ELEC 211 / MATH 264: Engineering Electromagnetics with Integrated Vector Calculus

Time and Place (January 2020 offering)

Lecture Section 201: Tuesday and Thursday 11 – 12:30 in MCLD 202	Lecture Section 202: Tuesday and Thursday 2 - 3:30pm in MCLD 228
Tutorial: Alternate Wednesdays starting January 8, 5 – 7pm, WOOD 2 (both sections)	

Instructors

Carol Jaeger Department of Electrical and Computer Eng. KAIS 5024 carolj@ece.ubc.ca Open office hours Mondays at noon in KAIS 3046, or by appointment (please email with requests)	**Seckin Demirbas** Department of Mathematics Math Building room 235 s.demirbas@math.ubc.ca Office hours: please see http://www.math.ubc.ca/~s.demirbas/current.html

Calendar Description

ELEC 211 (2) **Engineering Electromagnetics**

Electrostatics, electric currents, dielectrics, capacitance, electrostatic potential, magnetostatics. *This course is not eligible for Credit/D/Fail grading.* [2-0-1]
Prerequisite: One of MATH 263, MATH 253 and one of PHYS 102, PHYS 153, PHYS 158.
Corequisite: MATH 264.

MATH 264 (1) **Vector Calculus for Electrical Engineering**

Divergence, gradient, curl, theorems of Gauss and Stokes. Applications to Electrostatics and Magnetostatics. MATH 264 content is strongly coupled to ELEC 211 with topics and student evaluations weighted accordingly. *This course is not eligible for Credit/D/Fail grading.*
Prerequisite: One of MATH 200, MATH 217, MATH 226, MATH 253, MATH 263.
Corequisite: One of ELEC 211, EECE 261.

About the course

This course is a complete integration of ELEC 211 and MATH 264. Lectures topics are interwoven such that mathematical concepts are taught at appropriate times to support and illuminate the electromagnetics topics. The course builds on what you have learned in 1st year physics (PHYS 157/8/9 or PHYS 153), but adds the framework of vector calculus – a key ingredient in taking the study of electromagnetics to the next level.

The majority of this course is dedicated to static problems (things not changing with time), though towards the end some slowly time-varying phenomena will be introduced. The material contained in this course is key to the further study of nearly all areas of electrical engineering.

Grading Scheme

Midterms	2 @ 15% each	30%
Homework	Best N-2, where N ≅ 12	15%
Bonus points*	*only unlocked if combined average of quizzes and final is above 50%	5%
Final Exam	Single comprehensive exam covering material from both courses	55%

Quiz Dates

February 5; March 18, during the common tutorial period. Start time: 5:15pm. End time: 6:45pm.

Resources

We will rely on materials provided on Canvas and open source textbooks for reference. Please see Canvas for a list of suggested references. You will not need to buy any textbooks.

Course Topics

- Coordinate Systems & Unit Vectors
- Electric field for charged points, and lines
- Electric field for general oblique line and surface charges
- Potential difference from energy: point, line of charge
- Line integrals
- Potentials and antiderivatives
- Gauss' law
- Flux integrals
- Divergence theorem
- Dielectrics
- Conductors, continuity of current, &resistance
- Boundary conditions
- Capacitors
- Biot-Savart law
- Ampere's Circuital law
- Stokes' theorem
- Magnetic flux
- Magnetic potential
- Magnetic forces and torques
- Magnetic dipoles
- Magnetic materials and boundary conditions
- Magnetic circuits
- Induced EMFs, inductors, linear motors & generators
- Transformers & mutual inductance
- Maxwell's equations

