



AIMS for Metrology and Calibration Training Courses

To whom it may Concern

These Courses have been designed for;

- ❖ Trainee engineers and Technicians.
- ❖ On the Job Apprentices.
- ❖ Inspection engineers and technicians.
- ❖ Testing Engineers and technicians.
- ❖ Calibration engineers and Technicians.
- ❖ Maintenance engineers and technicians.
- ❖ Plant operators and QC Inspectors.
- ❖ Planning Engineers and decision makers.
- ❖ Equipment Inventory in-charges.
- ❖ Equipment Sales and Purchase engineers.
- ❖ Precision Measurement equipment dealers.

Training Benefits

Adding Values to Your Systems/Organization through;

- ❖ Compliance with HR training requirements.
- ❖ Compliance with training clauses of ISO standards.
- ❖ Best Choice and competitive purchase of Test Equipment.
- ❖ Enhanced confidence on measurements standards/systems.
- ❖ Fine tuning of operations/system through accurate measurements.
- ❖ Reduction in operational mistakes with expensive consequences.
- ❖ Better measurement and monitoring of OHSE activities.
- ❖ More reliable QC inspection/testing for raw material and finished goods.
- ❖ Waste reduction through improved measurement best practice.
- ❖ Decrease in re-work time / plant maintenance through improved accuracy and throughput.

Training Objectives

Appreciation of the concepts related to;

- ❖ World Metrology Structure.
- ❖ Unit of measurement and Traceability.
- ❖ Specifications and calibration results of Measurement Standards.
- ❖ Measurement principle, method and procedures.
- ❖ Accurate realization of measurement result from measuring instruments.
- ❖ Applicable environmental and other conditions.
- ❖ Calibration methods and techniques.
- ❖ Budgeting of measurement errors, i.e, Uncertainty.
- ❖ Reporting & understanding of measurement results.
- ❖ Best measurement practices.

About Trainer;

AIMS pool of freelance trainer consists of two instructors. Each having;

- ❖ Attended number of metrology related trainings in Pakistan and Abroad.
- ❖ + 20 years of national / international experience in the metrology field.
- ❖ Provided training to various organization in the Middle East and Pakistan.
- ❖ Worked as Technical Assessor with PNAC, ENAC and GAC.
- ❖ Headed number of accredited 17025 labs in the Middle East and Pakistan.

Detailed CV of the Instructor could be provided to the interested parties.

Brief Introduction of Training Courses Contents

MTC 01; Why Calibrate a Measuring Instrument

Duration 01 Day

This short training course have been designed to provide general awareness about importance of measurement and Calibration.

- ❖ Measurement in everyday life.
- ❖ Measurement system hierarchy.
- ❖ Measurement Traceability.
- ❖ Brief history of measurement.
- ❖ Concept of Calibration.
- ❖ Accuracy ratio and Test Uncertainty ratio.
- ❖ Calibration and Legal Metrology.
- ❖ Calibration and Industrial Metrology.
- ❖ Why go for accredited calibration?
- ❖ How to define Acceptance criteria?
- ❖ How to define re-calibration interval?
- ❖ How to select a calibration laboratory?
- ❖ How to read a calibration certificate?
- ❖ How to use calibration certificate information.
- ❖ How to use and maintain measurement standard?
- ❖ Management of an In-house Calibration system.

MTC 02; An Introduction to Metrology

Duration 01 Day

This advanced level training course will impart appreciation of concepts related to industrial, legal and scientific metrology to people involved in calibration.

- ❖ Definition of Metrology.
- ❖ Measurement in the global marketplace.
- ❖ Development and Concerns of Metrology.
- ❖ Need for better measurements.
- ❖ History of measurement.
- ❖ System of Units.
- ❖ Base Units of SI system.
- ❖ Derived Units of SI system.
- ❖ Elements of a Measurement System.
- ❖ Branches of Metrology.
- ❖ Fields of Metrology.
- ❖ Standards and Standardization
- ❖ Vocabulary of Measurement Terms.
- ❖ Managing the Metrology System.
- ❖ Making Good measurements:
- ❖ Concepts of Calibration.
- ❖ Justification for Calibration.
- ❖ Interpretation of Calibration results.
- ❖ Accredited Calibrations.
- ❖ Ensuring the validity of calibrations.

