# EE 381-01 Electric and Magnetic Fields (3-0), SDSM&T, Fall 2017

**Lecture Room & Time:** **MI 220** on MWF from 10-10:50am

**Instructor:** Dr. Thomas Montoya, EP325, Tel: 394-2459, e-mail: Thomas.Montoya@sdsmt.edu

**Office Hours:** 3-4 pm MWF, or by appointment.

**WWW:** See link from http://montoya.sdsmt.edu. The course web page will be heavily utilized for posting **assignments**, examples, solutions, ... E-mail will be utilized to notify students of course-related information and events (**check daily**). Your first.last@Mines.sdsmt.edu address will be used.

**Catalog 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.

**EE 381 Prerequisites:** EE 221/221L (Circuits II) with a minimum grade of "C", MATH 225 (Calculus III), and PHYS 213/213-A (University Physics II).

**Text:** *Elements of Electromagnetics* (Sixth Edition), Sadiku, Oxford, 2015, ISBN 978-0-19-932138-4.

**Course Policies:**

- Course instruction will be delivered in lectures. Attendance is required. Notify instructor in advance (when possible) if you will be absent from class.
- Except when otherwise specified, all coursework is to be individually completed. See the *Cheating Academic Integrity Policy* and *Community Standards* links under the *Policies/Definitions* link of the catalog (http://ecatalog.sdsmt.edu/).
- 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).
- 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.
- 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).
- Missed quizzes will **not** be made up. If you know that you will be missing a class for a school-related activity (athletic travel, academic conference, etc.), you may stop by the day before and ask to take a quiz early (if available).
- 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…
- To facilitate grading, homework shall meet the following specifications (see example at 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 $10^5\,\text{kHz}$. 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. Use lead zeros for fractional answers, e.g., 0.4 not “.4”.

(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.

## 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. By the end of the course, students should be able to calculate relevant quantities (e.g., impedances, voltages, currents, power …) for lossless transmission lines and simple circuits in the frequency-domain. For static fields, student should be able to calculate the electric field, electric flux density, and/or electric potential for symmetric electrostatic problems, and the magnetic field, magnetic flux density, magnetic flux, and/or magnetic vector potential for symmetric magnetostatic problems. Also, students should be able to calculate the resistance, capacitance, and inductance of simple structures.

## Student Learning Outcomes:

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

1. Calculate distributed parameters $L$ and $C$ for simple lossless transmission lines and dependent quantities (e.g., characteristic impedance, phase velocity, and phase constant).
2. Solve frequency-domain problems (e.g., find impedances, reflection coefficients, currents, voltages, and powers) for lossless transmission line circuits.
3. Perform basic vector algebra operations such as addition, dot product, and cross product in Cartesian, cylindrical, and spherical coordinates.
4. 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.
5. Calculate the electric field and electric potential in regions containing point charges and/or line, surface, and/or volume charge densities.
6. Apply Gauss’ Law to problems with spherical, cylindrical, and/or planar symmetry.
7. Calculate the electric potential, field, flux density, capacitance, and resistance of/for structures with spherical, cylindrical, and planar symmetry containing dielectric materials.
8. Apply electrostatic and magnetostatic boundary conditions.
9. Solve Poisson’s and Laplace’s Equations for one-dimensional electrostatic boundary-value problems.
10. Calculate the magnetic field, flux density, flux, and vector potential near wires, surfaces, and/or volumes carrying current(s).

11. Apply Ampere's Law to problems with cylindrical and/or planar symmetry.
12. Calculate the magnetic field, flux density, and inductance of/for simple structures with or without magnetic materials.

**<u>Evaluation</u>:**

| | |
|---|---|
| 3 Hour Exams | 45% |
| Quizzes | 20% |
| Homework | 15% |
| Final Exam (required) | 20% |
| **Total** | **<u>100%</u>** |

**<u>Grading scale</u>:** 100 > A > 90, 89 > B > 80, 79 > C > 70, 69 > D > 60, F < 60.

**<u>ADA</u>:** Students with special needs or requiring special accommodations should contact the instructor, (Dr, Montoya at 394-2459) and/or the Director of Counseling and Disability Services, Ms. Megan Reder-Schopp, at megan.reder-schopp@sdsmt.edu or 394-6988 at the earliest opportunity.

**<u>Freedom in learning</u>:**

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 judgment 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 to initiate a review of the evaluation.

**<u>Electronic Devices Policy</u>:** Please turn off your cell phone before class starts. No text messaging in class. No headphones. You may use a laptop/tablet in this class for purposes of note taking. No other use of any other electronic/computer media, **other than calculators**, is allowed during class time.

