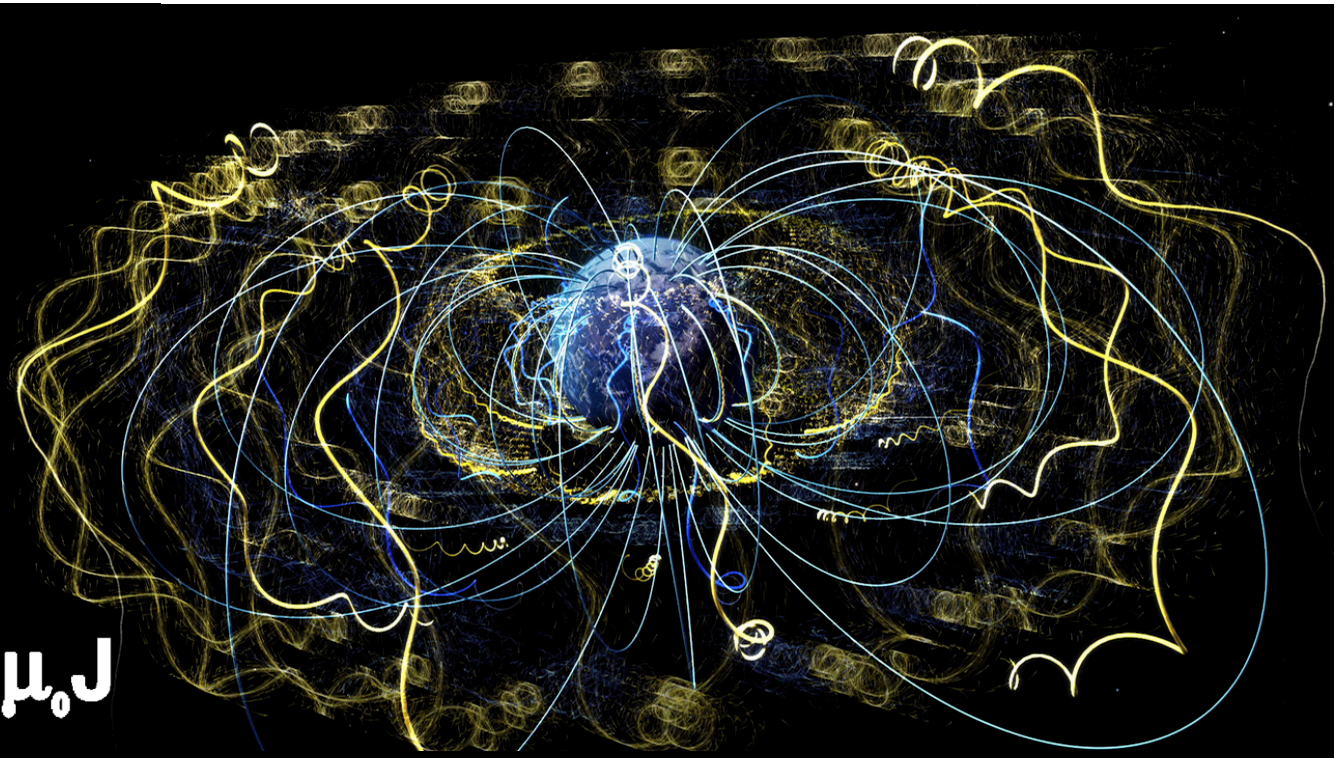
$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{B} = \mu_0 \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t} + \mu_0 \mathbf{J}$$



Electricity and Magnetism II: 3812

Professor Jasper Halekas
Van Allen 70
MWF 9:30-10:20 Lecture

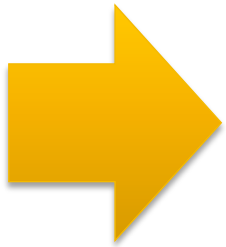
Electrodynamics (Maxwell's Equations)

