ECEG 497/697 Wireless System Design Spring 2023

Course Policies and Information

Objective

This course introduces students to the analysis, design, and characterization of wireless communication circuits, systems, antennas, and other hardware. This field of study is frequently referred to as RF and microwave engineering. The course also covers some fundamentals of RF circuit layout and special issues encountered when making RF/microwave measurements. Contemporary issues in RF and microwave engineering are also considered.

Course Outcomes

A student who successfully completes this course should be able to:

1. Design lumped-element impedance matching networks using L, T, and pi configurations.
2. Recognize and analyze basic receiver and transmitter system architectures.
3. Predict the frequency translation properties and image response of a frequency mixer circuit.
4. Calculate the S parameters of a given linear two-port network.
5. Calculate system noise figure given the gain and noise figures of individual system stages.
6. Understand the relationship between minimum detectable signal (MDS), third-order intercept (TOI or IP3), and spurious-free dynamic range (SFDR) of an amplifier or receiver system.
7. Use a Smith chart to plot impedances and to perform basic transmission line and matching network calculations.
8. Manually and/or numerically calculate important performance characteristics of commonly used antenna types.

Adjustments might be made to the list above, although significant changes are not likely. The outcomes above map to the general student outcomes specified in ABET Criterion 3 for accrediting college/university engineering programs as follows:
(1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics – Course outcomes 1–8

Instructor

Prof. David Kelley, 570-577-1313, dkelley@bucknell.edu

Health Protocols

Most, if not all, class meetings are currently expected to be in person. However, N-95 or KN-95 masks must be properly worn at all times during class if required by the instructor. This will generally be the case when the community COVID-19 transmission level for Union County is medium or high according to the United States Centers for Disease Control and Prevention (CDC). Mask use could become optional at the instructor's discretion if infection rates at Bucknell stabilize. I realize that this policy is more restrictive than the university's policy, but I am trying to protect a family member who is at high risk of developing serious complications from infection.

Remote instruction via Zoom might be used if, for example, I become ill, I have to travel away from campus, or a major snowstorm makes travel dangerous. I will provide as much advance notice as possible, but such instances should be rare. It is also possible that the university will impose remote instruction if an unforeseen crisis warrants it. Lectures and other meetings conducted via Zoom will be presented synchronously at their normally scheduled times.

Confidentiality Statement

Class meetings on the Zoom online meeting platform might be recorded to make them available to enrolled students who miss the material due to absence. Recordings will be maintained confidentially and will be accessible only to students enrolled in the course. Before a Zoom recording begins, you will be asked to provide your consent to participate. Students who provide consent may deactivate the microphone and/or camera within the session. Students who do not provide consent may exit the session and notify me of their decision. The latter group of students may access the recorded session at a later time.

Textbook

Steven W. Ellingson, *Radio Systems Engineering*, Cambridge University Press, 2016. ISBN: 978-1107068285

Recommended Text

Thomas H. Lee, *Planar Microwave Engineering: A Practical Guide to Theory, Measurement, and Circuits*, Cambridge University Press, New York, NY, 2004. ISBN: 978-0521835268

Web Site https://www.eg.bucknell.edu/~dkelley/eceg497

Prerequisite ECEG 390 (concurrent prerequisite) or its equivalent or permission of the instructor

Communication Check your e-mail and the course web site at least **once per day**. Most announcements and course materials will be distributed via the web site or Moodle site. E-mail might be used to distribute time-sensitive announcements. You are responsible for knowing all assignment due dates and adhering to any policies or updates posted at the web site. You should contact me as soon as possible if you expect to miss a lecture or lab session.

You may expect prompt, but not instant, responses from me to e-mails, phone messages, and other forms of communication, and I will expect the same from you. We all have multiple responsibilities in our lives, and none of us should be expected to respond instantly to requests. I will strive to provide responses within a few hours but no later than 24 hours. Quick responses, even within 24 hours, should not be expected late at night or on weekends.

Academic Responsibility I expect you to comply fully with the university's academic responsibility policies. All submitted problem solutions must be your own work. Deliverables produced for team exercises, if any, must be your group's own work. General discussion of solution techniques is okay, but copying problem solutions or full or partial text, sharing step-by-step instructions for solving a problem, sharing computer files, and other forms of plagiarism are not acceptable. If these policies are not clear, please contact me or consult Bucknell's "Academic Responsibility" web site: www.bucknell.edu/academics/academic-responsibility-support/academic-responsibility

Intellectual Property Exams, homework assignments, exam and homework solutions, supplemental readings, and all other documents shared with the class are my or others' intellectual property and may not be posted online or otherwise shared with people outside the course without my permission. Distributing someone else's intellectual property without their permission is a serious matter.

