Identification	**Subject**	ME 450, Metrology and Quality Control, 6 ECTS
	Department	Mechanical Engineering
	Program	Undergraduate
	Term	Fall, 2024
	Instructor	Faraj Khalikov
	E-mail:	f.khalikov@wesa.az
	Phone:	
	Classroom/hours	
	Office hours	
Prerequisites	---	
Language	English	
Compulsory/Elective	Compulsory	
Required textbooks and course materials	Main textbook: 1- Gupta. I.C., "Engineering Metrology", 7th edition, Dhanpatrai Publication, 2012. 2- Jain R.K "Engineering Metrology", Khanna Publishers, 21st edition, 2005.	
Course outline	The course "Metrology and Quality Control" offers an in-depth exploration of measurement science and its role in manufacturing. It begins with foundational concepts in metrology, including the importance of SI units and measurement standards. Students will learn about various measurement systems, instruments, and the processes of calibration and error analysis.	
Course objectives	The objective of the course "Metrology and Quality Control" is to equip students with a thorough understanding of the principles and applications of measurement science in engineering and manufacturing processes. Students will learn to accurately measure and assess the quality of components using various instruments and techniques, ensuring proper calibration and error analysis. The course aims to develop proficiency in interpreting tolerances, limits, and fits, as well as applying statistical quality control methods such as control charts and process capability analysis. Students will also gain hands-on experience with advanced metrology tools, including coordinate measuring machines (CMMs) and non-contact measurement systems, and understand how to implement quality management systems in line with international standards like ISO 9000. By the end of the course, students will be able to apply metrology and quality control methods to ensure the precision, reliability, and continuous improvement of manufacturing processes.	
Learning outcomes	Upon completing the course "Metrology and Quality Control," students will be able to demonstrate a comprehensive understanding of the principles and applications of metrology in engineering and manufacturing. They will be able to select and use appropriate measuring instruments, conduct accurate measurements, and perform error analysis. Students will develop the ability to interpret and apply tolerances, limits, and fits in the design and manufacturing of components. They will also be proficient in utilizing statistical quality control techniques, such as control charts and process capability analysis, to monitor and improve manufacturing processes. Additionally, students will gain practical experience with advanced metrology tools, such as coordinate measuring machines (CMMs), and will understand the implementation of quality management systems in accordance with international standards like ISO 9000. Ultimately, students will be able to apply metrology and quality control practices to ensure product precision, reliability, and continuous improvement in industrial settings	
Teaching methods	**Lecture**	x

	Group discussion	x
	Experiential exercise	x
	Case analysis	x

Evaluation	**Methods**	**Date/deadlines**	**Percentage (%)**
	Midterm Exam		25
	Class Participation		5
	Quiz		10
	Project		20
	Final Exam		40
	Total		100

Policy

- **Ethics**
  Copy of other students' work is highly discouraged. All assignments must be handled by the student himself. This is a university policy and violators will be reprimanded accordingly.
- **Preparation for class**
  The structure of this course demands your individual effort outside the classroom for extra practice of many problems within the textbook. After each session, every student needs to put sufficient time to practice and finish the assignments by the predetermined date.
- **Withdrawal (pass/fail)**
  This course strictly follows grading policy of the School of Engineering. Thus, a student is normally expected to achieve a mark of at least 60% to pass. In case of failure, he/she will be required to repeat the course the following term or year.
- **Cheating/plagiarism**
  Cheating or other plagiarism in handling the assignments, Mid-term and Final Examinations will lead to course failure. In this case, the student will automatically get zero (0), without any considerations.
- **Professional behavior guidelines**
  The students shall behave in the way to create favorable academic and professional environment during the class hours. Unauthorized discussions and unethical behavior are strictly discouraged.
- **Attendance**
  Students who attend the whole classes will get 5 marks. for three absence student loses 1 mark.

- **Quiz**
  There will be quizzes for checking understanding of content during class. We are not going to give make-up for a missing quiz due to any reason other than medical report.

- **Project**
  Students are required to complete a project that applies key concepts and techniques learned throughout the semester. Projects should focus on real-world applications of measurement systems, calibration methods, quality standards, and statistical process control. Each student or group must propose a project topic by Week 3, with the final approval from the instructor by Week 4. Regular progress updates will be expected, and the final submission will include both a written report and an oral presentation. The project will be evaluated based on the depth of research, application of course principles, innovation, and the quality of presentation. Late submissions will incur a penalty unless prior approval is granted for extensions.

Tentative Schedule

Week	Date/Day (tentative)	Topics	Textbook/Assignments
1		**Introduction to Metrology** • Overview of Metrology and Quality Control • Importance of Measurement in Manufacturing • Measurement Standards: SI Units	Textbook-1 Chapter 1-2
2		**Measurement Errors and Uncertainty** • Types of Measurement Errors: Systematic and Random • Accuracy, Precision, and Resolution • Concepts of Uncertainty in Measurement	Textbook-1 Chapter 3
3		**Measuring Instruments: Linear Measurements** • Vernier Calipers, Micrometers, and Dial Indicators • Gauge Blocks and Slip Gauges • Calibration of Linear Measuring Instruments	Textbook-1 Chapter 4
4		**Angular and Form Measurement** • Tools for Angular Measurement: Sine Bars, Bevel Protractors • Measurement of Angles, Straightness, Flatness, and Roundness	Textbook-1 Chapter 5
5		**Surface Roughness and Texture Measurement** • Concepts of Surface Roughness and Texture • Instruments for Measuring Surface Finish • Surface Roughness Parameters	Textbook-1 Chapter 6-7
6		**Tolerances, Limits, and Fits** • Introduction to Tolerances and Fits • ISO Standards for Tolerances • Types of Fits: Clearance, Interference, and Transition Fits	Textbook-1 Chapter 8
7		**Advanced Metrology: Coordinate Measuring Machines (CMM)** • Types of CMMs and Their Applications • Operation and Programming of CMMs • Inspection of Complex Geometries	Textbook-1 Chapter 9
8		Review, **Midterm Exam**	
9		**Optical and Non-contact Measurement Techniques** • Laser-based Measurement Systems • Optical Projectors, Interferometers, and Vision Systems • Non-contact Techniques: Ultrasonic and Optical Methods	Textbook-1 Chapter 10
10		**Introduction to Statistical Quality Control (SQC)** • Basics of Quality Control • Control Charts: X-bar, R-chart, P-chart • Process Capability: Cp and Cpk	Textbook-1 Chapter 11
11		**Process Capability and Six Sigma**	Textbook-1

		• Process Improvement with Six Sigma • DMAIC Methodology • Analyzing Process Capability and Variation	Chapter 11
12		**Inspection Techniques** • In-process, Final, and Automated Inspection • Acceptance Sampling and Inspection Plans • Automated Inspection Systems: Vision Systems and Robotics	Textbook-1 Chapter 11
13		**Quality Management Systems (QMS)** • Introduction to QMS: ISO 9000 and Other Standards • Auditing and Continuous Improvement • Quality Documentation and Records	Additional reading material will be provided as a PDF
14		**Case Studies and Industrial Applications** • Real-world Case Studies in Metrology and Quality Control • Applications of Metrology in Precision Manufacturing • Failure Analysis and Its Impact on Quality	Additional reading material will be provided as a PDF
15		**Project Presentation and Review** • Student Group Project Presentations	
16		**Final Exam/ Delivery of assignments**	