Fundamentals of Metrology – Detailed Learning Objectives

Course: Fundamentals of Metrology (20180101)

Requirements for Successful Completion

- 100 % attendance
- Participate in group and session activities and demonstrations
- Complete Two Cards: Concepts & Applications
- Complete homework (track time)
- Demonstrate learning objectives for each module (70 %)
- Complete Data Sheets, Spreadsheet, and Calibration Certificate (70 % passing)
- Final examination (70 % passing)
- NOTE: "Exam Topics at a Glance" are provided in the notebook.

Module	Learning Objectives After covering concepts, using your notes and resources, you will be able to:	Objective Evidence (Common problem areas noted)
Overall Course	• IDENTIFY and use reference materials to ensure good quality, accurate, traceable measurement results • EXPLAIN highlights and key concepts of each topic to each other and to your managers and show how these topics fit into a management system like ISO/IEC 17025 • IMPLEMENT several simple tools, job aids, and references to use and improve your laboratory operations	
Data Integrity	• DESCRIBE several characteristics of data quality • EXPLAIN the importance of data integrity to you and for your laboratory • APPLY concepts to this seminar – in the classroom and in the laboratory	Review of data sheets for measurement case study
Who's Who in the World of Metrology	• IDENTIFY acronyms of National Metrology Institutes and Accreditation Bodies	

Module	Learning Objectives After covering concepts, using your notes and resources, you will be able to:	Objective Evidence (Common problem areas noted)

	• DESCRIBE who/what/why of the Arrangements of the:
	    o International Committee on Weights and Measures (CIPM)
	    o International Laboratory Accreditation Cooperation (ILAC)
	• DESCRIBE roles of international and national participants
	• EXPLAIN impact of these arrangements on your laboratory (Why is it important to you?)	

Traceability and Risk	• DEFINE Metrological Traceability, Calibration, Measurand, Measurement Standard, Calibration, and Measurement Capability (CMC) • DESCRIBE why traceability matters • LIST seven essential elements of metrological traceability • EXPLAIN seven essential elements and associated risks • APPLY concept of traceability hierarchies, essential elements, and risk/gap analysis to measurement activity	
Measurement Case Study	• RESEARCH information about new measurement parameters for your laboratory Scope • COMPLETE data/observation sheets using CARE with data integrity • USE laboratory instruments and standards carefully and properly to measure • APPLY concept of traceability hierarchies and essential elements • APPLY method validation concepts • APPLY statistical analysis tools, calculate, and present statistics	Complete and Compliant Data Sheets Completed Excel File Complete and Compliant Calibration Certificate

Module	Learning Objectives After covering concepts, using your notes and resources, you will be able to:	Objective Evidence (Common problem areas noted)
	• APPLY measurement assurance using DMAIC method with check standards • PARTICIPATE in and ANALYZE a proficiency test • APPLY uncertainty analysis • CREATE calibration certificates	
Statistics	• DEFINE "what is statistics?" • IDENTIFY, DEFINE, and EXPLAIN • Normal distribution, accuracy, precision, coverage factors, confidence levels • CALCULATE mean, standard deviation, F-test, t-test • DESCRIBE, ANALYZE, INTERPRET, and EXPLAIN statistics/tests and their applications for example scenarios and for laboratory measurements	Statistics "Review" (Quiz) Team Homework Scenario Presentations Application of statistics to measurement assurance, measurement uncertainties, and proficiency tests
Traceability Activities	• RESTATE the essential elements of metrological traceability • DIAGRAM a simple traceability hierarchy • EVALUATE example certificate traceability statements • PREPARE a traceability statement for a calibration certificate	Traceability statements on calibration certificates
Calibration Certificates	• IDENTIFY compliance with required components of a calibration certificate • IDENTIFY gaps/non-conformities on calibration certificates • APPLY knowledge of the checklists and review of the certificates to • EVALUATE certificates from your peers during this	Complete and Compliant Calibration Certificate

Module	Learning Objectives After covering concepts, using your notes and resources, you will be able to:	Objective Evidence (Common problem areas noted)
	seminar • CREATE and UPDATE your compliant calibration certificate that will be turned in	

Measurement Assurance	• DESCRIBE Measurement Assurance and give some examples of problems when it is absent from a laboratory and procedures
	• REFERENCE applicable sections of ISO/IEC 17025 that relate to measurement assurance
	• IDENTIFY and MATCH activities with different approaches to measurement assurance
	• IDENTIFY control charts and components
	    ○ Variables
	    ○ Standard deviation
	    ○ Title, Axis, Statistical Control Limits
	• RECOGNIZE control charts that are out of control, SHARE ideas about causes and potential actions
	• DESCRIBE check/control standards and some key points about their use
	• APPLY measurement assurance concepts and practices to the measurement case study
		Measurement results in control charts for case study

Uncertainties (Parts I and II)	• DEFINE and DESCRIBE "uncertainty" • DEFINE standard uncertainty, combined uncertainty, expanded uncertainty and k values • IDENTIFY two methods for determining uncertainty components • IMPLEMENT uncertainty analysis and reporting methods consistent with the Guide to the Expression of	Uncertainty calculations for calibration certificate Uncertainty statement on calibration certificate

Module	Learning Objectives After covering concepts, using your notes and resources, you will be able to:	Objective Evidence (Common problem areas noted)
	Uncertainty in Measurement (GUM) and the 8-step process of SOP 29. This means, to correctly: 1. SPECIFY the measurand and measurement equation 2. IDENTIFY uncertainty components 3. QUANTIFY each component in appropriate units 4. CONVERT to standard uncertainties 5. COMBINE using appropriate equation (often Root Sum Square) 6. EXPAND using appropriate coverage factor 7. EVALUATE the result for accuracy, suitability, compliance, fit for purpose 8. REPORT the result, rounded to two significant digits, with an explanatory Statement that includes the components and how determined, coverage factor, degrees of freedom, and confidence interval	
Interlaboratory Comparisons, Proficiency Tests	• DESCRIBE purposes of an Interlaboratory Comparison • DEFINE an Interlaboratory Comparison and Proficiency Test • DESCRIBE where, when, and why PTs are performed • CALCULATE Normalized Error and Precision Test results • ASSESS the PT data from the measurement case study using the Normalized Error and Normalized Precision calculation results	Calculations of results for the measurement case study
Software Verification and Validation	• DESCRIBE the impact of software errors • IDENTIFY which criteria in ISO/IEC 17025 address	

Module	Learning Objectives After covering concepts, using your notes and resources, you will be able to:	Objective Evidence (Common problem areas noted)
	requirements for computer systems • IDENTIFY examples of software errors and non-conformities • DESCRIBE verification and validation techniques	
Mid-week Quiz		
Final Exam		
Calibration Certificate		