

Course Titles (click title to view topics)

[Introduction to Measurement and Calibration](#)

[Safety in the Calibration Lab](#)

[Precision Electrical Measurement](#)

[Precision Dimensional Measurement](#)

[Precision Temperature Measurement](#)

[Precision Pressure & Vacuum Measurement](#)

[Precision Flow Measurement](#)

[Precision Mass Measurement](#)

[Precision Force & Torque Measurement](#)

[Precision Humidity Measurement](#)

[Measurement Uncertainty](#)

[Certified Calibration Technician \(CCT\) Test Prep](#)

[Acoustics and Vibration](#)

[Time and Frequency](#)

[Dimensional: Roundness, Hardness, Surface Texture](#)

[Introduction to Microwave Measurement](#)

[AC/DC Calibration and Metrology](#)

[Fiber Optics](#)

[Test Instruments Operation and Calibration](#)

[CMMs](#)

[Water Quality, Measurement, pH, Conductivity](#)

[Metrology Applications for Engineers and Scientists](#)

[Introduction to ISO/IEC 17025 for Technicians](#)

[Assessment to the Requirements of ISO/IEC 17025](#)

[Uncertainty Management](#)

[Interval Analysis](#)

[Proficiency Testing](#)

WorkPlace Training E-Learning – Course Topics

Introduction to Measurement and Calibration

Introduction

Definition of metrology; measurements in manufacturing; measurement in the global marketplace; importance of measurement

Development and Concerns of Metrology

Need for better measurements; determine and describe the differences between resolution, accuracy, precision; calibration; Type A Uncertainty, Type B Uncertainty; review questions

Standards and Standardization

Working standards, check standards, international standards, levels of standard accuracies; accuracy ratio between levels of calibration pyramid: requirements of traceability: metrology standardization documents; review questions

Managing the Metrology System

When a metrology system is needed; components of a metrology system; periodic calibration; determining period, fixed time intervals or other means, measurement assurance; record keeping, categories on a good record keeping form, computer record keeping programs, record stickers; documented procedures; components of a procedure, standardization documents, ISO and QS9000, ANSI Z-540, ISO 25, Malcolm Baldrige, training; components of a training program, records, review questions

Making Good Measurements: Elements of a Measurement System

Measuring instrument (calibration); calibration pyramid, relating the instrument to the national standard; unit under test; preparation of the UUT; fixture or jig setup; measuring procedure; operator; analysis of measured data; display of final analyzed result; measurement assurance, isolating errors, capability study, gage R & R; review questions

Units and Measurement Instruments

Length; rulers, height gages, optical comparators, micrometer/calipers, metrology laser, others: roundness, squareness, flatness, surface finish, area, volume, Mass: balances (single-pan, dual pan, electronic) Time: electronic counters, atomic clocks, Temperature; thermometers (liquid-in-glass, metallic stem, thermostats, electrical thermometric, thermistors) flow; flowmeters (rotation, pressure drop, positive displacement) electrical quantities; DC voltages (meters), resistance (multimeters), DC current, AC measures, review questions

WorkPlace Training E-Learning – Course Topics

Safety in the Calibration Lab

Introduction

General Roles and Responsibilities for Supervisors and Technicians

Electrical Safety for Cal Lab Operations

Floors, Grounding, Benches, Mobile Equipment, Safety Devices; Fuses, breakers, interlocks, grounding sticks, Connecting and disconnecting equipment, RF Permissible exposure, Arc Flash, Electrical equipment cleaning, Solvents, 2-man teams

Fires

Electrical, Dry Chemical

Chemical

MSDS, Toxic and physical, mercury, hydrazine, disposal, Good housekeeping, Liquid Nitrogen and Oxygen; physical, physiological, and chemical

Pressure

Maximum Allowable Working Pressure (MAWP) and Maximum Operating Pressure (MOP), Test Pressure, Pressure Relief Devices, Component Requirements

Lasers

Principles, Industrial hygiene, Explosion hazards, Nonbeam optical radiation hazards, Collateral radiation, Electrical and flammable hazards, Biological Effects; Eye, thermal

Temperature

High heat, cold, cryogenics, Bath fluid flashpoints

Radiation;

Material, handling, storage, incident response

WorkPlace Training E-Learning – Course Topics

Precision Electrical Measurement

Basic DC and Low Frequency Measurement

Measurement Units; Coherent, uniform and unified; Defined, Realized and Represented; Disseminated and Extended. Measurement Instruments: Types; Principals of Operation; Measurement Methods: Direct; Differential; Transfer; Ratio; Indirect

