# Introduction to Signals and Systems
EEL 3135
***Class Periods:*** MWF | Periods 7 (1:55 PM – 2:45 PM)
***Class Location:*** Turlington Hall (TUR) L005
***Academic Term:*** Fall 2023
**Canvas:** https://ufl.instructure.com/courses/?tt5t5

## Instructor
Name: Nicholas J. Napoli                    E-mail: n.napoli@ufl.edu
Office Location: NEB 427                    Phone: 352-392-7723
Office Hours: Fri 2:45 – 4:00 pm

## Teaching Assistants

- Julian Maldonado          Contact: julian.maldonado@ufl.edu
- Jenna Sheldon             Contact: jennasheldon@ufl.edu
- David Rosales             Contact: david.rosales@ufl.edu
- Christopher Celano        Contact: ccelano1@ufl.edu
- Sabrina Wong              Contact: sabrina.wong@ufl.edu
- Kevin Chen                Contact: k.chen1@ufl.edu
- Rafaela Almeida           Contact: almeidacampelo.r@ufl.edu

## Course Description
Continuous-time and discrete-time signal analysis including Fourier series and discrete-time and discrete Fourier transforms; sampling; discrete-time linear system analysis with emphasis on FIR and IIR systems: Impulse response, frequency response, and system function; MATLAB-based programming for Signals and Systems.

## Course Pre-Requisites / Co-Requisites
Prerequisite: Calculus 2 or equivalent

## Course Objectives
This course aims to provide analytical skills and numerical tools necessary for further study in communications, control, and signal processing. At the conclusion of this course, you should be able to:
- Understand basic concepts of discrete-time signals and linear time invariant (LTI) systems
- Provide time-domain and frequency-domain descriptions of these signals and systems
- Employ Fourier analysis to design and analyze simple LTI systems
- Proficiently use MATLAB as a programming and numerical analysis tool
- Implement simple discrete-time systems, such as linear filters, in MATLAB
- Program MATLAB to numerically perform Fourier analysis of signals and LTI systems.

## Recommended Materials
- Textbook Required
  *DSP First, 2nd edition*
  Authors: James H. McClellan, Ronald W. Schafer, and Mark A. Yoder
  Publisher: Pearson
  ISBN: 0136019250
- Software Required: MATLAB
  - Student Stand Alone Version ($99 for student edition with toolboxes +$10 per toolbox)
    - The Stand-Alone Version is absolutely required and can't be substituted for a cloud-based option.

## Course Structure

*Class Schedule:* The schedule is subject to change and its only to be used as a broad guide. However, the exam dates will be fixed to those dates.

