Dimensional Calibration Procedures

Course No. 131

FOR WHOM INTENDED This course is intended for personnel involved in metrology, instrumentation and various testing activities. It is designed to provide a basic understanding of the methodology of calibration of measuring and test equipment.

BRIEF COURSE DESCRIPTION The course commences with an introduction and review of some basic terminology, then covers systems of units, measurement standards, traceability and types of error. The course then covers calibration standards and documents such as ANSI/NCSL Z540 requirements and ISO 9000 and ISO Guide 17025. The use of techniques as "virtual" standards is discussed. A review is made of statistical analysis and uncertainty analysis, distributions and explanation of common definitions and notations used. Technical requirements in calibration procedures are covered, with content requirements.

The course then covers calibration equipment and techniques in detail, starting with a discussion of mass and weight, including types of weighing devices and mass measurement techniques. Dimensional calibration is covered next, with precision instruments such as Vernier and digital calipers, height gages, micrometers and other devices. This section also covers measurement of force, torque, viscosity and hardness. Next comes a unit on fixed gauging, including Go and No Go gauging, and a detailed discussion of laser interferometry applications in calibration.

Physical standards are discussed in detail, starting with reference planes such as surface plates and optical flats, and moving on to gage blocks, linear measurement devices, comparators and high-precision cylinders. The discussion of calibration of angle measurement devices includes autocollimators, theodolites, levels and inclinometers.

The calibration of cylindrical rings, internal cylinders, thread gages is covered next. Other geometries and dimensional nightmares such as cylinders, threads and spheres are discussed. The course concludes with a discussion of the requirements of ISO Standard 17025 as they apply to calibration laboratories. Students are expected to participate in classroom discussion and exercises.

DIPLOMA PROGRAMS This course is a recommended elective for TTi's Metrology/Calibration Specialist Diploma Program and may be used an elective for any other TTi Diploma Program.

PREREQUISITES There are no definite prerequisites, but TTi's courses *Electronics for Non-Electronic Engineers, Metrology Concepts* and *Instrumentation for Test and Measurement* would be helpful.

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

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

Introduction and Focus • Metrology Terminology
Scope of Metrology • Measurement Processes • Systems of Units
Measurement Standards • Traceability • Measurement error
Accuracy • Precision • Uncertainty
Technical Requirements in Calibration Standards
US Gov't Agencies • Unified Standards • ANSI/ASQC M1
Technical requirements: ANSI Z540-1-1994 • NIST
Procedures and Accreditation • ISO Standard 17025
Calibration requirements in ISO 9000 documents • Quality Standards
Techniques used as "Virtual" standards • Reversal Methods • Level
Straightness & Flatness • Closure • Autocollimator • Traceability
Review of Statistical Analysis and Uncertainty • Uncertainty Components
Statistics of Measurement • Standard Deviations • Arithmetic Mean
Cumulative Distribution (cdf) and Probability Density (pdf) Functions
Confidence Levels • Measurement Decision Risks and Strategies
Technical Requirements in Calibration Procedures: Content requirements
Mass and Weight; Buoyancy • Newton's Second Law • Law of Gravitation
Weight • Mass • Units of Measure for Weight and Mass
Conversion Factors • Example • Material Density • Homework
Mass Measurement Techniques • Classification of Weighing Devices
Mass Measuring Technique: Direct vs. Indirect • Operator participation
Installation • Equilibrium Position • Direct Reading: Equal Arm Balance
Single Pan Optical-Mechanical and Electronic Balances • Substitution
Air Density, Tare Weights • Transposition
Dimensional Calibration: Precision scaled instruments
Vernier devices: Calipers, Height gages • Protractors
Digital dimensional devices: Calipers, Height gages & similar devices
Micrometers: Caliper • Applications • Calibration • Supermicrometers
Class Exercise: Calibration of Micrometers and Calipers
Force: Concept of Weight, Gravity correction • Force gages & transducers
Torque: Terminology • Torque tools • Calibration • Torque analyzers
Viscosity • Hardness • Tester calibration • Traceability
Laser Interferometry: Light as the Length Standard
Wavelength • In Phase vs. Out of Phase Waves • Two-Freq. Interferometry
Mixing Sinusoids • Types of Interferometers • Michelson Interferometer
Measurement Capabilities • Measurement Accuracy • System Diagram
Measurement Optics—Linear Interferometer vs. Angular Interferometer
Measuring Flatness, Squareness • Wavelength-Compensated Accuracy
Transducer vs. Calibrator • Laser Interferometry for Transducer Applications • Deadpath Error • Alignment Principles
Fixed Gauging: Principles • Go and No Go Gauging
Reference Planes - Calibration of Flatness: Surface plates • Optical flats
Planointerferometry • Class Exercise: Use of Optical Flats
Dimensional Standards • Gage Blocks: Style, Type, Class, Uses • Wringing
Calibration • Linear Measuring machines • Electronic comparators
High precision cylinders • Class Exercise: Gage Block Selection
Measurement of Angles: Angle Gage Blocks • Autocollimators: Applications
Small angles • Theodolites • Levels: Use of levels • Reversal Techniques •
Calibration • Inclinometers • Class Exercise: Using A Precision Level
Cylindrical Rings and Internal Cylinders • Ring Classes and Tolerances
Tolerances • Ring Gage Measuring Techniques • Tapping, Sliding, Rolling
Precision and Amplification • Geometry Measurements • XXX Rings
Threads and Cylindrical Rings • Thread Calibration • Thread Elements
Master Thread Setting—Plug Gages • Tolerances • ANSI B1.2 1983
"W" Tolerance Set Plugs • Measuring Machines for External Threads
Three Wire Method • Measurement Uncertainty in Thread Measurements
Other Geometries: Cylinders, Threads and Spheres • Cylinders: Wires,
Plugs, Pins, etc. • Definitions: Measurement, Cylinder, Roundness
Cylinder Geometry • Error Budget for Cylinder Calibration
ISO Standard 17025 in Calibration Laboratories
Summary, Final Quiz, Award of Certificates for Successful Completion

Technology Training, Inc.
(a tti group company)
Toll-free telephone: 866-884-4338 (866-TTi-4edu)
E-mail: Training@ttiedu.com
www.ttiedu.com