# ECE 301 Course Syllabus

## ECE 301 – Linear Systems

### Section 001, Spring 2024, 3 Credit Hours

## Course Description

This course covers the fundamental concepts in signal processing, with a focus on linear time-invariant systems. Signal processing has found its applications in many disciplines such as communications, controls, machine learning, bioengineering, security/privacy, and circuits. Having a good grasp of both intuitions and mathematics of signal processing theories can greatly benefit a student's future role as an engineer. Topics covered include: characterization of continuous- and discrete-time systems, sampling theorem, Fourier transforms, Laplace transform, and $z$-transform. This year's offering will also give a **concise introduction to artificial intelligence (AI) / machine learning (ML)**, covering basic topics such as the convolutional neural network (CNN), linear regression, and principal component analysis (PCA).

*More course information:*

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 introduces continuous-time and discrete-time signal processing, especially processing signals with linear systems. The tools in this course provide foundational tools for other courses.

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 data science/machine learning/AI, communications, signal processing, systems, control theory, circuit design, or 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 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 that we call "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.

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 Structure

The course consists of two mandatory 75-min lectures and **one optional 50-min discussion section per week**. A teaching assistant will lead the discussion section, covering practice problems and

answering questions from students. There will be weekly homework assignments that contain both written problems and programming problems, two midterm exams, and one final exam. Programming will be in Matlab, and optionally, in Python or R. **Students are expected to be able to write computer programs in C and Matlab and apply mathematical tools from ECE 220 and calculus**.

## Teaching Team

***Instructor:***

*Dr. Chau-Wai Wong*, https://ncsu-wong.org/

***Teaching Assistants:***

*Mushfiqur Rahman, Zhaoyu Zhang, Prasun Datta, and Nate Sullivan*

## Course Meetings

### Lecture (In-Person Only)
Days: MW
Time: 4:30 pm - 5:45 pm
Location: 1231 EB2
*Attendance is **required** with pop-up quizzes. Lectures will be **in person** and recorded.*

### Discussion (Online Synchronous or Asynchronous)
Days: F
Time: TBD
Location: Zoom (link can be found on Piazza)
*Attendance is **optional**.*

## Course Materials

### Textbooks

**Signals and Systems** by Alan Oppenheim, Alan Willsky, and S. Hamid Nawab

Edition: Second

ISBN: 978-0138147570

Cost: $208 new online, $23 to rent, various other purchase options available. International version (paperback) probably OK.

*This textbook is required.*

### Prerequisites

ECE 211 and ECE 220.

### Co-requisites

None.

### Restrictions

None.

## Transportation

This course will not require students to provide their own transportation.

## Safety & Risk Assumptions

This course follows the university's safety and risk policies.

## Grading

### Grade Components

| Component | Weight | Details |
|---|---|---|
| Homework assignments | 35% | Weekly (10 to 12) homework assignments containing both written problems and programming problems. Assignments may include bonus problems. Quiz grades will be factored into the assignment grades. Failure to submit four (4) homework assignments without justification will result in a failing grade. |
| Midterm 1 | 20% | Midterm will be held during the regular class time. |
| Midterm 2 | 20% | Midterm will be held during the regular class time. |
| Final Exam | 25% | The final exam will be held during the final exam timeslot. The final will be comprehensive covering the material of the whole semester and with a slightly more focus on the $3^{rd}$ part of the course. |

### Letter Grades

**This Course uses Standard NCSU Letter Grading:**

$97 \leq$ **A+** $\leq 100$
$93 \leq$ **A** $< 97$
$90 \leq$ **A-** $< 93$
$87 \leq$ **B+** $< 90$
$83 \leq$ **B** $< 87$
$80 \leq$ **B-** $< 83$
$77 \leq$ **C+** $< 80$
$73 \leq$ **C** $< 77$
$70 \leq$ **C-** $< 73$
$67 \leq$ **D+** $< 70$
$63 \leq$ **D** $< 67$
$60 \leq$ **D-** $< 63$
$\ 0 \leq$ **F** $< 60$

### Requirements for Credit-Only (S/U) Grading

In order to receive a grade of S, students are required to take all exams and quizzes, complete all assignments, and earn a grade of C- or better. ***Conversion from letter grading to credit only (S/U) grading is subject to university deadlines.*** Refer to the Registration and Records calendar for deadlines related to grading. For more details refer to http://policies.ncsu.edu/regulation/reg-02-20-15.

### Requirements for Auditors (AU)

Information about and requirements for auditing a course can be found at
http://policies.ncsu.edu/regulation/reg-02-20-04.