$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = 0$$

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J}$$



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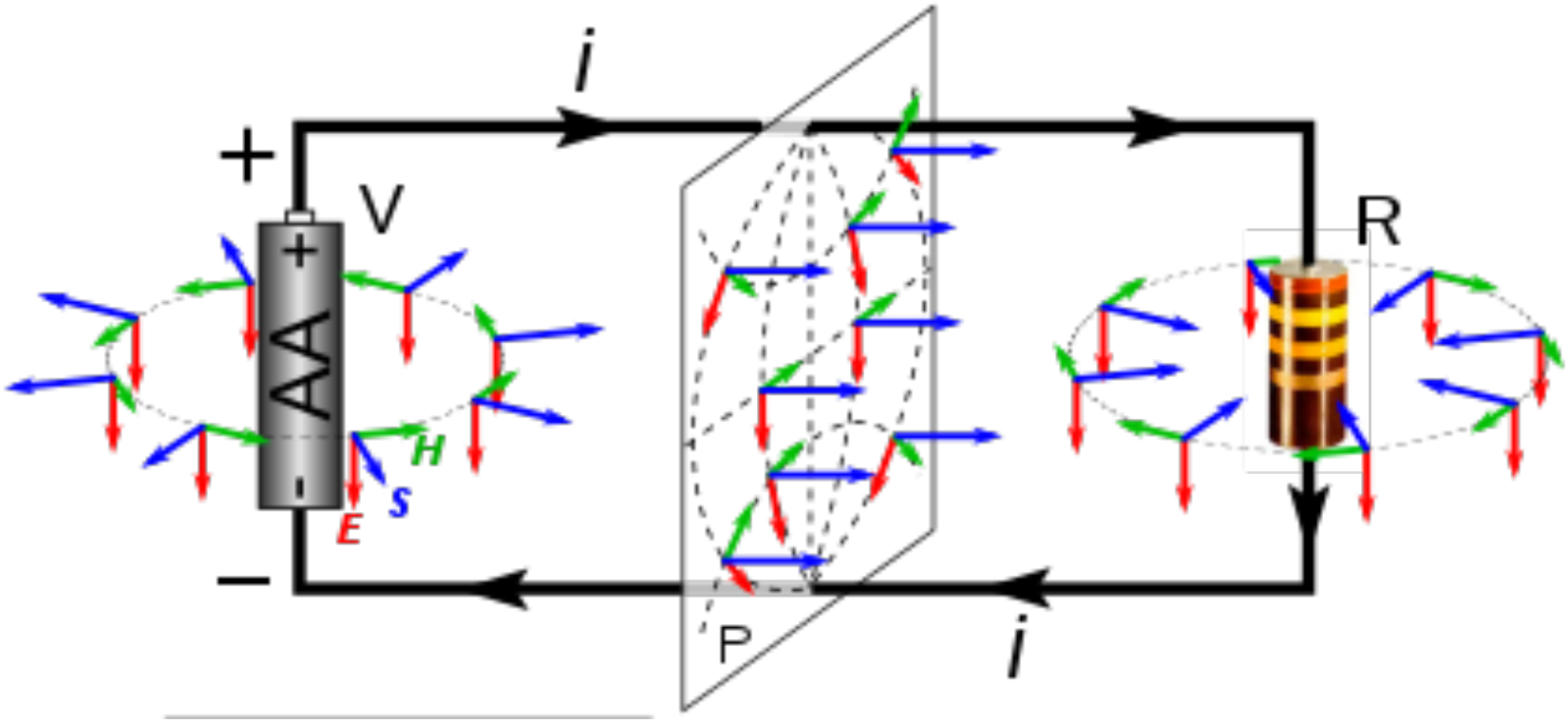
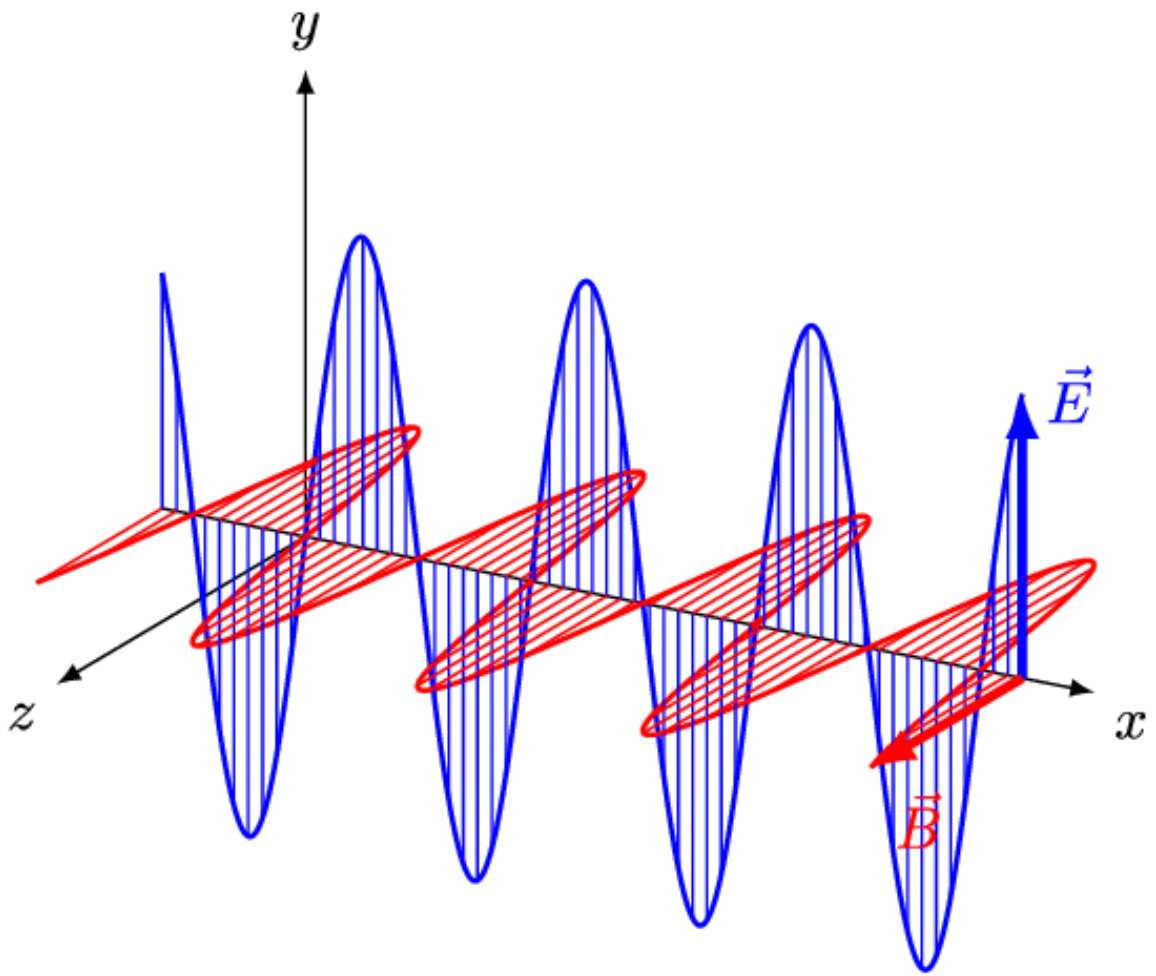
Conservation Laws (Energy Flow)

