



## COURSE OUTLINE: MCH607 - METROLOGY & QUAL CON

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<b>Course Code: Title</b>	MCH607: METROLOGY AND QUALITY CONTROL
<b>Program Number: Name</b>	4043: MECH ENG. TECHNOLOGY
<b>Department:</b>	MECHANICAL TECHNIQUES PS
<b>Academic Year:</b>	2022-2023
<b>Course Description:</b>	This course is dedicated to quality systems and learning the theory behind basic metrology and measurements. Students gain a theoretical understanding of calibration techniques and learn calibration standards, statistical process control, and methods of measurement using different measuring devices.
<b>Total Credits:</b>	3
<b>Hours/Week:</b>	3
<b>Total Hours:</b>	42
<b>Prerequisites:</b>	MCH121, MTH551
<b>Corequisites:</b>	There are no co-requisites for this course.
<b>Substitutes:</b>	DRF220, MCH241
<b>Vocational Learning Outcomes (VLO's) addressed in this course:</b>	<p><b>4043 - MECH ENG. TECHNOLOGY</b></p> <p>VLO 1 Monitor compliance with current legislation, standards, regulations and guidelines.</p> <p>VLO 2 Plan, co-ordinate, implement and evaluate quality control and quality assurance procedures to meet organizational standards and requirements.</p> <p>VLO 3 Monitor and encourage compliance with current health and safety legislation, as well as organizational practices and procedures.</p> <p>VLO 4 Develop and apply sustainability best practices in workplaces.</p> <p>VLO 6 Analyze and solve complex mechanical problems by applying mathematics and fundamentals of mechanical engineering.</p> <p>VLO 10 Establish and verify the specifications of materials, processes and operations for the design and production of mechanical components.</p>
<b>Essential Employability Skills (EES) addressed in this course:</b>	<p>EES 1 Communicate clearly, concisely and correctly in the written, spoken, and visual form that fulfills the purpose and meets the needs of the audience.</p> <p>EES 2 Respond to written, spoken, or visual messages in a manner that ensures effective communication.</p> <p>EES 3 Execute mathematical operations accurately.</p> <p>EES 4 Apply a systematic approach to solve problems.</p> <p>EES 5 Use a variety of thinking skills to anticipate and solve problems.</p> <p>EES 6 Locate, select, organize, and document information using appropriate technology and information systems.</p>



- EES 7 Analyze, evaluate, and apply relevant information from a variety of sources.
- EES 8 Show respect for the diverse opinions, values, belief systems, and contributions of others.
- EES 10 Manage the use of time and other resources to complete projects.
- EES 11 Take responsibility for ones own actions, decisions, and consequences.

**Course Evaluation:**

Passing Grade: 50%,

A minimum program GPA of 2.0 or higher where program specific standards exist is required for graduation.

**Books and Required Resources:**

The Metrology Handbook by J. Bucher  
 Publisher: Milwaukee, Wis: ASQ Quality Press. Edition: 2012  
 ISBN: 978-0-87389-838-6

**Course Outcomes and Learning Objectives:**

<b>Course Outcome 1</b>	<b>Learning Objectives for Course Outcome 1</b>
1. Understand the components of a quality system and its role in an organization.	1.1 Define what a quality system is, why it is utilized and describe the evolution of quality standards and metrology. 1.2 Identify, provide the uses, and give an example for the application of various quality tools: such as check-sheets, Pareto charts, flowcharts, cause and effect diagrams, histograms, scatter diagrams and control charts. 1.3 Identify and explain several process improvement techniques. 1.4 Define a quality standard, describe why it is important, and identify reasons why voluntary quality standards are imposed. 1.5 Explain and describe what ISO is, the role that ISO plays, the ISO 9000 series of standards, and its importance. 1.6 Define what a quality manual is and why it is important. 1.7 Explain the term Quality documentation, the role that it plays within the quality system, and the purpose of having written instructions such as SOP's, calibration procedures, protocols, work instructions etc. 1.8 Define audit, explain why they are essential for a quality system, and explain different types of audits. 1.9 Explain the importance of environmental controls as part of a laboratory environment, and key points of maintaining environmental control in a laboratory setting. 1.10 Explain the importance of training as part of the quality system.
<b>Course Outcome 2</b>	<b>Learning Objectives for Course Outcome 2</b>
2. Understand calibration and its importance to an organization's quality system.	2.1 Identify and explain 4 requirements for the calibration of measurement equipment. 2.2 Identify and explain 7 areas that calibration procedures must contain. 2.3 Interpret, develop and utilize a calibration procedure for a measuring device. 2.4 Explain and communicate the importance of maintaining calibration records and identify 10 requirements of a calibration



