Engineering Measurements - EEEN4420  
School of Engineering and Computing Sciences  
Fall 2017

A. COURSE INFORMATION

Course number/section: EEEN 4420/001  
Class meeting time:  
Monday and Wednesday: 12:00pm – 12:50pm (Lectures)  
Monday and Wednesday: 02:00pm – 03:50pm (Lab 4420.201)  
Tuesday and Thursday: 02:00pm – 03:50pm (Lab 4420.202)  
Class location: Lectures at EN108 – Laboratory at EN117  
Course Website: Blackboard

B. INSTRUCTOR INFORMATION

Instructor: Luis Rodolfo GARCIA CARRILLO  
Office location: Engineering Building 316M  
Office hours: Monday, Tuesday, and Wednesday: 08:00am – 10:00am  
Telephone: 361-825-3576  
e-mail: luis.garcia@tamucc.edu  
Appointments: By Request

C. COURSE DESCRIPTION

Catalog Course Description  
Principles of physical measurements; standards, calibration, error estimation; static and dynamic performance of measuring systems; laboratory experience, experiment planning, report writing. The purpose of this course is for students to gain proficiency in designing, assembling, and operating an experiment; and analyzing and presenting experimental results. This encompasses skills such as an understanding control and data acquisition electronics, operation and limitation of modern sensors, calibration and error analysis, assessing applicability of theory and the impact of secondary experimental variables, and writing and presenting reports and analysis. ENGR 2460 Circuit Analysis (or equivalent) and senior standing.

Extended Course Description  
This course serves as an introduction to the fundamental principles of instrumentation and measurement, along with statistics, and integrates and applies what student learned in math, physics, mechanical, and electrical engineering courses. The course includes a 3 hours and 40 minutes per-week hands-on laboratory where students will apply the material learned in the lecture. Lab activities will include 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 meters, pressure probes, pressure transducers, etc. Students 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.

D. PREREQUISITES AND COREQUISITES

Prerequisites
- ENGR 2460 Circuit Analysis (or equivalent) and senior standing.

Corequisites
None

E. REQUIRED TEXTBOOK(S), READINGS AND SUPPLIES

Required Textbook(s)
No required text - all necessary notes and lab manuals are provided on the course Blackboard website

Optional Textbook(s) or Other References
None

Supplies
None

F. STUDENT LEARNING OUTCOMES AND ASSESSMENT

Assessment is a process used by instructors to help improve learning. Assessment is essential for effective learning because it provides feedback to both students and instructors. A critical step in this process is making clear the course’s student learning outcomes that describe what students are expected to learn to be successful in the course. The student learning outcomes for this course are listed below. By collecting data and sharing it with students on how well they are accomplishing these learning outcomes students can more efficiently and effectively focus their learning efforts. This information can also help instructors identify challenging areas for students and adjust their teaching approach to facilitate learning.

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.
2. Apply statistical and error analyses to measured data to identify and remove outliers and predict uncertainties.
3. Apply linear and nonlinear regression analysis to perform curve fits to data and to determine correlation of variables and trends.
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.
5. Apply hypothesis testing techniques to both single variable and paired data samples to predict probabilities and confidence levels.
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.
7. Choose appropriate test matrices (design arrays), perform dimensional analysis, and design experiments that minimize cost and time.
8. Build and analyze basic electronic circuits such as amplifiers, filters, Wheatstone bridges, etc., using resistors, capacitors, inductors, diodes, and op-amps.
9. Apply differential equation analysis of first- and second-order dynamic systems to predict the behavior of sensors and instruments.
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.
11. Demonstrate professionalism in oral and written communications with course instructors and fellow students.

G. INSTRUCTIONAL METHODS AND ACTIVITIES

Programming in Matlab and Simulink, as well as LabView

H. MAJOR COURSE REQUIREMENTS AND GRADING

- Exams (24%) – There will be three in-class exams worth 8% of the final grade each. Please note the dates of the exams on the course schedule below and plan accordingly. Exams may only be made up with an approved University excuse and will be different from the in-class version of the exam. If you have a conflict with an exam date, please let me know as soon as you know about the conflict.
- Quizzes (22%) – Regular quizzes (on-line and in-class) will be given.
- Homework (24%) - Approximately one per week – expect 12 total at 2% each
- Participation, and Attendance (6%) – You are expected to attend all scheduled lectures and labs. 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. Either in hardcopy, e-mail, or on the course Blackboard page, you are encouraged to submit newspaper, magazine, Internet articles, or videos that relate to the topics discussed in class.
- Laboratory Reports (24%) - As part of this class, you will have to work on weekly laboratory project assignments. These projects are group effort. Approximately one per week, expect 12 total at 2% each

- Grade Scale: A (90-100%) B (80-89%) C (70-79%) D (60-69%) F (<60%)

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>% of FINAL GRADE</th>
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<tbody>
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## I. COURSE CONTENT/SCHEDULE

