**Technical Capacity Building Program**

**at**

 **TUBITAK UME**



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# Training List at TUBITAK UME

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| --- | --- | --- | --- | --- |
| **Code Name**  | **Subject** | **Description of Training** | **Duration** | **Date**  |
| **1-UME- M** | **Mass** | Legal metrology  | 6 weeks (30 Days) | September 2020  |
| Quality |
| Mass Metrology |
| **2-UME-P** | **Pressure** | Legal metrology  | 6 weeks (30 Days) | September 2020  |
| Quality |
| Pressure Metrology |
| **3-UME- FTH** | **Force ,Torque, Hardness Metrology** | Legal metrology  | 6 weeks (30 Days) | September 2020  |
| Quality |
| Force ,Torque, Hardness Metrology |
| **4-UME- VDV** | **Volume, Density, Viscosity Metrology** | Legal metrology  | 6 weeks (30 Days) | September 2020  |
| Quality |
| Volume, Density, Viscosity Metrology |
| **5-UME-F** | **Flow Metrology** | Legal metrology  | 6 weeks (30 Days) | September 2020  |
| Quality |
| Flow Metrology |
| **6-UME-D** | **Dimensional Metrology** | Legal metrology  | 6 weeks (30 Days) | September 2020  |
| Quality |
| Dimensional Metrology |
| **7-UME-T** | **Temperature Metrology** | Legal metrology  | 6 weeks (30 Days) | September 2020  |
| Quality |
| Temperature Metrology |
| **8-UME-PE** |  **Power & Energy Metrology** | Legal metrology  | 6 weeks (30 Days) | September 2020  |
| Quality |
|  Power & Energy Metrology |
| **9-UME- V** | **Voltage Metrology** | Legal metrology  | 6 weeks (30 Days) | September 2020  |
| Quality |
| Voltage Metrology |
| **10-UME-I** | **Impedance Metrology** | Legal metrology  | 6 weeks (30 Days) | September 2020  |
| Quality |
| Impedance Metrology |

# Training Program of Mass Metrology

| **Mass Laboratory****30 days at TUBITAK UME** |
| --- |
| **Legal Metrolog**y : **5 days****Orientation Program**: TUBITAK UME presntation and lab visits **: 2 days** |
| **Quality (General Metrology, Fundamentals of Measurement, Introduction and Implementation of ISO/IEC 17025: 2017 Standard) : 3 days** **General Metrology, Fundamentals of Measurement, Calibration and Validation*** Metrology as a science of measurements. Brief history of metrologyInternational System of Units (SI). SI Brochure
* International Metrological Infrastructure. Metre Convention. Mutual Recognition Arrangement (CIPM MRA)
* General terms and concepts in metrology. International Vocabulary in Metrology (VIM)
* National Quality Infrastructure. Role of National Metrology Institute in National Quality Infrastructure

**Introduction to Evaluation of Measurement Uncertainty** * Basic terms and definitions used in evaluation of Measurement uncertainty
* Basic method for evaluation of measurement uncertainty: GUM approach
* Type A evaluation of measurement uncertainty
* Type B evaluation of measurement uncertainty
* Statistical distributions used in uncertainty estimation
* Calculation of combined and expanded uncertainty
* Reporting calibration/measurement results

**Introduction and Implementation of ISO/IEC 17025: 2017 Standard** * General information about the ISO/IEC standard, history of its development
* Overview of the structure of the standard
* Normative references and bibliography
* General and structural requirements
* Resource requirements
* Process requirements
* Management requirements (Option A and Option B)
* Metrological traceability
* Risk based thinking
 |

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| **Mass laboartory : 20 days*** Secondary level mass measurements, dissemination of unit of mass, determination of mass value and conventional mass value and uncertainty calculations
* Performance tests of mass comparators to be used for mass determination
* Volume/Density determination of mass standards by hydrostatic weighing method
* Verification of weights / weight sets
* Verification of non-automatic weighing instruments
* Verification of automatic weighing instruments
* Calibration of non-automatic weighing instruments
* Calibration of automatic weighing instruments
 |

