

ECE 4460/6460 — Antennas

Spring 2020 Syllabus (revision 0)

Instructor: Anthony Q. Martin
Office/Phone: 333 EIB / 656-1052
Office Hours: TBD & via e-mail: martina@g.clemson.edu
Course Info: ECE 4460-001/6460-001 — Antennas
Class Time: 8:00 am to 9:15 am MW
Class Location WFIC 218
Required Items(s): (1) *Personal notes of instructor* (in lieu of formal Textbook).
(2) 4NEC2 (download from <https://www.qsl.net/4nec2/>). This software runs on Windows, thus a Windows computer is required to complete the assignments in this course.
(3) MATLAB, MS Word/Powerpoint. Clemson has site licenses for student use, please ensure these are installed and work on your computer.

Website: Canvas

Suggested Other Texts:

Antennas: For All Applications, Kraus and Marhefka, McGraw Hill
Antenna Theory and Design, Stutzman and Thiele, Wiley
Antenna Theory and Design, Elliott, IEEE Press & Wiley
Antenna Theory: Analysis and Design, Balanis, Wiley

Objectives: To provide the student with a basic understanding of antenna theory, including antenna fundamentals, antenna techniques, important antennas, antenna modeling & optimization, and some design aspects of antennas

Topics:

1. Antenna math, dipoles, near & far zones, radiated power	3
2. Patterns, directivity, gain, loss, radiation resistance	4
3. Line sources	3
4. Image theory, reciprocity	3
5. Linear arrays, planar arrays, array feeding	5
6. Induced voltage, Received power, effective area & length,	4
7. Antenna Types (resonant, broadband, directional, etc.)	3
8. Antenna modeling, optimization, and design	2
9. Simulation lecture	1
Total	27

Course Policy:

- Slight revisions to this syllabus, to correct mistakes, will be made during the first two weeks of the semester.
- Lectures are available as PDF files on your Canvas. Please bring them either in printed format or on your laptop. A PDF reader will be required.
- All assignments in this course will be done outside of class and will be project based and require written reports submitted electronically in PDF format.
- The projects will typically be a combination of worked problems and computer simulations. However, you will submit your work electronically as a project report, in report format (introduction, Body discussion, conclusions, labeled figures and tables, and full description of each problem assigned.) Good grammar is a requirement for the written project reports. Your report format is critical to your grade. Failure to follow this will result in a very poor grade in this course.