<table>
<thead>
<tr>
<th>DATE (BY DAY OR WEEK)</th>
<th>TOPIC</th>
<th>HOMEWORK</th>
<th>LABORATORY ASSIGNMENTS</th>
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<tbody>
<tr>
<td>09/04 Week 01</td>
<td>Introduction to engineering measurements; Dimensional analysis; Review of basic electronics and circuits; Errors and uncertainties; Basic statistics</td>
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<td>Safety - Lab</td>
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<tr>
<td>09/11 Week 02</td>
<td>Histograms; Probability density functions; The normal (Gaussian) distribution</td>
<td>HW01</td>
<td>Lab 01</td>
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<tr>
<td>09/18 Week 03</td>
<td>Central limit theorem; Other PDF distributions - lognormal, student's t, chi-squared; Correlation and regression analysis (least-squares curve fits)</td>
<td>HW02</td>
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<tr>
<td>09/25 Week 04</td>
<td>Outliers - single variables and data pairs; Experimental uncertainty analysis - RSS uncertainty; Experimental design - full vs. fractional factorial tests, Taguchi design arrays</td>
<td>HW03</td>
<td>Lab 02</td>
</tr>
<tr>
<td>10/02 Week 05</td>
<td>RSM - Response surface methodology - an efficient way to hunt for an optimum result; Hypothesis testing - how to use statistics to make decisions</td>
<td>HW04</td>
<td>Lab 03</td>
</tr>
<tr>
<td>10/09 Week 06</td>
<td>Digital data acquisition - introduction to digital data, A/D conversion, discrete sampling, clipping, aliasing; Signal reconstruction - the Cardinal series; Spectral analysis - introduction to Fourier series, harmonic amplitude plots; Fourier transforms - introduction to Fourier transforms, DFTs and FFTs</td>
<td>HW05</td>
<td>Lab 04</td>
</tr>
<tr>
<td>10/16 Week 07</td>
<td>FFTs (continued) - Windowing - a technique to reduce leakage in FFTs; How to analyze the frequency content of a signal</td>
<td>HW06</td>
<td>Lab 05</td>
</tr>
<tr>
<td>10/23 Week 08</td>
<td>Filters - first-order low-pass filter, first-order high-pass filter, other filters</td>
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<td>Lab 06</td>
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<tr>
<td>Date</td>
<td>Week</td>
<td>Topic</td>
<td>HW/Lab</td>
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<tr>
<td>10/30</td>
<td>9</td>
<td>Operational amplifiers (Op-Amps) - introduction and some circuits in which op-amps are used; Clipping circuits and examples, common-mode rejection ratio, gain-bandwidth product</td>
<td>HW07</td>
</tr>
<tr>
<td>11/06</td>
<td>10</td>
<td>Stress, strain, and strain gages - review of stress and strain, Hooke's law; Description of strain gages and how to use them; Wheatstone bridge circuits, and how they are used to measure strain</td>
<td>HW08</td>
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<tr>
<td>11/13</td>
<td>11</td>
<td>Dynamic system response - dynamic measuring systems, zero-, first-, and second-order systems</td>
<td>HW09</td>
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<td>11/20</td>
<td>12</td>
<td>Temperature measurement - types of temperature measurement including mechanical, thermoresistive, thermojunctive, and radiative methods</td>
<td>HW10</td>
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<tr>
<td>11/27</td>
<td>13</td>
<td>Mechanical measurements - mechanical measuring devices, such as potentiometers, linear variable displacement transducers, ultrasonic transducers, capacitance displacement sensors, accelerometers, tachometers, and dynamometers</td>
<td>HW11</td>
</tr>
<tr>
<td>12/04</td>
<td>14</td>
<td>Fluid flow measurements - pressure, velocity, and volume flow rate measurements</td>
<td>HW12</td>
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Note: Changes in this course schedule may be necessary and will be announced to the class by the Instructor. The assignments and exams shown are directly related to the Student Learning Outcomes described in Section F.

**J. COURSE POLICIES**

**Attendance/Tardiness**
- Students are expected to be in attendance, punctual, and **prepared** for class.

**Late Work and Make-up Exams**
- Late work is not going to be accepted. Make-up Exams are only arranged with 1 week prior notice. No make-up exam will be arranged after each exam.

**Extra Credit**
- Extra Credit questions/problems will be given in some of the tests and homework.

**Cell Phone Use**
- Please refrain from the use of electronic devices during class, as it is distracting to not only you, but also to your instructor and peers. Silence your phones and put them away so you are not tempted to stray off task.

**Laptop Use**
- Laptops will be permitted for particular activities as deemed appropriate.

**Food in Class**
- No food or drinks are allowed during class.

**Missed Exam**
- If you have a conflict with an exam date, please let me know as soon as you know about the conflict.

**Participation**
- In-group and individual activities on a regular basis will count towards final grade

**Others**
- All work submitted for grading must be the student's own work. Plagiarism will result in a score of 0 (zero) for the work or dismissal from the course and the Dean of Students office will be notified. No copying from another student's work of any type is allowed. It is the student's duty to allow no one to copy his or her work.

