

**Department of Electrical and Computer Engineering  
University of Massachusetts Amherst**

**ECE 213: Continuous-Time Signals and Systems, Spring 2020**

**Description**

Continuous-time signal and system representations. Linear time invariant systems, impulse responses, convolution. Frequency-domain analysis of continuous-time signals and systems: Fourier series, Fourier Transforms, frequency responses, filtering. Laplace Transforms for systems analysis: transient responses, transfer functions, stability. Sampling, aliasing, reconstruction. Applications: modulation, filter design, feedback systems. (4 credits)

**Prerequisites**

ECE 201, ECE 202, ECE 210

**Course Format**

Lectures: Monday, Wednesday, Friday, 10:10 – 11 AM, Goessmann 20.

Discussion: One 50-minute session on Monday. Sections: 12:20 – 1:10 PM, 1:25 – 2:15 PM, 4 – 4:50 PM, ELab 323

**Objectives**

Students completing this course will be able to:

1. Describe and analyze continuous-time signals in time and frequency domains.
2. Use time domain techniques to characterize responses of continuous-time systems.
3. Use transform domain techniques to analyze and specify properties of continuous-time systems.
4. Use sampling and reconstruction techniques to convert between continuous-time and discrete-time signals.
5. Apply signals and systems theory to the design of frequency-selective filters, modulators, and feedback systems.

**Instructors**

Patrick Kelly (Lectures, Exams); email: [pkelly@umass.edu](mailto:pkelly@umass.edu)

Office Hours: Tuesday, 2:30 – 3:30 PM; Thursday, 11:30 AM – 12:30 PM, Marcus 215B

Marco Duarte (Discussions, Homework); email: [mduarte@ecs.umass.edu](mailto:mduarte@ecs.umass.edu)

Office Hours: Wednesday, 1:30 – 2:30 PM; Thursday, 1:30 – 2:30 PM, Marcus 215I

Bill Leonard (Computing Exercises); email: [leonard@ecs.umass.edu](mailto:leonard@ecs.umass.edu)

Office Hours: TBD

Cameron Foss (TA); email: [cjfoss@umass.edu](mailto:cjfoss@umass.edu)

Office Hours: TBD

Bo Guan (TA); email: [boguan@umass.edu](mailto:boguan@umass.edu)

Office Hours: TBD

Sarah Lamotte (TA); email: [slamotte@umass.edu](mailto:slamotte@umass.edu)

Office Hours: TBD

**Textbook**

Signals and Systems: Theory and Applications, F. Ulaby and A. Yagle, Michigan, 2018.

(Available as free pdf download at <https://www.publishing.umich.edu/publications/ee/> - note that there are several books on the page, and you might need to scroll down to find the right one.)

**Additional References**

Linear Systems and Signals (3<sup>rd</sup> ed.), B.P. Lathi, Oxford, 2017.

Signals and Systems (3<sup>rd</sup> ed.), H. Hsu, Schaum's Outline Series, McGraw-Hill, 2014.

**Tentative weekly topics outline (may be adjusted as needed)**

Week	Topics	Readings from text	Assignment
1	Introduction; review of complex numbers and complex exponentials; classes of signals.	Appendix B; Sec. 1.1	Homework 1
2	Operations on signals; signal properties; introduction to continuous-time LTI systems.	Sec. 1.2-1.5, 2.1	Homework 2
3	Time domain analysis of LTI systems: impulse response, convolution; System properties: causality, stability.	Sec. 2.2-2.6	Homework 3
4	Time domain analysis of LTI systems (cont.): differential equation representations, response to complex exponential inputs, canonical (direct form) implementations.	Sec. 2.7-2.8, class notes	Homework 4
5	Laplace Transform: poles and zeros, properties, transient responses of linear circuits.	Sec. 3.1-3.3	Disc. Quiz 1 Exam 1 (covers up to Week 4)
6	Laplace Transform: partial fraction expansions, transfer functions, system stability, invertible systems.	Sec. 3.4-3.8	Homework 5
7	Laplace Transform applications: op-amp circuits, system synthesis, feedback control.	Sec. 4.5-4.8	Homework 6
8	Fourier Series: representations of periodic signals, application to circuit analysis.	Sec. 5.1-5.6	Homework 7
9	Fourier Transform: definition, properties.	Sec. 5.7-5.10	Disc. Quiz 2 Exam 2 (covers up to week 8)
10	Fourier Transform for systems analysis: frequency response, magnitude and phase, frequency-selective filters.	Sec. 5.11-5.13, 6.2	Homework 8
11	Fourier Transform applications: filter design, amplitude modulation.	Sec. 6.3, 6.6, 6.9, 6.12	Homework 9
12	Sampling theorem: sampling of bandlimited signals, reconstruction from samples, aliasing.	Sec. 6.13	Homework 10
13	Applications of sampling: Discrete Fourier Transform (DFT), discrete-time implementations of continuous-time processing.	Class notes	Disc. Quiz 3
<b>Final Exam</b> (comprehensive)			

