[30231053-0](https://webvpn.tsinghua.edu.cn/http/77726476706e69737468656265737421fcf2408e297e7c4377068ea48d546d30ca8cc97bcc/f/wlxt/index/course/teacher/course?wlkcid=2019-2020-2140259618" \o "电磁场与波（英）" \t "_blank): Electromagnetic Fields and Waves

**Instructor**

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**Office Hours**

Thursday afternoon, 2:00 – 5:00 pm.

**Course Description**

Electromagnetic field and wave is the theoretical foundation for the studies of electrical circuits, optics, photonics, microwave systems, etc. It provides the basic method and tool for understanding, analyzing, and solving problems involving electromagnetism. The course will introduce vector analysis, Maxwell's equations, Lorentz force, electrostatics and magnetostatics, electrodynamics, propagation of EM waves, and radiation. Beside basic principles, the course will introduce a number of examples including electrical circuits, optical and RF waveguides, antenna, and electrical measurement in biomedical applications, such that the students can implement the theory to solve real-world problems.

**Prerequisites/Recommendations**

College-level math and physics are required.

**Goals**

Students will be guided through the exciting journey of electromagnetic theory. We emphasize a rigorous logic flow, with clear physical concepts, throughout the study of this course. I hope the students can appreciate the beauty of the associated mathematical framework, and have certain in-depth understanding of the complex world of electromagnetism. The students’ analytical skills are expected to grow by the end of the course. Most importantly, I hope by learning this course, you’ll develop a capacity for independent and thoughtful judgement.

**Textbooks**

The following textbooks are recommended:

1. Main textbook: “Introduction to Electrodynamics”, David J. Griffiths, Cambridge University Press, Fourth edition (ISBN: 978-1108420419)
2. Reference textbook (in Chinese): “电动力学” 郭硕鸿 著，高等教育出版社，第三版（ISBN:978-7040239249）

**Web Resources**

1. A great online book: The Feynman Lectures on Physics, Volume II

<https://www.feynmanlectures.caltech.edu/II_toc.html>

1. The following link provides an online tutorial with many cool figures/videos, those will help you better visualize the EM fields:

<http://web.mit.edu/8.02t/www/802TEAL3D/visualizations/guidedtour/Tour.htm>

1. Prof. Walter Lewin’s lecture series at MIT (8.02), the lectures provide a number of interesting lab demos

<https://www.youtube.com/watch?v=rtlJoXxlSFE&list=PLyQSN7X0ro2314mKyUiOILaOC2hk6Pc3j>

1. There are many interactive tutorials online, see the following for example:

<https://nationalmaglab.org/education/magnet-academy/watch-play/>

<https://www.edumedia-sciences.com/en/node/82-electromagnetism>

**Grading**

Homework 30%; Midterm exam 30%; Final exam 40%.

**Academic Ethics**

Plagiarism is strictly prohibited, all academic work and exam must be finished independently. Any caught misconduct will result in course failure.

**Feedback**

Feedbacks are encouraged at all times.

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| 3 | Electrostatic field and its properties, electric potential |
| 4 | Conductor, dielectrics, boundary conditions, capacitors |
| 5 | Uniqueness theorem, method of images, separation of variables (part 1) |
| 6 | Separation of variables (part 2), Green’s function, electrostatic energy |
| 7 | Magnetostatic field, steady currents, B-S law, Ampere’s law |
| 8 | Vector potential, magnetic dipole, magnetization, boundary conditions |
| 9 | Nonlinear magnetic material and further discussions |
| 10 | EM induction, Faraday’s law, inductor, displacement current |
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| 13 | Retarded potentials, dipole radiation, Rayleign scattering, antenna |
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