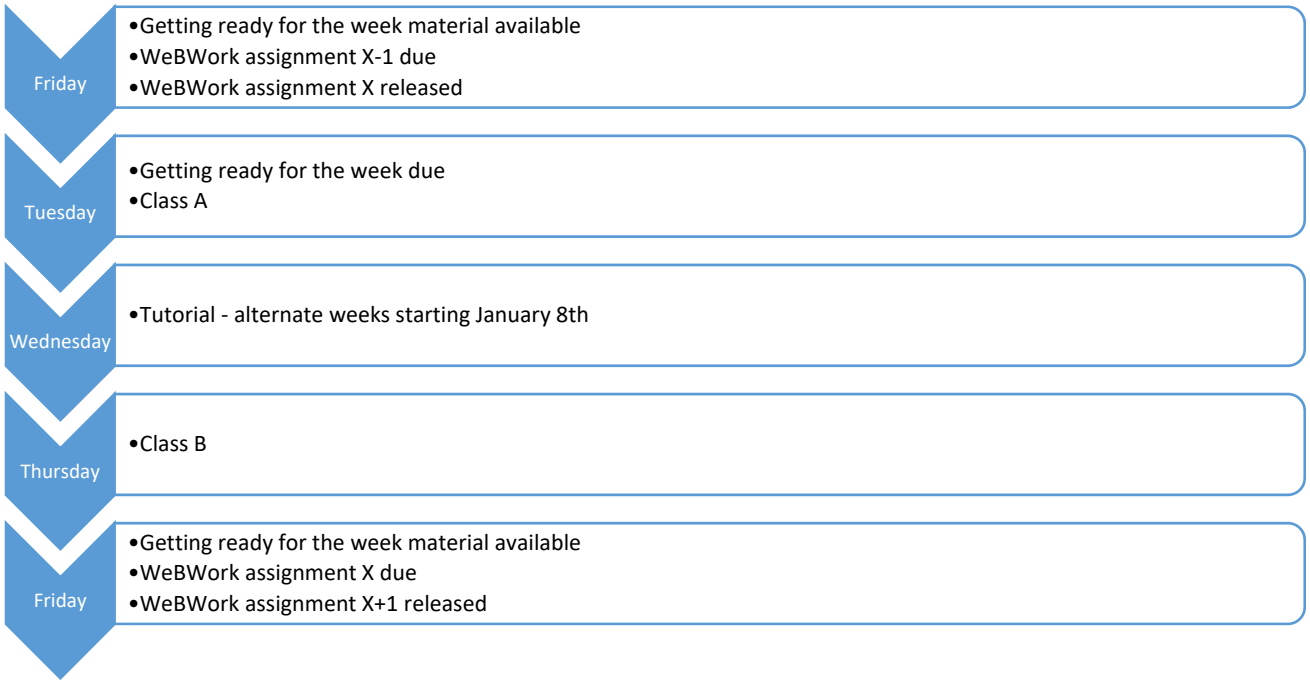
Learning Goals

By the end of this course you should be able to:

- Work comfortably with vector quantities, and perform a variety of mathematical operations with same
- Solve line, surface, and volume integrals in multiple coordinate systems
- Convert word problems to mathematical equations (and then solve them)
- Apply Divergence and Stokes' theorems correctly in problem solving
- Solve for the force on charged structures in the presence of electric fields
- Solve for the electric field at a point due to a variety of charge distributions
- Apply Gauss' law in the solution of electric field distributions resulting from charge distributions
- Use boundary conditions to determine the effect of different materials on electric and magnetic fields
- Evaluate the capacitance or inductance of a variety of structures
- Apply Ampere's law in the solution of magnetic field distributions resulting from current distributions
- Describe the different types of magnetic materials
- Calculate the displacement current in simple circuits
- Explain the principal of operation of a variety of electromagnetic devices
- Analyze the behavior of a variety of conducting structures in the presence of a time-varying magnetic field
- Understand and apply Maxwell's equations

Weekly schedule

This course is taught in a blended format. In class, there will be some formal lecturing, but also some group problem solving. Some lecture notes will often be released before class, but these should not be considered the full content – attending class is critical. Each week there will be some materials to review prior to coming to the lectures. Weekly assignments will be released on the WebWork platform (available through the Canvas site. Assignments will be based on the material from the week that has just been completed. A typical schedule will be as follows:



Course Policies

Pre-requisites: The pre-requisites for this integrated pair of courses are: One of MATH 263, MATH 253 and one of PHYS 102, PHYS 153, PHYS 158 or APSC 178. These are hard pre-requisites, and if you have not successfully completed these or equivalent courses, you will not be permitted to remain registered in the course.

Homework: Weekly assignments will be released on the WebWorK platform every Friday, and will be due on the following Friday at 11:59 pm. If there are a total of N WebWorK assignments, the best N-2 will count towards your final grade. No other concessions will be granted. The homework questions will be related to the material covered in the lectures for that week. In other words, we will cover material before assigning homework problems.

Midterms: Each midterm will start at 5:15pm and will last for 90 minutes. Formula pages will be provided. Allowed materials are pens, pencils, ruler, and an eraser. No calculators will be permitted.

Missed Midterms: If you miss a midterm and wish to apply for an in-term academic concession, you must fill out the online form available here: https://academicservices.engineering.ubc.ca/exams-grades/academic-concession/. For one missed test, if the concession is approved, the weight of that missed test may be transferred to the final exam.

Final Exam: The final exam will be a comprehensive exam covering the full course. It is scheduled centrally by UBC and we have no control over the exam date. If you miss (or are going to miss) the final exam, and you wish to apply for deferred standing, you must fill out the online form available here: https://academicservices.engineering.ubc.ca/exams-grades/academic-concession/.

Bonus Points: Up to 5 bonus points may be available during the term, but will only be applied to your final grade if you have a passing average on the combination of the quizzes and the final exam. These points may be awarded for GRFTW participation, class participation, bonus questions on tests, survey participation or other positive contributions to the class at the instructor's discretion.

Centre for Accessibility: If you are registered with the Centre and require academic accommodations for test writing, it is your responsibility to register the quiz dates with the Centre with sufficient notice for them to accommodate your needs. The course instructors are unable to provide custom accommodations for students during the published quiz times.

University Policies

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious, spiritual and cultural observances. UBC values academic honesty and students ae expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available here.