# ECE 301 Course Syllabus

## ECE 301 – Linear Systems

### Section 001, Spring 2021, 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. In the Spring 2021 offering, we will also cover basic machine learning tools such as the principal component analysis (PCA), the linear regression, and the convolutional neural network (CNN).

## Course Structure

The course consists of two 75-minute real-time Zoom lectures per week. There will be weekly homework assignments that contains both written problems and programming problems, two midterm exams, and one final project. Programming will be in Matlab, and optionally, in Python or R.

## Instructors

**Dr. Chau-Wai Wong** - *Instructor*
**Email:** chauwai dot wong at NC State
**Web Page:** https://people.engr.ncsu.edu/cwong9/
**Online Office Hours:** TuTh 4:30 - 5:30 pm (tentative)

**Jisoo Choi** - *Teaching Assistant*
**Email:** cjs2094 at Gmail
**Online Office Hours:** TBD

**Shweta Meena** - *Teaching Assistant*
**Email:** smeena@ncsu.edu
**Online Office Hours:** TBD

## Course Meetings

### Lecture (Synchronized)

**Days:** MW
**Time:** 4:30pm - 5:45pm
**Location:** Zoom (link can be found on Piazza)
*This meeting is required.*

## Course Materials

### Textbooks

A. V. Oppenheim and A. S. Willsky, *Signals and Systems*, Prentice Hall, 2nd edition.

### Expenses

None.

### Materials

None.

## Requisites and Restrictions

### Prerequisites

ECE 211 and ECE 220.

### Co-requisites

None.

### Restrictions

None.

## Transportation

This course will not require students to provide their own transportation. Non-scheduled class time for field trips or out-of-class activities is NOT required for this class.

## Safety & Risk Assumptions

None.

## Grading

### Grade Components

| Component | Weight | Details |
|---|---|---|
| Homework assignments | 40% | Weekly assignments containing both written problems and programming problems. |
| Midterm 1 | 20% | |
| Midterm 2 | 20% | |
| Final Project | 20% | |

### Letter Grades

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

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

## 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.

## Late Assignments

All assignments must be turned in at the beginning of class on the date they are due. A penalty of 20 out of 100 pts per day will be assessed for all homework assignments turned in late. You are expected to turn in your assignments on time for any anticipated absences that you will have so please plan accordingly. Emergency or unanticipated absences will be handled on a case-by-case basis.

There will be no make-up homework assignment or exam. Grades for a missing item with **valid excuses and documentation** will be estimated using the grades of other available items in the same category.

Students who believe they have valid excuses to miss an assignment, project, or exam must comply with University Attendance Regulations REG 02.20.03 on NC State's website.

# Attendance Policy

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

## Attendance Policy

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

### Academic Integrity

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): https://people.engr.ncsu.edu/cwong9/ece301_21Spring/

Piazza (for Q&A): https://piazza.com/class/kk1vwe8ct6pa1

Moodle (for homework submission)

## 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/).

## 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.

| Class | Date | Topic | Readings | Assignment |
|---|---|---|---|---|
| 1 | 1/20 | Introduction | | HW1 |
| 2 | 1/25 | Signal notation and systems | 1.1 – 1.5 | |
| 3 | 1/27 | CT and DT systems, properties | 1.6 | HW2 |
| 4 | 2/1 | Stability, TI, and linearity | 1.6 | |
| 5 | 2/3 | DT system response, convolution | 2.1 | HW3 |
| 6 | 2/8 | CT convolution, properties | 2.2 | |
| 7 | 2/10 | System properties | 2.3 | HW4 |
| 8 | 2/15 | Eigenanalysis for matrices, principal component analysis | | |
| 9 | 2/17 | Linear regression and prediction | 3.1 – 3.2 | HW5 |
| 10 | 2/22 | Convolutional neural networks | | |
| 11 | 2/24 | CT systems with differential EQs | 2.4 | |
| 12 | 3/1 | Midterm 1 | | HW6 |
| 13 | 3/3 | DT systems with difference EQs | 2.4 | Project |
| 14 | 3/8 | Eigenfunctions and Fourier series | 3.3 – 3.5 | HW7 |
| 15 | 3/10 | Filtering and frequency response | 3.8 – 3.9 | |
| 16 | 3/15 | Fourier transform | 4.1 – 4.2 | HW8 |
| 17 | 3/17 | Sinc, rect, and properties | 4.2 – 4.3 | |
| 18 | 3/22 | More Fourier properties | 4.3 | HW9 |
| | 3/24 | Wellness Day | | |
| 19 | 3/29 | Convolution and multiplication | 4.4 – 4.5 | HW10 |
| 20 | 3/31 | DT Fourier transform | 5.1 – 5.3 | |
| 21 | 4/5 | Properties of the DT Fourier transform | 5.4 – 5.7 | HW11 |
| 22 | 4/7 | Sampling theorem | 7.1-7.4 | |
| 23 | 4/12 | Connections among FT, DTFT, and DFT | | |
| 24 | 4/14 | Midterm 2 | | HW12 |
| 25 | 4/19 | Bilateral Laplace transform, pole-zero plots, ROC | 9.1 – 9.3, appendix | |
| 26 | 4/21 | CT LTI system characterization, connections to freq. response | 9.4, 9.7, 9.8 | |
| 27 | 4/26 | Z-transform, pole-zero plots, ROC | 10.1 – 10.2 | |
| 28 | 4/28 | DT LTI system characterization, connections to freq. response | 10.4, 10.5 | |