South Dakota School of Mines & Technology
Electric and Magnetic Fields, Fall, 2021
EE 381-M01 (3-0) 3 credits

Instructor Information

Instructor's Name- Thomas Montoya

Instructor's Contact Information- (605) 394-1219, Thomas.Montoya@sdsmt.edu, EEP 310

Instructor Office Hours- 8-9 am & 3-4 pm MWF, or when available (open door policy).

As I do not always notice voicemails in a timely fashion, e-mails or in person are the preferred contact methods. Unless I am traveling or it arrives late at night, I typically respond to e-mails the same day.

Course Information

Course Start/End Dates- 8/23/2021 to 12/15/2021

Course Meeting Times and Location- MWF from 10-10:50 am in McLaury 208

Course Delivery Method- The course will be delivered in-person for lectures, quizzes, and exams. I will post the syllabus and a link to my webpage http://montoya.sdsmt.edu on D2L. The course web page will be used for posting assignments, examples, solutions, etcetera. E-mail will be used to notify students of course-related information and events (**check daily**). Your first.last@Mines.sdsmt.edu address will be used.

Course Description

Fundamentals of field theory (i.e., Maxwell's equations) as applied to static electric and magnetic phenomena. Also, theory and applications of lossless transmission lines are covered.

Course Prerequisites- EE 221/221L with a minimum grade of "C", MATH 225, and PHYS 213

Student Learning Outcomes

Student Outcomes (SOs)

Student Outcomes are defined in ABET's accreditation standards for engineering programs:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Course Learning Outcomes (CLOs)

Upon completion of this course, students should demonstrate the ability to:

A. Calculate distributed parameters, e.g., *R*, *L*, *G*, and *C*, for simple transmission lines and dependent quantities (e.g., characteristic impedance, phase velocity, and phase constant) for lossless transmission lines. (SOs 1, 2)
B. Solve frequency-domain problems (e.g., find impedances, reflection coefficients, currents, voltages, and powers) for lossless transmission line circuits. (SOs 1, 2)
C. Perform basic vector algebra operations such as addition, dot product, and cross product in Cartesian, cylindrical, and spherical coordinates. (SOs 1, 2)
D. Perform basic vector calculus operations such as line, surface & volume integrals, gradient, divergence & curl operations, Laplacians, Divergence & Stoke's Theorems, and perform vector field classification in Cartesian, cylindrical, and spherical coordinates. (SOs 1, 2)
E. Calculate the electric field and electric potential in regions containing point charges and/or line, surface, and/or volume charge densities. (SOs 1, 2)
F. Apply Gauss' Law to problems with spherical, cylindrical, and/or planar symmetry. (SOs 1, 2)
G. Calculate the electric potential, field, flux density, capacitance, and resistance of/for structures with spherical, cylindrical, and planar symmetry containing dielectric materials. (SOs 1, 2)
H. Apply electrostatic and magnetostatic boundary conditions. (SOs 1, 2)
I. Solve Poisson's and Laplace's Equations for one-dimensional electrostatic boundary-value problems. (SOs 1, 2)
J. Calculate the magnetic field, flux density, flux, and vector potential near wires, surfaces, and/or volumes carrying current(s). (SOs 1, 2)
K. Apply Ampere's Law to problems with cylindrical and/or planar symmetry. (SOs 1, 2)
L. Determine the magnetic forces and torque on wires carrying current. (SOs 1, 2)
M. Calculate the inductance of/for simple structures with or without magnetic materials. (SOs 1, 2)

Course Goals

The goal of this course is to introduce students to the basic concepts of electromagnetic field theory. In particular, lossless transmission lines, electrostatics, magnetostatics, and the electrical properties of materials are introduced.

Course Materials

Required Textbook(s) and Materials

Elements of Electromagnetics (Seventh Edition), Sadiku, Oxford, 2018, ISBN 978-0-19-069861-4.

Technology Equipment Needed for the Course

The course requires use of a tablet computer and a scientific calculator (capable complex number operations).

Technology Skills Needed for the Course

Ability to navigate D2L and internet, upload/download files (e.g., pdf files), using MS Office programs, communicating via email, and **possibly, depends on COVID,** connecting audio/video and using tools such as Zoom. Matlab and/or MathCad may be useful for some assignments.

Course Grading

Coursework

- Course instruction will be delivered in lectures.

