Course Description

This course is designed to be taken concurrently with ECE 329 “Fields and waves I”, to strengthen the students’ understanding of the concepts in electromagnetism and their applications, through a combination of customized Virtual Reality (VR) experiences and computer simulations using Mathematica. Topics include static and quasi-static electric fields, polarization, static and quasi-static magnetic fields, dynamic fields and Maxwell’s equations, wave solutions of Maxwell’s equations in free space and homogeneous media, time- and frequency-domain analysis of waves in transmission line circuits, and Smith Chart analysis.

Student competencies around conceptual understanding of electromagnetism topics, as well as their understanding of mathematical concepts, will be measured via formative and summative assessments. Each lab period includes a multiple choice test in VR, and problem solving using Mathematica notebooks. Questions are designed to primarily measure conceptual understanding of the various topics, rather than measuring the ability to simply manipulate equations, and are tied to the specific contexts and topics of that lab’s instruction.

Prerequisites

Concurrent enrollment in ECE 329.

Main References

The lab’s instruction is aligned with that of ECE 329, and follows the notes of E. Kudeki.

Laboratory Equipment

Students enrolled in ECE 398 will be granted 24/7 access to the ECE VR Lab located in ECEB 3013. The VR Lab consists of 10 stations equipped with gaming grade GPUs and Oculus Rift S headsets. All stations have Mathematica and Unity installed. In addition, Mathematica is distributed freely to ECE students via UIUC Webstore. During the instruction lab period, students will complete a quiz of the type described above, while allowed to go back to the VR experience or Mathematica Notebook for guidance.
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<tr>
<th>Week</th>
<th>Topic of Instruction</th>
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| 01/29/2021   | Coulomb’s Law, Lorentz Force, Gauss’ Law                  | 1. **VR:** Oculus Headset Tutorial  
               |                                                           | 2. **VR:** Coulomb’s Law  
               |                                                           | 3. **VR:** Gauss’ Law |
| 02/05/2021   | The $\nabla$ Operator, Electrostatic Potential, Boundary Conditions | 1. **VR:** Vector Calculus ($\nabla \times \mathbf{A}, \nabla \cdot \mathbf{A}, \nabla f$)  
               |                                                           | 2. **VR:** Electrostatic Potential  
               |                                                           | 3. **VR:** Boundary Conditions for $\mathbf{E}, \mathbf{D}$ fields  
               |                                                           | 4. **MN:** Mathematica Tutorial  
               |                                                           | 5. **MN:** Conservative Fields, Path Independence |
| 02/12/2021   | Poisson’s and Laplace Equation                             | 1. **VR:** Coordinate System Transformations  
               |                                                           | 2. **MN:** Poisson’s and Laplace Equation  
               |                                                           | 3. **MN:** Polarization |
| 02/19/2021   | Fields in Media                                            | 1. **VR:** Gallery  
               |                                                           | 2. **MN:** Capacitance & Conductance  
               |                                                           | 3. **MN:** Polarization Current |
| 02/26/2021   | Ampere’s Law                                               | 1. **VR:** Ampere’s Law  
               |                                                           | 2. **VR:** Current Sheet, Solenoid, Current Loops  
               |                                                           | 3. **VR:** Earth’s Magnetic Field  
               |                                                           | 4. **MN:** Magnetic Materials |
| 03/05/2021   | Faraday’s Law                                              | 1. **VR:** Faraday’s Law  
               |                                                           | 2. **VR:** Lentz’s Law  
               |                                                           | 3. **MN:** Faraday’s Law Applications |
| 03/12/2021   | EM Waves                                                   | 1. **VR:** Wave Generator  
               |                                                           | 2. **MN:** Current Sheet Radiator |
| 03/19/2021   | Poynting Theorem                                            | 1. **MN:** Poynting Theorem  
               |                                                           | 2. **MN:** Damped Waves, Phasor Form |
| 03/26/2021   | *(Optional)* Make Up Labs                                   | 1. **VR:** Make-up Lab |
| 04/02/2021   | Wave Polarization                                           | 1. **VR:** Wave Polarization  
               |                                                           | 2. **MN:** Wave Polarization Problem Solving |
| 04/09/2021   | Wave Transmission and Reflection                            | 1. **VR:** Wave Propagation  
               |                                                           | 2. **MN:** Wave Propagation Problem Solving |
| 04/16/2021   | Bounce Diagrams                                             | 1. **VR:** Bounce Diagrams  
               |                                                           | 2. **MN:** Multi-line Circuits |
| 04/23/2021   | Smith Chart, Impedance Matching                             | 1. **MN:** Smith Chart Examples  
               |                                                           | 2. **MN:** Impedance Matching with Smith Chart |
| 04/30/2021   | *(Optional)* Make Up Labs                                   | 1. **VR:** Make-up Lab |