# Training Program of Pressure Metrology

| **Pressure Metrology****30 days at TUBITAK UME**  |
| --- |
| **Legal Metrology : 5 days****Orientation Program: TUBITAK UME presntation and lab visits : 2 days** |
| **Quality (General Metrology, Fundamentals of Measurement, Introduction and Implementation of ISO/IEC 17025: 2017 Standard) : 3 days** **General Metrology, Fundamentals of Measurement, Calibration and Validation*** Metrology as a science of measurements. Brief history of metrologyInternational System of Units (SI). SI Brochure
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 |

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| **Pressure laboartory : 20 days****General Concepts of Pressure Metrology*** What is pressure
* Terms and definitions
* Absolute pressure, barometric pressure, gauge pressure, differential pressure

**Calibrations of Analog and Digital Guges*** Calibration of Analogue and Digital Manometers
* Basics of analogue and digital manometers, types, working principles, classification, things to do prior to calibration
* International standards of “guidelines on the calibration of electromechanical manometers”
* Calibration procedure of analogue and digital manometer, calibration of analogue and digital manometers and uncertainty calculations
* Practical applications and examples on analogue and digital manometers
* Preparing for calibration, cleaning, setup&installation, calibration data recording form, preparing an excel calculation template
* Full calibration of a analogue manometer
* Calculating mesurement uncertainty, reporting results, preparing a calibration certificate

**Calibrations of Pressure Transducers**Calibration of Pressure Transducers&Transmitters * Preparing for calibration, cleaning, setup&installation, calibration data recording form, preparing an excel calculation template
* Full calibration of a analogue manometer
* Calculating mesurement uncertainty, reporting results, preparing a calibration certificate

**Pressure Balance Metrology**Introduction to pressure balance metrology* Costruction of pressure balance
* Pneumatic, hydraulic, gauge and absolute measurements on pressure balances
* Calculating the pressure for a measurement for pressure balances
* Doing practical measurements with pressure balances
* Uncertainty calculations on pressure balances

**Interlaboratory Comparisons*** Types of comparisons
* Organization and participation for comparisons
* Preparing comparison technical protocols
* Performing measurements
* Preparing measurement report
 |

# Training Program of Force-Hardness-Torque Metrology

| **Force-Hardness-Torque Metrology** **30 days at TUBITAK UME** |
| --- |
| **Legal Metrology : 5 days****Orientation Program: TUBITAK UME presntation and lab visits : 7 days** |
| **Quality (General Metrology, Fundamentals of Measurement, Introduction and Implementation of ISO/IEC 17025: 2017 Standard) : 3 days** **General Metrology, Fundamentals of Measurement, Calibration and Validation*** Metrology as a science of measurements. Brief history of metrologyInternational System of Units (SI). SI Brochure
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* Metrological traceability
* Risk based thinking
 |

| **Program of Training Force Metrology : 5 days** * General information about application fields of force proving instruments
* Types of force proving instruments
* force standard machines
* Knowledge of load (force) measuring devices
* Verification necessities and period of force proving instruments
* Verification method and procedure of force proving instruments
* Application about verification methods of force proving instruments
* Evaluation of measurement results taken during verification process.
* Calculation of measurement uncertainty
* Classification of force proving instruments
* General information about application fields of material testing machine
* Types of material testing machines in industry
* Knowledge of load (force) measuring devices
* Importance of material testing machine verification
* Verification necessities and period of material testing machine
* Verification method and procedure of force measuring instrument of material testing machines
* Application about verification methods of material testing machines for force measuring devices
* Evaluation of measurement results taken during verification process.
* Calculation of measurement uncertainty of material testing machines
* Classification of material testing machines force system
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| **Program of Training Torque Metrology : 5 days** **General information about Torque and Torque Metrology*** Calibration requirments acc. to the ISO 6789-1: 2017
* Calibration sequence acc. to the ISO 6789-1: 2017
* Calculation of deviation acc. to the ISO 6789-1: 2017
* Theoretical knowledge about uncertainty budget of torque hand tools calibration acc. to the ISO 6789-2:2017
* Preperation of Excel calculation form for torque hand tools, type I, Class A, B, C
* Preperation of Excel calculation form for torque hand tools, type II, Class A,B, C, D, E
* preparation of certificate of torque hand tools