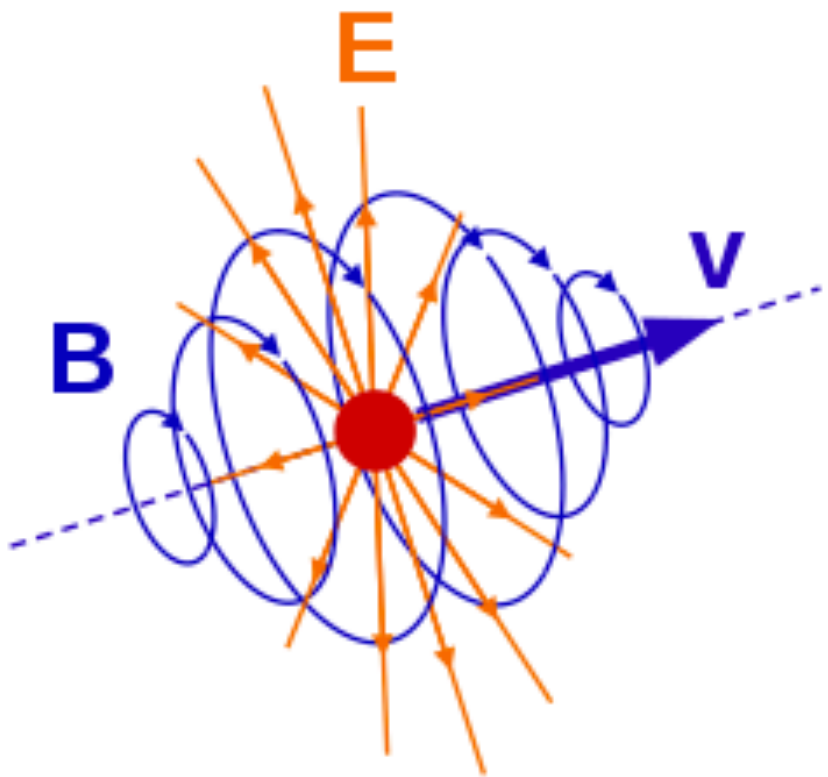


Electromagnetic Waves

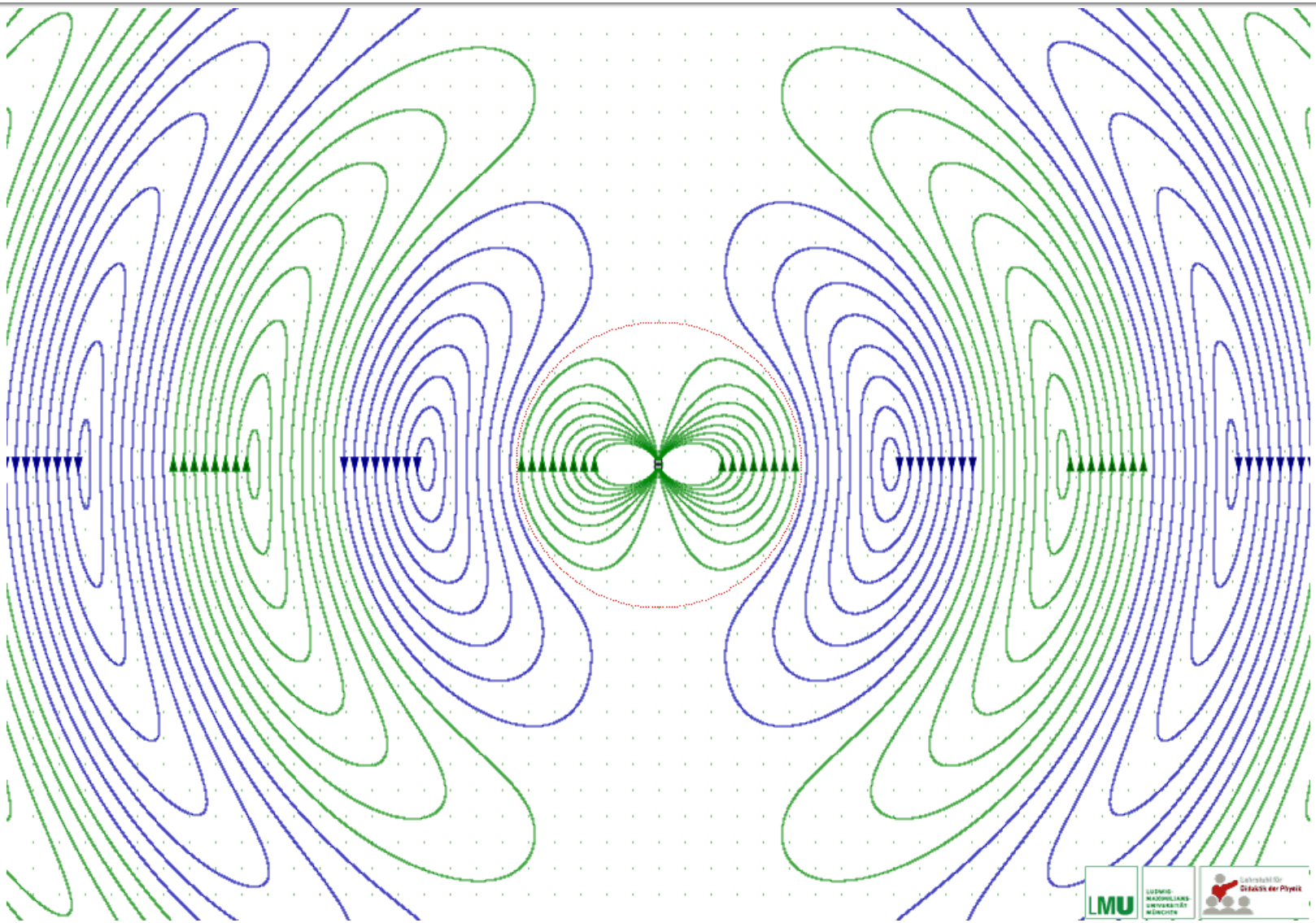


Potentials and Fields (Time Dependent)

$$\mathbf{B} = \nabla \times \mathbf{A}\,, \quad \mathbf{E} = -\nabla\phi - \frac{\partial \mathbf{A}}{\partial t}$$



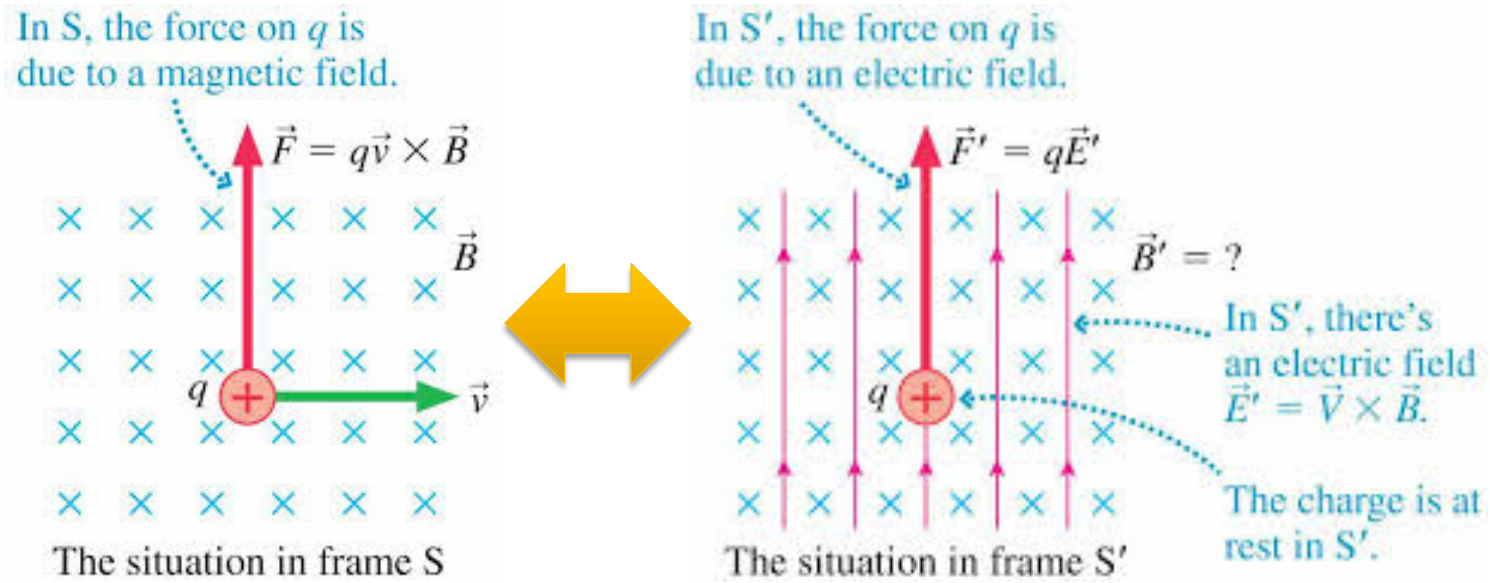
Radiation



Electrodynamics and Relativity

$$\mathbf{E}_{\parallel}{}' = \mathbf{E}_{\parallel}$$
$$\mathbf{B}_{\parallel}{}' = \mathbf{B}_{\parallel}$$
$$\mathbf{E}_{\perp}{}' = \gamma\left(\mathbf{E}_{\perp} + \mathbf{v} \times \mathbf{B}\right)$$
$$\mathbf{B}_{\perp}{}' = \gamma\left(\mathbf{B}_{\perp} - \frac{1}{c^2}\mathbf{v} \times \mathbf{E}\right)$$

$$\frac{\partial F^{\alpha\beta}}{\partial x^{\alpha}} = \mu_0 J^{\beta}$$
$$\frac{\partial G^{\alpha\beta}}{\partial x^{\alpha}} = 0$$