- Bring notes, text, and calculator (capable of complex number & linear algebra operations) to every class. Most quizzes will be unannounced and require a calculator (no smartphones). Occasionally a quiz may be open book/notes (no borrowing, no computers).
- To facilitate grading, homework shall meet the following specifications (see example on course web page):
  (a) Use the front side (i.e., single-sided) of 8.5" × 11" engineering graph paper or plain white paper (NO pages torn from spiral notebooks) for assignments.
  (b) At the top of **each** page should be the date, course number, problem number(s), your name, and the page numbering (i.e., page *x* of *y* or *x*/*y* formats in the right-hand corner). Ensure problems & pages are in order.
  (c) All work exceeding one page should be stapled - no paper clips, folded corners, or folders.
  (d) Write-out problem descriptions, copy/draw figures, and **show all** work so it can be understood without the text. No work (i.e., "magic" answer) $\rightarrow$ no credit.
  (e) Reference equations derived in the text (e.g., equation number and/or page number). Fundamental equations (e.g., Maxwell's equations, Ohm's Law ...) are excluded from this requirement.
  (f) Use notation, especially for vectors, and conventional engineering units & prefixes (i.e., MKS) as given in class and text. For example, $\bar{E} = \hat{a}_\theta\, 10\ \text{kV/m}$ and 100 MHz ***NOT*** $\bar{E} = \hat{\theta}\, 100\ \text{V/cm}$ and 10^5 kHz. Answers with incorrect notation and without applicable units are incomplete/incorrect.
  (g) Writing/figures/graphs must be legible/large enough to read $\rightarrow$ illegible = no credit.
  (h) Answers should be boxed/double underlined, in **decimal format** (if numbers), and the variables, values & units (if any) included. For example, $d = 3.4896\ \text{m}$ and ***NOT*** $d = 7\sqrt{42}/13\ \text{m}$. Use lead zeros for fractional answers, e.g., 0.4 not ".4". Typically, 4-5 significant digits are used.
  (i) Work problems sequentially in a **single** vertical column with subparts clearly labeled, e.g., a), b) ... Leave a space (e.g., 1/2") between consecutive parts of a problem, and draw a line across the page at the end of each problem if there is more than one.
  (j) **No** more than **two** problems on any single page.

Attendance Policy

Attendance is required. Notify instructor in advance (when possible) if you will be absent from class.

Late/Make-up Assignment Policy

- Homework (HW) is due at the beginning of class on the specified days (up to 20% penalty for being late w/out doctor's note, etc.). If you know that you will be missing a class, it may be turned in early. HW will **not** be accepted or graded after solutions are posted on the course web page.
- Missed quizzes will **not** be made up. If you know that you will be missing a class for a school-related activity (athletic travel, conference, etc.), you may stop by the day before and ask to take a quiz early (if available). Make-ups for exams only allowed for school-sponsored events, documented illness, …
- If 2/3 of quizzes and 2/3 of HW are completed at a **passing** level, the lowest HW grade and lowest two quiz grades will be dropped (no questions asked). If not, **all** quizzes and HW will count (no drops). The drops are meant to cover any absences, including those due to illness, interviews, trips…

Academic Integrity

South Dakota Mines is committed to academic honesty and scholarly integrity. The South Dakota Board of Regents Policy 2:33 provides a comprehensive definition of "Academic Dishonesty", which include cheating and plagiarism. All Instructors at South Dakota Mines are required to report allegations of academic misconduct to the Student Conduct Officer. The South Dakota Board of Regents Policy 3:4

provides detailed information regarding key definitions, policy information, prohibited conduct, and the Student Conduct process adhered to at South Dakota Mines. Any student suspected of violating academic integrity standards will be reported in accordance with the process outlined on the South Dakota Mines website.

- Students are encouraged to discuss homework with classmates in general terms. However, copying, plagiarism … is not acceptable and will be penalized (e.g., grade of zero).

Grading and Assessment

Student learning is assessed by a combination of in-person exams and quizzes as well as homework.

Description	Percent
Three (3) Hourly exams	45%
Quizzes	20%
Homework	15%
Final exam	20%
TOTAL	**100%**

Grading Scale- 100 > A > 90, 89 > B > 80, 79 > C > 70, 69 > D > 60, F < 60.

ADA Statement

South Dakota Mines strives to ensure that physical resources, as well as information and communication technologies, are reasonably accessible to users in order to provide equal access to all. If you encounter any accessibility issues, you are encouraged to immediately contact the instructor of the course and the Title IX and Disability Coordinator, Ms. Amanda Lopez at disabilityservices@sdsmt.edu or 605.394.2533, who will work to resolve the issue as quickly as possible.

COVID-19

In Fall, 2021 courses scheduled to meet face-to-face will be held in person and at normal capacities. If you contract COVID-19 and must isolate, you are asked to reach out to your instructor and the Dean of Students Office (deanofstudents@sdsmt.edu or 605.394.2416) to develop a plan for staying on track with your courses. Class lectures will not be recorded.

Freedom in Learning Statement

Under Board of Regents and University policy, student academic performance may be evaluated solely on an academic basis, not on opinions or conduct in matters unrelated to academic standards. Students should be free to take reasoned exception to the data or views offered in any course of study and to reserve judgement about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled. Students who believe that an academic evaluation reflects prejudiced or capricious consideration of student opinions or conduct unrelated to academic standards should contact the Provost and Vice President for Academic Affairs at provost@sdsmt.edu to initiate a review of the evaluation.

