EE 313 Linear Signals and Systems

Lecture: Tuesdays & Thursdays 11:00am-12:15pm UTC 3.104
Unique Number: 16045

Instructor Information
Robert W. Heath Jr., Ph.D., P.E.
Cullen Trust Endowed Professor
Office Address: UTA 7.516
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Office hours: Tuesdays 2:00-4:30pm, location 7.516 (or adjacent conference room)

Teaching Assistant Information
Megha Parhi
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Tutoring Information
The ECE Department offers free drop-in tutoring. The schedule will be updated here:
http://www.ece.utexas.edu/undergraduate/tutoring

Prerequisites
(1) Prerequisite: Electrical Engineering 411, 331, or Biomedical Engineering 311 with a grade of at least C-; Mathematics 427K with a grade of at least C-; and credit with a grade of at least C- or registration for Mathematics 340L.

Required Reading Materials

Slides based on Oppenheim and Willsky (O&W) will be provided at least one lecture in advance; it is recommended to print these slides before coming to lecture to allow efficient note-taking.

Computer Resources
Handouts, grading, announcements, and communication via email will be performed using Canvas http://canvas.utexas.edu. You should be able to log in if you have a valid UT ID and are registered for this class. You will be responsible for checking canvas and your email for notifications about assignments.

This class uses MATLAB to solve some homework problems and to create plots of functions. It is a powerful script-based programming language used by many practicing engineers and scientists. MATLAB is available on most campus computers and a student version can be purchased from the bookstore or campus computer store. We will provide more information and
a short tutorial around the 3rd week of class and there are many web tutorials to get you started. Being able to learn and eventually master such tools on your own (through self-study, online forums, etc.) is a crucial engineering skill, although you are welcome to seek help from your classmates and the TA. This class will require only simple MATLAB code.

**Course Introduction**

Signal processing is rich with tools that have applications in a broad class of problems including communications, controls, image compression, sonar, radar, array processing, and digital video. The theory is both elegant and beautiful. This course will be your first introduction to the concepts of signal processing, especially processing signals with linear systems.

Although this course will often seem abstract, e.g. it consists mainly of mathematical models engineers use when designing systems, the tools you learn in this course will have practical application to many areas of engineering. Most directly the concepts can be applied to everyday problems like audio signal processing, e.g. processing speech and music, and image processing, e.g. photoshopping your favorite picture. You will find these show up again and again in your further education, especially if you pursue a specialization in communications, signal processing, systems, control theory, circuit design, and biomedical engineering among others. The emphasis of this course is on signal processing tools but we will discuss applications as time permits. If something is too abstract, please be sure to ask to see how it fits in with a practical application.

This course is meant to prepare you for the remainder of your electrical engineering education by providing an abstraction of a large class of engineering systems, and tools for analyzing them. Many fields of engineering can be reduced to creating a series of block diagrams (systems), and analyzing the properties of the signals that move through the system. By the end of this course, you will be able to analyze and design systems by simply examining their input and output signals. You will be able to compute a system output in either the time or frequency domain given the system input and a description of the system, using the Laplace, Fourier, or Z-transform, as appropriate. You will understand the differences and similarities between discrete and continuous time signals and systems. A detailed lecture outline is provided in a separate document.

Finally, I hope you will learn not only the “rigor” and methodology (which is what most of the homework will cover), but also come to appreciate the generality, power, and elegance of these intellectual tools and this way of thinking. This class, for most students, does require a considerable amount of time, dedication, and concentration in order.
Course Policies

Homeworks – Homework will typically be assigned on or before Thursday and due the following Thursday at the beginning of class at 9:30am. After a grace period of up to 5 minutes, homework will be considered late and count for 50% until Friday evening, at which point they will count for 0%. Discussion of homework questions is encouraged. Please submit your own independent homework solutions. Late homework will be accepted for full credit only if prearranged at least seven days in advance or under extraordinary circumstances (if you aren't sure that your excuse is extraordinary, then it isn't).

Exams - There will be two midterm exams and one final. You are responsible for material covered in the course and in the assigned readings.

Regrade Policy - All requests for regrades, on homework or exam, must be submitted in writing within a week of their return to you. No verbal complaints will be considered. Before submitting any request for partial credit, please keep in mind that the first objective of grading is to be consistent. It may seem unfair that you did not get as much partial credit as you think you deserve. Keep in mind, however, that this may have been consistently applied to all students thus no more partial credit can be given. Mistakes can be made in the grading process, which will be corrected, but it is unlikely that more partial credit will be given. Be aware that the result of a regrade can actually be a lower score as the entire problem will be regraded.

Evaluations - Course and instructor evaluations will occur at the end of the semester.