Contacts/Office Hours

- **Instructor:** Jasper S Halekas
- **Office:** 414 Van Allen Hall
- **Phone:** (319) 335-1929
- **E-mail:** jasper-halekas@uiowa.edu
- **Walk-In Office Hours:**
  - Wednesday 1:30-3:30 am,
  - Thursday 2:00-3:00 pm
  - *Or by Appointment*

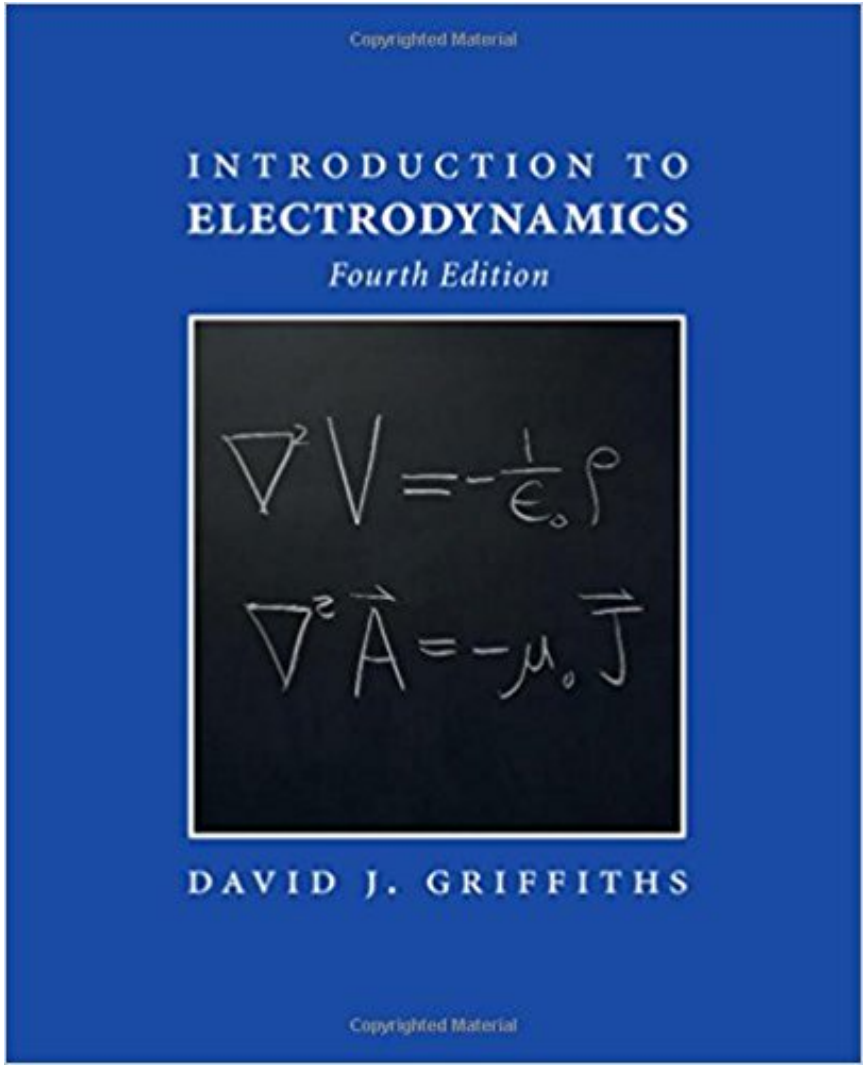
Resources: Web Pages

- Web Pages:
  - Main Web Page
    - http://www.physics.uiowa.edu/~jhalekas/teaching/eandm2_2020/index.html
      - Hosts syllabus, schedule, class notes, assignments, etc.
  - ICON:
    - https://uiowa.instructure.com/courses/135289
      - Links to main site, syllabus, schedule, etc.
        - All grades will be posted here

Resources: Class Notes

- Notes from each class (both slides and blackboard material) will be merged and placed online in PDF form within one day after the class
  - Can be found on the main class web page, on the "Notes" tab

Resources: Textbook



The textbook can be purchased anywhere
Make sure you get the Fourth Edition.