### K. COLLEGE AND UNIVERSITY POLICIES

- **Academic Integrity (University)**
  University students are expected to conduct themselves in accordance with the highest standards of academic honesty. Academic misconduct for which a student is subject to penalty includes all forms of cheating, such as illicit possession of examinations or examination materials, falsification, forgery, complicity or plagiarism. (Plagiarism is the presentation of the work of another as one’s own work.) In this class, academic misconduct or complicity in an act of academic misconduct on an assignment or test will result in a failing grade.

- **Classroom/Professional Behavior**
  Texas A&M University-Corpus Christi, as an academic community, requires that each individual respect the needs of others to study and learn in a peaceful atmosphere. Under Article III of the Student Code of Conduct, classroom behavior that interferes with either (a) the instructor’s ability to conduct the class or (b) the ability of other students to profit from the instructional program may be considered a breach of the peace and is subject to disciplinary sanction outlined in article VII of the Student Code of Conduct. Students engaging in unacceptable behavior may be instructed to leave the classroom. This prohibition applies to all instructional forums, including classrooms, electronic classrooms, labs, discussion groups, field trips, etc.
• **Statement of Civility**
  Texas A&M University-Corpus Christi has a diverse student population that represents the population of the state. Our goal is to provide you with a high quality educational experience that is free from repression. You are responsible for following the rules of the University, city, state and federal government. We expect that you will behave in a manner that is dignified, respectful and courteous to all people, regardless of sex, ethnic/racial origin, religious background, sexual orientation or disability. Behaviors that infringe on the rights of another individual will not be tolerated.

• **Deadline for Dropping a Course with a Grade of W (University)**
  I hope that you never find it necessary to drop this or any other class. However, events can sometimes occur that make dropping a course necessary or wise. **Please consult with your academic advisor, the Financial Aid Office, and me, before you decide to drop this course.** Should dropping the course be the best course of action, you must initiate the process to drop the course by going to the Student Services Center and filling out a course drop form. Just stopping attendance and participation **WILL NOT automatically result in your being dropped from the class.** Please consult the Academic Calendar ([http://www.tamucc.edu/academics/calendar/](http://www.tamucc.edu/academics/calendar/)) for the last day to drop a course.

• **Grade Appeals (College of Science and Engineering)**
  As stated in University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures, a student who believes that he or she has not been held to appropriate academic standards as outlined in the class syllabus, equitable evaluation procedures, or appropriate grading, may appeal the final grade given in the course. The burden of proof is upon the student to demonstrate the appropriateness of the appeal. A student with a complaint about a grade is encouraged to first discuss the matter with the instructor. For complete details, including the responsibilities of the parties involved in the process and the number of days allowed for completing the steps in the process, see University Procedure 13.02.99.C2.01, Student Grade Appeal Procedures. These documents are accessible through the University Rules website at [http://www.tamucc.edu/provost/university_rules/index.html](http://www.tamucc.edu/provost/university_rules/index.html), and the College of Science and Engineering Grade Appeals webpage at [http://sci.tamucc.edu/students/GradeAppeal.html](http://sci.tamucc.edu/students/GradeAppeal.html). For assistance and/or guidance in the grade appeal process, students may contact the chair or director of the appropriate department or school, the Office of the College of Science and Engineering Dean, or the Office of the Provost.

• **Disability Services**
  The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please call (361) 825-5816 or visit Disability Services in Corpus Christi Hall 116.
If you are a returning veteran and are experiencing cognitive and/or physical access issues in the classroom or on campus, please contact the Disability Services office for assistance at (361) 825-5816.

http://disabilityservices.tamucc.edu/

- **Statement of Academic Continuity**
  In the event of an unforeseen adverse event, such as a major hurricane and classes could not be held on the campus of Texas A&M University–Corpus Christi; this course would continue through the use of Blackboard and/or email. In addition, the syllabus and class activities may be modified to allow continuation of the course. Ideally, University facilities (i.e., emails, web sites, and Blackboard) will be operational within two days of the closing of the physical campus. However, students need to make certain that the course instructor has a primary and a secondary means of contacting each student.

L. **OTHER INFORMATION**

- **Academic Advising**
  The College of Science & Engineering requires that students meet with an Academic Advisor as soon as they are ready to declare a major. The Academic Advisor will set up a degree plan, which must be signed by the student, a faculty mentor, and the department chair. Meetings are by appointment only; advisors do not take walk-ins. Please call or stop by the Advising Center to check availability and schedule an appointment. The College’s Academic Advising Center is located in Center for Instruction 350 or can be reached at (361) 825-3928.

**GENERAL DISCLAIMER**

I reserve the right to modify the information, schedule, assignments, deadlines, and course policies in this syllabus if and when necessary. I will announce such changes in a timely manner during regularly scheduled lecture periods.