**Grading Policy:** The course grade will be based on the following components:

1. Homework Assignments - 15% of total grade.
2. Computing Exercises – 6% of total grade.
3. Discussion Quizzes – 10% of total grade.
4. Exam 1 (Wed., Feb. 26, 7-9 PM, ISB 135) – 23% of total grade.
5. Exam 2 (Wed., April 1, 7-9 PM, ISB 135) – 23% of total grade.
6. Final Exam (Friday, May 1, 10:30 AM – 12:30 PM, Goessmann 20) – 23% of total grade.  
(Please see topics outline for assignment schedule.)

The letter grades corresponding to numerical grade ranges are as follows:

If total course grade is in the range:	The letter grade will be at least:	If total course grade is in the range:	The letter grade will be at least:
88 - 100	A	68 - 71	C+
84 - 87	A-	64 - 67	C
80 - 83	B+	60 - 63	C-
76 - 79	B	55 - 59	D
72 - 75	B-	< 55	F

**Homework:** There will be ten homework assignments (one every week except for exam weeks). Each homework assignment will be posted on Moodle on Friday and due the following Friday. Your solutions should be submitted on paper at the beginning of class. **Late submissions will not be accepted.** Each homework assignment will receive two separate scores:

A-Grade: This grade reflects the fraction of assigned problems for which complete solutions were submitted (maximum of 50 points).

B-Grade: This grade is the score achieved on a subset of the assigned problems that are selected for full grading (maximum of 50 points).

The total grade for a given homework assignment is  $\text{Grade} = A+B$ .

**Computing Exercises:** A total of three computing exercises will be assigned in this course. The purpose of the exercises is to give you practice with computational aspects and implementations of course topics. The computing exercises will be assigned and administered by Prof. Leonard.

**Discussion Quizzes:** A very short online quiz will be assigned on Moodle before each discussion – these short quizzes are meant to give practice (with quick feedback) on the topics covered in the discussions. In addition, there will be a longer quiz given in the discussion session before each exam, intended to give practice and help with preparation for the exams.

**Exams:** Exams will be closed-book and closed-notes; calculators are not allowed. The exam packets will include some formula sheets. An additional single-sided handwritten formula sheet will be allowed for exams 1 and 2, which are non-cumulative. The final exam will be cumulative and a double-sided handwritten formula sheet will be allowed.

**Piazza:** This term we will be using Piazza as an aid for class discussion. We encourage you to post **short and relatively easy to answer** questions about course topics on Piazza, where they can be seen and receive replies from other members of the course. For longer and more complicated questions we ask that you come to one of the instructor or TA office hours. The link to the course Piazza site is: [piazza.com/umass/spring2020/ece213](https://piazza.com/umass/spring2020/ece213)

**Health and Wellbeing.** Success in this course and the College of Engineering depends heavily on your personal health and wellbeing. Recognize that stress is an expected part of the college experience, and it often can be compounded by unexpected setbacks or life changes outside the classroom. We strongly encourage you to reframe challenges as an unavoidable pathway to success. Reflect on your role in taking care of yourself throughout the term, before the demands of exams and projects reach their peak. Please feel free to reach out to us about any difficulty you may be having that may impact your performance in your courses or campus life as soon as it occurs and before it becomes too overwhelming. We encourage you to contact support services on campus that stand ready to assist you. Within the College, you may reach out to your academic advisor, the Office of Student Affairs (126 Marston) or the Office of Community Equity and Inclusion (128 Marcus). You can learn about the confidential mental health services available on campus by calling the Center for Counseling and Psychological Health (CCPH) at 413.545.2337 or visiting their website at [umass.edu/counseling](http://umass.edu/counseling). There are many other resources on campus for students facing personal, financial or life challenges to find support, stay in school, and graduate. See a comprehensive list at [umass.studentlife/single-stop](http://umass.studentlife/single-stop). Help is always available. Please reach out for support finding the resources you need.

