

COLORADO STATE UNIVERSITY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 341 – *Electromagnetic Fields and Devices I*, Fall 2021

COURSE SYLLABUS

(1) Course Details:

Instructor: BRANISLAV M. NOTAROS, Professor, Eng C101C, Phone: (970) 491-3537

E-mail: notaros@colostate.edu, Web: www.engr.colostate.edu/~notaros

Class Meetings: Tuesday, Thursday 3:30pm-4:45pm, Johnson Hall 222

Office Hours: Tuesday 2:00-3:00pm and Thursday 2:00-3:00pm, or by appointment

Textbook: - *Electromagnetics*, Branislav M. Notaros, PEARSON Prentice Hall, 2010

Companion Website for the book: www.pearsonhighered.com/notaros
Conceptual Questions
MATLAB Exercises

Additional References:

- *MATLAB-Based Electromagnetics*, Branislav M. Notaros, PEARSON Prentice Hall, 2013
- *Conceptual Electromagnetics*, Branislav M. Notaros, CRC Press, Taylor and Francis, LLC, 2017

Class Web page: Canvas

Teaching Assistant: Stephen Kasdorf, Electromagnetics Lab (Engineering B110), skasdorf@rams.colostate.edu

(2) Course Description:

Fundamentals of time-invariant electric and magnetic fields and time-varying electromagnetic fields leading to general Maxwell's equations. Topics include the electromagnetic model, vector calculus, electrostatic fields, steady electric currents, magnetostatic fields, electromagnetic induction, slowly time-varying electromagnetic fields, electromagnetic materials, and Maxwell's equations in integral and differential form. Solutions of Maxwell's equations in the presence of boundary conditions are presented. Electromagnetic energy and power, and electric and magnetic potentials are studied. Capacitance, self and mutual inductances, low-frequency resistance, and leakage conductance are evaluated. Circuit theory and its relationship to electromagnetics is presented as an approximate form of Maxwell's equations.

(3) Organization of Course Topics:

Weeks (tentative)

1. Electrostatic Field in Free Space (Weeks 1, 2)

- Electric Field Due to Charge Distributions (Sections 1.1–1.5)
- Electric Scalar Potential, Gradient (Sections 1.6–1.10)

- Gauss' Law, Integral Form (Sections 1.12, 1.13)
 - Gauss' Law, Differential Form, Divergence (Sections 1.14, 1.15)
 - Conductors in the Electrostatic Field (Sections 1.16–1.19, 1.21)
- 2. Electrostatic Field in Material Media** (Weeks 3, 4)
- Polarization of Dielectrics, Bound Volume and Surface Charge Densities (Sections 2.1–2.4)
 - Generalized Gauss' Law, Dielectric-Dielectric Boundary Conditions (Sections 2.5–2.10)
 - Analysis of Capacitors with Homogeneous Dielectrics (Sections 2.12, 2.13)
 - Analysis of Capacitors with Inhomogeneous Dielectrics (Sections 2.14, 2.17)
 - Electric Energy and Energy Density (Sections 2.15, 2.16)
- 3. Steady Electric Currents** (Weeks 7, 8)
- Current Density Vector and Current Intensity (Section 3.1)
 - Conductivity and Ohm's and Joule's Laws in Local Form (Sections 3.2, 3.3)
 - Continuity Equation (Sections 3.4, 3.5)
 - Resistance, Ohm's Law, and Joule's Law (Sections 3.8, 3.9)
 - Analysis of Capacitors with Imperfect Inhomogeneous Dielectrics (Sections 3.11)
- 4. Magnetostatic Field** (Weeks 9, 10)
- Magnetostatic Field in Free Space, Biot-Savart Law (Sections 4.1–4.3)
 - Ampère's Law, Integral Form, Curl (Sections 4.4–4.7)
 - Magnetostatic Field in Material Media (Sections 5.1–5.3)
 - Generalized Ampère's Law, Boundary Conditions (Sections 5.4–5.6)
 - Magnetic Circuits (Sections 5.9, 5.10)
- 5. Low-Frequency Electromagnetic Field** (Weeks 13, 14)
- Faraday's Law of Electromagnetic Induction (Sections 6.1–6.3)
 - Computation of Transformer Induction (Sections 6.5)
 - Electromagnetic Induction due to Motion (Sections 6.6, 6.7)
 - Self-Inductance, Mutual Inductance (Sections 7.1–7.3)
 - Magnetic Energy and Energy Density (Sections 7.4, 7.5)

(4) Homework:

- Homework (post-class work) will be assigned weekly (roughly). Homework assignments will be posted on Canvas.
- Homework will be due at the specified time (typically the following week) as online submission in Canvas. Late homework is not allowed and will not be collected.
- The solutions to homework problems will be posted on Canvas.

