

**Course Policies and Information****Objective**

This course introduces students to the solution of practical problems involving electromagnetic field theory. A major goal is to expose students to technologies that they are likely to encounter in their careers. Topics covered include Maxwell's equations, propagation and reflection of transverse electromagnetic waves, and antenna and transmission line theory. The course also exposes students to analysis and design issues often encountered by engineers in professional practice.

**Course Outcomes**

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

1. Predict voltages, currents, and/or power flow along a transmission line given the line parameters and the signal source and load connected to the line.
2. Design a transmission line-based impedance matching system.
3. Relate the power density of a radiated electromagnetic wave to an antenna's gain, radiation pattern, and applied input power.
4. Perform link budget calculations using the Friis transmission formula.
5. Mathematically express and/or analyze the polarization of an electromagnetic wave.
6. Relate the attenuation, wavelength, and/or speed of a TEM wave propagating through a lossy medium to the medium's known constitutive parameters.
7. Predict the magnitudes and propagation directions of reflected and transmitted plane waves at a planar interface between two materials.

Adjustments might be made to the list above, although significant changes are not anticipated. The outcomes 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 1–7

**Instructor**

Prof. David Kelley, 570-577-1313, [dkelley@bucknell.edu](mailto:dkelley@bucknell.edu)

**Office Hours**

Times will be announced. Evening office hours, if any, will likely take place via Zoom.

**Textbook**

Fawwaz T. Ulaby and Umberto Ravaioli, *Fundamentals of Applied Electromagnetics*, 8th ed., Pearson, 2019. Supplemental readings will be posted at the course Moodle site.

**Web Site**

<https://www.eg.bucknell.edu/~dkelley/eceg390>

**Prerequisites**

ECEG 210 and MATH 211 or their equivalents 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 the 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 other activity.

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. I will strive to provide responses within a few hours but no later than 24 hours during the work week. You should not expect responses, nor should I, late at night or on weekends.

**Health and Safety Protocols**

Class meetings are expected to be in person. Remote instruction via the Zoom online platform might be used if, for example, I become ill, I must travel away from campus, or a major weather event makes travel dangerous. In such cases, I will provide as much advance notice as possible. The university could impose or allow remote instruction if an unforeseen crisis warrants it. Any class meetings via Zoom will take place synchronously at their normally scheduled times. If the meeting is not recorded (see next section), all students must have their cameras on.

The use of masks in class is likely to be optional but recommended if an outbreak of a highly contagious disease occurs. However, I reserve the right to require everyone in the class to wear properly fitted N-95 or KN-95 masks at all times in the case of a dangerous health crisis. I realize that this policy could be more restrictive than the university's policy, but I must protect a family member who is at high risk of developing serious complications from infection.

**Confidentiality of Recordings**

If any class meetings take place on the Zoom online platform, then they *might* be recorded for the purpose of making them available to students who miss the material due to absence; however, recordings are not guaranteed. Recordings will be stored securely 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 do not provide consent may exit the session and notify me of their decision. The latter group of students may access the recorded session later but are responsible for keeping up with the course material on their own. All students are expected to participate in a Zoom session with their camera on if it is not recorded.

**Final Grade Determination**

Your final course grade will be determined as shown below, although your weighted exam average must be greater than 50 out of 100 points for you to pass the course. Significant extra credit opportunities are not likely to be provided. Exam dates will be posted at the course web site.

Mandatory Office Hours Visit	3%	
Professional Conduct	5%	
Homework	12%	Weighted equally; lowest score dropped
Individual Invest.	10%	
Exams #1–#4, Final	4×15%, 5%	Lowest of five scores weighted less than the other four
Final Concept Exam	5%	

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

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 your final course grade.

