

MECA380: Measurements and Instrumentation

Fall 2023

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Office hours: See Canvas for OHs
OHs also available outside OCNL 416

Sections: Discussion Section (Yolo 143):
01: Mon/Fri, 10-10:50AM
Laboratory Sections (PLMS 112):
03: Tues 2-4:50PM
04: Weds 2-4:50PM

Course Description and Goals

Measurement of steady-state and dynamic systems using standard laboratory instruments. Topics include calibration and dynamic response of instruments, statistical treatment of data, and applied feedback control systems. Concepts are reinforced with hands-on laboratory exercises.

Prerequisites

EECE 211/211L (Linear Circuits) or EECE 215 (Practical Circuits and Electronics), plus one of the following: CSCI 111 (Programming and Algorithms), MECH 208 (Introduction to Technical Computing), or AMAR 300 (Applied Mathematics and Programming for Advanced Manufacturing).

Student Learning Objectives

After completion of this course, students will be able to:

- Measure resistance, temperature, acoustic, strain and other measurements using common laboratory and data acquisition instruments, including development of virtual instruments in LabVIEW.
- Analyze characteristics of, design, and calibrate measurement systems consisting of sensors, transducers, signal conditioning, data acquisition, and output stages.
- Conduct experiments implementing methods to reduce errors from noise and interference, apply statistical treatment, analyze, and interpret data.

- Apply signal conditioning techniques to improve measurement quality focusing on excitation signals, amplification/attenuation, buffering, filtering, linearization, scaling, and additional application-specific methods.
- Evaluate signals in the frequency domain, including optimization of sampling frequencies to avoid aliasing and other measurement errors.
- Gain understanding of common noise and mitigation strategies to reduce measurement errors from common sources intrinsic and extrinsic noise.
- Calculate instrument uncertainty and apply strategies to design instruments with sufficient accuracy for any given application.
- Understand and apply instrumentation standards in a laboratory environment
- Write convincing technical reports and instrument specification sheets.

Core Knowledge Development

Throughout this course, students are expected to acquire core knowledge in:

- Basic Concepts of Measurement and Measurement Instruments
- Sensors and Characteristics of Sensors
- Calibration Errors and Methods to Minimize
- Professional Standards
- Experiment Design
- Temperature Measurements
- LabVIEW Fundamentals
- Application of Probability and Statistics to Measurement
- Regression, Correlation and Causation, and Correlation Coefficients
- Characterizing 1st and 2nd Order Systems
- Electrical Measurements and Basic Lab Instrumentation
- Signal Conditioning Fundamentals
- Filtering Methods
- Scaling and Linearization
- Frequency Domain and Basic Spectral Analysis
- Aliasing and Sampling Considerations
- Analog-to-Digital and Digital-to-Analog Conversions
- Strain Measurements
- Sources of Electrical Noise & Mitigation Strategies
- Determining Instrument Uncertainty

Course Usage of Canvas

Copies of the course syllabus, all assignments, schedule, and due dates can be found on Canvas. You are responsible for regularly checking Canvas for updates and announcements, which can be accessed through the [Chico State Portal](#).

Classroom Etiquette and Attendance

During classroom sessions, students are expected to be completely engaged and committed to the class (no personal web surfing, messaging, social media, etc.). Attendance is required and students will receive credit for active and engaged participation in the course. If you are unable to attend a class due to an emergency or any other reason, please notify the instructor promptly (before class if possible).

Dropping and Adding

You are responsible for understanding the policies and procedures about add/drops, academic renewal, etc., found in the [CSU Chico University Catalog](#).

Lab Notebooks

You will need a bound lab notebook for the laboratory section of the course. This will be reviewed during lab sections and turned in at the end of the course. More details will be discussed in class.

Assigned Reading

Reading assignments from the course textbook can be found on Canvas. They will need to be completed before the first class of the week they are posted. You should be prepared for a pop quiz based on these readings.

Grading Policy

Your grade will be based on:

- 20% Attendance, Conduct, Participation, and Quizzes
- 40% Lab Reports and Assignments
- 40% Exams (Curved)

A ≥ 93% > A- ≥ 90% > B+ ≥ 87% > B ≥ 83% > B- ≥ 80% > C+ ≥ 77% > C ≥ 73%

73% > C- ≥ 70% > D ≥ 60% > F

Late Assignments

Late assignments will lose 20% of the full credit for each day they are late. A cover letter will be required for consideration of a reduced penalty, this should be submitted through Canvas (not email) and will be considered at the end of the semester. Always upload any assignments to Canvas and re-download them to confirm they have been submitted properly to avoid late penalties due to submission errors.

