Electrical and Computer Engineering (ECE) 835

Advanced Electromagnetic Fields and Waves I

Fall 2019 Semester Syllabus

Version of 25 August 2019

Part 1: Course Information

Instructor Information

Instructor: Ed Rothwell
Office: 3241 Engineering Building
On-campus class: 10:20-11:40 T/Th 2205 Engineering Building
Office Hours: Tuesday 11:45-1:00, Thursday 11:45-1:00, in person or by Zoom
Tuesday office hours Zoom ID: 778 491 172
Thursday office hours Zoom ID: 710 130 165
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Course Description (from the MSU catalog)

Electrostatics, magnetostatics, electrodynamics and Maxwell's equations. Potential functions. Eigenfunction expansion. Green's functions. Radiation of EM waves. EM boundary-value problems. TEM waves. Maxwell's equations with magnetic sources.

Prerequisites

There are no official prerequisites. Suggested background material is:

- An undergraduate course in electromagnetics (electrical engineering or physics)
- An undergraduate course in signals (or comfort with Fourier transforms)
- Vector calculus (at the undergraduate level)
- Complex analysis (undergraduate level complex algebra and calculus)

Textbook & Course Materials

Required textbook: Roger F. Harrington, *Time Harmonic Electromagnetic Fields*. IEEE Press/Wiley Interscience, New York, 2001. ISBN 0-471-20806-X. Note: IEEE books are available online to all MSU students through the link https://ieeexplore-ieee-org.proxy2.cl.msu.edu/Xplore/home.jsp

Suggested reference: Edward J. Rothwell and Michael J. Cloud, *Electromagnetics*, 3rd edition. CRC Press, Boca Raton, FL, 2018. ISBN 978-1-4987-9656-9. Note: The first and second editions also cover the material relevant to the class.

Class notes: We will be using the ECE 835 class notes developed by Prof. Dennis Nyquist. These notes closely parallel the required textbook. They are supplemented using notes from the suggested reference by Rothwell and Cloud. All course notes are posted to D2L.

Recommended Texts & Other Readings

Many other excellent textbooks cover the topics from the class. You may find the following books useful; they can be found at the MSU main library.

- J.A. Stratton, Electromagnetic Theory, McGraw-Hill, 1941.
- C.A. Balanis, Advanced Engineering Electromagnetics, Wiley, 1989.
- S. Ramo, et.al., Fields and Waves in Communication Electronics, Wiley, 1994.
- J.A. Kong, Electromagnetic Wave Theory, Wiley, 1990.
- D.H. Staelin, et. al., Electromagnetic Waves, Prentice Hall, 1994.

Course Structure

This course will be delivered online through the course management system and you will need your MSU NetID to log in to the course from the D2L homepage (http://d2l.msu.edu). In D2L, you will access online lessons, course materials, and additional resources.

Technical Assistance

If you need technical assistance at any time during the course, or if you need to report a problem, you can:

- Visit the Discovery Services Support Site
- Visit the Desire2Learn Help Site (http://help.d2l.msu.edu/)
- Call Distance Learning Services: (800) 500-1554 or (517) 355-2345

Resource Center for Persons with Disabilities (RCPD)

- To make an appointment with a specialist, contact: (517) 353-9642

  Or TTY: (517) 355-1293
- Web site for RCPD: http://MYProfile.rcpd.msu.edu

Class Guide

A step-by-step guide to lead you through the intricacies of completing ECE 835 may be found on D2L at **Content → Overview**

Part 2: Course Objectives

ECE 835 is the first graduate level course in electromagnetics (EM). Students interested in continuing in the EM discipline typically take ECE 836 and ECE 837, as well as selected advanced courses under the ECE 929 course number. ECE 835 is also a core course for the MS program in electrical engineering.