MTC 03; Precision Pressure and Vacuum Measurement

Duration 02 Day

This course has been designed to impart knowledge about pressure measurement principle, measuring instruments, calibration standards and avoidance of associated errors.

- ❖ Pressure definition and formulae.
- ❖ Scope of pressure measurement.
- ❖ Principles of Pressure Measurement and Calibration.
- ❖ Absolute, Gauge and Differential Pressure.
- ❖ Pressure Units, terminology, traceability and standards.
- ❖ Types of Pressure instruments and standards.
- ❖ Primary Pressure Standards (Dead Weight Piston Gauges).
- ❖ Secondary Pressure Standards.
- ❖ Field Pressure Instruments.
- ❖ Vacuum Measurement Standards.
- ❖ Factors affecting the accuracy of DWT piston Gauges and Significant sources of error.
- ❖ Errors associated with portable calibrators.
- ❖ Uncertainty in pressure calibration.
- ❖ Accuracy of pressure measuring instruments and standards.
- ❖ Pressure calibration – good practice and principles.

MTC 04; Temperature Metrology Concepts and Calibration

Duration 02 Day

This course has been designed to improve appreciation of temperature measuring principles and instrument. The emphasis is on avoidance of common errors.

- ❖ Temperature measurement an Introduction.
- ❖ Scope of Temperature Measurement.
- ❖ Physical Laws governing heat and temperature phenomena.
- ❖ Temperature scales definition and inter-conversion.
- ❖ ITS 90 Temperature scale.
- ❖ Appreciation of conduction, convection and radiation.
- ❖ Contact and non-contact thermometer.
- ❖ Principles of temperature measurement.
- ❖ Mapping of environmental chambers and cold stores.
- ❖ Reference and comparison calibration of temperature standards.
- ❖ Characterization and tolerance testing of temperature sensors.
- ❖ Types of temperature sensors / instruments.
- ❖ Errors associated with temperature sensors.
- ❖ Temperature Indicators and transmitters.
- ❖ Temperature Mediums and associated errors.
- ❖ Budgeting of temperature measurement errors.
- ❖ Best measurement practices in Temperature.

MTC 05; Humidity Measurement Concepts & Calibration

Duration 02 Day

The course provides the knowledge and expertise for professionals who use humidity measuring devices or require an appreciation of the importance of measurement, calibration and the use of humidity instruments and standards in the performance of their daily tasks.

- ❖ Introduction to humidity.
- ❖ Scope of humidity measurement.
- ❖ Hygrometric definitions, units, terminology, traceability.
- ❖ Physical Laws governing humidity measurements.
- ❖ Principles of humidity measurement.
- ❖ Types of humidity sensors.
- ❖ Types of hygrometers used in industry.
- ❖ Mapping of environmental chambers and cold stores.
- ❖ Humidity calibration reference standards.
- ❖ Salt standard solutions.
- ❖ Climactic chambers.
- ❖ Two pressure and two temperature chambers.
- ❖ Error associated with humidity calibration.
- ❖ Budgeting of humidity errors.
- ❖ Best measurement practices in humidity.
- ❖ Practical advice on applications.

MTC 06; Precision Mass Metrology & Weighing Scale Calibration

Duration 02 Day

The course is designed to provide participants with an understanding of weighing machines and mass standards and covers topics such as mass classification, mass standards, calibration procedures and environmental influences.

- ❖ Introduction to Mass Metrology.
- ❖ Scope of mass measurement.
- ❖ Standardization in Mass Metrology.
- ❖ Future of Kilogram.
- ❖ Traceability in Mass Metrology.
- ❖ Technical requirement for precision mass standards.
- ❖ Care and use of mass standards.
- ❖ Principle and types of weighing scales.
- ❖ Double pan and single pan weighing scales.
- ❖ Electronic weighing scales.
- ❖ Precision mass comparators.
- ❖ Weighing with an electronic balance.
- ❖ Work room, work bench and other pre-requisites.
- ❖ Terms used to describe balance operation.
- ❖ Quantization of errors associated with balance operation.
- ❖ Budgeting the error for balance calibration.
- ❖ Budgeting the error for mass calibration.

