, at your facility.

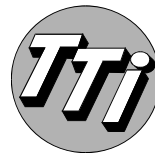
PREREQUISITES A good understanding of the engineering problem to be analyzed is expected. An understanding of basic computer and data acquisition principles will be useful.

TEXT Each student will receive a set of [course notes](#) including most of the view-graphs used in the presentation.

COURSE HOURS, CERTIFICATE AND CEUS Open courses meet seven hours per day. Upcoming presentation dates can be found on our current [open course schedule](#). 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.

NOT AFFILIATED WITH ANY VENDOR. TTI sells no hardware or firmware. Before buying data acquisition or analysis equipment, take this course. Equipment manufacturers' field sales people may lack time to teach fundamentals. TTI training helps you to negotiate for the equipment you really need.

For [schedules](#), [general information](#) and [registration forms](#), see TTI's web site.



**Technology
Training, Inc.**

(a tti group company)

Toll-free telephone:

866-884-4338 (866-TTi-4edu)

805/715-2638 • FAX 805/715-2650

E-mail: Training@ttiedu.com

<http://www.ttiedu.com>

Digital Signal Processing, Data Acquisition and Analysis

Course Outline No. 197-5

Part I

Overview of the Measurement Process—The System Approach
The role and function of digital data acquisition.
Testing and experiment types—what capabilities are required?
Accuracy, Dynamic Range, Headroom

Basic Concepts
Basic calculations
The Fourier Transform as a “Black Box”
Data presentation in time and spectral domain

Sampling and Digitization Theory
Data acquisition speed and accuracy/resolution considerations
Aliasing
Noise and other data corruption problems

Data Acquisition Hardware
Signal Conditioning
Amplifiers
Common-mode rejection
Transducer wiring practice

Anti-alias filters
Estimating aliasing errors for different filter types
Filter/Sample-rate tradeoffs

Sample-and-hold amplifiers
Multiplexers
Analog-to-digital converters
Flash, Successive-approximation, Multi-pass, Sigma-Delta, Integrating

The Computer System
Candidate computer systems—tradeoffs
Interface concepts—speed, implementation ease and robustness
Data storage—speed, volume considerations

Types of Digital Acquisition Systems
Applications, Special considerations, Performance and limitations of available system architectures

Data Analysis
Engineering-Unit Conversions
Data Interpolation
Correction of Anti-Alias filter distortion

Evaluating Data Acquisition Systems
Simple tests to evaluate system accuracy/capability

Specifying a system
How do you specify a system to get what you want?

Part II

Introductions and Overview

Review of Basic Concepts
The time and frequency domains
Time histories and time series analysis
Sampling theory; acquiring good data
Linear systems; transform concepts • Spectra

“Static” (Load/Deflection) Test Analysis
Basic curve fitting
Least squares techniques, linear regression, polynomial regression • Spline fitting
Yield point determination

Oscillating-Signal Analysis
Basic characterization • Decibels
Data smoothing, averaging, trend removal...
Random signals • Probability distribution • Correlation

Spectral Domain Operations
Calculating and displaying the spectrum
The Fourier Transform
What it does (and doesn't) do
Fast Fourier Transform (FFT)
Basic relationships and rules • Spectral “arithmetic”
“1/N” Octave analysis
Spectral graphing formats
Engineering applications
Power Spectral Density (PSD)
Transfer functions • Forced-response analysis

Data Filtering
Filtering in the spectral domain
Time-domain filtering
FIR, IIR filters
When to use time-domain and spectral-domain filters

Signal Integration and Differentiation
Practical problems with real data

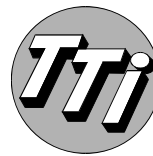
Transient Data Analysis: Spectral Analysis
Shock Response Spectra

Continuous-Data Analysis
Finite measurement-length effects
Gibb's Phenomenon...Ringing
Windowing, window types/uses/advantages and disadvantages

Data Averaging
Time block averaging • Spectral averaging, PSD
Average transfer-function calculation • Coherence

Special Topics
Anti-alias filter-correction techniques
The “Ideal” filter
Data interpolation: Averaging and derivative techniques
Spectral extension
Data Acquisition System Calibration

Using the tools • Class problems
Student Topic/Problem Discussion
Summary, Discussion
Final quiz
Award of Certificates for Successful Completion



Technology Training, Inc.

(a tti group company)

Toll-free telephone:
866-884-4338 (866-TTI-4edu)
805/715-2638 • FAX 805/715-2650

E-mail: Training@ttiedu.com
<http://www.ttiedu.com>