MEEN 4345 Sensors and Systems  
School of Engineering and Computing Sciences  
Spring 2016

A. COURSE INFORMATION
Course number/section: MEEN 4345.001  
Class meeting time: MWF 2:00-2:50 pm  
Class location: EN 107  
Course Website: bb9.tamucc.edu

B. INSTRUCTOR INFORMATION
Instructor: Dr. Ruby Mehrubeoglu  
Office location: EN 222B  
Office hours: MW 9:30-11:00, F 10:00-12:00  
Telephone: 361-825-3378  
e-mail: ruby.mehrubeoglu@tamucc.edu  
Appointments: set-up through e-mail or phone

C. COURSE DESCRIPTION
Catalog Course Description
This course introduces sensors and sensing systems, and the acquisition, processing, and interpretation of signals obtained with selected sensors and systems. The course will also cover sensing modalities, signal transmission and reception. Measurement and uncertainty in sensors and systems will be discussed as applied to signal noise and interference. Filtering and estimation will be introduced. Sensing systems for vision, monitoring, and control applications will be surveyed. Sensor interfacing, signal conditioning and transforms will be applied. Other topics include multidimensional signal and image processing, object tracking, multisensor data fusion, applications in environmental monitoring, remote sensing and surveillance.

Extended Course Description
The objectives of this course include introducing students to sensors at component level to develop subsystems and more complex sensing systems that monitor physical phenomena in laboratory or marine/terrestrial environments; apply signal conditioning techniques to improve signal quality; design and integrate an application-specific sensing system in a final project.

This is a senior technical elective course.

D. PREREQUISITES AND COREQUISITES
Prerequisites
MATH 2414 Calculus II, PHYS 2426 University Physics II, ENGR 2460 Circuit Analysis or equivalent
E. REQUIRED TEXTBOOK(S), READINGS AND SUPPLIES

Required Textbook(s)

Other materials will be provided by the instructor.

Optional Textbook(s) or Other References

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.

By the end of this course, students should be able to:

1. Understand types of sensors and survey modern sensor systems for measuring a variety of physical quantities
2. Characterize and calibrate sensors
3. Design measurement systems
4. Investigate aggregation and analysis of sensing modalities; sensed data; data transmission;
5. Understand and investigate signal representation
6. Apply principles of signal conditioning for prediction, filtering and estimation in the context of sensing systems
7. Analyze linear and nonlinear systems and their performance
G. INSTRUCTIONAL METHODS AND ACTIVITIES

Methods and activities for instruction include the following: lectures, homework assignments, pop-quizzes, mini projects (hands-on lab exercises), one midterm exam, a final project, oral presentations, and a comprehensive final exam.

Mini projects will involve hands-on exercises using hardware components that will allow students to interface, calibrate, and characterize sensors. The final project will be a more extensive implementation of sensor systems that will involve sensor system design, interfacing, signal acquisition, and signal conditioning to solve an engineering/scientific detection/monitoring problem. Homework assignments will involve both problems and software simulations. All assignments are due in one week from the date of assignment unless otherwise announced. Mini projects and final project are team assignments. All others are individual exercises.

H. MAJOR COURSE REQUIREMENTS AND GRADING

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>% of FINAL GRADE</th>
<th>Guaranteed Grade</th>
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</thead>
<tbody>
<tr>
<td>Midterm Exam</td>
<td>20</td>
<td>90 – 100 A</td>
</tr>
<tr>
<td>Homework and Pop-quizzes</td>
<td>20</td>
<td>80 – 89 B</td>
</tr>
<tr>
<td>Mini Projects (team)</td>
<td>20</td>
<td>70 – 79 C</td>
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<tr>
<td>Final Project (team)</td>
<td>15</td>
<td>60 – 69 D</td>
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<tr>
<td>Final Exam</td>
<td>25</td>
<td>&lt; 60 F</td>
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<tr>
<td>TOTAL</td>
<td>100</td>
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# I. COURSE CONTENT/SCHEDULE