| Date | | | Lecture | Text Chapters |
|------|------|-----|---------|---------------|
| **Wed** | Aug | 23 | Class Expectations / What is Signals and Systems | 0 |
| **Fri** | Aug | 25 | Introduction Signals and Systems | 1, App. A |
| **Mon** | Aug | 28 | Complex Number Review | 2 |
| **Wed** | Aug | 30 | Complex Number and Sinusoids | 2 |
| **Fri** | Sept | 1 | Sinusoids, Complex Sinusoids + Sums of Sinusoids 1 | 2 |
| **Mon** | Sept | 4 | **Holiday** | 3 |
| **Wed** | Sept | 6 | Sums of Sinusoids 1 | 3 |
| **Fri** | Sept | 8 | Sums of Sinusoids 2, Fourier Series 1 | 3 |
| **Mon** | Sept | 11 | Fourier Series 2, | 3 |
| **Wed** | Sept | 13 | Sampling Sinusoids 1, | 4 |
| **Fri** | Sept | 15 | Sampling Sinusoids 2, | 4 |
| **Mon** | Sept | 18 | Discrete-Time Systems | 5 |
| **Wed** | Sept | 20 | FIR Filters 1 | 5 |
| **Fri** | Sept | 22 | FIR Filters 2 | 5 |
| **Mon** | Sept | 25 | Convolution 1 | 5 |
| **Wed** | Sept | 27 | Convolution 2 | 5 |
| **Fri** | Sept | 29 | LTI Systems 1 | 6 |
| **Mon** | Oct | 2 | LTI Systems 2 | 6 |
| **Wed** | Oct | 4 | Frequency Response 1 | 6 |
| **Fri** | Oct | 6 | **Holiday (Homecoming)** | 6 |
| **Mon** | Oct | 9 | Frequency Response 2 & Review | - |
| **Wed** | Oct | 11 | **Midterm** | - |
| **Fri** | Oct | 13 | Frequency Response 3 | 6 |
| **Mon** | Oct | 16 | Transient Response | 6 |
| **Wed** | Oct | 18 | Discrete-Time Fourier Transform 1 | 7 |
| **Fri** | Oct | 20 | Discrete-Time Fourier Transform 2 | 7 |
| **Mon** | Oct | 23 | Z-Transform 1 | 9 |
| **Wed** | Oct | 25 | Z-Transform 2 | 9 |
| **Fri** | Oct | 27 | Poles and Zeros 1 | 9 |
| **Mon** | Oct | 30 | Poles and Zeros 2 | 9 |
| **Wed** | Nov | 1 | IIR Filters 1 | 9 |
| **Fri** | Nov | 3 | IIR Filters 2 | 9 |
| **Mon** | Nov | 6 | IIR Filters 3, | 10 |
| **Wed** | Nov | 8 | Inverse Z-Transform 1 | 10 |
| **Fri** | Nov | 10 | **Holiday** | 10 |
| **Mon** | Nov | 13 | Inverse Z-Transform 2, | 10 |
| **Wed** | Nov | 15 | Analysis in Three Domains | 10 |
| **Fri** | Nov | 17 | Discrete Fourier Series 1 | -- |
| **Mon** | Nov | 20 | Discrete Fourier Series 2 | -- |
| **Wed** | Nov | 22 | Thanksgiving Break | -- |
| **Fri** | Nov | 24 | Thanksgiving Break | 8 |
| **Mon** | Nov | 27 | Discrete Fourier Transform 1 **(Virtual)** | 8 |
| **Wed** | Nov | 29 | Discrete Fourier Transform 2 **(Final Quiz)** | 8 |
| **Fri** | Dec | 1 | Fast Fourier Transform 1 | 8 |
| **Mon** | Dec | 4 | Fast Fourier Transform 2 | -- |
| **Wed** | Dec | 6 | Review / Final Exam | TBD |

# Evaluation Methods and Criteria

The following section discusses the policies for each of the graded assessments in this course. You should look here first for answers to any general, course-related inquiries. **TIP**: Pay attention to the workflow: There will be approximately one quiz per chapter (Every 1.5 weeks). Quizzes will not be held on the week of the midterm and final. Homework will be due before each class period, and lab reports will generally be due every week. **DO NOT FALL BEHIND**.

## *Homework (~9 in total)*

**When:** Assigned approximately each week (see course schedule on website).

**What:** Analytical problems that can be solved by hand.

**Why:**  Homework is intended to guide you through material and present you with questions that will require time to think and complete. Homework exercises are meant to be done with your peers.

**Grading:** Homework is graded on a scale 1 to 100.

**Late policy:** Late assignments will not be eligible for any points.

**Submission:** Homework will be submitted on canvas within 1 hour before the class starts the day it is due.

## *Mid-term Exam & Final Exam (1 midterm and 1 final in total)*

**When:** The midterm is half-way thru the course on **October, 11, 2020 or October, 12, 2020 (Depending on Room Availability)**. The final will be the last week of classes and will be determined based on evening room assignments.

**What:** Analytical problems that can be solved by hand. Similar to the homework and quizzes, but may require a deeper understanding of the material. MatLab will be required to be used on the exam, but internet access must be disabled.

**Why:** Exams are an opportunity to show what you know about signals and systems.

**Grading:** Each exam is graded on a 100-point scale.

**Make-up Exams:** There are no make-up exams.

## *Quizzes (~9 in total)*

**When:** Occur *roughly once every 1.5 weeks only on* Wednesday (except for the midterm and midterm weeks).

**What:** A set of analytical problems.

**Why:**  These quizzes are intended (1) to help you, the TAs, and the instructor assess your current understanding of material and (2) to broaden the course's grading and lower the stakes of each exam.

**Re-grades:** You may submit a regrade request no later than **one week** after the respective quiz grade has been unmuted. No additional regrades will be accepted. **E-mail or speak in class to the TA who graded your quiz to receive a regrade.** You can appeal the regrades decision by going to the instructor, but only after you have spoken to the TA.

