NC STATE UNIVERSITY

ECE 301 Course Syllabus

Linear Systems

Table of Contents

Back to TOC

ΩΩΩ

INSTRUCTOR AND INFORMATION

Name	Email	Office Location
Dr. Greg Bottomley	gebottom@ncsu.edu	Rm 2052, EB2

Student (Office) Hours

In-person: Monday and Wednesday, 2:45 – 3:15 PM
Virtual: Tuesday, 1:30 – 2:30 PM (see Zoom link in Moodle)

Preferred Method of Communication

Discussion Forum for questions of interest to others, Email otherwise

Response Time

Please allow 24 hours for a response to discussion forum and email inquiries.

Teaching Assistant(s)

Typically one or more teaching assistants (TAs) are assigned to this course. Their names and student (office) hours will be posted on Moodle and/or the lecture. TA duties may include grading homework, proctoring and grading tests and exams, and holding problem/help sessions.

COURSE INFORMATION

Course Website: https://wolfware.ncsu.edu/courses/my-wolfware/
Course Credit Hours: 3

Meeting Time and Tool Used

Monday, Wednesday, 1:30 – 2:45 PM in-person lectures in room 2124, EB3. Lectures will be recorded and available via Panopto.

Prerequisites/Corequisites

C– or better in ECE 211 AND C– or better in ECE 220

General Education Program (GEP) Information

None

NC STATE UNIVERSITY

GEP Category Fulfilled

None

GEP Corequisites

None

COURSE OVERVIEW

Informal Description

Characterization, representation, and analysis of signals and systems in both continuous-time and discrete-time with an emphasis on continuous-time. System characteristics include linearity and time-invariance, and signal types include finite-energy and periodic, power signals. Representation and analysis of signals and systems if performed primarily using Fourier transforms or series and their inverses, though bilateral Laplace transforms and z-transforms are introduced. Convolution is used to compute a system's output from its impulse response and input signal.

Informal Course Objectives

A. To provide students with an understanding of linear, time-invariant systems.
B. To provide Fourier analysis and synthesis tools.
C. To determine how to sample analog signals.

Structure

This course consists of weekly lectures, homework assignments, quizzes, tests, and a final exam. Resources and assignments are provided via Moodle, an (online) learning management system (LMS).

INFORMAL LEARNING OUTCOMES

Upon completion of this course, students will be able to:

1. Identify signal types including finite-energy and periodic, power signals.
2. Identify system characteristics including linearity and time-invariance.
3. Determine the output of a linear, time-invariant (LTI) system from its impulse response and input signal.
4. Perform Fourier analysis and synthesis of both finite-energy and periodic, power signals for both continuous-time and discrete-time signals.
5. Determine the minimum sampling rate required to reconstruct a bandlimited signal from its samples.
6. Compute Laplace transforms and z-transforms of continuous-time and discrete-time signals, respectively.

7. Describe introductory concepts of related topics introduced at the instructor's discretion, such as machine learning or communications.

COURSE MATERIALS

Required Textbook and/or Software

Alan V. Oppenheim, Alan S. Willsky, with S. Hamid Nawab, Signals & Systems, 2nd edition. Upper Saddle River, NJ: Prentice Hall, 1983. Available from Pearson (1997). Available to own for approximately $67.

MATLAB® software. Zero cost to student. See Technology Requirements below.

Optional Materials

None

TECHNOLOGY REQUIREMENTS

Hardware

Standard laptop or desktop computer. Recommendations can be found at technology requirements and recommendations.

Software

- Moodle and Wolfware
  - Moodle Accessibility Statement
  - Moodle Privacy Policy
  - NC State Privacy Policy
- Adobe Reader (for reading PDF files)
  - Accessibility Statement
  - Adobe Privacy Policy
- Zoom (for online synchronous meetings)
  - Zoom Accessibility Statement
  - Zoom Privacy Policy
- Panopto (for lecture/video capture and viewing)
  - Accessibility Features
  - Privacy Policy
- MATLAB(R) at NC State (software tool for DSP, you will need Signal Processing and Audio Toolboxes)
  - Accessibility Statement
  - Privacy Policy
  - Accessibility Statement
  - Privacy Policy

NC STATE UNIVERSITY

Minimum Computer and Digital Literacy Skills

- Obtain regular access to a reliable internet connection
- Ability to use online communication tools, such as email (create, send, receive, reply, print, send/receive attachments).
- Download and upload attachments
- Basic MATLAB® programming

NETIQUETTE

Netiquette is the term used to describe the special set of rules for online communication.

Students should be aware that their behavior impacts other people, even online. I hope that we will all strive to develop a positive and supportive environment and will be courteous to fellow students and your instructor. Due to the nature of the online environment, there are some things to remember when taking an online course and engaging with others.