Essential Math: Basic Algebra, Engineering and Scientific Notation, Logarithms, Calculating Power Gain/Loss; Ratios, Decibels, Conversions, Calculating Specifications; three types of ac meter responses; peak, full wave, and root mean squared (*rms*), Conversion of ac voltages using form factors , Calculation of pass/fail measurement limits from instrument specifications Measurement Uncertainty-a Beginning: Calculating error and Correction Factors, Types of Errors: Systematic Errors; Instrument, Environmental, Observational, Concepts of Measurement Uncertainty

Standards and Traceability

Why Measurements Must be Traceable; What Is Involved in a Traceable Calibration, Standards, The Ideal Standard; Standards for your Measurements, Traceability: Establishing and Maintaining Traceability

Practical Considerations for Precision Electrical Measurement

Grounding: Ideal vs. Real Ground; Power Line Ground Systems; Safety-Ground Ground Loop Errors, Shielding: Electromagnetic Radiation; Shielding from Electric Fields; Magnetic Field Coupling; Minimizing Magnetic Pickup; Magnetic Shielding, Guarding: Instrument Guard; High-Impedance Measurements; Guarding Current Sources

Sources of Measurement Error

Thermal EMFs, Contact Resistance, Insulation Resistance, Surface Leakage, Dielectric Absorption, Noise and AC to DC Converters, Parasitic Capacitance, Bias Current, Pumpout Current

Electrical Safety

Introduction, Electrical Safety Fundamentals, Shocking Stories

Additional topics

Environmental Errors (Temperature, Pressure, Humidity, Vibration), Technician Observational Errors (Parallax, Interpolation), Instrumental Errors (Zeroing, Leveling, Wear, Loading), Random Errors (Drafts, Radiation, Dirt, Noise, Readability, Resolution) Good Laboratory Practices (Adjustment, Repair, Maintenance) Safety, 8 Hints for Making Better Scope Measurements

Precision Dimensional Measurement

Linear Measurements Standards

Definition of the Meter, Length Standards, Units of Measure

Measuring Instruments

Micrometers, Calipers, Types and Accuracies, Selection, Sensitivity, and Accuracy of Measuring Instruments, Absolute and Comparison Measure, Causes of Error and Correction: Temperature, Gage Deformation, Elastic Deformation, Error Analysis

Gage Blocks

History, Requirements, Methods of Measuring, Traceability, Uncertainty, Surface Finish, Thermal Expansion, Selection, Precautions, Calibration, Wringing, Types and Characteristics

Making Angular Measurements

Clinometers, Sine Bars and tables; Trigonometric functions, Practical applications; Angle gage blocks

Optical Instruments

Using the eye as an optical instrument, Hints for making precise optical measurements, Use and principles of Optical flats, Grades, Light Interferometry, Light Interference, Reflection, Calculating surface flatness using interference patterns, Reading flatness error, Care of optical measurement devices, Microscopes, Comparator

Precision Temperature Measurement

Introduction

Temperature affects nearly every physical measurement you make, requiring you to make corrections to your measurements due to temperature variations. Because of this, the accuracy of all your measurements depends on your ability to accurately measure temperature.

Heat and Temperature

Describe and understand basic Molecular structure, Kinetic Energy, Heat, Temperature, Thermometers, Ice Point, Steam Point and Triple Point, Absolute Zero.

Temperature Scales

Celsius, Kelvin, Fahrenheit, Rankine, Thermodynamic, ITS-1990, Conversion Formulas

Thermometers

Mercury-in-Glass, Alcohol-in-Glass, Resistance Thermometers, Operating Principles, Calibration Principles, Thermometer Calibration, Uncertainty, Measurement Errors

Related Heat Sensing and Measuring Instruments

Principles, Construction and Methods of Operation of Thermistors, Thermocouples, Infrared Sensing Devices

Precision Pressure & Vacuum Measurement

Pressure Fundamentals Definition, Mathematical Formulas

Type of Pressure

Gauge Pressure, Vacuum, Absolute, Differential, Effects of changes in Atmospheric Pressure, Pressure Units and their Conversion

Pressure Measurement Devices

The Bourdon Tube Pressure Gage, Dead Weight Piston Gages, Calibration, Errors

Transducers

Measurand, Displacement or Stress, Force-Summing Devices, Accuracy; Stability, Drift, Aging, Frequency Response; Step Pressure Change, Natural Frequency and Resonance's, Static Overpressure, Dynamic or Transient Overpressure, Concepts of Accuracy; Static Error Band, Linearity, Hysteresis, Repeatability

Principles of Vacuum

Concepts, Production of Vacuum, Conductance, Long Path vs. Short Path, Vacuum Ranges

WorkPlace Training E-Learning – Course Topics

Precision Flow Measurement

Density Principles and Measurement Corrections

Mass, Density Measurement Principles, Correcting Indicated Weight, True Mass vs Apparent Mass, Weight Density Principles, Weight Densities of Various Materials.