Application I: * Calibration practise for indicating torque hand tools
* Calibration of torque wrench (Type I - Class B or C)
* Calculation of calibration results,
* Certification of calibration,

Application II: * Calibration practise for setting torque hand tools
* Calibration of torque wrench (Type - II Class A)
* Calculation of calibration results,
* Certification of calibration,
 |
| --- |
| **Program of Training Hardness Metrology : 5 days** * General information about application fields of hardness instruments
* Calibration of Rockwell,
* Calibration of Brinell,
* Calibration of Vickers,
* Hardness Reference Blocks and Uncertainty Calculations
* Calculation of measurement uncertainty
* General information about application fields of hardness instruments
* Calibration of Force Application Systems,
* Calibration of Indentation Measurment Systems,
* Calibration of Indirect Calibration by Hardness Reference Blocks of Hardness Testing Machines (Rockwell, Brinell, Vickers)

Calculation of measurement uncertainty |

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# Training Services at TÜBİTAK UME in Volume, Density and Viscosity Laboratory

| ume_yeni_2**Training Program****20 days at TUBITAK UME**  |
| --- |
| **Days / Hours** |  **Activities** |
| **Day 1** | **Welcome and Short Introduction*** Visiting three laboratory areas
* Information about the facilities of each laboratory areas
 |
| **Day 2 - 8** | **Volume Metrology*** Introduction and terminology of Volume Metrology according to volumetric instruments (ISO 4787 and EURAMET cg-19)
* Theoretical knowledge about volumetric instruments calibration
* Theoretical knowledge about uncertainty budget of volumetric instruments calibration
* Practice of volumetric instruments
* Assessment of input quantities and calculation of uncertainty parameters of volumetric instruments. (ISO 4787 and EURAMET cg-19)
* Introduction and terminology of Volume Metrology according to Piston-Operated Pipettes (ISO 8655-1)
* Theoretical knowledge about Piston-Operated Pipettes calibration (ISO 8655-2 and 6)
* Theoretical knowledge about uncertainty budget of Piston-Operated Pipettes calibration (ISO 8655 and ISO 20461)
* Practice of Piston-Operated Pipettes
* Assessment of input quantities and calculation of uncertainty parameters of Piston-Operated Pipettes (ISO 8655 and ISO 20461)
* Discussion of training results
 |
| **Day 9 - 16** | **Density Metrology*** Introduction to hydrometer calibration (ISO 649)
* Theoretical knowledge about hydrometer calibration
* Requirements for hydrometer calibration
* Introduction of hydrometer calibration setup
* Theoretical knowledge about uncertainty budget of hydrometer calibration
* Practice of hydrometer calibration
* Uncertainty evaluation in hydrometer calibration
* Example of the calculation
* Self practice of trainees and calculation of input values with uncertainties
* Discussion of training results
 |
| **Day 16 - 20** | **Viscosity Metrology*** Viscosity metrology general description and concepts
* Theoretical knowledge about uncertainty budget of viscosity calibration
* Viscosity Metrology according to Kinematic Viscosity measurement (ASTM D 445 and DIN 51 562-1-4)
* Practice of determination of Kinematic Viscosity using Ubbelohde Viscometer calibration
* Viscosity Metrology according to Capillary Viscometer calibration (ASTM D 446 and DIN 51 562-1-4)
* Practice of calibration Capillary Ubbelohde Viscometer
* Discussion of training results
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# Training Program of Flow Metrology

| **Flow Metrology** **Fluid Mechanics Laboratory****30 days at TUBITAK UME** |
| --- |
| **Legal Metrology : 5 days****Orientation Program: TUBITAK UME presntation and lab visits : 2 days** |
| **Quality (General Metrology, Fundamentals of Measurement, Introduction and Implementation of ISO/IEC 17025: 2017 Standard) : 3 days** **General Metrology, Fundamentals of Measurement, Calibration and Validation*** Metrology as a science of measurements. Brief history of metrologyInternational System of Units (SI). SI Brochure
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* Risk based thinking
 |
| **Training Program in Fluid Mechanics Laboratory : 20 days** **Welcome and Short Introduction*** Visiting laboratory areas
* Information about the facilities of each laboratory areas
* Fundamentals of fluid mechanics