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–	

**Mandatory Office Hours Visit**

You must attend scheduled office hours (help sessions) for at least five minutes at least once after the first week of the semester but before the end of the fourth week. You may attend either an in-person or online session. During the visit, you must discuss something with me that is relevant to the course such as assigned homework problems, an assigned project, a challenging concept, or something that I covered in class that you found interesting. Of course, you are strongly encouraged to visit more often than once! During the visit you must also show evidence that you have access to the textbook. You may bring a physical copy with you, or you may bring up an e-textbook on computer, smart phone, or tablet. Up to two people may satisfy this requirement simultaneously during a single visit. You will earn only 2.5 points if your visit is during the last scheduled session before the deadline. You may not satisfy this requirement by making an appointment outside regularly scheduled sessions unless you have a verifiable time conflict.

**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 permission except briefly to take pictures of the whiteboard. Tablet PCs and tablet-like devices may be used to take notes if they are kept flat on the table and are used with a stylus or quiet keyboard, but they will not be allowed if they become a distraction. Please notify me if you need to monitor a device for an important reason such as an ongoing family crisis.

Similar distractions to those listed above during remote instruction will not be tolerated. Unless you have made different arrangements with me, during online sessions I expect you to have your camera on most of the time. Please contact me if you have a reason for 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 engage with 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 that you rely on a study group to complete assignments, the more effectively you are likely to learn the material. Ultimately, you need to make sure that you can solve exam problems and complete assigned activities on your own.

Homework assignments will be posted at the course web site, and your completed work must be submitted via the course Moodle site by the indicated deadline. Please follow the formatting guidelines listed below. They are not meant to trip you up or to test whether you can follow instructions. Instead, they help ease the strain on your hard-working grader, and they help ensure that you receive proper credit for your work:

- At the top of the first page, add your name, the course number (ECEG 390), and the homework number. You do not have to use a cover page.
- 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 page to prevent "bleed-through."
- You are not required to use green "engineering paper."
- Scan (preferred) or photograph your homework pages and convert them to PDF format. For photos, use a low-resolution setting to minimize the file size. Collect photos into a single PDF file or a word processing file that you then convert to PDF.
- If available, use the black & white photo setting on your phone or scanner to minimize the file size and improve contrast. Check photos for glare that makes the text difficult to read.
- Make sure that submitted images have good contrast and are close to 8.5 x 11 inches in size. Moodle does not have a page zoom feature.
- If you use the Goodnotes app, select the "no background" option when you convert to PDF; otherwise, your homework might not be visible in Moodle.
- The file size of your scanned document must be less than 10 MB.

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.

Some of the assigned problems might not be graded. If so, they will be clearly indicated. Only a subset of the problems might be graded if the assignment is especially long. However, you must study the concepts embodied in *all* problems whether graded or ungraded. Solutions to all problems will be posted at the course Moodle site. It is your responsibility to review the 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.

If a homework grader is not assigned to the course, then each problem will be scored using a coarse rubric based primarily on apparent engagement. Comments will not usually be added, so you should contact me if you would like clarification.

## Individual Investigation

You will be required to demonstrate that you have gained a relatively high level of expertise through your own study of a topic chosen by you that is relevant to the course. To earn maximum credit, you will have to be proficient in the subject well beyond the scope of the course, and you will have to communicate what you have learned effectively via an oral presentation. The assessment of your work will take place during a 30-minute meeting with me at a mutually agreed time during the semester. Details of the assignment and a schedule will be provided later.

## Exams

Four 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 15% for the purpose of determining the overall course grade. The final exam will consist of two parts. The first part will resemble the four in-semester exams and, like them, will be quantitative in nature. The second part (the Final Concept Exam) will be more qualitative and will assess your understanding of the key course concepts over the full semester.

## Scoring Rubric

The following rubric will be used to assign scores to most individual exam problems. The four numerical columns below apply to problems with total point values of 25, 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.

25	20	15	10	Perfect or nearly perfect solution.
23	18	14	9	Minor math error; missing or incorrect unit in numerical answer; not enough or too many significant figures in numerical answer; rounding error; miscopied value.
19	15	11	7	Concept essentially understood, but solution contains a procedural or factual error; concept mostly but not completely understood; incorrect form of key equation; unit prefix error (e.g., mV instead of $\mu$ V); major math error.
13	10	8	5	Concept mostly understood, but solution contains several procedural or factual errors; concept only partially understood.
7	5	4	3	Solution contains a few steps in the right direction but is essentially incorrect; main underlying premise mostly misunderstood.
3	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 “19, 15, 11, 7” category above) is present, then the score will drop to ~50% or ~25% of full credit, as appropriate.

