

Spring 2015
MCEN 3037: Experimental Design & Data Analysis
Course Syllabus

A primary objective of the Mechanical Engineering (ME) Department is to prepare each of our students for careers in the engineering profession. As professionals, engineers must meet high standards of technical competence and ethical behavior. According to the Accreditation Board of Engineering and Technology (ABET) code of ethics, engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

1. Using their knowledge and skill for the enhancement of human welfare;
2. Being honest and impartial, and serving with fidelity the public, their employers and clients;
3. Striving to increase the competence and prestige of the engineering profession.

The Department of Mechanical Engineering believes that it is essential for each of you to learn the professional behavior that will prepare you for your career. Therefore, in each mechanical engineering course you will be required to practice the professional behavior that will be expected by your future employers. This syllabus clearly outlines the campus and ME policies regarding academic integrity and academic climate. These policies will be upheld in each of your courses throughout the mechanical engineering curriculum. In addition, we also expect that this culture of professionalism will pervade all of your University of Colorado experiences.

1. Basic Information

- Instructor: Professor Wei Tan, ECME 265; wtan@colorado.edu
- Teaching Assistant: Hang Yin; Hang.Yin-1@Colorado.EDU
- Lectures: Mondays/Wednesdays, 1:00-1:50 AM, ITLL 1B50
- Office Hours: Mondays, 11:00AM -12:00PM; OR Other times by appointments (setting up times with Email communications), ECME 265
- Class Communication Mode: D2L Learn <https://learn.colorado.edu> and CU student email address

2. Prerequisites: APPM 2360, Differential Equations and Linear Algebra

3. Course Objective

This class is a prerequisite for Measurements 1 Lab (MCEN 4037) and Measurements 2 Lab (MCEN 4047), and will also be of significant value in ME Design Project 1 and 2 (MCEN 4045 and 4085). Experiments, measurements, and analysis of the resulting data are at the very core of science and engineering, and thus information from this course may well be the one that you will use most frequently as a practicing engineer. In this class, you will learn how to design and implement experiments, how to process the measured data, and how to interpret and report the final result.

4. Description of the Course

This introductory-level undergraduate course is a first step in preparing students to properly plan and carry out experiments, analyze the resulting information, and draw the appropriate conclusions. The course is divided into three sections: Basic Statistical Concepts, Measurement Fundamentals, and Design and Analysis of Experiments. There is a vast amount of information concerning these topics, and we will strive to obtain a proper balance between breadth and depth while being mindful of the relatively limited time available. Thus, students should recognize that this course provides only an introduction to these topics; additional information and insight will be obtained in subsequent courses, on-job experience and independent learning.

5. Topics: A summary of the topics that would comprise complete coverage for this introductory course is given below. This is an ambitious topic list for a 2-hr/week course, and thus there will likely be changes in the list as the semester progresses.

I. BASIC STATISTICAL CONCEPTS

1. Sampling & Descriptive Statistics (Ch1)
2. Probability (Ch 2)
3. Probability Distributions (Ch4)
4. Confidence Intervals (Ch5)
5. Hypothesis Testing (Ch 6)
6. Correlation & Regression (Ch7)

II. MEASUREMENT FUNDAMENTALS

1. Measurement Error (Notes/handouts)
2. Uncertainty Analysis (Notes/handouts)
3. Propagation of Error (Ch 3)

III. DESIGN & ANALYSIS OF EXPERIMENTS

1. Introduction to Experimental Design (Notes/handouts)
2. Simple Comparative Experiments (Notes/handouts)
3. Single-Factor Experiments: ANOVA (Ch 9)
4. Two-Factor Experiments: ANOVA (Ch 9)

6. Course Policies

Students and faculty each have responsibility for maintaining an appropriate learning environment. Students who fail to adhere to such behavioral standards may be subject to discipline. Faculty have the professional responsibility to treat all students with understanding, dignity and respect, to guide classroom discussion and to set reasonable limits on the manner in which they and their students express opinions. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender variance, and nationalities. Details of these policies are available at : <http://www.colorado.edu/policies/classbehavior.html> and http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code.