Equipment / Textbooks / Additional Resources

Computer and Software (Required)

You are required to have a PC-based laptop capable of running LabVIEW's NI ELVISmx Software Suite 2019 (a student software license will be provided to you for the duration of this course). You will need to bring your laptop to all lab sections. MATLAB and/or Excel are also highly recommended software for this course.

Course Textbook (Required)

Figliola, RS and Beasley, DE, Theory and Design for Mechanical Measurements, 7th edition, Wiley, 2019. ISBN: 978-1119723455. 5th and 6th editions are acceptable alternatives.

You are welcome to use either the print version, enhanced e-book version, or other digital copy or pdf.

Supplemental Textbook (Optional)

Beckwith, TG, Marangoni, RD, Lienhard, JH, Mechanical Measurements, 6th edition, Pearson, 2019. ISBN: 978-0201847659.

This covers much of the same course content in an alternative format.

Recommended book for learning LabVIEW (Optional)

Bishop, R., Learning with LabVIEW, 2nd Edition, Pearson, 2020. ISBN: 978-0135825754

I would recommend this book for anyone interested in learning LabVIEW in greater detail.

Recommended book for electronics (Optional)

Scherz, P and Monk, S, Practical Electronics for Inventors, 4th edition, McGraw-Hill, 2016. ISBN: 9781259587542.

I would recommend this book for all mechatronics majors and anyone interested in building mechatronics systems.

University Policies and Campus Resources

Academic Integrity

Students are expected to be familiar with the University's Academic Integrity Policy. Your own commitment to learning, as evidenced by your enrollment at California State University, Chico, and the University's Academic Integrity Policy requires you to be honest in all your academic coursework. Faculty members are required to report all infractions to the Office of Student Judicial Affairs. The policy on academic integrity and other resources related to student conduct can be found on the [Student Judicial Affairs website](#).

Artificial Intelligence

AI writing tools are not permitted for any stage or phase of work in this class. If you use these tools, your actions will be considered academically dishonest, and a violation of [Chico State's Integrity Policy](#) and you may be reported to the [Office of Students Rights and Responsibilities](#).

IT Support Services (Optional)

Computer labs for student use are located on the first and fourth floor of the Meriam Library, Room 116 and 450, Tehama Hall Room 131, and the Bell Memorial Union (BMU) basement. You can get help using your computer from IT Support Services; contact them through the [ITSS web site](#). Additional labs may be available to students in your department or college.

Student Services (Optional)

Student services are designed to assist students in the development of their full academic potential and to motivate them to become self-directed learners. Students can find support for services such as skills assessment, individual or group tutorials, subject advising, learning assistance, summer academic preparation and basic skills development. Student services information can be found on the [current students page of the CSU Chico web site](#).

Americans with Disabilities Act

If you need course adaptations or accommodations because of a disability or chronic illness, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Please also contact Accessibility Resource Center (ARC) as they are the designated department responsible for approving and coordinating reasonable accommodations and services for students with disabilities. ARC will help you understand your rights and responsibilities under the Americans with Disabilities Act and provide you further assistance with requesting and arranging accommodations.

[Accessibility Resource Center](#)

530-898-5959

Student Services Center 170

arcdept@csuchico.edu

Student Learning Center (Optional)

The mission of the Student Learning Center (SLC) is to provide services that will assist CSU, Chico students to become independent learners. The SLC prepares and supports students in their college course work by offering a variety of programs and resources to meet student needs. The SLC facilitates the academic transition and retention of students from high schools and community colleges by providing study strategy information, content subject tutoring, and supplemental instruction. The University Writing Center has been combined with the Student Learning Center. You can also visit the [Student Learning Center web site](#).

A Final Note on Equity, Diversity, and Inclusion

It is important to me that this course is accessible to each and every one of you. If there is any reason why the format of the course creates unique difficulties to you, please find time to talk with me. This includes those that have a physical or learning disability, those who have other emotional or physiological challenges, those of you who have past experiences that make college attendance or class content anxiety producing, those of you who are first-generation students and may not understand the university system, those of you who feel you can't actively participate, those of you who have more responsibility than the typical college student (such as dependent parents, children, or an especially heavy workload outside of school), those of you with financial hardships, and any other situations that I might not be able to anticipate.

My objective in this course is to assess your ability to learn and apply knowledge related to this subject matter. This should never be a factor of anything other than your own talents and efforts. The earlier you come and see me, the more I can do to try to work with you to alleviate any unique disadvantages you may face. I would prefer that you come to speak with me in the first two weeks.