Table 1: MN = Mathematica Notebooks, VR = Virtual Reality experiences

Note: New VR experiences *(in addition to the ones listed here)*, are currently under development, and we anticipate to use them as they become available.
Grading Policy

In class quizzes (50%), Mathematica Notebooks Homeworks (50%),

Class Philosophy

- Research has demonstrated that the best learning occurs when the learner is actively involved. Thus the students are expected to come to class prepared to **think, participate in active learning activities, and learn.**

Class Policy

- The classroom is a learning environment. Please avoid distractions for yourself and others.
- Please turn off your cell phone during class. Do not keep your cell phone on your desk. **NO TEXTING** during class.
- Tablets and laptops are allowed only for note taking purposes as well as for use of Mathematica notebook exercises.

Academic Integrity

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: http://studentcode.illinois.edu/.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: https://studentcode.illinois.edu/article1/part4/1-401/. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

COVID Safety

Following University policy, all students are required to engage in appropriate behavior to protect the health and safety of the community, including wearing a facial covering properly, maintaining social distance (at least 6 feet from others at all times), disinfecting the immediate seating area, and using hand sanitizer. Students are also required to follow the campus COVID-19 testing protocol.

Students who feel ill must not come to class. In addition, students who test positive for COVID-19 or have had an exposure that requires testing and/or quarantine must not attend class. The University will provide information to the instructor, in a manner that complies with privacy laws, about students in these latter categories. These students are judged to have excused absences for the class period and should contact the instructor via email about making up the work.

Students who fail to abide by these rules will first be asked to comply; if they refuse, they will be required to leave the classroom immediately. If a student is asked to leave the classroom, the non-compliant student will be judged to have
an unexcused absence and reported to the Office for Student Conflict Resolution for disciplinary action. Accumulation of non-compliance complaints against a student may result in dismissal from the University.

**Students with Disabilities**

To ensure equity for each student’s educational experience, those with documented disability and required accommodations should contact me early in the semester so that all learning needs may be appropriately met. If you have not yet contacted DRES, please do so as soon as possible.

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to https://www.disability.illinois.edu. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnosis a previously undiagnosed disability. You may access these by visiting the DRES website and selecting “Request an Academic Screening” at the bottom of the page.

**Anti-Racism and Inclusivity Statement**

This classroom is a place where you will be treated with respect. I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, national origins, religious affiliations, sexual orientations, abilities - and other visible or non-visible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

The intent is to raise student and instructor awareness of the ongoing threat of bias and racism and of the need to take personal responsibility in creating an inclusive learning environment. The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, or religious beliefs. The College recognizes that we are learning together in the midst of the Black Lives Matter movement, that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course director if you feel comfortable. You can also report these behaviors to the Bias Assessment and Response Team (BART) (https://bart.illinois.edu/). Based on your report, BART members will follow up and reach out to students to make sure they have the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.
Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University’s Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options. A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: wecare.illinois.edu/resources/students/confidential. Other information about resources and reporting is available here: wecare.illinois.edu.

Religious Observances

Illinois law requires the University to reasonably accommodate its students’ religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at https://odos.illinois.edu/community-of-care/resources/students/religious-observances/ to request appropriate accommodations. This should be done in the first two weeks of classes.

Family Educational Rights and Privacy Act (FERPA)

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ for more information on FERPA.