- **In-Class Expectations:** It is our expectation that each of you will be respectful to your fellow classmates and instructors at all times. In an effort to create a professional atmosphere within the classroom, it is requested that you:
 - Arrive to class on time;
 - Turn off your cell phone;
 - Limit use of your laptop computer to class purposes;
 - Put away newspapers and magazines;
 - Refrain from having disruptive conversations during class;
 - Remain for the whole class, or if you must leave early do so without disrupting others;
 - Display professional courtesy and respect in all interactions related to this class.
- **Out-of-Class Expectations:** Although many of the above stated policies address academic climate within the classroom, these policies should also be upheld outside of the classroom. As a member of the ME community, you are expected to consistently demonstrate integrity and honor through your everyday actions. Furthermore, faculty and staff members are very willing to assist with your academic and personal needs. However, multiple professional obligations make it necessary for us to carefully schedule our availability. Suggestions specific to interactions with faculty and staff include:
 - Respect posted office hours - plan your weekly schedule to align with scheduled office hours;

- Avoid disrupting ongoing meetings within faculty and staff offices. Please wait until the meeting concludes before seeking assistance.
- Respect faculty and staff policies regarding use of email and note that staff and faculty are not expected to respond to email outside of business hours - send emails to faculty and staff using a professional format - tips for a professional email include:
 - Always fill in the subject line with a topic that indicates the reason for your email to your reader.
 - Respectfully address the individual to whom you are sending the email (e.g., Dear Professor Smith).
 - Avoid email, chat room or text message abbreviations.
 - Be brief and polite.
 - Add a signature block with appropriate contact information.
 - Reply to emails with the previously sent message. This will allow your reader to quickly recall the questions and previous context.

Compliance with these expectations will assist us with the creation of a learning community and a high-quality educational experience.

- If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671 or dsinfo@colorado.edu.
- If you have a temporary medical condition or injury, see guidelines at [Disability Services website](#).
- Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please notify me at least two weeks in advance of the conflict, and I will make every effort to accommodate your needs. Policy details are available at http://www.colorado.edu/policies/fac_relig.html.
- The University of Colorado at Boulder Discrimination and Harassment Policy and Procedures, the University of Colorado Sexual Harassment Policy and Procedures, and the University of Colorado Conflict of Interest in Cases of Amorous Relationships policy apply to all students, staff, and faculty. Any student, staff, or faculty member who believes s/he has been the subject of sexual harassment or discrimination or harassment based upon race, color, national origin, sex, age, disability, creed, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Student Conduct (OSC) at 303-492-5550. Information about the ODH, the above referenced policies, and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at <http://www.colorado.edu/odh>.
- All students are expected to complete assignments competently and in the time allocated.
- All students are expected to seek timely consultation regarding any problems that occur.
- Policy on Privacy of Graded Work: Federal law requires that your grades be communicated to you privately. You have been assigned a unique, private ME ID number for this purpose, and it will be the same for all your ME courses. Put this number on all work that you hand in, instead of or in addition to your name. You can pick up your graded work filed under this number. Returned assignments will be available in the ME common filing cabinet.

7. Campus and Department Integrity Policies

- University of Colorado Honor Code Policy: All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at the following site: <http://www.colorado.edu/policies/honor.html> and at <http://www.colorado.edu/academics/honorcode/>.
- Mechanical Engineering Policy: Any instances of dishonesty on homework or tests will result in a minimum sanction for your first violation of the honor code of a zero score and an entry in your department file. Additional sanctions will be imposed by the ME Department for subsequent violations, possibly including expulsion from the ME program. You may contest any accusation according to the campus honor code system.

8. Reference Materials

- Required textbook. *Statistics for Engineers and Scientists (Version 4)*, W. Navidi, McGraw Hill.

In addition, I would recommend several reference books that also provide comprehensive coverage of probability and statistics. Go and check these out, particularly if you have no background in this area.