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- All computer assignments and problem solutions must be the result of your own work. You must turn in your **own** computer/simulated solutions and work on assignments. All problems that you are asked to work are not to be discussed with others outside of class.
- Students will need access to a computer that runs Microsoft Windows for computer-based projects.
- Notes will be posted on Canvas. It is important that you check it for new updates before coming to class.
- The project reports are to be turned in via electronic means, i.e., MS Word or Powerpoint PDFs sent as an e-mail attachment (no supersized files, please!!). **Under no circumstances will printed materials be accepted!! Please be doubly sure to save all submitted work (i.e., back up your computer) in case there is a failure in receiving your email submissions.** I may need to ask you to resubmit an assignment if there turns out to be a problem with your prior submission. This is the nature of electronic submissions. Save backup copies of all of your work!!!
- Reasonable neatness is required on handwritten parts of reports for assignments/projects. You are not required to submit completely typed up reports. Combinations of handwriting, typing, copy&paste, etc, are perfectly acceptable, as long as the report format is respected. **The hand-written parts of your reports MUST be done on ruled paper, not blank paper with no lines, and you are REQUIRED to use those lines to make your work easier to read. Verbose discussions are required (I want to you talk antennas!).** You are to write in the English language to discuss in-depth technical aspects of antenna theory, use and design. All problem descriptions are to be included in your reports to make them standalone documents. All figures must be clearly labeled and discussed in the text. Your report should have an introduction, a body (with discussions are the various problems and solutions) and a conclusions section. All computer code must be in an addendum at the end of your report and referenced in the main body of your report. Appropriate identification is expected. All equations in your report should be numbered and discussed. Note that long strings or lists of equations with no discussions will be considered a “data dump” and will reflect negatively on your grade. If you use any reference material in creating your report it is expected that you will provide adequate citations of such. Your report should be a self-contained document that anyone off the street can read without the need to consult any other document for relevant information about what is contained in the report. Failure to follow this rule can result in a failing grade even if your work is 100% correct. If it cannot be followed and understood, then it is incomplete and will not be read to completion. **Your grade, as a result, will be F.**
- Credit will not be given for *magic* answers or solutions on projects. I must be able to follow your solution from beginning to end to be able to assign any credit. I do not want to be guessing as to what you mean and what problem you are addressing. This is the reason for the report format. You must provide commentary on everything in the report. Failure to do so will ruin your grade in this course.
- At minimum, a 10-point scale will be used (A=90+, B=80+, C=70+, etc.) to determine overall grade.
- Students will not work together on the antennas aspects of projects. Your submitted work must be entirely your own. You can discuss MATLAB-specific things, such as how to make a 3D plot or how you do a surface plot. You cannot discuss how to solve antenna problems given on assignments.
- No solutions to project problems will be given. You are to fight for your own solutions!
- Each projects value will be based on points. For example, a project of 5 questions/problems could be worth 50 points total (depending on the depth of the problems in the project). All projects points will be summed up and your grade is the % of points earned divided by the total number of points available. Longer projects with more problems are generally worth more than shorter ones, but this does depend, to some extent, on the problems themselves.

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- Extra Credit:** Students who acquire one grade of amatuar radio license during this course will receive project credit in the form of 1 project grade (= 50 points) of 100% factored into their project average. Any student who acquires two licenses will get 2 project grades (50+50=100 points) of 100% factored into his/her project grade. Any student who already has an amatuar radio license and cannot upgrade to the next higher level, can develop a Powerpoint lecture (at least 25 slides) on an antenna type choosen after consultation with the instructor. One lecture developed satisfactorily (as deemed by the instructor) is worth 1 project grade (50 points) of 100%. This lecture option can only be used by someone already having at least a general-class radio licence. Any student is free to just go with the earned grades on the projects and bypass the license (there is a fee for getting a licence and that is your responsibility). The amatuar radio licence(s) must be acquired during the spring 2020 semester before final exams start as otherwise it cannot be counted while this course is in progress. CU has an active amatuar radio club. Seek it out for more information.

The weighting will be:

Course	4460	6460
Simulation Projects	70%	60%
Final (take home)	30%	30%
Antenna Lecture	NA	10%
Total	100%	100%

Your written simulation project reports will be graded on the basis of quality/quantity of written commentary and technical competence on the subject of antennas. Quality is more important than quantity, but you must reach a critical mass for your report to be considered a useful report. The idea is for you to demonstrate the ability to discuss antenna-related topics intelligently. The simulation project reports are to be a written report (in MS Word with introduction, body discussion, and conclusions), not just a collection of computer simulations and/or graphs. It must be something that anyone off the street with a background in antennas could read from beginning to end and gain a complete understanding of your topic. ~~You must heavily reference at least one textbook (or notes) other than the one used for this course.~~

Late work: Projects will have due dates which students are expected to meet. Any project assignment which is not submitted within one week of its due date will not be accepted and a grade of zero points will be given for that assignment.