Tips for Success:

- **Do**: Follow the same standards of behavior that you subscribe to offline. Keep in mind that all online communication is documented and therefore permanent.
- **Don't**: Flame others in discussion forums. Flaming is the act of responding in a highly critical, sarcastic, or ridiculing manner – especially if done on a personal level. Remember that these discussions are meant for constructive exchanges and learning!

- **Do**: Ensure you are responding to forums by the due date, in order to leave time for peers to comment on your response.
- **Don't**: Go for long periods of time without communicating to your instructors or classmates. It is important to stay a part of the online community!

- **Do**: Remember to read over your posts before selecting "Submit."
- **Don't**: Use slang, poor grammar, and other informal language in discussion forums or email messages to instructors or classmates.

GRADING

Grading Policy (varies by instructor within ranges given)

- 5 % - Quizzes: short quizzes to ensure engagement in lectures
- 15 % - Homework assignments: problems that go along with lectures.
- 50 % - Tests: two tests to provide intermediate evaluation of learning outcomes.(25% each)
- 30 % - Final exam: comprehensive evaluation of learning outcomes

NC STATE UNIVERSITY

Grading Scale

This course uses the standard NC State grading scale:

Low	Letter	High
97 ≤	A+	≤ 100
93 ≤	A	< 97
90 ≤	A-	< 93
87 ≤	B+	< 90
83 ≤	B	< 87
80 ≤	B-	< 83
77 ≤	C+	< 80
73 ≤	C	< 77
70 ≤	C-	< 73
67 ≤	D+	< 70
63 ≤	D	< 67
60 ≤	D-	< 63
0 ≤	F	< 60

Numerical grade values may or may not be curved prior to conversion to a letter grade.

COURSE SCHEDULE

Note: course schedule subject to change during the semester.

Topic	Description	Book	Lectures	Dates
Chapter 1	**Signals and Systems**			
Introduction & review	Signals & systems, continuous- & discrete-time, review math tools, power vs. energy signals	1.0, 1.1, 1.2	1,2	8/18,20
Signal types and common signals	Impulse, step, sinusoids, complex exponentials	1.3, 1.4	3	8/25
	Holiday (Monday)			9/1
System characterization	Function of functions, Linearity, time-invariance, memory, causality, stability, invertibility	1.6	4,5,6	8/27 9/3,8
Chapter 2	**LTI Systems**			

LTI systems	Impulse response, DT graphical convolution, CT semi-graphical convolution	2.0 – 2.2	7 – 10	9/10; 9/15,17; 9/22
	Wellness Day (Tuesday)			9/18
LTI system properties and types	Commutative, Distributive, Associative; causal, stable, invertible; more convolution	2.3	11	9/24
	End material test 1			
Chapters 3 & 4	**Fourier Analysis**			
CT periodic, power signals	CT Fourier Series, table, properties (review)	3.0, 3.1, 3.3	12	9/29
	Review for test 1		13	10/6
	TEST 1			10/8
	Fall Break			10/13
CT energy signals	Fourier transform, pseudo-FT, table	4.0 – 4.2	14,15	10/1,15
CT Fourier Transform Properties	Linearity, Time-shift, diff., int., time & freq scaling, time inversion, freq shifting, convolution, multiplication, table-based CTFT	4.3 – 4.6	16, 17	10/20,22
CT LTI systems, bandwidth, dBs	Filtering, magnitude & phase, bandwidth, decibels	3.9, 4.4, 6.0 – 6.2.0	18	10/27
DT signals	DT Fourier series, Fourier transform	3.6, 5.0 – 5.2	19,20	10/29; 11/3
A/D conversion	Sampling theorem, aliasing, quantization	Proakis & Manolakis	20	11/3
	End material test 2			
Two-side Laplace and z transforms	Two-sided Laplace transform, two-sided z-transform		21,22	11/5,10
Applications & related areas	TBD	Not in book	23,25	11/12; 11/24
	Review for test 2		24	11/17
	TEST 2			11/19
	Holiday			11/26
	Review for final exam		26	12/1
	Final exam, noon			12/10

There will be no field trips or out-of-class activities. Course schedule is subject to change.

COURSE POLICIES

Course Continuity

To ensure course continuity, changes made to the method of instructional delivery, course structure, course schedule, number of assignments, grading or other aspects of the course after the start of the

term will be communicated to all students in written form (e.g., dated syllabus revision or syllabus addendum) when course changes are implemented.

Audit Policy

Information about and requirements for auditing a course can be found at http://policies.ncsu.edu/regulation/reg-02-20-04. In addition, to receive an AU grade, students auditing the course must receive a passing score on the homework assignments and passing score on the quizzes.

Late Assignments

- In general, late assignments will not be accepted. However, the TWO lowest quiz grades and the TWO lowest homework grades will be dropped. This is to cover typical extenuating circumstances.
- If a student needs to miss more than two homework assignments and/or quizzes, the student is instructed to notify the professor as soon as possible to discuss further.

