Course Instructor
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EE 4347
Applied Electromagnetics

Topic 0

Course Introduction

Lecture Outline

• Welcome!
• About this class
• Rules and syllabus
• Let’s get started!
Welcome

Course Information

http://emlab.utep.edu/ee4347appliedem.htm
EE-4347 Applied Electromagnetics
3 credit hours

Instructor Information

Name: Dr. Raymond C. Rumpf
Office: ENGR A-337
Office Hours: M/W, 3:00pm – 4:00pm, or by appointment
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Important Dates

13 May Final Exam. 4:00pm – 6:45pm

Course Website

- Syllabus
- Homework assignments
- Notes
  - Red – class notes
  - Black – supplemental information
  - Green – Summaries
- MATLAB codes
- Other resources & more!

http://emlab.utep.edu/ee4347appliedem.htm
About This Class

Topics for this Course

• Topic 1 – Maxwell’s Equations
• Topic 2 – Electromagnetic Properties of Materials
• Topic 3 – Electromagnetic Waves
• Topic 4 – Transmission Lines
• Topic 5 – Waveguides
• Topic 6 – Computational Electromagnetics
• Topic 7 – Smith Charts
• Topic 8 – Electromagnetic Devices
Topic 1 – Maxwell’s Equations

<table>
<thead>
<tr>
<th>Integral Form</th>
<th>Differential Form</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \nabla \cdot \mathbf{D} = \rho )</td>
<td>( \nabla \cdot \mathbf{E} = 0 )</td>
<td>Gauss’ Law</td>
</tr>
<tr>
<td>( \nabla \times \mathbf{B} = \mathbf{0} )</td>
<td>( \nabla \times \mathbf{H} = \mathbf{0} )</td>
<td>No Magnetic Charge</td>
</tr>
<tr>
<td>( \frac{1}{2} \int \mathbf{E} \times \mathbf{E} , dV )</td>
<td>( \frac{1}{2} \int \mathbf{D} \times \mathbf{D} , dV )</td>
<td>Faraday’s Law</td>
</tr>
<tr>
<td>( \frac{1}{2} \int \mathbf{B} \times \mathbf{B} , dV )</td>
<td>( \frac{1}{2} \int \mathbf{H} \times \mathbf{H} , dV )</td>
<td>Ampere’s Circuit Law</td>
</tr>
</tbody>
</table>

Parameter Definitions:
- Electric Field Intensity, \( \mathbf{E} \) (V/m)
- Electric Flux Density, \( \mathbf{D} \) (C/m²)
- Magnetic Field Intensity, \( \mathbf{H} \) (A/m)
- Magnetic Flux Density, \( \mathbf{B} \) (Wb/m²)
- Electric Current Density, \( \mathbf{J} \) (A/m²)
- Volume Charge Density, \( \rho \) (C/m³)
- Permittivity, \( \varepsilon \) (F/m)
- Permeability, \( \mu \) (H/m)
- Electrical Conductivity, \( \sigma \) (S/m)

Constants:
- \( \varepsilon_0 = 8.85 \times 10^{-12} \) F/m
- \( \mu_0 = 4 \pi \times 10^{-7} \) H/m
- \( c_0 = 3 \times 10^8 \) m/s

Lorentz Force Law:
\[ \mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B}) \]

Sign Convention:
- \( \mathbf{E} \) and \( \mathbf{B} \) are perpendicular in the \( \mathbf{v} \) direction.

Topic 2 – EM Properties of Materials

\[ \mathbf{E} = 0 \]

\[ \mathbf{E} \]

\[ \mathbf{P} \]

Anomalous and Negative Dispersion
Topic 3 – Electromagnetic Waves

Course Introduction

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Topic 4 – Transmission Lines

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**Topic 5 – Waveguides**

Waveguides
- Contains two or more conductors
- No low-frequency cutoff

**Transmission Lines**
- Has TEM modes
- Has TE and TM modes

**Metal Shell Pipes**
- Enclosed by metal
- Does not support TEM mode
- Has a low-frequency cutoff
- Supports TE and TM modes

