Sample Syllabus

ME 345: Instrumentation, Measurements, and Statistics

Lectures	111 Forum Bldg, Mon, Wed., and Fri., 11:15 a.m. – 12:05 p.m.
Labs	237 Reber Building**,** once per week, 3 hours (times vary according to section number)
Text	*No required text – all necessary notes and lab manuals are provided on Canvas*
Prerequisites	A basic EE course (EE 211, EE 212, or equivalent); can be taken concurrently
Instructor	J.-M. Mongeau**,** Assistant Professor of Mechanical Engineering Office: 204 Reber Building, Phone: 814-865-7842
Office Hours	Monday 1:30-2:30 pm in 237 Reber & Friday 1:30-2:30 pm in 204 Reber
Assistants	See Canvas for a list of teaching assistants and their office hours.
Contact Info	You must contact the professor *via* Canvas to ensure you receive a response to your request

Course Description

This course is required for all mechanical engineering students and is taken in the junior year. It serves as an introduction to the fundamental principles of instrumentation and measurement, along with statistics; accordingly, it integrates and applies what you have learned in your math, physics, engineering mechanics, and mechanical and electrical engineering courses. The course includes a 3-hour-per-week hands-on laboratory where you apply the material learned in the lecture. For many students, this may be the first time you have actual hands-on experience with electronics and measurement equipment, such as oscilloscopes, breadboards, function generators, digital data acquisition systems, integrated circuits, strain gages, displacement meters, thermocouples, tachometers, dynamometers, filters, volume flow meters, velocity meters, pressure probes, pressure transducers, etc. You will learn not only how to *use* these devices in the lab, but also the fundamental principles of their operation – *how they work*. Statistical analysis is integrated into the course, especially in the hands-on laboratories, where statistics is used to analyze, manipulate, plot, and interpret acquired data.

Course Content

The course is divided roughly in thirds – 1/3 statistics, 1/3 measurements, and 1/3 instrumentation. A detailed schedule of lectures, material to read, labs, and homework is available on Canvas.

Communication and Course Site

There is a course site on Canvas for our class. Course materials, homework assignments, homework solutions, lab instructions and grades will be posted on this site. You are expected to check this site at least once a week. In addition, you are encouraged to seek clarifications and ask questions through the 'Inbox' on Canvas. Responses will be made in a timely manner if using Canvas. You are also encouraged to communicate with your TA for prompt attention.

Course Material

Course materials consist of learning modules and lab manuals, available on the Canvas site for this course. These documents are posted under Files. The learning modules should be read weekly, ***before*** each class. The lab manuals should also be read before each lab; in addition, the pre-calculation portion of the lab manual has to be completed individually and turned in at the start of the lab session. More on that in the 'Lab rules, regulations, and format.pdf' document in the Lab-related folder on Canvas.

Class Participation and Attendance

You are expected to attend all scheduled lectures and labs. In case of absences from lectures, it is your responsibility to obtain the lecture notes and missed assignments, if any. In case of a university-approved absence, make-up of a course work may be approved. Both the TA and the instructor would need to be alerted to the absence no less than a week before the due date of said-assignment. Refer to the university policy on what constitutes a university-approved absence:
https://handbook.psu.edu/content/class-attendance

Topics and approximate time frame

Week 1: Introduction, Dimensional Analysis

Week 2: Histograms, Probability Density Functions

Week 3: Correlation, Regression

Week 4: Outliers, RSS Analysis, Taguchi Design

Week 5: Response Surface Methodology, Hypothesis testing

Week 6: Aliasing, Cardinal, Fourier

Week 7: Fourier Transform, Windowing

Week 8: Basic electronics, Filters

Week 9: Operational-amplifiers

Week 10: Strain gages

Week 11: Dynamic systems

Week 12: Temperature measurement

Week 13: Mechanical measurements

Week 14: Pressure, velocity measurement

Week 15: Volume flow rate measurement

Grading

You will be assessed and evaluated on the following course assignments:

Reading assignments	**-**	Every course topic has a corresponding learning module. The learning module introduces the topic in details and usually includes practice problems with solutions. The reading assignment should be completed *before* coming to class. The reading schedule is posted on Canvas and lists the reading assignments per week.