The course is designed to provide basic advanced skills in electromagnetic theory. Students will obtain proficiency

- Working with Maxwell's equations, Poynting's theorem, and jump conditions
- Formulating and solving the wave equation
- Interpreting the physical meaning of wave phenomena
- Solving advanced problems involving transmission lines, waveguides, resonators, and radiation
- Applying the fundamental theorems of EM to various problems
- Computing fields using Green's functions
- Constructing fields using potentials
- Solving a variety of canonical problems in rectangular coordinates

You will meet the objectives listed above through a combination of the following activities in this course:

- Watch the course videos posted to D2L
- Complete the homework assignments
- Interact with fellow students through the Discussion Forum
- Interact with the instructor during office hours
- Study for the class exams

Part 3: Course Outline/Schedule

Important dates

Note: These dates may also be found in the D2L calendar

Date	Activity
8/28	Classes begin
9/2	Holiday – University closed
9/23	**Homework 1 due**
9/23	Tuition refund period ends
10/7	**Homework 2 due**
10/16	Middle of semester – last day to drop
10/23	**Homework 3 due**
10/28	**MIDTERM EXAM**
11/20	**Homework 4 due**
11/28-11/29	Holiday – University closed
12/6	**Homework 5 due**
12/6	Last day of class
TBD	**FINAL EXAM**

Outline of topics

Topic	Title	Dates	Notes Pages	Homework where assessed	Exam where assessed
1	Navigating ECE 835 (53:33)	8/28			
	Chapter 1 (4:28:09)				
2	Introduction (50:35)	8/30-9/2	1-12, R1-3	**1,2**	**M**
3	Maxwell's Theory of Electromagnetics (2:54:53)	9/4-9/11	R5-64	**1,2,3**	**M**
4	Energy and Power (25:21)	9/13	26-29	**2,4**	**M,F**
5	Complex Quantities and the Phasor Maxwell's Equations (26:29)	9/16	29-32	**2,3,4**	**M,F**
6	Complex Constitutive Relationships and Complex Power (30:54)	9/18	32-36	**2,3**	**M,F**
7	Jump (Boundary) Conditions (19:57)	9/20	36-39	**2,3,5**	**F**
	Chapter 2 (10:10:36)				
8	The Wave Equation (58:12)	9/23	40-44	**2,3**	**M**

9	Waves in Perfect Dielectrics (1:39:08)	9/25	45-53	**3**	
10	Intrinsic Wave Constants (17:56)	9/27	53-54	**2**	**M**
11	Waves in Lossy Matter (26:20)	9/30	54-55	**2**	**M**
12	Reflection of Waves (1:35:35)	10/2	56-63	**2**	
13	Transmission Line Concepts (1:34:46)	10/4	64-68	**3**	
14	Waveguide Concepts (1:14:06)	10/7	69-74	**3,5**	**F**
15	Resonator concepts (32:32)	10/9	74-77		
16	Radiation (1:30:16)	10/11	77-81	**4**	**F**
17	Antenna Concepts (1:21:45)	10/15	81-85	**4**	**F**
	Chapter 3 (7:04:42)				
18	The Source Concept (22:50)	10/16	86-89	**4**	
19	Duality (Superposition) (18:59)	10/16	89-91		
20	Uniqueness (20:14)	10/18	91-93		
21	Image Theory (38:06)	10/21	94-96	**4**	
22	The Equivalence Principle (28:15)	10/23	96-98	**4**	**F**
23	Fields in Half-Space (12:32)	10/23	99		
24	The Induction Theorem (14:41)	10/25	99-101		
25	Reciprocity (47:34)	10/28	101-105		
26	Green's functions (2:17:46)	10/30-11/1	105-113	**5**	
27	Tensor (Dyadic) Green's functions **-- optional**	11/4	113-115		
28	Integral Equations (30:20)	11/6	116-118		
29	Construction of Solutions (26:49)	11/8	118-121		
30	The Radiation Field (26:36)	11/11	121-123	**4**	
	Chapter 4 (7:28:23)				
31	The Wave Functions (34:37)	11/13	124-127	**3**	**F**
32	Plane Waves (1:01:45)	11/15	127-131	**3**	
33	The Rectangular Waveguide (1:17:13)	11/18	131-135	**5**	**F**
34	Alternative Mode Sets (27:25)	11/20	136-138	**5**	
35	The Rectangular Cavity (26:23)	11/25	138-139		
36	Partially Filled Waveguide (51:41)	11/27	140-144	**5**	
37	The Dielectric-Slab Guide (1:11:29)	11/29	145-151		
38	Modal Expansions of Fields (46:19)	12/2	151-156		
39	Currents in Waveguides (51:51)	12/4	156-161		