Attendance: ~~Attendance of class is required for all 4460-001/6460-001 students. Photo roll will be taken during every lecture (this does not apply to section 843 students and there is NO attendance requirement). All students are expected to be in class and seated by 8 a.m. Attendance will affect your final grade by causing a percentage to be subtracted from it based on the number of unexcused absences recorded. The following table shows how class attendance will impact your grade:~~

Unexcused Absences	Change in final grade percentage
1 to 6	No change
7 or more	-20% (FG*0.8)

~~Absences for **serious illness** (emergency and/or acute) will only be excused with a doctor's note (i.e., excused absences) supported by office visit payment. Absences for **minor illness** (i.e., those **not**~~

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~~requiring a doctor's visit and payment for care or for a simple common cold or a common malady like a stomach ache) are not excused, but that is why there is an allowance for 6 unexcused absences as noted above (routine doctor's appointments are unexcused). Missing class for university activities will be considered an unexcused absence unless special permission is granted by the instructor in advance (generally this permission is not granted). Certainly, a student who has several unexcused absences will not be given favorable consideration for missing class due to university activities.~~

~~A student is required to keep track of his/her number of missed lectures. Do not contact the instructor about your missed absences until after the last week of class, at which time the final tabulations will be completed.~~

If the instructor does not arrive within 15 minutes after the class period has started (by 8:15 a.m.) class is cancelled, all students may leave, and no student will receive an unexcused absence.

~~**Excused Absences:** Any student wanting to be excused for a medical absence must submit valid documentation within one week of the absence in question. This applies to attendance, tests and exams. Failure to do so will result in the absence counted as not excused. NO EXCEPTIONS.~~

Disability Access: It is University policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities. Students are encouraged to contact Student Disability Services to discuss their individual needs for accommodation, obtain a letter if appropriate, and then to discuss those needs with the instructor. To obtain accommodations, the student must notify the instructor no later than the end of first week of class.

~~**Habitual Tardiness:** Due to the way the classroom is constructed students who come late to class disrupt the entire lecture period (late is defined to be any time after the class session has started). Thus, any student who is recognized to be habitually late (defined to be 2 or more times during any two week period) to class will be penalized. Each student identified as habitually late will be given one warning. After this warning, 5% will be deducted from the score of the simulation project due after the warning. This means one could lose up to 5 % on each of project. If it occurs after the final project, then it applies to the final exam, meaning 5 % deduction on the score of the final exam.~~

ECE6460 Extra Assignments: Graduate students enrolled in ECE6460 must develop, deliver, and turn in, as a Powerpoint file, a 25-slide lecture that you have devised on your own. It will be on an antenna topic that I provide for you. The due date will be announced in lecture, but expect to deliver the lecture near the end of the semester. Note: the in-class presentation may be waived if I deem there is insufficient time left toward the end of the semester, but the lecture Powerpoint will still be required.

Scheduled Final Exam: Since this course meets from 8-9:15am, MW, the time slot for MWF from 8-8:50 should find all students free. Thus, the final exam time slot for this course is Thursday, April 30, 2020, from 11:30-2pm. However, it is very likely we will have a take-home final exam. The due date and time for this exam is Thursday, April 30, 2020, at 2 pm. The report is to be submitted electronically.

If there is some reason the final exam slot in the table above does not work, alert me of the reason immediately. Failure to do so is your tacit acceptance of this testing arrangement.

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Electronic Submission:

Filenames: Please name your submitted electronic file according to the following scheme:

`lastname_ECE4460_project_X.pdf`

Here, lastname = your surname and X = the number of the project.

Example: `Martin_ECE4460_project_1.pdf` .

If you do not follow this scheme I will not review your work. Also, a PDF file is preferred over docx or pptx.

Some tips about scanning assignments:

- If you scan a document at 600 dpi and 24-bit color, the filesize will be huge. Most likely, this file will be too large to send through email. It is better to scan at, say, 150 dpi and in grayscale or in color if a low color depth. The scanned file will be much smaller.
- After you scan your work, please inspect it to ensure that it is legible.
- If including Matlab results, a direct cut & paste into your document is better than scanning. You may combine scanned solutions (obtained cut & paste) with computer generated results. Both are considered objects in a Word or Powerpoint file.
- You can use Word or Powerpoint to create a PDF file.
- The copier machine in EIB 337 will scan your written work and you can direct it to send the scanned file to you at your email address. Then you can manipulate the results (cut & paste) and send your final file, with the correct naming scheme (see above), to me. Please do not direct the output of the copier/scanner to me because I will not accept any work with an improper naming scheme.

