

South Dakota School of Mines & Technology
Advanced Engineering Electromagnetics, Spring, 2023
EE 780-M01 (3-0) 3 credits

Instructor Information

Instructor's Name- Thomas Montoya

Instructor's Contact Information- (605) 394-1219, Thomas.Montoya@sdsmt.edu, EEP 314

Instructor Office Hours- 8:15-9 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 after 5 pm, I typically respond to e-mails the same day.

Course Information

Course Start/End Dates- 1/9/2023 to 5/5/2023

Course Meeting Times and Location- MWF from 1-1:50 pm in EEP 336

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

The course will cover advanced topics often encountered in engineering electromagnetic practice, e.g., uniform plane waves and their normal and oblique scattering from planar layered media; antennas; physical optics and scattering by strips; metallic waveguides and resonant cavities; and dielectric waveguides.

Course Prerequisites- none. Undergraduate course(s) in electromagnetics, or the equivalent, and knowledge of a mathematics package are highly suggested.

Student Learning Outcomes

Course Learning Outcomes (CLOs)

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

- A. Know and work with the solution to wave equations in Cartesian/rectangular and circular coordinates.
- B. Solve Uniform Plane Wave (UPW) problems for propagation in lossless medium- principal axis and oblique.
- C. Solve UPW problems for propagation in lossy medium- principal axis and oblique.
- D. Solve problems for the reflection and transmission of UPWs on a lossless half-space for normal and oblique incidence.
- E. Understand electrical properties of matter, e.g., dielectrics (polarization and permittivity), magnetics (magnetization and permeability).
- F. Solve problems for and understand TE and TM modes for rectangular waveguides and resonant cavities.
- G. Solve problems for and understand TE and TM modes for circular waveguides and resonant cavities.

Course Goals

The objective of this course is to have students develop a deeper understanding of electromagnetics and introduce students to more advanced engineering electromagnetics topics not covered at the undergraduate level. In particular, Uniform Plane Wave (UPW) propagation in lossless and lossy mediums, UPW reflection and transmission when incident on lossless half-spaces, rectangular cross-section waveguides and cavities, the electrical properties of materials, and circular cross-section waveguides and cavities are covered.

Course Topics- See tentative course schedule.

Course Materials

Required Textbook(s) and Materials

Advanced Engineering Electromagnetics (Second Edition), Balanis, Wiley, 2012, ISBN-10: 0470589485, ISBN-13: 978-0470589489.

Technology Equipment Needed for the Course

The course requires use of a 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, **depending on COVID**, connecting audio/video and using tools such as Zoom. Ability to use MATLAB will be needed for some assignments and Mathcad may be useful.

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).
- Timing, content, requirements, and format of computer projects will be announced when assigned.
- To facilitate grading, homework shall meet the following specifications (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. Hardcopy only!
 - 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) → 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, $\vec{E} = \hat{a}_\theta 10 \text{ kV/m}$ and 100 MHz **NOT** $\vec{E} = \hat{\theta} 100 \text{ V/cm}$ 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 → 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, etcetera). 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, etcetera), 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/projects with classmates in general terms. However, direct 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 and projects.

Description	Percent
Two Hourly Exams @ 15%/each	30%
Quizzes	20%
Homework	15%
Computer Projects	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.

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: Selected topics from Chapters 1-5, 6 (time-allowing), 8, and 9. See attached tentative schedule. As this is the second time this course has been taught in many years, the schedule is subject to revision.