<table>
<thead>
<tr>
<th>WEEK</th>
<th>TOPIC</th>
<th>CHAPTER</th>
<th>ASSIGNMENTS</th>
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<tbody>
<tr>
<td>1, 1/20</td>
<td>Introduction, Terminology</td>
<td>1</td>
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<tr>
<td>2, 1/25</td>
<td>Sensors and Transducers: Types, characteristics</td>
<td>2</td>
<td>HW 1: Sensing modalities, sensors, systems, sensor signals (research based) [SLO 1]</td>
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<tr>
<td>3, 2/1</td>
<td>Sensors and Transducers: Characteristics, limitations (temperature, optical sensors)</td>
<td>3, 4</td>
<td>HW 2: Sensor characterization, calibration and analysis [SLO 1, 2]</td>
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<tr>
<td>4, 2/8</td>
<td>Data Acquisition and Interfacing (electric and magnetic sensors)</td>
<td>5, 11.1-11.3</td>
<td>Mini Project 1 (Hands-on): Sensor Data Acquisition, Sensor Characterization and Interfacing [SLO 2, 4]</td>
</tr>
<tr>
<td>5, 2/15</td>
<td>Transforms (mechanical sensors)</td>
<td>5, 6 Handouts</td>
<td>HW 3: Fourier and other transforms (calculations and MATLAB simulations) [SLO 4, 5, 6]</td>
</tr>
<tr>
<td>6, 2/22</td>
<td>Error Analysis, Calibration (acoustic sensors)</td>
<td>7, 8 Handouts</td>
<td>Mini Project 2 (Hands on): Sensor Calibration [SLO 2, 5]</td>
</tr>
<tr>
<td>7, 2/29</td>
<td>Noise and Interference (chemical sensors)</td>
<td>8, 11 Handouts</td>
<td>MIDTERM EXAM</td>
</tr>
<tr>
<td>8, 3/7</td>
<td>Signal Conditioning/Filtering (radiation sensors)</td>
<td>9, 11, 12.3-12.4 Handouts</td>
<td>HW 4: Signal Error Analysis [SLO 6]</td>
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<tr>
<td>9, 3/14</td>
<td>SPRING BREAK</td>
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<tr>
<td>10, 3/21</td>
<td>Sensor Applications: vision, monitoring, control (MEMS sensors)</td>
<td>10.1-10.3 Handouts</td>
<td>Introduction to Final Project and Requirements</td>
</tr>
<tr>
<td>11, 3/28</td>
<td>Digital/Analog Interfacing</td>
<td>11.4-11.5, 12</td>
<td>HW 5: Filtering techniques and operations (calculations and MATLAB applications) [SLO 5, 6]</td>
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<tr>
<td>12, 4/4</td>
<td>Sensor Systems (smart sensors)</td>
<td>10.4-10.5 Handouts</td>
<td>Mini Project 3 (Hands on): Sensor and System Performance [SLO 2, 5, 7]</td>
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<tr>
<td>13, 4/11</td>
<td>Sensor Systems, data fusion</td>
<td>Handouts</td>
<td>HW 6: Sensor Systems, Data Fusion [SLO 4, 6, 7]</td>
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<td>14, 4/18</td>
<td>Linear and nonlinear systems</td>
<td>Handouts</td>
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<tr>
<td>15, 4/25</td>
<td>Data Processing and Analysis/Transforms</td>
<td>Handouts</td>
<td>Final Projects Due – Oral Presentations [SLO 3, 6]</td>
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<td>16, 5/2</td>
<td>Virtual Sensing for monitoring and control</td>
<td>Handouts</td>
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<td>FINAL EXAM</td>
<td>May 6, 2015 – Friday, 1:45 – 4:15 pm</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
You are advised to attend all lectures and laboratories. If you miss a class period, you are responsible for whatever is covered or announced during your absence. There will be no make-ups for oral presentations or quizzes. The students are expected to display responsible conduct in the classroom and laboratory, including but not limited to adhering to the rules and regulations, and respecting the instructor and fellow classmates.

Late Work and Make-up Exams
No makeup examinations will be given except in the case of a documented extreme emergency, or University-accepted excuse. Makeup exams will be different from the regular exams and more challenging.

All assignments, both individual and team, must be uploaded by each student to Black Board online system as well as hard copies handed to the course professor in class by the due dates. Late assignments will only be accepted with penalty and with prior notification. There will be a 20 point deduction per late day from the total score of maximum 100 up to 5 days, after which a late assignment will not be accepted. Late assignments will not be accepted after the graded assignments are returned to class.

Extra Credit
Extra credit may be assigned at the discretion of the instructor.

Food in Class
Eating or drinking is strictly prohibited in the labs, and not permitted in the lecture rooms. Students with food or drink in visible sight will be asked to discard them, or leave the room. All signage regarding health and safety must be followed in the lecture rooms and laboratories.

Missed Exam
No makeup examinations will be given except in the case of a documented extreme emergency, or University-accepted excuse. Makeup exams will be different from the regular exams and more challenging.

Participation
Students are expected to participate in the in-class and online exercises, discussions, and team work.

Use of Electronic Devices
The use of cell phones, electronic devices, or computers for purposes other than those of the course objectives of the day is not permitted. Restricted activities include but are not limited to text messaging, twittering, talking on the phone, instрамmimg, browsing on the internet,
and disrupting the classroom activities. Anyone displaying unsuitable classroom behavior will be asked to leave the classroom or the laboratory. Recording of part or all of the lecture or lab instruction and materials requires approval of the course instructor.

**Safety**
The safety of students, faculty, staff and visitors to the engineering laboratories is of paramount importance to the Mechanical Engineering and Engineering Technology programs. You must follow all safety procedures and use personal protective equipment as required in each laboratory and workshop. Any student who attempts to use equipment without authorization or violates any safety policy or regulation will be immediately removed from the laboratory.

### 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)**
  The grade of W will be assigned to any student officially dropping a course. Please consult with the instructor before you decide to drop to be sure it is the best thing to do. Just stopping attendance and participation WILL NOT automatically result in your being dropped from the class. Should dropping the course be the best course of action, visit the Office of the University Registrar for the Course Drop Form that must be submitted. No student is eligible to receive a W without completing the official drop process by this deadline. 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/](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.