MTC 07; Force Metrology and Calibration of Load Cells

Duration 02 Day

This course had been designed to refresh the concepts of force metrology with particular emphasis on measurement principles, techniques and transducers and avoidance of associated errors.

- ❖ Introduction and Scope of Force Measurement.
- ❖ Newton law of Force and Motion.
- ❖ Forces at work in Nature.
- ❖ Manifestation of Force as stress, pressure, weight, torque and work.
- ❖ Realization of Force Unit.
- ❖ Stress vs. strain and modulus of elasticity.
- ❖ Force measuring principles and force transducers.
- ❖ Ring dynamometers and Proving Rings.
- ❖ Hydraulic and Pneumatic Load Cells.
- ❖ Electromechanical Load Cells.
- ❖ Strain Gauge Electronic Load Cells.
- ❖ Choosing a Force Measuring System.
- ❖ Load Cells as Secondary Force measurement standards.
- ❖ Load Cell Measuring Circuits and Indicators.
- ❖ Traceability in Force Measurement.
- ❖ Universal Force Calibration Machines.
- ❖ Compressive and Tensile testing machines.
- ❖ Force measurement terminologies.
- ❖ Budgeting of errors in Force Metrology.
- ❖ Best practices in Force Metrology.

MTC 08 Torque Measurement and Calibration

Duration 02 Day

This course has been designed for appreciation of torque concepts with particular emphasis on torque tools calibration and maintenance.

- ❖ Introduction and concepts of torque measurement.
- ❖ Static and dynamic torque measurement and torque units.
- ❖ Scope of torque measurement.
- ❖ Type of hand torque tools.
- ❖ Type I and II torque tools.
- ❖ Type III and IV torque tools.
- ❖ Torque wrench extensions and multipliers.
- ❖ Power torque tools.
- ❖ Calibration of Static torque tools.
- ❖ Torque tools calibrators.
- ❖ Torsion bar strain gauge torque transducers.
- ❖ Torque Calibration techniques.
- ❖ Torque Calibration Procedures.
- ❖ Torque Application tips.
- ❖ Torque terms and definitions.
- ❖ Calibration of torque calibrators and primary standard torque.
- ❖ Sources of error in torque tools calibration.
- ❖ Budgeting of errors in torque calibration.

MTC 09; Precision Measurement of Volume in Analytical Labs

Duration 02 Day

The course have been designed for improving the volumetric measuring techniques available to chemical and biological lab technician and making them proficient for in-house calibration of pipettes and glassware.

- ❖ Definition and scope of volumetric measurement in analytical labs.
- ❖ Volumetric standards and traceability of measurement.
- ❖ Volumetric glassware material and classification.
- ❖ Volumetric Flask, pipette and burette.
- ❖ Single volume and graduated glassware and associated errors.
- ❖ Operating temperatures and other systematic errors.
- ❖ Tips for correct use of volumetric glassware.
- ❖ Glass ware calibration through proving method.
- ❖ Gravimetric calibration method and equations.
- ❖ Factors affecting gravimetric calibration.
- ❖ Quantization of measurement errors.
- ❖ Budgeting of major error sources.
- ❖ Verification of POVA and calculation of random and systematic errors.
- ❖ Best measurement practices for volumetric glass wares.

MTC 10; Pipetting Techniques for Precise Volume measurement

Duration 02 Day

This course is designed for analyst working in analytical labs and geotechnical / chemical lab technicians to learn correct pipetting techniques.