**Make-up Policy:** If you need to make-up a quiz due to university events, family, or anything major, you must provide documentation to a **course instructor one week** before the due date unless it is something unpredictable, such as a death in the family. If approved, the instructor will forward you to a TA for scheduling. You will have **one week** after the quiz to make it up. Failure to provide proof or not asking for a make-up quiz on time will require the quiz to be taken at the scheduled time.

## *Labs (~9 in total) + In Lab Analytical Problems (~10  in total)*

**When:** There are 10 labs + 10 Sets of Practice Problems over the course of the semester.

**What:** Each lab consists of MATLAB design exercises in two parts. You are expected to complete parts 1 and 2 of each lab.  The lab analytical practice problems *will be graded for correctness*. The analytical problems will be due that day before leaving the lab.

**Why:**  In each lab, we apply signals and systems theory to a particular application. This gives you a better understanding about how signals and systems theory is applied in practice using MATLAB.

**Reports:** After each lab, you are required to submit short reports via Canvas.  These reports demonstrate your understanding of the material and should be self-sufficient (i.e., the report should be self-explanatory). **Reports are due 11:59pm every Friday (except for the midterm and midterm weeks).** In each report, you will be asked to submit your MATLAB code. **Always submit your complete code for each lab assignment, even if it's just one line.** Penalties will be marked off accordingly. **Commenting on**

**code is very important for other classes and in the workforce.** You will receive a penalty for not commenting your code. **Reports will be submitted as PDFs**, using the "publish" function in MATLAB. This will display all of your code and all of your outputs together. If you write a 40-line script, then change one line as an objective later, show both full scripts in your submission. **Do not screenshot your code and make sure to submit all code used in the lab (the MATLAB 'type' function is super helpful).**

**Attendance:** Attendance is mandatory for the Lab and will be recorded each week. More than 3 missed labs sections will result in a zero for your total lab grade. Thus, I would make sure that the TA properly records your attendance before leaving the lab.

**Expectation In Lab:** Each week, specific milestones must be completed within the lab. Work must be prepared and presented to the TA before leaving the lab. If the milestone is not reached during your lab period, a 20% reduction of your total lab assignment will be imposed.

**Late policy:** Your late assignments have at maximum of **3 days** before receiving a 0. Every day late receives a 10% late penalty on the maximum possible value. For example, if the assignment is out of 50 points and is due 11:59pm June 2, turning it in at 12:00am June 3 will result in a maximum of 45 points on the assignment.

**Extension Policy:** If you need an extension on an assignment due to university events, family, or anything major, you must provide documentation to the TA grading your lab **one week** before the due date unless it is something unpredictable, such as a death in the family. Failure to provide proof or not asking for an extension on time will require the assignment to be submitted on-time.

**Re-grades:** You may submit a regrade request no later than **one week** after the respective lab grade has been unmuted. No additional regrades will be accepted. **The re-grade be new PDF with comments that start with the word "RE-GRADE."** These comments should state what you want points and why. Submit the new document in the same manner you submitted the assignment. DO NOT EMAIL OR MESSAGE asking for a regrade. If you still don't like the regrade from a TA, you can go to the instructor and ask for an appeal to the regrade, but please go through your lab TA first.

## *Evaluation of Grades*

| Assignment | Percentage of Final Grade |
|---|---|
| Homework | 15% |
| Analytical Course Work in Lab | 10 % |
| Graded Labs | 15% |
| Midterm Exam | 20% |
| Final Exam | 20% |
| Quizzes | 20% |
| | 100% |

## *Grading Policy*

| Percent | Grade | Grade Points |
|---|---|---|
| 93.3 - 100.0 | A | 4.00 |
| 90.0 – 94.0 | A- | 3.67 |
| 87.5 - 89.9 | B+ | 3.33 |
| 83.5 - 87.4 | B | 3.00 |
| 80.0 - 83.4 | B- | 2.67 |
| 77.5 - 79.9 | C+ | 2.33 |
| 73.5 – 77.4 | C | 2.00 |
| 70.0 - 73.4 | C- | 1.67 |
| 67.5 - 69.9 | D+ | 1.33 |
| 63.5 - 67.4 | D | 1.00 |
| 60.0 - 63.4 | D- | 0.67 |
| 00.0 - 60.0 | E | 0.00 |

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx
Note that the table is given as a guideline from the university. The grade thresholds may be adjusted according to the class average.