Bucknell University Honor Code As a student and citizen of the Bucknell University community:

1. I will not lie, cheat, or steal in my academic endeavors.
2. I will forthrightly oppose each and every instance of academic dishonesty.
3. I will let my conscience guide my decision to communicate directly with any person or persons I believe to have been dishonest in academic work.
4. I will let my conscience guide my decision on reporting breaches of academic integrity to the appropriate faculty or deans.

Final Grade Determination All undergraduate students' final course grades will be computed as shown below, although an individual student's weighted exam average must be greater than 50 out of 100 points to pass the course. Significant extra credit opportunities are not likely to be provided. Exam dates will be posted at the course web site.

Professional Conduct	5%	
Homework	15%	Weighted equally; lowest two scores dropped
Mini Projects	15%	Lowest score weighted less than other(s)
Exams #1–#3, Final	3×20%, 5%	Lowest of four scores weighted less than the other three

The weightings above could be adjusted and/or alternative assessment methods might be introduced if necessary to account for unusual circumstances, such as a major error in an exam or other assignment, a health-related change in instructional mode, or a long-term university closure. Any such changes will be announced with as much advance notice as possible.

Students taking the graduate version of the course (ECEG 697) must complete enhanced versions of the mini-projects and one or two special individual assignments. Completion of homework assignments is highly recommended, but homework for graduate students will not be graded. Detailed grading criteria for graduate students will be distributed separately.

Scores on major assignments will not be discussed until a 24-hour "cooling off" period has passed unless points have been added incorrectly to obtain an overall score. An absolute scale with the following distribution will be used to determine all final course grades.

93–100 A	87–89.9 B+	77–79.9 C+	60–69.9 D
90–92.9 A−	83–86.9 B	73–76.9 C	< 60 F
	80–82.9 B−	70–72.9 C−	

Scoring Rubric

The following rubric will be used to assign scores to most individual exam problems. The three numerical columns below apply to problems with total point values of 20, 15, and 10, respectively. For problems with other total point values, scores will be scaled proportionately to the nearest whole number. Some problems could be scored using a different rubric or method.

20	15	10	Perfect or nearly perfect solution.
18	14	9	Minor math error; unit not included (or incorrect unit) in numerical answer; not enough or too many significant figures in numerical answer; miscopied value.
15	11	7	Concept essentially understood, but solution contains one or two procedural or factual errors; concept mostly but not completely understood; incorrect form of key formula or equation; unit prefix error (e.g., mV instead of μV); major math error.
10	8	5	Concept mostly understood, but solution contains several procedural or factual errors; concept only partially understood.
5	4	3	Solution contains a few steps in the right direction but is essentially incorrect; main underlying premise mostly misunderstood.
2	2	1	One or two relevant facts (such as equations) or diagrams are provided, but the solution is essentially incorrect or missing; main underlying premise is missed.

Typically, if more than one type of error that leads to ~75% credit (the "15, 11, 7" category above) is present, then the score will drop to ~50% or ~25% of full credit, as appropriate.

Professional Conduct

Everyone in the classroom must act in a professional manner. Distractions that prevent your classmates from concentrating on instructional activities will not be tolerated. For in-person instruction, these include checking social media, reading newspapers or other noisy print media, web browsing, disruptive eating, excessive talking, chronic tardiness, and other inappropriate behavior. Smart/cell phones, laptops, and other electronic devices other than non-wireless calculators may not be used in class without prior permission, although such devices may be used briefly to take pictures of the whiteboard. Tablet PCs and tablet-like devices may be used to take notes in class if they are kept flat on the table and are used with a stylus or a quiet keyboard; however, they could be disallowed as well if they become a distraction. Similar distractions to those listed above during remote instruction also will not be tolerated. Please contact me if you need to monitor your communication device for an important reason such as an ongoing family crisis.

Unless you have made different arrangements with me, during online sessions I expect you to have your camera on most of the time. An exception is when a session is recorded (if that occurs); in those cases, you have the option of turning off your camera. Please contact me if you have a reason for otherwise keeping your camera off.