Specific Gravity

Principles, Determining Specific Gravity; Picnometer and Balance, Hydrometer, Specific Gravity Balance

Fluid Flow Measurements

Basic Flow Concepts, Units of Measurement, Reynolds Numbers, Viscosity, Turn Down Ratios, Calibration Techniques; Weighing Methods; Dynamic, Static, Volumetric Method; Calibrated Tank, Piston/Cylinder

Flow Measurement Devices

Differential Pressure Meters; Orifices, Venturi tubes, Flow tubes, Flow nozzles, Pitot tubes, Elbow meters, Target meters, Variable-area meters, Positive Displacement Meters, Reciprocating piston meters, Oval-gear meters, Nutating-disk meters, Rotary-vane meters, Velocity Meters; Turbine meters, Vortex meters, Electromagnetic meters, Ultrasonic flowmeters, Mass Flowmeters; Coriolis meters, Thermal-type mass flowmeters

WorkPlace Training E-Learning – Course Topics

Precision Mass Measurement

Mass and Weight Principles

Units, Classification and Applications, Physical Characteristics, Weight Calibration Reports, Density Standards, Calibration Weight Selection, Balance Verification, Weight Care and Maintenance

Weighing Instruments

Mechanical; Principles of Operation, Electronic; Principles of Operation

Location

Weighing Bench, Work Room, Temperature

Operation

Leveling, Draft Shielding, Weighing Vessel, Weighing Pan, Calibration, Errors, Application

Weights

Classes, Selection

Physical Influences

Temperature, Moisture, Electrostatics, Magnetism, Static Buoyancy, Gravitation

Data Acquisition

Standard Deviation, Sensitivity Drift, Linearity, Readability, Reproduceability, Uncertainty

WorkPlace Training E-Learning – Course Topics

Precision Force & Torque Measurement

Stress and Strain

Relationships, Stress, Strain Elasticity, Tension or Compressability

Characteristics and Operations of a Load Cell

Strain Gages, Load Cell Configuration, Practical Apps

Torque Concepts and Applications

What is Torque? Cosine Error, Torque Wrenches, Hooke's Law, Run Down Resistance, Set or Seizure, Breakaway, Reading the Scale

Torque Testers Calibration

Torque Auditing

How Fasteners Fasten, Torque Measurement, Torque and Clamping Force, Torque Auditing; Static, Dynamic, Sources of Variation; Actual installation vs. specification, Fall-off (joint relaxation), Hard and soft joints, Tightening speed (frictional coefficients)

WorkPlace Training E-Learning – Course Topics

Precision Humidity Measurement

Introduction to Humidity Measurement

Traceability

Key Terminology

Vapor Pressure, Saturation Water Vapor Pressure, Relative Humidity, Dalton's Law, Dew Point, Frost Point, Supercooled Water, Absolute Humidity, Mixing Ratio, PPM by Volume, PPM by Weight, Enthalpy, Pressure Effects

Specification

Vapor Pressure, Saturation Water Vapor Pressure, Relative Humidity, Dalton's Law, Dew Point, Frost Point, Supercooled Water, Absolute Humidity, Mixing Ratio, PPM by Volume, PPM by Weight, Enthalpy, Pressure Effects

Humidity Measuring Instruments

Wet and Dry Bulb Psychrometers, Theory, Operating Principles

Chilled Mirror Hygrometer Theory

Principles in Chilled Mirror-Peltier Cooling, Dew Point Depression, Slew Rate, Platinum RTD

CM Operation and Maintenance

Dew Point Measurement, Contamination, Dew or Frost, Sampling, Pressure Effects

Sensors

Displacement, Bulk Polymer Resistive, Capacitive, Saturated Salt Lithium Chloride, Aluminum Oxide Dew Point, Piezo-Resonance

Accuracy of the Measurement

Error Sources; Conformity, Hysteresis, Dead Band, Repeatability Kelvin Effect, Raoult Effect

Calibration

Two Pressure Humidity Calibration, Two Pressure Principle, RH Generator, Computer Controlled System