**Gas Flow Measurements*** General information
* Laboratory Work and Practices
* Uncertainty calculations

**Water Flow Measurements*** General information
* Laboratory Work and Practices
* Uncertainty calculations

**Air Velocity Measurements*** General information
* Laboratory Work and Practices
* Uncertainty calculations

**CFD analysis with ANSYS*** A sample for water flow in a pipe
* A sample for air flow in a pipe

**Laboratory Work and Practices*** Water Flow Measurements
* Air Velocity Measurements
* Gas Flow Measurements

**Comparisons*** Preparation of the protocol
* How to take measurements
* How to make uncertainity calculations
* Preparation of the comparision report
 |

# Training Program of Dimensional Metrology

| **Dimensional Laboratory** **30 days at TUBITAK UME** |
| --- |
| **Legal Metrology : 5 days****Orientation Program: TUBITAK UME presntation and lab visits : 2 days**  |
| **Quality (General Metrology, Fundamentals of Measurement, Introduction and Implementation of ISO/IEC 17025: 2017 Standard) : 3 days** **General Metrology, Fundamentals of Measurement, Calibration and Validation*** Metrology as a science of measurements. Brief history of metrologyInternational System of Units (SI). SI Brochure
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| **Program of Training Dimensional Laboratory : 20 days** **Special Training program for Basic Dimensional Devices (Micrometers, Dial Gauges, Height Gauges, Vernier Calipers)** * Use of basic dimensional devices,
* Calibration methods,
* Uncertainty parameters and calculations

**Short Gauge Blocks And Their Calibration*** Short gauge blocks calibration and uncertainty calculation, gauge blocks definitions, technical specifications, materials, production and classifications

**Short Gauge Block Comparators And Their Calibration*** Training of short gauge block comparators calibration (Acc.to EURAMET/cg-02/v.02)

**Special Training program for measurement tapes and scales*** General terms and definitions
* Calibration of tapes and scales
* Uncertainty parameters and calculations

**Special Training program for Surface Roughness Measurements and Uncertainty Calculations*** Surface roughness measurements and uncertainty calculations, surface texture and their types, roughness measurements techniques

P**arallel Ring-Plug Gauges Calibration and Uncertainty Calculation** * Parallel ring-plug gauges calibration and uncertainty calculation, calibration of reference ring-plug gauges with form measurements and without form measurements, calibration of Go-NoGo ring-plug gauges

P**arallel Thread Ring-Plug Gauges Calibration and Uncertainty Calculation** * Parallel Thread Ring-Plug Gauges Calibration and Uncertainty Calculation

**Form Measurements and Uncertainty Calculations*** Form measurements and uncertainty calculations, form deviations and method of determination of form deviations, calibration of form measurement device
 |