(5) Evaluation of Students and Grading Policy:

- Homework (20%)
- Pre-Class Quizzes (5%)
- KI Activities (8%)
- Exam 1 (22.5%)
- Exam 2 (22.5%)
- Final Exam (27%)
- Math Foundation (2%) (Extra Credit)

The final exam is cumulative (covers all topics of the course).

Grades will be assigned from A+ through F, including plus and minus categories (no C-, D+, and D-), according to the following grading rubric:

$97 \leq x \leq 100$ A+; $93 \leq x < 97$ A; $90 \leq x < 93$ A-; $87 \leq x < 90$ B+; $83 \leq x < 87$ B; $80 \leq x < 83$ B-; $77 \leq x < 80$ C+; $70 \leq x < 77$ C; $60 \leq x < 70$ D; $x < 60$ F;

(6) Exams:

- Exam 1 – Tuesday, October 5, 2021
- Exam 2 – Tuesday, November 30, 2021
- Final Exam – see the Fall 2021 Final Exam Schedule on the CSU web

All exams are closed book, closed notes. One sheet with **hand-written formulas** prepared by the student is allowed per each partial exam, and two sheets for the final exam.

(7) Additional Requirements:

Note 1: Pre-class work is required. It consists of Reading Assignments and Pre-Class Quizzes.

Note 2: The KI activities will be worth 8% of the grade for each course. Students will get the same KI grade for each course they are enrolled in. KI grade consists of several components, including prework, question/discussion contributions, video presentations, and social responsibility case studies. Please see the KI Canvas course for details.

Note 3: Demonstrating competency in each learning studio module (LSM) of the course is required. Competency is assessed through Assessment 1 (Exam 1), 2 (Exam 2), and 3 (Final Exam), for LSMs covered in individual assessments. Students who do not demonstrate competency in an LSM will be notified after the corresponding assessment and will be given the opportunity to gain competency by completing remedial course-related work, assigned by the instructor. Completing the remedial work in a satisfactory fashion establishes the student's competency in the corresponding LSM, but does not affect the student's grade. However, if the remedial work is not completed in a satisfactory fashion the student will automatically receive the grade 'F' in the course.

Note 4: Math foundation extra credit consists of two components: attending lectures and solving problems sets. (1% extra credit for any student who attends at least seven math foundation lectures; 1% extra credit for any student who receives an average grade of 85% or more on math foundation problem sets)

(8) Academic Integrity Policy:

- This course will adhere to the CSU Academic Integrity Policy as found in the General Catalog (<http://www.catalog.colostate.edu/FrontPDF/1.6POLICIES1112f.pdf>) and the Student Conduct Code (<http://www.conflictresolution.colostate.edu/conduct-code>). At a minimum, violations will result in a grading penalty in this course and a report to the Office of Conflict Resolution and Student Conduct Services.

(9) Course Objectives/Outcomes:

Please also see the ECE341 IO Diagram

https://www.engr.colostate.edu/ece/pdfs/i_o_diagrams/ece341_i_o_diagram.pdf

The objectives of the course are for the students to develop an understanding of electromagnetic-field fundamentals by emphasizing both mathematical analytical rigor and physical conceptual reasoning, as applied toward practical engineering problems. Students learn to analyze engineering systems based on electrostatic fields, steady electric currents, and magnetostatic fields in arbitrary material media, and to apply vector calculus to solve a large variety of static field problems. Students develop a solid grasp and true appreciation of Maxwell's equations and use these equations to solve slowly time-varying field problems. By the end of this course, students should be able to:

1. Appreciate fields.
2. Solve realistic electromagnetic-field problems utilizing physical conceptual reasoning and mathematical synthesis of solutions, and not pure formulaic solving.
3. Understand electric and magnetic properties of material media and how these properties can be exploited in engineering applications.
4. Visualize electric and magnetic fields and understand associated abstract field phenomena.
5. Utilize three-dimensional vector differential and integral concepts to solve real-life electromagnetic-field problems.
6. Understand fundamentals of energy and power, and electric and magnetic potentials.
7. Appreciate fundamental laws and work of pioneering giants of electromagnetics, their historical perspective in the development of science and engineering and current relevance in cutting-edge engineering applications.
8. Mathematically model electromagnetic-field physical structures and processes.
9. Geometrically represent and spatially visualize realistic three-dimensional devices and systems.
10. Appreciate electromagnetic field theory as a foundation of circuit theory and electrical engineering as a whole.
11. Understand limitations of circuit theory as an approximation of field theory.