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# Instrumentation for Electrical Test and Measurement

Course No. 164

**FOR WHOM INTENDED** Engineers, aides and technicians. Some background in electronics is helpful but is not essential. The course will be tailored to student objectives.

**OBJECTIVES** To provide a basic understanding of electrical measurement systems. To alert the students to the many varieties of meters, 'scopes and transducers available, their operating principles, strengths and weaknesses. To give students enough applications information that they can select optimum meters, transducer, amplifier, recording and readout devices to assemble a system for routine measurements of electrical phenomena.

**BRIEF DESCRIPTION OF COURSE** Mainly lectures, supported by slides, transparencies, videotapes and sample hardware. Students are expected to participate in classroom discussions, as well as read text materials and class notes.

Course 164 presents basic information on selection, application, calibration and usage of modern measurement systems to measure electrical phenomena. The course emphasizes a non-mathematical approach to understanding concepts and mechanisms. A variety of measurands and device types is covered, as well as signal conditioning, recording and analysis.

Participants are encouraged to bring a specific measurement problem to class for use as a case study. The instructor will introduce one or more student problems (and/or a preselected case) on the first day. Each day's course material will further develop the case study. A solution will be given at the end.

**CERTIFICATE PROGRAMS** This course is required for TTI's [Instrumentation Test Specialist \(ITS\) Certificate program](#). It may be used as an elective for any other [TTi Certificate program](#).

**PREREQUISITES** There are no definite prerequisites, but participation in TTI's course "[Electronics for Non-Electronic Engineers](#)" or the equivalent would be helpful.

**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.

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

## Course Outline

Introduction: Characteristics of Dynamic Measurements  
What makes data dynamic • Types of dynamic data  
Periodic, transient and non periodic (random)  
Sine waves, frequency and phase

The language of electrical measurements  
Charge, Voltage, Current • Electrical units  
Average, peak and root-mean-square values  
Digital measurement systems • Noise • decibels

Parameters of linear systems  
Accuracy • Calibration • Precision • Errors

Simple statistics of measurement  
Accuracy and error assessment • Performance testing and calibration  
Quantifying and minimizing measurement error

Electrical laboratory practice  
Safety • Grounds • Circuit protection devices  
Input impedance, output impedance and loading  
Power transfer and impedance matching

Analog DC and AC meters  
DC and AC ammeters and voltmeters • Analog multimeters  
How to use basic meters • Meter errors • Digital Electronic Meters

Oscilloscopes: Subsystems • Probes • How to operate  
Special-purpose • Digital

Time and frequency measurements

Power and energy measurements: Power in AC circuits  
Single-phase measurements • Polyphase • Higher frequencies

Measurement of resistance: Voltmeter-ammeter method  
Ohmmeters • Wheatstone bridges

Measurement of Capacitance, Inductance, Impedance  
Bridge circuits for measuring capacitance  
AC voltmeter measures capacitance, inductance

DC and AC signal sources  
Batteries • DC power supplies: How to use  
Oscillators • Sweep-frequency generators  
Pulse generators • Function generators

Transducers: Strain gauges, Silicon Transducer  
Principles • Piezoelectric • Temperature transducers

Interference signals  
Capacitive interference • Inductive interference, shielding  
Electromagnetic interference and shielding  
Ground loop interference

Measurement Systems  
Signal conditioners • Amplifiers • Integrating, differentiating and filters

Digital signal processing  
Introduction to generating and processing digital data  
Introduction to digital analytical techniques

Recording and readout devices  
Summary and overview • Final Review  
Award of Certificates for successful completion



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