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

## Course Schedule

| Class | Date(s) | Topics | Reading/ Text |
|---|---|---|---|
| 1 | 8/21 | **Transmission Lines-** Introduction, transmission line parameters and equations, reflection coefficient, input impedance, SWR, and power. Only lossless transmission line case in the frequency-domain is discussed. | 11.1-11.2 |
| 2 | 8/23 | | 11.2-11.3 |
| 3 | 8/25 | | 11.3 |
| 4 | 8/28 | | 11.4 |
| 5 | 8/30 | | 11.4 |
| 6 | 9/1 | | 11.4 |
| **9/4** | | **Holiday** | |
| 7 | 9/6 | | 11.4 |
| 8 | 9/8 | **Vector Algebra-** Intro, scalars & vectors, unit vector, addition & subtraction, position/distance vectors, dot/cross products, components | 1.1-1.6 |
| 9 | 9/11 | | 1.6-1.8 |
| 10 | 9/13 | **Coordinate Systems & Transformation-** Intro, Cartesian, Circular Cylindrical, Spherical, constant-coordinate surfaces | 2.1-2.3 |
| 11 | 9/15[MDay] | | 2.4-2.5 |
| 12 | 9/18 | **Vector Calculus-** Intro; differential length, area & volume; line, surface & volume integrals, Del operator | 3.1-3.2 |
| 13 | 9/20 | | 3.2-3.3 |
| **14** | **9/22** | **Exam #1** (covers sections 11.1-11.4, Chapters 1 - 2) | |
| 15 | 9/25 | gradient; divergence & divergence theorem; curl & Stoke's theorem, Laplacian; classification | 3.4-3.5 |
| 16 | 9/27 | | 3.6-3.7 |
| 17 | 9/29 | | 3.8-3.9 |
| 18 | 10/2 | **Electrostatic Fields-** Intro, Coulomb's Law and field intensity, electric fields, electric flux density, Gauss's Law & applications | 4.1-4.2 |
| 19 | 10/4 | | 4.2-4.4 |
| 20 | 10/6 | | 4.5-4.6 |
| **10/9** | | **Holiday** | |
| 21 | 10/11 | electric potential, electric potential, electric dipole, energy density | 4.6-4.7 |
| 22 | 10/13 | | 4.9-4.10 |
| 23 | 10/16 | **Electric Fields in Material Space-** Intro, material properties, convection & conduction currents, conductors, dielectric polarization, dielectric constant & strength | 5.1-5.3 |
| 24 | 10/18 | | 5.4-5.5 |
| 25 | 10/20 | | 5.6-5.7 |
| **26** | **10/23** | **Exam #2** (covers Chapters 3-4) | |
| 27 | 10/25 | continuity equation, boundary conditions | 5.8 |
| 28 | 10/27 | | 5.9 |
| 29 | 10/30 | **Electrostatic Boundary-Value Problems-** Intro, Poisson's & Laplace's equations, Uniqueness theorem, solution procedure, resistance & capacitance, Method of Images | 6.1-6.3 |
| 30 | 11/1 | | 6.3-6.4 |
| 31 | 11/3 | | 6.5-6.6 |
| 32 | 11/6 | **Magnetostatic Fields-** Intro, Biot-Savart's Law, Ampere's Circuit Law | 7.1-7.2 |
| 33 | 11/8 | | 7.2-7.3 |
| **11/10** | | **Holiday** | |
| 34 | 11/13 | Ampere's Circuit Law & applications, magnetic flux density, static Maxwell's equations,magnetic scalar and vector potentials | 7.3-7.5 |
| 35 | 11/15 | | 7.5-7.7 |
| 36 | 11/17 | **Magnetic Forces, Materials, and Devices-** Intro, magnetic forces, magnetic torque & moment, magnetic dipole | 8.1-8.2 |
| 37 | 11/20 | | 8.3-8.4 |
| **11/22 – 11/24** | | **Holiday** | |
| 38 | 11/27 | magnetization of materials, magnetic materials classification | 8.5-8.6 |
| 39 | 11/29 | **Exam #3 (covers Chapters 5-7)** | |
| 40 | 12/1 | boundary conditions, inductance, magnetic energy, & possibly magnetic circuits. Review for Final | 8.7-8.8 |
| 41 | 12/4 | | 8.9-8.10 |
| **EE 381 Final Exam- Thursday, December 7, 2017 from 5-6:50pm, MI 220** | | | |