Weekly schedule

Week	Videos	Dates	Topics	Homework	Exam
1	1:09:03	8/28-8/30	1,2.1		
2	2:40:26	9/2-9/6	2.2,2.3,3.1.1-3.1.4		
3	1:14:53	9/9-9/13	3.1.5-3.1.9,4		
4	1:17:20	9/16-9/20	5,6,7		
5	2:55:16	9/23-9/27	8,9,10	HW 1 9/23	
6	3:36:41	9/30-10/4	11,12,13		
7	3:16:54	10/7-10/11	14,15,16	HW 2 10/7	
8	2:23:48	10/14-10/18	17,18,19,20		
9	1:33:34	10/21-10/25	21,22,23,24	HW 3 10/23	
10	3:05:20	10/28-11/1	25,26		Midterm 10/28
11	57:09	11/4-11/8	27,28,29		
12	2:02:58	11/11-11/15	30,31,32		
13	1:44:38	11/18-11/22	33,34,35	HW 4 11/20	
14	2:29:33	11/25-11/27	36,37		
15	1:37:10	12/2-12/6	38,39	HW 5 12/6	
Finals					Final TBD

Part 4: Grading Policy

Graded Course Activities

The table below describes the graded course activities including points and activity description.

Points	Description
25	Homework assignments 1-5 (5 points each)
25	Midterm exam
50	Final exam
100	Total Points Possible

Homework Policies

- Homework must be submitted through D2L by 11:59 pm on the date listed below
- Homework must be submitted as a **single pdf file**
- Homework must be clear and legible
- You are encouraged to work in groups. You may submit a homework solution for each student or one solution for a group of two students. Be sure all names are listed.
- More policies and details regarding homework may be found on D2L at **Content → Homework Assignments → Homework guidelines**.

Homework Assignment Due dates

Assignment	Date due
1	9/23
2	10/7
3	10/23
4	11/20
5	12/6

Viewing Grades and Graded Work

You may view your grades on D2L at **Assessments → Grades**.

Exams

Details on how exams will be administered to off-campus students may be found on D2L at **Content → Syllabus/Course Resources → Exam Guidelines**.

Part 5: Course Policies

Inform Your Instructor of Any Accommodations Needed

From the Resource Center for Persons with Disabilities (RCPD): Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Requests for accommodations by persons with disabilities may be made by contacting the Resource Center for Persons with Disabilities at 517-884-RCPD or on the web at rcpd.msu.edu. Once your eligibility for an accommodation has been determined, you will be issued a Verified Individual Services Accommodation ("VISA") form. Please present this form to me at the start of the term and/or two weeks prior to the accommodation date (test, project, etc.). Requests received after this date may not be honored.

Drops and Adds

The last day to add this course is the end of the first week of classes. The last day to drop this course with a 100 percent refund and no grade reported is September 23, 2019. The last day to drop this course with no refund and no grade reported is October 16, 2019. You should immediately make a copy of your amended schedule to verify you have added or dropped this course.

Commercialized Lecture Notes

Commercialization of lecture notes and university-provided course materials is **not permitted** in this course. (Note: The Code of Teaching Responsibility requires instructors who permit students to commercialize their class lecture notes to include a statement in their course syllabi that gives such permission. Absent such permission, students may not do so.)

Exam Policy

If you must miss an exam, you must contact me at least three days **before** the day of the exam to make alternative arrangements. True emergencies will be dealt with on a case-by-case basis.

Religious Observances

If any exam or assignment conflicts with a religious observance, let me know **ahead of time** and we will make other arrangements.

Academic Honesty

Information on academic honesty may be found at https://www.msu.edu/~ombud/academic-integrity/index.html. Note in particular that General Student Regulation 1.00 *PROTECTION OF SCHOLARSHIP AND GRADES* states

> The principles of truth and honesty are fundamental to the educational process and the academic integrity of the University; therefore, no student shall:
>
> 1.01 claim or submit the academic work of another as one's own.
> 1.02 procure, provide, accept or use any materials containing questions or answers to any examination or assignment without proper authorization.
> 1.03 complete or attempt to complete any assignment or examination for another individual without proper authorization.

1.04 allow any examination or assignment to be completed for oneself, in part or in total, by another without proper authorization.
1.05 alter, tamper with, appropriate, destroy or otherwise interfere with the research, resources, or other academic work of another person.
1.06 fabricate or falsify data or results.