PHYS3053 (L1) - Honors Electricity and Magnetism I

Course Description

PHYS-3053 Honors Electricity and Magnetism I is a more in-depth version of PHYS3033 Electricity and Magnetism I and designed for more enthusiastic students who wish to acquire a deeper understanding of the subject. Students taking this course instead of PHYS3033 will benefit from the more vigorous approach and can build a solid foundation for possible graduate studies and research in future.

The course requires the following prerequisites: Students must have passed PHYS1114 or General Physics II with a grade of B- or above and they must have taken PHYS1314 Honors General Physics II. Students will follow the same lecture as the PHYS-3033 students but with an additional 50 minutes lecture, during which additional topics will be introduced. The assignments and examination problems will be more challenging than in PHYS-3033.

Intermediate Electricity and Magnetism I, provides a more mathematical approach than the first year courses on the same topic. It is a required core course in the undergraduate education and followed by an elective course: PHYS-3034, Intermediate Electricity and Magnetism II. The electromagnetic phenomena covered and the mathematical tools introduced are important in a wide range of technological areas. The course starts with a review on the important mathematical concepts such as vector calculus. In the following, these concepts are applied to electrostatics in vacuum and in matter. In the third chapter, special techniques for solving electrostatic problems such as the Laplace's equation are discussed. In the second half of the course, we are having a close look on the relation between currents and magnetic fields and the effect of magnetic fields in matter. We discuss the phenomena of magnetism in the framework of the concepts of bound currents and finally introduce in detail the Maxwell Equations in vacuum and in matter. In the end, we have a brief look on electromagnetic waves.

Textbook:

Introduction to Electrodynamics (3rd or 4th Ed.) by David J. Griffiths

Instructors

Dr. LORTZ, Rolf Walter (coordinator and responsible for main lectures)

Office:	Rm 4478
Office Hours:	Appointment by email
Telephone:	2358 7491
E-mail:	lortz@ust.hk

Dr. LI, Chu (honors lectures)

Office Hours:	Appointment by email
E-mail:	ccli@ust.hk

TAs / IAs

Name	Tutorial	Phone	Office	E-mail	Office Hours
CHU, Shek Kit	IA	23587528	4469	phskchu@ust.hk	Appointment per email
LI, Zhongchangfei	T1		4485	zlihc@connect.ust.hk	Appointment per email
YANG Zixian	T2		1526	zyangdi@connect.ust.hk	Appointment per email

Schedule

Main Lectures (3 credits, provide the fundamental knowledge about Electromagnetism	Wednesday 15:00 - 16:20 Friday 15:00 - 16:20	LORTZ, Rolf Walter Rm 2464, Lift 25-26
Additional Honors Lecture (1 credit, provide additional more advanced	Wednesday 12:00 - 12:50	Dr. LI, Chu Rm 1032, LSK Bldg

topics and some training in problem
solving skills)

Grading Scheme:

This course will be assessed using criterion-referencing and grades will not be assigned using a curve.

Assignments 15%

Honors lecture attendance 5%

Midterm Assessment 35%, Final Examination 45% or: Midterm Assessment 45%, Final Examination 35%

(the higher score will be used to calculate the total score).

All tasks assess students' ability to explain and apply electromagnetic concepts to enhance their problem-solving skills.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include [specific details, e.g., strengths, areas for improvement]. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Schedule of the main lecture

Week	Date	Lecture Topics
1	4. Sept.	Vector Analysis / Vector Calculus
	6. Sept.	Curvilinear Coordinates
2	11. Sept.	The Dirac Delta Function
	13. Sept.	**Electrostatics:** Coulomb's Law, Gauss Law