Some tips on ensuring a good grade in this course are:

- Used ruled paper and write on the lines to keep your math organized. Consider the use of “white space” between lines of math to make your presentation easier for someone else to follow. This is commonly done in textbooks and research monographs to keep complex material accessible to the reader.
- Do NOT write in a micro-font (extremely tiny handwriting designed to minimize the use of paper) as this cannot be read & followed efficiently. Undergraduate students are notorious for this. As graduate students, you want to do this opposite of this because you may need to produce pages and pages of math and you need to finish with the correct result at the end. If others cannot follow your work, then it is very likely that you will not be able to either after some time as gone by.
- Perform a “cut & paste” of each problem statement into your document so as to make your work self-contained within a single file.
- Number the major equations of your work and refer back to them to help guide a reader through your math.
- Label your figures and tables and refer back to them. Do not leave it to the reader to figure out what your figures and tables mean. What are the units of quantities shown on the various axes? What do the various line colors correspond to? Make sure anything you put on a figure or in a table is completely explained. To assume that anyone reading what you have created is easily followed is a major flaw and will degrade the quality of your entire effort.

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- Look at other major works for examples on how to present very technical information. Almost any textbook on engineering, physics, and math is a good source.
- Words are your friend in this course. Lack of them will hurt your grade tremendously.
- Do not wait until the last minute to start on an assignment in this course. Your grade is based on these assignments. These assignments should NOT be viewed as homework. I will not grade any report that looks like typical homework. You will get a zero if you turn in anything that looks like some sloppy response to a homework assignment.
- Put MATLAB/computer code at the back of your document and refer to it in your text as an appendix. Be sure your appendices have titles and descriptions.

Statement for Undergraduate Syllabi

Title IX Statement

Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. This policy is located at <http://www.clemson.edu/campus-life/campus-services/access/title-ix/>. Mr. Jerry Knighton is the Clemson University Title IX Coordinator. He also is the Director of Access and Equity. His office is located at 111 Holtendorff Hall, 864.656.3181 (voice) or 864.565.0899 (TDD).

The policies in this syllabus are general policies common to all courses in ECE. Course specific information will likely be included in a separate, course specific syllabus. **Students are responsible for reading and understanding the information in both this common syllabus and in the course specific syllabus.**

The syllabus is subject to change based on extenuating circumstances or at the instructor's discretion. **In the event that there is a conflict or discrepancy between the common syllabus and course specific syllabus, the course specific syllabus overrides the common syllabus.**

Attendance

Unless otherwise stated on the course specific syllabus, **students are expected to attend class, and to arrive on time.**

In the event of an **emergency**, students should contact the course instructor, preferably before class or the exam. Students should speak with instructors regarding any scheduled absence as soon as possible and develop a plan for any make-up work, if allowed by the instructor. It is the student's responsibility to secure documentation of emergencies, if required by the instructor. A student with an excessive number of absences may be withdrawn at the discretion of the course instructor.

If the instructor is late, students are expected to wait 15 minutes for the instructor to arrive.

Any further attendance policies in place will be listed on the course specific syllabus and will serve to supplement these policies.

Notification of Absence

The Notification of Absence module in Canvas allows students to quickly notify instructors (via an email) of an absence from class and provides for the following categories: court attendance, death of family member, illness, illness of family member, injury, military duty, religious observance, scheduled surgery, university function, unscheduled hospitalization, other anticipated absence, or other unanticipated absence. The notification form requires a brief explanation, dates and times. Based on the dates and times indicated, instructors are automatically selected, but students may decide which instructors will receive the notification. This does not serve as an "excuse" from class, and students are encouraged to discuss the absence with their instructors, as the instructor is the only person who can excuse an absence. If a student is unable to report the absence electronically, he/she may call the Office of Advocacy and Success at 864-656-0935 for assistance and guidance.