# Training Program of Temperature Metrology

| **Temperature Laboratory****30 days at TUBITAK UME** |
| --- |
| **Legal Metrology : 5 days****Orientation Program: TUBITAK UME presntation and lab visits : 2 days**  |
| **Quality (General Metrology, Fundamentals of Measurement, Introduction and Implementation of ISO/IEC 17025: 2017 Standard) : 3 days** **General Metrology, Fundamentals of Measurement, Calibration and Validation*** Metrology as a science of measurements. Brief history of metrologyInternational System of Units (SI). SI Brochure
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| **Program of Training Temperature Laboratory : 20 days** **Primary Level Contact Temperature Metrology****Calibration of Standard platinum Resistance Thermometers*** Terms and definitions related to temperature
* Theoretical background for temperature measurements, Basics of Thermodynamics, Phase Transitions, Temperature- Resistance Relationship
* International Temperature Scale (ITS-90)
* Basic elements of Primary Level Temperature Calibration (Fixed Points, SPRTS, Bridges, etc)
* Practical work – Measurements with ITS-90 fixed point cells, Inducing freezing plateau, Evaluation of the plateau
* Applying hydrostatic head and self-heating corrections
* Calculation of W value
* Uncertainty Evaluation
 |
| **Secondary Level Contact Temperature Metrology****Calibration of Industrial Thermometers** * Theoretical background for temperature measurements with industrial PRTs, Digital Thermometers, Thermistors, Interpolation Equations
* Laboratory Practice : Calibration of Industrial PRT and Digital Thermometer by comparison method
* Uncertainty Evaluation
 |
| **Calibration of Temperature-controlled Enclosures and Dry-Block Calibrators*** Definition of the thermometers used for temperature measurements for temperature-controlled volumes, The related standards EURAMET/cg.20 guide, EURAMET/cg.13 guide TS EN 600068-3-5, in accordance with TS EN 600068-3-11,
* Laboratory practice with characterization of temperature-controlled volume and dry-block calibrator
* Uncertainty evaluation
 |
| **Calibration of Radiation Thermometers by Comparison Method*** Theoretical background on ITS-90 Radiation Temperature Scale & Planck’s Radiation Law, Industrial Radiation Thermometers and Blackbody Sources and Emissivity
* Laboratory Practice : Calibration of IR calibrator and radiation thermometer by comparison method
* Uncertainty evaluation
 |
| **Calibration of Thermo-Hygrometers** * Definitions and equations related with relative humidity, working principles of various hygrometers, humidity generators, humidity measuring techniques, Theoretical background of Two-pressure humidity generator in terms of Relative Humidity
* Laboratory Practice : Hygrometer relative humidity calibration in the Two-pressure humidity generator
* Uncertainty Evaluation

**Calibration of Dew-point temperature meters** * Definitions and equations related with dew-point temperature, working principles of dew-point meters, dew-point temperature measuring techniques, uncertainty evaluation of dew-point meters, Theoretical background of Two-pressure humidity generator in terms of Dew-Point temperature
* Laboratory Practice : Dew-point meter calibration in the Two-pressure humidity generator
* Uncertainty Evaluation
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# Training Program of Power and Energy Metrology

| **Power and Energy Laboratory****30 days at TUBITAK UME** |
| --- |
| **Legal Metrology : 5 days****Orientation Program: TUBITAK UME presntation and lab visits : 2 days**  |
| **Quality (General Metrology, Fundamentals of Measurement, Introduction and Implementation of ISO/IEC 17025: 2017 Standard) : 3 days** **General Metrology, Fundamentals of Measurement, Calibration and Validation*** Metrology as a science of measurements. Brief history of metrologyInternational System of Units (SI). SI Brochure
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| **Program of Training Power and Energy Laboratory : 20 days** **Welcome and Short Introduction*** Visiting two laboratory areas
* Information about the facilities of each laboratory areas

**General Concepts Relating to AC Power Measurements*** AC Power Measurements in general
* Precision Active, Reactive and Apparent Power Measurements
* Uncertainty calculations

**Laboratory Work and Practices*** Practices on AC Power Mesaurements
* Precision Active, Reactive and Apparent Power Measurements
* Using Digital Sampling Method for AC Power Measurements
* Error sources in Measurements
* Prediction, Definition, Calculation and Compensation of Errors

**General Concepts Relating to Energy Measurements*** Energy measurements in general
* Minimum Requirements for Energy Meter Measurements

**Laboratory Work and Practices*** Electricity meter tests and calibrations
* Need for Isolation Current Transformers in Meter Testings
* Uncertainty calculations

**AC Power & Energy Tracebility, CMCs, Comparisons*** Preliminary Works on AC Power Comparisons and CMCs
* Comparison Methods and Traceability in AC Power Measurements
* Recent Research Areas in AC Power Measurements

