ECE4370 Syllabus

Antenna Engineering, Autumn 2026

Mon/Wed, 3:30 - 4:45 pm, VL C457

Class page: https://canvas.gatech.edu

Delivery Mode: In person

Instructor Information

Instructor	Email	Office Hours & Location
Prof. Nima Ghalichechian	nima.1@gatech.edu	2-3pm on Mondays (or by appointment, TSRB, Room # 534
Teaching Assistant(s)	**Email**	**Office Hours & Location**
TBD	TBD	N/A

General Information

Description

Electromagnetic radiation; fundamental antenna parameters; dipole, loops, patches, broadband and other antennas; introduction to array theory; ground plane effects; horn and reflector antennas; pattern synthesis; antenna measurements.

Pre- &/or Co-Requisites

ECE 3025 Introduction to Electromagnetics. Basic understanding of the theory of electromagnetisms including Maxwell's equations, electrostatics, plane waves, and transmission lines is required.

Course Goals and Learning Outcomes

1. Teach students basic antenna parameters, including radiation resistance, input impedance, gain and directivity. Upon successful completion of this course, you should be able to describe intuitively and mathematically why selected types of antennas radiate
2. Expose students to antenna radiation properties, propagation (Friis transmission formula) and wireless point to point communication connectivity requirements
3. Study elementary antennas and their radiation properties
4. Expose students to impedance matching techniques, and mutual coupling
5. Study antenna arrays and array design methods
6. Introduce students to patch antennas
7. Introduce students to commercially available antenna simulation toolbox

Course Requirements & Grading

Assignment	Date/Frequency	Weight	Notes
HomeWorks	~Weekly	0%	
Homework quizzes	~Biweekly	15%	
Midterm 1	TBD	20%	

Assignment	Date/Frequency	Weight	Notes
Midterm 2	TBD	20%	
Projects	3-4 per semester	20%	
Final exam	TBD	25%	

Extra Credit Opportunities

Several extra credits problems, each having 1 point, will be assigned throughout the semester. These are optional and will be directly added to your total grade. Extra credit assignments are expected to be slightly more challenging that regular homework problems. Occasionally, a simulation or MATLAB program will be assigned as an extra credit. You can expect 2-4 extra credits throughout the semester.

Homework Assignments

Homework assignments are an important part of the learning process. Approximately 10 homework assignments will be posted throughout the semester. The solution to these problems will also be posted at the same time. HomeWorks will not be due and will not count towards the final grade. You don't turn in these assignments as they are not graded. You are expected to work on them on a weekly basis and check your work with the solution that I provide.

Homework Quizzes

After 2-3 homework assignments, a 15-minute closed-book/closed-notes quiz will be given during the lecture. The quiz will be similar to your homework problems and will cover the corresponding lectures. The set of homework assignments and lectures that each quiz will cover will be announced a week in advance. The first quiz should be expected at the beginning of Week 3. At the end of the semester, the lowest grade (quiz) will be dropped. No make-up quiz is given.

Midterm #1 and #2

Two midterm exams will take place during the semester. The exam will be closed-book/closed-notes. You will be allowed a single cheat sheet, 8.5" by 11", with handwritten notes only, on both sides. Do not print or type your cheat sheet. Only handwritten notes are allowed! No internet-enabled devices are permitted. You may bring a simple calculator to the exam.

Projects (Individual and Team)

A few simulation-based mini-projects will be given throughout the semester. These are designed to complement the class material. For example, you will be asked to model a dipole. Recommended software is ANSYS HFSS (provided by ECE). Access instructions are available in CANVAS. See also "Additional Materials/Resources" section in this document. These are submitted as an individual project. However, you may work with your classmates if you prefer.

A team project will be assigned in the second half of the semester. It will involve literature review, physics of operation, simulations, and an oral presentation. Presentation will be given by all group members towards the end of the semester. Each team prepares a power point presentation and submits on a due date in CANVAS. Please see the due date on page 1. No other report is due for this assignment.