WorkPlace Training E-Learning – Course Topics

Measurement Uncertainty

Components

Sources of Uncertainty

Essentials of Expressing Measurement Uncertainty

Definitions, Evaluating, Distributions; Uniform, Triangular, Nominal, Combining, Expanded, Examples

Specification

Coverage Factors, Confidence Limits Correlation, Reporting Uncert; Manufacturer, User, Capabilities Statement, Traceability

Risk Analysis Introduction

Quantification, Consumer vs Producer, Approximation Methods, Measurement; Average Quality Level, Distribution, Bias, TUR, Guardband Limits, Interval Width, Delta Specification Limit, EOP% Intolerance

Related Statistical Tools

PMAP, Process Capability, Gage R & R, ANOVA, Models for Measurement Uncertainty Analysis, Sample Plans, Structure of Random Samples, Reverse Standards

Standards

Background and list of member organizations NIST-1297, ISO-GUM, NASA

Software

Features and Benefits; ISG, Compaq, Dikken, Boeing, Gage R & R

Features and Benefits

Statistics, JMP, Minitab

Summary

Developing a Company Specific Uncertainty Guide to Measurement Uncertainty

WorkPlace Training E-Learning – Course Topics

Certified Calibration Technician (CCT) Test Prep

General Methodology

Base SI Units, Derived SI Units, SI Multipliers and Conversions, Fundamental Constants, Common Measurements, Principles and Practices of Traceability, Types of Measurement Standards, Substitution of Calibration Standards

Measurement Systems

Measurement Methods, Measurement Data, Characteristics of Measurements, IM&TE Specifications, Primary Error Sources, Measurement Systems and Capabilities, Measurement Assurance Programs (MAPs)

Calibration Systems

Calibration Methods, Industry Practices and Regulations, Control of the Calibration Environment, Calibration Processes for IM&TE, Process flow; Logistical information, Roles and responsibilities, Scheduling, Manual and Automated Calibration, Systems Records and Records Management, Reporting Results

Applied Mathematics and Statistics

Technical and Applied Mathematics (Application), Scientific and engineering notation, English/Metric conversions, Ratios, Linear interpolation and extrapolation, Rounding, truncation, and significant figures, Number bases, Volume and area, Angular conversions, Graphs and plots Applied Statistics, Basic statistical tools, Common distributions, Descriptive statistics, Sampling issues

Quality Systems and Standards

Quality Management Systems; System components, Procedures, The Seven Quality Control Tools, Quality Audits, Preventive and Corrective Action; Process improvement techniques, Nonconforming material identification, Impact assessment of nonconformances Supplier Qualification and Monitoring, Professional Conduct and Ethics, Occupational Safety Requirements; Hazards and safety equipment, Hazardous communications (HAZ-COM), Housekeeping, Quality Standards and Guides

Uncertainty

Uncertainty Budget Components, Uncertainty Management, Uncertainty Determination and Reporting

WorkPlace Training E-Learning – Course Topics

Acoustics and Vibration

Acoustics

What Sound Is, Units of Measure used to Quantify Sound, Components of the Human Ear, Elements of a Sound Meter, Procedures used to Calibrate an Acoustic Meter, Basic Types of Sound Field Microphones, the Addition and Subtraction of Sound Levels

Vibration

What Vibration is and Where it Comes From, How to Quantify Vibration Levels, Vibration Parameters, Motion, and Degrees of Freedom, the Selection of Acceleration, Velocity and Displacement Parameters

Accelerometer Design and Calibration

The Operating Principles and Construction of Piezoelectric Accelerometers Including Voltage and Charge Mode, Accelerometer Design, the Design and Application of Piezoresistive Accelerometers, Components of an Accelerometer Calibration System, Calibration Techniques; Frequency Response, Calibration Reports, Periodic Calibration, Accelerometer Mounting Techniques Including Direct, Adhesive and Magnetic, Probe Tips, Mass Loading, Ground Isolation, Ground Noise and Ground Loops, Cables and Connections, the Use of Long Cables

WorkPlace Training E-Learning – Course Topics

Time and Frequency

Time

Measurement Time Scales, Universal Time, International Atomic Time, Synchronization, Coordinated Universal time

Digital Clock Accuracy and Synchronization

General Purpose Units, Precision Units

Time Base Standards in Clocks

Accuracy and Stability, Cesium Beam Standards, Hydrogen Masers, Rubidium Standards, Quartz Oscillators

Sources of Error

Frequency Offset and Oscillator Aging, NIST, Loran C, GOES, GPS

Time Code Formats

Frequency, Specifications, Universal Time, International Atomic Time, Synchronization, Coordinated Universal time