Incomplete Final Grades

When needed, the student requests an incomplete final grade and extended deadline from the instructor. If an extended deadline is not authorized, an unfinished incomplete grade will automatically change to an F after either (a) the end of the next regular semester in which the student is enrolled (not including summer sessions), or (b) by the end of 12 months if the student is not enrolled, whichever is shorter. Incompletes that change to F will count as an attempted course on transcripts. The burden of fulfilling an incomplete grade is the responsibility of the student. The university policy on incomplete grades is located at http://policies.ncsu.edu/regulation/reg-02-50-03. Additional information relative to incomplete grades for graduate students can be found in the Graduate Administrative Handbook in Section 3.18.F at http://www.fis.ncsu.edu/grad_publicns/handbook/

Attendance and Participation

Attendance at lectures is strongly encouraged as students help clarify the material through questions. If a test/exam is missed, the instructor should be contacted as soon as possible, and the student should be prepared to provide documentation. **If the absence is excused, the test/exam grade will be determine from the remaining tests/exams.**

For complete attendance and excused absence policies, please see *NC State's Attendance Policy: https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/ and the Withdrawal Process: https://studentservices.ncsu.edu/your-classes/withdrawal/process/*

Artificial Intelligence

This course permits you to use artificial intelligence (AI) tools, such as chatbots, text generators, paraphrasers, summarizers, or solvers, to get guidance on assignments, as long as you do so in an ethical and responsible manner. Essentially, you can think of these tools as ways to help you learn but not to entirely create work for assignments. AI is more like your tutor or TA, not a replacement for your independent thinking or creating your own work.

UNIVERSITY POLICIES

Academic Integrity and Honesty

Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct. Therefore, students are required to uphold the university pledge of honor and exercise honesty in completing any assignment. Violations of academic integrity will be handled in accordance with the Student Discipline Procedures REG 11.35.02 – Student Discipline Procedures – Policies, Regulations & Rules (ncsu.edu).

Please refer to the Academic Integrity web page for a detailed explanation of the University's policies on academic integrity and some of the common understandings related to those policies.

Privacy

Students may be required to disclose personally identifiable information to other students in the course, via electronic tools like email or web-postings, where relevant to the course. Examples include online discussions of class topics and posting of student coursework. All students are expected to respect the privacy of each other by not sharing or using such information outside the course.

In-person lectures may be recorded, including audio recording of students asking or answering questions. If that is a concern to the student, they may discuss that with the instructor for possible opt-out options.

Additional Rules and Regulations

Students are responsible for reviewing the NC State University Policies, Rules, and Regulations (PRRs) which pertain to their course rights and responsibilities, including those referenced both below and above in this syllabus:

- Equal Opportunity and Non-Discrimination Policy Statement and additional references
- Code of Student Conduct
- Grades and Grade Point Average
- Credit-Only Courses
- Audits

Students with Disabilities

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the Disability Resource Office at Holmes Hall, Suite 304,Campus Box 7509, 919-515-7653 . For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (REG02.20.01)

Trans-Inclusive Statement

In an effort to affirm and respect the identities of transgender students in the classroom and beyond, please contact me if you wish to be referred to using a name and/or pronouns other than what is listed in the student directory.

NC STATE UNIVERSITY

Basic Needs Security

Any student who faces challenges securing their food or housing or has other severe adverse experiences and believes this may affect their performance in the course is encouraged to notify the professor if you are comfortable in doing so. Alternatively, you can contact the Division of Academic and Student Affairs to learn more about the Pack Essentials program https://dasa.ncsu.edu/pack-essentials/

COURSE EVALUATIONS

ClassEval is the end-of-semester survey for students to evaluate instruction of all university classes. The current survey is administered online and includes 12 closed-ended questions and 3 open-ended questions. Deans, department heads, and instructors may add a limited number of their own questions to these 15 common-core questions.

Each semester students 'responses are compiled into a ClassEval report for every instructor and class. Instructors use the evaluations to improve instruction and include them in their promotion and tenure dossiers, while department heads use them in annual reviews. The reports are included in instructors ' personnel files and are considered confidential.

Online class evaluations will be available for students to complete during the last two weeks of the semester for full semester courses and the last week of shorter sessions. Students will receive an email directing them to a website to complete class evaluations. These become unavailable at 8am on the first day of finals.

> Contact ClassEval Help Desk: classeval@ncsu.edu
> ClassEval website
> More information about ClassEval

SYLLABUS MODIFICATION STATEMENT

This syllabus represents a flexible agreement. It outlines the topics we will cover and the order we will cover them in. Minor changes in the syllabus can occur if we need to slow down or speed up the pace of instruction. Changes to the syllabus will be communicated to the students via Moodle.