**Technical Capacity Building Program**

**at**

 **SASO NMCC**

**CONTENTS**

 Training List at SASO NMCC 3

 General Quality Training Courses 4

1. Training Program of Mass Metrology 5

2. Training Program of Force Metrology 5

3. Training Program of Hardness Metrology 6

4. Training Program of Dimensional Metrology 6

5. Training Program of Thermometry Metrology 7

6. Training Program of Voltage Metrology 8

7. Training Program of Time and frequency Metrology 8

8. Training Program of Reference material Metrology 8

Training List at NMCC/SASO

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Code Name**  | **Subject** | **Description of Training** | **Duration** | **Date** |
| 1-NMCC- Mass | MassMetrology | Quality | 3 weeks (15 Days) | JUNE 2020 |
| Mass Metrology |
| 2-NMCC-Force | ForceMetrology | Quality | 3 weeks (15 Days) |  JUNE 2020 |
| Pressure Metrology |
| 3-NMCC-Hardness | HardnessMetrology | Quality |  3 weeks (15 Days) |   JUNE 2020 |
| Hardness Metrology |
| 4-NMCC-Dimensionmal | DimensionalMetrology | Quality | 3 weeks (15 Days) |   JUNE 2020 |
| DimensionalMetrology |
| 5-NMCC-Thermometry | Thermometry Metrology | Quality | 3 weeks (15 Days) |   JUNE 2020 |
| Thermometry Metrology |
| 6-NMCC-Voltage | VoltageMetrology | Quality | 3 weeks (15 Days) |  JUNE 2020 |
| VoltageMetrology |
| 7-NMCC- T & F | Time and Frequency Metrology | Quality |  3 weeks (15 Days) |   JUNE 2020 |
| Time and Frequency Metrology |
| 8-NMCC-RMs | Reference Materials Metrology | Quality | 3 weeks (15 Days) |  JUNE 2020 |
| Reference Materials Metrology |

 First: General Quality Training Courses

|  |  |  |
| --- | --- | --- |
| **No** |  **Course Name and outlines** | **Duration (D)** |
| 1 | **General Metrology, Fundamentals of Measurement, Calibration and Validation*** Metrology as a science of measurements. Brief history of metrology
* International 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
 | 1 |
| 2 | **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
* Common sources of uncertainty in calibrations
* 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
 | 2 |
| 3 | **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
 | 2 |
| 4 | **Introduction and Implementation of ISO 17034: 2016 Standard*** Scope of the standard
* Normative references
* Terms and definitions
* General requirements
* Structural requirements
* Resource requirements
* Technical and production requirements
* Management system requirements (Option A and Option B)
 | 2 |

Second: Specialized Technical Training Courses

|  |  |  |
| --- | --- | --- |
| **Area** | **Course outlines** | **Duration (D)** |
|  Mass | * 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
 | 10 |
|  |
| Force |   Basic concepts of force  Necessity of force Measurement  Types of force proving instruments and application  Force standard machines  calibrate of force proving instruments   Calculations the calibration of force proving instruments  Calculation of measurement uncertainty  Classification of force proving instruments  Calibration certificate  practical training | 5 |
|  |
| Hardness | * 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
* Calibration of Force Application Systems,
* Calibration of Indentation Measurement Systems,
* Calibration of Indirect Calibration by Hardness Reference
* Blocks of Hardness Testing Machines (Rockwell, Brinell, Vickers)
* Calculation of measurement uncertainty
 | 5 |
|  |
| Dimensional | **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
* 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
 | 10 |
|   |
| Thermometry | **Primary Level Contact Temperature Metrology****Calibration of Standard platinum Resistance Thermometers**  Theoretical background for temperature measurements. International Temperature Scale (ITS-90)  and terms and definitions related to temperature  Basic elements of Primary Level Temperature Calibration (Fixed Points, SPRTS, Bridges)  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 and  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**  Definitions and equations related with Radiation thermometry in ITS-90 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  Laboratory Practice : Dew-point meter calibration in the Two-pressure humidity generator   Uncertainty Evaluation | 10 |
|  |
| Voltage | **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

**High Precision (8.5 Digit) Multimeter Calibration*** Calibration of the multimeter by Reference Calibrator

Uncertainty calculations | 10 |
|  |
| Time and Frequency | * Calibration of function generator
* Calibration of universal frequency counter
* Calibration of Tacometer
* Calibration of Stopwatch
* Uncertainty calculation
 | 10 |
|  |
| Reference Materials | * Weighing of gas cylinder by automatic balance
* Calibration of GC-TCD by standard gas concentrations
* Measurement of HCl concentration by Coulometry
* Measurement of Buffer pH by primary Harned Cell
* Extraction of catchup from tomato paste
* Preparation of calibration solution of Na benzoate CRM
* Calibration of HPLC-UV using Na benzoate CRM
* Calculation of the expanded uncertainty of measurement
* Calibration of Spectrophotometer using Na benzoate CRM
* Calculation of uncertainty of measurement
 | 8 |