Offset

Phase Comparison, Phase Deviation, Measurement Period, 10:1 DUR, Sample Graphs

Stability

Short-term, Long-term, Frequency Domain, Time Domain, Standard Deviation, Allan Variance, Sample Graphs, Flicker Floor

Frequency Standards

Operating Principles of; Quartz, Atomic, Rubidium, Cesium, Hydrogen Masers

Transfer Standards

WWVB, Groundwave; Loran-C, GPS, Receiving Equipment-Pseudo-random noise, Course acquisition code, Precision code GPS

Performance

GPS Calibration Methods: Frequency counter, Time interval method

Dimensional: Roundness, Hardness, Surface Texture

Roundness

Introduction, Measurement Methods, Workbench Measurements, Instruments-Turntable and Rotating Pick-up, Geometry of a Part, Interrupted Surfaces, Stylii, Diameter, 3-Point, Radius Methods, MCC, MIC, LSC, MZC, Roundness Evaluation Methods, Interpretation of Graphs, Measuring from a Graph, Using a Template, Filters

Hardness

How Hardness is Quantified and Tested, Principles of Scratch, File, Durameters, Eddy Current and Indentation Testing, Range and Application of Scales, Conversion Relationships, Surface Preparation, Brinell, Vickers, Knoop, Rockwell, Shore, Microhardness, Types and Use of Indenters

Surface Texture

Introduction, Why Measure Surface Texture, Causes, Roughness, Waviness, and Form, Peaks and Valleys, Lay, Profile, Sampling Length, Frequency Response, Numbers, Amplitude, Spacing and Hybrid Parameters, Measuring Lengths, Reference Lines, Cut-off, Roughness Average, Stylus

WorkPlace Training E-Learning – Course Topics

Introduction to Microwave Measurement

Microwave Theory and Application

Development of the various types of waveguides in terms of their advantages and disadvantages

Physical dimensions of the various types of waveguides and their effects on power and frequency

Propagation of energy in waveguides in terms of electromagnetic field theory

Modes of operation in waveguides

Basic input/output methods used in waveguides

Basic principles of waveguide plumbing

Reasons for and the methods of terminating waveguides

Basic theory of operation and applications of directional couplers

Basic theory of operation, construction, and applications of cavity resonators

Basic theory of operation of waveguide junctions

Operation of ferrite devices in terms of their applications

MW Components and Circuits

Basic principles of microwave tubes and the limitations of conventional tubes

Basic principles of velocity modulation

Development of microwave tubes

Basic theory of operation of klystrons including multicavity and reflex klystrons

Basic theory of operation of traveling-wave tubes and backward-wave oscillators

Construction, basic theories of operation, and typical applications of magnetrons and amplitrons

Basic theory of operation of tunnel diodes when used in oscillator-, amplifier-, and frequency-converter circuits

Operation of varactors when used in parametric amplifiers and frequency converters

Basic principles of operation of bulk-effect diodes and the gunn oscillator

Basic operation of passive microwave diodes in terms of theory and application

Basic operation of microwave transistors in terms of theory and application

Antennas

Basic characteristics of coupling, directivity, reciprocity, and efficiency in microwave antennas

Construction and basic theory of operation of reflector antennas and horn radiators

Construction and operation of microwave lens antennas

Construction and theory of operation of driven and parasitic antenna arrays

Basic operation and applications of frequency-sensitive antennas

AC/DC Calibration and Metrology

Basic concepts, including power produced by voltage

Thermal converters, single element vacuum thermocouple converters.

Making transfers and the determination of alternating voltage and current, frequency effects.

Understand AC-DC Devices including multijunction thermocouples, log/antilog converters, electrostatic and electrodynamic instruments

Using AC-DC transfer standards

Explain and understand types of AC-DC transfer standards.

Vacuum thermocouple-based standards.

AC-DC voltage transfers i.e. plane of reference and frequency response

Follow the correct procedures in making the transfer; preparation and using shunts for AC-DC current transfers.

Describe transfer errors and their avoidance; 4-terminal connections, proper connections and hookups, distortion and noise.

Understand transfer standard calibration; AC-DC difference, half-scale range intercomparison

Inductance and Capacitance

Explain the SI definition of inductance; standard of inductance, traceable standards, time constants and inductive reactance in AC circuits.

Explain the SI definition of capacitance.

Describe the Realization of the Farad, traceable capacitance standards, time constants, capacitive reactance in AC circuits, comparing the currents in inductors and capacitors.