- *Probability and Statistics for the Engineering, Computing and Physical Sciences*, E.R. Dougherty, Prentice Hall.
- *Applied Statistics for Engineers and Scientists*, D.M. Levine, P.P Ramsey, and R.K. Smidt, Prentice Hall.
- *Applied Statistics and Probability for Engineers*, D.C. Montgomery and G.C. Runger, Wiley.
- *Statistics for Engineering Problem Solving*, S. Vardeman, PWS Publishing.
- *Experimental Methods for Engineers*, J.P. Holman, McGraw Hill.
- *An Introduction to Error Analysis; The Study of Uncertainties in Physical Measurements*, J.R. Taylor, University Science Books.
- *Introduction to Engineering Experimentation*, A.J. Wheeler and A.R. Ganji, Prentice Hall.
- *Design and Analysis of Experiments*, D.C. Montgomery, Wiley.

Class lectures will be based on notes that will be presented in a Powerpoint format. Copies of the *notes* will be posted on Desire2Learn (D2L) in as timely a manner as possible. Although these notes will overlap the information contained in the various texts, they will not be identical. Therefore, the best way to approach the course material will be with the expectation of regular reading from a variety of sources including notes, texts and on-line sources.

As with textbooks, there are many commercial *software* products that address statistical analysis. In this course, we will demonstrate the use of Excel and Origin. Although not required, use of such software will make calculations and analysis easier although such software does not always contribute to a fundamental understanding as to why a particular analysis is used or what are the basic steps and underlying assumptions. However, in combination with the knowledge gained in this course, students are encouraged to become familiar with one such software product.

9. Learning Activities

- **Lectures:** Lectures meet on Monday and Wednesday. Short quizzes *may* also be given in class throughout the semester during the class period. Grades from any quizzes will be appropriately integrated into the overall grading format.
- **Reading and Homework Assignments:** Reading and homework assignments will be posted on the course website. Reading assignments will be based on topics rather than referenced to a particular textbook. Homework assignments will be posted a minimum of one week before they are due, which will be at the start of class on the designated due date. Late assignments must be submitted at the start of our next class, and will receive a 50% grade reduction; assignments more than 2 days late will not receive credit. After two late assignments, no additional late submissions will be accepted. Homework solutions will be posted on the Desire2Learn website.

Students may work together and discuss possible homework solution approaches. However, each student is expected do all problems in their entirety by themselves once discussion is completed. This approach facilitates learning and will help ensure the best possible performance on exams. Note that copying homework solutions from *any source* is *plagiarism* and hence *academic dishonesty*.

- **Homework Format:** It is your responsibility to make your solutions *clear, organized, and legible*. The graders have the discretion to deduct points (up to and including full credit) for solutions that are hard to read or unprofessional in appearance. Unless the problem requires only a conceptual or short answer, please use the format below. This will facilitate grading and will assist you to approach problems in a consistent, organized way that will lead to the correct solution. Problems may be written by hand or printed out, but must be *submitted in hard copy*. Email/electronic submittals will not be accepted.
 - Clear and succinct problem statement, including variables that are given and quantities to be found.
 - State any major assumptions and governing equations.
 - List of known values including units, if applicable.
 - Solution
 - First do the algebra, *in symbolic form*. Obtain and present a simplified expression for the answer.
 - Then do the calculations, adding the appropriate numbers. Pay attention to (a) units and (b) significant figures. Show all work.

- Present the final answer including units with a **box** around it.
- **Exams:** There will be two in-class exams and a final exam. The format for the exams will be reviewed in class. Note that any deviation from exam rules and instructions may be regarded as cheating and hence *academic dishonesty*.

10. Grading

- **Policies:** Exams will be given only at the time specified in the syllabus or mutually agreed upon after discussion in class. An appropriate opportunity will be provided to reconsider the points awarded for particular homework or exams; however, final course grades are not negotiable.
- **Point Distribution**

Mid-Term Exam #1:	20%
Mid-Term Exam #2:	20%
Final Exam:	35%
Homework and Project:	25%

11. Important Dates

- Martin Luther King holiday: Monday, January 19; no class.
- Mid-Term Exam #1: Wednesday, February 18; 1:00-1:50am; in class.
- Mid-Term Exam #2: Wednesday, March 18; 1:00-1:50am; in class.
- Spring Break: March 23-27; no classes.
- Final Exam: TBA (refer to the university Final schedule).