## Accreditation Information

### *Relation to Program Outcomes (ABET):*

| Outcome | Coverage |
|---|---|
| **Outcome 1.** An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics | Students are assessed using:<br>- Focused exam questions on<br>   o their ability to solve differential equations<br>   o using engineering techniques<br>   o their ability to work with complex numbers and exponentials.<br>- Exam questions target the use of<br>   o impulse responses, frequency response, DTFT, and z-transform methods.<br>- Using a MATLAB programming, the students are required to<br>   o apply filtering concepts to design a piano octave detection system to meet specifications. |
| **Outcome 6.** An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions | Students are assessed using:<br>- A MATLAB assessment where<br>   o Students are provided EKG signals (actual data) of a number of patients from a public database. The students are required to break each EKG signal down into overlapping windows and apply FFT on each window.<br>   o From the FFT results, the students then generate a time trajectory of the heart rate of a patient.<br>   o As the EKG signals are noisy and could occasionally be distorted, the students are required to design algorithms that carefully interpret the FFT results to rid out readings that are not physically reasonable. |

## Course & University Policies

### *Modifying Syllabus by Class Vote*
**When:** If you and/or other students believe the course would be improved by a change in the syllabus and I agree that it would be a reasonable change. **What:** The proposed change will be put to an anonymous vote with the entire class. If the majority of the class agrees to this change, it becomes part of the syllabus. **Why:** Changes to the syllabus may be necessary do to unforeseen situations. The class vote ensures the entire class agrees with the change.

### *Collaboration*
**Healthy collaboration:** To solve homework assignments, healthy discussion and collaboration amongst classmates is encouraged. Healthy collaboration includes:
- Discussing and explaining general course material
- Discussing assignments for better understanding
- Providing assistance for general programming and debugging issues

If another student contributes substantially to your understanding of a problem, you should *cite* this student to let myself and the teaching assistants be aware of your similar interpretations of a problem. You will not be judged

negatively for citing another student. However, being caught with old labs, solutions from Chegg and other sources that are presented as your own work will result in failing the class.

**Cheating and plagiarism:** While collaboration is encouraged, you are expected to *submit your own work*. Submitting work completed by another student is considered plagiarism and will be dealt with according to university policy. In general, if you do not fully understand your solution, the work is not your own. Examples of plagiarism or cheating include:
- Copying (or allowing someone to copy), even partially, an assignment solution or program from the course
- Submitting material, particularly code, using material taken from another source without proper a citation
- Obtaining solutions to assignments or exams through inappropriate means

Note that I may elect to use a plagiarism detection service in this course, in which case you will be required to submit your work to such a service as part of your assignment.

**Consequences:** If you are suspected of dishonest academic activity, I will invite you to discuss it further in private. Academic dishonesty will likely result in a grade reduction, with severity depending on the nature of the dishonest activity. I am obligated to report on academic misconduct with a letter to the department, college, and/or university leadership. Repeat offences will be treated with significantly greater severity.

### *Students Requiring Accommodations*
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

### *Course Evaluation*
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

### *In-Class Recording*
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

### University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Conduct Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions.  If you have any questions or concerns, please consult with the instructor or TAs in this class.

### Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination.  It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
• Your academic advisor or Graduate Program Coordinator
• Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

### Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use.  Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator.  Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate.  We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

### Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments.  For more information, please see:  https://registrar.ufl.edu/ferpa.html

### Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
• Your academic advisor or Graduate Program Coordinator
• Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@ufl.edu

*Sexual Discrimination, Harassment, Assault, or Violence*: If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the Office of Title IX Compliance, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

### Campus Resources:

### Health and Wellness

> **Covid-19 Protocols:**
> • You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated. Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

• If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus. UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.

**U Matter, We Care:**
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

**Counseling and Wellness Center:** https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

**Sexual Discrimination, Harassment, Assault, or Violence**
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

**Sexual Assault Recovery Services (SARS)**
Student Health Care Center, 392-1161.

**University Police Department** at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

## *Academic Resources*

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

**Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

**Library Support**, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

**Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

**Student Complaints Campus**: https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

**On-Line Students Complaints**: http://www.distance.ufl.edu/student-complaint-process.