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Electromagnetics:
Electromagnetic Field Theory

Course Introduction

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Outline

- Welcome*!*
- About this class
- Rules and syllabus
- Let's get started*!*

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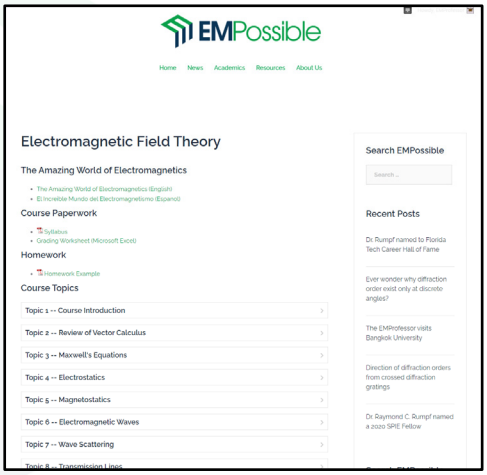
Course Website

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



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

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About This Class

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About This Course

Who fears this class?

Can you tie your shoelaces?

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.

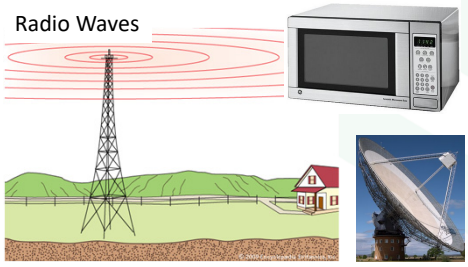
Electromagnetics is the single topic in EE which connects all other topics.

Four Fundamental Forces in the Universe

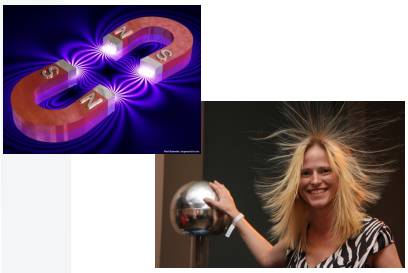
- Electromagnetic force
- Gravitational force
- Weak nuclear force
- Strong nuclear force.

Electromagnetics is…

Radio Waves



Charges and Magnets



Light

X-Rays

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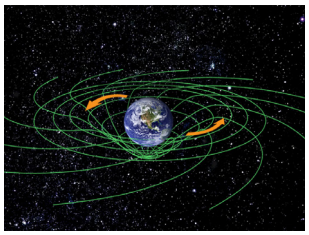
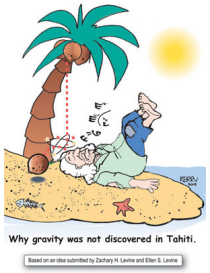
Electromagnetics is NOT…

Sound Waves

Gravity



Vibrations



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Equations Often Imply a Process

A novice looks at an equation simply as something to plug numbers into.

$$v = \frac{d}{t}$$

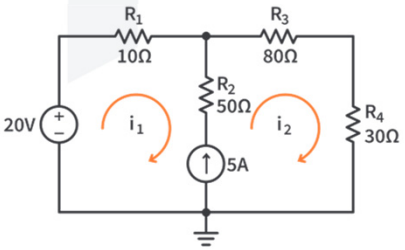
$$v = \frac{100\ \text{m}}{11\ \text{s}}$$

$$v = 9.1\ \text{m/s}$$

$$v = 20.4\ \text{mph}$$

More often in STEM, equations imply a process instead of being "plug-and-chug."

$$\sum_i V_i = 0$$



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Rules and Syllabus

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Prerequisites By Topic

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

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Required Materials

- Notebook to archive notes, tests, homework, etc.
- Scientific calculator (TI-85 or equivalent)
- 30 cm ruler
- Compass
- Pen or pencil
- Blank paper
- Access to a computer with MS Office & MATLAB 2022+

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Topics Covered in This Course

Review of Electromagnetic Field Theory Part 1

Maxwell's Equations

$$\oiint_S \vec{D}\bullet d\vec{s} = \iiint_V \rho_v dv \qquad \oint_L \vec{E}\bullet d\vec{\ell} = \iint_S \left[-\frac{\partial \vec{B}}{\partial t}\right]\bullet d\vec{s}$$

$$\oiint_S \vec{B}\bullet d\vec{s} = 0 \qquad \oint_L \vec{H}\bullet d\vec{\ell} = \iint_S \left[\vec{J}+\frac{\partial \vec{D}}{\partial t}\right]\bullet d\vec{s}$$

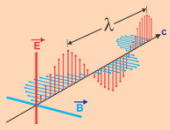
Constitutive Relations

$$\vec{D}=[\varepsilon]\vec{E} \quad \vec{B}=[\mu]\vec{H}$$

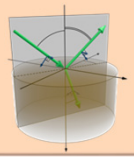
Lorentz Force Law

$$\vec{F}=Q\vec{E}+Q(\vec{u}\times\vec{B})$$

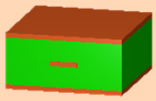
EM Waves



Wave Scattering

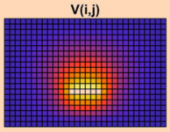


Transmission Lines

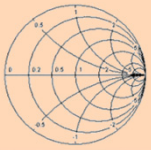


Waveguides

Computational EM



Smith Charts



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Grading

Area	Weight
Homework	30%
Exams	30%
Participation	20%
Final Exam	20%

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

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Homework

- Assigned on a weekly basis.
- Show all work. Only use a calculator for basic arithmetic.
- Homework must be submitted by 4:59pm on due date.
- No late assignments accepted.
- Homework cannot be electronic, unless specifically requested by the instructor.
- DO YOUR OWN WORK*!!*

Homework Format

- Must be submitted as a single hard-copy document. No electronic submissions.
- Must include a cover page
  - Course info, student name, assignment number, due date, etc.
  - No work should appear on cover page.
- Problems must be answer in the same order they were given.
- Work must be neat and well organized.
- Finish your calculations. $\sqrt{14} \rightarrow 3.7417$ $2\pi/3 \rightarrow 2.0944$
- 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 the 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.
- All computer codes must be provided at the end of the assignment in an Appendix, not mixed in with answers.
- Graphics checklist must be provided as the last page of the assignment if any graphics are submitted as part of the assignment.

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 textbook.

Exams

- Allowed both sides of one 8.5”×11” 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.
  - Do not 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.