Homework assignments	**16%**	The due date for each homework assignment is indicated on the course Canvas site. Homework assignments are due in class. **NO LATE HOMEWORK WILL BE ACCEPTED.** If a homework is turned in late or if it is missing, a grade of zero will be assigned. If a homework is missed due to an acceptable excuse, student will be excused from that homework. All homework assignments are comprehensive. Students are allowed (and encouraged) to work in groups of two to three on the homework assignments, provided that each person in the group is contributing to each solution. If students choose to work in a group, only one completed assignment needs to be turned in per group. Please make sure that each student's name is indicated clearly on the cover page of the homework assignment. All students in a group will receive the same grade for that assignment.
Labs	**24%**	You will complete an in-class lab procedure and report as part of a team. Each lab experiment is designed such that it can be completed within the allotted three-hour class time. **ALL REPORTS WILL BE FINISHED DURING LAB TIME AND WILL BE HANDED IN BEFORE THE TEAM MEMBERS LEAVE THE LAB.** **If a lab is missed due to a university-approved excuse, you will need to make arrangements with your TA to make it up that same week. Contact Head TA (Matthew D. Erdman) AND your TA at least a week in advance. The head TA and instructor will decide if make up is legitimate and arrange the make-up time. You must submit a class absence form to the Head TA at least a week in advance for approval: http://undergrad.psu.edu/aappm/classabs.pdf** **If a lab is missed without an acceptable excuse, a zero grade will be assigned.** **In case your team was not able to complete the report before the end of the lab period it will be due to the TA before 5 pm the next day, with permission from your TA. After this period a zero grade will be assigned to this lab.** **You must attend the lab section assigned.** **Read the document 'Lab rules, regulations, and format' on Canvas for additional information.**
Lab peer evaluation	**3%**	At the end of the course, you will have an opportunity to provide feedback on the performance of your team mates. This peer review will be used to determine your lab participation grade.
Class participation	**3%**	Interactive questions will be given in class; your participation will count for class attendance, and your answers will count for a portion of the class participation grade. In the participation grade, I will excuse all for two weeks (6 classes) – no questions asked. This should cover illnesses, job interviews, etc. Beyond that, you will need to provide a university-approved class absence form to be excused.

Midterm Exams **Final Exam**	**28%** **26%**	There will be two midterms (14% each) and one cumulative final exam (26%). **If you cannot attend the exam due to a legitimate reason, you must submit a *signed* class absence form to the instructor at least a week in advance for approval:** http://undergrad.psu.edu/aappm/classabs.pdf **EXAM SCHEDULE:** **Exam 1: Wed. October 3 11:15am–12:05pm (in class)** **Exam 2: Wed. November 7 11:15am–12:05pm (in class)** **Final exam: 2 hrs, To be announced by the University** ***No laptops or smart phones are allowed during exams. Only a basic calculator is permitted, no graphing calculators are allowed. It must be a calculator, not a cell phone, ipad, tablet, etc., or any device that can store notes, example problems, etc.***

Grade Disputes

If you feel there is an error in the grading of an exam, lab, or problem set, it should be first brought to the attention of the grader the same week the graded material is handed back; scores will not be re-considered beyond a week after they are handed back. For an official regrade request, you must attach a detailed explanation of the regrade request in writing. For a list of who grades what assignment, refer to the document on the Canvas site.

Grading Scale

The grading scale for the course grades at the end of semester if the class course grade average is 70 or higher is:

Final average	**93–100**	**90–92**	**86–89**	**82–85**	**79–81**	**75–78**	**70–75**	**60–69**	**<60**
Letter grade	A	A-	B+	B	B-	C+	C	D	F

Program Outcomes, Course Objectives, and Course Outcomes

Program Outcomes Mapped to this Course

1e. Statistics
2a. Analysis of mechanical components
2b. Analysis of thermal/fluids components
3a. Work effectively on multidisciplinary teams
3d. Communicate effectively with the written word
3f. Demonstrate professionalism in interactions with colleagues, faculty, and staff
4b. Learning in less structured circumstances
5a. Principles of measurements, instrumentation methods, and experimental design
5b. Exhibit a broad understanding of mechanical instruments and sensors, both in theory and practice
5c. Use appropriate statistical tools
5e. Make effective use of spreadsheets as an analysis and design tool
5g. Computer technology for report writing, presentations, and electronic communications

Course Objectives (Mapping to Program Outcomes is shown in brackets)

A. Understand basic statistics, and develop proficiency in the application of statistical tools. [1e, 5c, 5e]
B. Understand digital data acquisition and spectral analysis of data. [5a. 5b. 5c]
C. Understand basic electronics and circuit analysis for filters, amplifiers, and other signal conditioning circuits, and be able to build such circuits. [5a, 5b]
D. Understand how to design, conduct, and analyze laboratory experiments, and how to properly report the results. [3a, 3d, 4b, 5g]
E. Understand how various kinds of analog and digital sensors and instruments work, how they are calibrated – both statically and dynamically, and how they are applied in engineering. [2a, 2b, 5a, 5b]
F. Advance proficiency in professional communications and interactions. [3f]

Course Outcomes (Mapping to Course Objectives is shown in brackets)

Upon completion of this course, students should be able to:

1. Apply statistical analysis to data samples to calculate mean, standard deviation, etc. and to determine the accuracy, precision, and sensitivity of sensors and instruments. [A, E]
2. Apply statistical and error analyses to measured data to identify and remove outliers and predict uncertainties. [A]
3. Apply linear and nonlinear regression analysis to perform curve fits to data and to determine correlation of variables and trends. [A]
4. Create histograms and probability density functions (PDFs) of data samples, demonstrate the ability to compare the results to standard PDFs such as the Gaussian and student's t PDFs, and demonstrate the ability to predict probabilities based on the PDFs. [A]
5. Apply hypothesis testing techniques to both single variable and paired data samples to predict probabilities and confidence levels. [A]
6. Predict resolution, clipping, and aliasing when using digital data acquisition, and be able to generate frequency spectra using FFTs with and without windowing to determine the frequency content of a signal. [B]
7. Choose appropriate test matrices (design arrays), perform dimensional analysis, and design experiments that minimize cost and time. [D]
8. Build and analyze basic electronic circuits such as amplifiers, filters, Wheatstone bridges, etc., using resistors, capacitors, inductors, diodes, and op-amps. [C, E]
9. Apply differential equation analysis of first- and second-order dynamic systems to predict the behavior of sensors and instruments. [E]
10. Predict, analyze, and test the performance of sensors of various kinds, including strain gages, thermocouples, tachometers, displacement transducers, dynamometers, pressure gages and transducers, laser and Doppler velocimeters, pressure probes, and flowmeters. [E]
11. Demonstrate professionalism in oral and written communications with course instructors and fellow students. [F]

STATEMENT ON ACADEMIC INTEGRITY

Definition and expectations: Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle.

Academic honesty and integrity is of utmost importance. Detailed information on this topic can be found at http://undergrad.psu.edu/aappm/G-9-academic-integrity.html

Some examples are given below:

CHEATING: Using crib sheet; pre-programming a calculator; using notes or books during a closed book exam etc.
COPYING ON TEST: Looking at another unsuspecting student's exam and copying; copying in a complicit manner with another student; exchanging color-coded exams for the purpose of copying; passing answers via notes; discussing answers in exam, etc.
PLAGIARISM: The fabrication of information and citations; submitting others work from professional journals, books, articles and papers; submission of other students papers or lab results or project reports and representing the work as one's own; fabricating in part or total, submissions and citing them falsely, etc.
ACTS OF AIDING OR ABEADING: Facilitating acts by others; unauthorized collaboration of work; permitting another to copy from exam; writing a paper for another; inappropriately collaborating on home assignment or exam without permission or when prohibited, etc.
UNAUTHORIZED POSSESSION: Of examinations, through purchase or supply; stealing exams; failing to return exams on file; selling exams; photocopying exams; buying exams; any possession of an exam without the custodian's permission, etc.
SUBMITTING PREVIOUS WORK: Submitting a paper, case study, lab report or any assignment that had been submitted for credit in a prior class without the knowledge and permission of the instructor.
TAMPERING WITH WORK: Changing own or another student's work product such as lab results, papers, or test answers; tampering with work either as a prank or in order to sabotage another work, etc.
GHOSTING: Taking a quiz, an exam, performing a laboratory exercise or similar evaluation in place of another; having another take a quiz, an exam, or perform an exercise or similar evaluation in place of the student, etc.
ALTERING EXAMS: When instructor returns graded exams for in class review and subsequently collects them, student changes incorrect answers and seeks favorable grade adjustment asserting that instructor made mistake in grading; other forms may include changing the letter or and/numerical grade on test; obtaining test in discretely, etc.
COMPUTER THEFT PROGRAM: Electronic theft of computer programs, data, or text belonging to another etc.

Specifically for this course:

> **First offense**: Zero score for the item in question, and infraction reported to the College.
> **Second offense**: Failure of the course, and infraction reported to the College.

STUDENTS WITH DISABLILITIES

Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. The Student Disability Resources Web site provides contact information for every Penn State campus: http://equity.psu.edu/student-disability-resources/disability-coordinator. For further information, please visit the Student Disability Resources Web site: http://equity.psu.edu/student-disability-resources.

In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: http://equity.psu.edu/student-disability-resources/applying-for-services. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

COUNSELING & PSYCHOLOGICAL SERVICES (CAPS)

CAPS can help students resolve personal concerns that may interfere with their academic progress, social development, and satisfaction at Penn State. Some of the more common concerns include anxiety, depression, difficulties in relationships (friends, roommates, or family); sexual identity; lack of motivation or difficulty relaxing, concentrating or studying; eating disorders; sexual assault and sexual abuse recovery; and uncertainties about personal values and beliefs.

You can contact CAPS by calling the Main CAPS number/Appointment Scheduling: 814-863-0395 (Please call between the hours of 8am and 5pm, Monday-Friday to schedule an appointment) or visit us at our office location, 5th Floor Student Health Center.

Online Resources for Relaxation

It's important to take care of yourself. There are a number of valuable online resources that you can use for relaxation and stress reduction.

Learn how stress impacts your health and life, as well as some self-help strategies for managing it through the PSU Student Affairs EDGE online workshop. Check out other stress management resources available, including a guided program called Stress Recess. There are also a number of relaxation, visualization, and mindfulness resources at the Mind Body Spa. You can also download mindfulness meditations here. If winter has got you down and you need an upbeat song to listen to, check this out.

Sexual Assault and Relationship Violence Hotline

A hotline has been established for victims and observers of sexual assault and relationship violence. Trained counselors on the hotline will help students access appropriate resources. Penn State students from any campus can call 1 (800) 560-1637 to access the 24 hour a day, seven day a week hotline.