## Policies on Incomplete Grades

If an extended deadline is not authorized by the instructor or department, 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) 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-02-50-3.

## Homework Assignment Policy

Due date & time: All assignments must be turned in before the beginning of class at 4:30 pm on the date they are due. The exact date will be indicated on the course webpage. If there is a discrepancy between the due dates listed on the course webpage and Gradescope, you must follow the due date indicated on the course webpage.

Final homework grade: Failure to submit four (4) homework assignments without justification will result in a failing grade. **The two lowest homework grades will be dropped** at the end of the semester, so you have two "free passes." Please use them sparingly, e.g., to allow for the possibility of illness, unanticipated events, and short-noticed deadlines of other courses.

Late assignment: You may turn in any assignment **one day late for up to 75% credit** and **no other extensions will be given**. There will be no make-up assignments even for those who have valid excuses to miss an assignment per the university regulation. The remedy for unexpected situations is built into the policy of dropping the two lowest homework grades. There will be no response to requests for extensions on assignments and excused assignments.

Submission: Homework will be submitted electronically via Gradescope. You will be required to mark the pages corresponding to different problems and subproblems when you make an upload. You may always upload multiple times if you make a mistake in marking. You will receive a zero for any problems not corrected identified/marked.

Regrade policy: All requests for regrades must be made through Gradescope **within 7 days**. No verbal complaints or email 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 may be given. Mistakes can be made in the grading process, which the TAs will be happy to correct, but it is unlikely that more partial credits will be given.

## Attendance Policy

For complete attendance and excused absence policies, please see
http://policies.ncsu.edu/regulation/reg-02-20-03

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Attendance/Absence Policy (see Attendance Regulation NCSU REG 02.20.03 at
http://policies.ncsu.edu/regulation/reg-02-20-03).

### Absences Policy

Excuses for unanticipated absences must be presented to the instructor within one week after the return to class.

### Makeup Work Policy

None.

### Additional Excuses Policy

None.

## Academic Integrity

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Discussion of homework questions is encouraged but please submit your own independent homework solutions.

Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct found at http://policies.ncsu.edu/policy/pol-11-35-01

Violations of academic integrity will be handled in accordance with the Student Discipline Procedures (NCSU REG 11.35.02).

### Honor Pledge

Your signature on any test or assignment indicates "I have neither given nor received unauthorized aid on this test or assignment."

## Digital Course Components

Students may be required to disclose personally identifiable information to other students in the course, via digital tools, such as 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.

**Digital Course Components:**

Course webpage (course portal): [Google "ncsu wong", find Dr. Wong's webpage, and go to the "Teaching" tab]

Piazza (for Q&A) [for hyperlink, see course webpage]

Gradescope (for homework submission) [for hyperlink, see course webpage]

Moodle (for in-class quizzes) [for hyperlink, see course webpage]

## Accommodations for 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) (https://policies.ncsu.edu/regulation/reg-02-20-01/).

## Accommodations for Mental Health Concerns and Stressful Events

As a student, you may experience a range of personal issues that can impede learning, such as strained relationships, increased anxiety, alcohol/drug concerns, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may impact your ability to participate in daily activities. It is very important that you have a support system and that you ask for help when you are struggling. The Counseling Center at NC State offers confidential mental health services for full time NC State students, including *same-day emergency services*. Please visit https://counseling.dasa.ncsu.edu/ to get connected.

The WolfPack Wellness Resources (https://wellness.ncsu.edu/resources/) is available to everyone. At the bottom of link, you can find the Mental Health First Aid (MHFA) and QPR Training programs.

## Non-Discrimination Policy

NC State provides equal opportunity and affirmative action efforts, and prohibits all forms of unlawful discrimination, harassment, and retaliation ("Prohibited Conduct") that are based upon a person's race, color, religion, sex (including pregnancy), national origin, age (40 or older), disability, gender identity, genetic information, sexual orientation, or veteran status (individually and collectively, "Protected Status"). Additional information as to each Protected Status is included in NCSU REG 04.25.02 (Discrimination, Harassment and Retaliation Complaint Procedure). NC State's policies and regulations covering discrimination, harassment, and retaliation may be accessed at http://policies.ncsu.edu/policy/pol-04-25-05 or https://oied.ncsu.edu/divweb/. Any person who feels that he or she has been the subject of prohibited discrimination, harassment, or retaliation should contact the Office for Equal Opportunity (OEO) at 919-515-3148.