The Office of Advocacy and Success also assists students in identifying various appropriate methods of documenting absences and assists families in using the electronic Notification of Absence system when students are unable to do so themselves.

Academic Continuity Plan

In the event the physical classroom facility becomes unavailable, as determined by the University's administration, class will be conducted in a virtual (online) format. The University issues official disruption notifications through email /www /text notification/social media. When notified, use one of

the following links to navigate to Clemson Canvas where you will find important information about attending class:

- Primary access link: <https://www.clemson.edu/canvas>
- Secondary access link, if needed: <https://clemson.instructure.com/>
- You can also use the Canvas Student App.

February 19, 2020, has been declared an E-Learning Day by the university. A real-time test of the Academic Continuity Plan will be conducted.

Inclement Weather Policy

Any exam that was scheduled at the time of a class cancellation due to inclement weather will be given at the next class meeting unless contacted by the instructor. Any assignments due at the time of a class cancellation due to inclement weather will be due at the next class meeting unless contacted by the instructor. Any extension or postponement of assignments or exams must be granted by the instructor via email or Canvas within 24 hours of the weather related cancellation.

Academic Integrity

As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form. In instances where academic standards may have been compromised, Clemson University has a responsibility to respond appropriately to charges of violations of academic integrity.

Further information on Academic Integrity can be found in the [Undergraduate Announcements](#) and in the [Graduate School Policy Handbook](#).

Access Accommodations

Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to this class should let the professor know, and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848, by emailing studentaccess@lists.clemson.edu, or by visiting Suite 239 in the Academic Success Center building. Appointments are strongly encouraged – drop-ins will be seen if possible, but there could be a significant wait due to scheduled appointments. Students who receive Academic Access Letters are strongly encouraged to request, obtain and present these to their professors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student's responsibility to follow this process each semester. You can access further information here: <https://www.clemson.edu/academics/studentaccess/index.html>.

Anti-Harassment and Non-Discrimination

Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. This policy is located at <http://www.clemson.edu/campus-life/campus-services/access/title-ix/>. Ms. Alesia Smith is the Clemson University Title IX Coordinator, and the Executive Director of Equity Compliance. Her office is located at 110 Holtzendorff Hall, 864.656.3181 (voice) or 864.656.0899 (TDD).

Online Courses

In an online course, you will interact with the content, instructor, and/or classmates on at least a weekly basis through course assignments, asynchronous discussions and/or synchronous sessions as indicated on the course specific syllabus. Further resources for online courses may be found here: <http://www.clemson.edu/online/students/>.

Computing technology questions may be sent to ITHELP@clemson.edu.

Emergency Procedures

Emergency procedures have been posted in all buildings and on all elevators. Students should review these procedures for their own safety. Clemson University is committed to providing a safe campus environment for students, faculty, staff, and visitors. As members of the community, we encourage you to take the following actions to be better prepared in case of an emergency:

- Ensure you are signed up for emergency alerts: <https://www.getrave.com/login/clemson>
- Download the Rave Guardian app to your phone: <https://www.clemson.edu/cusafety/cupd/rave-guardian/>
- Learn what you can do to prepare yourself in the event of an active threat: <http://www.clemson.edu/cusafety/EmergencyManagement/>

Copyright Statement

Materials in some of the courses are copyrighted. They are intended for use only by students registered and enrolled in a particular course and only for instructional activities associated with and for the duration of the course. They may not be retained in another medium or disseminated further. They are provided in compliance with the provisions of the Teach Act. Students should be reminded to refer to the Use of Copyrighted Materials and "Fair Use Guidelines" policy in on the Clemson University website for additional information: <https://clemson.libguides.com/copyright>.