- ❖ Pipettes as small volume dispenser.
- ❖ How the pipettes work?
- ❖ Positive displacement and air displacement.
- ❖ Why seal integrity is important?
- ❖ Hydrostatic Pressure and spring mechanism.
- ❖ Mechanics of piston cylinder.
- ❖ Pipette design and type.
- ❖ Serological pipettes.
- ❖ Proper pipette ergonomics.
- ❖ Periodic cleaning and maintenance.
- ❖ Pipetting techniques.
- ❖ Forward and reverse pipetting.
- ❖ Pipettes calibration and traceability.
- ❖ Pipettes acceptance criteria and verification interval.
- ❖ Errors in pipette calibration.
- ❖ Budgeting of errors and UOM.
- ❖ Best Measurement practices.

MTC 11; Level Measurement Techniques for Process Industry

Duration 02 Days

This course have been designed as refresher for process designer, maintenance engineers and calibration technicians with available level measurement techniques and comparative advantage of each technique.

- ❖ Introduction to level measurement.
- ❖ General Scope of level measurement.
- ❖ Primary principles of level measurement.
- ❖ Level measurement techniques and available devices & Selection of best measurement method.
- ❖ Point and continuous level measurement.
- ❖ Mechanical methods, float and board and displacer gauges.
- ❖ Hydrostatic level measurement.
- ❖ Ultrasonic and microwave level transmitters.
- ❖ Conductance and capacitance level gauging.
- ❖ Gamma rays, laser and magneto restrictive level sensors.
- ❖ Gravimetric level gauging by employing load cells.
- ❖ Comparison of level measurement techniques.
- ❖ Specialty level switches.
- ❖ Calibration of level measuring instruments.
- ❖ Best measurement practices level measurements.

MTC 12; Fluid Flow and Calibration of Flow meters

Duration 02 Days

This course have been designed for appreciation of fluid flow measurement techniques, instrumentation and errors involved in metering and custody transfer.

- ❖ Introduction to fluid flow measurement.
- ❖ Units of flow measurement.
- ❖ Orientation to flow measurement principles.
- ❖ Factors affecting the flow variable.
- ❖ Volume and weight flow conversions.
- ❖ Standard and actual flow measurements.
- ❖ Flow meters “K” factors and other flow constants.
- ❖ Classification of Quantity and Rate Meters.
- ❖ DP flow meter like orifice, venture, nozzle and pitot tube.
- ❖ Mechanical flow meters i.e, positive displacement, turbine and propeller etc.
- ❖ Electronic flow meter i.e, Magnetic, Vortex and Ultrasonic flow meters
- ❖ Mass flow meter i.e, Coriolis, thermal mass flow meters.
- ❖ Effects of flow conditions and Flow stream temperatures.
- ❖ Flow profiles and straitening devices.
- ❖ Flow meter selection and sizing.
- ❖ Flow Calibrator for Liquid Flow.
- ❖ Flow Calibrator for Gas Flow.

MTC 13; Dimensional Metrology and Tools Calibration

Duration 02 Days

This course provides the knowledge and expertise for people who use measurement tools or require an appreciation of the importance of measurement, calibration and the use of measurement techniques in their daily tasks.

- ❖ Introduction to dimensional metrology.
- ❖ Scope of dimensional measurements.
- ❖ Brief history of dimensional measurement.
- ❖ Dimensional metrology and SI system of units.
- ❖ Definition and realization of Meter.
- ❖ Dimensional metrology measurement principles.
- ❖ Line standards and end standards.
- ❖ Sub-fields in dimensional metrology.
- ❖ Traceability in dimensional metrology.
- ❖ Gauge Blocks classification and uses.
- ❖ Non-precision and precision dimensional tools.
- ❖ Linear measurement tools and their correct usage.
- ❖ Precision angular measurement.
- ❖ Roundness measurement tools and handling of test item.
- ❖ Straightness, squareness and parallelism measurement.
- ❖ Automated Gauging machines.
- ❖ Mechanical, pneumatic and optical gauging comparators.
- ❖ Factors affecting linear measurement.
- ❖ Quantization and budgeting of dimensional measurement errors.
- ❖ Measurement good practices in linear measurement.

TM 14; Precision Electrical Measurement

Duration 02 Days

The training course is intended for appreciation of theory and techniques required for calibration of electrical measuring instruments (DC and low frequency). The emphasis is on the practical aspects of electrical calibration.

