Electromagnetics: Electromagnetic Field Theory

Course Introduction

Outline

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

- Syllabus
- Homework assignments
- Course notes
- Lecture videos
- Summaries
- Supplemental information

https://empossible.net/academics/emp3302/

About This Class
Maxwell’s Equations

<table>
<thead>
<tr>
<th>Integral Form</th>
<th>Differential Form</th>
<th>Name</th>
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</thead>
<tbody>
<tr>
<td>[ \nabla \cdot \mathbf{D} = \rho ]</td>
<td>[ \nabla \cdot \mathbf{D} = \rho ]</td>
<td>Gauss’ Law</td>
</tr>
<tr>
<td>[ \nabla \times \mathbf{E} = \mathbf{J} ]</td>
<td>[ \nabla \times \mathbf{E} = \mathbf{J} ]</td>
<td>No Magnetic Charge</td>
</tr>
<tr>
<td>[ \nabla \times \mathbf{B} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t} ]</td>
<td>[ \nabla \times \mathbf{B} = \mathbf{J} + \frac{\partial \mathbf{D}}{\partial t} ]</td>
<td>Faraday’s Law</td>
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<tr>
<td>[ \nabla \cdot \mathbf{H} = \frac{\rho_s}{\mu_0} ]</td>
<td>[ \nabla \cdot \mathbf{H} = \frac{\rho_s}{\mu_0} ]</td>
<td>Ampere’s Circuit Law</td>
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</tbody>
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Parameter Definitions
- Electric Field Intensity, \( E \) (V/m)
- Electric Flux Density, \( D \) (C/m²)
- Magnetic Field Intensity, \( H \) (A/m)
- Magnetic Flux Density, \( B \) (Wb/m²)
- Electric Current Density, \( J \) (A/m²)
- Volume Charge Density, \( \rho \) (C/m³)
- Permittivity, \( \varepsilon \) (F/m)
- Permeability, \( \mu \) (H/m)
- Electrical Conductivity, \( \sigma \) (S/m)

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<thead>
<tr>
<th>Time Domain</th>
<th>Frequency Domain</th>
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<tr>
<td>[ \mathbf{D} = \varepsilon \mathbf{E} ]</td>
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<td>[ \mathbf{H} = \mu \mathbf{H} ]</td>
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About This Course

Who fears this class?

Can you tie your shoe laces?

Be proactive and ask questions!

- especially the “dumb” questions.
What is Electromagnetics?

Electromagnetics is the branch of science concerned with the forces that occur around electrically charged particles and the relation between those forces.

Electromagnetics is the single topic in EE which connects all other topics.

Four Fundamental Forces in the Universe
- Electromagnetic force
- Gravitational force
- Weak nuclear force
- Strong nuclear force.
Electromagnetics is NOT...

- Sound Waves
- Vibrations
- Gravity

Rules and Syllabus
Prerequisites By Topic

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

Required Materials

• Notebook to archive notes, tests, homework, etc.
• Scientific calculator (TI-85 or equivalent)
• 30 cm ruler
Topics Covered in This Course

- Review of Vector Calculus
- Classical Electromagnetics

Maxwell’s Equations
\[ \oint D \cdot dl = \oint \rho \, dv \]
\[ \oint B \cdot ds = 0 \]

Constitutive Relations
\[ D = \epsilon E \]
\[ B = \mu H \]

Electrostatics
Magnetostatics
Electrodynamics
Transmission Lines
Waveguides
Computational EM

Grading

<table>
<thead>
<tr>
<th>Area</th>
<th>Weight</th>
<th>Grade</th>
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<tbody>
<tr>
<td>Homework</td>
<td>30%</td>
<td>A</td>
</tr>
<tr>
<td>Exams</td>
<td>30%</td>
<td>A</td>
</tr>
<tr>
<td>Participation</td>
<td>20%</td>
<td>A</td>
</tr>
<tr>
<td>Final Exam</td>
<td>20%</td>
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If you have...

- A
- A
- A

you do not have to take the final exam!!

Note: 89.99999999999 ≠ A
Homework

- Assigned on a weekly basis.
- Show all work. Only use a calculator for basic arithmetic.
- Homework must be submitted by 11:59pm on due date.
- No late assignments accepted.
- Homework cannot be electronic, unless specifically requested by the instructor.
- 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 placed in proper order.
- Work must be neat and well organized.
- Finish your calculations. \( \sqrt{25} \rightarrow 3.7417 \) \( \sqrt[3]{8} \rightarrow 2.0944 \)
- 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.
  - There will be one test where a cheat-sheet is not allowed.
- Write your name VERY neatly.
- Work must be written neatly.
- Same rules as for homework
  - Final answers must be boxed.
  - Don’t box intermediate results.
  - Use proper units.
  - Finish calculations.
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 so that you can relearn the information 10 years from now.
• Be sure you are on the e-mail list for the class.