	<p>record.</p> <p>2.5 Define Calibration certificates and the role that they play in the quality system. Be able to identify a calibration certificate.</p> <p>2.6 Define traceability, identify the six essential elements that traceability is characterized by, and illustrate a traceability pyramid. Understand reverse traceability.</p> <p>2.7 Identify influences that determine calibration intervals and explain three different types of calibration laboratory policies regarding calibration intervals.</p>
<b>Course Outcome 3</b>	<b>Learning Objectives for Course Outcome 3</b>
3. Understand and apply metrology concepts.	<p>3.1 Define Metrology and explain the importance of the basic concept.</p> <p>3.2 Identify frequently used constants and explain their uncertainty.</p> <p>3.3 Identify common measurement parameters, their units and instruments used to measure these parameters.</p> <p>3.4 Identify and define measurement parameters and the physical world factors that comprise their makeup.</p> <p>3.5 Define the terms: measurement, measurand and method of measurement, measurement system, measuring instrument, measurement signal, measuring chain, results of measurement and indication as per VIM.</p> <p>3.6 Identify and explain the seven measurement methods and provide examples of each.</p> <p>3.7 Identify and interpret the 10 stage sequence in defining measurement requirements.</p> <p>3.8 Define measuring capability.</p> <p>3.9 Explain the term bias, linear scale, repeatability, reproducibility, stability and drift as per VIM and provide causes of each.</p> <p>3.10 Utilize SPC charts, both x-bar and r-bar, to determine that a process is out of control.</p> <p>3.11 Utilize the gage R&amp;R study to determine % Equipment Variation, % Appraiser Variation, % Repeatability and Reproducibility, and % Part Variation.</p> <p>3.12 Explain the importance of 5 key measurement data considerations.</p> <p>3.13 Identify and explain the most common calibration methods and techniques.</p> <p>3.14 Define the terms tolerance and specifications and distinguish the two terms.</p> <p>3.15 Interpret and explain one way and two way specification limits.</p> <p>3.16 Calculate and explain the baseline, modifier and qualifier specifications by utilizing specification tables.</p> <p>3.17 Determine instruments suitability by comparing the uncertainty of both instruments.</p> <p>3.18 Define the terms proficiency testing and inter-laboratory comparisons.</p>
<b>Course Outcome 4</b>	<b>Learning Objectives for Course Outcome 4</b>

4. Utilize mathematics and statistics in the application of metrology.

4.1 Calculate and explain significant digits, and explain how the number of significant digits is determined through the operations of addition, subtraction, multiplication and division.  
4.2 Utilize standard notation, scientific notation and SI prefix notation.  
4.3 Explain the ISO Preferred Numbers.  
4.4 Utilize and explain five number rounding methods.  
4.5 Interpret and utilize the understanding that all SI units are based on the 7 base and 2 derived units.  
4.6 Explain why all SI units are considered coherent.  
4.7 Identify and define all SI units derived from base, derived units with specialized names and symbols and other derived units.  
4.8 Identify and define all recognized SI prefixes.  
4.9 Understand which units cannot be used in the SI system.  
4.10 Utilize conversion factors to move from customary units and SI.  
4.11 Review of logarithmic functions and their properties and how that relates to decibel measures.  
4.12 Explain the term degrees of freedom and how it impacts statistics in metrology.  
4.13 Explain what is meant by residuals.  
4.14 Understand and calculate mean, median, mode, bimodal distribution, root mean square, sum square, root sum square, variance, standard deviation, sample variance, sample standard deviation and standard error of mean.  
4.15 Interpret distributions which indicate kurtosis and skew and calculate those values based on a set of data.  
4.16 Determine Pearson's coefficient and explain how the data analyzed is related based on this constant.  
4.17 For linear systems demonstrate the use of two point slope intercept relationships and linear regression.  
4.18 Identify the various linear and non-linear interpolation methods and demonstrate the ability to utilize these methods.  
4.19 Identify and explain various types of distribution.  
4.20 Demonstrate a broad understanding of uncertainty in measurement.

**Evaluation Process and Grading System:**

Evaluation Type	Evaluation Weight
Assignments	40%
Final Exam	30%
Tests & Quizzes	30%

**Date:**

August 15, 2022

**Addendum:**

Please refer to the course outline addendum on the Learning Management System for further information.