- ❖ Introduction to AC/DC low frequency metrology.
- ❖ Scope of electrical measurements.
- ❖ Physical laws forming the basis of measurement instruments.
- ❖ Electrical terms and definitions.
- ❖ Measurement methods commonly employed.
- ❖ Electrical unit of measure, realization and traceability.
- ❖ Electrical safety while using electrical measuring instruments.
- ❖ Reference Electrical Calibration standards.
- ❖ Calibration of analogue and digital multimeters.
- ❖ Calibration of process indicators and simulators.
- ❖ Calibration of Insulation and earth resistance meters.
- ❖ Calibration of LCR meters.
- ❖ Common errors in electrical measurement.
- ❖ Quantization and budgeting of measurement errors.
- ❖ Measurement best practices.

MTC 15; Time Frequency and RPM Measurement

Duration 02 Days

The course has been developed to provide appreciation of techniques required for calibration of time, frequency and rpm measuring instruments.

- ❖ Introduction and scope of time, frequency and rpm measurement.
- ❖ Some basic relevant terms and definitions.
- ❖ Realization of SI base unit of time.
- ❖ Primary standard for time and frequency.
- ❖ Frequency and time period.
- ❖ RPM measuring tools.
- ❖ Methodology used in frequency calibration.
- ❖ Direct comparison method for stop watches.
- ❖ Totalization method of calibration.
- ❖ Type I and type II stopwatches.
- ❖ Calibration of frequency measurement instruments.
- ❖ Errors in frequency calibration.
- ❖ Phase deviation and frequency off-set.
- ❖ Temperature stability comparison of various frequency generators.
- ❖ Model equation of measurements.
- ❖ Quantization and budgeting of calibration errors.
- ❖ Measurement best practices.

TM 16; Calibration of Power and Energy Meters

Duration 02 Days

This course have been designed to provide appreciation of working principles of these meters, power / energy calibrators and techniques for good measurement.

- ❖ Introduction to power and energy measurement.
- ❖ Scope of power and energy measurement.
- ❖ Underlying principles of measurement.
- ❖ Terms and definition in power measurement.
- ❖ Power factor active and reactive power.
- ❖ Improving the power factor through capacitive banks.
- ❖ Single phase and three phase power.
- ❖ Power meter calibrators.
- ❖ Safety precautions for power measurement.
- ❖ Characteristics of power cables, connectors and terminations.
- ❖ Power sensor and watt meters.
- ❖ Cal Factor for power sensors.
- ❖ Power sensors, theory and operation.
- ❖ Power measurement typical instrument hook up.
- ❖ Energy meter calibrator and hook up.
- ❖ Common measurement error and budgeting.
- ❖ Measurement best practices.

MTC 17; Acoustic Noise and Vibration Metrology

Duration 02 Days

This course has been designed to impart knowledge about basic of sound and vibration measurement and calibration techniques employed for calibration noise and vibration survey meters.

- ❖ Sound as form of energy & Units of measurement.
- ❖ Relationship between sound level and pressure.
- ❖ Basic types of sound field microphones.
- ❖ Procedure employed for sound level meter calibration.
- ❖ Addition and subtraction of sound levels.
- ❖ Introduction to vibration and its sources.
- ❖ Scope of vibration measurement in OHS.
- ❖ Vibration analysis (diagnostic tool) for rotating machinery.
- ❖ Vibration parameters i.e, displacement, velocity and acceleration.
- ❖ Selection and measurement of most suitable parameter.
- ❖ Working principle for velocity pickups and accelerometers.
- ❖ Electric charge and voltage inter conversion for a piezo resistive sensor.
- ❖ Components of a calibration system and techniques.
- ❖ Calibration frequency response.
- ❖ Vibration pick up mounting techniques.
- ❖ Inter-connecting cables and connectors characteristics.
- ❖ Mass, Loading, Ground Isolation, Ground Noise and Ground Loops,
- ❖ Calibration result and calibration certificates.