## Conflict and Lateness Policies

If you know that you will not be able to complete an assignment by its deadline or to take an exam at its scheduled time, **please notify me at least 48 hours in advance**. 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. 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 or other major graded activity, a make-up opportunity will be arranged.

Absences or delays due to job interviews, religious observances, participation in performances, participation in varsity athletic competitions, and extraordinary personal opportunities will normally be accommodated. However, in accordance with university policy, incomplete or late work due to personal travel plans under your control (especially around spring recess and final exam week) will not be accommodated. If possible, please provide me with a list of your expected absences early in the semester.

Unexcused absences or missed deadlines (e.g., due to oversleeping) will be handled on a case-by-case basis, probably 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. However, you may not take the exam if you arrive after the first student has completed it and left the room; this policy includes the final exam. Such a situation is equivalent to missing the exam. 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, but homework will not be accepted at all after the solutions have been posted. Adjustments will be made for extenuating circumstances.

Additional policies might be posted at the course web site. If so, they will be announced via multiple methods. You are responsible for knowing and adhering to any posted policies.

**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 390] 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** 8 hours per week beyond class time. The total includes time spent on reading, homework, help sessions, 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.

**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 any absences as a contributing cause. 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 directly affect your course grade, they could nevertheless help you greatly to comprehend the material. I will not go over course material in detail (i.e., I will not essentially repeat a lecture) for students who miss class without a valid reason such as illness, injury, or an authenticated family crisis.

**Academic Responsibility** You must 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 full or partial solutions or text, sharing step-by-step instructions for solving a problem, sharing computer files, and other forms of plagiarism are not acceptable. It is considered plagiarism if you use text written by an automated system and claim it as your own (e.g., the output from an artificial intelligence tool such as ChatGPT). If these policies are not clear, please contact me or consult Bucknell's "Academic Responsibility" web site:  
<https://www.bucknell.edu/academics/current-students/academic-responsibility>

Artificial intelligence (AI) tools are proliferating, and it is tempting to use them to solve homework problems, produce written work, etc. It is impossible for me to monitor such usage; therefore, I cannot enforce a prohibition against it. However, you should be aware that if you use such tools, you will not fully develop your ability to solve problems and express ideas nor will you fully develop your technical skill and knowledge. You will not be able to use such tools during exams and presentations. Furthermore, if an AI tool generates an erroneous solution or text and you pass it along as your own, you must accept the resulting grade penalty. As explained above, claiming text generated by an AI tool as your own is considered plagiarism.

**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.

**Accessibility and Accommodations**

If you have or develop a medical condition or a documented or suspected learning disability that might 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](mailto:OAR@bucknell.edu)) as soon as possible. Moving an exam or obtaining approval for extra time requires coordination with OAR.

Bucknell and I 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 or [trn005@bucknell.edu](mailto:trn005@bucknell.edu)) or me if you feel comfortable doing so. Working through official channels will enable me to provide resources and support. If you need 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 prefer a specific set of pronouns and other forms of address or if you use a name that differs from the one that appears 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 welcoming 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 makes you feel uncomfortable, please contact me. If you are not comfortable doing that, then please contact someone else whom you trust. They might include other instructors, the ECE Department chair (Stu Thompson, [mst008@bucknell.edu](mailto:mst008@bucknell.edu)), or Associate Dean Terri Norton ([trn005@bucknell.edu](mailto:trn005@bucknell.edu)). Incidents of bias may be reported (anonymously, if you wish) online 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 who express concerns and/or report bias and will ensure that they are protected from repercussions of any kind.