3	20. Sept.	Applications of Gauss's Law / Electric Potential
4	25. Sept.	Work and Energy, Conductors
	27. Sept	**Special Techniques for Calculating Potentials:** Laplace's Equation, The method of Image Charges
5	2. Oct.	Separation of Variables I
	4. Oct.	Separation of Variables II, Multipole Expansion
6	9. Oct.	**Electric Fields in Matter:** Effect of External Field on Matter, The Field of a Polarized Object
7	16. Oct.	**Electric Fields in Matter:** the Dielectric Displacement, Energy in dielectric systems
	18. Oct.	Magnetic Fields, Currents, Continuity Equation, Magnetic Force on Currents, Biot-Savart Law
8	23. Oct.	Biot-Savart Law, Magnetostatic Boundary Conditions
	25. Oct.	Multipole Expansion of the Vector Potential
9	30. Oct.	Long tutorial
	1. Nov.	mock examination
10	6. Nov.	**Midterm during the regular lecture time**

	8. Nov.	**No Lecture!**
11	13. Nov.	Magnetic Field in Matter: Diamagnetism, Paramagnetism, Ferromagnetism, Magnetization.
	15. Nov.	The Field of a Magnetized Object, Physical Interpretation of Bound Currents, The Auxiliary Field H, Linear Media, Boundary Conditions
12	20. Nov.	Electrodynamics and Maxwell's Equations I
	22. Nov.	Electrodynamics and Maxwell's Equations II
13	27. Nov	Long Tutorial
	29. Nov.	Mock Examination

Honors Lecture Schedule (tentative)

Week	Date	**Topics**
2	11. Sept.	Maxwell's Equations
3	25. Sept.	Conservation of Energy: Poynting's theorem
4	2. Oct.	Exercises
5	9 Oct.	Electromagnetic waves
6	16. Oct.	Conservation of Momentum and Angular Momentum
7	23. Oct.	Exercises
8	30. Oct.	Solving the Laplace's Equation inside Dielectric Matter
9	6. Nov.	Potentials and fields
10	13. Nov.	Exercises
11	20. Nov.	Solving the Laplace Equation inside Magnetic Matter
12	27. Nov.	Course Review and Exercises

Intended Learning Outcomes

On successful completion of this course, students are expected to be able to:

1. Define electric and magnetic fields and apply the Coulomb’s law, Gauss’ law, Biot-Savart law and Faraday’s law to calculate the electric fields of static charge distributions and the magnetic fields originating from flowing currents.
2. Describe the vector nature of electric and magnetic fields and their relation to a scalar and a vector potential, respectively, solve the Laplace’s equation for different boundary conditions and perform multipole expansion of the electromagnetic potentials.
3. Explain the interaction of electromagnetic fields with matter using the concepts of relative permittivity and permeability, polarization and magnetization, the fields ***D***, ***H***, ***E*** and ***B***, bound charges and bound currents define the boundary conditions on fields at interfaces between media.
4. Apply the Maxwell’s equations to formulate the relation between time-varying electric and magnetic fields based on Faraday’s law and the Ampere-Maxwell Law and apply the concepts of Maxwell's displacement current, the continuity equation, inductance and electromagnetic waves.

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of subject matter, expertise in problem-solving, and significant creativity in thinking. Exhibits a high capacity for scholarship, going beyond core requirements to achieve learning goals.
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues. Displays high motivation to learn.
C	Satisfactory Performance	Possesses adequate knowledge of core subject matter, competence in dealing with familiar problems, and some capacity for analysis and critical thinking. Shows

		persistence and effort to achieve broadly defined learning goals.
D	Marginal Pass	Has threshold knowledge of core subject matter, potential to achieve key professional skills, and the ability to make basic judgments. Benefits from the course and has the potential to develop in the discipline.
F	Fail	Demonstrates insufficient understanding of the subject matter and lacks the necessary problem-solving skills. Shows limited ability to think critically or analytically and exhibits minimal effort towards achieving learning goals. Does not meet the threshold requirements for professional practice or development in the discipline.

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to Academic Integrity | HKUST – Academic Registry

Links to an external site. for the University's definition of plagiarism and ways to avoid cheating and plagiarism.