**Dielectric Pipes**
- Composed of a core and a cladding
- Symmetric waveguides have no low-frequency cutoff

**Inhomogeneous**
- Supports only hybrid modes
- Supports quasi-TE and quasi-TM modes

**Differential**
- Buried parallel plate
- Coplanar strips
- Slotline

**Homogeneous**
- Supports a hybrid (TEM, TE, & TM) mode

**Course Introduction Slide 12** Topic 6 – Computational EM (CEM)

\[ \nabla \times \mathbf{E} = -j \omega \mu \mathbf{H} \]
\[ \nabla \times \mathbf{H} = j \omega \varepsilon \mathbf{E} \]

\[ [A][x] = [b] \]

**APPLIED EM**

Course Introduction
Rules & Syllabus

Prerequisites By Course

- EE 3331 – Electromagnetic Field Theory
- MATH 2313 – Calculus III (Vector calculus)
- MATH 2326 – Differential Equations
- EE 2351 – Electric Circuits II
- EE 2353 – Continuous-Time Signals and Systems
- PHYS 2421 – Fields and Waves
Prerequisites By Topic

- Fundamental laws of electricity
- Differential equations
- Vector calculus
- Fields and waves

Required Materials

- Notebook to archive notes, tests, homework, etc.
- Scientific calculator (TI-85 or equivalent)
- 30 cm ruler, compass, and colored pencils
- Access to a computer with MATLAB and internet
- Textbook
  - Elements of Electromagnetics, 7th Ed.
  - Matthew N. O. Sadiku
  - Oxford University Press
  - ISBN-10: 0190698616
## Grading

<table>
<thead>
<tr>
<th>Area</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>30%</td>
</tr>
<tr>
<td>Exams</td>
<td>30%</td>
</tr>
<tr>
<td>Participation</td>
<td>20%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20%</td>
</tr>
</tbody>
</table>

90% – 100% → A  
80% – 89% → B  
70% – 79% → C  
60% – 69% → D  
0% – 59% → F

## Homework

- Assigned on a weekly basis.
- Show all work. Only use calculator or computer for basic arithmetic.
- Homework is due before midnight on assigned due date.
- 20 points deducted for every day late
- DO YOUR OWN WORK!!
Homework Format

- Must include a cover page
  - Course info, student name, assignment number, due date, etc.
  - No work should appear on cover page.
- Problems must be provided in the same order they were asked.
- Work must be neat and well organized.
- Finish your calculations. \( \sqrt{4} \rightarrow 3.7417 \)  \( \pi \rightarrow 2.0944 \)
- Show all work or answer will be graded as incorrect.
- Final answers must be boxed or answer will be graded as incorrect.
- Do not box intermediate results or answer will be graded as incorrect.
- Include proper units or answer will be graded as incorrect.
- Homework must be stapled at upper-left corner. No additional binding.
- Single-sided pages are preferred, but not required except when using engineering paper.

Participation / Attendance

- ASK QUESTIONS!!
- Be proactive in class and respond to polls.
- Attend every lecture.
- Show up to lecture on time.
- Contact me ahead of time if you have to miss a class, test, or homework.
- You are responsible for anything you missed during your absence.
- Be quiet and courteous. Electronic devices should be turned off or put in silent mode.
- Purchase the text book.
Tests

- Few or frequent?
- Allowed both sides of one 8.5”x11” cheat-sheet, a scientific calculator, and pens/pencils.
- Write your name VERY neatly.
- Work must be written neatly.
- Essentially same rules as homework
  - Final answers must be boxed. Don’t box intermediate results.
  - Don’t forget to use proper units.
  - Finish calculations.
  - Answer problems in the order they were asked.

Recommended Habits

- Come to every lecture.
- Ask questions and respond to polls.
- Don’t let yourself get behind.
- Rewrite your lecture notes and fill in the gaps.
- Create summary sheets to organize information.
- Do your homework in a format that will let you easily relearn the information 10 years from now.
- Be sure you are on the e-mail list for the class.
Let’s Get Started!