Impedance and AC Ratio

Describe and understand impedance, admittance and immittance, AC reactance.

Understand and use audio frequency dividers; resistive and reactive dividers.

Explain RF ratio; and connector and hookup considerations.

WorkPlace Training E-Learning – Course Topics

Fiber Optics

Fiber Optics Background

Definition of Fiber Optics , FO Data links, History, FO Systems

Fiber Optics Concepts

FO light transmission, Propagation of light, Properties of light, Transmission of light through Optical Fibers

Optical Fibers and Cables

FO and cable design, Fibers and cables

Optical Splices, Connectors and Couplers

FO connections, Optical fiber coupling loss, Splices, Connectors, Couplers

Fiber Optic Measurement Techniques

FO measurements

Optical Sources and Fiber Optic Transmitters

Introduction, Semiconductor light-emitting diodes and Laser diodes, FO transmitters

Optical Detectors and Fiber Optic Receivers

Introduction , Optical detector, Semiconductor photodiodes, FO receivers

Fiber Optic Links

FO system topology, Link classification, System design and installation

WorkPlace Training E-Learning – Course Topics

Test Instruments Operation and Calibration

Test Equipment Administration

Identification of Instruments, Classification, Calibration and Repair Procedures, Test equipment Technical Documentation, Metrology Logistics; Stickers, Documentation and Recall, Storing and Handling Instruments, General Test Equipment Information

Test Equipment Safety Precautions

Working on Energized and De-Energized Circuits, Grounding of Power Tools and Equipment

Basic Measurements

Voltage and Current Measurements, Resistance Measurements, Capacitance Measurements, Inductance Measurements, Wheatstone Bridge Measurements; Resistance, Capacitance, Inductance

Advanced Measurements

Power Measurements

The Decibel System, Measurement Methods, Thermocouple Ammeter, Dummy Loads, Bolometers

Measurement Methods

Frequency Measurements; Mechanical (Tachometers, Strobes, Chronometric), Audio Frequencies (Comparison, Direct), Wavemeters (Resonant Frequency), Frequencies above Audio Range (LF to SHF) Waveform Analysis; Basics of the Oscilloscope and Spectrum Analyzer

Testing Semiconductor Devices

Diodes, Transistors, Special Devices (SCR, UJT, FET), Use of Basic Meters, Use of Curve Tracers

Basic Meters

Analog Meters

Basic Meter Movements; Galvanometer, D'Arsonval Meter Movement, DC Ammeter, Shunts (External and Internal), DC Voltmeter, Voltage Dividers, Ohmmeter; Megohmmeter, VOM

Electrodynamometer Type Meters

Power meters, Voltmeter, Ammeter, Ohmmeter

Test Instruments Operation and Calibration (cont.)

General Meter Specifications

Techniques for Meter Use

Continuity Tests, Testing for Grounds, Caution, Testing for Shorts; Warning, Resistance Tests; Caution

Calibration of Meter Movement

Standards, Calibration intervals, Measurement Uncertainties

Common Test Equipment

VOM Multimeters

Types of Measurements

Electronic Digital Multimeters

Example of Digital Multimeter (Block Diagram/Operation)

AC/DC Differential Voltmeter

Example of Differential Meter (Block Diagram/Operation)

Meter Design Characteristics

Front Panel Controls, Modes of Operation, Functional Block Diagram

Transistor Testers

Leakage Tests, Beta Tests

Inductance Measurements

RLC Bridge

Operation of Common Electronic Instruments

Multimeters, Differential Voltmeters, Component Testers, RLC Bridges

Test Instruments Operation and Calibration (cont.)

Special Application Test Equipment

Electronic Digital Multimeters

Example of Digital Multimeter (Block Diagram/Operation)

AC/DC Differential Voltmeter

Example of Differential Meter (Block Diagram/Operation)

Meter Design Characteristics

Front Panel Controls, Modes of Operation, Functional Block Diagram

Transistor Testers

Leakage Tests, Beta Tests

Inductance Measurements

RLC Bridge

Operation of Common Electronic Instruments

Multimeters, Differential Voltmeters, Component Testers, RLC Bridges

The Oscilloscope and Spectrum Analyzer

Oscilloscopes

Cathode-Ray Tubes

Electron Gun, Electron Beam Deflection System, Vertical Deflection Plates, Horizontal Deflection Plates, CRT Graticule, CRT Designations

Components Used to adjust CRT Display Quality

INTEN (Intensity) Control, FOCUS and ASTIG (Astigmatism) Controls, TRACE ROTATION Control, BEAM FINDER Control, Horizontal and Vertical POSITION Controls

Components Used to Determine the Amplitude of a Signal

Vertical POSITION Control, Input Connector/Coupling, Attenuator Control, Graticules

Components Used to Select the Horizontal Operating Mode

TIME/DIV, ALT/CHOPPED Mode

Test Instruments Operation and Calibration (cont.)

