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

Time and Place (January 2024 offering)

Lecture Section 201: Tuesday and Thursday 11am - 12:30pm – Friedman Building 153	Lecture Section 202: Tuesday and Thursday 2pm - 3:30pm - LIFE 2302
Tutorials: • Alternate Wednesdays starting January 24th, 5pm – 7pm, Forest Sciences Centre 1005 • Note that an asynchronous video will be posted in place of the January 10 tutorial	

Instructors

Carol Jaeger Department of Electrical and Computer Eng. carolj@ece.ubc.ca Office hours: Please see Canvas Syllabus page	**Seckin Demirbas** Department of Mathematics s.demirbas@math.ubc.ca Office hours: Please see Canvas Syllabus page

Calendar Description

ELEC 211 (2) **Engineering Electromagnetics**
Electrostatics, electric currents, dielectrics, capacitance, electrostatic potential, magnetostatics.
Prerequisite: One of MATH 263, MATH 253 and one of PHYS 108, PHYS 118, PHYS 158. (note APSC 178 also accepted).
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 BMEG 220 and ELEC 211 with topics and student evaluations weighted accordingly.
Prerequisite: One of MATH 200, MATH 217, MATH 226, MATH 253, MATH 254.
Corequisite: One of BMEG 220, ELEC 211.

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) 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

Assessment	Description	Weight
Midterms	• 1 @ 10% & 1 @ 20% (automatically weighted for the best outcome on a per-student basis) • See final exam entry for additional assessment adjustments	30%
Homework	• WeBWorK assignments, unlimited attempts • Best N-2 scores will count, where N ≈11	15%
GRFTW* & participation	• Short auto-graded quizzes to help you prepare for the week • Surveys connected to assessment (e.g. post midterm surveys)	5%
Final Exam	• Single comprehensive exam covering material from both courses • If the score on the final exam is higher than one or both midterms, then the grade for the final will be substituted for the relevant midterm(s). This will be automatically calculated for the best outcome on a per-student basis.	50%
Total^		**100%**

* GRFTW = Getting Ready For The Week

^ Note: Students must pass the weighted combination of the midterms and the final exam to pass the course, otherwise the final course grade will be capped at 49%. In other words, **after** any shifting of test marks due to academic concessions as per the reweighting policies listed above, students must have a minimum of 40 out of the 80 points dedicated to tests.

Midterm Dates

February 7; March 20, during the common tutorial period.

Resources

We will rely on materials provided on Canvas and open-source textbooks for reference. Please see the Canvas Syllabus page 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
- Maxwell's equations

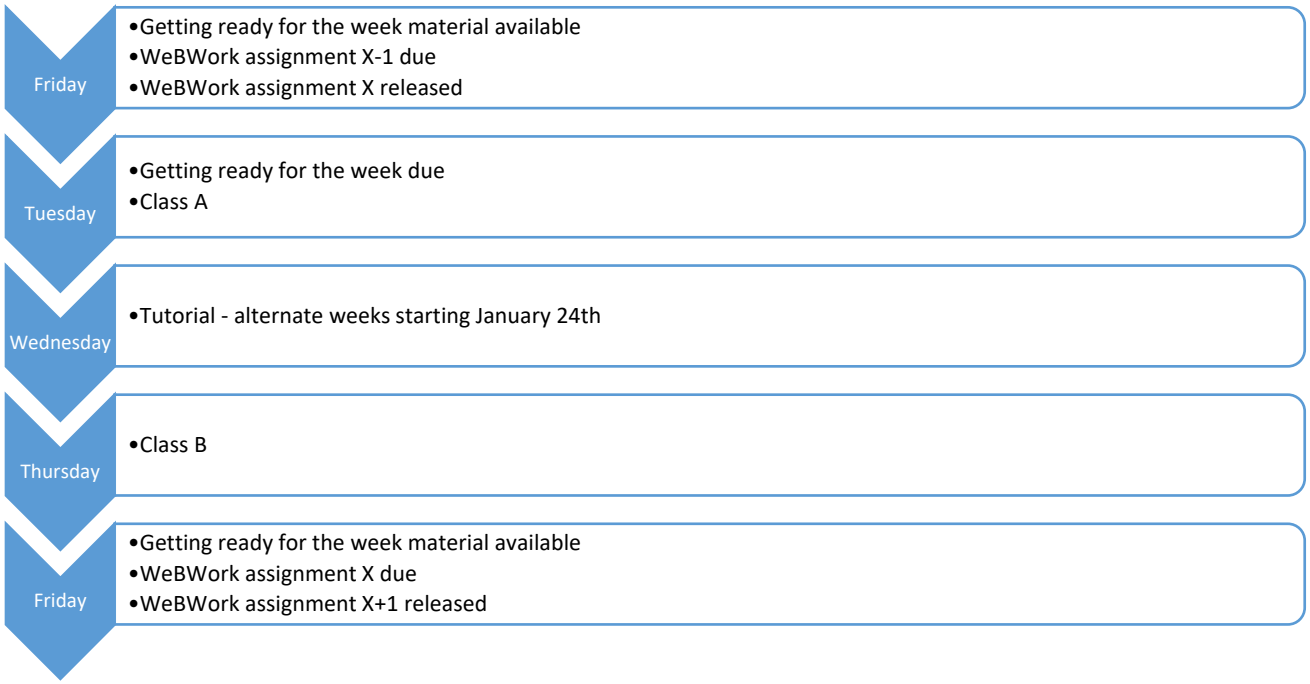
Learning Goals

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 magnetic forces and torques
- 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 activities and guided problem solving. Some lecture notes will often be released before class, but these should not be considered the full content. 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.



Course Policies

Pre-requisites: The pre-requisites for this integrated pair of courses are: One of MATH 263, MATH 253 and one of PHYS 108, PHYS 118, 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.

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 a missed midterm, the weight of that missed midterm will be transferred to the final exam. If the remaining written midterm has a higher score than the final, it will count for 20%, otherwise the weight of the written midterm will be transferred to the final. For 2 missed midterms, the weight of both will be moved to the final.

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/.

Centre for Accessibility (CfA): If you are registered with the CfA and require academic accommodations for test writing, it is your responsibility to register the midterm and final exam dates with the Centre in a timely fashion. The course instructors do not have the ability to provide accommodations during the midterms or the final exam.

Discussion Board: The discussion board within Canvas will be made available during the term but will not be monitored continuously by the course instructors. You may use the discussion board to

communicate with your peers, but you may **not** post solutions to homework questions, and you must adhere to the UBC Respectful Environment Policy at all times when posting to the discussion board. Failure to do so will result in removal of the discussion board.

Reproduction of course materials: All material provided by the course instructors is for your personal use only. Redistribution or reposting of notes, videos, or other teaching materials is forbidden. Misconduct proceedings will be initiated if any such cases are identified.

Use of Integrity Statements

You may be asked to agree to an academic integrity statement as part of testing and other assessment activities. As a student in a professional program, adhering to course rules and upholding the academic integrity of your educational experience is in your best interest. Every effort will be made to ensure that assessment is fair for all students in the course. You can do your part by following the rules set out by your course instructors and seeking assistance or clarification if you have any questions. Students found to have violated the rules set out for any given assessment will be reported to the Faculty of Applied Science Dean's Office for investigation.

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.