Since part of the educational mission of Bucknell is to prepare you for professional practice, conduct in the classroom and/or online comprises a portion of your course grade. You should act as you would in an engineering staff meeting. If you have a valid reason for frequent lateness or for leaving the room or online session during class time, please notify me. Use of prohibited substances and/or possession of associated paraphernalia in class will result in a 1-point drop in the Professional Conduct score per incident and referral to the ECE Chair and/or Dean's office.

Please contact me if you feel that any of these policies should be adjusted. Professional expectations change often, and practices that were once considered unacceptable sometimes later become part of normal work culture. I am willing to modify expectations for good reasons and/or truly changing norms. However, I will not permit practices that distract others from learning.

Homework Policies The primary purpose of homework is to help you master the concepts presented in the course at a high level. I encourage you to work on homework in groups and to help each other understand the material within the scope of the "Academic Responsibility" section below. However, the less you rely on a study group to complete your assignments, the more effectively you are likely to learn the material. Ultimately, you need to make sure that you can solve exam problems, respond to discussion prompts, and complete other assigned activities on your own.

Homework must be submitted by the indicated deadline. Please follow the formatting guidelines listed below:

- At the top of the first page, add your name, the course number (ECEG 497), and the homework number.
- Add a page number at the top of each subsequent page.
- Arrange problem solutions in the order in which they are listed on the assignment.
- If appropriate, clearly indicate your answers by enclosing them in boxes.
- Write on only one side of the homework page.
- Trim the fringe pieces if you use paper torn from a spiral notebook.
- You are not required to use green "engineering paper."
- You do not have to include a cover page.

Lack of compliance with one or more of these requirements could result in a score reduction. Sloppy or unreadable work is unacceptable and could result in a score of zero. Assignments will be posted at the course web site, and solutions will be posted at the course Moodle site.

It is likely that only some of the problems in a homework assignment will be graded. Those problems will be clearly indicated. Note, however, that you must become familiar with the concepts embodied in *all* problems whether graded or ungraded. Solutions to graded and ungraded problems will be posted at the course Moodle site.

Because a homework grader will not be available for this course, only one or two randomly selected problems per homework set will be carefully reviewed for content. The other problems will be assigned scores using a coarse rubric based primarily on apparent effort. The carefully graded problem(s) will not be identified beforehand. It is your responsibility to review the posted solutions and to understand and rectify any conceptual errors that you might have. You may contact me at any time for assistance with this task.

Your homework will be submitted either in physical form or online. If online, then scan (preferred) or photograph your homework pages and convert them to PDF format. Upload the file via the link provided at the course Moodle site or other specified collection method. If you have to photograph your homework, use a low-resolution setting to minimize the file size. Collect the photos into a single PDF file or into a single word processing file that you then convert to PDF. If you have a black & white photo setting on your phone or scanner, please use it to further reduce the file size and improve contrast. Check your photos for glare that makes the text difficult to read.

Mini Projects This course does not have a formal laboratory component, but small hardware-oriented or simulation-based projects will be assigned. The former will require you to use laboratory facilities and/or the Maker-E. The latter will make use of *Multisim*, *EZNEC*, or other software. One or more projects could involve a combination of hardware and software. Details regarding projects and their scoring criteria will be provided later. I will offer help sessions on a regular basis to provide assistance with assigned projects.

Exams Three in-semester exams and one final exam will be scheduled. The lowest exam score (including the final exam) will be weighted only 5% and the others 20% for the purpose of determining the overall course grade. The final exam will be designed to be completed in much less time than the allotted three hours.

Conflict and Lateness Policies

If you know that you will not be able to complete an assignment by its deadline or take an exam at its scheduled time, **please notify me at least 48 hours in advance.** Because of the uncertainty of the current health crisis, it is possible that circumstances could change rapidly. It will be important to maintain lines of communication. However, it will also be helpful and perhaps therapeutic to maintain as much regularity and consistency as possible in the face of the uncertainty. You will normally be expected to meet posted deadlines, but do not hesitate to ask for patience if you or someone close to you becomes ill or if you face unexpected hardships.

Absences or delays due to job interviews, religious observances, performances, varsity athletic competitions, and extraordinary personal opportunities will normally be accommodated. However, in accordance with university policy, incompletions or late work due to personal travel plans under your control (especially around the times of recesses and final exam week) will not.