Components Used to Provide a Stable Display

Trigger Level, Trigger Slope, Trigger Coupling, Hold Off Control (Jitter Reduction)

Using the Oscilloscope

Dual-Trace Operation

Coupling, Source Level, and Slope controls, ALT/CHOPPED Modes

Dual Time Base Operation

ALT/CHOPPED Modes, Delayed Operation

Oscilloscope Probes

Types of Probes, Probe Calibration

Oscilloscope Calibration

Vertical, Horizontal, Triggering, Display Systems, Power Supplies

Spectrum Analyzer

Basic Functional Description

Block Diagram, Theory of Operation

Spectrum Analyzer Front Panel Controls, Indicators and Connectors

Spectrum Analyzer Calibration

Power Supplies, Vertical System, Horizontal System

WorkPlace Training E-Learning – Course Topics

CMMs

Content Partners: Renishaw

Review of Basic Concepts and Vocabulary

Basic CMM Measurements

Sampling Issues

Probing Systems

Basic CMM Accuracy and Specifications

Thermal Effects

CMM Calibration

Measurement Uncertainty

WorkPlace Training E-Learning – Course Topics

Water Quality, Measurement, pH, Conductivity

pH Measurement Intro

Equipment Used to Measure pH Calibration

Uncertainty of pH Measurement

Power Measurements

Conductivity Intro

Conductivity Measurements

Influences on Conductivity Measurements Applications

WorkPlace Training E-Learning – Course Topics

Metrology Applications for Engineers and Scientists

Measurement Parameters

Principles and Instrumentation to Measure the following: Electrical, Dimensional, Pressure, Temperature, Humidity, Mass, Light Radiation, Acoustics, Chemical

Statistics

Basic and Reliability Models, Measurement Decision Risk

Measurement Uncertainty

Types of Uncertainty

Determining Measurement Uncertainty

Uncertainty calculations

Combined uncertainty calculations

Combining uncertainty methods

Determining expanded uncertainty

Analyzing and reporting uncertainty

Analyzing and understanding calibration reports

Applying uncertainty data

Special topics in Measurement Uncertainty

Test Uncertainty Ratios

Guardbanding Techniques

Applications

Applying metrology concepts in product and instrument design

Selecting Instruments

Quality Aspects

Validation/verification issues

Safety Characteristics

Determining Test Specifications

Assigning appropriate Tolerances

Calibration Aspects

Assessment Checklist

WorkPlace Training E-Learning – Course Topics

Introduction to ISO/IEC 17025 for Technicians

Introduction

Intro to documentary standards
Quality systems and standards
Prescriptive and non-prescriptive standards
Accreditation, registration, and certification
ISO/IEC 17025 and ISO/IEC Guide 58
Accreditation bodies and ISO/IEC 17025
Mutual agreement and mutual recognition Conformance and conformity assessment
Requirements of the standard(s)
Shalls, shoulds, and notes
Normative references
Additional requirements from accreditation bodies
The assessment process
Deficiencies, nonconformances, corrective action, responses
Preassessment, reassessment, surveillance

Audits and Auditors

ISO 10011
Assessor qualifications
Assessor training requirements
Requirements for confidentiality
Assessor roles – Lead, technical, associate

The Assessment Process

Assignment
Planning
Desk audit, first round of deficiencies and corrective action
Scheduling the assessment
Agenda and assessor roles
The opening meeting
The tour
Lead assessor roles and responsibilities
Technical assessor roles and responsibilities
Technical interviews and observations of tests/calibrations
Daily meetings
The closing meeting

Introduction to ISO/IEC 17025 for Technicians (cont.)