**Disability Accommodation and Inclusive Learning Statement.** Your success in this class is important to us. We all learn differently and bring different strengths and needs to the class. The University of Massachusetts Amherst is committed to making reasonable, effective and appropriate accommodations to meet the needs of students with disabilities and help create a barrier-free campus. If you have a qualifying disability and require accommodations while participating in this course, please work with Disability Services to have an accommodation letter sent to Prof. Kelly in a timely manner. If you have a disability but are not yet affiliated with Disability Services, please register with Disability Services (161 Whitmore Administration building; phone 413-545-0892). Information on services and materials for registering are also available on their website [www.umass.edu/disability](http://www.umass.edu/disability). *It is incumbent upon you contact Prof. Kelly during the first few weeks of the semester, or shortly following registration with Disability Services, to ensure that your accommodations are being sufficiently met, including extra time and note-taking access, as applicable.* Finally, beyond disability accommodations, if there are aspects of the course that prevent you from learning or make you feel excluded, please let us know as soon as possible. Together we'll develop strategies to meet both your needs and the requirements of the course.

**Integrity.** There is no place for a dishonest engineer! Please read and be aware of the academic honesty policy: [http://www.umass.edu/dean\\_students/academic\\_policy](http://www.umass.edu/dean_students/academic_policy). While this isn't something that should arise, it is something we should be aware of and discuss as a class, as integrity is a core value of the engineering profession.

**Inclusivity:** The diversity of the participants of this course is a valuable source of ideas, problem solving strategies, and engineering creativity. If you feel that your contribution is not being valued or respected for any reason, please speak with one of us privately. If you wish to communicate with someone else in the College, speak with Assistant Dean Dr. Paula Rees ([rees@umass.edu](mailto:rees@umass.edu), 413.545.6324, 128b Marcus Hall). You may also submit anonymously through the College of Engineering Climate Concerns and Suggestions on-line form (<https://tinyurl.com/UMassEngineerClimate>) and/or the Positive and Negative Classroom Experience online form (<https://tinyurl.com/UMassEngineerClassroom>). We are all members of an academic community with a shared responsibility to cultivate a climate where all students/individuals are valued and where both they and their ideas are treated with respect.

**Pronouns and Names.** Everyone has the right to be addressed by the name and pronouns that they use for themselves. Students can indicate their preferred/chosen first name and pronouns on SPIRE, which appear on class rosters. Please let us know what name and pronouns we should use for you if they are not on the roster. A student's chosen name and pronouns are to be respected at all times in the classroom. To learn more, read the Intro Handout on Pronouns: [https://www.umass.edu/stonewall/sites/default/files/pronouns\\_intro.pdf](https://www.umass.edu/stonewall/sites/default/files/pronouns_intro.pdf)

**Title IX.** Any conduct that has the purpose or effect of unreasonably interfering with an individual's performance by creating an intimidating, hostile, or sexually offensive educational, academic, residential, or working environment is considered sexual harassment. Faculty have the responsibility to inform students of the resources and reporting options relevant to reporting an incident of sexual assault, sexual harassment, relationship violence or stalking for all genders. You may go to the Title IX webpage at <http://www.umass.edu/titleix/> and the Sexual & Relationship Violence Resource Guide at [https://www.umass.edu/titleix/sites/default/files/documents/sexual\\_violence\\_resource\\_guide-fall2019.pdf](https://www.umass.edu/titleix/sites/default/files/documents/sexual_violence_resource_guide-fall2019.pdf)

to find more information about resources and reporting options. Please reach out to one of us if you would like assistance connecting with any of these resources/options. You may also contact William Brady, the Interim Title IX Coordinator by email at [wbrady@umass.edu](mailto:wbrady@umass.edu) or by phone at (413) 545-6204 if they have any questions or want to make a report, file a complaint, find out about resources and/or academic support.