Final Exam

The final exam is cumulative and covers the entire course material. The exam will be closed-book/closed-notes. You will be allowed two (2) cheat sheets, each 8.5" by 11", with handwritten notes only, on both sides. Do not print or type your cheat sheet. Only handwritten notes are allowed! No internet-enabled devices are permitted. You may bring a simple calculator to the exam.

Grading Scale

Your final grade will be assigned as a letter grade according to the following scale.

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

Course Materials

Course Text

Antenna Theory: Analysis and Design, 4th Edition, by Constantine A. Balanis, Wiley 2016. The electronic version of the book is available online at http://library.gatech.edu. Here is the direct Link to the book. You can view the book online, but there is a limit for your PDF downloads. Please see Canvas for a copy of the first three chapters. Please note that this material is provided to Georgia Tech class students only. Do not distribute.

In my opinion, this book covers a lot of material and is generally a good reference text on a variety of antenna topics. However, it lacks the intuitive approach and clear explanations needed for a typical textbook. The author often throws equations without explaining where they came from! To address these deficiencies, I provide class notes to students. I encourage students to read the textbook because we have a limited time in the class to cover each topic. See additional recourses below for alternative sources and textbooks.

Additional Materials/Resources

Numerical Simulation Tools

- **ANSYS HFSS:** The actual name is Ansys EM Desktop Suite. A few years ago, the software was acquired by ANSYS and became a part of their package. HFSS uses frequency-domain finite element method and is the most popular full-wave simulation tool for antennas. It is more user-friendly than other tools. HFSS is available through the ECE Computer Support Group https://help.ece.gatech.edu/software. Don't forget to check out the examples and tutorials.
- **CST Microwave Studio**: Also known as ST Studio Suite is a powerful full-wave program with several types of solvers. Time-domain, frequency domain, integral, etc. For electrically large antennas or wide-band structures it makes sense to use a time-domain solvers. CST is great in this area. Examples includes arrays or Vivladi antennas. It also offers other types of solvers as well. Many years ago, my research group used exclusively HFSS. Nowadays, most students use CST instead. Software is available at ECE https://help.ece.gatech.edu/software. The difference with HFSS is that the students will need to read the ECE EULA for each respective software before access is granted https://eulas.ece.gatech.edu/CST/
- **Feko from Altair:** https://www.altair.com/feko/ is a good antenna simulation toolbox that uses method of moments. Students can download the free student edition at https://altairuniversity.com/free-altair-student-edition , but there are campus wide licenses at Georgia Institute of Technology for full version of Feko, if you need. The student version has limitation. For example, max number of mesh elements is 25k. Feko has a lot of educational material. Here is one example https://altairuniversity.com/46078-antenna-modeling-and-simulation-techniques-webinar. Check Canvas resource tab for more information on Feko. In my experience, setting up ports in Feko is somewhat tricky, otherwise, it's easy to use.
- **MATLAB:** For certain HW assignments and projects you will need to use MATLAB. In addition to the core program, MATLAB has an RF Toolbox that is useful for visualization of polar plots for gain patterns, S-parameters, Smith Chart, and others.

https://www.mathworks.com/products/rftoolbox.html . Moreover, the Antenna Toolbox https://www.mathworks.com/products/antenna.html provides direct simulation of specific types of antennas using method of moment. As compared to HFSS and CST, the capability is very limited. MATLAB's Phased Array Systems Toolbox is useful for quick analysis of antenna arrays https://www.mathworks.com/products/phased-array.html. For toolbox installation check here.

- **ADS:** Agilent Advanced Design System (ADS) is a simulation tool for microwave circuits. Full-wave simulation is also possible in ADS but less common. While our course is concentrated on antennas (radiating elements), ADS is a great tool for simulation of transmission lines (non-radiating elements and study of impedance matching. Optimization is much faster in ADS as compared to HFSS or CST. I highly recommend that you "play" with the Smith Chart tool in ADS and perform several impedance matching practices https://help.ece.gatech.edu/software/keysight/ads