**General Concepts Relating to Instrument Current & Voltage Transformers*** Current & Voltage Transformers in general
* Current & Voltage Transformer Tests and Calibrations
* Uncertainty calculations
 |
| **Laboratory Work and Practices*** Practices on Current & Voltage Transformer Measurements
* Error Sources of Current & Voltage Transformers
* Compensation Methods
* Electronically-compensation Methods

**Laboratory Work and Practices*** Current Transformer Test Set and Bridge Calibrations
* Current Transformer Burden Measurements
* Voltage Transformer Test Set and Bridge Calibrations
* Voltage Transformer Burden Measurements

**Instrument Transformers Tracebility, CMCs, Comparisons*** Preliminary Works on Current & Voltage Transformers (High Current and High Voltage Ratios) Comparisons and CMCs
* Comparison Methods and Traceability in High Current Ratio Measurements
* Comparison Methods and Traceability in High Voltage Ratio Measurements
* Recent Research Areas in AC High Voltage and High Current Measurements including New Transducers and Sensors
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# Training Program of Voltage Metrology

| **Voltage Laboratory****30 days at TUBITAK UME** |
| --- |
| **Legal Metrology : 5 days****Orientation Program: TUBITAK UME presntation and lab visits : 2 days**  |
| **Quality (General Metrology, Fundamentals of Measurement, Introduction and Implementation of ISO/IEC 17025: 2017 Standard) : 3 days** **General Metrology, Fundamentals of Measurement, Calibration and Validation*** Metrology as a science of measurements. Brief history of metrologyInternational System of Units (SI). SI Brochure
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| **Training Program Voltage Laboratory : 20 days** **DC Voltage Measurements** * Introduction to Voltage Metrology
* DC Electronic Standards
* Josephson Standards
* Calibration of the DC standards using Josephson Standard
* Calibration of the DC standard by Reference group
* Uncertainty calculations

**DC Ratio Measurements*** Voltage Dividers
* Calibration of a Voltage Divider
* Calibration of the DC voltage source by using divider
* Uncertainty calculations

**DC Current Measurements*** Calibration of the DC Current source by using Reference Shunt
* Uncertainty calculations

**AC-DC Transfer Measurements*** Basic Concepts of AC-DC transfer
* Thermal Converters
* Calibration of the thermal converters by comparison
* Calibration of the AC-DC shunts
* Calibration of the AC Voltage sources and meters by using thermal converters
* Calibration of the AC Current sources and meters by using thermal converters and ac-dc current shunts
* Uncertainty calculations

**High Precision (8.5 Digit) Multimeter Calibration*** Calibration of the multimeter by Reference Calibrator
* Uncertainty calculations
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# Training Program of Impedance Metrology

| **Impedance Laboratory****30 days at TUBITAK UME** |
| --- |
| **Legal Metrology : 5 days****Orientation Program: TUBITAK UME presntation and lab visits : 2 days**  |
| **Quality (General Metrology, Fundamentals of Measurement, Introduction and Implementation of ISO/IEC 17025: 2017 Standard) : 3 days** **General Metrology, Fundamentals of Measurement, Calibration and Validation*** Metrology as a science of measurements. Brief history of metrologyInternational System of Units (SI). SI Brochure
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| **Training Program in Impedance Laboratory : 20 days** **General Concepts Relating to Impedance Measurements*** Introduction to impedance metrology
* Definitions
* Impedance units
* Calibrations in the scope of impedance

**DC Resistance Measurement Methods and Standards*** 2 wire measurements
* 4 wire measurements
* Low value resistance measurements
* High value resistance measurements

**Calibration of DC resistors and current shunts** * Standard resistor types
* History of standards
* Calibration methods for standard resistors
* Calibration methods for current shunts

**Calibration of DC Resistance Meters*** Types of ohmmeters
* Calibration of ohmmeters
* Microohmmeters, megaohmmeters

**Calibration of High Value Resistors and Resistance Meters*** High value resistance measurements
* High value resistors
* High resistance meters
* Calibration of high value resistance and meters

**Uncertainty Calculations and Reporting the Measurement Results*** Introduction to uncertainty analysis in DC resistance measurements
* Uncertainty Analysis and Model Functions
* Examples and reporting the measurement results
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