After the Assessment

The final report
Typical documentation produced
Deficiencies and Corrective action
Proficiency testing and interlaboratory comparisons
Review of laboratory submissions
Review of entire final package
Assessor revisits and continuing assignments

Internal Assessments

The internal audit team
Process and schedule
Contents of the assessment
Documentation
Corrective action

Assessment to the Requirements of ISO/IEC 17025

Introduction

- Intro to documentary standards
- Quality systems and standards
- Prescriptive and non-prescriptive standards
- Accreditation, registration, and certification
- ISO/IEC 17025 and ISO/IEC Guide 58
- Accreditation bodies and ISO/IEC 17025
- Mutual agreement and mutual recognition Conformance and conformity assessment
- Requirements of the standard(s)
- Shalls, shoulds, and notes
- Normative references
- Additional requirements from accreditation bodies
- The assessment process
- Deficiencies, nonconformances, corrective action, responses
- Preassessment, reassessment, surveillance

Audits and Auditors

- ISO 10011
- Assessor qualifications
- Assessor training requirements
- Requirements for confidentiality
- Assessor roles – Lead, technical, associate

The Assessment Process

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- Planning
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- Technical assessor roles and responsibilities
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- Daily meetings
- The closing meeting

Assessment to the Requirements of ISO/IEC 17025 (cont.)

After the Assessment

The final report
Typical documentation produced
Deficiencies and Corrective action
Proficiency testing and interlaboratory comparisons
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Internal Assessments

The internal audit team
Process and schedule
Contents of the assessment
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WorkPlace Training E-Learning – Course Topics

Uncertainty Management

Introduction

Communicating about measurements and measurement equipment

What is a Specification?

Why do we need specifications?

The use of specifications in measurement and metrology

The form(s) taken by specification

Some examples of specifications of measuring equipment

How to read and interpret specifications

The importance of specifications in calibration

What it means to be in or out of spec.

Practice reading, interpreting, calculating

What is a Tolerance?

How are tolerances stated?

What is the difference between a tolerance and a specification?

Some examples of tolerances of measuring equipment

How to read and interpret tolerances

The importance of tolerances in calibration

What it means to be in or out of tolerance

Practice reading, interpreting, calculating

Measurement Uncertainty (this is not a full treatment, just an intro in context)

Definitions (in context) of measures of measurement reliability and quality

Accuracy

Precision

Resolution

Repeatability and Reproducibility

Traceability

How do these definitions fit with specifications and tolerances?

Special cases: floor specs, % of full scale vs % of reading, ppm, values near zero

Calculation of measurement uncertainty – budgets

Converting specifications and tolerances to uncertainty

Practice calculating

Uncertainty Management (cont.)

Accreditation

rules relating to specifications and tolerances

Ratios

The 10:1 principle; 4:1, 3:1

What did they mean in the past: Definitions in MIL-STD-45662

What do they mean now? Definitions in ANSI/NCSS Z-540-1, ISO 10012-1 and ISO/IEC 17025

Are they useful? If so, why?

Accuracy ratios, tolerance ratios, uncertainty ratios

Ratios and traceability

Practice calculations

Specifications, Tolerances, and Uncertainty

Inspection and test

Errors of Type I

Errors of Type II

Decision rules

Definitions

Applying them

Responsibility (whose)

Measurement uncertainty and decision rules

Changes to and Adjustment of Decision Rules

Guardbanding

Determining conformance to identified metrological specifications and taking measurement uncertainty into account

Practice calculations

WorkPlace Training E-Learning – Course Topics

Interval Analysis

BONUS: INTERVAL ANALYSIS CALCULATOR TOOL INCLUDED!!

The requirement for Interval Analysis
Definitions associated with Interval Analysis
Statistics associated with with Interval Analysis
Basic Statistics
Statistical techniques
Reliability Models
Implementing Interval Analysis
Reliability Targets & Measurement Risk
Data Conditioning
Equipment Groups
Analyzing Data and reviewing Reliability Model
Interval Analysis Methods
Adjustment Methods
Economics of Interval Analysis
Implementation Methods
Interval Extensions

WorkPlace Training E-Learning – Course Topics

Proficiency Testing

BONUS: INTERVAL ANALYSIS CALCULATOR TOOL INCLUDED!!

Introduction to Proficiency Testing
Justification for Proficiency Testing participation
Standards associated with Proficiency Testing
Basic Statistics in Proficiency Testing
Measurement Uncertainty Considerations in Proficiency Testing
Proficiency Testing schemes (with examples for testing and calibration laboratories)
Proficiency Testing Data Interpretation and Analysis (with examples)
Simple implementation of Measurement Assurance Programs (MAP) within the laboratory

Measurement Uncertainty (this is not a full treatment, just an intro in context)

Definitions (in context) of measures of measurement reliability and quality

Accuracy

Precision

Resolution

Repeatability and Reproducibility

Traceability

How do these definitions fit with specifications and tolerances?

Special cases: floor specs, % of full scale vs % of reading, ppm, values near zero

Calculation of measurement uncertainty – budgets

Converting specifications and tolerances to uncertainty

Practice calculating