The textbook is the same one as last semester.

Reading

- Reading should be completed before lecture
- There are no graded quizzes
  - We will do some ungraded problem-solving sessions in class
- Reading ahead is highly recommended, and will make lecture and discussions more productive
  - It will also make you better prepared for exams

Homework

- Weekly homework assignments will be hand-written and hand-graded. Assignments are due in class on Fridays (or before). If you do your homework in electronic form please print it out.
- You are allowed to work with other students on the homework, but each student must write out a full set of solutions.
- Solutions **must** clearly show all work. Full credit will not be given for incomplete work. Partial credit may be assigned for correct logic on intermediate steps even if you don't get the final answer.
- The lowest scoring of the 11 homework assignments will be dropped – i.e. you get a "freebie"

Homework Grading Rubric

- Solid attempt = 50% credit
- Correct approach but errors = ~75% credit
- Fully correct solution = 100% credit
- Copy of online solutions = 0% credit
- Late homework = <<100% credit

Exams

- Midterm exams will be held during regular class hours. The final exam will be two hours, scheduled during finals week at a time to be announced.
- Exams will be closed book, long-form, hand-graded
  - You will be provided with an equation sheet, which you can annotate as you see fit
  - Questions will require symbolic or text answers – no calculators needed
- No make-up exams other than in legitimate extenuating circumstances with **prior** approval!
  - If you do not contact me in advance you **will not** earn full credit for the exam

Tests/Grading

- **Exam Schedule: Two Midterm Exams:**
  - Wednesday, Feb. 26 Ch. 7-9.2
  - Wednesday, Apr. 15 Ch. 9.3-11
  - Final Exam, TBD Date Ch. 7-12
- **Grading:**
  - Homework 25%
  - Two Midterms 20% Each
  - Final Exam 35%

Grading: How it Works

- Student A has the following scores:

Category	Score	Percentage	Weight	Class Points
Homework	900/1000	.900	25	22.5
Midterm 1	65/100	.65	20	13.0
Midterm 2	72/100	.72	20	14.4
Final	68/100	.68	35	23.8
Total				73.7/100

Student A has 73.7 class points. These will determine his/her class rank, which will be used to determine his/her grade.

Grading: How it Works

- CLAS recommends the following grade distribution for advanced courses:
  - A 22%, B 38%, C 36%, D 3%, F 1%.
  - A similar curve will be used in assigning final grades – this curve may be adjusted slightly depending on the overall performance of the class
- For example:
  - If 73.7 translated to a class rank of 9/18 = 50th percentile, Student A would get a B by this curve.

Cheating

- **Don't!**
- Cheating is a major disservice to you and your classmates. If you are caught, it will affect your grade, and you could face disciplinary action
- Copying homework solutions from **anywhere** is **not** fair play
  - If you don't work out your homework yourself, it will very likely hurt your performance on exams

Communication

- Please let me know if you have questions, comments, complaints, or are struggling with particular concepts. This class is for you, and I am here to help.
  - Students may communicate with me by phone, e-mail, or in person
  - Students with issues or questions should if possible raise them in person by attending office hours or by scheduling an appointment
  - If you prefer to give me anonymous feedback there is a comments envelope on my door

E&M I Feedback (11/23 students)

- What students liked:
  - Jokes, posted lecture notes, conceptual explanations, lectures (x3), coherent presentation, responses to questions
- What students didn't like:
  - Lengthy proofs, too long exams, too much material to cover, jump between Ch. 2 & 3, lack of connections to other physics & math, notational differences from other classes (e.g. $d\tau$ vs. dV)

E&M I Feedback (11/23 students)

- Students would like more:
  - Problem solving sessions (x5), worked examples (x2), demos (x2), practice exams, big conceptual questions, labeling of online notes, test questions on derivations, derivations from basic mathematical principles, covariant formulation and connection to special relativity, E&M in curved space time, big picture relationship to other physics and math
- Students would like less:
  - Statics (as opposed to dynamics), drawing problems, exams, homework, rigorous derivations, "assert but not prove", "in the weeds" discussions

Ask Questions!