Books

- Antennas for all applications, 3rd Edition[1], by John Kraus and Ronald Marhefka, McGraw-Hill, 2001. This is my favorite antenna book, very rich in concepts with less emphasis on math. Covers advanced topics. Unfortunately, it is out of print.
- Antenna theory and design, 3rd Edition, Warren L. Stutzman, Gary A. Thiele, John Wiley & Sons, 2012. This is a classical and a popular antenna textbook.
- Microwave Engineering, 4th Edition, David Pozar, John Wiley & Sons, 2011. This is a great source for transmission line, smith charts, and microwave engineering basics. While the 4thEditiona is updated, any other edition will be just fine.
- Antennas and Radio wave Propagation, Robert E Collin, McFraw-Hill, 1985. Excellent book in making connections between electromagnetics and antennas.
- Antenna Theory and Applications: Hubregt J Visser, Wiley, 2012. This is a great entry level text. The author tries to mix intuitive understanding of antennas with practical applications.

Other

- www.antenna-theory.com: Great web page for learning about antennas. The approach is intuitive and practical. Review sections related to Smith Chart and impedance matching if you feel less comfortable with these topics.
- The author and publisher of our textbook have created student companion cite here. There is occasionally some good complimentary information here, however, most students don't find this site useful!
- IEEE Antennas and Propagation Magazine [includes educational technical articles on antennas]
- IEEE Antennas and Propagation Society (AP-S) [includes comprehensive list of antenna related journal and conference publications]

Course Schedule

- Introduction to Antennas (Weeks 1-4)
- Elementary Antennas: Dipole and Loop (Weeks 4-6)
- Antenna Arrays (Week 6-7)
- Antenna Impedances and Matching (Week 8)
- Broadband and Frequency-Independent Antennas (Weeks 9-10)
- Microstrip Antennas (Week 11-13)
- Project Presentations (Week 14)

[1] The book has unauthorized 4th edition that was revised and published in India but not written by the original authors (Kraus and Merhefka)! Stick with the 3rd edition!

Course Website and Other Classroom Management Tools

https://canvas.gatech.edu

Contacting me

Please contact me if you can't attend the office hour but you want to meet me. Also contact me for any other issue. I typically respond within 24 hours (nima.1@osu.edu). My office is in TSRB room # 534. We can also schedule a virtual meeting if you prefer.

Attendance and/or Participation

Class attendance is highly recommended. During the class, it is recommended that you take notes. While supplementary lecture notes will be posted on CANVAS, the notes are not to be considered as a direct replacement for your own class notes and participation. Discussions during lectures are an important part of the learning for this course. If you miss a lecture, review the posted lecture notes on CANVAS. Complete the reading assignments and attend the office hours.

Collaboration & Group Work

Students are encouraged to work together on homework assignments and simulation projects. However, you must submit your own version of the assignment. That you are expected to complete the quizzes, midterms, and final exams yourself, without any external help or communication.

Extensions, Late Assignments, & Re-Scheduled/Missed Exams

The dates of the 2 midterms and the final exams are announced in this document. Please note these dates and make the necessary arrangements to attend. If you can't attend any exam, notify me as soon as possible. No makeup exam (midterms and final) will be given unless there is a documented emergence. Any missed quiz or exam will result in a zero grade. Quizzes are announced a week in advance and are held in the class. Notify me regarding your emergency if you can't attend a quiz. I will exclude that quiz, but no makeup quiz is given. Homework assignments are not graded and are not due. No late submission is accepted for extra credit assignments. Late submission will result in a zero grade.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit http://www.catalog.gatech.edu/policies/honor-code/ or http://www.catalog.gatech.edu/rules/18/.

Any student suspected of cheating or plagiarizing on a quiz, exam, or assignment will be reported to the Office of Student Integrity, who will investigate the incident and identify the appropriate penalty for violations. Violating Georgia Tech's Academic Honor Code may result in the grade of zero for the assignment.

Accommodations for Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at (404)894-2563 or http://disabilityservices.gatech.edu/, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible to set up a time to discuss your learning needs.

Student-Faculty Expectations Agreement

At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See http://www.catalog.gatech.edu/rules/22/ for an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions

will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.