TM 18; Measurement Uncertainty Calculation (Basic)

Duration 01 Day

This basic level course have been designed to impart knowledge about measurement system errors and uncertainties with emphasis upon development of simple UOM budgets.

- ❖ Definition of measurement uncertainty.
- ❖ Accuracy and precision.
- ❖ Best estimate of a measurement result.
- ❖ Standard deviation and spread of results.
- ❖ Calculating the spread of a measurement result.
- ❖ Sources of measurement errors and uncertainties.
- ❖ Classification of measurement system errors.
- ❖ Probability distribution or shape of measurement error.
- ❖ Steps for evaluation of UOM components.
- ❖ Combining the individual uncertainties.
- ❖ Application of coverage factor to enhance the level of confidence.
- ❖ Preparing a sample UOM budget.
- ❖ Reporting the result of measurement.
- ❖ Use of reported results to check compliance with specifications.
- ❖ Reducing measurement uncertainties.
- ❖ Good measurement practices.
- ❖ What is not included in the basic course?

MTC 19; Advanced Calculation of UOM (Gum Approach)

Duration 02 Days

This training course is intended for professionals who perform or manage critical measurement/calibration tasks and who need to evaluate the measurement uncertainties associated with their measurement results.

- ❖ Defining the measurement model with output and input estimates & developing the General Error Model.
- ❖ Overview of error model for Different Calibration Scenarios.
- ❖ Calculate calibration correction from significant (systematic) errors sources.
- ❖ Calibration uncertainty is square root of variance of calibration correction.
- ❖ Variance addition rules for different mathematical operations.
- ❖ Type A and type B approach for UOM Calculation.
- ❖ Standard deviation and type A measurement uncertainty.
- ❖ Probability distribution, containment limits and degree of freedom for type B.
- ❖ Sensitivity coefficient for each input estimate.
- ❖ Contribution from component uncertainties.
- ❖ Correlation coefficient between the input estimates
- ❖ Combining the correlated and uncorrelated input uncertainties.
- ❖ Effective degree of freedom for combined uncertainty.
- ❖ Expansion coefficient from Student t distribution table for 95% Confidence level.
- ❖ Calculating the expanded uncertainty at required confidence level.
- ❖ Reporting requirement for measurement result and associated UOM.

MTC 20; UOM for analytical measurements (CITAC CG 4 Approach)

Duration 02 Days

This approach is employed in testing laboratories for calculation of uncertainty using the data available from method validation studies, quality assurance data (PT, ILC) or in house repeatability and reproducibility data.

- ❖ Scope and Field of Application.
- ❖ Analytical Measurements and Uncertainty.
- ❖ Customer requirement of UOM and method.
- ❖ Concept of Traceability in Analytical Measurements.
- ❖ Specification of the Measured.
- ❖ Method validation equations and Experimental studies.
- ❖ Identification of Errors sources, Fish bone diagram & quantification of input uncertainties.
- ❖ Relevance of prior studies.
- ❖ Certified Reference materials.
- ❖ Using prior collaborative method development and validation data.
- ❖ Estimation of individual uncertainty components.
- ❖ Estimation based on other results or data.
- ❖ Modelling from theoretical principles.
- ❖ Estimation based on judgment.
- ❖ Significance of bias.
- ❖ Standard and Combined uncertainties.
- ❖ Expanded Uncertainties and Reporting of Results.
- ❖ Compliance against limits.

AIMS offers the possibility of taking a tailored course containing short training modules on specific topics, at a foundation and intermediate level.

- ❖ Such modules are ideal as refresher courses, for those already working in the field who wish to extend their knowledge to other measurement areas, or those requiring training on a specific measurement topic.
- ❖ Intending participants may tailor the course to their requirements by indicating the training modules of interest to them.
- ❖ AIMS will then arrange the course for a suitable date, normally within one month of the request. Training can be provided at the AIMS or in-company.
- ❖ In the latter case, the practically based modules will require access to the company's own laboratories facilities.
- ❖ Participants will receive a documentation pack for each training module.
- ❖ The courses are normally restricted to six persons or less.
- ❖ It is intended to add further modules in the near future.

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