- If you have a question, others likely have the same question
  - There are no "dumb questions"!
- Don't be afraid to speak up!
- And, please let me know if I did or did not fully answer your question…

What I Care About (And Don't Care About) as an Instructor

- I care about:
  - Developing a strong conceptual understanding
  - Learning how to approach problems of different types and apply appropriate problem-solving techniques
- I don't care about:
  - Rote memorization of facts or equations
- As you progress in physics, you will never be able to remember every equation
  - You don't need to – that's what reference material is for!
  - If you remember concepts and remember how to approach problems of different types, you can be a good physicist
  - Caveat: To do well on the GRE, you may need to memorize some equations

Schedule

Physics 3812 Electricity and Magnetism II 2020 Schedule

Dates	Week	Reading (Due Monday unless noted)	HW Due Friday	Notes
Jan. 20-24	Week 1	Ch. 7.1	No HW	*Holiday Monday 1/20*
Jan. 27-31	Week 2	Ch. 7.2	HW 1	
Feb. 3-7	Week 3	Ch. 7.3	HW 2	
Feb. 10-14	Week 4	Ch. 8	HW 3	
Feb. 17-21	Week 5	Ch. 9.1-9.2	HW 4	
Feb. 24-28	Week 6	No Reading	No HW	Midterm 1 Ch. 7-9.2 Wednesday Feb. 26
Mar. 2-6	Week 7	Ch. 9.3-9.4	HW 5	
Mar. 9-13	Week 8	Ch. 9.5-10.1	HW 6	
Mar. 16-20	Spring Break	No Reading	No HW	Spring Break, Woohoo!
Mar. 23-27	Week 9	Ch. 10.2-10.3	HW 7	
Mar. 30-Apr. 3	Week 10	Ch. 11.1	HW 8	
Apr. 6-10	Week 11	Ch. 11.2	HW 9	
Apr. 13-17	Week 12	No Reading	No HW	Midterm 2 Ch. 9.3-11 Wednesday Apr 15
Apr. 20-24	Week 13	Ch. 12.1-12.2	HW 10	
Apr. 27-May 1	Week 14	Ch. 12.3	HW 11	
May 4-8	Week 15	No Reading	No HW	
May 11-15	Finals Week	No Reading	No HW	Final Exam TBA on Ch. 7-12

Ch. 7.1 | Electromotive Force

- Maxwell's Equations for static cases

$$\nabla \cdot \vec{E} = \rho/\varepsilon_0$$
$$\nabla \times \vec{E} = 0$$
$$\nabla \cdot \vec{B} = 0$$
$$\nabla \times \vec{B} = \mu_0 \vec{J}$$

- Where do ρ, $\vec{J}$ come from?

ρ = imbalance of +/- particles

- What about $\vec{J}$?

$\vec{J}$ is $\dfrac{[\text{charge}]}{[\text{time}][\text{cross-sectional area}]}$

- Requires motion of charge

- Need a force to set charges in motion

Ohm's Law

$$\vec{J} = \sigma \vec{f}$$

σ = conductivity (not surface charge)

$\vec{f}$ = force per unit charge

If $\vec{f} = (q\vec{E})/q = \vec{E}$

$$\Rightarrow \boxed{\vec{J} = \sigma \vec{E}}$$

- Ohm's law is an empirical relation, not a law

- If all charges move together w/ same $\vec{v}$

$$\vec{J} = \rho \vec{v} \Rightarrow \rho \vec{v} = \sigma \vec{f}$$

$$\text{or } \vec{v} = \frac{\sigma}{\rho} \vec{f}$$

- Not consistent w/ Newton's laws.??
- This is because of collisions

- A similar relation is found for terminal velocity in a viscous medium