Grading

• 20% Midterm 1
• 20% Midterm 2
• 15% Homework and participation
• 40% Final exam
• 5% Weekly quizzes (no retakes, lowest score dropped)

Note that letter grades will be assigned only at the end of the course. Plus/minus grading will be employed. Grades will be curved at the end of the semester (in your favor).

Academic Dishonesty

Faculty in the ECE Department are committed to detecting and responding to all instances of scholastic dishonesty and will pursue cases of scholastic dishonesty in accordance with university policy. Scholastic dishonesty, in all its forms, is a blight on our entire academic community. All parties in our community -- faculty, staff, and students -- are responsible for creating an environment that educates outstanding engineers, and this goal entails excellence in technical skills, self-giving citizenship, and ethical integrity. Industry wants engineers who are competent and fully trustworthy, and both qualities must be developed day by day throughout an entire lifetime. Scholastic dishonesty includes, but is not limited to, cheating, plagiarism, copying, collusion, falsifying academic records, or any act designed to give an unfair academic advantage to the student. The fact that you are in this class as an engineering student is
testament to your abilities. Penalties for scholastic dishonesty are severe and can include, but are not limited to, a written reprimand, a zero on the assignment/exam, re-taking the exam in question, an F in the course, or expulsion from the University. Don’t jeopardize your career by an act of scholastic dishonesty. Details about academic integrity and what constitutes scholastic dishonesty can be found at the website for the UT Dean of Students Office and the General Information Catalog, Section 11-802. Note: Copying in any form is considered cheating, whether from another student or the solution manual.

**Documented Disability Statement for Syllabus**

The University of Austin provides upon request appropriate academic accommodations for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-6441 TTY.

**The University of Texas Honor Code**

The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

**Religious Holidays**

Religious holy days sometimes conflict with class and examination schedules. If you miss a work assignment or other project due to the observance of a religious holy day you will be given an opportunity to complete the work missed within a reasonable time after the absence. It is the policy of the University of Texas at Austin that you must notify each of your instructors at least fourteen days prior to the classes scheduled on dates you will be absent to observe a religious holy day.

**Classroom Evacuation for Students**

All occupants of university buildings are required to evacuate a building when a fire alarm and/or an official announcement is made indicating a potentially dangerous situation within the building. Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building. If you require assistance in evacuation, inform your instructor in writing during the first week of class. For evacuation in your classroom or building:

1. Follow the instructions of faculty and teaching staff.
2. Exit in an orderly fashion and assemble outside.
3. Do not re-enter a building unless given instructions by emergency personnel.

**About Your Instructor**

Robert W. Heath Jr. is a Cullen Trust for Higher Education Endowed Professor in the Dept. of Electrical and Computer Engineering at the University of Texas at Austin. In 2011, the IEEE
Board of Directors elevated him to IEEE Fellow for “contributions to multiple antenna wireless communications”, their highest level of membership. He was an elected Distinguished Lecturer in the IEEE Signal Processing Society and the IEEE Vehicular Technology Society. He is also an amateur radio operator and a registered Professional Engineer in Texas.

He has considerable real-world engineering experience, including working at a wireless startup in Silicon Valley, running a consulting company MIMO Wireless Inc, and co-founding a local startup Kuma Signals LLC. He has consulting with many companies around the world and is on the technical advisory board of several startup companies.

His approximately 400 publications are among the most cited in wireless communications and signal processing. He has published two books: Millimeter Wave Wireless Communications (a book on the theory and practice of wireless communications at high frequencies) and Digital Wireless Communication: Physical Layer Exploration Lab Using the NI USRP (a laboratory book on signal processing for wireless communications). A third book is in press: Introduction to Wireless Communications: A Signal Processing Perspective. He is working on a final book on MIMO wireless communication, which he hopes to finalize in 2017.

He is among the most highly cited researchers in Computer Science and Electronics, with a rank of 94 worldwide [http://www.guide2research.com/scientists](http://www.guide2research.com/scientists). He is among the top cited research in wireless communications and signal processing. His papers have received numerous awards including the 2010 and 2013 EURASIP Journal on Wireless Communications and Networking best paper awards, the 2012 Signal Processing Magazine best paper award, a 2013 Signal Processing Society best paper award, the 2014 EURASIP Journal on Advances in Signal Processing best paper award, the 2014 Journal of Communications and Networks best paper award, the 2016 IEEE Communications Society Fred W. Ellersick Prize, and the 2016 IEEE Communications Society and Information Theory Society Joint Paper Award. He is an elected member of the IEEE Signal Processing Society Board of Governors.

Outside of teaching, Prof. Heath is interested in stand up jetskis (where he has built two custom carbon fiber skis), running, mountain biking, wakeboarding, and scuba diving. He recently became a private pilot.