If you miss an exam, a major deadline, or other major activity due to illness, injury, or other misfortune, you must contact me as soon as possible, preferably before the scheduled activity. If a health professional or other relevant authority confirms the seriousness of your case, then your absence and/or missed deadline will be excused. In the case of an exam, a make-up opportunity will be arranged.

Unexcused absences or missed deadlines (e.g., due to oversleeping) will be handled on a case-by-case basis, usually in consultation with the Dean's office. If you begin an exam after the start time, you must complete it in the remaining allotted time. If you miss all of an exam due to an unexcused absence, you must notify me as soon as possible. Depending on the reason for the absence, a make-up opportunity of some kind *might* be offered for the first unexcused absence. Further unexcused absences will likely result in a score of zero for the exam or assignment.

A 10% per day score reduction will be imposed for homework submitted after the deadline; however, no homework will be accepted after the solutions have been posted. Adjustments will be made for serious extenuating circumstances.

Additional policies might be posted at the course web site. If so, they will be announced via e-mail and on the main web page. You are responsible for knowing and adhering to any posted policies.

Attendance Policy

The decision to attend class either in person or remotely is your responsibility. Although attendance at lectures is not specifically required for this course, I do notice when you are missing. If you struggle in the course, I will point to your absences as a likely cause. Please note that I frequently cover supplemental topics or details in class that do not appear in the textbook. There could also be occasional in-class exercises. While they might not be directly applicable to your course grade, they could nevertheless help you greatly to comprehend the material.

Time Commitment

Time allotted to coursework outside of class is guided by Bucknell University's expectations for academic engagement: "Courses at Bucknell that receive one unit of academic credit [like ECEG 497] have a **minimum** expectation of 12 hours per week of student academic engagement. Student academic engagement includes both the hours of direct faculty instruction (or its equivalent) and the hours spent outside of class on student work." During some weeks the work load could be greater than average, some weeks less, but it should average **at least** 12 hours per week (9 hours beyond lecture time). The total includes time spent on reading, homework, help sessions, mini-projects, exams, and any other activity related to the course. If some aspect of the work seems to require an excessive amount of time, please let me know either directly or anonymously.

I realize that sometimes special circumstances arise in a student's senior year, mainly because of Senior Design and possible job or graduate school interviews. Those commitments are already accounted for in the structure of the fourth-year curriculum and therefore are not excuses for neglecting course work. Nevertheless, unusually busy periods can arise during the semester, and I will attempt to minimize the demands of this course during those times.

Accessibility and Accommodations

If you have or develop a medical condition or a documented or suspected learning disability that will affect your work in this course and for which you might require an accommodation, please contact the Office of Accessibility Resources (570-577-1188 or OAR@bucknell.edu) as soon as possible. Note that moving an exam or obtaining approval for extra completion time requires official coordination with OAR.

Bucknell and I also support efforts to maintain mental health. If you are struggling and believe that it could affect your performance in this course, please contact Associate Dean Terri Norton (570-577-1800, trn005@bucknell.edu) or Dean of Students Amy Badal (570-577-1601, badal@bucknell.edu). Please also contact me if you feel comfortable doing so. Working through official channels will enable me to provide resources and support. If you require immediate mental health assistance, call the Counseling & Student Development Center at 570-577-1604; after business hours, call 570-577-1604 and choose option 2.

Statement of Support

I support the right of every student to define their own identity. If you have a preference for a specific set of pronouns and other forms of address or if you use a name that differs from the one in the university's records, please let me know.

The ECE Department values and respects all of our students, staff, and faculty regardless of race, ethnicity, nationality, gender, gender expression or sexual orientation, religion or belief system, economic status, or physical ability. We strive to offer a safe environment for learning, growth, inquiry, and the respectful sharing of ideas. By joining this community, all members commit to welcome others in the same manner.

We appreciate and encourage your suggestions to help the ECE Department and the College of Engineering meet this commitment. If something occurs in class that makes you feel uncomfortable, please contact me. If you are not comfortable doing that, then please talk with someone else you trust. Resources could include your other instructors, the department chair (alan.cheville@bucknell.edu), or Associate Dean Terri Norton (trn005@bucknell.edu). Incidents of bias may be reported (anonymously, if you wish) at:
https://www.bucknell.edu/life-bucknell/health-wellness-safety/bias-incident-policy
The ECE Department and the College of Engineering commit to supporting students expressing concerns and/or reporting bias to empower them in any follow-up actions and to ensure that they are protected from repercussions of any kind.