Electronic Devices Policy

Please silence/turn off your cell phone before class starts. No text messaging or headphones in class. You may use a laptop/tablet in class for purposes of note taking (NOT allowed for exams or quizzes). No other use of any other electronic/computer media, other than calculators, is allowed during class time.

Topics/Course Schedule: Chapters 1-8 & parts of 11, see attached schedule (subject to revision).

Tentative Course Schedule

Class | Date	Topics/Activities	Reading/Text
1 | 8/23/21 2 | 8/25/21 3 | 8/27/21 4 | 8/30/21 5 | 9/1/21 6 | 9/3/21 **9/6/21** 7 | 9/8/21	**Transmission Lines-** Introduction, transmission line parameters, equations, reflection coefficient, input impedance, SWR, and power. Apart from parameters, only the case of lossless transmission lines in the frequency-domain is discussed.	• 11.1 - 11.2 • 11.2 - 11.3 • 11.3 • 11.4 • 11.4 • 11.4 **Holiday** • 11.4
8 | 9/10/21 9 | 9/13/21	**Vector Algebra-** Intro, scalars & vectors, unit vector, addition & subtraction, position/distance vectors, dot/cross products, components	• 1.1 - 1.6 • 1.7 - 1.8
10 | 9/15/21 11 | 9/17/21	**Coordinate Systems & Transformation-** Introduction, Cartesian, Circular Cylindrical, Spherical, constant-coordinate surfaces	• 2.1 - 2.3 • 2.4 - 2.5
12 | 9/20/21 13 | 9/22/21	**Vector Calculus-** Introduction; differential length, area & volume; line, surface & volume integrals, Del operator	• 3.1 - 3.3 • 3.3 - 3.4
14 | 9/24/21	**Exam #1**- Covers material from Chapters 11, 1, and 2	
15 | 9/27/21 16 | 9/29/21 17 | 10/1/21	**Vector Calculus cont.**- gradient; divergence & divergence theorem; curl & Stoke's theorem, vector & scalar Laplacian; vector classification	• 3.4 - 3.5 • 3.6 - 3.7 • 3.8 - 3.9
18 | 10/4/21 19 | 10/6/21 20 | 10/8/21 **10/11/21** 21 | 10/13/21 22 | 10/15/21	**Electrostatic Fields-** Introduction, Coulomb's Law and field intensity, electric fields, electric flux density, Gauss's Law & applications, electric potential, electric potential, electric dipole, energy density	• 4.1 - 4.2 • 4.2 - 4.4 • 4.5 - 4.6 **Holiday** • 4.6 - 4.8 • 4.9 - 4.10
23 | 10/18/21 24 | 10/20/21 25 | 10/22/21	**Electric Fields in Material Space-** Intro, material properties, convection & conduction currents, conductors, dielectric polarization, dielectric constant & strength	• 5.1 - 5.3 • 5.4 - 5.5 • 5.6 - 5.7
26 | 10/25/21	**Exam #2**- Covers material from Chapters 3 and 4	
27 | 10/27/21 28 | 10/29/21	**Electric Fields in Material Space cont.**- continuity equation, boundary conditions	• 5.8 • 5.9
29 | 11/1/21 30 | 11/3/21 31 | 11/5/21	**Electrostatic Boundary-Value Problems-** Intro, Poisson's & Laplace's equations, Uniqueness theorem, solution procedure, resistance & capacitance, Method of Images	• 6.1 - 6.3 • 6.3 - 6.4 • 6.5 - 6.6
32 | 11/8/21 33 | 11/10/21 34 | 11/12/21 35 | 11/15/21	**Magnetostatic Fields-** Intro, Biot-Savart's Law, Ampere's Circuit Law & applications, magnetic flux density, static Maxwell's equations, magnetic scalar and vector potentials	• 7.1 - 7.2 • 7.2 - 7.3 • 7.3 - 7.5 • 7.5 - 7.7
36 | 11/17/21 37 | 11/19/21 38 | 11/22/21 **11/24-26/21**	**Magnetic Forces, Materials, and Devices-** Introduction, magnetic forces, magnetic torque & moment, magnetic dipole	• 8.1 - 8.2 • 8.3 - 8.4 • 8.5 - 8.6 **Holiday**
39 | 11/29/21	**Exam #3**- Covers material from Chapters 5, 6, and 7	
40 | 12/1/21 41 | 12/3/21 42 | 12/6/21	**Magnetic Forces, Materials, and Devices cont.**- magnetization of materials, magnetic materials classification, boundary conditions, inductance, magnetic energy, & magnetic circuits. Review for Final	• 8.7 - 8.8 • 8.8 - 8.9 • 8.10
	Final Exam- Monday, December 13, 2021 from 12-1:50 pm, M 208	