**Advice for Success**

Electromagnetics is a difficult subject, and you will be challenged in this course. You should attend all lectures and keep up with the reading. Homework assignments will be closely aligned with the assigned reading and could cover material discussed in class as little as two days before the due date. Start working on homework assignments early.

You **must** read the textbook and the supplemental readings. Lectures are not a replacement for the readings but instead are meant to add value to them and explain the more challenging aspects. Students who do not complete assigned readings tend to struggle significantly with the material. The readings fill in the details that I do not have time to cover in class and provide valuable reinforcement of the lecture topics. I know that textbooks are not as engaging as a bestselling romance novel, but Ulaby is a good one and widely used; many students can learn from it alone.

Homework and other assigned activities are for your benefit. Take advantage of the opportunity to practice solving problems on your own to improve your learning and retention. Choose active studying over passive studying. Instead of just reading examples and derivations, work out at least some of them yourself. Your primary concern should be to understand the concepts and solution techniques presented in the course. Arriving at the correct numerical answer is of secondary (although not least!) importance. If you obtain an answer that does not make sense physically (e.g., an answer that is orders of magnitude too large), I expect you to notice it.

Please contact me if you are struggling with any aspect of the course. If you think that you might be dealing with test anxiety, you should review the resources available on the Exams page at the course web site. They have been prepared by professional counselors and educators and comprise a rich and proven collection of advice for managing test anxiety. You should also consider consulting Bucknell's Counseling & Student Development Center (570-577-1604).

Finally, reflect on this quote from NFL Hall of Fame wide receiver Jerry Rice:

"Today I will do what others won't, so tomorrow I can do what others can't."

## Final Thoughts and Assessment Philosophy

Hard work is a necessary but not sufficient requirement for succeeding in any endeavor, especially electrical and computer engineering. In ECEG 390, effort and comprehension are both important, but the aim of this course is for you to attain the essential knowledge and skills necessary to analyze and design basic electromagnetic systems in a professional setting. Your final course grade will depend primarily on the degree to which you achieve the stated course outcomes, not necessarily on how hard you work.

That means that the effort that you put into this course should be intentional toward understanding the fundamentals of electromagnetics and how you can adapt them to solve some of the technical problems that you will encounter in your career. This course cannot cover every aspect of the solution to every future electromagnetics problem in its entirety. There are too many variables and special constraints in the real world. Engineering is almost never about simply finding the right equation and then substituting numerical values to arrive at a design. Often the engineer is called upon to produce new designs (and sometimes derive new equations to model them) to deal with new challenges. Success is much more likely if the engineer has studied thoroughly how similar problems have been solved in the past. You should therefore view this course as a way to develop a set of tools that you can use as a starting point to craft exciting and innovative solutions to future problems.

Next, students sometimes ask professors why they “take off” points for mistakes on exams or other assignments. Please understand that professors never *remove* points. Instead, we *assign* points that reflect the quality of the work. Viewed another way, when a student takes an exam, they do not start with 100 points and, by making mistakes, lose them. Instead, they start with zero points and, by demonstrating the development of their knowledge and skills, add them. You should approach your assignments as opportunities to show me how much you have grown as an engineer.

You have heard many times by now that we are in unprecedented territory and that we have been facing many new challenges. That reality is forcing all of us to alter our plans and our priorities in unforeseen ways. ECEG 390 covers some very important fundamental material that almost every electrical or computer engineer encounters. The course strives to make you familiar with the electromagnetic aspects of all electronic devices and systems in use today – both digital and analog. I therefore want to help you succeed and thrive in this course. Although some of the expectations of the university remain relaxed after the COVID-19 crisis, the expectations of your future employers are likely to be the same as they have always been. Moreover, the technical problems facing society have not diminished, nor have they been put on hold. On the contrary, they could be even more demanding now. You need all of the tools that you can gather.

If it seems that I am pushing you a little more than some of your other professors, that is why. My industry and sabbatical experiences have taught me that society is going to need your skills and is going to need you to be very good at them.

That being said, if there is anything that I can do to help you, or if you feel that the pace of the course is exceeding your ability to keep up, please let me know.