Class Date	Tentative Topics/Activities	Reading/Text
1 1/9/23 2 1/11/23 3 1/13/23 1/16/23 4 1/18/23	Time-Varying and Time-Harmonic Electromagnetic (EM) fields – Intro, Maxwell's equations, Constitutive Parameters and Relations, Circuit-field Relations, Power and Energy, Time-Harmonic Electromagnetic fields	<ul style="list-style-type: none"> • 1.1 - 1.3 • 1.3 - 1.5 • 1.2 - 1.6 <li style="text-align: center;">Holiday • 1.6 - 1.7
5 1/20/23 6 1/23/23	Wave Equation and its Solution - Intro, Time-Varying and Time-Harmonic EM fields, Solution to Wave eq'n in Cartesian coordinates	<ul style="list-style-type: none"> • 3.1 - 3.2 • 3.3 - 3.4.1
7 1/25/23 8 1/27/23 9 1/30/23 10 2/1/23 11 2/3/23	Wave Propagation and Polarization – Intro, Transverse EM Modes, Uniform Plane Waves (UPWs) in lossless medium- principal axis and oblique, UPWs in lossy medium- principal axis and oblique, Polarization	<ul style="list-style-type: none"> • 4.1 - 4.2.1 • 4.2.2 • 4.3.1 • 4.3.2 • 4.4
12 2/6/23 13 2/8/23 14 2/10/23	Reflection and Transmission – Intro, UPWs normally incident on lossless half-space, UPWs obliquely incident on lossless half-space,	<ul style="list-style-type: none"> • 5.1 - 5.2 • 5.2, 5.3.1 • 5.3.1
15 2/13/23	Exam #1 over Chapters 1, 3, & 4 material	
16 2/15/23 17 2/17/23 2/20/23 18 2/22/23 19 2/24/23 20 2/27/23 21 3/1/23	UPWs obliquely incident on lossless half-space w/ Brewster and critical angles, Lossy media- normal incidence: conductor-conductor, oblique incidence: dielectric-conductor, & oblique incidence: conductor-conductor, Reflection and Transmission of Multiple Interfaces, Polarization Characteristics on Reflection (time allowing)	<ul style="list-style-type: none"> • 5.3.2 - 5.3.3 • 5.3.3 - 5.3.4 <li style="text-align: center;">Holiday • 5.4.1 - 5.4.2 • 5.4.2 - 5.5.1 • 5.5.1 - 5.5.2 • 5.5.2 - 5.6
22 3/3/23	<i>Time allowing-</i> Auxiliary Vector Potentials, ...	• 6.1 - ??
23 3/6/23 24 3/8/23 25 3/10/23	Electrical Properties of Matter – Intro; Dielectrics, Polarization, & Permittivity; Magnetics, Magnetization, & Permeability; Linear, Homogeneous, Isotropic, & Nondispersive Media; AC Variations	<ul style="list-style-type: none"> • 2.1 - 2.2 • 2.2 - 2.3 • 2.8 - 2.9
3/13-17/23	Spring Break	
26 3/20/23 27 3/22/23 28 3/24/23 29 3/27/23 30 3/29/23	Rectangular Cross-Section Waveguides and Cavities – Intro; Rectangular Waveguide- TE modes, TM modes, TE ₁₀ mode, Power, & Attenuation; Rectangular Resonant Cavities- TE & TM modes	<ul style="list-style-type: none"> • 8.1, 8.2.1 • 8.2.2 - 8.2.3 • 8.2.4 - 8.2.5 • 8.2.5, 8.3.1 • 8.3.1 - 8.3.2
31 3/31/23	Exam #2 over Chapters 5, 2, & 8 (through 8.2) material	
32 4/3/23 33 4/5/23	<i>Time allowing-</i> Dielectric Waveguide- slab, TM modes, & TE modes; Dielectric-covered ground plane	<ul style="list-style-type: none"> • 8.7.1 – 8.7.2 • 8.7.3, 8.7.5
4/7/23		Holiday
34 4/10/23 35 4/12/23 36 4/14/23 37 4/17/23 38 4/19/23 39 4/21/23 40 4/24/23 41 4/26/23	Solution to Wave equation in cylindrical coordinates; Circular Cross-Section Waveguides and Cavities – Intro; Circular Waveguide- TE, TM, & attenuation; Circular Resonant Cavities- TE & TM modes & Quality Factor; Circular Dielectric Waveguides and Circular Dielectric Resonators	<ul style="list-style-type: none"> • 3.4.2, 9.1 • 9.2.1 - 9.2.2 • 9.2.2 - 9.2.3 • 9.3.1 - 9.3.2 • 9.3.2 - 9.3.3 • 9.5.1 • 9.5.1 - 9.5.2 • 9.5.2
42 4/28/23	Catch up. Review for Final	
	EE 780 Final Exam- 4-5:50 pm, Monday 5/1/2023, EEP 336	